

CURTIN UNIVERSITY OF TECHNOLOGY

SCHOOL OF DESIGN AND THE BUILT ENVIRONMENT

**EXPERIENCE DESIGN MODELLING OF THE
RELATIONSHIP BETWEEN PATIENT RECOVERY
AND HOSPITAL DESIGN IN THE KINGDOM OF
SAUDI ARABIA**

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AUTHORSHIP STATEMENT

I hereby declare that I am the sole author of this thesis and I have not used any sources other than those listed in the bibliography and references. I further declare that I have not submitted this thesis to any other institution in order to obtain a degree, this is the best to my knowledge and belief, and it does not contain any material previously published or written by another person.

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ABSTRACT

Hospitals are designed to facilitate patients' timely recovery. Thus, patients' connection to the built space plays an important function in their recovery. However, evidence suggests there are issues with the spaces designed for care services as they may induce physical and psychological disruptions to patients' healing and detract from hospital's service quality. They may also lead to adverse incidents (AIs), including the spread of infectious diseases, they cause errors in dispensing medication and problems caused to the patient by the medication. Design faults in care facilities can also cause injuries that could lead to impairments and psychological stress resulting from fatigue, emotional issues and isolation.

Whilst several studies have found evidence that the design of a health facility can impact patient's wellbeing and recovery, there is a limited literature regarding the hospital design process in the Kingdom of Saudi Arabia, particularly how to design, develop and operate hospital buildings in ways that optimise the desired outcome in the patient's recovery process.

This study investigates the relationship between hospital design, development and operational stages and patient recovery in public hospitals in the Kingdom of Saudi Arabia. It examines environmental design issues in relation to stakeholders' satisfaction by analysing events that support patient's healing and recovery as well as the effectiveness of care services. To achieve these, the study focuses on patient health recovery causations [that is, factors, requirements, needs and causes that influence patients' health] and the role played by the current design process in Saudi's public hospitals.

Inductive and deductive approaches were used within the context of mixed method research. Case studies were drawn from three Saudi cities to examine patient treatment and diagnosis plans in extant hospital design models. Analysis also covered how their designed spaces facilitate medical intervention. In addition, data were collected through three stages using seven tools. Stage 1 involved a literature review and archival study. Stage 2 involved the analyses of nine incidents reports and 80 architectural designs. In addition, qualitative data was collected via interviews with 39 medical managers and technicians on 24 re-design projects. A total of 14 patients, 41 healthcare providers, 23 members of design teams and 18 members of maintenance teams were also interviewed. In Stage 3, 76 responses to a questionnaire survey, obtained from maintenance and design teams, were analysed.

Qualitative and quantitative data were collected and analysed in the study. The qualitative analysed by raw data model for the categorisation system to analysis raw data in five steps: main topics, sub-headings, main categories, main concepts and final key findings within research areas. The quantitative dated were analysed using nominal and ordinal scales, illustrated with graphs and charts, and were presented in descriptive and inferential statistical analysis.

The study found AIs originated from 13 elements of design defects and faults and had impacted patient health and the care services provided. Findings also suggest AIs were evident in 12 aspects of atmospheric design that support patient recovery. By tracking these design issues from the occupancy stage back to the design stage, the study found 71 process flaws in seven development phases spanning the planning and design stages. The flaws were related to issues in the shortcomings of design teams' abilities and administrative management procedures, and the lack of required data and information before or during the design phase. Areas impacted by this research findings include academic, policy, economic, social, technological, environmental and legal practice. Contributions of knowledge of this study covered six major areas: built environment and healthcare domains. research gap, problem, methodology, framework and variables of design issues in the design and occupancy stages.

Implementation of the findings can have a significant impact on Saudi hospital designs. They can be used as a standard checklist for defining design issues relating to defects and faults, and how design can facilitate healing right from the early stages of the design process. In addition, the findings on design flaws can be used to evaluate and measure the current design process in order to protect and simultaneously facilitate patient recovery by minimising the occurrence of design issues and AIs. The outcomes of this investigation can lead to improvements in the design of future public hospitals in Kingdom of Saudi Arabia (KSA) by putting patient recovery and complete healthcare services provision back at the heart of the hospital design process.

Keywords: adverse incidents, design issues, design process flaws, patient recovery, physical and psychological impacts

1.0 GENERAL INTRODUCTION

1.1 INTRODUCTION TO STUDY

Mosby's Medical Dictionary (2009) defines healthcare systems as a network of organisations, resources, techniques and facilities that provide healthcare in a specific geographic space. Examples of healthcare facilities include ambulatory care centres, diagnostic clinics, nursing homes, maternity homes, general and specialist hospitals. In general, healthcare services offered at various healthcare facilities differ from country to country. As Nah and Osifo-Dawodu (2007) suggest, a way to classify healthcare facilities is to group them into three categories: in-patient facilities, out-patient facilities and diagnostic facilities.

In-patient facilities can be divided into acute care facilities such as hospitals, and long-term care such as rehabilitation centres and nursing homes (Farr 2009). Acute care facilities can be subdivided into secondary and tertiary healthcare facilities. Tertiary care facilities are usually located in major cities and regional centres (Nah and Osifo-Dawodu 2007). A tertiary healthcare facility could have between 150 and 500 beds. Their construction and operation are more complex and costlier than secondary healthcare, which usually have between 50 and 150 beds. Outpatient healthcare facilities can be subdivided into primary or general healthcare facilities and specialized healthcare facilities. Diagnostic centres are the facilities offering medical services for diagnosis, such as specialized imaging or laboratories.

A report by World Health Organization (2002) shows patients at a healthcare facility may be more exposed to adverse incidents than persons in a nuclear energy facility or in an aircraft. For example, the report identifies the probability of an adverse incident occurring during air travel is one in a group of a million users. However, they found one out of every three hundred users of a healthcare facility is likely to be harmed due to issues in their built environment. West (2006) found most adverse incidents (AIs) occur at tertiary care facilities, especially large hospitals offering several services in different spaces. The Australian Institute of Health and Welfare (2019) defines AIs as incidents in which harm results to a patient during healthcare provision. AIs may involve infection, falls resulting in injuries, or problems with effectiveness of medications and medical devices. In general, AIs impact patients physically, psychologically and financially (Adams et al. 2009).

The focus of the present research is tertiary care hospitals in the Kingdom of Saudi Arabia (KSA). According to a report by KSA's Ministry of Health, published by the General Directorate of Statistics & Information (2013), tertiary care facilities represent the majority of KSA's public healthcare infrastructure; in broad terms, they shape the physical and psychological health of patients within the Kingdom.

Hospitals are spaces designed for providing healthcare for patients. The importance of the relationship between patient health and designed spaces has been widely acknowledged (Reiling et al. 2008). Designing an environment that supports the recovery processes of patients and an effective delivery of medical services is essential to patient safety and protection and will accelerate the healing process (Schweitzer et al. 2004). Creating a safe and healthy environment includes the prevention of AIs that may affect the psychological and physical health of patients (Joseph and Rashid 2007). When a healthcare service environment lacks adequate design considerations, they can lead to AIs such as infections and medical situations that critically affect patient health (Zimring et al. 2004). Despite continuous improvement in the management of hospital operations, AIs have not decreased in frequency and severity since 1999 (Kohn et al. 2000).

The theoretical premise of this study is that many AIs can be prevented by devoting greater attention to the early stages of the hospital design process. According to RIBA (2013), most buildings involve 11 lifecycle phases, which can be grouped into four stages: pre-design, design, construction, and operation and maintenance (O&M) stages. These phases apply to hospital designs in the KSA (see Section 1.3).

Almalki et al. (2011) reported that KSA's health sector is the responsibility of the Ministry of Health (MOH), the primary government agency committed to the provision of preventive, curative and rehabilitative healthcare for the KSA population. They are also responsible for the management, planning, financing and regulation of the healthcare sector. The government of KSA has made a concerted effort to deliver planned healthcare facilities. In 2014, according to the Central Department of Statistics and information (CDSI), KSA's Gross Domestic Product (GDP) was USD \$746.25 billion, of which the health sector accounted for nearly six percent (Ministry of Finance 2015). Evidence in the work of Damrah (2013) suggests KSA has one of the largest health sector budgets in the Gulf region.

In hospital buildings, AIs arise from two main sources: (1) direct interventions relating to caregivers and (2) indirect interventions that expose the patient to unnecessary and potentially harmful risks from the care facility environment (Brady et al. 2009). Recently, KSA has focused on patient safety through the reduction of adverse incidents or medical errors during indirect interventions (Almasabi 2013). They achieve this by applying healthcare accreditations standards (Al Awa et al. 2010). Healthcare accreditation standards cover patient safety practices related to some patient outcomes but not building design issues (Thornlow and Merwin 2009). In addition, healthcare facilities in KSA still suffer from increasing AIs, as it is a developing country where the risk of patient harm is up to 20 times higher than in developed countries. In other words, one out of every ten patients receiving care at a hospital is likely to be harmed (World Health Organization 2002).

1.2 THE RESEARCH PROBLEM CYCLE

This study focuses on how thinking that supports care efficiency and the recovery process can be embedded in the early stages of the hospital design processes, to provide an environment that promotes patients' psychological and physical health by avoiding design issues and AIs. In addition, the study focuses on fostering supportive events within patient's environment and how this facilitates recovery.

To provide a greater understanding of the research investigation areas, two target domains have been identified. They are:

- A. The Built environment domain [A], which includes:
 - a. the construction stage [A1],
 - b. the design stage that involves flaws arising from the design process and design defects [A2]
 - c. the operation stage, where AIs and design defects have the greatest effect on the end-users of care facilities [A3]

- B. Healthcare domain [B], which includes:
 - a. adverse incidents [BI] and the care recovery process [B2].

A concept map shown in Figure 1.1 illustrates the research investigation areas in relation to the research gap and problem. In addition, Figure 1.2 has been created to show the indirect link between design processes and the healing process and research interventions to improve design and support the healing and recovery process.

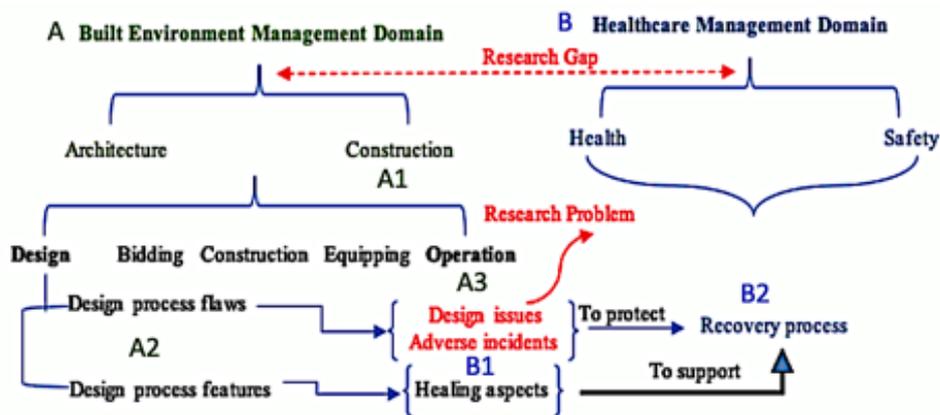


Figure 1.1: Research Concept Map

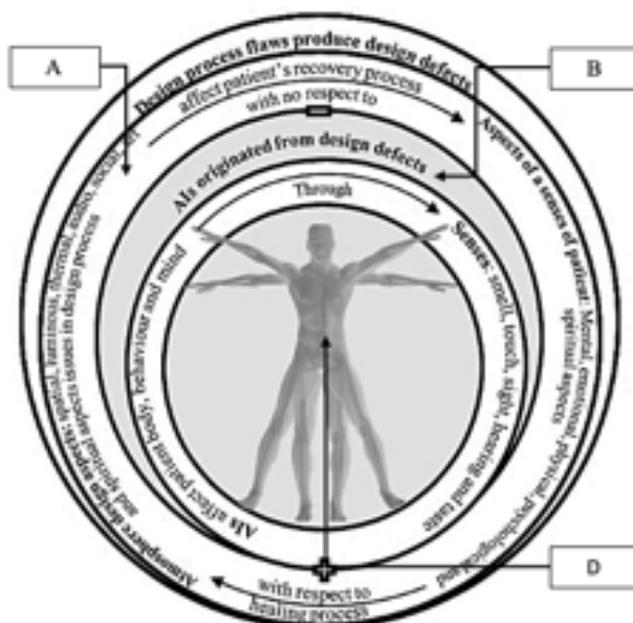


Figure 1.2: Typology of Research Concept – the linkage between design and healing process

In addition, Figure 1.2 shows the indirect link between the design process and the healing process and research interventions to improve the design, support healing and recovery – this is the central claim of the research. This claim involves three perspectives:

Design process flaws producing the design issues in the aspects of environmental design: spatial, luminous, thermal, audio, social, art and spiritual aspects [A].

The design issues leading to the AIs that affect aspects of the patients' physical, and psychological health [B].

The AIs impacting the patient's healing process within their body, mind and behaviour through the five senses [D].

Studies have demonstrated process improvement during design involves four sub-study areas:

- a) design stages in hospital refurbishment and new developments, involving pre-construction outline definition, development planning design and, operation and maintenance (RIBA 2013);
- b) factors affecting the design process, including during concept design, design development and technical design, which encompasses function, aesthetics, user-needs, environmental sustainability, social sustainability, workplace laws, ergonomics, safety and culture (Demkin 2001);
- c) personnel responsible for design processes: the design teams, including architectural and multidisciplinary engineering teams, interior designers, landscape architects and specification writers (Carpenter and Ollmann 2008);
- d) design issues, including architectural and engineering issues, defined by Al-Hammad et al. (1997).

The experience of patients and care-givers will improve if the issues that may arise during the operation phase of a hospital can be fixed during the design phase. In this research, the focus is on the occurrence of AIs caused by design issues. This purpose of this is to facilitate in-depth understanding of the background factors and relationships which link the effects of the design process, including environmental psychology and physiology aspects, to patients' in-hospital recovery. With this view, supporting patient recovery basically involves four sub-study areas:

- i. AIs arising from design issues;
- ii. the causes of AIs – for example, physical impact from falls; care error such as medication errors; and psychological impact such as stress
- iii. the results of AIs – for example injuries, infections and disability or death; and

- iv. the impact of AIs on the healing process, including prolonged stays resulting from delayed recovery process (Baker et al. 2004).

This study seeks evidence to identify the relationship between design flaws and healing process issues, flaws in design processes, designed environment issues as well as issues in design thinking strategies, hospital design principles, the senses of the patient, healing space design, and AIs that impact the healing and care service in the context of the Saudi hospital design stage. This study presents the research problem and gap through two domains in the built environment and healthcare sector management (illustrated in Figure 1.1 and amplified in Figure 1.2):

1. the impact of improvements on the built environment design, through **construction processes**, involves the stage of designing, constructing and operating a new hospital environment and project management processes related to identifying the design issues;
2. **architecture management**, which involves design process flaws, sources of these flaws, design issues, features, impacts and therapeutic aspects of design;
3. **healthcare domain**: identifying the impacts of AIs that originate from hospital design issues, how the patients' senses react to design issues to improve patient safety and support healing process right from early design stages.

In the current study, the research commenced by examining three public tertiary hospitals in KSA (see Table 1.1) located in different local climates, municipal populations, topographies and emergency departments (ED). It is assumed these differences will affect design considerations and processes. Data were collected using deductive and inductive approaches. The combined approach seeks to investigate the sources and the effects of design on the psychological and physical health of patients, whilst the deductive approach tests the research hypotheses.

Table 1.1: Summary of case studies

Case Study	Location	Topography	Weather conditions	Population served	No. of disease and injury cases at ED
1	Al Baha	Mountainous area	Cold	450,733	686,435
2	Al Riyadh	Desert area	Hot and dusty	7,516,959	276,5691
3	Jeddah	Coastal area	Hot and humid	4,108,156	1,102,410

Source: KSA's General Directorate of Statistics and Information (2013)

1.3 DESIGN PROCESSES

Figure 1.3 shows the stages in design processes, the teams involved and their responsibilities. Outcomes at the occupancy stage is shaped by circumstances in the design stage. According to Millsap (2007), the planning and designing stage involves four phases:

- *Project request*: justification for building a new hospital, determination of hospital size and needs, identification of the scope of services and preliminary estimation of the budget;
- *Strategic planning*: identification of the number of forms of patient treatment, technology, equipment and services in each department and location;
- *Needs assessment*: determination of space requirements for each department through evaluation of current and future workloads and service lines; and
- *Assignment of space* for specific programs, with staff, patient and visitor flow diagrams.

The participants in this stage are the clients, professional staff, hospital management and patients.

According to (RIBA 2013), the traditional design stage involves three phases:

- *Schematic design*: development of specific program into floor plans, interior elevations, stoking and blocking diagrams, building sections, exterior elevations and a site plan;
- *Design improvement*: updating proposals for structural design, building systems (heating, plumbing, ventilation, elevators and outline specifications); and
- *Technical design*: presenting all architectural, structural and building services information, specialist subcontractor designs and specifications.

In this stage, the design team is responsible for applying input from the planning phase in the design stage to produce the outcomes of the occupancy stage. Therefore, flaws in the inputs of design stage lead to design issues that originate AIs consider as the research problem. Data flow relating to this is illustrated in Figure 1.3. According to Carpenter and Ollmann (2008), the design team may include architects, commissioning agents, engineers (mechanical, energy consultants, electrical, lighting designers, plumbing, structural and civil), landscape architects, interior designers, specification writers, cost consultants, environmental consultants and sustainable design consultants.

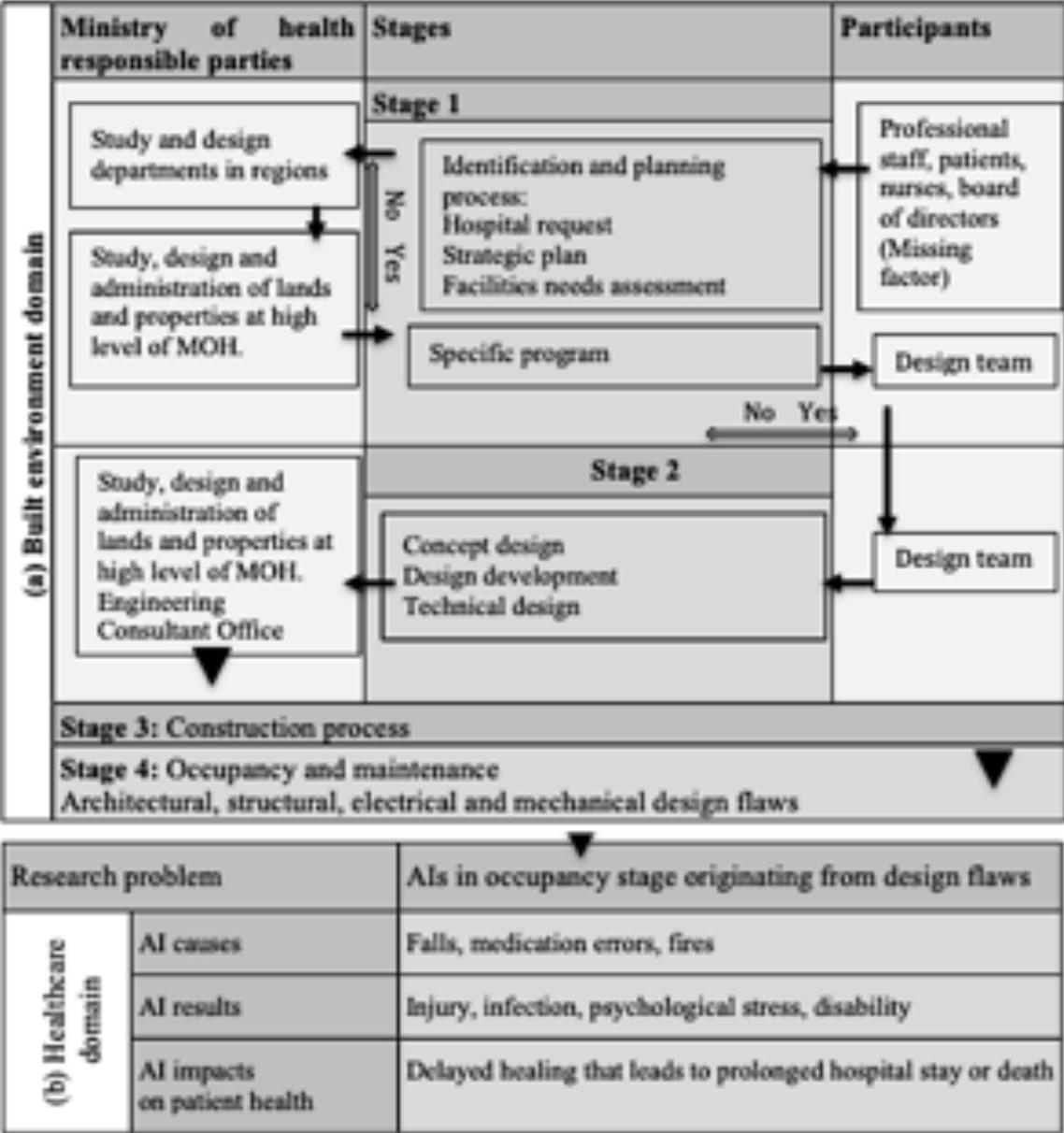


Figure 1.3: Design flow chart and mapping of the research problem

1.4 SIGNIFICANCE OF STUDY

In a report by Jazan Press (2016), Saudi Arabia's Health Minister announced the results of an investigation into a fire incident in Jazan General Hospital. The incident killed 25 and injured 107 people. The minister stated that the fire arose from defects in the design and implementation of the building plan, which led to the rapid spread of smoke and difficulty in the evacuation. In 2018, 11 types of AI were confirmed through occurrence variance reports (OVRs) received from 16 hospitals: Taif, Najran, Al-jouf, Hfr AL-Baten, Aseer, Jeddah, Qunfudah, Al-Ahssa, Northern, Qurayat, Al-qassim, Eastern Region, Madinah, Hail, King Fahad Specialist Hospital (KFSH) and Riyadh (Saudi Central Board for Accreditation of Healthcare Institutions, 2017).

A total of 27,533 AIs occurred in these 16 hospitals in 2018, about four-fifths of which were of low risk. However, 7,761 had moderate risk level whilst 154 cases of the AIs were of a high level of risk that exposed patients to danger or harm. The Saudi Central Board for Accreditation of Healthcare Institutions (CIBAHI) also evaluated the risk levels of AIs that occurred in 274 Saudi hospitals in 2017. They found 4.1% of AI cases involved environmental design issues (see Chapter 5 for more details). Such AIs could have been prevented at an early stage of the design process.

Nonetheless, evidence from this study shows there was a significant lack of consideration regarding the patient recovery process in the KSA among the design teams. Whilst a great deal of research has been conducted worldwide with regard to patients' health and hospital design, such research is rare in the KSA, where most studies have been written from maintenance and construction perspectives, all concentrating on minimizing costs – for instance, the works of Al-Hammad et al. (1997), Ikhwan and Burney (1999), Al-Ghamdi, Andrew and Joyce (2011). Limited research has been conducted in the KSA regarding the impact of healthcare facility design on the psychological and physical health of patients and it is expected that this study will help to bridge knowledge gaps in this important area. The purpose of this research is to contribute knowledge to improvise the design process that can lead to the creation of project environments that reduce design flaws and create positive events aiding in patients' recovery. The outcome this study is expected to deliver and its significance is detailed in Table 1.2.

Table 1.2: Expected outcomes of the research

Aim: To develop a framework for hospital design that can protect and simultaneously facilitate the recovery of patients in public hospitals in the KSA	
What the study is expected to deliver (outputs)?	Significance of the study (outcomes)
Identification of factors of patient health and safety in the occupancy stage within the design process, to better understand how these affect healing and improve design.	Encouragement of responsible decision-making among participants in every stage of designing a new hospital, by addressing the ways that design can support patient health.
Identification of the roles of responsible parties during the design process in preventing AIs and creating positive events.	Increased knowledge amongst design professionals about the relationship between design and patient health, with a view to improving design.
Identification of design flaws that are sources of AIs and affect patient health.	Creating future hospitals that are free from design flaws.
Identification of factors that influence decisions made by responsible design parties most significantly, in terms of supporting healing.	Improving hospitals by shifting their design towards patient health and safety, rather than just a location for medical services.

Primarily, this study expects to benefit:

- a) participants in the planning and design process,
- b) companies who provide critical systems, medical and non-medical furniture, equipment and materials for hospitals
- c) patient health and safety,
- d) investors in healthcare facilities sector.

This research set out to investigate the relationship between hospital design and patient health for specific public hospital design and occupancy perspectives. Further studies can be based on this work with a focus on other types of healthcare facilities, from different perspectives, so that a holistic framework to improve hospitals in KSA can be developed. The current research will provide a solid platform for the future development of such a holistic framework.

1.5 RESEARCH AIM AND OBJECTIVES

The aim of this study is to develop a framework for hospital design that can protect and simultaneously facilitate the recovery of patients in public hospitals in the KSA. To achieve this aim, the following objectives have been set:

1. to analyse the contemporary design processes of public hospitals in the KSA and identify design issues that manifest during the occupancy stage
2. to identify the effects of design issues on patient health and safety and identify the roles of the parties responsible for preventing design issues during the design process
3. to analyse the supportive features and stressful elements that impact patient recovery and identify their direct and indirect effects on patients' physical and psychological health
4. to develop a framework towards hospital design in public hospitals in the KSA so that patient recovery is fostered.

1.6 BRIEF INTRODUCTION OF THE RESEARCH METHODOLOGY

There are three main stages of data collection used in this study. First, an inductive approach was applied to identify the causes, impact and sources of design defects. This involved review of scholarly resources, technical reports and statistical records of adverse incidents (AIs), participant observations in a case study and archival resources.

Second, an inductive approach was applied to identify the causes, impact and sources of adverse incidents in order to define and address the identified design defects from the previous stage. This involved using qualitative methods such as analysis of interviews and case studies.

Third, a deductive approach using quantitative methods (questionnaire) was applied to measure the number and types of environmental issues, and the relationship between them and AIs and:

- 1) their impact on patient health;
- 2) design defects effects and AIs;
- 3) patient reactions and AIs;
- 4) design process flaws and design defects;
- 5) sources of flaws in design stage and;
- 6) healing design aspects that can be linked under the main Saudi hospital design processes issues.

To achieve the research objectives, data were collected and analysed through three stages, seven phases, eight methods, six sessions of participant observations held at five locations and four case studies, all of which were in the KSA. Figure 1.5 presents the data collection flow of the study. The middle area presents the research areas including the occupancy stage (design defects and faults), healing process stage (AIs that originated from design issues and their impact on patient health) and design stage (design process flows and its sources). To fill the research gap, solve the research problems, and to test the research hypotheses through achieving the research objectives, the following four links were investigated within data collection tools: (a) sources of flaws in the design stage and process, (b) design issues and design process flaws, (c) AIs and design issues, (d) the impact of AIs and the recovery process of patients. The coloured circles represent the research objectives within three stages of data collecting involving seven tools to collect data. Each stage was conducted for specific and common objectives as shown through coloured circles above each stage tools. The coloured dotted arrows point back from the research areas to the outcomes from seven instruments in each stage (see Section 3.10).

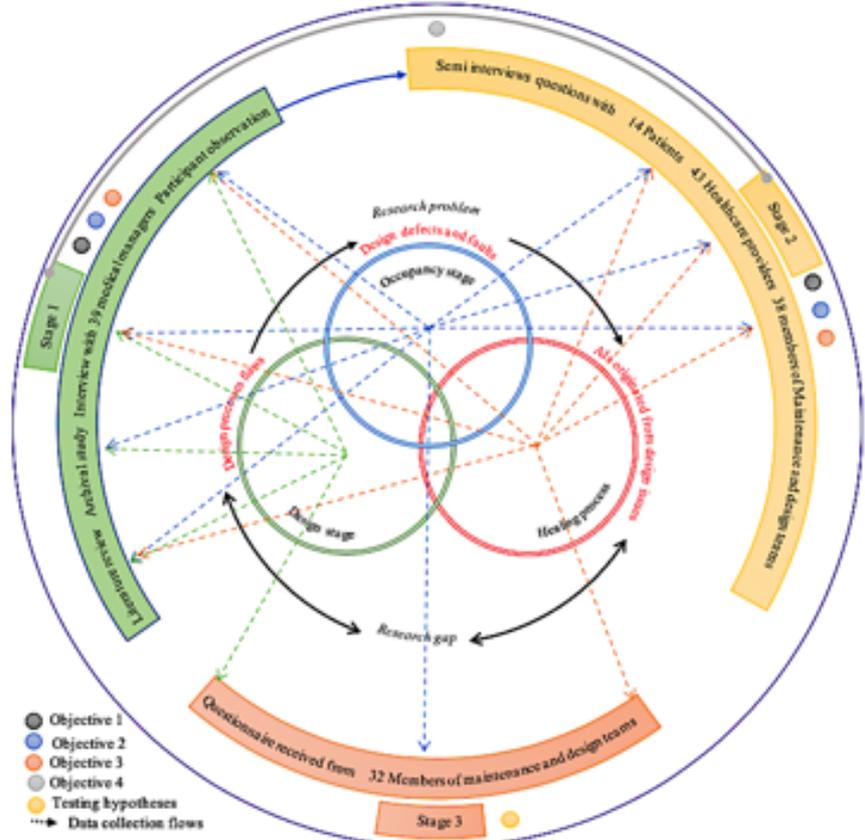


Figure 1.3: Concept Map 1- Data collection flows, tools, stages and participants

1.7 CONTRIBUTIONS TO KNOWLEDGE

This research project contributes to extant literature by promoting patient health and safety by urging complete care service to be at the heart of hospital design. It examines the establishment of an environment that can be embedded in the early stages of hospital design in order to provide a safe and protective environment that positively affects the psychological and physical health of patients. The research problem was identified from flaws in the current design process of hospitals, and the aim of the research is to present a bridge between the built environment and the healthcare domain, with a view to improving the design features of hospitals in KSA and to create better hospitals in future that are free of design defects and faults.

Most studies on design issues in the built environment have focused on a single field of study independent of others, and specific data has been collected from particular participants in order to solve a problem, achieve the research aims or to fill a knowledge gap between two areas within the same domain. In this study, the researcher tried to shift the focus of design issues to different study areas and to draw conclusions on perspectives relating to both the built environment and healthcare (Figure 1.1). This is done by adapting multiple methodologies and methods, involving different groups of participants including construction, architecture and health and safety management personnel (Figure 3.2). By means of this, the gap between design and patient recovery can be bridged, and a framework is proposed for uniting, protecting, and supporting patient recovery through the provision of a complete service. Figure 1.4 illustrates the contribution of knowledge to the six major areas covered in this study.

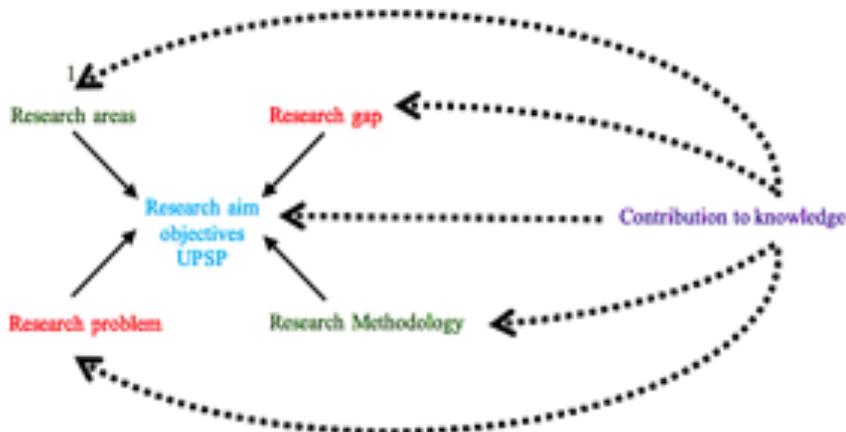


Figure 1.4: Knowledge contribution to six areas of research

The first area of contribution is *the research areas*. This study investigated two domains using three management tools: (a) the built environment domain, which includes construction and design: (a1) the construction management tool focuses on the stages of designing, equipping and operation and maintenance; (a2) the design stage is the first stage of the construction management tool and involves the predesign and design stages of each phase of the design process, including the parties responsible for those stages, design thinking, design issues and the healing aspects of the design. (b) The second domain is the healthcare domain, which includes safety and healthcare management, involving patient safety and including health management tools. This domain covers adverse incidents (AIs) originating from design issues (DIs). DIs impact on the patient healing process and on patients' senses in reacting to designed space issues and features. Through these two domains, this study discusses the potential links between concepts in the design and operation stages. In the operation stage, these include: (1) the patient healing process and AIs, (2) design issues and the occurrence of AIs, (3) aspects in design that support the recovery process and (4) design issues and care services. The concepts in the design stage include (4) design process flaws and design issues, (5) physical and psychological aspects of the design process and healing process, (6) design process flaws and their sources (Figure 2.1).

The second area of contribution relates to *the research gaps*. This study creates an indirect link between design processes in the built environment and the healing processes of the healthcare domain and uses research interventions to improve design, to support healing and to provide a complete examination, diagnostic and therapeutic plan.

In the third area of contribution, avoiding design issues is identified as a *research problem*. This study focuses on how the creation of an environment that is conducive to fewer AIs can be embedded in the early stages of the hospital design process in order to provide a safe and protective atmosphere that will positively affect the psychological and physical health of patients. In addition, the focus here is on fostering supportive events within the patient environment that will facilitate recovery.

The fourth area of contribution involves the *research methodology*. On the basis of the research areas, claims and hypotheses that direct the study, a pragmatic paradigm (see Chapter 3: Figure 3.1) and a mixed method approach, were applied to the data collection. This process involved

three stages, eight methods, six types of participants, five different locations and four case studies, all of which were in the KSA (Figure 3.2).

The fifth area of contribution relates to a framework for patient recovery. Based on the findings of the study, a list of recommendations is provided, research hypotheses have been created, and tested and a framework for *Uniting, Protecting, Supporting patient recovery and the Provision of complete services* was proposed. This framework can be measured and tested from two perspectives. Firstly, this can be done with healthcare service measurements; by the reduction in the number of design defects, the number and risk level of the AIs occurring, the length of patient stays, pain medication use, patient and healthcare satisfaction and the quality of the care services provided. Secondly, healing space measurements can be assessed according to the level of patient comfort, mental status, well-being, anxiety, depression, pain, stress, sleep, infection, stress behaviour, weight gain (patients in Neonatal Intensive Care Unit Paediatric (NICU) and Intensive Care Unit (PICU)), heart rate, respiration and blood pressure.

The sixth area of contribution stems from this study identifying the variables in design issues in the occupancy stage, types of design field issues in the occupancy stage, areas impacted by design issues, flaws in pre-design (inputs) and design (outputs) processes, sources of flaws in design processes and design element, patient sensory systems and healing aspects of design. Therefore, these findings can be implemented in teaching future architects and design teams, positively shaping future practitioners, influencing policy, design standards, practice and guidelines for healthcare facilities, positively impacting community confidence and future patient experience in local systems, and raising more questions in hospital design for further investigations.

1.8 THE RESEARCH HYPOTHESES

Null Hypothesis [Ho]: There is no a significant relationship between design and maintenance design and maintenance team's agreement in the research observation areas.

Hypothesis 1 [H1]: The mean of maintenance team's agreement is the same as mean of design team's agreement in the research observation areas.

1.9 SUMMARY OF INTRODUCTORY CHAPTER

This chapter defines the design, development and operation of the healthcare environment in relation to patient recovery. It explains elements of hospital buildings, adverse incidents and their relationship with patient's health and medical services, and the relationships between patient's health and medical services, and considerations during hospital design processes. The chapter also presents information on the concept of hospital design and how they influence the physical and psychological recovery of patients, in that, designers should consider these while designing hospitals. An important point put forward by this chapter is that poor design causes design issues, and design issues cause ais that impact recovery. This chapter introduces and emphasizes the fact that patient safety and protection will accelerate patient recovery and are clearly important elements in the hospital design process. The relationship between hospital design and how the stability of patient's recovery is affected can no longer be ignored in future built environment and medical research. By looking at this relationship, the importance of design process of the hospital in general can be understood. These findings also help in identifying the causes and sources of design issues and ais. These ais occur due to deficiencies in design processes and the lack of attention to the linkage between design processes and patient recovery. The emphasis of this chapter is that there is a need for future hospitals to be free from design issues and that design solutions must support healing. These were highlighted as an important common area between built environment and healthcare domains. Acknowledging design issues at early stage of the hospitals design is essential and is associated with improvements in design processes for future public hospitals in KSA by putting patient recovery and complete healthcare services provision as a priority.

2.0 LITERATURE REVIEW ON HOSPITAL DESIGN AND PATIENT RECOVERY

2.1 INTRODUCTION

This chapter presents the conceptual framework on the relationship between the built environment and healthcare. In particular, it discusses the link between five concepts across the two domains. The section on the built environment discusses construction management activities between the design and occupancy stages, whilst the discussion on the occupancy stage includes explanations on the types and causes of design defects and their effects on patient recovery, as well as the relationship between design defects and ais. Relating to the design stage, the review covers design defects and flaws in the design process, and the healing effect of design. The section regarding the healthcare domain discusses patient health and safety management, including the impact, types and sources of ais. Also included in this section is a review of the physical and psychological impact of ais on patients' recovery. The conclusion of the chapter is that previous studies show patient health is influenced by many events in the design and occupancy stages. The assumptions, hypotheses and observations of this study are based on these.

2.2 CONCEPTUAL FRAMEWORK OF DESIGN AND RECOVERY PROCESS PLANNING

Figure 2.1 presents a concept map drawing together the research problem, gaps and hypotheses in relation to the design process, the built environment within care facilities and patients' recovery. The built environment domain details the narrative on the construction and design management tools. The discussion regarding the construction management tool focuses on the phases of designing, equipping, and the operations and maintenance stage. The design stage involves pre-design activities and a detailed design process, which bring together parties that are responsible for design thinking, design defects and designing the healing aspects in design. Furthermore, the discussions relating to healthcare deal with safety and healthcare management involving patient safety and health management tools, as well as ais that originate from design defects. The discussion also includes the impact of ai on the patient healing process and how patients' senses react to designed space issues.



Figure 2.1: Research problem cycle – design development and facility operation for patient health and safety

By means of these domains, this chapter discusses the potential link between five concepts involving the design and operations stages. Those in the operations stage include patient recovery and ais, design defects and the documented ais and design processes which support recovery. Those in the design stage are sources and manifestations of flaws in the design process, and the relationship between flaws in the design process and their manifestations as design defects, and the physical and psychological aspects of design processes that influence patient recovery.

2.3 THE BUILT ENVIRONMENT AND HEALTH

Last (2001, p5) defines the environment from public health sector perspective as “[all] that which is external to individual human host. [it] can be divided into physical, biological, social cultural any or all of which can influence health status in populations”. Health, within an environment, is defined by world health organization (who) (1946) and Huisman et al. (2012) as a state of complete physical, mental and social wellbeing; not merely the absence of disease or infirmity. In other words, any change in a person’s state of health is measurable by a change in the functionality related to the design of the care environment. Therefore, it is possible to achieve a healthy state within the environment where its elements and components are available to meet people’s demands and needs to live and work in an environment that is protected from threats to life and health, including from diseases, illness, physical harm and incidents (who 1992).

The who (2019) describes issues related to the environment and health as environmental health. They define environmental health as a system that addresses all the chemical, physical and biological factors external to people and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing diseases and creating health-supportive environments. Although the built environment has beneficial effects impacting health conditions, according to Yassi et al. (2001), the built environment can also have adverse effects that may have a negative impact on health. The built environment can cause damage to health with a range of different risks from low to extremely severe.

The built environment includes all involved physical parts (Srinivasan et al. 2003). Health Canada (1997, p.141) defines the built environment as “part of the overall ecosystem of our earth. It encompasses all the buildings, spaces and products that are created, or at least significantly modified by people”. It has four elements: the external built environment such as roadways, trails, transit networks, parks and streets; open spaces; infrastructure; and indoor environments, described by Srinivasan et al. (2003) to include office buildings, schools, laboratories, government, military institutions and healthcare facilities (HCFs). All aspects of the built environment require thoughtful planning to accommodate human needs, especially spaces where people spend most of their time during healing in a care facility (Srinivasan et al. 2003). Hcfs include such elements as building materials, commodities, graphic symbols, tools,

machines and interior spaces involving products such as furniture, structure and landscapes (Glanz and Kegler 2009). Hospitals buildings are an important example of the internal physical environments of HCFs involved in this study as they are related to health concepts.

Hospitals are places where people with various health conditions go for diagnostic and treatment plans provided by specialised caregivers. The physical environment of a hospital is designed to facilitate the diagnosis and treatment of illnesses and diseases both in the short and long-term (Carmona et al. 2010). Pain and stress arising from illness and disease compel patients to visit hospitals. Physically, illness is an abnormal condition affecting an organism, such as injury or trauma, infection, exposure to toxic materials, development of cancer, diabetes, asthma and other factors causing pain. Psychologically, disease refers to feelings that might come with having a disease including fatigue, weakness, discomfort, distress, confusion, dysfunction, depression, violence, social inequities and other factors causing stress. Pain and stress, as adverse effects originating from health conditions and the physical environment and design issues, can have an impact on patient recovery processes.

A great deal of consideration had been given to the construction of hospitals. According to Huisman et al. (2012) however, less attention has been paid to control the impact of pain and stress on patient comfort, safety, security, privacy and family support levels with a view to improving of design processes of hospitals. This study investigates the design stage and the crucial roles it plays in supporting and protecting patient recovery. Significant emphasis should be paid to how physical environments and healthcare domains interact with design. The improvements in hospital design as a way of facilitating recovery are the focus in this study.

The main challenge for this research is the integration of healing demands (that is, healthcare domain) into hospital construction (that is, built environment domain) at an early stage of the design process. Most studies focus on the positive and negative elements and components of design without proposing the prevention of adverse effects and suggesting a way to apply the positive effects during the design process. Figure 2.2 presents the study area common to both domains. The built environment of HCFs and hospital buildings consists of external and internal elements. Design, planning and construction are tools used to establish these. In addition, the healthcare domain uses safety and health management tools to manage or reduce pain and stress in patients. Thus, the common area of both domains is improving the hospitals' design in ways

that integrate the design process to manage pain and stress that may result from design issues or problems from long-term health conditions.

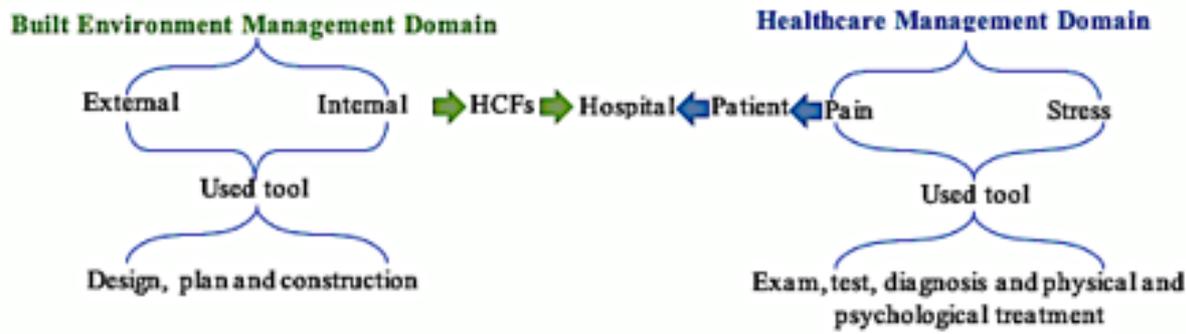


Figure 2.2: research scope – the built environment and the healthcare domains

2.3.1 BUILT ENVIRONMENT DOMAIN TOOLS AND HEALTH

hospitals are designed and maintained through a complex collection of planning and design choices, tools, processes, instruments and methodologies utilized by the responsible parties. by not dealing with these complexities during the planning and design stages, issues in patient designed physical environment may appear. issues such as design defects that cause ais can delay the delivery of needed health services, thereby affecting patient well-being (Carmona et al. 2010). the planning, design and construction stages are usually included in the hospital development process, dealing perfectly with physical and psychological health conditions through design and planning tools (Halpern 2014). Figure 2.3 shows the main processes in the construction stage. in this study, the focus is on the design stage to improve its processes, and in the operation stage to track the design issues back to the design stage. Figure 2.4 presents the predesign stage sub-divided into processes including identification, brief, feasibility, hospital building programming, functional programming and space programming, leading to the design stage including, schematic and design development processes. these processes are considered as references to define the design issues in the operation stage.

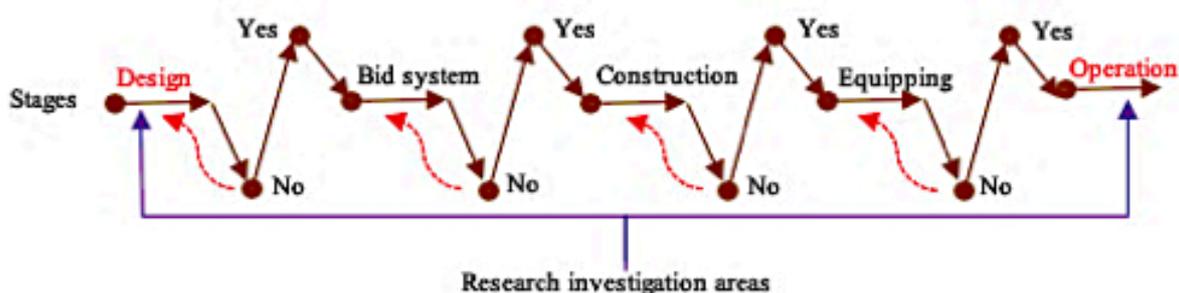


Figure 2.3: hospital construction stages

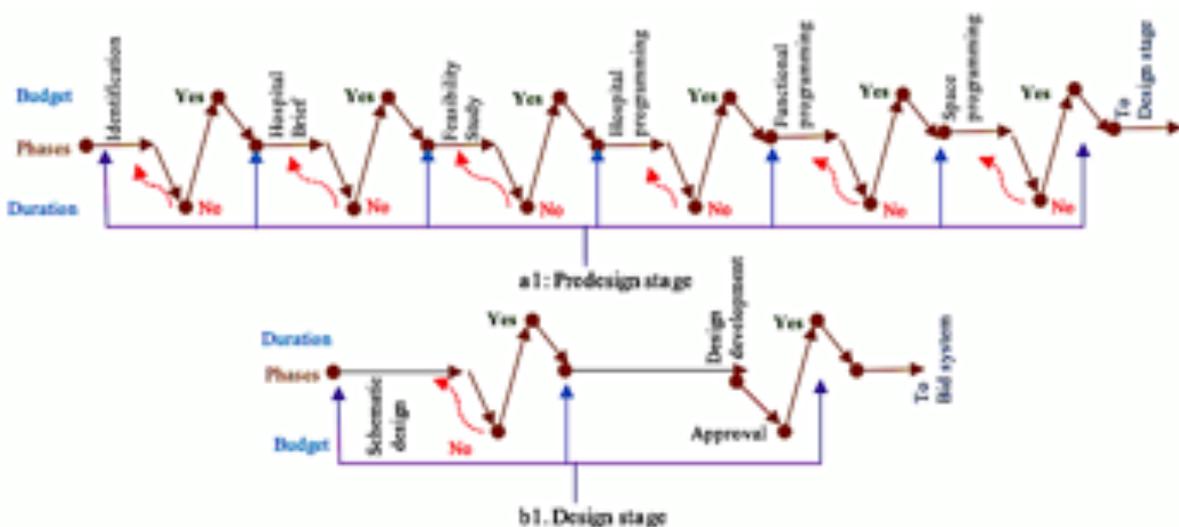


Figure 2.4: hospital design stage phases

The lifecycle of care facilities typically involves 11 phases (RIBA 2013). These are divided into four distinct stages: design, planning, construction and maintenance and operations (see Figure 2.3). Each stage is important, with its own team, processes and responsibilities. During the initial design stage, there are major processes that take place which determine the outcomes of other stages. In this study, the design stage is sub-divided into two: pre-design and design production and documentation sub-stages, involving the identification of design requirement and the planning of project execution, which itself has four stages (see Figure 2.4). The first stage is the project request, which aims at providing the justification for the hospital building request, determining the size and the needs of the building, identifying the scope and the budget estimation. The second stage is strategic planning, which involves the process of identifying the prescriptive variables regarding patients, the equipment and technology and the services that each patient requires in each department. The next stage is the needs assessment stage

which determines the space of each department through the process of evaluating the current and future service lines and workloads. Stage 4 is the assignment of space for specific programs and patients, with staff and visitor flow diagrams (Millsap 2007) (see Figure 2.4). In this fourth stage, the participants are clients, hospital management professional staff and patients.

The design stage has three processes. Firstly, concept design involves the incorporation of specific programs into the plans of floors, interior elevations, building sections, exterior elevation stoking, blocking diagrams and a site plan. Secondly, design improvement involves the process of updating proposals in order to approve structural design and the building systems which include heating, elevators, plumbing, ventilation and outline specifications. Thirdly, technical design involves the process of presenting all the building service information and structural designs, specifically the sub-contractor design (riba 2013). By processing planning and design in the early stages, this study investigates the process flaws as sources of design defects, the controlling of which will minimise or help to avoid design defects in the occupation stage.

The initial stages of hospital inception planning and design are amongst the most critical stages of decision-making. They can have long-lasting repercussions throughout the lifecycle of a built asset. Operations carried out in the hospital buildings are also important as they impact practical processes and reflect the design issues of the building. Hospital design includes both technical elements and an artistic requirement to manage the interactions between localities and occupants (Mcclure and Bartuska 2011). This is particularly important in a healthcare setting where patient comfort, or a lack thereof, can have a significant impact on overall recovery. Initial planning steps oversee the conceptual work, while the designing period is used to translate those concepts into reality.

These processes must interact in detail to result in a fully implemented structure through specialised skill and thinking. Designers planning a facility must have a previously constructed model in mind. They must conceptualize the whole idea of how the building should appear and think critically to generate a design or provide a solution (Lawson 2006). They must possess relevant skills, including creativity and an intuition to solve design issues as they arise (Mcclure and Bartuska 2011). According to Lawson (2006), initial design concepts are not fully formed and must be carefully elaborated upon by the designer to produce a workable outcome. Planning

and design processes play a main role in controlling the subsequent stages of hospital construction by design teams. As illustrated in figure 2.5, design procedures includes brief development, analysis, synthesis, evolution and implementation to create a new design or deal with existing design issues during the planning and design stage (Reekie 1972). These procedures are controlled by the ideas, principles, skills and the thinking strategy of designers during the planning and design stages.



Figure 2.5: Art of planning process

There are three ways in which designers' thinking and skills can be measured through the design process and usages, and how designers select solutions to design issues. They are:

1. solutions to design issues within the *design process methods*. this includes:
 - a) linear solutions, quickly solved design issues, however the options are limited in all processes (Reekie 1972);
 - b) divisional solutions, several options to solve design issues, however the test for a solution is not available in all processes (jones 1992);
 - c) centralized solutions, several options to solve design issues, however the design issue may not be fully understood (Lawson 2006);
 - d) cyclical solutions, many options to solve design issues, focused at preparing the programming stage (Snyder and Catanese 1979); and
 - e) investigative solutions, unified solutions for the design issues, however they depend on the inputs of the methods used by relevant parties (Kalay 1987).
2. solutions to design issues within the selection of *thinking strategies*. they include:

- a) *lateral solutions*, generating several solutions for an issue in comparison with other solutions to evaluate the appropriate solution (de bono and Zimbalist 1970);
- b) *visual solutions*, a designer using drawing tools to produce mental images to solve the problem (Mckim 1980, Laseau 2000, Lawson 2006);
- c) *solutions* depending on the design principles and standards employed by the design team in solving problems (Broadbent 1973); and
- d) *group discussions*, in which there are conversations amongst the design team, experts or interested people to solve design issues (Broadbent 1973, Sanoff 2016).

3. solutions to design issues within *hospital design principles* involve:

- a) *lean healthcare*, intended to lower healthcare costs by reducing waste and patient wait time and improving patient safety (Lawal et al. 2014);
- b) *patient-centred care*, which respects emotional support, physical comfort, information and communication flow, continuity and transition, care co-ordination, involvement of family and carers and access to care (gage 1995, Gerteis et al. 1997);
- c) *evidence-based design*, which means making hospitals safer and healthier for patients and better places for staff to work (Ulrich 2001, Ulrich et al. 2008);
- d) *salutogenic design*, which pertains to creating an environment that stimulates the mind to create pleasure, creativity, satisfaction and enjoyment. it is the relationship between health, stress and coping illness (Antonovsky 1979, Nordenfelt 1991); and
- e) *healthcare system*, which means creating an environment for delivery of services and for the commissioning teams to enable and initiate the services (health care system 2009).

2.3.2 THE BUILT ENVIRONMENT AND HEALING PROCESSES

In the 1990s, the design solution in the healthcare sector was known as evidence-based design (EBD), a theoretical concept for the healing environment (Huisman, Morales et al. 2012). According to Ulrich (1992), a healing environment presents care facilities with a less stressful environment. It reduces the duration of in-patient stay and the cost of care, and increases caregivers' productivity. Devlin and Arneill (2003) and Jonas and Chez (2004) have defined a

healing environment further as a place where patient recovery is improved due to the interaction between the design of spaces and elements of comfort in patient's recovery.

Reducing stress and pain and providing conditions conducive to recovery greatly enhances the success rate of recovery. This is the main concept of this study: improving therapeutic outcomes of the built environment of care facilities through the design process. Being physically, mentally and socially fit cannot be a matter of physical subjects (Day 2007). An environment that supports healthy living also leads to a patient feeling comfortable and less stressed (Zimring et al. 2004; Ulrich et al. 2007). This can be achieved by selecting an appropriate plan for patient spaces (Lawson 2002, Day 2007). The consideration of physical attributes in an ideal healing environment must be free from elements that add no value to care-receivers' recovery and must be a quantitative measure for ensuring their timely treatment and recovery.

When public hospitals provide free treatment for those patients who qualify, the service they provide to patients must be safe, and support that they are unlikely to get treatment in private care facilities (Commonwealth of Australia, 2009; Slade et al. 2009; Frazee 2010). KSA public hospitals operate under these principles, including a focus on offering services to people in need and utilizing as many available staff as possible. It is important therefore for designers to adhere to hospital building requirements, free from design issues and that impact positively on patient recovery. However, they tend to comply only with the basic standards of hospital design requirements without emphasizing the provisions of a reliable and holistic hospital environment. This leads to hospitals operating with design issues that directly increase the pain and stress of the recovery processes (Malkin, 1991, Schweitzer et al. 2004).

The results of studies by Horsburgh (1995), Jones (2002) and Lawson (2002) show that the physical environments of healthcare can also have a positive impact on patients, caregivers, other end-users as well as visitors. The Commission for Architecture and the Built Environment (CABE) of the United Kingdom presented a report on the role of hospital design in the recruitment, retention and performance of National Health Service nurses in England. The report shows strong evidence that improvements in the physical environment and the design of hospitals has a significant positive influence on users. Design elements and components that should be considered in designing future UK hospitals were suggested by those participants who were hospital visitors. They include providing more spaces (32%), increasing the fresh air

access (16%), privacy (9%), having warm and friendly feelings in the hospital environment (12%), providing a calm colour (11%), green areas (10%), technology (5%) and decreasing the noise levels (5%) (Commission for Architecture and the Built Environment 2004).

From the CABA (2004) report and an analysis of patients' memories by Simini (1999), adverse factors in the physical environment include confusing layouts, a lack of windows, poor ventilation, low lighting quality, excessive noise, bad sleeping conditions, undue patient isolation, limited freedom of movement, difficulty in access to the required information, poor privacy and bad communication. These factors have negative influences not only on the hospital building but also on recovering patients, including patients who cannot walk on their own and are highly susceptible to environmental factors (Malkin 1992, Gross et al. 1998, Schweitzer et al. 2004, Mazuch and Stephen 2005). In addition, factors considered to have positive impacts on health include reducing adverse incidents, medication malfunctions, infections and patient falls, and increasing the privacy, safety, security and comfort of patients (Huisman et al. 2012). These led to the conclusion that the adverse and positive effects of the elements and components of physical surroundings have a great impact on patient recovery, which can be managed and controlled by improving the design of hospitals.

According to Ulrich et al. (1991), Ulrich (1992) and Horsburgh (1995), the main responsibility of hospital designers is to ensure the quality of healthcare service delivery is able to reduce adverse effects and their impact on the pain and stress that harms patient health in hospitals. However, diseases and illnesses that trigger stress and pain can be caused by the adverse effects of design issues. These have been given limited consideration in the hospital development process when designing solutions that assist patients and support them in coping with diseases and illnesses (Ulrich 1991, Ulrich 1992, Horsburgh, 1995). Reducing these effects can lead to a shorter length of stay for patients and an increase in patient comfort and satisfaction levels (Ulrich et al. 2004). These could be the outcomes of the appropriate design of physical aspects of the environment (Lawson 2002, Day 2007). Therefore, it is highly beneficial for hospital design to take these factors into consideration at an early stage of the design process.

A supportive physical environment has the potential to reduce costs that would otherwise be incurred by long hospital stays as patients require less time to recover (Ulrich 1991). A therapeutic environment is one that gives the staff and patients a helpful/constructive interaction

zone and leads to positive gains through health recovery (Devlin and Arneill 2003, Jonas and Chez 2004, Zimring et al. 2004, Ulrich et al. 2008). The impact of the physical environment on healthcare services and patients sensory systems, has not been well investigated (Raanaas, Patil and Hartig 2012; Shackell and Walter 2012)). Even though environmental factors affect the curing process, a definitive explanation for what makes an environment good or bad for healing is still lacking (Lakey 2009, Veitch 2010). These factors affect the physical and psychological health of patients through their five senses: smell, touch, sight, hearing and taste (Sfandyarifard et al. 2010). These sensory systems of patients reflect his or her feelings about the design quality of their care space (Totaforti 2018).

Although some researchers have called for greater attention to the environmental factors that have an impact on patient's mental and physical health and care service, Shackell and Walter (2012) argue that there is little evidence that the environment components and elements directly lead to good results that support the process of healing. At this early stage, the current study assumes that designing hospitals that are free of defects and simultaneously creating a therapeutic environment with appropriate physical and psychological aspects of design can support the healing process and reduce pain and stress, and that these are the main trigger factors that should be considered in the design process of the healing environments in KSA hospitals. This assumption is illustrated in Figure 2.6.

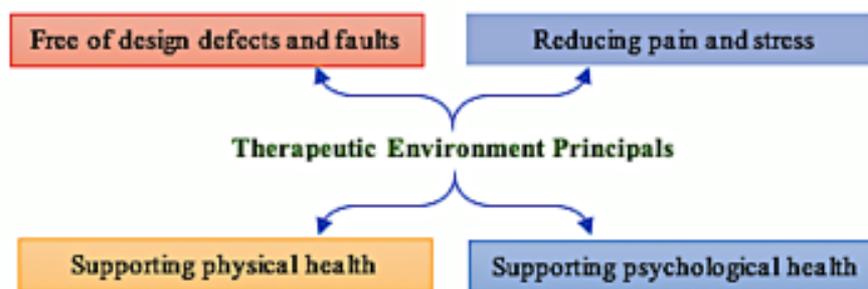


Figure 2.6: Main trigger factors in the design process of the healing environments

2.3.3 DESIGN DEFECTS IN THE OCCUPANCY STAGE

Georgiou (2010) describes a design defect as a component that has a shortcoming and no longer fulfils its intended function. They also describe building defects as a failure or shortcoming in the function, performance, statutory or user requirements of the structure, fabric, services or other facilities where most of these defects are initiated by weakness in the design stage. Design defects can be classified into patent and latent failures (Pheng and Wee 2001, Rhodes and Smallwood 2002). Patent failures can be identified during building inspection and during the defect liability period (DLP). This is different to latent failures that happen after the structure is inhabited (Isa et al. 2011, Ismail et al. 2011). In addition, design defects occur in different engineering fields, including civil, architectural, structural, mechanical and electrical fields. These defects can be caused by raw materials or an issue caused by building machinery and errors caused by description (Assaf et al. 1996; Olanrewaju et al. 2010). Other causes include weather, labour, design and raw materials, amongst other factors (Chew 2005, Ahzahar et al. 2011).

Other studies have presented additional sources of design defects. Richardson (2002) identifies soil and structural movements and the chemical reaction between materials. Ahzahar et al. (2011) discussed the roles of construction site, construction methods and application issues in design defects. Furthermore, Olanrewaju (2012) identifies modes of building, standards, rules and regulations, whilst Shabha (2003) and Isa et al. (2011) outline inadequate supervision during construction stage with precipitation, water ingress and cold connection together with inefficient thermal insulation.

A defect can affect the typical operation of ceilings, the installation of equipment, power systems, mechanized processes, lubrication and levelling (Olanrewaju et al. 2010). According to Low and Chong (2004), building defects are caused by flaws in design processes. Defects can also arise from design outcomes, and this plays an important role in the outcomes of building construction and operation. According to De Silva et al. (2012), design faults are repairable shortcomings that can be avoided or reduced during the design phase. Faults are caused by choices made and acts taken, or by the thinking of designers (Gatlin 2013). Defects in the building's operation stage can trigger substantial outcomes, and may not be captured during the design process (Backman 2010; De Silva et al. 2012).

design issues are major contributors to building defects and such issues can only be prevented by improving the design process (low and chong 2004). this current study suggests the design process is causing design defects that affect patients' healing and recovery process within the care environment. studies by pheng and wee (2001), pretorius and grobler (2002) and mills et al. (2009) have identified the necessity of investigating defects and possible approaches to track their causes and outcomes. these defects may contribute to a high occurrence of adverse incidents (ais).

The previous studies presented design defects as the major reason to reduce the cost of maintenance and increase the life span of buildings. In this current study, design defects are investigated to define their sources in the design process and how they trigger AIs that reduce patients' recovery in Saudi hospitals.

2.4 THE HEALTHCARE DOMAIN

An incident in a care facility could trigger a call for improvements in the entire health sector. One AI could affect several aspects of care facilities as well. Rafter et al. (2014) suggest that to decrease AIs, focus should be on all areas of the healthcare domain. A WHO (2002) presentation states that people in hospitals are more likely to find themselves in dangerous circumstances than those flying on airplanes. The chance of an airplane-based incident is one victim per million. In this section, the impact of adverse incidents on recovery will be discussed.

2.4.1 ADVERSE INCIDENTS AND RECOVERY

Recovery means the restoration of health after having illnesses, diseases or injuries. According to LeCount and Koberstein (2000), recovery includes the healing process for the body, mind and spirit. Nonetheless, the healing process can be affected by any harm that exposes people to adverse incidents (AIs). In the healthcare domain, AIs are defined as incidents in which harm befalls a patient during the provision of healthcare (AIHW 2015). AIs may involve infection, patient falls resulting in injury, or problems with medication and medical device error, and may impact patients physically, psychologically and financially as a result of pain, stress and prolonged stays in hospitals (Adams et al. 2009).

The physical impact of AIs includes an increase in disability and a decrease in activity (Linton 2000). Financial damage caused by AIs comes mainly in the form of increased costs associated with prolonged stays (Linton 2000). The psychological impact of AIs includes anger, stress, depression and fear of exposures to injuries (McArdle 2010; Lumley et al. 2011; Lucchetti et al. 2012). Pain and stress also impede recovery (McCaffery and Pasero 1999, Pasero et al. 1999). They increase respiratory rate and susceptibility to fever (Kehlet 1998). They also cause high heart rate, blood pressure and oxygen demands (Torpy et al. 2007). According to Pasero et al. (1999), pain and stress are other factors which affect the immune system. Evidence by Gouin and Kiecolt-Glaser (2011) suggests the impact of pain and stress reduces the possibility of a swift recovery, thereby increasing the risk for infections, lengthening hospital stays, adding to patient discomfort and delaying the moment when patients can return to the normal activities of their daily lives.

AIs develop from design defects that are noticed only in the occupancy stage, brought about by agony and tension that slow patient recuperation. AIs occur either directly or indirectly: direct occurrences expose patients to harm during the course of treatment, while indirect incidents lead to potentially harmful risks due to a poor environmental structure (Moullin 2002). The designer can only be questioned if severe cases take place as a result of the planner's ignorance (Mohammed and Hassanain 2010).

As noted in Chapter 1, recently, the Saudi Arabian Ministry of Health attempted to combat the frequency of AIs and medical mistakes by applying healthcare safety standards (Almasabi 2013; Al Awa et al. 2010). However, KSA still faces increasing AI issues in healthcare structures with a rate of occurrence that is 20 percent greater than in developed countries (WHO 2012).

It is vital that patients' needs are considered as central during hospital design in order to maximize recovery rates and to minimize the occurrence of AIs (Joseph 2012). Specifically, it is crucial that designers focus on discovering potential causes of AIs during the conceptual stage, particularly as many of these can severely affect patients' health (The Centre for Health Design 2012). Norman (2013) indicates planners learn special needs that, in general, are different from the actual requirements of the recuperating patients. The Centre for Health Design (2012) states that hospital designer groups are rarely uninformed about the fact that AIs

are connected to a hospital plan and design. Challenges, such as reducing the occurrence of AIs, are typically only addressed once they have affected patients in harmful ways.

West (2006) and the WHO (2002) argue that hospital structures have a huge number of medical services and surrounding facilities where incidents can unfold. Possible AIs in this context include contamination, slips, trips and falls that lead to injuries, as well as challenges with medication and medical devices (AIHW 2015). These AIs are derived from two major sources: direct involvement connecting to medical practitioners during healthcare provision or treatment and indirect involvement is related to design, which exposes victims to needless risk in healthcare spaces (Moullin 2002).

To present a greater understanding of the distribution of AIs in hospitals, this research intends to show AIs from five angles so as to portray a comprehensive explanation of AIs and their link to environment effects on the health of end-users:

1. AIs happening from a medical point of view; controlled comprehension presented by science about how occasions take place; in that, health providers do not need their intelligence precisely and the inadequate knowledge presented by science and technology to comprehend AIs (McDonald et al. 2000);
2. AIs happening from a sociological point of view; the source of many mistakes in health centres originating from care organizational structure (West 2006);
3. AIs happening from a psychological perspective; inquiry to operating with AI like an attention to behavioural mistakes rather than aiming at the effects of social, physical, organizational surroundings, flaws of conditions and work outline (Leape 2000; Parker and Lawton 2006);
4. AIs happening from a low level of quality management perspective; negligence of using empowering program in healthcare organization resulting to challenges in highlighting and minimize AIs (Moullin 2002);
5. AIs from a hospital plan view; AIs in designed care spaces and components could expose victims to risk (Brady et al. 2009).

There remains a need for more detailed studies to highlight tools that improve hospital design and construction and minimize the occurrence of damaging events (Srinivasan et al. 2003). During the preliminary design stage, designers should be given proper guidelines to avoid

incur errors. They should also take this opportunity to ensure that internal spaces have a positive effect on patients without exposing them to elements that will make them fear for their lives or otherwise face hazardous conditions. AIs arising from these have psychological and physical impacts on patient health outcomes (Zimring et al. 2004). It is crucial to fulfil patient needs early in the design of hospital development to support their recovery (Joseph 2012). Patient recovery is associated with physical, mental, emotional, social and spiritual aspects in the hospital design (Egnew 2005). AIs often develop from design defects and they usually delay or halt the healing process in patients, both physically and psychologically.

2.4.2 ADVERSE INCIDENTS ORIGINATING FROM DESIGN DEFECTS

There are links between AIs and design issues in the occupancy stage of hospital. Hospital planning has a key effect on the efficiency of treatment programs. However, shoddy work may lead to the spread of diseases, particularly as a result of poor ventilation and inadequate/unsatisfactory temperature control and inferior materials (Kumari et al. 1998, Kromhout et al. 2000, Smedbold et al. 2002, Jiang et al. 2003). When air filters are deficient, airflow and air pressure issues may trigger changes in air humidity and ventilation systems may lead to infection. This is a mechanical type of defect (McDonald et al. 1998, Lutz et al. 2003).

Chang et al. (2004) found physical and psychological injuries, as well as prolonged hospital stays, can be triggered by patient falls as a result of low lighting levels. They can also be caused by slippery floors, issues in rail placement, inappropriate door openings and incorrect toilet and furniture heights (Brandis 1999). This is an architectural type of design defect.

Medication mistakes, another example of AIs, sometimes happen due to distractions or a lack of lighting in the medication room when nurses are preparing medication (Buchanan et al. 1991, Booker and Roseman 1995, Flynn et al. 1999). These can also be triggered when transferring patients between rooms in an incorrect manner which may lead to loss of medical information (Cook et al. 2000; Kistner et al. 1994; Flynn et al. 1999). This is an electrical type of design defect. AI mishaps can occur because of design layout choices such as inappropriate hallway structures and room placement; they can have dramatic effects on the efficacy of hospital staff and on the time utilized or wasted in the care of patients and the passage from one room to the next (Sturdivant 1960, Trites et al. 1970, Shepley 2002, Shepley and Davies 2003). Under such

circumstances, AIs take the form of medication errors, falls or fires. Each of these could have several ill effects and be attributed directly to flaws in the initial design process (see Figure 2.7 which shows the link between the design defects giving rise to seven types of AIs which affect the recovery process and the provision of care services during the occupancy stage).

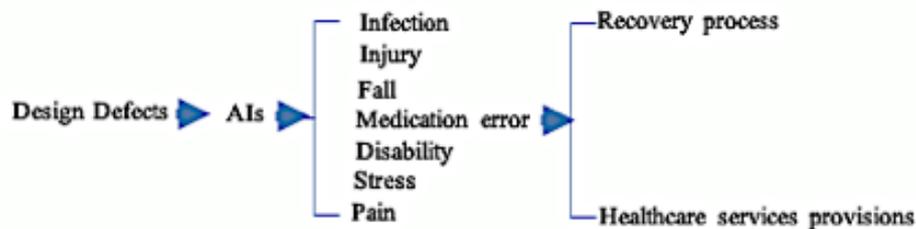


Figure 2.7: the impact cycle of ais

2.5 THE BUILT ENVIRONMENT AND HEALTHCARE DOMAINS

This section describes the relationships between design defects in the occupancy stage, flaws in the design process and the healing elements of care facility design (the built environment domain) within patient recovery system (the healthcare domain).

2.5.1 DESIGN PROCESS FLAWS AND DESIGN DEFECTS

Flaws in the design stage often lead to issues in the occupancy stage. AIs stemming from such initial imperfections proceed to disrupt patient recovery. Flaws affect the cyclic processes of design, reducing the quality of the final product and increasing the chance of design defects appearing later on (Gries and Blessing 2006). These can be considered a direct result of a failure of the design team (Gatlin 2013). They can also be considered as lack of crucial data and information for end-users (Gries et al. 2005). These flaws occur in the design itself or the final layouts (Gatlin 2013).

During the building development process, the design contains central information about construction stages. As indicated by Formoso et al. (1998), the process has to go through several stages: outline design, feasibility review, scheme design, detail design, production monitoring, design for legal requirements and feedback from the operation stage (see Figures 2.3 and 2.4). During the designing process, designers must come up with all the information needed to build

and operate a facility. Such information includes legal provisions, regulation briefs provided by local authorities, the aesthetic value, technology, creativity and economy (Øyen 2007).

During the design process, it is possible to reduce infection by providing single rooms and fresh air (Shirani et al. 1986, McManus et al. 1992, McManus et al. 1994, Thompson et al. 2002). Another way to reduce the level of infection is by providing negative-pressure curtain barriers in various areas, for example in isolation rooms (Farquharson and Baguley 2003). The lack of utilizing such infection prevention methods by designers is a clear indication of a design level flaw.

Patients' falling or AI may originate from the design defect in rooms such as bedrooms or toilets which have slippery floors (Hanger et al. 1999, Grasso et al. 2001, Capezuti et al. 2002). Likewise, frequent injuries from falls indicate the likely presence of an error in material selection from the early stages of the design process. Infections, patient falls, medication errors, stress, depression, noise, length of stay and other negative AI effects can be minimized by recognising design process flaws early on, after understanding the course of the design defects by tracking their root causes and sources back to design stage.

2.5.2 THE DESIGN PROCESS AND SUPPORTING HEALING PROCESS

Healing processes can be supported from the early stages in the development of therapeutic facilities. Noise levels greater than 80 decibels can be caused by alarms and trolleys and may result in patients having an increased blood pressure and stress (Meyer et al. 1994, Moore et al. 1998). This can lead to heart and respiratory problems, which may prolong the healing process (Zahr 1995, Slevin et al. 2000, Johnson 2001). Providing sound-attenuating surfaces, insulated rooms and soothing music can help ameliorate unfavourable spatial conditions. Such changes are best implemented in the early stages of the design process.

According to Buchanan and co-workers (1991), lighting between three distinctive brightness levels can prevent 58% of AI (medication errors) and depression and the health outcome can be improved, leading to a faster patient discharge (Booker and Roseman 1995, Benedetti et al. 2001, Wallace-Guy et al. 2002).

Another measure that may improve recovery outcomes is the exposure of patients to natural elements, which has been proven to positively impact psychological wellbeing, and lower blood pressure and heart rate (Ulrich 1991). This can be achieved through increasing the size of windows or changing their location. These aspects can be integrated at an early stage of the biophilic design process.

2.5.3 DESIGN ASPECTS OF HEALING SPACE TO SUPPORT HEALING PROCESS

Over the last ten years there has been a gradual increase in research focusing on the relationships between the built environment and the physical activities of patients (Srinivasan et al. 2003). Research suggests a clear relationship between patient health and the built environment resulting in enhanced recovery outcomes (National Research Council Committee and Medicine 2005, Brown et al. 2009). A better understanding is required of how hospital buildings and the environment they create can facilitate healthcare providers' provision of care and affect patient outcomes (National Research Council Committee and Medicine 2005, Brown et al. 2009). It is therefore critical that these factors be considered at the outset of facility design.

Improved hospital quality and design supports the healing process. With this, the early initiation of decision-making in the design phase of such facilities is critical, as is the skill and capability of the design and engineering team, planners, landscapers and builders. These parties, all project stakeholders, and steering committees must collaborate and cooperate to ensure best practice outcomes in all areas of healthcare project delivery (Jackson 2003, McClure and Bartuska 2011, Jackson et al. 2013). The Design and Health Leadership Group has suggested there are six aspects of design through which these groups can deliberate to make the hospital a better place for patients and for medical team productivity (Rear 2015). These are environmental quality, safety, natural systems, physical activity, sensory environments and social interactions. It is suggested that addressing these facets will likely result in an improved physical setting, thereby aiding recovery. The environment in which a patient is treated is critical in any healing process. Even in well-designed facilities, prolonged stays can increase patient discomfort and impede/disrupt the return to normal life (Gouin and Kiecolt-Glaser 2011). This attests to the critical impact and symbiotic relationship between the health sector and the disciplines of the built environment (Jackson et al. 2013).

In 1946, the constitution of the WHO defined health as “a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity”. To achieve this state, one has to meet all the physical, medical, psychological and social states listed (Dodge et al. 2012). Therefore, patient-environment interactions can elicit either balance or imbalance, which may lead to timely or prolonged healing respectively (Stokols 1992).

This environment influences a patient’s mental health recovery in four areas: (i) through the planning process itself, (ii) the impact on patients’ social life, (iii) as the figurative role of architecture and planning and the impact of social tagging; and (iv) as a source of stress (Halpern 1995). Pain and stress can be reduced by creating healing spaces to support physical and psychological wellbeing through design and planning considerations. Notable aspects include:

- ***Spatial design:*** to plan, design and create components and elements for patient interactions with the environment. This includes:
 - 1) lines showing movements, harmony and mood, guiding eyes throughout the space, conveying the senses to serenity and strength, and affecting feelings in space. Using these elements in design can lead to an improved sense of calm, freedom and restfulness.
 - 2) The space; presenting positive or negative feelings, linking the components and elements of design to space, presenting the spatial size and shape in distinct parts, and creating an illusion and a feeling of great depth.
 - 3) The shape; the shape of space can be created by lines, colours, lights and edges attracting attention.
 - 4) The form; defined by three dimensions (light, colour and shadow), providing stability and positive feelings.
 - 5) The texture; defined as feeling the surfaces of objects by sight or touch.

- 6) Colour; using hue, value and intensity to create an aesthetically pleasing psychological impact, supporting brain activities, increasing feelings of relaxation and concentration as well as excitement and peace (Hermann et al. 2016).
- **Luminosity design:** includes nature and artificial lights that have physical (eyes and skin) and psychological impacts on the patient (Zilber 1993; Mahmoodi 2001). Using lights in space influences sleep, activity level and symptoms of stress and fatigue (Boivin 2000). Poor lighting design using flicker and glare lights can cause fatigue, headache and loss of concentration (Arneill and Frasca-Beaulieu 2003).
 - **Thermal design:** considers the levels of airflow speed and temperature, object temperatures and humidity (Lin and Deng 2008). To reach thermal comfort, the body should keep the temperature within a narrow range and the moisture of the skin low (Ogbonna and Harris 2008). Itchy, dry skin and feeling thirsty can be a distressing result of thermal design (Hashiguchi et al. 2005).
 - **Audio design:** using music and natural sounds in patient care environments produce relaxing and calming effects that increase relaxation and quality of sleep (Williamson 1992). Increased feeling of pain, usage of pain killers, disorientation and confusion are considered a result of noise in the patient environment (Grumet 1993). The sources of noise are surfaces and equipment made in metal materials, alarms systems, overhead paging and beepers (Grumet 1993, Pattison and Robertson 1996).
 - **Social design:** family and friends are source of strength and support for patient health (Ulrich et al. 2008). Social support occurs in four forms, emotional support, affirmation, physical aid, and assistance (Carpman and Grant 2016). Social design involves providing areas and furniture within the rooms and allowing families to customise the components of patient room as they wish (Khakzand et al. 2017, Rashid 2010).
 - **Spiritual design** deals with cultures, beliefs and traditions which are spiritual or religious practices that are important for health and healing (Schlitz et al. 2005). Inspiring feelings of peace, hope, reflection and spiritual connection can be transformed

by space through the five senses to produce a powerful and anxiety-reducing experience from a sacred space (Gallagher and Edelstein 2004). Providing visual arts in the patient environment can lead to a decrease in stress and medication, and improves the patient health recovery (Ulrich et al. 1993).

- ***Aesthetic elements*** in design include images, paintings, photographs, pictures and prints (Ulrich 1991, Ulrich et al. 1993).
- ***Freedom in design***: the freedom to control components of space by a patient may reduce violent behaviour (Mooney and Nicell 1992) and stress, and increase positive mood (Marcus and Barnes 1999) and mental health (Curtis et al. 2007). Such freedom for a patient may include access to outdoor spaces, controlling room temperature, lighting, curtains and movements, and the positions of furniture and beds (Rashid 2010).
- ***Safety in design***: Designing patient space should convey a sense of safety to reduce the feelings of fear by being exposed to danger. This can be done by systems such as emergency evacuation plan and fire protection systems against hazards to prevent adverse incidents (falls and injuries) (Kjellén 2000).
- ***Security design***: a lack of security can have negative psychological impact on patient health. To ensure a secure place, patients should be protected against any threat by providing security systems, and internal and external lighting (Kjellén 2000).
- ***Objects usage***: reducing the physical and mental efforts of a patient can reduce feelings of fatigue, especially when a patient trying to move or use objects such as furniture (bed), toilet accessories (tap), doors and windows (Handy et al. 2002). These objects should be automatable (Huisman et al. 2012).

2.6 HEALTHCARE IN THE KINGDOM OF SAUDI ARABIA

The healthcare sector in KSA lies within the responsibility of the Ministry of Health, which is the primary government agency committed to the provision of preventive, curative and rehabilitative healthcare for the population of KSA (Almalki et al. 2011). The Ministry of

Health is also responsible for the management, planning, financing and regulation of healthcare facilities. The government of the KSA has made a concerted effort to deliver planned healthcare facilities. In 2014, according to the Central Department of Statistics and Information (CDSI), the KSA healthcare sector accounted for nearly 5.7% of the total gross national product (Ministry of Finance 2015), making the KSA's one of the largest healthcare sector budgets in the Arabic Gulf (Damrah 2013).

As explained in Chapter 1, KSA has focused on patient safety recently through the reduction of AIs or medical errors during direct interventions by applying healthcare accreditation standards that cover patient safety practices related to some patient incidents (Almasabi 2013, Al Awa et al. 2010, Thornlow and Merwin 2009). However, the KSA, as a developing country, is still suffering from an increase in AIs in which the risk of patient harm is up to 20 times greater compared to developed countries. In other words, one out of every ten patients receiving care at a KSA hospital is likely to suffer an AI (WHO 2012).

This study focuses on how the creation of an environment conducive to fewer AIs can be embedded in the early stages of the hospital design process in order to provide a safe and protective atmosphere that positively affects the psychological and physical health of patients, thus avoiding AIs originating from design defects. In addition, the focus here is on fostering beneficial systems within the patient environment to facilitate the healing process.

To provide a clear understanding of the research gap (the lack of attention to the link between the design process in the built environment domain (see Figure 1A) and the healing process of patients in the healthcare domain (see Figure 1B) and to highlight the research problem, AIs can be prevented by design. Figures 1 and 2 display the research problem cycle in relation to both domains.

In a study of KSA hospital buildings, Al-Ghamdi et al. (2011) presented the design defects impacting the maintenance and operation phases in the following categories: selection of materials, climate conditions, structural designs, written specifications, architectural design, construction drawings, architectural drawings, design team, harmful human behaviours and defects in design team administration. These categories reflect the missing factors in the design process addressed in this study. Furthermore, compared to the design process elsewhere, such

as the U.S, the users' participation in the design stage is another missing factor. Thus, these factors were considered to be indirect interventions (Brady et al. 2009) to patient environments that led to AIs in KSA hospitals and impacted patient health.

The plan and design of healthcare facilities playing important role in producing negative effects such as pain and stress. These effects can be managed and reduced by improving the design of the physical environment to be free of design issues while considering the recovery process of patients (Zimring et al. 2004).

A spiritual aspect plays a pivotal role in how a patient heals and deals with disease. Any change to this delicate bond can push the healing process into a negative or positive direction. Integrative therapies are shown to aid in disease prevention, disease recovery and to facilitate in coping. In fact, in some cases, simply having spiritual expectations or beliefs can increase a patient's wellbeing up to 80% (Sierra 2012).

2.7 THE MISSING LINK: THE IMPACT OF HOSPITAL DESIGN PROCESS ON PATIENT RECOVERY

Hospital design and patient health have a unique relationship. With an increase in the number of adverse patient incidents in hospital buildings (Dentzer 2011), many researchers, including Ulrich et al. (2008), Joseph and Rashid (2007), Nelson et al. (2005), Bobrow and Thomas (2000) and Gallant and Lanning (2001), have highlighted the detrimental effects of poorly designed hospitals on patient recovery. The evidence clearly indicates the significant impact on patient health outcomes if health considerations are not integrated in the patient environment during the hospital design process (Centre for Health Design 2012). A review of the previous discussion shows that many events can impact a patient's health under the following assumptions:

- 1) The resulting incidents can be traced back to environmental design issues that potentially affect both physical and psychological aspects of the patient's healing process.
- 2) The occurrence of adverse incidents can be avoided, and positive events fostered, by paying more attention at the early stages of the design process.

- 3) These events can have direct or indirect effects on patient wellbeing through the patients' interactions with the environment.
- 4) The nature of the AI is indirectly related to the design process flaws of the hospital and healing process of the patient.

Creating a safe and conducive environment includes the prevention of AIs that might impact the psychological or physical health of patients (Zimring et al. 2004, Joseph and Rashid 2007). Inadequately designed 'environments' may cause AIs, such as infections, patient falls and medical errors that can critically affect patient health (Zimring et al. 2004). Despite continuous improvements in hospital operations, the numbers of AIs have not decreased since 1999 (Kohn et al. 2000).

2.8 SIGNIFICANCE OF THE RELATIONSHIP BETWEEN HOSPITAL DESIGN PROCESSES AND PATIENT RECOVERY

As indicated by the Jazan Hospital fire (see Chapter 1), the AIs could have been prevented at an early stage of the design process, but evidence shows there was a significant lack of consideration about patient recovery in the KSA among the design teams. While a great deal of research has been conducted worldwide with regard to patient health and hospital design, this type of research can be considered rare in the KSA, where most studies have been written from maintenance and construction perspectives that concentrate on minimizing costs (Al-Hammad et al. 1997, Ikhwan and Burney 1999, Al-Ghamdi et al. 2011).

Little research has been conducted in the KSA into the impact of healthcare facility design on the psychological and physical health of patients and it is expected that this study will help to bridge the gap in this important area. Improving the design process to create environments that are free of design flaws and will create positive circumstances to promote healing and recovery is central to this research.

2.9 SUMMARY OF LITERATURE REVIEW ON HOSPITAL DESIGN PROCESSES AND PATIENT RECOVERY

Over the past few decades, a unique relationship has been discerned between hospital design and patient health. AIs in hospital buildings have increased and the detrimental effects of poorly designed hospitals have been noted. Design process flaws and their impacts on patient health had been neglected as research topics, especially in developing nations. The acknowledged dilemma investigated here can help to improve the understanding from a special design perspective.

Sfandyarifard et al. (2010) state that colour, ventilation, lighting and heating should be considered in building friendly environment for hospitals in the UK. These physical elements have impacts on the psychological health of patients through the five senses: smell, touch, sight, hearing and taste. Furthermore, air quality, thermal comfort, privacy, light, views of nature, access to nature, visual serenity, visual stimulation, positive distractions, access to social support and options for choice considered as aspects in design to create better healing place (Stichler 2001, Beggs 2003, Ampt et al. 2008, Omar 2014, McCullough 2010, Pati 2011, Salonen et al. 2012).

It is important to emphasize patient health requirements in the early design process of hospital projects, as design teams must become knowledgeable as early as possible about the requirements for supporting the healing process within a given environment (Joseph 2012). The evidence clearly indicates the significant impact of hospital design on patient health outcomes if health considerations are not integrated in the patient environment during the hospital design process (Centre for Health Design 2012). In particular, there is an urgent need during the hospital design stages of planning, design and operation and maintenance to identify and eliminate the causes of incidents and aspects in design that can adversely influence patient health.

The main focus of this investigation is to establish patient health concerns as the primary focus across multidisciplinary fields in the hospital design process. Norman (2013) has stated that designers generally study space requirements as opposed to patient needs. This deficiency is manifested in environmental issues, namely as consequences of designers' lack of consideration about relationships between the patient recovery process and built environment design. The

problems are commonly realized only during the operation of the hospital, when certain types of physical and psychological impacts can be identified after the incident. Research teams at The Centre for Health Design (2012) stated that hospital design teams are often unfamiliar with potential incidents that may relate to environmental design. A review of the previous literature shows that many events can impact a patient's recovery process under the following assumptions:

- These AIs can have direct or indirect effects on patient recovery through the patients' interaction with the environment.
- The resulting incidents can be traced back to design defects that potentially affect both physical (pain) and psychological (stress) aspects of the patient's healing process negatively.
- The design defects can be avoided by paying more attention at the early stages of the main design process.
- The design defects can be traced back to design process flaws.
- The indirect relationship between the design process in the design stage and the healing process of patients in the occupancy stage can be explain through AIs originating from design defects affecting patient safety and health. These defects may be produced by flaws in the design process.
- Creating healing space to support the healing process through consideration of design aspects as positive events can be implemented by paying more attention to healing aspects of design at the early stages of the main design process.

This research is anchored on identifying the design that can create the best environment for the fastest recovery of patients. It is expected to be beneficial for patients, the hospital workers and the organizations that are concerned with patient's welfare, as well as those companies that are interested in offering medical and non-medical services and equipment. It will also be helpful for researchers and investors in the KSA healthcare department.

3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

The purpose of this research is to investigate the relationship between the design process (in the design stage) and patient recovery (in the occupancy stage). Knowledge gaps relating to this research involve:

- a) Sources of flaws in the design process and the project outcomes;
- b) Design issues and flaws in the design process;
- c) AIs and design issues;
- d) The impact of AIs and the recovery process of patients.

The challenge of this study is to fill the gaps between these elements and recommend how to deal with design issues caused by design process flaws (DPFs). This chapter discusses and justifies the utilisation of a research methodology that involves a research paradigm (pragmatism) with mixed ontologies, epistemologies, approaches and methods for the study (see Section 3.2). Inductive and deductive approaches are combined to collect data that identify design issues, sources of DPFs and their impacts on the design and occupancy stages of KSA hospital facilities (see Sections 3.4.1 and 3.4.2). Findings from these are targeted at preventing design issues, as well as protecting and supporting patient recovery. In addition, such findings are aimed at facilitating care designs in hospitals in a way that optimises complete diagnostic and therapeutic services in creating future hospitals that are free from design flaws. To achieve the aim of the research (see Chapter 1: section 1.4 and 1.5), and in relation to the research problems, four objectives were identified. Relative to this, a pragmatic paradigm was chosen for the study which provided an opportunity to apply both inductive and deductive approaches and multiple research methods in order to understand the research problem and to provide answers to each of the sub-questions. A mixed methods approach was used to collect different forms of data. This was supported by a range of methods of analysis.

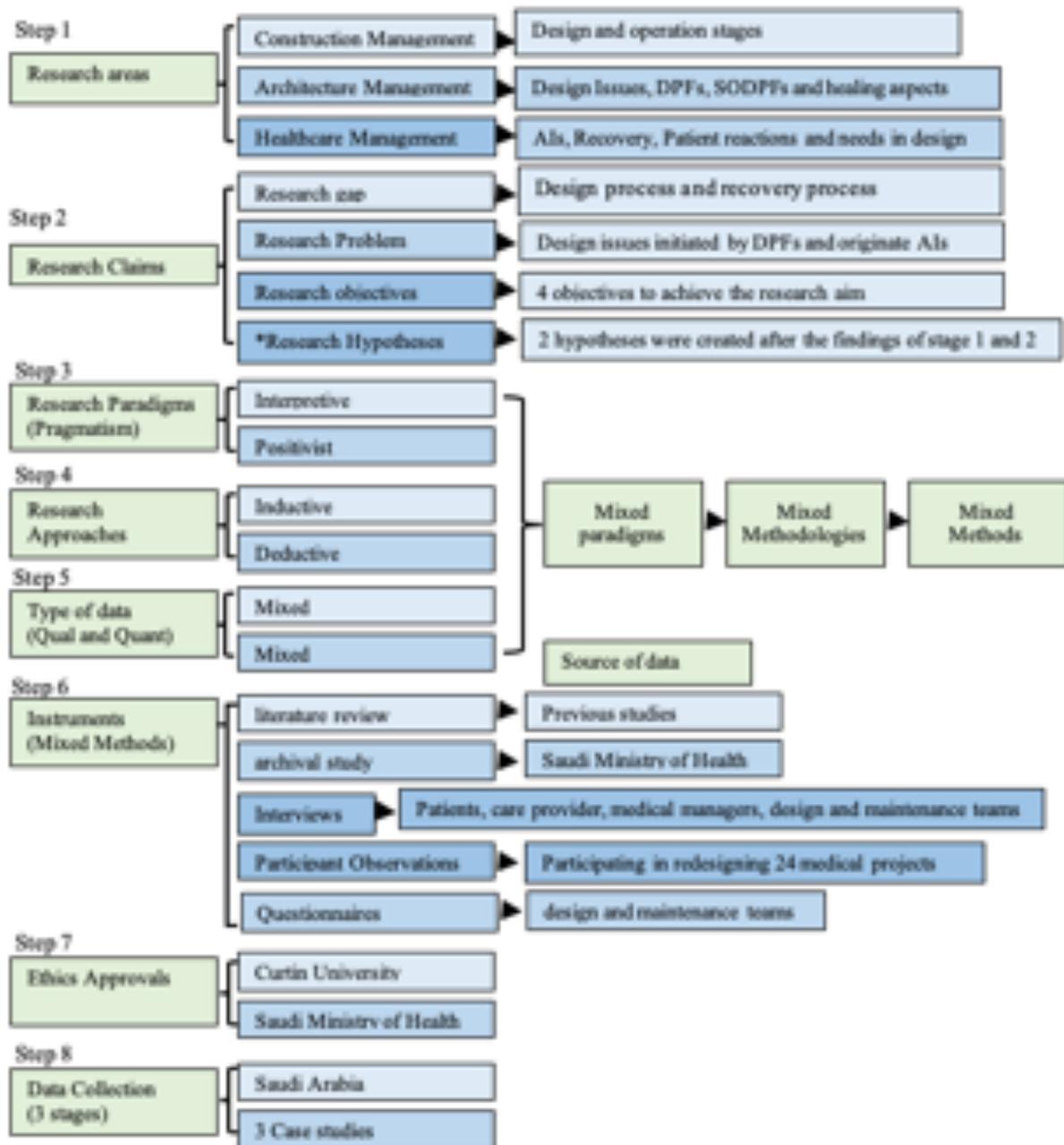


Figure 3. 1: Research methodology framework

Figure 3.1 presents a framework for the eight methodological steps used in this study. these include:

- **Step 1:** determining the three research areas: (1) Construction management covers the design and operation stages; (2) Architecture management involves design issues, design process flaws (DPFs), sources of design process flaws (SODPFs) and healing aspects; (3) Healthcare management including AIs, patient reactions and recovery needs in healthcare facilities.

- **Step 2:** identifying the research aims to fill the research gap, solve the research problem, achieve research objectives and to test the research hypotheses.
- **Step 3:** identifying the research paradigms (pragmatism).
- **Step 4:** selecting inductive and deductive as research approach.
- **Step 5:** identifying the types of data (qualitative and quantitative)
- **Step 6:** choosing data-collection instruments and the sources of data
- **Step 7:** obtaining ethical approval and
- **Step 8:** gathering data from the case studies in KSA.

3.2 RESEARCH PARADIGM, APPROACHES AND METHODS

Research has been described as a systematic approach to investigation with a requirement for information to be collected, analysed and interpreted (Burns and Robert 1997). Research is an effort to "understand, describe, predict or control an educational or psychological phenomenon or to empower individuals in such contexts" (Martens 2005, p. 2). Designing a paradigm for the research at the beginning of an investigation is a fundamental step that will enable the investigator to determine the research methodology, approach and methods to be used (Mackenzie and Knipe 2006).

The term of "paradigm" can be defined as "a loose collection of logically related assumptions, concepts, or propositions that orient thinking and research" (Bogdan and Biklen 1997, p. 22) or the philosophical intent or motivation for undertaking a study" (Cohen and Manion 1994, p.38). Alternatively, provided definition by MacNaughton, Rolfe et al. (2001,p.32) " paradigm that involves three factors: a belief about the nature of knowledge, a methodology and the criteria for validity. Possible types of research paradigms include: emancipatory, positivist, postpositivist, transformative, constructivist, interpretivist, deconstructivist, critical and the pragmatic (Mackenzie and Knipe 2006). After consideration, pragmatism was selected as an appropriate paradigm for this research, as it provides the freedom to use mixed ontologies, epistemologies, approaches and methods to achieve the aims and objectives of the research.

First, the pragmatic paradigm was chosen in response to the research claims. This approach to research provides space for "multiple methods, different worldviews, and different

assumptions, as well as different forms of data collection and analysis in the mixed methods study" (Creswell 2003, p. 12). Furthermore, the pragmatic paradigm is not obligated to any specific reality (Mackenzie and Knipe 2006). This paradigm focuses on the "what" and "how" of the research dilemma (Creswell 2003, p. 11). Therefore, the research approaches and data collection methods used within this paradigm can be mixed to achieve different outcomes from different sources (Wiersma 2000).

Second, both the inductive and deductive approaches (mixed approaches) and qualitative and quantitative methods (mixed methods) were used in this study. Both approaches were implemented to tackle the research problem (see Saunders and Lewis 2000), to fill the research gap and to test the hypotheses. The inductive approach focuses primarily on collecting data to generate findings (Grix 2010). It explains what the research has found as it moves from data to hypothesis, being part of a theory (Schutz 1989). In contrast, the deductive approach depends on the development of a hypothesis to be tested through the data collected. In doing this, it begins with a hypothesis as part of a theory and then moves to the data (Locke 1989). The deductive approach allows relationships between factors to be discovered (Lewis, Thornhill et al. 2007), particularly those related to human interactions (Yin 2013). Ideally, according to Dubois and Gadde (2002), both approaches should be applied in one research project. The application of both approaches has been proven to be a suitable way of extracting the required details when carrying out research (Lukka and Modell 2010). The diversity of these approaches adds to the research by making the methodology resourceful and by eliminating the challenges that could arise through the use of only one approach (Antaki and Rapley 1996).

Third, the mixed-methods and mixed approaches are more acceptable in this study involving pragmatic research. A mixed-methods approach to research involves the gathering of both numeric information (from instruments) as well as textual information (from interviews) so that the final database represents both quantitative and qualitative information (Creswell 2003, p. 20). This approach, previously called by a variety of names, has been used extensively by research experts (Creswell and Plano Clark 2007). The main reasons for the use of a mixed research method were usually given as a means of widening the view or depth of the research and to bring a balance to the shortcomings that arise from the application of a single method (Blake 1989; Greene, Caracelli et al. 1989; Rossman and Wilson 1994).

Researchers who intend to apply the mixed methods in their research will have different ways of classifying and describing the combined research methods. The difference in the designs is the level used to prioritise data from one structure to the other, the merging of data structures, the study procedure and at what stage the information will be obtained (the quantitative and qualitative stages may happen simultaneously or may follow a certain pattern and if so, what order will it follow) (Creswell et al. 2004, Datta 2001, Onwuegbuzie et al. 2003, Johnson and Christensen 2004). Several researchers have combined different standards and generated a system that classifies the mixed methods (Creswell et al. 2003, Johnson and Onwuegbuzie 2004). Overall, they are yet to come up with a list of distinct combined strategy design choices, hence the experts have to strategize to generate a style that gives feedback of their research queries within the restrictions and boundaries of the research conditions (Johnson and Onwuegbuzie 2004).

Experts are not in agreement about mixed methods being used to explain the research designs that can be combined through the two strategies within or across the phases of the study procedures. They propose that the terminology mixed models would be the most suitable phrase to different study designs combining qualitative and quantitative data from those that only use the two forms of data. They include transformative designs that remodel data from one form to another so that the data obtained by the combined method designs can be integrated (Caracelli and Greene 1993, Onwuegbuzie et al. 2003).

The word “quantitating” is modified to explain the procedure of changing covered qualitative data into quantitative data while "qualifying" is tuned to explain the procedure of changing quantitative data to qualitative data (Tashakkori et al. 1998). Some researchers have used a mixed method approach, combining qualitative and quantitative data (Adamson et al. 2004 Sandelowski 2000, Weisner 2005). These mixed-method study designs give detailed feedback as well as comprehensive grasp of the study questions by allowing the researcher to explore beyond the challenges of a single method (Sandelowski 2000, Weisner 2005).

For this type of approach, experts recommend employing structured interviews and questionnaires to gather information. These are regularly used to monitor academic motivation and achievement (Brookhart and Durkin 2003, Lai and Waltman 2008). Questionnaires can show patterns amongst a huge number of people, whilst qualitative interview data regularly

gather a comprehensive understanding of the respondent's attitudes, ideas and actions (Kendall 2008).

This research aims to collect detailed data to gain a more holistic understanding of what is being investigated. It will do this by examining the issues deeply and collecting data of various types that can subsequently be explained and clearly presented (Sherry 2009). The next section presents the justification and reasons for the research paradigm with its combined approaches and methods.

3.2.1 THE RESEARCH PARADIGM

Table 3.1 shows the justification and reasons for selecting the pragmatic paradigm as the first step in designing the research methodology as this allows the researcher to identify the approaches and methods to be used for data collection. In this study, 11 strategies were involved that combined the approaches and methods. These are: (1) determining the research areas, (2) identifying the research philosophy, (3) identifying the research approach, (4) defining the research claims, (5) selecting the data type, (6) identifying the mixed methods strategy, (7) selecting the types of research, (8) identifying the research investigation strategy, (9) choosing data-collection tools, (10) selecting the data-collection process, and (11) determining the research design.

Table 3.1: research paradigm, showing the design and strategy for mixed approaches and methods

Research paradigm		
Pragmatism: 1- Problem-centred 2- Consequences of actions 3- Real-world-practice oriented	(1) Allows multiple assumptions and different forms of data. (2) Allows the freedom to choose the techniques, methods and procedures of a study to meet the research needs and purposes.	
Research domains	Healthcare (patient health and safety) and built environment (design and occupancy stages).	
Research approaches	Inductive	Deductive
Research claims	Aim and objectives, problem and gap.	Hypothesis testing.
Types of data	Qualitative data: interviews.	Quantitative data (using a Likert scale).
Mixed methods strategy	Sequential procedures: Explaining or extending the findings of a qualitative method by following up with a quantitative method.	
Types of research	Descriptive:	Analytical research:
	Describing the problem at present.	Using available data and analyses to evaluate findings.
Research investigation strategy	<p>The study attempts to investigate the views of participants based on a literature review. This is achieved through the use of multiple phases of data collection from the interrelationships between:</p> <ul style="list-style-type: none"> (a) AI and healthcare, (b) AI and design defects, (c) design process and design defects. <p>This was done by comparing data differences from five groups across four site studies.</p> <p>Case studies were used to explore in-depth the nature of design defects by collecting detailed information about their causes and sources and by tracking them to flaws at the design stage.</p> <p>The phenomenological approach was used to identify patient experiences with AIs in relation to design issues.</p>	<p>Surveys: Using structured and open ended questions for data collection (Babbie 1990)</p>

Data-collection tools	(1) Interviews; (2) archival research, with focus on images, project designs and text data (3) observations	Questionnaires based on the data from interview questions and case studies
Data collection and analysis process	(1) data reduction, (2) data display, (3) conclusion-drawing, and (4) verification	1. Rating participants' agreement on issues relating to designed environment and the impact of AIs on patient health, resulting from flaws in design processes; 2. Test statistics
Research design	Exploratory: (1) The research design depends on the findings from the literature, interviews, archival study and case studies. (2) Experts in the healthcare and construction sectors will be interviewed for explanation of indirect relationships between the design and healing processes	Conclusive (causal research): identifying the nature of design defects in terms of causes of AIs and their effects on relationships within design and healing processes

3.2.2 DATA COLLECTION APPROACHES AND METHODS

After determining the research paradigm, the justification and reasons for selecting both the inductive and deductive approaches and the mixed method approach are discussed in following sections.

3.2.2.1 MATCHING THE RESEARCH CLAIMS WITH THE INDUCTIVE APPROACH

Table 3.2 shows the justification and reasons for selecting the inductive approach and a mixed method for stages 1 and 2 of the data collections. This is presented through six elements: (1) reasons for selecting an inductive approach, (2) measurements and types of data produced by the selected methods, (3) justifications for choosing those forms of data, (4) the techniques used for collecting data, (5) the types of participants to be selected, and (6) the anticipated outcomes of the research.

Table 3.2: research methodology and strategies for the inductive approach and methods

Type of approach	Inductive Research Design
Why	<p>To find the causes of AIs originating from design issues that impact patients' health and to determine a way of addressing these design defects</p> <p>To study the impact of the design defects in the patient environment on the physical and/or psychological health of patients</p> <p>To explore the meaning of patients' reactions to the perceived design defects</p> <p>To take previously researched into account, phenomena from the architect's perspective</p> <p>To move from data to theory</p> <p>To include observations as part of the data collected</p> <p>To move from the impacts of AIs to the causes (Saunders et al. 2007)</p> <p>To move from the effects of design defects to the causes (Saunders et al. 2007)</p>
Measurement Methods	From qualitative and quantitative methods to qualitative conclusions
Why	<p>To identify patient health issues by moving from events to impacts</p> <p>To obtain a deep understanding (Creswell and Clark 2007) of the impact of design defects on patient health</p> <p>To focus on patient connections with space</p> <p>To combine qualitative research with an inductive approach to reasoning</p> <p>To acquire new information on which conclusions can be based (Saunders et al. 2007)</p> <p>To create recommendations for reducing AIs and design defects and for supporting patient recovery</p> <p>To track the design defects back to issues in the design process</p> <p>To identify sources responsible for design process issues</p> <p>To identify aspects of the design process that enhance patient recovery</p>
How (Techniques)	<p>Participant observations</p> <p>Interview questions (open-ended and close-ended questions)</p> <p>Archival research (incident reports and architectural maps) (Creswell 2007)</p> <p>Eight case studies</p> <p>Grounded theory and Rich picture diagram (RPD) (Sutrisna and Barrett 2007)</p>
Who (participants)	<p>Post-treatment patients</p> <p>Nurses</p> <p>Doctors</p> <p>Medical and non-medical managers at hospitals</p> <p>Maintenance team members</p> <p>Design team members</p>
Why	Direct and indirect connections to patient environment
Expected outcomes	<p>Finding links between:</p> <ul style="list-style-type: none"> • Patient health and safety issues and AIs • AI and design defects • Design defects in the occupancy and design stages <p>Identifying aspects of design process that support the healing process</p> <p>Finding solutions for improving design process to design space free from design defects and to create a therapeutic environment</p> <p>Closing the gap between the design process in the design stage and patient recovery</p>

3.2.2.2 MATCHING RESEARCH CLAIMS WITH THE DEDUCTIVE APPROACH

Table 3.3 presents the justification and reasons for selecting the deductive approach within a mixed method for the final stage of data collection. This is presented through six elements: (1) reasons for selecting the approach, (2) measurements used and types of data produced by selected methods, (3) justification for choosing the types of data, (4) techniques used in data collection, (5) types of participants selected, and (6) anticipated outcomes of the research areas.

Table 3. 3: research methodology and strategy for deductive approaches and method

Type of approach	Deductive Research Design
Why	This study begins with a hypothesis as part of theory (Babbie 2010) Through the data findings collected, the research aims to test the hypothesis (Singh and Bajpai 2007; Creswell and Plano Clark 2007) The collected data are aggregated across design and maintenance teams for comparison (Lomax 2004) The approach will move from theory to data The deductive approach may determine causality (Saunders et al. 2007) The investigation starts from cause and works to effect (Saunders et al. 2007)
Measurement Methods	From quantitative methods to qualitative conclusions
Why	To investigate the relationships between space defects and patient issues (Saunders et al. 2007) Quantitative research adopts a deductive approach to reasoning.
How (Techniques)	Questionnaires Statistics (Trochim 2006)
Who (participants)	Design and study department managers and design team members Engineering management directors and maintenance team members
Why	Maintenance teams deal with the patient environment directly in the operation and maintenance/occupancy stages Design team deals with hospital buildings' design requirements in the design stage
Expected outcomes	Rejection or acceptance of the hypothesis Identification of the strengths of the relationship and the effects between each dependent and independent variable between and within groups

3.3 DATA MANAGEMENT

There are three main stages for collecting data in such a research design. First, an inductive approach is applied to identify the causes, impacts and sources of design defects in order to define and address the design defects. This approach in stage 1 applies qualitative methods (a literature review, archival study, reports and statistical records of adverse incidents (AIS), participant observations in a case study, and interviews) as tools (figure 3.2).

Stage 1	objectives	Data sources	Outcomes
Phase 1 Methods literature reviews	Define research gaps and problem details to establishing links among research areas	Previous studies	Potential links between 5 areas, including: managing pain and stress as results of design issues impacts: (1) immense system and recovery processes, (2) recovery process and AI impacts; (3) AI and design defects; (4) design process flaws and design defects, managing pain and stress as reason to visit and stay in hospital; (5) healing aspects in design processes
Phase 2 Methods Archival research	Objectives 1 and 2	SMOH Reports	identified: Type of Design field issues Design issues results (AIs) Design issues effects on: Patient health Patient safety Treatment plan Missing factors in design stage
Phase 3-1 Methods interview questions	Objectives 1, 2 and 3	39 participants In a case study 1	identified: Type of Design field issues Design issues results (AIs) Design issues effects on: Patient health Patient safety Treatment plan Diagnostic plan Sources of design issues Stressful elements in design
Phase 3-2 Methods Participant observations	Objectives 1, 2 and 3	Redesigned 24 projects In a case study 1	identified: Type of Design field issues Design issues results (AIs) Design issues effects Sources of design issues Stressful elements in design Designers abilities issues Requirement of treatment plan Requirement of diagnostic plan

Figure 3.2: Data collection methods in Stage 1

Secondly, an inductive approach was applied to identify the causes, impacts and sources of adverse incidents in order to define and address the identified design defects in the previous stage. This approach adopted in the second stage of data collection applied qualitative and quantitative methods as shown in Figure 3.3.

Stage 2	objectives	Data sources	outcomes
Phase 1	Objective 3	14 post-treatment patients In a case study 1	identified: Type of Design field issues Design issues results (AIs) Design issues effects Stressful elements in design Healing aspects in design
Methods			
Interview questions			
Stage 2	objectives	Data sources	outcomes
Phase 2	Objective 3	43 healthcare givers In case studies 1 and 2	identified: Type of Design field issues Design issues results (AIs) Design issues effects Stressful elements in design Healing aspects in design
Methods			
Interview questions			
Stage 2	objectives	Data sources	outcomes
Phase 3	Objective 2 and 3	38 participants from design and operation stages in case studies 1, 2, 3 and 4	identified: Type of Design field issues Design issues results (AIs) Design issues effects Design issues sources Healing aspects in design Missing factors in design stage Design issues solution Designer thinking issues Administration roles issues
Methods			
Interview questions			

Figure 3.3: data collection methods in stage 2

Thirdly, a deductive approach using quantitative methods (a questionnaire) was applied to measure relationship between environmental issues and (1) ais and their impacts on patient health, (2) effects of design defects and ais, (3) patient reactions and ais, (4) design process flaws and design defects, (5) sources of flaws in the design stage and (6) healing aspects of design. To ensure sufficient findings from the previous stages of data collection, four case studies were explored (Figure 3.4).

Stage 3	objectives	Data sources	outcomes
Phase 1	Test hypotheses	32 participants from design and operation stages in 4 case studies	understand the difference between the lowest and highest variables values of the design healing aspects
Methods			
Questionnaires			

Figure 3.4: Data collection methods in Stage 3

Data collection in stages 1 to 3 encompassed all main areas of the research and these were investigated from the design and facilities operations' point of view. The research involved seven phases, eight research methods, six types of participants across five locations, and included four case studies, all of which were in the KSA.

3.4 SAMPLES OF THE STUDY

Figure 3.5 presents a framework for the seven-sampling process steps used in this study. These include:

Step 1: identifying the type of population of the study: A population for the research study contains groups of people, events, case studies, observations and outcomes defined in many different ways (Garg 2016; Banerjee 2010). The criteria used in this study to define population are geographic location to conduct the study.

Step 2: defining the type of general target population: the target population is the group on which the research outcomes would be extracted (Stanley 2007). For this study, the groups dealing with Saudi healthcare system are the general target population that selected on base of demographic characteristics (Table 1.1). Furthermore, dealing with the whole of target population is not possible, therefore; it is necessary to identify an accessible population as a subset of the target group (Robinson 1979). For this study, the study population is limited to three four cities within three regions where located in K.S.A as presented in Section 3.11. The selected research samples include six groups of participants and archival studies and possess to the characteristics of the study population (Imelda and Muyangwa 2000).

Step 3: Selecting Sampling frame and unit: Sampling frame is the list of elements/participants under this study (Salant 1974), as presented in Table 3.7. The sampling units are healthcare provider, report, drawing, medical manager, designer and engineer (Table 3.7).

Step 4: defining methods of obtaining samples: participants in this study are volunteers who accept the invitation to be part of this study (Section 3.12). The archival studies were obtained from SMOH (Table 3.7). However, the invitation of participants depends on criteria that mentioned in Section 3.7 for each group of participants.

Step 5: identifying the type of sampling is the basis of selecting the sampling techniques and allows any method of selection based on characteristics of the choice of groups of participants, as detailed in Section 3.7. Therefore, non-probability sampling type is chosen for its association with research design (qualitative and quantitative research). With regards to the selected case studies that tend to focus on different samples to examine the research problem, not to make statistical inferences in relation to the wider population (Yin, 2003).

Step 6: choosing sampling technique: Multi-stage sampling is a method of moving from broad samples to narrow samples by using a stage-by-stage process (Ackoff, 1953). For this study, four stages were involved: selecting three regions, four cities, eight case studies and six groups of participants (Table 3.7).

Step 7: obtaining sample size: The sample sizes of qualitative methods are not concerned with making generalisation to a large size. In this study, the sample size is concerned with gaining an in depth understanding of the research areas and dose not rely on hypothesis testing (Charmaz 1990). In addition, the sample size depends on criteria that mentioned in section to clarify relationships between research areas and to identify issues in design processes (Charmaz, 2006; Morse, 1994, 1995). The questionnaire form involves to domains (operation and design stages) as shown Chapter 11: Table 11.1. The five-point Likert scale (Table 10.1) was used to evaluate the statements in both domains. At least 10 participants per scale item; therefore, 50 participants were required for reliability analysis (Nunnally JC, 1978, as cited in Boateng, Godfred O., et al., 2018). Data collection in all six phases (Section 3.7) continued to saturation and was achieved when further data failed to add new information and relevant data (Strauss and Corbin 1998).

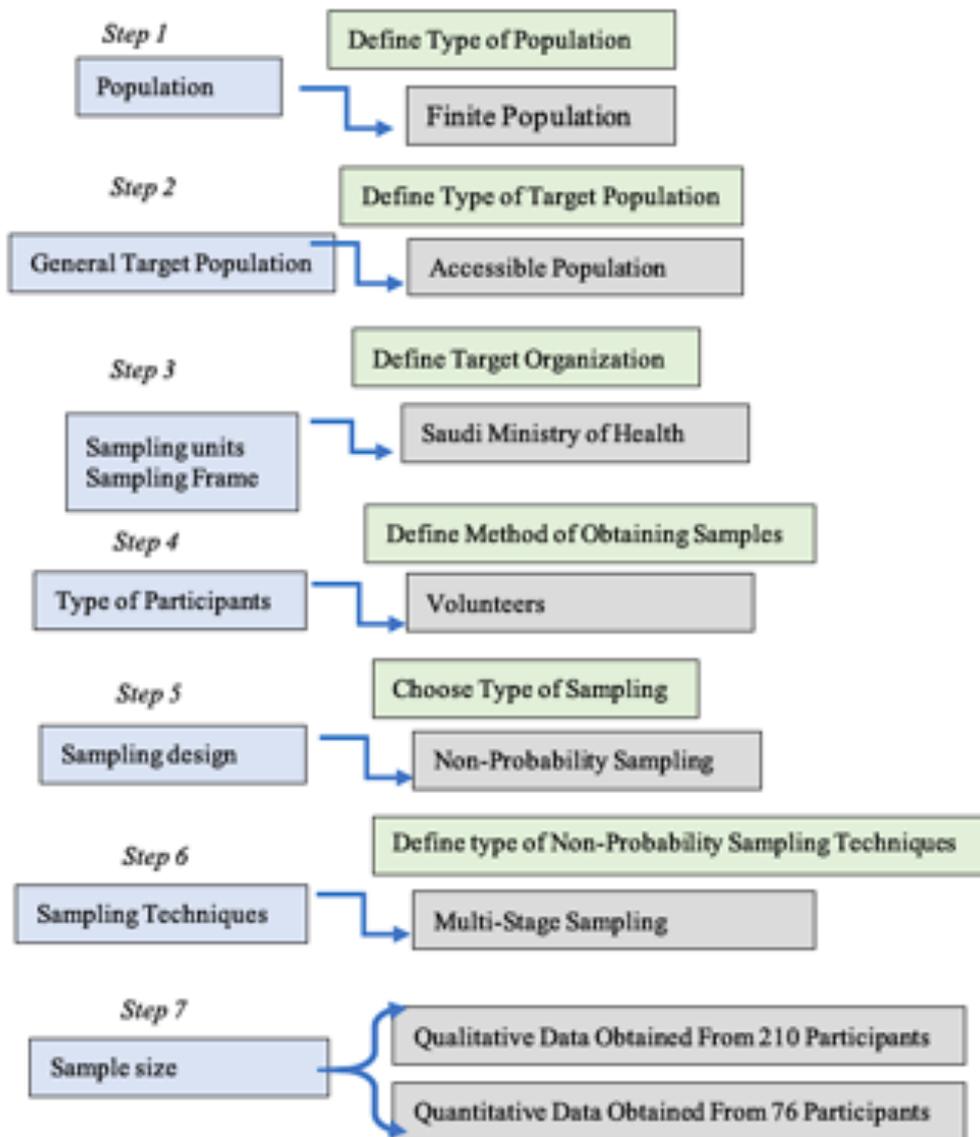


Figure 3.5: Sampling process framework

3.5 DATA COLLECTION

The tools used to collect data are presented in the three following stages:

3.5.1 THE FIRST STAGE OF DATA COLLECTION

This stage includes three phases: *Phase 1* includes *a literature review*. Hart (1998, p2) described a literature review as:

“the selection of available documents (both published and unpublished) on the topic, which contain information, ideas, data and evidence written from a particular standpoint to fulfil certain aims or express certain views on the nature of the topic and how it is to be investigated and the effective evaluation of these documents in relation to the research being proposed”.

Using a literature review as a source of data provides a clear understanding of research gaps and details of problems by gaining knowledge of relevant or recent research studies in a specific area (Burns and Robert 1997). Available and relevant work was investigated to identify the most important criteria linking the design and healing processes, such as the design process flaws, design environment issues and AIs that impact the healing process within the KSA hospital design process.

Archival research technique (ART) (see Schell 1992) used in Phase 2 provides a clear means of studying the Saudi Ministry of Health (SMOH). As explained by Covalski and Dirsmith (1988) and Jermier and Barley (1998), this technique provides invaluable access to data through technical records and reports. In this study, ART was used to describe AIs as the source of the research problem to provide a clear picture of the impact of AIs on patient outcomes, as well as the source of AIs in terms of environment design issues. The data sources in this technique include AI reports (patient safety department), statistical records (Statistics and Indicators MOH), survey archives of accreditation standards (The Saudi Central Board for Accreditation of Healthcare Institutions), Saudi Food and Drug Authority (SFDA), and 80 architectural layouts for different KSA healthcare facilities and departments, images and plans of hospital buildings.

Phase 3 employed a *participant observation tool* during the redesign of 24 internal medical projects and design analysis. A total of 39 participants were interviewed, involving medical managers, doctors and technicians in each project, in one case study. The purpose behind using the participant observation tool to collect data is to gain a more accurate understanding of common issues under investigation, to avoid the limitations of other methods and make the study as objective as possible (Musante DeWalt and DeWalt 2002). Participant observation can be used as a way to maximise the validity of the collected data (Lincoln 1985). Additional strategies used with observations (archival study, surveys and interviews in a mixed methods approach) increase the validity of the tools of data collection (Lincoln 1985).

Participant observations can be used to help answer descriptive research questions, to build theory, or to generate or test hypotheses (DeWalt and DeWalt 2002). Collecting different kinds of data related supports a clear understanding and interpretation of the nature of AIs initiated by design defects in healthcare facilities from multiple perspectives (Sherry 2009). Data collected were used as a basis for formulating the interview questions during the second stage.

3.5.2 THE SECOND STAGE OF DATA COLLECTION

Data from Stage 1 defined design defects and the impacts of AIs in the context of the Saudi hospital design process. Stage 2 builds on the achievements of Stage 1, to formulate interviews in three phases, by targeting participants in a way that is able to reflect the nuances of their professional fields, the nature of their work experience and their backgrounds.

Phase 1 includes interviews with 12 patients who were able to identify design defects, the impact of AIs on patients' health, and reactions to discomfort in designed space. They were able to narrate their understanding regarding mechanisms of the response of their senses to different aspects of design. Post-treatment patients were selected on the basis of their length of stay in hospital so that the study could identify their in-patient resource needs at the time of receiving care. An understanding from this would help the research to shape in-patient care in future hospital design.

Phase 2 comprises interviews with 43 healthcare providers in three case studies to identify the nature of design defects, impact of AIs on patient health and patient demand in future hospitals.

Participants were nurses, medical managers and doctors selected from different departments, and were selected because they have a direct connection with the designed environment and are responsible for patients' health and safety.

Phase 3 comprises interviews with 38 participants in two groups: (1) hospital maintenance team members responsible for operating and maintaining care facilities and are able to identify the design defects in the occupancy stage; and (2) the design team members responsible for hospital design.

Data collection in all six phases continued to saturation and was achieved when further data failed to add new information (Strauss and Corbin 1998).

3.6 TECHNIQUE FOR ANALYSING QUALITATIVE AND QUANTITATIVE DATA

Qualitative and quantitative data analysis were applied in this study using four techniques. Scoring systems used for quantitative data analysis as detailed in section 3.8.3. Figure 3.6 shows the raw data model to analysis qualitative data as first technique.

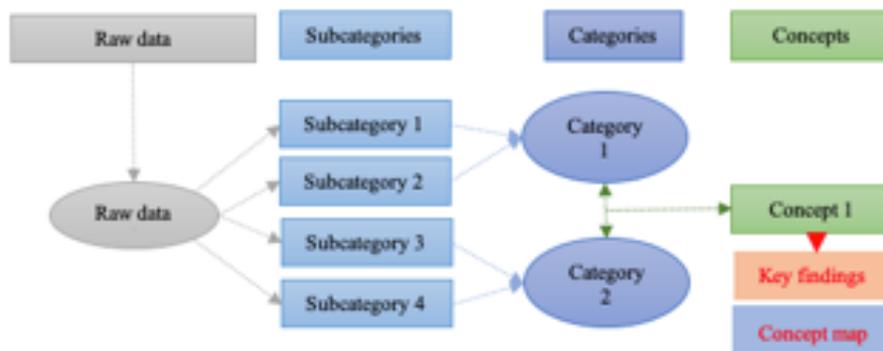


Figure 3.6: First Key technique of qualitative data analysis

The categorisation system of raw data involves five steps. These steps are:

- 1) grouping the raw data of each phase in data collection stages to sort them by topic
- 2) organising each topic of raw data into subcategories that related to the research areas
- 3) combining two or more subcategories into one category
- 4) combining two or more categories into one concept

5) from each concept, the key findings were presented as conceptual framework within the research area (see categorisations of data for phases 1-7 of appendix d:)

Figures 3.7 and 3.8 show an example of how data were extracted from the unstructured interview questions and observation in redesigning 24 projects as described in chapter six: sections 6.2 and 6.3.

Design elements of previous unit	Design elements of current unit	Requirements of participants
Exam Rooms	Exam Rooms	Exam Rooms
Inadequate	Women Waiting Area	Women Waiting Area
Inadequate	Unavailable	Men Waiting Area
Inadequate	Women Toilet	Women Toilet
Unavailable	Unavailable	Intercom/Program (ICCO)
Unavailable	Unavailable	Drainage
Inadequate	Unavailable	Nurse Office
Unavailable	Female Staff Changing Room	Nurse Station
Unavailable	Female Staff Toilet	Female Staff Changing Room
Unavailable	Unavailable	Female Staff Toilet
Unavailable	Unavailable	Blood Extraction
Unavailable	Unavail	W/ Waiting Blood Extraction
Unavailable	Dirty Utility (dressing)	Dirty Utility
Unavailable	Unavailable	Wash Utility
Unavailable	Unavailable	Cardiology Room (CBAM)
Cardiography (CTG)	Unavailable	Cardiography (CTG)
Visiting Indicator Room	Unavailable	Visiting Indicator Room
Unavailable	Unavailable	Supply scope Room
Unavailable	Unavailable	Treatment Room
Unavailable	Doctor Lounge	Doctor Lounge
Unavailable	Doctor Office	Doctor Office

Figure 3.7: Second key technique of qualitative data analysis

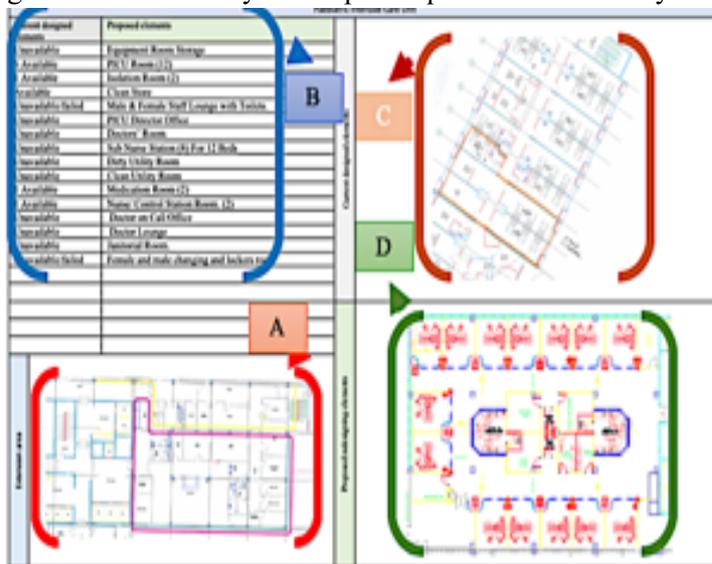


Figure 3.8: Third key technique used in the participant observation analysis

3.6.1 THIRD STAGE OF DATA COLLECTION

The findings of stages 1 and 2 formed the basis for formulating a questionnaire for stage 3 of data collection. The questionnaire was administered to two groups of participants. The first group were members of the maintenance team responsible for the operation and maintenance stage (and for managing design defects) in care facilities. Their roles include operating and maintaining facilities' critical systems and equipment, both in the form of general maintenance of the built environment and the maintenance of medical equipment and allied operational systems. The second group were the design team members responsible for the design stage of a new hospital (design process flaws usually originate from them). Participants were also selected from high-level staff members in the SMOH and public authorities involved in the planning and design department of three KSA regions where the eight case studies were drawn. Data from this were used to test the research hypotheses. In particular, findings from the data were aimed at determining the difference between elements of the healing aspects of design. They were also targeted at analysing the design-process flaws and their sources during the design stage, as well as design issues and the impact of ais on patient health in the occupancy stage. The relationship between these elements of research findings may give a clear picture of the relationship between critical considerations in design processes and occupational outcomes amongst care receivers and care givers, using inferential statistics (spearman's rank correlation coefficient).

3.6.2 THE STATISTICAL PROCESS AND TOOLS USED FOR HYPOTHESES TESTING

The process of statistical design and the tools used for the testing of hypotheses are described below.

3.6.1.1 STATISTICAL QUESTIONS

- How do participants evaluate the research areas – AIs, flaws in design processes, healing potential of design, and impact of designs on health?
- What is the relationship between design perceptions and maintenance outcomes, using the views of participants from the participant observation stage of the study?

3.6.1.2 RESEARCH HYPOTHESES

The research hypothesis are as follows

Null Hypothesis [H_0]: There is no significant relationship between design and maintenance teams' decisions in the research areas.

Hypothesis 1 [H_1]: The mean of maintenance team's agreement is the same as mean of design team's agreement in the research areas.

3.6.2 SCORING SYSTEMS

The first section of the questionnaire collected participants' demographic information and was not scored. However, the second section of the questionnaire measures the agreement level in 15 pillars of the research. Each statement was evaluated using a five-point Likert scales (Likert 1932) as shown in Table 3.5.

Table 3. 4: Criteria used for data analysis

Likert-Scale	Interval scale	Deference	Description	Interval level or weighted mean	
1	1.00 – 1.79	0.79	Strongly Disagree	1.00 – 2.59	Low
2	1.80 – 2.59	0.79	Disagree		
3	2.60 – 3.39	0.79	No Opinion	2.60 – 3.39	Moderate
4	3.40 – 4.19	0.79	Agree	3.40 – 5.00	High
5	4.20 – 5.00	0.80	Strongly Agree		

The data obtained using the questionnaire tool was analysed in terms of means, standard errors, variances and standards deviation. The weighted mean and standard deviation calculated from the means of each observation or variable is shown in Appendix D: Part B. The Excel Microsoft Programme was used to compute the data. The various formulae used for data analysis and testing of hypotheses are shown in Table 3.6.

Table 3. 5: Statistical formulae used

Mean, $\mu = \frac{\sum x}{n}$	
Variance, $S^2 = \frac{\sum(x - \bar{x})^2}{(n - 1)}$	
Standard Deviation, $S = \sqrt{\frac{\sum(x - \bar{x})^2}{(n - 1)}}$	
$\alpha = \frac{\kappa}{\kappa - 1} \left(1 - \frac{\sum_{i=1}^{\kappa} \sigma_i^2}{\sigma_x^2} \right)$	Cronbach's alpha reliability estimate (Cronbach 1951)
$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n^3 - n}$	Spearman's rank correlation
$z = \frac{(x_1 - x_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n} + \frac{\sigma_2^2}{n}}}$	Z-test (Pagano 1990)

3.7 ETHICAL CONSIDERATIONS

To interpret interviewee's perceptions of hospital design processes as way of enhancing patient health, the researcher selected three public hospitals as case studies. Post-treatment patients, healthcare providers, design and maintenance teams were involved in providing data for this study.

The patients were interviewed according to the requirements of patient safety and quality of the Department of Social Services, Admissions and Discharge Office and Public Relations. Ethical requirements of the research were as outlined by Saudi Ministry of Health in (SMOH) and Curtin University Human Research Ethics Committee.

During the interviews, the researcher considered grievous experiences that post-treatment patients may have suffered in the course of receiving care at the hospitals used for the study. Care were given so as to ensure the interviews did not offend, upset or frighten participants. Participants' health, safety and sensitiveness were the researcher's primary concern (Milne and Powell 2010).

Written permission was obtained from the Curtin University of Technology and SMOH. Interviewees assured that their responses are voluntary and that they have the right to withdraw

from the study at any time. Interviewees also guaranteed anonymity and confidentiality. Letter of authorisation to conduct research at the Saudi Ministry of Health was obtained also. Ethical approval, recruitment material and the consent and participant information statements can be found in Appendix A.

3.8 CASE STUDIES

This study involves eight case studies in three different regions in KSA (Table 3.7):

- The southern region comprises three case studies: two hospitals and the administration of SMOH in Al Baha and Baljurashi.
- The eastern region comprises two case studies: one hospital and the administration of MOH in Jeddah.
- The central region comprises three case studies: six administrative sections of the Saudi Ministry of Health, Saudi Food and Drug Authority, and Saudi Central Board for Accreditation of Healthcare Institutions in Al Riyadh.

Table 3.6: details of the case study

Region	Case studies	Data sources	No. of participants / materials	Stage	Phase	Method	
South Al Baha City	Case study 1: King Fahad Hospital and Medical Tower	Architectural drawings	41	1	1	Archival research	
		Medical managers and technicians	39	1	3-1	Interviews	
		Projects	24	1	3-2	Participant observations	
		Post-treatment patients	14	2	2	Interviews	
		Healthcare givers	24	2	2	Interviews	
	Case study 2: Engineering Affairs General Administration	Maintenance team	3	2	3	Interviews	
		Maintenance team	30	3	1	Questionnaires	
		Design team	2	2	3	Interviews	
		Design team	6	3	1	Questionnaires	
Baljurashi City	Case study 3: Prince Mishari General Hospital	Healthcare givers	19	2	2	Interviews	
		Maintenance team	14	2	3	Interviews	
		Maintenance team	14	3	1	Questionnaires	
East: Jeddah City	Case study 4: East Jeddah Hospital	Maintenance team	2	2	3	Interviews	
Central: Al Riyadh City	Case study 5: Engineering Affairs General Administration	Design team	7	2	3	Interviews	
		Design team	3	3	1	Questionnaires	
	Case study 6: General Administrations in Saudi MOH:	Design team	10	2	3	Interviews	
		Design team	23	3	1	Questionnaires	
		1. Engineering Affairs	Architectural drawings				
		2. Equipment	Architectural drawings	39			
		3. Studies and Designs	Books	2			
	4. Information and Statistics						
	5. Quality and Patient Safety	Reports	4				
	Case study 7: Saudi Food and Drug Authority	Reports	3				
Case study 8: Saudi Central Board for Accreditation of Healthcare Institutions	Reports	1	1	1	Archival research		

3.8.1 SOUTHERN REGION

Data were gathered from archival study and five groups of participants (medical managers, healthcare providers, maintenance and design teams and post-treatment patients) in the three case studies.

Case study 1: King Fahad Hospital (KFH) and Medical Tower had many development stages to extend the healthcare services starting in 1981. These stages included increasing the bed capacity from 160 to 400 beds. In the last two decades, five buildings have been added to the main hospital: a day surgery unit, a diabetic centre, a dialysis building with a capacity of 40 beds, and a training and education centre. The fifth stage of development was the Medical Tower (64 beds), operating in 2014 with a budget of USD 27,000,000. Currently, all medical and non-medical units of the main hospital are being redesigned to increase the bed capacity, extend the current departments and provide new medical units and equipment after moving 38 clinics to Medical Tower. For studying and redesigning 24 projects in this study, participant observations method was applied.

According to the local press (Al-Bahatoday, 2018; Al-Madina, 2014), this hospital suffered from many issues that may relate to design issues affecting the healthcare services and causing adverse incidents (AIs). These issues include the breakdown of an elevator causing the eight women and a man to be trapped, water leakage in the pharmacy department and the visitor waiting area, interruptions in the main water and power supply, and a low bed capacity which increased pressure and resulted in refusing many patients. The hospital appears to be unable to provide healthcare services that suit the large numbers of patients and visitors. Many modifications have been made to this hospital, which contributed to the delay in the delivery of healthcare services meaning that many of the local people are still visiting hospitals in major cities for treatment and diagnosis that are not available in this hospital. In addition, it took six months for the Medical Tower to be fully operational because of a delay in equipment. Local patients experienced a long wait for appointments that may exceed five months due to the growth in patient numbers. 13 babies in NICU were in serious danger because of an issue in the oxygen system.

To investigate these issues in the first case study, data were collected from four groups using seven qualitative and quantitative methods in three stages of data collection. In the first stage,

an inductive approach was applied using qualitative (combined) methods: (1) archival study (41 architectural drawings), (2) unstructured interviews with 39 medical managers and technicians, and (3) participant observation of the redesigning of 24 projects in KFH. In the second stage, both inductive and deductive approaches were applied using semi-structured interviews. This mixed approach involved four qualitative and quantitative methods: (4) semi-structured interviews conducted with 14 patients, (5) semi-structured interviews conducted with 24 healthcare providers, (6) and semi-structured interviews conducted with three participants from the maintenance teams. In the third stage, (7) a deductive approach was adopted using quantitative methods with a questionnaire completed by 30 participants from the maintenance team.

Case study 2: Data were gathered from two groups of participants at the Engineering Affairs General Administration (EAGA) who were responsible for design stage. In the second stage, semi-structured interviews conducted with two participants from the design teams. In the third stage, a deductive approach was adopted using quantitative methods with a questionnaire completed by six participants.

Case study 3: Prince Mishari General Hospital (500 beds) in Baljurashi operated in 2016 with budget of USD52,000,000. This hospital faced many design issues affecting the delivery of healthcare. These issues include rainwater entering the emergency department (ER) and preventing services, the hospital operated without water supply for 15 hours, and a lack of diagnostic and treatment units, and medical equipment. There was a two-year delay in provision of healthcare services to complete the construction stage (Al-kabarnews, 2017; Al-Madina, 2014).

Three methods were used in two stages of data collection to investigate this case study. The second stage of data collection involved applying qualitative and quantitative methods: (1) semi-structured interviews conducted with 19 healthcare providers and (2) semi-structured interviews conducted with 14 participants from the maintenance team. In the third stage, (3) a deductive approach was adopted using quantitative methods with a questionnaire completed by 14 participants from the maintenance teams.

3.8.2 EASTERN REGION

Data were gathered from two groups of respondents in one city from two case studies (East Jeddah Hospital (EJH) Engineering Affairs General Administration)

Case study 4: East Jeddah Hospital (500 beds) operated in 2016 with budget of USD57,240,000. From the history of this hospital, many design issues exposed patients to danger and prevented the provision of healthcare services. There was a suicide when a patient threw himself from the third-floor window because of a lack of a private room that met the safety and security requirements preventing patients with psychological problems from harming themselves (Sabaq, 2016). There was a lack of sterilization devices to prevent the spread of infection (Qadaya, 2020). Other issues were the low privacy level for surgical patients with no dedicated pathway to move patients to the theatre (Profilenews, 2020) without crossing other paths, a low capacity of beds in intensive care, operating rooms, the obstetrics and gynaecology department and emergency unit, and a lack of safety design requirements to evacuate patients (Adwaalwatan, 2020).

Two methods of data collection were used within two stages in the case studies 4 and 5 to investigate these issues. In the second stage of data collection involved applying combined qualitative and quantitative methods: (1) A semi-structured interview conducted with two participants from the maintenance team. In the second stage, (1) semi-structured interviews conducted with seven participants from the design teams in case study 5. In the third stage, *Case study 5*, (2) a deductive approach was adopted using quantitative methods with a questionnaire completed by three participants from the design team in Engineering Affairs General Administration.

3.8.3 CENTRAL REGION

Data were gathered from two groups of design teams and archival studies from three case studies in one city (Table 3.7).

Case study 6: Saudi Ministry of health: Three methods were used to investigate the research problem. In the first stage of data collection, an inductive approach was applied by applying qualitative (combined) methods: (1) archival study, including 39 architectural drawings and

report of AIs obtained from General Administration of Quality and Patient Safety, Equipment General Administration, Studies and Designs General Administration, Information and Statistics General Administration, Saudi Food and Drug Authority (*Case study 7*), and Saudi Central Board for Accreditation of Healthcare Institutions (*Case study 8*). In the second stage, *in case study 6* (2) semi-structured interview questions tools conducted with 10 participants from design team. In the third stage, (3) a questionnaire was completed by 23 participants from the design team. The two design teams were drawn from three administrations that are responsible for designing new healthcare facilities or developing existing buildings at SMOH.

Figure 3.9 presents the data collection flow of the study showing how each case study was investigated to fulfill the research objectives. Data from eight case studies (A) were gathered from five groups of participants in four cities. Area (B) presents the five main sources of data collection. The arrows indicate the data flow from each case study using the data sources to achieve the objectives and to test the hypotheses (C) (as detailed in Chapter 1: Section 1.4). Using seven qualitative and quantitative methods of data collection in a number of case studies is aimed at improving hospital design by identifying the type of design field issues, design issue-related AIs, the effects of design issues on patient health and safety, missing factors in the design stage, sources of the design issues, stressful elements in design, issues regarding designers' abilities leading to flaws in the design stage, and the requirements of diagnostic and treatment plans.

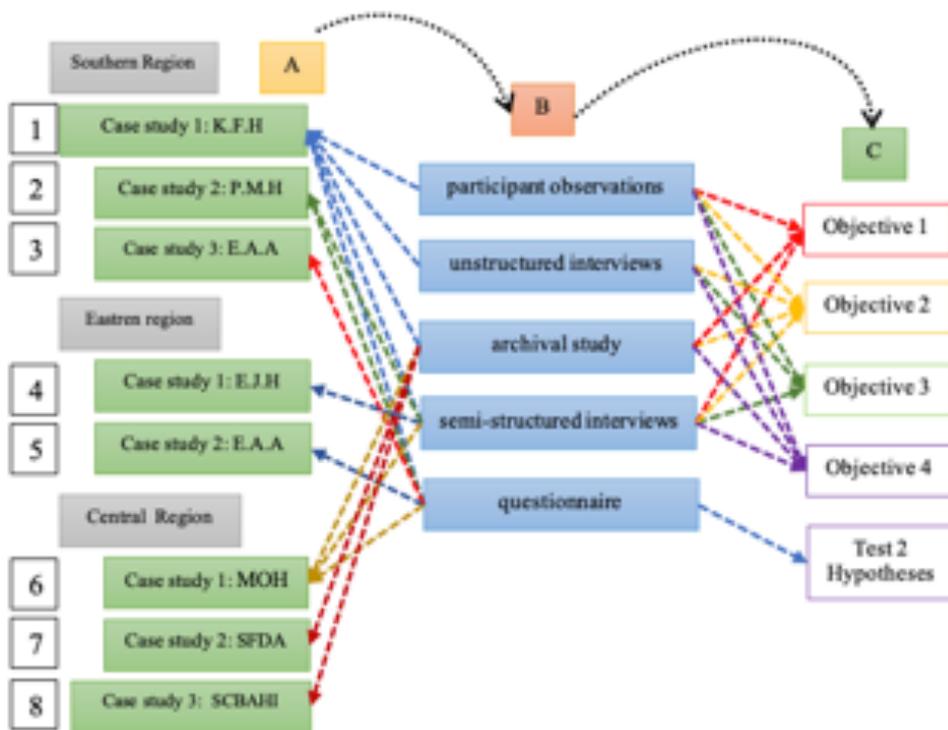


Figure 3.9: Data collection flow linking case studies, data sources and objectives and hypotheses

Table 3.7 shows the timetable of data collection activities in month from 2018- 2019.

Table 3. 7: Timetable of data collection activities

Year		2018					
Month		Jan.-Feb.	Mar.-Apr.	May-Jun.	Jul.- Aug.	Sep.-Oct.	Nov.-Dec.
Activities							
Stage 1	Phase 1						
	Phase 2						
	Phase 3-1						
	Phase 3-2						
Year		2019					
Month		Jan.-Feb.	Mar.-Apr.	May-Jun.	Jul.- Aug.	Sep.-Oct.	Nov.-Dec.
Activities							
Stage 2	Phase 1						
	Phase 2						
	Phase 3						
Stage 3	Phase 1						

3.9 RESEARCH INSTRUMENTS

This section presents the research instruments used to collect data (interview questions, observation and the questionnaire) as well as their advantages and disadvantages. It is also worth noting that the design of the research instruments and how they were applied have been guided by the works of Zohhrabi (2013).

3.9.1 THE INTERVIEW QUESTIONS

According to Burns and Robert (1997) and Burns (1999), question and answer sessions are among the known and applied methods of obtaining text statistics from the field. In this particular method, the investigator aims to collect information and data from specific groups dealing with a designed physical environment and needs the data to be accurate. Participants were observed or interviewed in their usual environment so that the information could be as precise as possible. With that understanding, Flick (2018) adds that the main aim of the interview is to use questions that can uncover the data in the form of answers to facilitate easy and quick interpretation.

There are various types of interviews; the decision on the type of interview to use is driven by study's motives, the type of data that the researcher intends to collect and the phenomenon that is being investigated. The use of interviews has many advantages (Johnson and Turner 2003). These advantages include:

- They are appropriate for testing the interviewee's attitude and other areas of interest.
- They provide the opportunity to examine the authenticity of the interview.
- They are successful at obtaining information.
- They give the researcher the chance to interpret the information and ask for clarity in ambiguous areas.
- They help in measuring the validity of the information provided by the respondent.
- They help the researchers to receive high feedback for the entire question that they ask.
- They enable the researcher to go beyond the set questions and dig deeper for more relevant information.

Interviews also involve challenges, and these include:

- They are time-consuming and they are expensive to conduct because the researcher may have to travel to the location of the interview.
- The respondents may not be willing to open up to strangers
- For interviews where the researcher uses open-ended questions it can become challenging and tedious to analyse and interpret the feedback.

Two approaches were used to conduct the interviews. In the first approach, individual interviews were conducted with participants in Phases 1 to 3 of Stage 2. The second approach involved group interviews with participants in Phase 3 of Stage 1.

To allow flexibility, Bell and Waters (2014) encouraged the combination of structured and unstructured interview questions (yes or no, rating scale and open-ended questions). This was used in Phases 1 to 3 of Stage 2. Open-ended questions were set before the interview and were arranged in a particular order. For this study, particularly in Phase 3 of Stage 1, the casual open question and answer sessions used did not follow any particular order nor employ predetermined questions to dig information from interviewees – these are medical managers, doctors and technicians. The three questions arose as the researcher engaged participants in friendly talks (see interview questions in Phase 3 of Stage 1 of Appendix B:). The researcher made the respondents feel free to open up on even the most sensitive issues about design issues in their units. Most new researchers find it challenging to conduct this type of interview (Merriam 1998). This is because open-ended questions are giving respondents the freedom to express themselves, but limiting the researcher to triggering such expressions and listening. To deal with this limitation, the interviews involved a direct question to respondents, asking them to express their thoughts (e.g. What are your thoughts about how AIs affect the physical and psychological health of patients in the occupancy stage?). “This interview contains many boring questions”, some of participants commented during the sessions. As a result, some participants withdrew themselves from the interview. This kind of feelings may occur as respondents lose concentration, or found the questions irrelevant to their experiences; thus, some of them chose to withdraw from the interview. However, the type of interview used is mostly preferred as it allows the interviewee to have room to reflect and offer thorough information.

The diverse questions (yes or no, rating scale and open-ended questions) in this study provided the researcher with the ability to deal with explicit intention to obtain reliable data from the interview. As the participants were Arabic-speakers, the interviews and other data collections tools were conducted in this language.

In this study, multiple questions were used, such as “Can you tell us what things in your designed environment and components made you uncomfortable or comfortable regarding your sensory systems (listed below) and why? Leading questions were used also, such as “Who was responsible for the incidents that affected your health during hospitalisation?”. Examples of Yes or No question used in the study include “Did you ever feel unsafe, stressed or at risk in relation to the design and components of your environment during this hospital stay?”. Rating questions used include “Please indicate/discuss the level of effectiveness of the design process type that you have used in order to solve design issues or create a new design?”

Moreover, the researcher focused on finding out the knowledgeable and appropriate respondents who have precise information through inclusive and exclusive criteria. To obtain significant, extensive and quality data that are reliable and valid, the researcher selected the participants carefully. The essential strategy used was to select knowledgeable participants according to their experience, background and professional fields in dealing with patients, their environment design and care needs. The second strategy used was to introduce the research objectives and why they were invited to be part of the study – for more details, see Chapter 3: Section 3.10: Stage 1 to 3 for information on participants’ background and participations.

During the interview, the researcher considered a variety of factors in the process, including the need to:

- develop a pleasant environment in which the participant can express their views
- create a trusting environment.
- provide the participants with the scope of the study to help them express their opinion
- be non-judgmental but embrace neutrality in the interview process
- create rapport
- not interrupt the respondent during the interview when expressing their opinion or facts
- guide them and explain the question when they tend not to understand the question

- take into consideration the fact that they may not wish to answer every question.

The interview data were recorded using a voice recorder and were transcribed thereafter. In addition, notes were taken. Analysis was by three key techniques to analysis qualitative and quantitative data. The findings are reported in Chapters 4 to 8.

3.9.2 OBSERVATIONS

Participant observation was used to collect data for this study. According to Burns (1999), a researcher should observe interaction and events taking place in reality and deduce findings from this experience. Participant observation presents the researcher with the opportunity to combine it with interviews and questionnaires to collect first-hand information (John and Turner 2003). Thus, observation provides data triangulation for substantiating outcomes. The observers study the subject variables being investigated to gain information about the actions of the subject actors and the way they react to the design of physical environment of a care facility.

The observation approach has strengths and weaknesses. In particular, analysing the observational data can become challenging as it is time-consuming. Also, there is the possibility that the researcher as designer might be biased, reactive to the designers. However, being biased with this tool, the researcher only blamed the designers for the design defects that occurred during the analysis to conform to the research objectives and scope and identify the valid information and data. The key priority is to select observations to record by taking the notes that are pertinent to the research objectives. Thus, the researcher tried to control their bias to get accurate and relevant information, rather than according to their own opinions.

In this study, two approaches used during the data collection process were non-participant and participant approaches. In a non-participant approach, the observer is actively concerned with only watching and recording the activities and events occurring in the environment, without being involved (Fraenkel and Wallen 2003). As an example, in Case Study 2, whilst visiting the Emergency Department of Western Jeddah General Hospital, the researcher observed the oral triage station next to the main entrance and diagnosis unit. Thus, if a visitor had an infectious disease, they are isolated in a separate waiting room until their final blood test results were known. This appears appropriate; however, a design issue was noted as these patients had

to cross another waiting room before accessing their own waiting area. The danger in this instance is that the ventilation and air conditioning systems in the waiting areas are shared with the whole hospital, possibly leading to the spread of infection throughout the hospital.

The second method used in this study is participation, in which the researcher was part of the design team activities. They interacted with the designers, healthcare providers, and other parties that were responsible for hospital design, operations and maintenance. Burns (1999) suggests that it is an option for the observer to be a member of the context in participating in the activities and the culture of the setting. Also, Flick (2006), emphasised that the observer obtains first-hand information through verbal cues and the information that the participants share.

Participant observation requires the researcher to pay attention to specific details to record them objectively in order to reduce bias. Fraenkel and Wallen (2003) proposed two kinds of observations: the “narrow focus” and “broad focus”. A narrow-focused observation concentrates on a particular issue, while the broad focus considers the overall activities that are happening in the whole environment. Factors determining what should be observed include the goals of the observer, the research objectives, the field of study, practical issues and researcher’ subjective impressions (Merriam 1998).

3.9.3 QUESTIONNAIRES

Questionnaires have proven to be one of the most reliable primary methods of collecting data during research. However, the crucial part in developing a questionnaire is to ensure that it is valid, reliable and definite. There are three types of questionnaires:

- structured questionnaires (close-ended)
- unstructured questionnaire (open-ended)
- a combination of structured and unstructured questionnaires (semi-structured).

The main purpose of close-ended questionnaires is that they provide the researcher with quantitative data, while open-ended questionnaires provide qualitative text. Blaxter et al. (2006) grouped questionnaires into seven common question types: quantity or information, category,

list or multiple choice, scale, ranking, complex grid or table and open-ended questions. Many of these formats were applied in this study.

The different types of questionnaires have their advantages and disadvantages. Seliger and Shohamy (1989) suggested that close-ended questionnaires are more effective because they are easy to analyse and interpret. Gillham (2008) noted that open-ended questionnaires are the most effective because they lead to discovery and a better understanding of the research questions. However, such questionnaires are difficult to analyse and interpret and may be challenging to report and discuss and compare with interview data (Alderson 1996 and Gilham 2008). An important aspect is that the responses reflect the thoughts and views of the respondents without any external influence. A combination of both types of questions may be most effective.

A well-developed and designed questionnaire has many advantages such as

- it is an effective way of gathering data from a wide study area.
- it can be sent concurrently to many individuals.
- experts can use them to quickly and easily collect data.
- individuals can easily give their independent thoughts.
- using the same questions with a large number of respondents results in findings of high accuracy, validity and reliability.
- it is time-saving for research that involves a large population.
- close-ended questionnaires allow quick, easy analysis and interpretation.
- it can cut research costs.

Some disadvantages with the application of questionnaires in data collection should be taken into consideration. According to Gillham (2008) and Brown (2001), they include;

- answers may be inaccurate and questionable.
- usually, a low return rate when sent by post or email.
- ambiguity and a lack of clarity of questions might lead to inaccurate and unrelated responses.
- some questions may cause misunderstanding.
- the wording of the questions might affect the responses.

- the wording of the questions might influence how the respondents respond.

In this study, the questionnaires were given by hand. This method ensured that the response rate was high and any issues regarding the questions could be clarified as stated by National Oceanic and atmospheric administration (NOAA) (2015). Potential low response rate and opportunity for clarification if a respondent doesn't understand a question (mail), participants can end the call at will (phone), they can easily terminate survey before completion (web survey and time consuming (post) are reasons for not using other methods to collect questionnaire data.

3.10 RELIABILITY AND VALIDITY IN MIXED METHODS

The various methods used in this study for collecting data can support each other and lead to improved rationality and reliability of information (Zohrabi 2013). This is a major process that requires the collection of quantitative and qualitative data in line with the research objectives as well as the knowledge gaps, the research problem and how the research hypotheses had been tested.

3.10.1 VALIDITY

Validity is concerned with whether the research can be believed or is true or can evaluate the objective set in conducting the study. Burns (1999) maintains that validity is significant to help assess quality and research acceptability. Therefore, the quality of the data collecting method is crucial since the conclusion drawn depends on the information collected (Fraenkel & Wallen, 2003).

3.10.1.1 INTERNAL VALIDITY

The research congruency depends on the internal validity of the information obtained from the sample size. Furthermore, the internal validity takes the nature of the observation information and its relation to the intended objective of the measurement taken. However, to increase validity, Merriam (1998) six methods: triangulation, member checks, long-term observation on the setting of the research, peer examination, collaboration, or participatory and biasness of the researcher.

Triangulation, which aims at strengthening validity in the data and results (Merriam 1998). In this study, the researcher gathered information from different sources including a literature review, archival study, participant observations, interviews and questionnaires. When the data are collected using a single method, the results may be criticised due to bias or weakness (Merriam 1998). Therefore, using a variety of sources and different methods of collecting the information can confirm the finding and enhance validity. Similarly, if the data collected from the various sources are the same, data validity is assured. The triangulation method helps to corroborate the finding through data gained from qualitative and quantitative methods (Merriam 1998).

Member checks: the results of the interviews and the redesigned projects were given back to the interviewees and participants for confirmation. By doing so, the information can be verified as trustworthy and reliable.

Long term observation: The researcher visited 26 projects over three months and the redesign of 24 types of medical and non-medical projects to acquire the information required by this research. However, the researcher had planned to measure the difference in the instances of design defects and AIs between the current designed projects and the new designs by measuring the time of the recovery process and the quality of healthcare services provision, if he had had more time.

Examination by Peers: Research data were reviewed by construction management and internal architecture supervisors from the School of Design and the Built Environment, Curtin University, as well as by the design and maintenance teams for each case study and by members of the Plans and Design General Administration at KSA Ministry of Health. However, the collected data were not reviewed peers outside the field of study because of the specialised nature of the findings.

Participative or collaborative modes of research: Five types of participants were involved in all stages of this study in order to gather results that are reflective of the perspectives of a variety of participants (Lynch 1996). Group 1 comprised medical managers, technicians and doctors, Group 2, post treatment patients, Group 3, healthcare providers, Group 4, maintenance teams

and Group 5, design teams. Therefore, involving five different groups of participants was very essential for the validity of the findings of the study (Lynch 1996).

Researcher's bias: Every researcher has their own unique set of beliefs and values. However, the researchers must do their best to make sure that the collection, analysis, and interpretation of the research data does not have any kind of bias (Merriam 1998). The researcher tried to conduct the study explicitly, critically and faithfully during all the stages of the study.

3.10.1.2 EXTERNAL VALIDITY

Another factor that considered is external validity. The main concern is how applicable the findings of the survey are in different contexts or participants. According to Burns (1999), external validity is more concerned with how the research can be generalised to different subjects and environments, depending on the similarities between two or more contexts. This study was designed in such a way that it could be generalised to other contexts (Nunan 1999). Most of the findings of this study are supported by similarities in the results of other research (for more details, see Chapter 4: Stage 1: Phase 1: literature review data analysis).

3.10.2 RELIABILITY

Ensuring that the collected data and subsequent research findings are reliable is a critical area of research. For research to be reliable, the results have to be highly consistent, dependable, and replicable (Nunan 1999). Research should be more concerned with how reliable or consistent the data are rather than focusing on attaining matching outcomes (Lincoln and Guba, 1985). It is therefore important to ensure dependability and consistency and that the data have been obtained using reliable methods. Through proper training and practice, the reliability of participants as an instrument of data collection can be enhanced (Merriam (1998). Three techniques, *the investigator's position*, *triangulation* and *audit trail* are the measure of the reliability of the researchers (Lincoln and Guba 1985, Merriam 1998).

Regarding *the investigator's position*, the researcher provided a sufficient explanation and clear elaboration of the various procedures and stages involved in the study. Regarding *triangulation*, the researcher collected data using various methods of collection from seven sources, thereby

ensuring the validity and reliability of the outcomes. Finally, *the audit trail* required the researcher to clearly provide and explain sufficient details of data collection, methods of analysis and ascertaining results (for more details, see Chapter 3: Research methodology design and strategy for mixed approaches and methods).

3.10.2.1 EXTERNAL RELIABILITY

External reliability is about how the results of the research can be replicated in other areas and on different subjects. As noted by Burns (1999), the investigator needs to ask the question if another research conducted by a different result would produce similar results to the ones provided in the initial study. According to observations made by LeCompte and Goetz (1982), external reliability of a study is enhanced when investigator is able to follow five fundamental phases of an inquiry. These include the researcher's status, the kind of informants they select, the situations and conditions in the social context, analytical constructs and premises, and the approaches used by the researcher to collect and analyse data.

In this study, the researcher introduced themselves to the respondents at the beginning of the interview. Consents were obtained and documented (see Appendix A, which displays all recruitment materials and the ethics approval requirements).

Participants in this study were described comprehensively within the seven phases in three stages of data collection. In this manner, it would be easier for any subsequent researchers to replicate the results with ease and certainty.

In addition, data collections were carried out in two layers. The group of participants with higher academic qualifications (Group 1) e.g. medical managers; healthcare providers (Group 3) and maintenance and design teams (Groups 4 and 5). Questions posed to participants from these groups involved some medical and academic terms which participants who were not as educated may not be able to answer. Participants in Group 2 are in the second layer – they are less knowledgeable in medical practice e.g. post-treatment patients. The questions they answered were redesigned so that they are easy to understand. For example. The question “were there any adverse incidents that harmed your recovery process; if so, how?” was changed to “were there any events that had caused you a significant negative feeling in the cause of the

recovery?”. Moreover, each group of participants had common questions that introduces the research areas at the start of the interview so that participants can keep their answers within research scope.

The researcher also ensured all the essential terms, units used for data analysis, the definition of terms and constructs were made clear, and any assumptions made in the research process were made elaborate. In addition, the researcher ensured all the methods and procedures employed in the data collection process were explained clearly. Descriptive, inferential and correlational statistics analyses were used for quantitative data analyses, whilst qualitative data analyses used descriptive and interpretive methods.

3.10.2.2 INTERNAL RELIABILITY

Internal reliability explains the consistency of data collection, analyses, and interpretations (Zohrabi 2013). This is achieved when another researcher who did not take part in the initial study is able to come up with similar results and findings after reanalysing the information collected. The main question, according to Burns (1999), is whether similar results can be arrived at by another researcher if they use similar methods of analysing information in the original research. The researcher in the present study has employed the four fundamental techniques suggested by LeCompte and Goetz (1982) to evade any threats that would lower the internal validity of the study, namely: making use of descriptors of lower influence, the use of various researchers and study participants, the examination of the results by independent peers, and the use of data that is recorded mechanically.

In this study, *Low inference descriptors* was used because they were easy to observe, and were not difficult to quantify; implying that measuring and counting of these descriptors were easy to achieve (Richards & Schmidt, 2002). Using data that are easy to observe and quantify makes the results of a study easy to replicate in other settings by other independent researchers. However, the measuring the aspects of feelings, thoughts and thinking among participants were not easy to quantify, so rating questions was applied (see Appendix B: Interview questions).

Multiple researchers' strategy: in the words of Nunan (1999), it is not practicable in most of the research to have multiple participants and researchers as it can be very costly. However, the

investigator has a professional supervision in all field of expertise to assist him in making observations and giving comments throughout the stages of collecting, analysing, and interpreting data. Therefore, this research involves more than one researcher as the supervision team was able to confirm the analyses, understood and validated the conclusions arrived at in this study.

Examination by Peers strategy: According to Lecompte and Goetz (1982), this technique is easy to achieve when the researcher utilises the research findings by other researchers who have carried out studies in a similar field. The researcher incorporated the findings and conclusions arrived at by other researchers in the results and discussion chapter. Therefore, the investigator used the relevant findings from other studies in same fields of this research to ensure that the internal reliability of the tools is attained.

Mechanically recorded data: the investigator used voice recorders and written notes to record all the interviews and observations. Consequently, the raw data stored well so that other researchers can reanalyse the data. Furthermore, the results of the researcher can be replicated later by other researchers who did not take part in the initial study. Mechanically storing data plays a crucial role in ensuring that the data and findings attain high levels of internal validity (Lecompte and Goetz 1982). This technique is achieved as part of Curtin University requirement (see Appendix A: Part C: Research Data Management Plan).

3.11 SUMMARY OF RESEARCH METHODOLOGY

This chapter contains a detailed analysis of the pros and cons of the various methods used in collecting data for this study. The tools were the literature review, participants observation, archival study, interviews and questionnaires, as shown in the introduction. Mixed-method approaches were used in this study so as to increase the reliability as well as the validity of the data collected. Inductive and deductive approaches were implemented to achieve the aim and objectives of the research. In particular, inductive approaches were used to identify the causes, impact and sources of design defects in order to define and address the design defects. This was adopted in the first stage of data collection by applying qualitative methods: a literature review, archival analysis of reports and statistical records of adverse incidents (AIs). In addition, participant observation, interviews and archival study were used in a case study.

In addition, a deductive approach using quantitative methods (questionnaire) was applied to measure the relationship between environmental issues and: (1) AIs and their impacts on patient health, (2) effects of design defects and AIs, (3) patient reactions and AIs, (4) flaws in design processes and design defects, (5) sources of flaws in design stages and (6) healing aspects of design that can be linked to issues in Saudi hospital design processes.

Statistical questions were explained. Tools used for hypothesis testing were described in a tabulated form. The rating scale used in scoring system that was designed for evaluating each questionnaire response was described. In addition, methods of statistical analysis were also enumerated. Finally, advantages and disadvantages of all research instruments were presented in this chapter also.

4.0 RESEARCH CONCEPTUALIZATION AND FRAMEWORK

4.1 INTRODUCTION

This chapter presents the framework for the analysis of Stage 1 of the research (see Chapter 3). It involves four phases, namely: literature reviews, archival studies, interviews and participant observations, all of which are aimed at achieving the research objectives (Figure 3.2). From a review of the literature the research gaps, as noted in Chapter 1, were defined as the design process, the impact of the built environment on recovery, the design considerations for healing and the care management in health facilities.

The purpose of the analysis is to gain knowledge from recent studies in a specific area of this study. In particular, the chapter focuses on reviewing the research literature regarding pain and stress and on identifying important areas that may link the design and recovery processes. It builds on Chapter 2 with a view to establishing how the variables logically link the research areas together, as follows:

- A. Managing pain and stress as a result of the impact of ais:
 - I. Recovery process and the impact of ais;
 - II. AIs and design defects;
 - III. Flaws in the design process and design defects,

- B. Managing pain and stress as a reason to visit and stay in hospital by suggesting aspects in design processes to support recovery; and

- C. Conceptualising the research problems.

4.2 MANAGING PAIN AND STRESS RESULTING FROM THE IMPACT OF ADVERSE INCIDENTS

As stated in Chapter 2, pain and stress arising from illness and disease compel patients to visit hospitals. In order to manage pain and stress as a result of design issues, four mechanisms were identified from Chapter 2: (1) the impact of AIs on recovery; (2) AIs that originated from design issues; (3) flaws in the design process that led to design issues; (4) sources of flaws in the design process.

4.2.1 IMPACT OF ADVERSE INCIDENTS ON RECOVERY

Section 2.4 provides information regarding how AIs impact the recovery of hospital patients. The section concluded that AIs can cause infections through avoidable exposures (including to biological agents such as viruses or bacteria), through mechanical agents that cause slips, trips and falls, through difficulties with chemical agents such as medication and care administration, or through medical equipment (AIHW 2015). AIs had physical, psychological and financial impacts on patients as a result of pain, stress and prolonged stays (Adams et al. 2009). The physical impact includes increasing disability and decreasing activity and the financial impact increases the healthcare service costs (Linton 2000). The psychological impact involves anger, stress, depression and fear of injury (Lumley et al. 2011, Lucchetti et al. 2012). Both pain and stress are known to impede the recovery process (Pasero et al. 1999, McCaffery and Pasero 1999, Linton 2000, George and Hirsh 2009, Lumley et al. 2011). These impacts can affect the immune system by increasing the respiratory rate, fever, heart rate, blood pressure, and oxygen demands. This may lead to a poor recovery and cause delays in patients returning to their daily activities (Gouin and Kiecolt-Glaser 2011, Linton 2000).

Improving the design process may depend on identifying the impact and type of AIs originating from design issues that result in the pain and stress (see Figure 4.1). Figure 2.7 had shown how the research data were extracted to determine the impact of AIs cycle on patient recovery and healthcare. As noted earlier in Chapter 2: Section 2.4, AIs that originate from design defects often manifest as infections, patient falls and medication errors. The impacts of AIs on patients can be physical injury, psychological stress, financial burden (i.e., care service expenses), and extended care service provision.

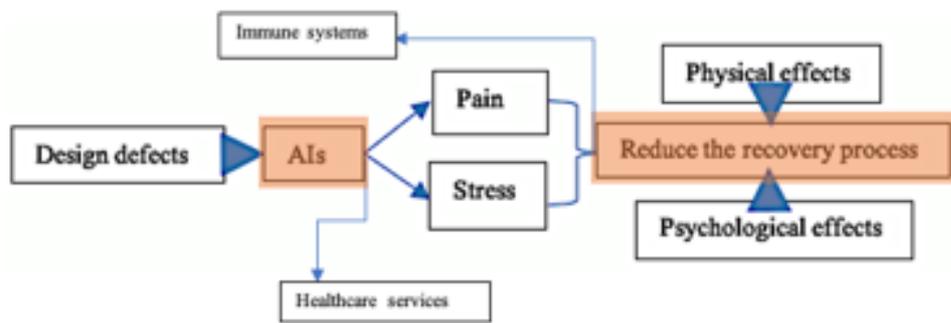


Figure 4.1: potential link between ais and recovery processes

4.2.2 ADVERSE INCIDENTS AND DESIGN DEFECTS

Section 2.4.2 provides a background to how design defects contribute to pain and stress amongst receivers and givers of healthcare. AIs from design defects may originate from caregivers whilst rendering services and from exposure of patients to unnecessary and harmful risks in the care environment (Moullin 2002). As noted in Chapter 2, designers of healthcare facilities can only be interviewed if severe cases take place due to the designer's negligence (Mohammed and Hassanain 2010). According to Gabrielli (2010), architects are responsible for providing healthy and safe building designs because of their experience, training, responsibilities, legal requirements and input in the design stage. Many AI events that happened are in hospital facilities – see West (2006) and WHO (2002) who argue hospital facilities have a huge number of medical services and surroundings where extreme AIs happen.

Table 4.1 shows the possible relationship between common forms of AIs, design defects and flaws in the design process. The table also presents four processes of tracking design defects back to their sources in the design stage; viz through the analysis of the symptoms of AIs, manifestations of design defects in the operation stage, flaws in the design process and the source of design flaws. The purpose of this relationship is to help identify the link between design and patient recovery. For example, infections could occur as a result of flaws in the design process when a designer does not allow for structural expansions in walls (source of flaws), causing a lack of thermal movement in the care facility (process flaw). This results in structural cracks that allow water leakage, thus affecting building surfaces with moisture and rust stains. In this case, wall cracks create an enabling environment for fungal growth, possibly causing infectious diseases. Tracking AIs like the examples above is considered as a strategy

to track design defects from the data collected and the findings described in subsequent chapters.

Table 4. 1: Possible link between ais and design issues in the occupancy stage

Adverse incidents	Symptoms of AIs	Design defects	Design process flaws	Source of flaws
Infection	wet areas lead to fungal growth	Cracking in walls	Lack of thermal movement	ignoring thermal expansion
Fall	Feet lose traction on floor surfaces	Slippery floors	Incorrect material selected	Unclear specifications
Medication error	Loss of medication information	long paths low level of lights		Ignoring distance between patient spaces and medication rooms

4.2.3 FLAWS IN THE DESIGN PROCESS AND DESIGN DEFECTS

The relationship between conceptual inputs during design stages and how they are revealed in the operation stage is presented in section 2.3 and Figure 4.2. The predesign and design stages are depicted in Figure 4.2 (and Figure 2.4 which has been described in detail in section 2.3). The Figure also illustrates the outputs in the occupancy stage, which include elements, components, spaces, critical systems and equipment. The concept map (Figure 4.3) demonstrates how design defects can be traced back to the design process. Evidence from chapter 2 demonstrates that the majority of defects that occurred in the occupancy stage arose from flaws in the design and construction process.



Figure 4.2: conceptual framework 1- the links between design inputs and outputs

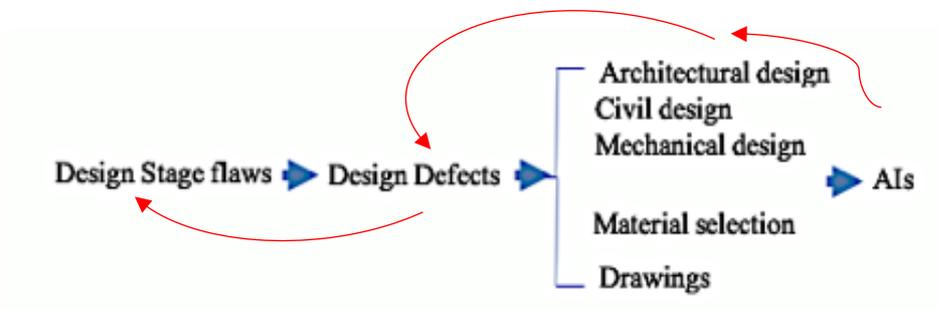


Figure 4.3: types of design field defects

Further to the explanations presented in section 2.3.3 regarding manifestations of design defects in the occupancy stage, this current section presents the mechanism by which flaws in the design process manifest into different forms of design defects and ais (see Figure 4.3). According to Hoe (2009), most building defects result from flaws in the design process.

From section 2.4.2, the conclusion is that ais can be determined from design defects. This study is able to track three forms of ais affecting patients viz infections, patient falls and medication errors. Figure 4.4 presents sources of flaws from design defects within the design process that lead to infections, falls and medication errors and how they originate from design defects first, diseases are spread as a result of poor ventilation and bad temperature control and the use of inferior materials and these design defects can be tracked back to four flaws in the design stage:

- 1) *the functional programming process* e.g. lack of activity assessments required to identify infection controls;
- 2) *the design development process* e.g. the layout of mechanical designs does not include pressure zones in the required spaces;
- 3) *the feasibility study* e.g. the absence of a site analysis to assess the impact of sunlight and fresh air flow on the health of patients;
- 4) *space programming* e.g. the lack of capacity required for the ventilation system to deal with infectious diseases.

Second, falls may result from design defects which can be tracked back to the following flaws in the design stage:

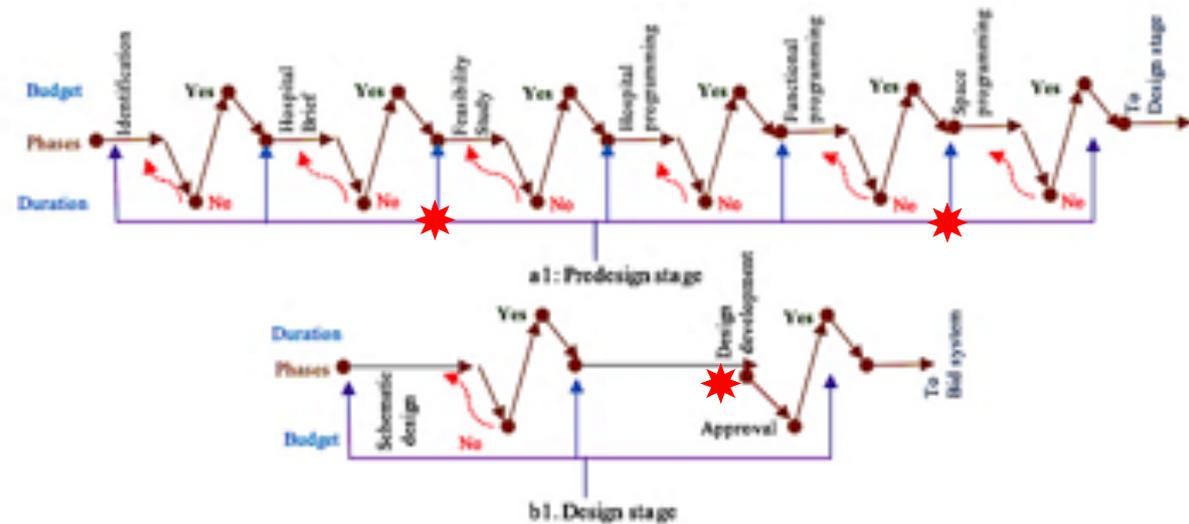
- (1) *the schematic design process:*
 - (a1) poorly justified material selection and system specifications to meet patient health, safety and security standards, or
 - (b1) unclear justifications in the selection of specifications for materials and systems used to avoid falls.

Third, medication mistakes may result from design defects which can be tracked back to the following flaws in the design stage:

- 1) *hospital building programming* e.g. the flow and circulation required in a hospital was not considered to minimise crossing points within the movement of patients and healthcare givers;

- 2) *functional programming* e.g. the lack of a proper study into the circulation requirements needed to establish a link between the clinical, treatment and diagnostic departments in short distances;
- 3) *space programming* e.g. a lack of the required number and types of staff working to provide adequate spaces and sizes for free movements and to avoid the disruptions during the provision of medical services.

Figure 4.4: Sources of design defects within design process flaws



4.2.4 FLAWS IN DESIGN PROCESSES AND THE RESPONSIBLE PARTIES

In Section 2.3.3, possible sources of design flaws were presented. Most defects were caused by flaws during the early stage of design (Al-Shiha 1993). The elements accountable for these flaws are attributable to the thinking strategy of designers who may not scrutinize the design process adequately (Ishak et al. 2007) or who may be insufficiently qualified (Al-Farra 2011).

From the keywords presented in this section (Section 4.2.4), Figure 4.5 illustrates the sources of flaws in the design process, including:

- 1) the design team's abilities, skills, knowledge, experience and thought processes;
- 2) the role issues amongst parties that are responsible for managing the design team, including the provision of adequate structural designs and the hiring of qualified architects and building system design professionals;

- 3) an inadequate quality control program for the design stage;
- 4) unavailability of design information such as a lack of information on social considerations, satisfaction level and thinking of users, a lack of information of the functional requirements of buildings in brief projects and a lack of feedback between the design and maintenance teams.

The question from this synthesis is: how can issues with design thinking be measured?

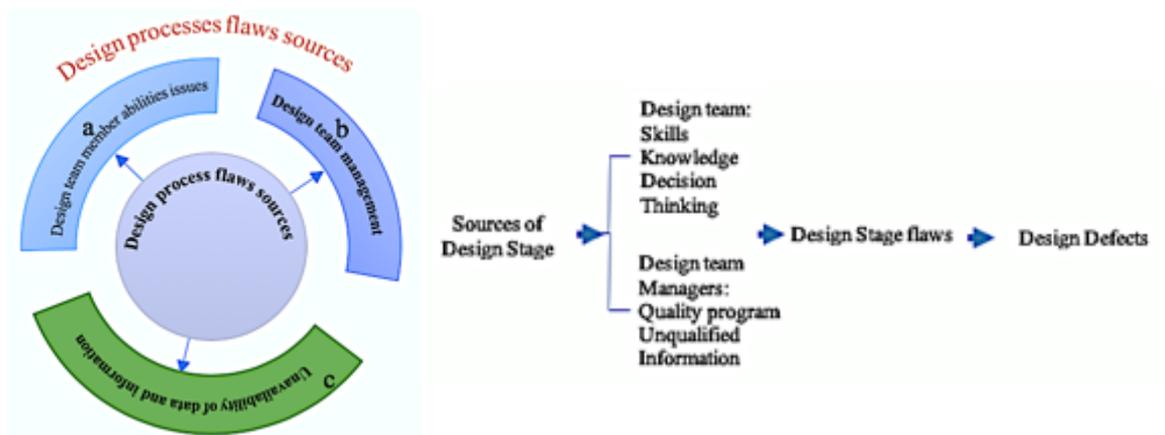


Figure 4.5: conceptual framework 2 – sources of flaws in design processes

4.2.5 ISSUES IN DESIGN THINKING

In Section 2.3.4, flaws in the design process were related to design strategy. Figure 4.6 shows the tools and factors underlying design thinking and how they may trigger design flaws. The illustration shows the link between design thinking through the design process, and how design methods, thinking and strategies are used to deal with design issues. The figure also applies to how design issues can be used to measure issues in design thinking involving selections of solutions in the three areas of design methods, design thinking and strategies and hospital design principles:

- a. Solutions to design issues within the *design process methods* which include linear; divisional; centralized, cyclical and investigative design processes methods.
- b. Solutions to design issues within the selection of *thinking strategies* that include lateral, visual, design principle and standards and group discussions thinking strategies.

- c. Solutions to design issue within *hospital design principles* that involve lean healthcare, patient-centred care, evidence-based design, salutogenic design and the healthcare system.

In all, flaws in design thinking can be recognised from designers' choices regarding design processes and methods, as well as implementation strategies and hospital design principles.



Figure 4.6: conceptual framework 3 - design issue solving selections and designer thinking

4.3 MANAGING PAIN AND STRESS AS A RESULT OF BEING HOSPITALISED

In order to manage or reduce pain and stress during hospital care, this section presents two main concepts of the study. First, taking into consideration the five senses of patients during the design process can play a positive role in supporting the recovery process and in creating healing spaces as a result of construction and design. Second, ais can play a disruptive role in patient recovery through stress and pain.

4.3.1 RECOVERY PROCESSES AND ASPECTS AND DESIGN PROCESS

Sections 2.5.2 and 2.5.3 outline the several factors that designers must take into consideration whilst developing ideal healthcare facilities to reduce the pain and stress produced by the health problems which will support recovery (Figure 4.7). The Figure shows the links between three areas of research:

- (a) patient sensory systems,
- (b) healing aspects of designs,
- (c) design processes

Patients' senses are sight, hearing, smell, touch, and taste. These senses react physically and psychologically and both positively and negatively to the design elements of the environment. Aspects of environmental design involve social, spatial, luminous, thermal, audio, safety, security, freedom, and objects usage through which patient's sensory systems react with design elements. These design aspects should be considered in the early stage of design, to support the psychological and physical effort that enhance healing.

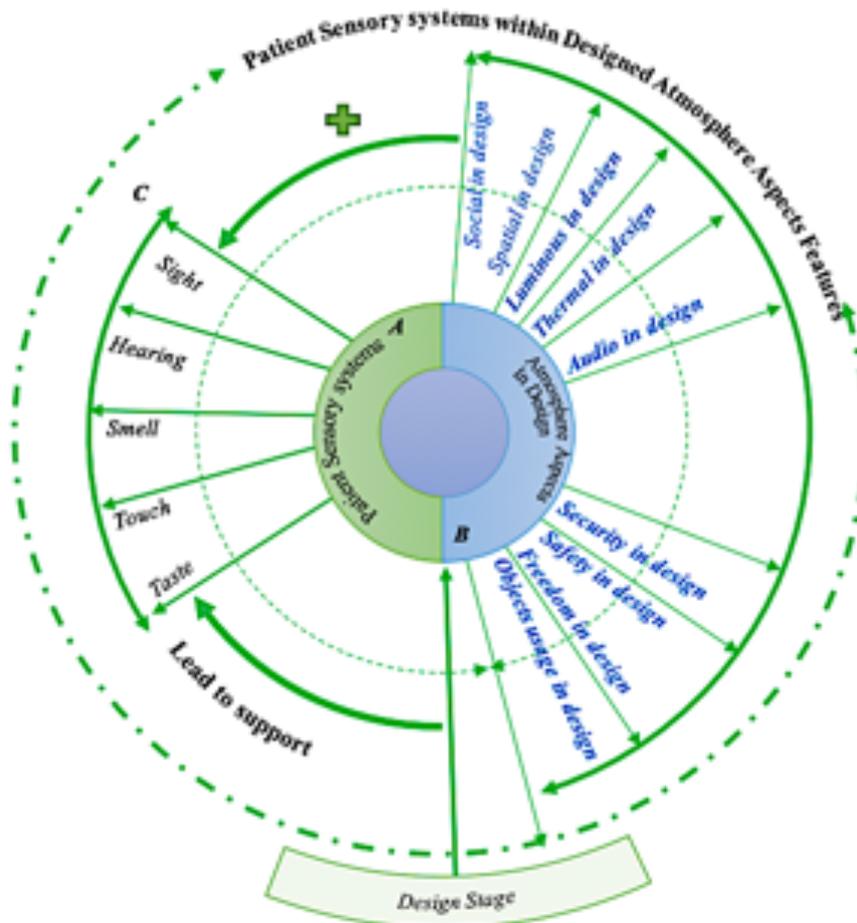


Figure 4.7: conceptual framework 4 - aspects of healing in design

4.4 THE LINK BETWEEN THE RESEARCH AREAS

Figure 4.8 shows key issues extracted from chapter 2 to represent the potential link between design and recovery. This chapter has defined four areas relating to designed spaces, including:

- a) AIs that originate from design issues and impact patient health, safety and the care services they receive (see Figure 4.1);
- b) forms of design issues in the occupancy stage which include five types of design fields (Figure 4.3);
- c) by tracking these design issues, design flaws can be traced to early stages in the design process (Figure 4.4);

- d) AIs triggered by design issues may relate to issues with (1) design teams' abilities (skills, knowledge, thinking and experience), (2) administration management and (3) lack of required data and information before or during the design phases (Figure 4.5);
- e) aspects of environmental design which explain how patients' senses react to design elements (Figure 4.7).
- f) factors underlying design thinking and how they may trigger design flaws

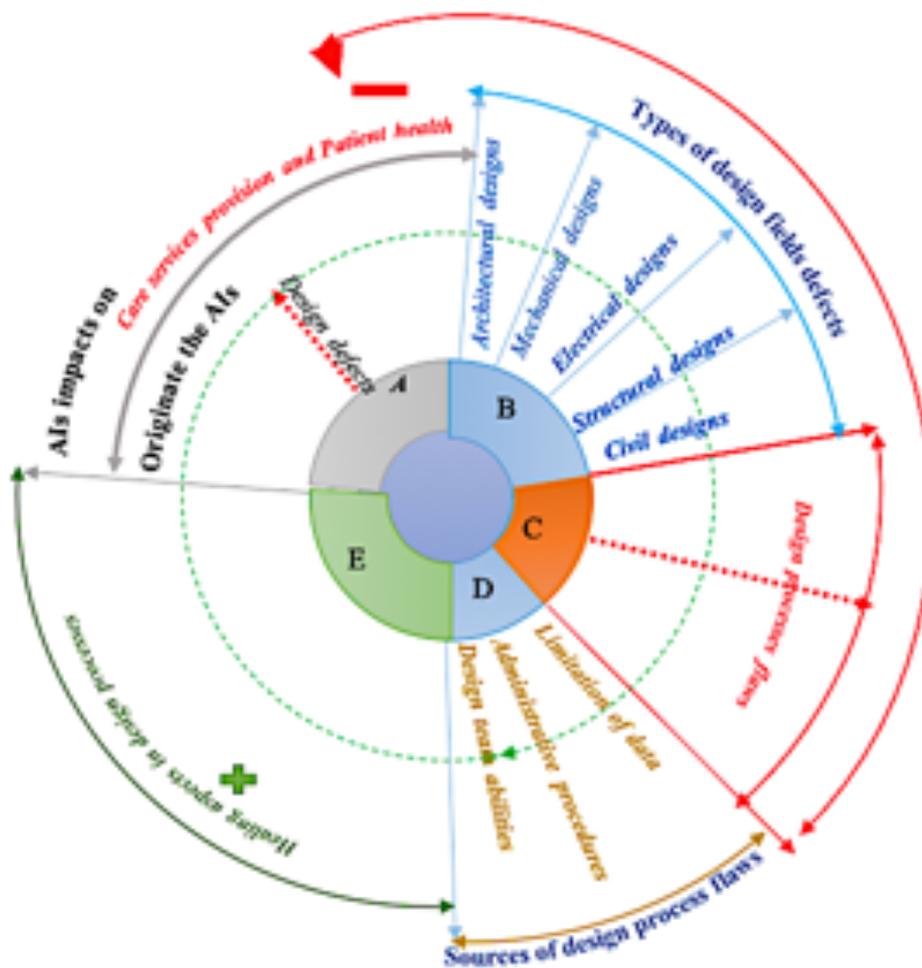


Figure 4.8: conceptual framework 5 - the links between ais and design processes

4.5 SUMMARY OF RESEARCH SCOPE

This chapter builds on Chapter 2 in two ways. It further defines the research areas regarding the impact of design issues on recovery and care service, forms and sources of design defects, and the link between design defects and flaws and healing. In addition, the chapter determines the research investigation areas by tracking the origins of AIs in design defects in relation to design thinking and processes. Available and relevant works in the literature reviews have not identified many important criteria required for this study. For example, specific concepts for identifying flaws in hospital design process, design defects and impact of AIs in hospital are not available. In addition, information on harm level and location of AIs are not identified. How patients respond to designed space with their sensory systems and the effects of design defects on patients are unknown. This is because most of the studies present the design defects from the perspectives of maintenance cost. However, the way of responding is not identified to define design elements in healing processes. In the context of the design issues for Saudi hospitals, the types of defects, AIs and data of design process flaws are also not available. Most importantly, this chapter presents the scope of the research areas: (1) AIs and their impact on patient health, (2) effects of design defects and AIs, (3) patient reactions and AIs, (4) flaws in design processes and design defects, (5) sources of flaws in design stages and (6) healing aspects of design that can be linked to issues in Saudi hospital design processes. In addition, the presentation of findings in this chapter, was identified within six areas and illustrated in Figures 4.2- 4.8, is the way of presenting the findings of data analysis of next chapters. The next chapter presents the findings of the analysis of archival data from the Saudi Ministry of Health, as shown in Figure 4.9.

Stage 1	Objectives	Data sources	Outcomes
Phase 2	Objectives 1 and 2	SMOH Reports	Identified: Type of design field issues Design issues results (ais) Design issues effects on: Patient health Patient safety Treatment plan Missing factors in design stage
Methods			
Archival research			

Figure 4.9: phase 2 of stage 1 - data analysis and findings

5.0 ANALYSIS OF ARCHIVAL DATA

5.1 INTRODUCTION

This section presents findings from the analysis of archival data to achieve the research objectives. Approval was obtained from the Saudi ministry of health (SMOH) – see appendix a for copy of the recruitment materials. The purpose of the approval sought is to gain a clear understanding from SMOH’s historical records about ais, design defects and care environment and outcomes. Such data sources include reports of patient safety generated from case studies 1, 6 and 7, located in the three regions which are the focus of this study (see Section 3.10). In addition, statistical records, survey archives of accreditation standards and 80 architectural designs of different Saudi healthcare facilities and departments were also examined. These include images and modification plans of hospital buildings to analyse the contemporary design process of public hospitals. Additional sources were interrogated to identify the factors underlying patient health and safety in the occupancy stage as well as to identify the roles of responsible parties at different stages of design processes in preventing initiated ais design issues.

5.2 BACKGROUND OF ARCHIVAL STUDY’S DATA

Table 5.1 provides the sources of archival data (administrative units) and lists the target outcomes in the context of buildings design issues and the circumstances of AIs. 12 reports and 80 architectural designs were made available for the analysis.

Table 5.1: sources of archival data

Units visited in Saudi Ministry of Health	Target outcomes
Administrative unit	
Researches and Studies General Administration	Previous studies discussed parts of the research problem and/or knowledge gap
Patient Rights and Relations General Administration	Any complaints related to the research problem (AIs)
Safety and Security General Administration	What investigations revealed on the reasons, causes, impact and corrective actions for AIs
Information and Statistics General Administration	Types, number of AIs and general/specific information about KSA hospitals (numbers, sizes, types of current and future hospitals)
Financial affairs General Administration	The justifications, procedures and criteria to approve and establish a new hospital
Infection Control General Administration	The criteria required to control infection within hospital design, used materials, devices and equipment
Quality and Patients Safety General Administration	Collecting data of AIs, patient safety and health standards
The Saudi Central Board for Accreditation of Healthcare Institutions (CIBAHI)	Collecting data of AIs, patient safety and health standards
Food and Drug Authority	Collecting reports related to AIs
Legal Affairs General Administration	Any lawsuits relevant to the research problem
Equipment General Administration	Requirements of medical furnishing for hospitals relating to hospital design issues
Maintenance General Administration	Requirements, needs and demands in hospital design related to AIs
Studies and Designs General Administration	Saudi hospital design processes, procedures, criteria, needs, justifications and demand for new hospitals, Hospital design standards and design of selected hospitals
Planning - General Administration	Criteria, needs, justifications and demands to plan for future hospitals

5.3 ARCHIVAL DATA

Table 5.2 presents a summary of the archival data consulted during 2017 and 2018. Data were obtained on general administration of quality and patient safety, occurrence variance reports (OVR) of 25 hospitals, investigation reports by Saudi food and drug authority (SFDA) on medical device incidents and adverse incidents, and risk assessment reports (RARS) on 274 hospitals by SCBAHI. Hospital design documents were accessed from equipment general administration, whilst information and statistics general administration provided access to 3 reports about Saudi healthcare facilities. All the documents consulted are available in part a of appendix a.

Table 5.2: summary of archival data

Report name	Coverage
Occurrence variance reports ¹	Reports of AIs received from 25 hospitals
Risk Assessment Reports ¹	1. 447 AIs received from hospitals in Hassa region 2. 25 AIs received from hospitals in Al Jouf region 3. 3941 AIs received from hospitals in Al Riyadh
Investigation of medical advices incident ⁴	AIs involving medical equipment in KSA (pictures)
Risk Assessment Report ³	Risk levels of 274 Saudi hospitals
Hospital designs ⁴	80 architectural designs
Administration policies ⁵	Saudi Design hospital processes, procedures
Annual Report of SMOH ⁶	Hospitals numbers, sizes, types.
Summary report ⁶	Future hospitals
Health Statistics annual book ⁶	General information on the healthcare sector in KSA
Manager’s statement to the Researcher ⁷	“13 Saudi hospitals without fire protection system and 63 without fire sprinkler and smoke-control systems”

Data sources

¹ General administration of quality and patient safety
² Medical devices sector, Saudi Food and Drug Authority (SFDA)
³ Saudi Central Board for Accreditation of Healthcare Institutions
⁴ Equipment general administration of Saudi MOH
⁵ Studies and Designs General Administration of Saudi MOH
⁶ Information and Statistics General Administration
⁷ Safety and Security General Administration

5.4 ANALYSIS OF ARCHIVAL DATA

5.4.1 SAUDI HEALTHCARE SYSTEM

Figure 5.1 shows the 13 healthcare regions in ksa. Each region has independent management boards that are responsible for designing, establishing and operating healthcare facilities in each region. According to smoh’s annual report (2017), there are 2,127 healthcare facilities under various stages of development in ksa. Table 5.3 provides a summary of these.



Figure 5.1: healthcare maps of KSA regions

Table 5.3: new healthcare facilities under development in KSA

Healthcare facility	Project Development State					
	Finance Approval	Design	Bidding	Construction	Equipment	Delivery
Primary Healthcare	0	0	372	321	0	978
Specialized Healthcare	0	0	0	76	0	0
General Hospitals	6	321	0	37	0	12
Medical Cities	4	0	0	0	0	0
Total	10	321	372	434	0	990

5.4.2 ADVERSE INCIDENT DATA RELATING TO QUALITY AND PATIENT SAFETY

Four reports from SMOH’s quality and patient safety general administration (QPSGA) department were consulted to understand the origins and manifestations of ais in Saudi hospitals. These included occurrence variance reports (OVR), which present patient and staff safety, quality of care and risk management practices in Saudi hospitals. Figure 5.2 shows the frequency of ais in 16 Saudi regions, including 16 hospitals. For conciseness, the 11 most frequent forms of ais confirmed in the OVRs were analysed. A total of 27,533 ai cases that occurred in 2018 were reported. Analysis shows 27% of all ais were caused by patient care management, whilst 23% were related to procedural issues, 19% to medication errors and 14% to staff issues. 7% of ais were related to user’s behaviour, 4% were documentation issues, 2% were related to laboratory issues, while 4.1 % were caused by environment, infections, medical equipment and patients falls. These reports did not include the causes or the impact of ais on patient health and safety.

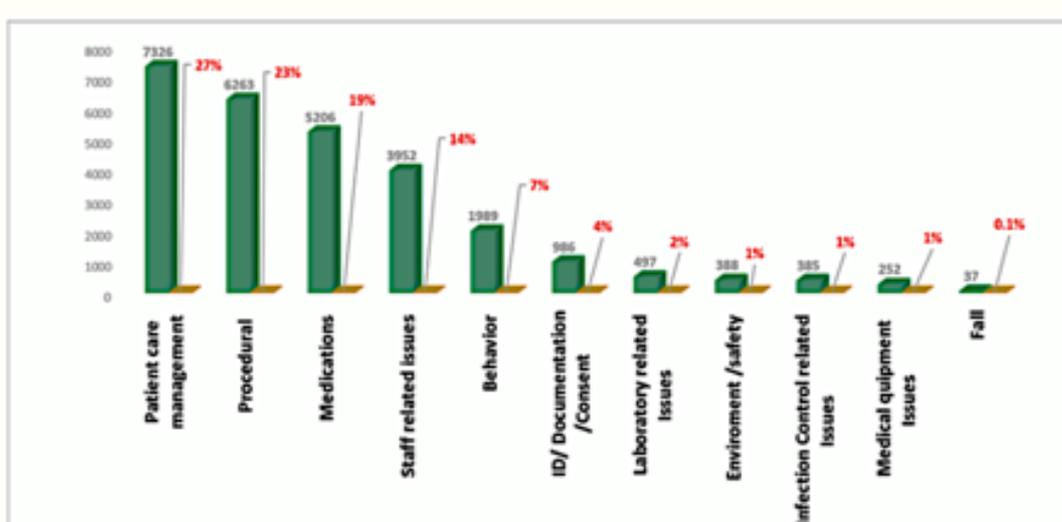


Figure 5.2: Frequency and forms of AIs in 16 Saudi regions

Figure 5.3 shows the ais in the 16 regions. 79% were low level risks, 17% (7,761) of moderate risk level and 3% (1,499) of a high-risk level. However, 0.3% (154 cases) were of an extreme risk level, thereby exposing patients to severe danger.

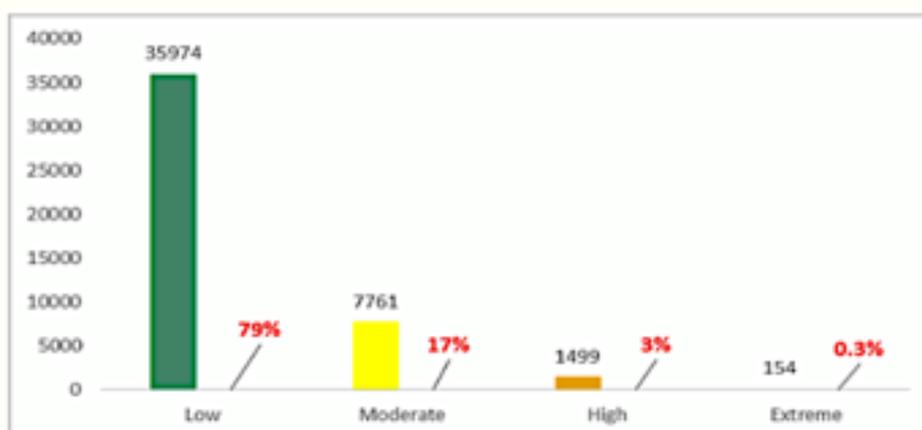


Figure 5.3: Risk levels of AIs

5.4.2.1 ADVERSE INCIDENTS IN HASSA AND AL JOUF REGIONS

Hospitals in three regions, which are the focus of this study, are situated in Hassa, Al Jouf and Al-Riyadh. In the Hassa region during 2018, a total of 447 AIs, grouped into 9 themes relating to hospital design issues, were reported (see Table 5.4).

Table 5.4: adverse incidents reported in HASSA region

AIs	Risk Assessment			
	Likelihood	Impact	Risk level	No of cases
Fire	4	5	Extreme	20
Power shutdown	4	5	Extreme	20
Patient identification errors	4	4	Extreme	16
Infections	5	3	High	15
Medication error	4	3	High	12
Slips, trips and falls	3	4	Medium	12
Improper sterilization technique	4	3	High	12
Isolation rooms without negative pressure	3	4	High	12
Blood transfusion errors	5	2	High	10

Of the AI cases that occurred in al Jouf region during 2018 (Table 5.5), a total of 97 were of high to extreme risk levels.

Table 5.5: adverse incidents reported in Al Jouf region

AIs	Risk Assessment			
	Likelihood	Impact	Harm level	No. of cases
Incomplete patient information	4	5	Extreme	20
Medication errors	4	5	Extreme	15
Blood transfusion errors	4	5	Extreme	15
Testing errors	4	5	Extreme	15
Infection	5	4	Extreme	20
Delays in medication	4	3	High	12

A total of 3,941 ais was reported in the Al Riyadh region hospitals (Table 5.6), including some of high and extreme harm levels. The cases were grouped into six ais themes related to hospital design issues, possibly leading to severe infections and death. Findings from these reports will help to minimize or avoid them in the future by making improvements to the design stage. Examples of ais that are related to design flaws include cross contamination lines, breaks in infection control, lack of isolation rooms and poor hospital information systems. This can lead to clinical errors, low levels of patient satisfaction, stress, prolonged stay and loss of CBAHI accreditation [Saudi's central board for accreditation of healthcare institutions].

Table 5.6: risk level of ais in al-Riyadh region

Risk levels	No. of cases	Percentages
Extreme	4	0.07
High	93	2.34
Moderate	790	20.05
Low	3,045	77.49

This information indicates that 10 forms of ais may be related to hospital design issues. These include medication errors, infections and blood transfusion errors, fire, medication errors, slips, trips and falls, improper sterilization techniques, lack of negative pressure in isolation rooms, patient identification errors, the use of contaminated instruments and power shutdowns. These patient identification errors may result in loss of patient information and laboratory investigation errors and may lead to delays in administration of medication.

5.4.3 EVIDENCE FROM THE SAUDI FOOD AND DRUG AUTHORITY REPORT

Ais that originated from planning issues involving medical equipment in all public and private hospitals in KSA during 2018 can be grouped into four AI themes: burns, injuries, infections, and deaths. The most frequent sources of ais and the issues in the design of the environment are listed in Table 5.7.

Table 5.7: AIs involving medical equipment planning issues

AIs	AIs sources	Design environment issues
Death	Sharp edges	Poor or inadequate design:
Burn	Electrical safety	Emergency plan (electricity shutdown)
Infection	Power supply failure	Keeping damaged, expired or recalled medical devices
Injury	Software inadequacy	Exposure of medical devices to:
	Error codes in device memory	Direct sunlight
	Lack of incident reporting	Dirt and unhealthy environment
	Errors in imageries	Moisture
	Support systems failures	Wet areas
	End users	Inappropriate environmental conditions for medical devices:
	Lose data from devices	Temperature
	Medical gas system failure	Humidity
	Vacuum system failure	Light and ventilation

5.4.4 EVIDENCE FROM THE SAUDI CENTRAL BOARD FOR ACCREDITATION OF HEALTHCARE INSTITUTIONS (CIBAHI)

Figure 5.4 illustrates the risk levels according to CIBAHI standards of all AI cases that led to serious harm or death during 2017 in 274 Saudi hospitals. The majority had a very high risk and did not meet the majority of safety standard requirements. 30% had moderate to high risks and had met less than five elements of the requirements. Only 17 hospitals had low risks as a result of applying 85% of patient safety standards. Five of those standards relate to hospital design issues such as the lack of building exits, fire alarms, fire sprinklers and smoke-control systems, as well as standards for walls, floors and ceilings related to the design and construction of the hospital to resist the passage of fire and smoke. Al Wahabi et al. (2017) examined the type of events, outcomes, causes and their preventability for patient safety in KSA. They found that from 2012 to 2015, there were 433 events related to defects in the healthcare system. 91.6% of those adverse events could be avoided and led to delays in treatment.

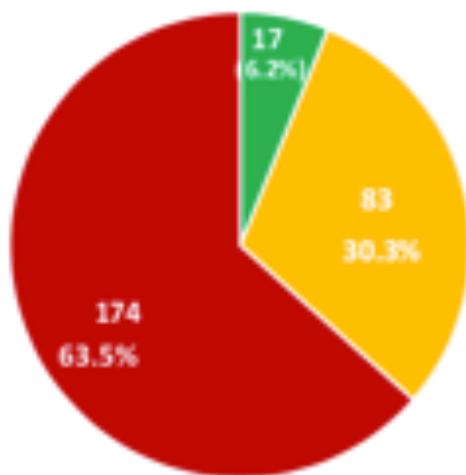


Figure 5.4: Risk level of AIs in Saudi hospitals during 2017

5.4.5 EVIDENCE FROM THE ARCHITECTURAL DESIGN REVIEW

Requirements, standards and specifications of medical planning, medical equipment, furniture, diagnostic and therapeutic plans in hospital design were studied by reviewing 80 maps of different types of current healthcare facilities (three small hospitals (50 beds) three general hospitals building (400-500 beds), a medical tower (64 clinics), dental, ophthalmology and diabetes centres) in KSA. Data and information provided via hospital requests from regions is the main factor controlling the size of healthcare facilities within the scope of medical services,

the serviced patient number, the available budget for new hospitals. At this stage of study, a lot of similiters in designs were found in the hospitals reviewed, although they were intended for different geographical regions, populations and medical peculiarities.

5.5 FINDINGS

The analysis of the archival data uncovered design issues in five areas, grouped as: types and impact of design issues, design fields, flaws in design processes, sources of flaws and healing aspects of design. First, 10 forms of ais were found to have occurred in Saudi hospitals, viz. Falls, fires, infections, deaths, burns, injury, stress, blood transfusion and testing errors, medication and medical errors. These ais may be associated with design defects listed in table 5.8. These defects may occur in four areas namely laboratories, sterilisation centres, stores for equipment and isolation rooms. Defects associating with them can arise from four disciplines: electrical (power shutdown and lack of light), architectural (crossing contaminated and decontaminated lines and unsuitable spaces to store equipment), equipment planning (design defects in electrical, mechanical and architectural design leading to deficiencies in software and memory devices, error in medical imageries and the loss of data from medical equipment and devices) and mechanical (isolation rooms without negative pressure and the failure of support systems). These design defects lead to issues for patients regarding their health, safety, satisfaction and experience, treatment delays, provision of medication and diagnostic plans. These patient-related design defects extend hospitalisation, result in the loss of patient identification, and CBAHI accreditation for patient safety standards. According to reports by the information and statistics general administration (ISGA) and studies and design general administration procedures and policies (SDGAPP), there are issues not considered. Those impacted, such as construction and maintenance staff, and in particular, patient advocates, typically have no role in the design process. Land selection, site feasibility and spatial requirements are usually not considered by the planning teams, while the design team uses a combination or, or both, American and British design standards. Private engineering consultants, with a lack of knowledge of the region's environmental conditions for planning and designing hospitals are hired. The equipment planning design process is typically only implemented after 60% of the construction stage has been completed.

ISGA and SDGAPP reports provide information on the risk levels of ais, ai types and symptoms and design issues. However, tracking these issues back to the flaws and their sources during the design process cannot be made because many issues that were not clarified such as the link between the ais and its causes and impact within specific design processes. For example, patient infections associated with patient or care-givers' behaviour, diagnosis and treatment plans, patient identification, blood transfusion or sterilization techniques. Saudi's food and drugs authority (SFDA) report was more specific in identifying links between ais and medical equipment. For instance, a severe ai (second-degree burns) was caused by a medical equipment fire (see Figure 5.5), resulting from overheating due to a design issue viz. Poor environmental consideration (ventilation, a/c systems capacity).



Figure 5.5: Burns caused by equipment planning defects

The AIs (see Table 5.8) in the operational stage originate from design defects undertaken in the early stages of design. These flaws may correlate to following processes:

- *the feasibility study*; site analysis to study the impacts of sunlight, humidity and fresh air flow on the hospital building.
- *hospital building programming*: lack of provision for dedicated service-only and house-keeping circulation, resulting in the confluent vertical and horizontal movement of patients, healthcare personnel and waste transfer; poor selection criteria to procure

design teams with sufficient experience, background and technical knowledge regarding healthcare facility design.

- *hospital building functional programming*: lack of activity assessment required to identify infection controls within critical systems.
- *hospital building space programming*: lack of or inadequate equipment, such as air conditioning, to provide adequate thermal conditions for critical systems services to prevent their breakdown; a lack of capacity needed for critical systems such as medical gas, ventilation and heating.

Table 5. 8: AI circumstances in context of Saudi designed hospital issues

Symptoms/phenomenon	Errors in: Patient care management and documentation Diagnosis and treatment plan Healthcare providers' practices Patient behaviour Laboratory and testing Medical equipment Power shutdown Patient identification and information Ordering of medication Sterilization Isolation rooms without negative pressure Cross contamination lines Hospital information system defects Medical equipment planning issues: Sharp edges, software deficiency, device memory, error in photographs and Loss of device data
Design issues/defects	Poor or inadequate design in: Supporting systems failures (Medical gas, Vacuum, ventilation, mechanical systems) Keeping damaged, expired or recalled medical devices in one area Exposure medical devices to: Direct sunlight, Dirt and non-clean environment, Moisture, high temperature and humidity Lack of light and ventilation

The Figure 5.6 Below presents the flaws in the design process at the predesign stage.

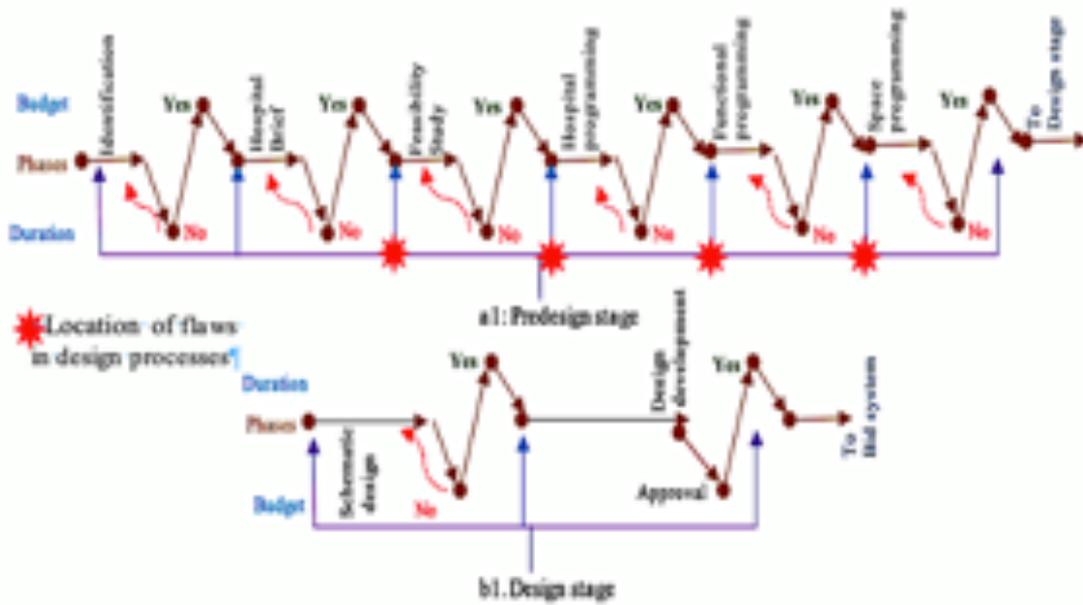


Figure 5.6: flaws in the design process at predesign stage

5.5.1 HEALING DESIGN ELEMENTS ISSUES

Figure 5.7 shows the links between two areas: (a) patient sensory systems, and (b) atmospheric of design issues. **Patient sensory systems** are sight, hearing, smell, touch, taste, and physical movement. These senses are linked to healing **aspects of design elements** and these involve luminosity (lack of light), thermal control (support systems failures), safety (lack of building exits, fire alarms, fire sprinklers and smoke-control systems) and security (expose patients to danger or harm). These issues may increase the psychological and physical efforts that lead to lengthening the recovery period.

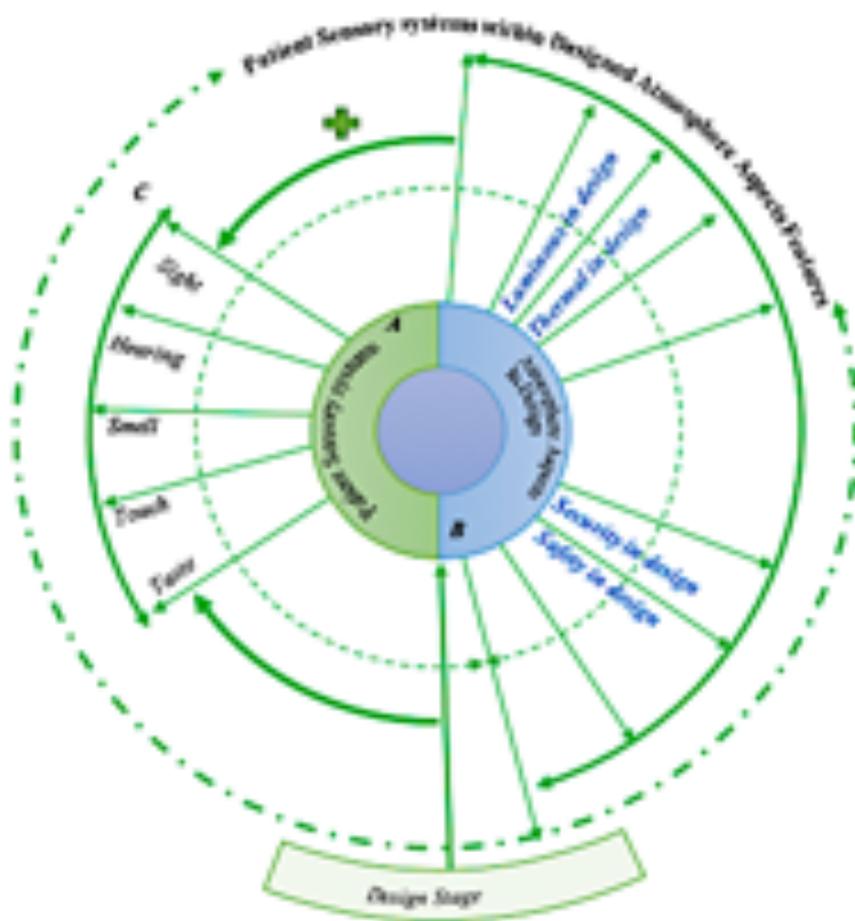


Figure 5.7: conceptual framework - aspects of healing space design within the sensory systems

5.6 SUMMARY OF ARCHIVAL DATA ANALYSIS

Figure 5.8 shows the summary of findings that have been extracted from archival studies to define the potential link between the design process and recovery. This chapter defined five main areas in design spaces viz.

- A. Design issues including the defects may trigger the ais, thereby affecting patient health, safety and care;
- B. Design fields issues occurred in the operation stage, including six types;
- C. By tracking these design issues, this study found flaws in three phases of the early design stage: the feasibility study, functional programming of hospital building and programming processes of hospital building spaces (see Figure 5.6);
- D. By tracking these flaws in the design phases, flaw sources may be associated with the quality of design teams' experience and the administrative management of projects before or during design phases; and
- E. Four elements of the environmental aspects in design which may psychologically and physically affect the patient's senses (see Figure 5.7).

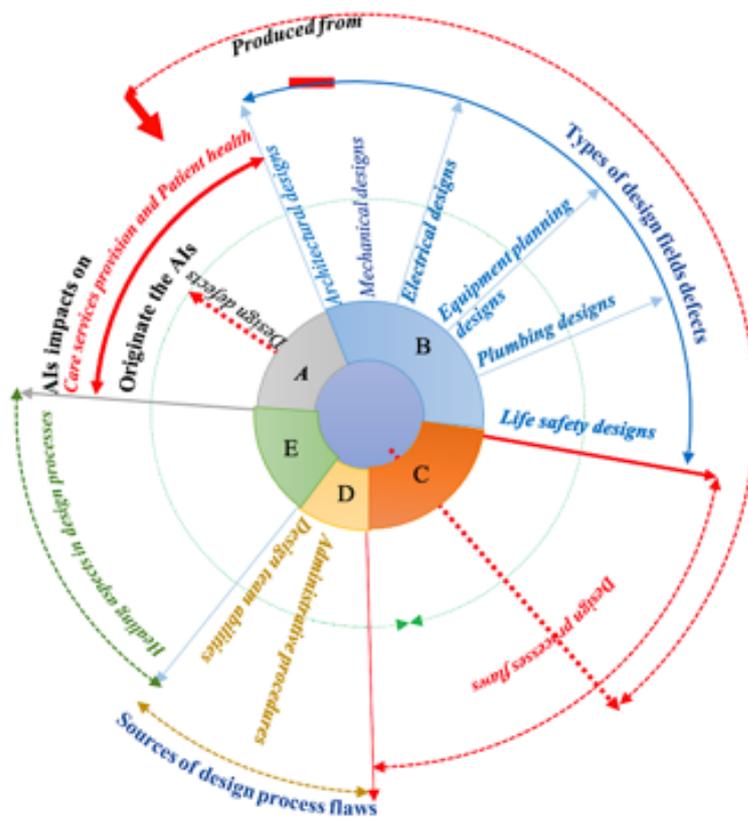


Figure 5.8: conceptual framework - summary of findings within the research areas

Factors found to be absent at this stage of the study (blood transfusion errors, sterilization techniques errors, loss of patient identification information) were associated with defects in design or with others causes and those defects resulted from flaws in the design stage itself or with the implementation of the design process. In the next chapter, interviews and participant observations will be described which aimed to investigate those missing factors further.

6.0 ANALYSIS OF INTERVIEWS AND PARTICIPANT OBSERVATIONS

6.1 INTRODUCTION

This chapter presents the analysis and findings of applying the unstructured interviews questions method (phase 3-1) in case study 1 King Fahd Hospital (KFH) as first step and participant observations method (phase 3-2) as second step in case study 3 (see chapter 3: section 3.10): Engineering Affairs General Administration (EAGA) in participation in redesigning the main building of KFH as shown in Figure 6.1.

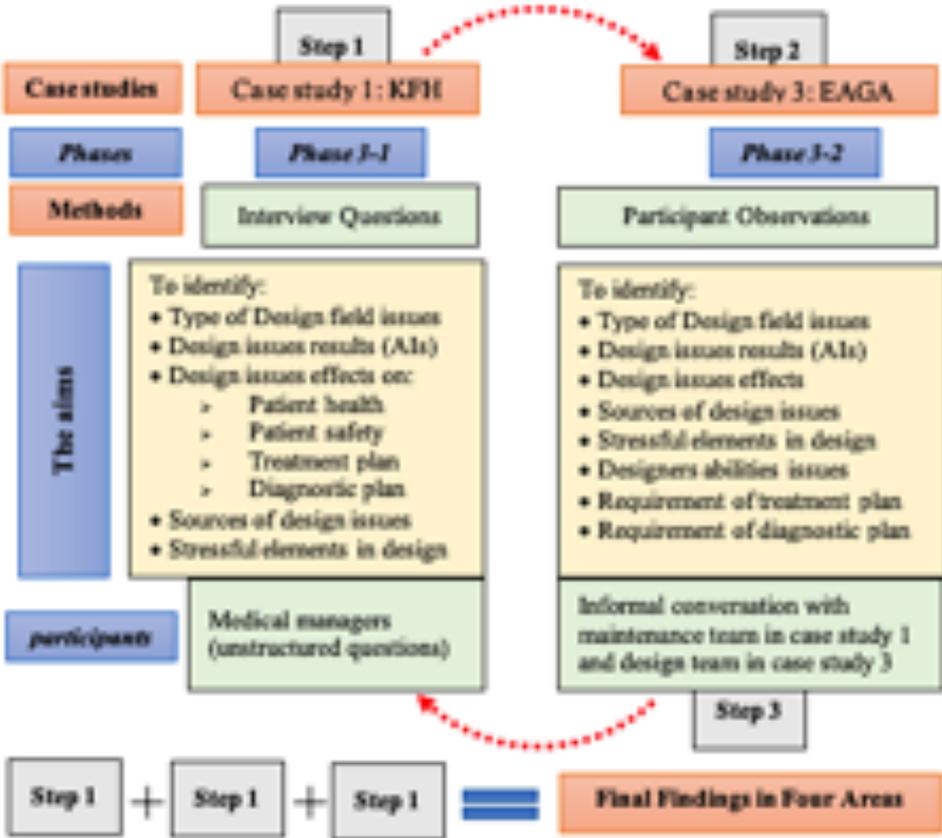


Figure 6.1: data collection methods for phase 3 of stage 1

Analysis of phase 3 of stage 1 focused on the responses of 38 participants to the research areas, aimed at drawing out evidence in four areas, namely: how design issues affected healthcare services and patient health, the source of the design issues, recommendations for improvement in the design process, and participants’ recommendations regarding possible improvements to

24 ongoing project designs in phase 3-2, by identifying requirements and elements from case study 1, that can help prevent current design issues.

The findings section covers five areas: design defects and faults (shown in section 13.2.6: tables 13.1 to 13.28), areas impacted by design issues, forms and sources of flaws in the design process, the manifestations of design issues and definitions of design issues classifications (detailed in section 13.2.9 of appendix b). The data drawn from the interviews and participant observations, identified the types and sources of design issues, designers' limitations, stress elements in design outcomes, outcomes of design issues generally, impact of outcomes of design issues on patient health and safety, their diagnosis and treatment plans, as well as the requirements of the diagnosis and treatment plans.

The aims of combining interviews and participants observations were to:

- a) Obtain a deep understanding of the impact of design defects on patient health, safety and care services.
- a) Investigate the state of the current environment elements in the context of Saudi Arabia, and their underlying challenges, in the context of hospital design.
- b) Recommend strategies for reducing ais and design defects,
- c) Recommend requirement of diagnostic and treatment plans for improving the current designs,
- d) Analyse the impact of design defects on the physical and/or psychological health of patients in case study 1.
- e) Track the design issues from current designs to the design processes
- f) Investigate in the sources of design issues at early stage of design in case study 3

6.1.1 PROCESS OF PARTICIPATING IN THE OBSERVATION

The process of participating in the observations includes an analysis of data provided by 39 participants regarding evidence from their perspectives in relation to design issues that had prevented healthcare services and affected patient health. The data also captured sources of the design issues, and participants' recommendations for improvement as intended for implementation in a new design process. Data were collected from participants' inputs to the

redesign of 24 projects where the objective was to apply participants' requirements into design decisions, and prevent current design issues from re-occurring in the new projects.

Three processes were involved in this: studying participants' requirements and their considered needs for each project, and reviewing samples of architectural designs of existing units and departments from Saudi and international healthcare facilities. Outcomes were presented as the first draft of the new designs to managers in each department for discussion and feedback; and thereafter, final evaluation of design decisions were made by participants. It is noteworthy that the participants were representatives of each unit as managers who have assistants dealing with doctors and technicians from their units as well as other units. Participants must have approved the inputs relating to their operations on the new architectural design. This means the new redesigned units have met their requirements to serve patients in diagnostic and therapeutic plans. Findings from these projects were used to obtain evidence on how to closely investigate current design issues, their impact and sources in a Saudi hospital building. The limitation of this process is that this researcher has had to wait for a long time for participants, from other phases of data collection, to accept the invitations to be part of this phase of the research. This is because the SMOH has strict requirements before permitting this researcher to collect data from patients, healthcare givers and design and maintenance teams.

6.2 PROFESSIONAL BACKGROUND OF PARTICIPANTS

A total of 39 participants from 24 departments and units and 32 professional disciplines were interviewed in case study 1. They ranged from medical professionals involved in treatment and diagnostic services to non-medical professionals involved in keeping medical records. Their day-to-day duties were to deal with various health issues. Two of the participants were female doctors who deal with female health issues and 22 were medical managers of their respective units (for details, see Appendix B: Section 13.2.3).

Table 5. 9: Demographic background of respondents

Department/ Clinic	Unit	No. of Participants	Professional level
Obstetrics and Gynaecology	Labour & Delivery	2	Obstetrician, Gynaecologist
Paediatrics	Paediatric & Neonatal intensive care	4	Paediatrician, Neonatologist and 2x Respiratory Physiology Technicians
Psychiatry	--	1	Psychiatrist
Internal medicine	--	1	Physician
Neurology and Brain	--	1	Neurosurgeon
General Surgery and Theatre	--	3	2x Surgeon and Anaesthetist
Gastroenterology	--	1	Surgeon
Ophthalmology	--	2	Ophthalmologist and Optometrist
Dental Surgery	--	1	Dental Surgeon
Orthopaedic	--	1	Orthopaedic Surgeon
Cardiology	--	3	Cardiologist, Cardiographers and Cardiac Physiologist
Urology	--	1	Urologist
Dermatology	--	1	Dermatologist
Adult intensive care	--	2	Internal Medicine Physician and Intensive Care Specialist
Accident and Emergency	--	3	Paediatrician, Surgeon and Emergency Doctor
Radiology	--	2	Radiologist and radiographer Technologist
Medical Laboratory	--	3	Biomedical Scientist and 2x Laboratory Technicians
Physical therapy	--	1	Physiotherapist
Central Sterile Services	--	3	Sterile Services Manager and 2x Sterile Services Technicians
Medical records	--	2	2x Health Records Staff

6.3 ANALYSIS OF INTERVIEW DATA

Participants were asked the following questions:

- 1) “is there anything regarding design in this hospital or your unit that affects patient health or prevents you from providing appropriate care to your patients?”.
- 2) “why do you think these design issues occur?”.
- 3) “what would you recommend to improve the design in terms of creating safer and healthier environments that are free from design issues and are able to support recovery?”.

Tow Keys techniques of qualitative data analysis applied. The technique for the first question in the interview is presented in the next section. The categorisation system of data technique used for second and third questions as shown in section 3.4.2.

6.3.1 ANALYSIS AND FINDINGS FROM THE FIRST QUESTION

The responses of 39 participants to the first interview question is summarised into Tables 13.4 to Table 13.27 in Appendix B (Section 13.2.4). These Tables presents the space requirements in the treatment and diagnostic plans mentioned by participants as first step (Figure 6.1, Step 1) to participate in redesigning 24 projects within case study 3 (Figure 6.1, Step 2).

Design elements of previous unit	Design elements of current unit	Requirements of participants
6 Exam Room	5 Exam Rooms	5 Exam Rooms
Inadequate ●	Women Waiting Area	Women Waiting Area } (orange)
Inadequate ●	Unavailable	Men Waiting Area } (orange)
Inadequate ●	Women Toilet	Women Toilet } (orange)
Unavailable ●	Unavailable	Electrocardiogram (ECG) } (blue)
Unavailable ●	Unavailable	Ultrasound } (blue)
Unavailable ●	Nurse Office	Nurse Office } (orange)
Inadequate ●	Nurse Station	Nurse Station } (orange)
Unavailable ●	Female Staff Changing Room	Female Staff Changing Room } (orange)
Unavailable ●	Female Staff Toilets	Female Staff Toilets } (orange)
Unavailable ●	Unavailable	Blood Extraction } (green)
Unavailable ●	Unavailable	W. Waiting Blood Extraction } (green)
Unavailable ●	Dirty Utility (crossing)	Dirty Utility } (red)
Unavailable ●	Unavailable	Clean Utility } (red)
Unavailable ●	Unavailable	Janitorial Room(CIBAH) } (red)
Cardiotocography (CTG) ●	Unavailable	Cardiotocography (CTG) } (blue)
Vitality Indicator Room ●	Unavailable	Vitality Indicator Room } (blue)
Unavailable	Unavailable	Trophy scope Room } (green)
Unavailable	Unavailable	Treatment Room } (green)
Unavailable ●	Doctor Lounge	Doctor Lounge } (orange)
Unavailable	Doctor Office	Doctor Office } (orange)

Figure 6.2: key technique of qualitative data analysis

Figure 6.2 shows an example of how data were extracted from the first interview question (Part 1: Column 3), from previous hospital designs (Part 2: Columns 1) and visiting the current designed units (Part 2: Columns 2). Data from there were presented for analysis in two ways. First, the **coloured brackets**: the orange brackets indicate design issues suggesting inadequate space for the healthcare providers, whilst the green brackets indicate the design issues suggesting inadequate space for patients. The red brackets indicate the design issues regarding the control of infection and, the blue brackets indicate the design issues in equipment planning. Second, the **coloured dots**; these indicate the form of design issues identified. Red dots are for design defects; yellow dots, design faults; green dots, design requirements; brown dots, a failure in implementing the recommendations from the interviews and observations data. In **second step**, the data were analysed further with evidence from participant observations to define sources of design defects within the design stage in case study 3 (see Section 6.5).

6.3.2 DESIGN ISSUES THAT PREVENT THE PROVISION OF MEDICAL SERVICES

Participants' responses to the first question: "*Is there anything regarding design issues in this hospital or your unit, that affects patient health or prevent you from providing care services to patient in the right manner?*", reported in Tables 13.1 to 13.28 (see Appendix B: Section 13.2.6) that show the design issues extracted from interviewing 38 participants through key technique of qualitative data analysis.

Five common areas of design issues were identified by the participants viz. inadequacies in spaces of treatment and diagnostic plans, lack of medical equipment, inadequacies in support areas (electrical and mechanical services, patient waiting rooms, resting areas) for patient and healthcare providers, and issues regarding infection control areas. All requirements mentioned by respondents were implemented through second step: the participant observations method in Case study 3 as architectural designs (see Appendix B: Section 13.2.7: Layout 13.1-24). However, some requirement for treatment and diagnostic plans mentioned by participants in case study, are failed to be implemented through participant observations method, as shown in brown dot (see Appendix B: Section 13.2.6), because the available spaces of current units are limited and no more spaces to extend.

All requirements mentioned by respondents were implemented through the participant observations method as architectural designs (see Appendix B: Part C: observation outcomes: Layout 13.1). However, a requirement is failed to be implemented through participant observations method (see Appendix B: Part C: observation outcomes: Layout 13.1-23), as shown in brown dot, because the available spaces of current units are limited and no more spaces to extend.

6.3.3 FACTORS RESPONSIBLE FOR DESIGN ISSUES

Data were analysed from participants' responses to the following two questions:

- 4) "Why do you think these design issues occur?"
- 5) "What would you recommend as ways to improve design processes in terms of creating safer and healthy environments that are free from design issues and are able to support healing processes?"

Whilst responding to why design defects and faults exist in their clinic and why patients refuse or to continue their treatment plan (see Table 13.9), one *psychiatrist* identified the following:

- 6) No consideration for doctors' gender in a clinic where most female patients does not want to deal with male doctors (cultural issue).
- 7) Limited respect for the privacy and feelings of patients who have psychological issues, especially while moving them within the hospital and when approaching the clinic on admission. More specifically,
- 8) the patient waiting room and the clinic entrance are shared with other patients from different clinics;
- 9) many patients need to walk long distances from the car park, through many clinics to reach the relevant clinic. Because of this, patients could be recognised, an outcome they do not often want. In addition, the children's playground is close to the Psychological clinic, thereby exposing patients who lost child to the psychological effects of their medical situation.

Participants from the *obstetrics and gynaecology clinic* and *labour and delivery* (LD) unit explained how these design issues affected the provision of patient care in a number of ways (see Table 13.29). First, some cases cannot be admitted to the unit or to the related in-patient ward (male medical wards) because there are no available beds. Second, some units and clinics lack key diagnostic devices. Third, there is a lack of space for storing medical waste, such as the afterbirth and medical consumables. This often causes serious infections.

Furthermore, there are difficulties in patient movement because some devices were stored on the corridors. In addition, many people accompanying patients inside the care unit or waiting at the main entrance means further obstructions to patients. Not only this, many units are far from the emergency department. Also, there are difficulties in applying patient safety standards and the policies of The Saudi Central Board for Accreditation of Healthcare Institutions (CIBAH). These arise from a lack of negative pressure in the labour and delivery rooms, storage for medical waste (to store contaminated items, instruments and other waste disposed of by the clinic) and clean utility (to store decontaminated items, instruments and equipment). Moreover, participants complained about no space for healthcare givers to rest or have meetings. This resulted in difficulties or delays in providing medical services, causing distress of different forms to patients.

Interviewees' expectations are that hospital designers must have a clear understanding of hospital care processes in order to produce the right designs. These include the need to monitor the management of all steps in the healthcare process from the beginning of a patient's visit until they are discharged. The interviewees think this is necessary to avoid issues of the lack of space, inadequate tools and equipment, and the design being unable to support the care process.

Participants from the *operating theatre*, the *gastroenterology* and *surgery* clinics confirmed six design issues (see Table 13.34):

- 1) all critical medical equipment and tools must be connected to the Uninterruptible Power Supply (USP) points to avoid the breakdown when they are being used on patients,
- 2) there must be positive pressure inside the operating theatre to protect the patient from potential infection from outside,
- 3) advance technology must be used in performing operations to reduce medical errors and save medical staff effort and time (Digital operating theatres),
- 4) water leakage from ceilings in some rooms is a serious issue that affects patient health and equipment, sometimes leading to the cancellation of the operation,
- 5) the number of operating theatres is too low, so many cases were transferred to other hospitals
- 6) some medical instruments could not be used on patient, because they were not adequately sterilised.

Participants from the *cardiology* clinics (see Table 13.39) complained about the lift size meaning that the patient's bed could not get into the lift easily. In the cardiac surgery unit, the doctor expressed a wish to have a space with windows overlooking the main operating theatre in case other surgeons needed advice when dealing with patients (e.g. open-heart surgery).

Besides what the participant mentioned about the new requirement in redesigning *the internal medicine clinics* (see Table 13.32), a physician in this unit complained about the difficulty in obtaining the patient history, because of missing files or delays in bringing the patient file from the medical records department. These issues may be due to infrastructure issues in the medical records department. When asked if the problem was related to design issue in medical records

department, the participant mentioned that the designers lacked knowledge about the main function of departmental space.

The participant from *urology* clinic mentioned the requirement and needs (see Table 13.40) in his clinics and assumed that the designer had not realised the space needed to measure bladder pressure as part of diagnostic planning. The participant from dermatology clinics noted that the designer did not appear to realise the space needed for treating patients and using current equipment, because the current space cannot fit the dermatology equipment (see Table 13.41).

Participants from *intensive care unit* mentioned the lack of bedrooms to accept more patients. As a result, the department always worked to full capacity, of no more than 11 patients at a time, whilst they need a minimum carrying capacity of 30 beds. During a visit to the unit, the researcher found the number of patients being served was more than 12. Another issue mentioned was that some patients who needed kidney dialysis or the healthcare provider needed to move patients to the dialysis unit on another floor. However, the water supply and drain nets were not available in the dedicated space. As a result, the required equipment could not be installed (see Table 13.42).

Participants from *radiology department* complained about some sections of the department being located on other floors with a lack of capital equipment such as computerised tomography scan (CTS)/ Magnetic resonance imaging (MRI) that doctors required (see Table 13.44).

Beside the requirements and design issues mentioned by the participants in this laboratory (see Table 13.45), they recommended redesigning the department in a number of ways:

- 1) the current area cannot accommodate modern medical equipment needed to identify some diseases. Some devices are located in the internal corridors of the department.
- 2) the over-crowding of the devices in the different sections of the laboratory caused many issues such as difficulty in the movement of staff in each section, the A/C system not working efficiently in adapting to the increased temperature due to the thermal load produced by medical equipment, leading to some of them breaking down. In addition, there was the additional increase in electrical load to operate new devices which may cause a fire;

- 3) this department dealt with too many requests for testing (e.g. blood tests) from the ER department and 68 clinics within the new extended medical sections and clinics, thus increasing the potential for error;
- 4) the lack of required infrastructure prevents installing advanced and specialised laboratory equipment that helps in identifying and diagnosing diseases. These issues affect both patient health and care.

The participant from *physical therapy* complained about the low level of patient privacy because some employees were walking through his departments to reach other administrative departments (see Table 13.46). Apparently, the designers did not recognise the type of treatment and equipment required in this department.

Participants from *central sterilisation services department* noted the requirement and needs in their department to supply sterilised equipment to other departments, units and wards and making sure all medical equipment, tools and instruments are not contaminated (see Table 13.48).

Besides the requirement and design issues mentioned, Participants from the *medical records department* reported on the requirements and needs in their department to organise, retrieve and archive patient records on the wards and in outpatient clinics (see Table 13.47).

Participants from operating theatre mentioned the design issues and the required design elements if the unit could be redesigned. It is observed that the factors causing these issues are related to the design of the clinic. They include limited designer knowledge in terms of types of treatment plans, roles and responsibilities in diagnosing and treating the health problems from a medical perspective and knowledge about the activities of the department. In order to solve this, a participant recommended that healthcare professionals should be invited to be part of the design team. By researching hospital design, designers' knowledge in how doctors deal with patients and diseases and of current advanced technologies and techniques in medical equipment and the new methods, plans and procedures to diagnose and treat patients could be increased.

6.4 PARTICIPANT OBSERVATION

In case study 2 [Engineering Affairs General Administration (EAGA) of MOH at Al Baha City], data were gathered from one group (design team) of participants who were responsible for design stage of redesigning the main hospital building in case study 1, the KFH. In this case study, participant observation was adopted as a way of participation in redesigning 24 projects in case study 1. This researcher relied on informal conversations to gather inputs from participants. The researcher also examined architectural designs of the projects in case study 1 to learn about the processes, procedures and activities of design team during the design stage. Of particular interest to the researcher was how they had tracked sources of design issues and their causes within redesigning case study 1. The outcomes of participant observation methods for redesign 24 medical projects are reported in Part C of Appendix B, titled *Observation Outcomes: Layout Plans* 13.1 to 13.24.

Figure 6.3 presents architectural designs generated whilst redesigning a medical unit as an example of the outcomes of an observation conducted. Each design has four sections:

- 1) the current design and location of the unit
- 2) a table presenting the design elements in the current unit and the proposed designs
- 3) the new location or extension of the medical unit
- 4) the final, approval units design

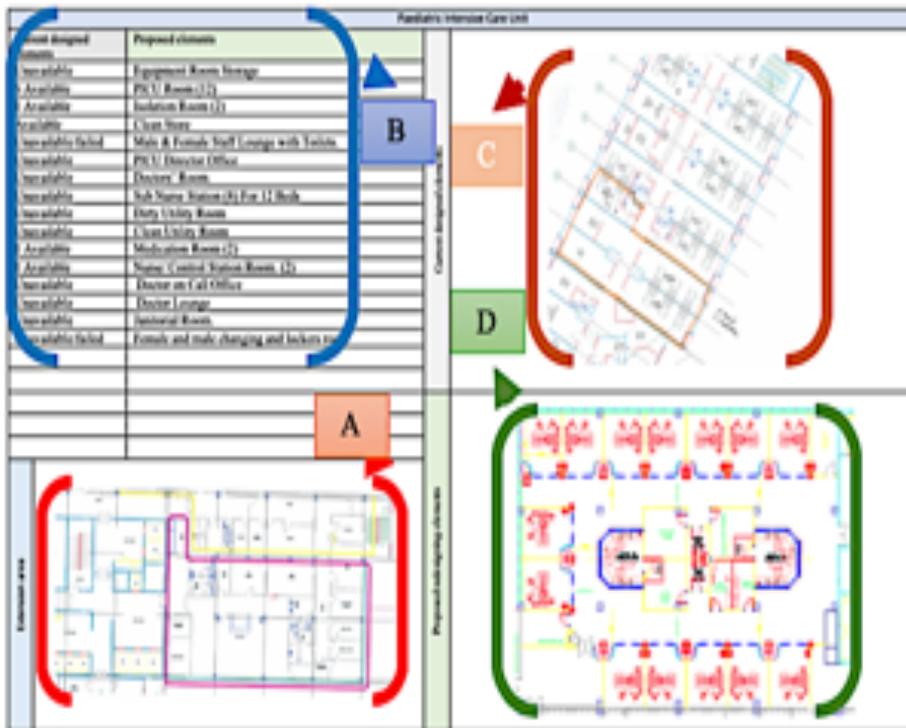


Figure 6.3: key techniques used in the analysis of participant observation

The responses of the participants (Section 6.2) in case study 1, were used to improve the 24 projects being redesigned in terms of the requirements considered for treatment, diagnosis, equipment planning and patient safety. Five steps were involved:

- 1) studying participants' requirements and needs for each project;
- 2) reviewing 41 architectural designs of existing medical units and 39 designs for other healthcare facilities in line with the national standards of KSA and preminent international standards;
- 3) raising questions in designing these projects about missing factors to meet the design requirements
- 4) presenting the first draft of the new designs to medical managers in each department for discussion and gaining feedback from participants in each project in case study 1 (Figure 6.1: step 3);

After that the final evaluation and decision on the final draft of the redesigned projects as outcomes of participants inputs, changes to the 24 projects were approved by the administration

of the King Fahad Hospital and Medical Tower and the Health Affairs General Administration at Al Baha City (see Figure 6.5). This means the new redesigned units meet the demands of patients in diagnostic and therapeutic plans and that the new redesigns are free from design issues currently. Only 10 of the 24 redesign projects were approved by the SMOH as written in the letter of appreciation (see Appendix B - Section 13.2.8).

This stage of the study involved redesign of these units as a way to investigate the sources and impact of design issues in one Saudi hospital. The intention to track the design issues which were identified and their sources from the operation stage to the design stage within these redesigned projects.

By tracking the design issues from the participants in Case Study 1 and participation in redesigning 24 projects (Case study 2), flaws in the design process were identified from three sources viz. the inability of the design administration teams to deal with the design teams adequately, limitations in the abilities and skills of the design teams, and limitations in the data and information upon which design elements were based.

From the requirements mentioned by participants in case study 1 as well as studying and analysing architectural drawings, the following were observed:

- 1) the designers lacked experience in hospital design;
- 2) the designers lacked knowledge about the requirements and expectations of patients and doctors' needs and wants as well as the types and stages of treatment and diagnosis plans and the required equipment and tools for the procedures.
- 3) the design also had limited consideration for the movement of waste and of patients' or appropriate spatial considerations for care personnel – for example, the required levels and number of medical professionals and their activities were not considered adequately in the designed spaces.
- 4) design considerations for levels, quantity and stages of cases of a disease were unclear.

From the design observations in the operating theatres (see layout 13.8), there was evidence that the designers were not aware of many factors, including sizes, types and functions of equipment in spaces; movements of the patients within and across departments; and medical

procedures and plans being used to deal with patients. The designs also showed the designers lacked knowledge on the movement of healthcare providers and administrators. In addition, the movement of equipment and waste was often across the same space dedicated to the movement of the patient on a bed. Evidence on the design suggests the designers lacked knowledge on the movement of sterilised equipment and tools and of each type of medical waste such as hazardous, infection, general and radioactive wastes. The designs mixed the tracks of recovery, preparation, examinations, sterilisation zones and dirty areas within the unit. Sterile rooms were far away from the operating theatre and should be part of it.

It is observed that there are common missing factors causing these issues in 24 projects. These factors associated with low designer knowledge level in terms of types of treatment plans, roles and responsibilities in diagnosing and treating the health problems from a medical perspective and knowledge about the activities of the department. In order to solve this, a participant recommended that healthcare professionals should be invited to be part of the design team. By researching hospital design, designers' knowledge in how doctors deal with patients and diseases and of current advanced technologies and techniques in medical equipment and the new methods, plans and procedures to diagnose and treat patients could be increased.

From the design observations in the radiology department (see layout 13.20). It is observed that there are many missing important considerations in this department, including the procedures for dealing with diagnosing patients and using the equipment, patient and staff needs and requirements in the spaces to provide care, adequate space for mechanical and electrical services for medical equipment, safety standards (the researcher found X-Ray unit doors were not protected), and some radiology sections needed to be connected to the emergency room and Medical Tower building to save time and effort.

From the design observations in laboratory department (see layout 13.22), It is observed that these issues in this department may be the result of a low level of experience and knowledge in the following areas:

- 1) the equipment and procedures, types and stages of patient symptoms' testing to analyse them for doctors to diagnose health issues,
- 2) the way to collect samples for testing and reporting,
- 3) types and functions of laboratory equipment to test and analyse symptoms and diseases;

- 4) types, functions and activities of each section in the department,
- 5) types of material used and the waste produced in sections, and
- 6) a lack of attention to future extensions for hospital departments or patients' number.

All these factors lead to delays in presenting the outcome of results or lack of data needed to help doctors diagnose health problems.

From the space requirement noted by the participant in the physical therapy, it is observed that the designer did not recognise the type of treatment and equipment required in this department (see layout 13.21).

From current architectural drawings of central sterilisation services department (see layout 13.23), it is observed that there is lack of designer knowledge level in many areas, including the type of washing equipment and machines required to clean and sterilise the tools and instruments coming from different departments; the movement of: (a) a contaminated instrument inside the sterile department and their way back to other sections, (b) uncontaminated instruments from other departments to the sterilisation department, (c) staff among the dirty, clean and packaging areas. In addition, the unit lacks the space to receive contaminated instruments from operating theatres, to wash the instrument trolley that carries the contaminated instruments and for staff requirements. These issues often lead to the spread of infections.

The researcher observed most of the design issues and lack of required space and furniture in medical record department (see layout 13.24) can be the reasons behind missing files and the time or effort wasted to find them. In addition, that the researcher faced issues in redesigning this department by using a mobile shelving system to gain more spaces for both active and inactive files. This is because the structural load on the floor could not withstand the weight of the new mobile system. The designer of this department may have ignored the importance of the files, staff movements and activities and their types.

6.5 FINDINGS FROM INTERVIEWS AND PARTICIPANT OBSERVATION

The requirements and needs mentioned by the 38 participants and from participant observation involving the redesigning of 24 projects fall within six areas:

- 1) Design issues can be classified as either defects or faults
- 2) Types of design field issues
- 3) Design elements causing stress
- 4) Flaws in design processes as sources of design issues in the operation stage
- 5) Impacted areas by design issues
- 6) Sources of processes flaws

6.5.1 DEFINITIONS OF CONCEPTS IN THE CONTEXT OF CIRCUMSTANCES OF DESIGN ISSUES

Design issues can be classified as either defects or faults:

- a) Design faults result from an inability to provide diagnosis or treatment services for more patients and for specific diseases and illnesses due to an inadequate amount of space.
- b) Design defects result from an inability to provide complete and appropriate diagnosis and treatment services for more patients and to deal with common health problems (see Table 13.49).

6.6 DESIGN DEFECTS AND FAULTS

This study found occurred defects and faults within eight types of design field, viz. Architectural, construction, mechanical, life safety and security, electrical, equipment planning and plumbing.

6.6.1 ARCHITECTURAL DESIGN ISSUES

Architectural design defects and faults as design issues were identified in ten aspects. These inadequate or unavailable requirements for:

- 1) The examination, diagnosis and treatment spaces in each project to provide a complete care service.
- 2) Support spaces for (a) storage equipment to avoid storing them in corridors or in the patients' rooms, (b) collecting waste to prevent the spreading of infection, (c) mechanical service space to install the machines supporting the medical equipment, (d) medication rooms within the medical unit to limit the need for nurse movement outside the unit, (e) main and sub nurse stations for closely monitoring and supervising all patients.
- 3) Adequate space for (a) the activities of healthcare providers and (b) functioning of examination, diagnostic and treatment equipment inside the spaces, (c) the future growth of patient numbers and users either by extending the space or applying new and advanced medical technology.
- 4) Many crossing points in circulation both vertically and horizontally, especially between the contaminated and decontaminated lines of waste that may lead to the spread of infection or disruption in the movement of healthcare providers.
- 5) Lack of planning for the remote future, including the possibility of extending current building and designing new spaces, without which the hospital may not function optimally and may refuse admission of patients.
- 6) Insufficient linkage between medical and nonmedical departments leading to difficulty in the movement of patients and supplies.
- 7) Support areas for (a) electrical systems (b) mechanical services (c) machines (d) patient waiting rooms (e) healthcare (f) changing gears, (g) room to rest and (h) managing new equipment or systems which affect the diagnostic and therapeutic plans for patients.
- 8) The size of the lifts to allow the patients' beds to fit or extend, causing delays in care.
- 9) Monitoring, watching patient directly, especially in the intensive care units where the sub nurse stations are important.
- 10) Examination and screening space to diagnose patients with contagious diseases.

6.6.2 CONSTRUCTION DESIGN ISSUES

Structural design issues arising from the interviews and participant interviews affect the improvements in healthcare in providing a new plan for treating or diagnosing patients. These structural design issues are related to:

- 1) The difficulty in expanding some areas of projects because of the existence of concrete and steel walls between spaces avoiding the additional treating activities. Removable walls would provide the opportunity to extend the space for more treating activities.
- 2) The difficulty in providing new medical equipment or systems because their weight is more than the allowable structural load. Dead and live load in hospital should be maximum.
- 3) The inability of extending the hospital building (a) vertically because of critical systems placed on the roof or (b) horizontally because it is surrounded by residential and commercial buildings.

6.6.3 MECHANICAL DESIGN ISSUES

The common mechanical design issues observed in this case study have an extreme level of risk for patients' lives and health. These mechanical design issues included:

- 1) Miscalculations of the pressure required in different types of spaces, such as in the burn unit, isolation rooms, waste disposal and the waste area in the sterilisation department, where negative pressure is required to control and prevent the contaminated air from an infectious patient or material spreading out of the room,
- 2) The operation and delivery rooms which required positive pressure to protect the patient from contaminated air coming from outside,
- 3) A deficiency in the a/c system capacity and air flow in the patient and medical equipment rooms and the new expanded units, that may lead to an increase in temperature impacting users and the functioning of equipment as well as the results of this equipment, especially in the laboratory department.
- 4) A lack of important types of gases used in life-saving treatment to expand children's veins, especially in the NICU and PICU

6.6.4 LIFE SAFETY ISSUES IN DESIGNS

Two safety issues were identified in the designs. They are:

- 1) Difficulty in the evacuation plan for inpatients from the paediatric, neonatal and adults intensive care units, because they are located on the upper floor (third level),
- 2) A long distance between some departments and the emergency evacuation zones, forcing individuals to expend time and effort to reach safety zone. This may cause death, poisoning, burns and suffocation to patients and users.

6.6.5 LIFE SECURITY ISSUES IN DESIGNS

The main security design issue mentioned by participants and via observation is that the door locks do not link to the alarm system in an emergency such as kidnaping from the nursery unit.

6.6.6 ELECTRICAL DESIGN ISSUES

In terms of electrical design issues, participants reported the following issues;

- 1) some critical (e.g. ventilators), capital (e.g. MRI scan) and medical (patients monitor) equipment, especially in the operating theatre, x-ray and emergency departments, are not connected to the uninterruptible power supply to maintain their function when the power cuts out from the mains or the standby generators do not respond.
- 2) the limited load capacities of electrical panels that do not allow the installation of new or additional equipment or the expansion of the medical space.

6.6.7 EQUIPMENT PLANNING ISSUES

From the observation, medical equipment required to help in testing, diagnosing and treating patients and identifying diseases was unavailable and inadequate in all 24 projects.

6.6.8 PLUMBING DESIGN ISSUES

The only serious issues in plumbing design are water leakage from ceilings in some operating theatres causing issues with patient's health and equipment, and sometimes causing the cancellation of operations and the spreading of infection.

6.7 IMPACT OF DESIGN ISSUES

Patient health and healthcare are impacted directly and indirectly by design issues, including by ais resulting in physical impacts (infections, burns, poison, death and kidnapping) and psychological impacts (depression, anger and loss of privacy).

Healthcare service is impacted by design issues in two ways. Firstly, delaying, stopping and hindering the provision of healthcare because of inadequate or unavailable spaces and equipment for diagnoses and treatment, which lead to prevent care from being provided in the appropriate manner and time. Second, design issues reduce the quality of healthcare services and increases care costs because care services can only be provided in part.

6.8 DESIGN ELEMENTS CAUSING STRESS

Figure 6.4 shows the links between three areas of research objectives: patient sensory systems, design stage atmospheric aspects in designs. Patient sensory systems in this stage of research include sight, hearing, and touch (skin).

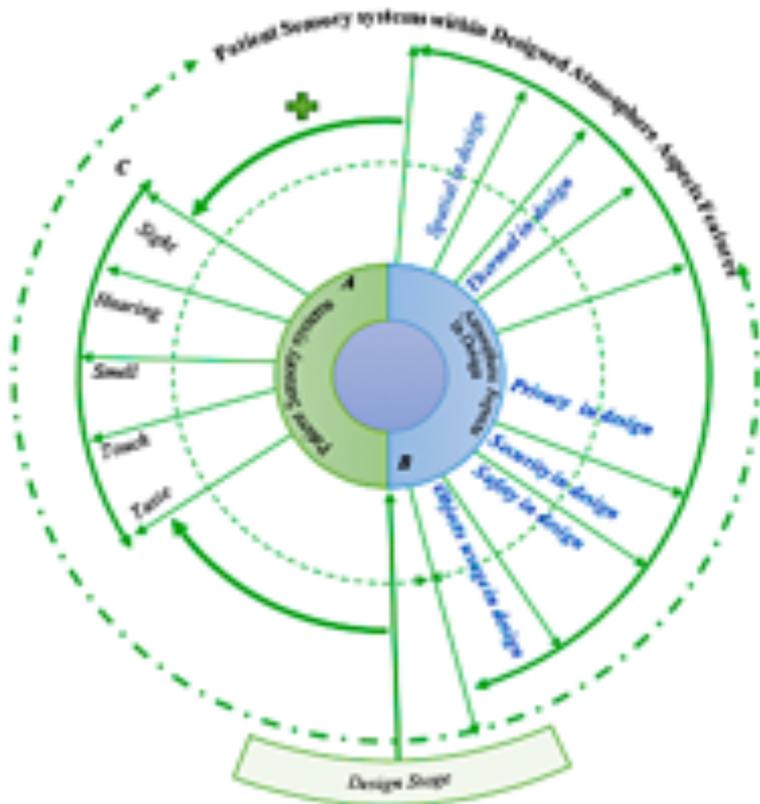


Figure 6.4: Conceptual framework - links between the patients' senses and aspects of design

These senses react to the design elements of the environment atmosphere in physical and psychological ways both positively and negatively. Healing aspects of design involve thermal issue in design: when patients skin feels hot can be caused by an a/c system that does not work efficiently may increase a patient's body temperature effecting their comfort and sleep. Spatial issue in design: to inform patient that the hospital cannot accept them for treatment or they need to wait to be transferred to other hospitals is stressful conditions. This condition occurred because spatial issue such as the number of operating theatres is too low, and the lack of bedrooms. Another issue, the lift size that the patient bed cannot get in the lift easily to reach the cardiac surgery unit is a cause of stress of being trapped in the small lift.

Safety issues in design: patient can be exposed to infection during stay in hospital is considered a source of stress, because the difficulty to apply the patient safety standards and policies to control infections in design; *objects movements:* difficulty in patient movements may increase effort within the move because of storing some devices in the corridors where patients can only be moved through, a long and indirect way from the unit to the operations unit, especially, in

case of emergency surgical intervention needed for patient to bring him from emergency department (er) to the operating theatres in long time.

Privacy issues in design: without concerning the privacy and feelings of patient, who has psychological ill, during their movements inside the hospital or during the walk to the clinic is also uncomfortable situation. *Security design issue:* stress can be caused by feeling insecure in the hospital, especially, when patient hears that there is a chance of kidnaping event happen in nursery unit because security issues in design such the doors locks do not link to the alarm system in emergency cases. At early **stage of design**, these annoying issues in design aspects can be prevented with considering positive aspects in design, that may lead to support patient health and safety.

6.9 FLAWS IN THE DESIGN STAGE

From interviews and participant observation, this study found flaws that originated during the design stage occurred in the following five phases. These flaws were identified as a result of tracking the design issues in the operation stage (case study 1) to design stage (case study 2). Figure 6.5 presents the location of the design defects (red start) within the design process leading to design issues in the operation stage.

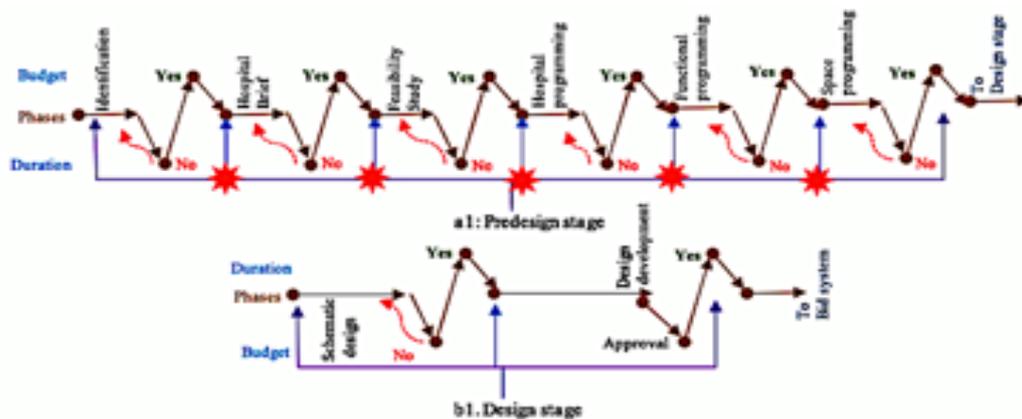


Figure 6.5: sources of flaws in the design process

Flaws in *the identification phase* include inadequate descriptions of a hospital's needs, particularly relating to the requirements of new cases to ensure that the hospital is able to

provide complete treatment and diagnosis plans within the designed spaces and with the appropriate equipment. In addition, there were inadequacies in requirements in planning for the future, particularly being able to accept more patients and providing new technology for treatment and diagnosis. Another notable flaw is the inability to identify the actual scope of medical services to avoid design changes during construction and in the operations stages, leading to the inability to extend or provide the medical services required. Moreover, the study found poor descriptions of and planning for specific types of therapeutic or diagnostic processes, particularly the ability to serve certain patients with particular diseases, illnesses or health problems. The number of patients who could be diagnosed or treated in order to save time is also not clear.

Flaws in the *hospital projects briefs* include poor justifications regarding the need for flexibility in hospital design, in particular the need to extend the current hospitals vertically, horizontally or both and in the accessibility to healthcare services for all types of patients. Another notable flaw is the failure to invite interested participants, such as healthcare providers, maintenance and construction workers and equipment contractors, to define the most appropriate requirements and needs for a hospital. In addition, there were inadequacies in data collection for hospital designs. In particular, data collection should be conducted by design teams as part of their responsibilities because the current data are provided by administrative employees who are not qualified to collect relevant data or the current data were copied from other designs that were unrelated to current projects requirements.

Flaws in the *feasibility study process* included copying and pasting designs and specifications of existing hospitals to hospitals in other regions, resulting in defects and faults in those hospitals being copied into new projects. Space and their programming requirements were unable to achieve a high level of efficiency in their functions as well as the areas supporting them.

Flaws in the *hospital building programming process* included interested participants not being invited to present their requirements accurately; thus, buildings did not meet the care services they were planned for. Another notable flaw is that the circulation both vertically and horizontally within hospital spaces must minimise cross-points in the movements of patients, healthcare givers, waste and supplies (dead and live objects) .

Flaws in *the functional programming process* include inadequacies in the spaces required by each medical unit, clinic, testing and diagnosis spaces, including janitorial, medication and clean supplies and waste disposal rooms. In addition, there were inadequacies identifying infection controls, communications and critical systems, patients, visitors, users and medical staff volumes and activities within area of care spaces. Furthermore, there was insufficient space for mechanical services, particularly the inability of elevators to accommodate the movement of beds.

The noise of power generators was not preventable and the possibility of increasing the capacity of critical systems was limited. Movement between the clinical, treatment and diagnostic departments was poorly linked both horizontally and vertically in hospital buildings. Current designs have not accounted for potential future growth needs, particularly the need to accommodate the incidence of new diseases, staff increases, equipment, services, treatments and diagnoses plans and new technologies. Additional flaws include circulation issues, including the inability to segregate, distribute, control and discharge patients and to control the movement of equipment, supplies, medications, patient information and waste. There were also inadequacies in the space assigned to deal adequately with illness, disease, psychological issues and the volume of cases in each region.

Flaws in the *space programming process* include limited information on patients to determine their type of medical treatment plan, such as medications, chemical or radiation therapies and palliative care. There was inadequate information on the type, numbers and sizes of equipment needed in each area to provide suitable conditions for critical services (e.g. Ac) so as to prevent their breakdown. Other flaws were the uncertainty regarding the amount of space to allow free movement depending on the volume and the type of staff and to avoid the disruptions during the provision of medical services. Uncertainty exists in the capacity for all critical systems (e.g., medical gas, ventilation and heating) required in future extensions to deal with new equipment and technology relating to diagnosis and treatment plans. Limited waste management plans and the inability to prevent their harmful circulation, disposal and storage were also issues. In addition, the number and location of nurse stations required to observe and serve a specific number of patients were inadequate.

6.10 SOURCES OF FLAWS IN THE DESIGN PROCESS

This section discusses sources of flaws in the design stage through dealing with design teams in informal conversation during redesigning 24 projects in case study 2: engineering affairs general administration (EAGA). This study found the flaws in the design process originated from three factors, viz the inability of the design administration teams to deal with the design teams adequately, limitations in the abilities and skills of the design teams, and limitations in the data and information upon which design elements were based.

6.10.1 FLAWS THAT AROSE FROM ADMINISTRATIVE TEAMS

The flaws in design processes originated from administrative team include quality control programmes are inadequate in defining and reducing flaws in design processes, inadequate design and engineering experience of managers, particularly to review or define design issues in the early stage of a project, and lack expertise in certain engineering fields required in design stages, such as medical equipment engineering, architecture, medical planning, life safety and security systems design.

6.10.2 FLAWS IN THE ABILITIES OF DESIGN TEAMS

The flaws in design processes originated from the issues in the abilities of design teams include the design team had limited the ability to use digital design software. Communication amongst members was insufficient. The team showed inability to imagine solutions with reactions, opinions and senses of patients in space. Some designers do not have enough confidence in their abilities to design the hospital buildings by themselves. Because of the fear of punishment for making mistakes, they are depending on the copy of existing projects or examples on the websites. There is noticeable weakness in the personality of some engineers during the research discussion. In particular, they had defended the design solutions they provided only because they wanted to avoid interventions of higher authority, though the designers only have low qualifications in hospital design.

6.10.3 UNAVAILABILITY OF DATA AND INFORMATION

This study found the unavailability of data and information about patient space requirements leading to the design process flaws in design stage within the lack of required data in eleven factors. These factors include the measuring and monitoring the signs and symptoms of the patient physically and psychologically; the methods, stages and equipment of diagnosing and treatment plans in spaces, such as clinical history (medical records), interview, physical and oral exam and diagnostic testing spaces such as laboratory and imaging apartments; the conditions and behaviours of the diseases and illnesses as cause of health problems within all space components and design; the way of the spreading, extending and cases number of current diseases, illnesses and viruses; the procedures, types and plans of the disease treatment such as drug, chemical, radiation, palliative care and surgery therapies; predicting the course of the disease after and before it appears; the stages of follow-up for patients after main treatment: blood tests, imaging tests and physical exam; type, size, gender, culture and health issues of patients; the movements lines of users, materials and equipment as contaminated or uncontaminated objects within corridors in hospital; spaces functions and activities types and amount and patient data; and information movements.

6.11 SUMMARY OF FINDINGS FROM INTERVIEWS AND OBSERVATIONS

Figure 6.6 summarises the findings from the interviews and participant observations aimed at defining the potential link between the design process and patients’ recovery.

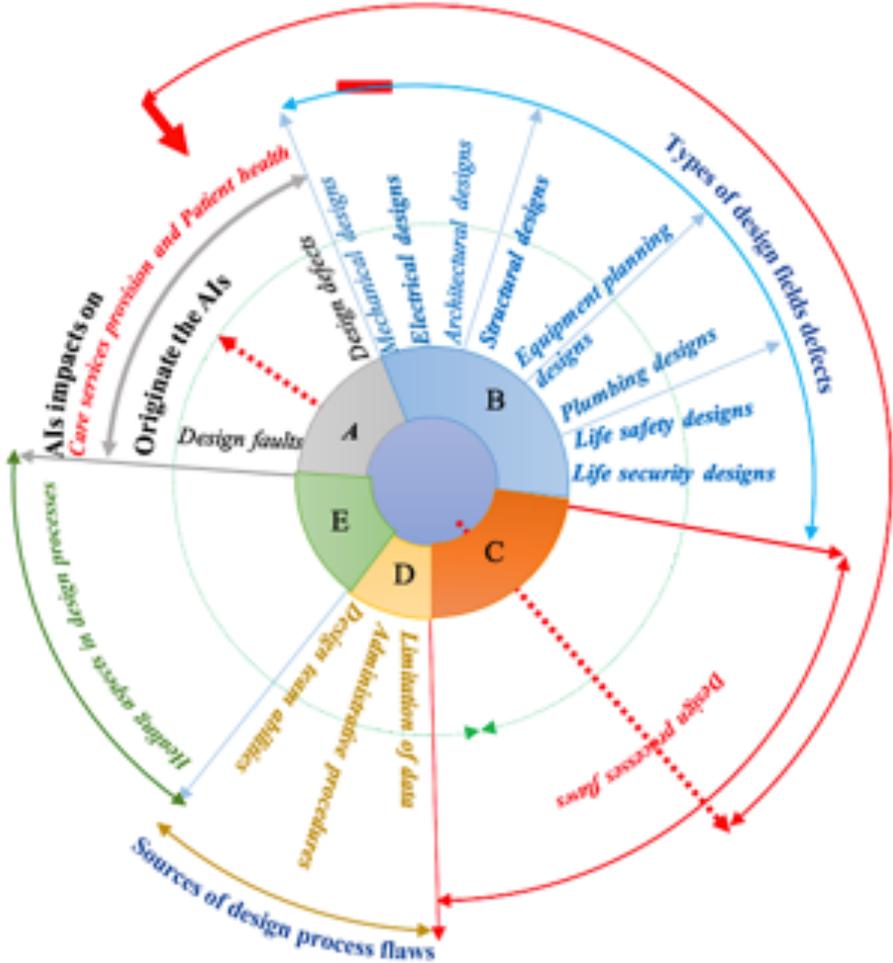


Figure 6.6: Conceptual framework - summary of findings within the research areas

This chapter has discussed five main issues:

- 1) design issues, including defects and faults that initiate ais, and how they affect patient health and care;
- 2) types of design issues that occur in the operations stage of facilities, including eight types of design fields;

- 3) flaws in the early design stage in six phases: identification of needs, the hospital brief, the feasibility study, the hospital building programming, the hospital functional programming and the hospital building space programming processes (see Figure 6.5);
- 4) the source of flaws associated with the abilities of design teams and the administrative management and the missing data and information required for accurate design before or during the design phases;
- 5) five stress-causing aspects were identified in hospital design, affecting psychological and physical health of patients. these aspects include issues in thermal, spatial, patient movements, privacy, security and safety designs (see Figure 6.2).

The next chapter will provide the analysis of the interviews with patients (see Figure 6.7).

Stage 2	Objectives	Data sources	Outcomes
Phase 1	Objective 3	14 post-treatment patients In Case study 1	identified: <ul style="list-style-type: none"> • Type of Design field issues • Design issues results (AIs) • Design issues effects • Stressful elements in design • Healing aspects in design
Methods			
Interview Questions			

Figure 6.7: Findings from interviews with patients

7.0 ANALYSIS OF THE INTERVIEWS WITH PATIENTS

7.1 INTRODUCTION

This chapter presents the analysis of semi-structured interviews conducted with post-treatment patients in case study 1 (see Chapter 3: Section 3.10). A total of 14 patients were interviewed to investigate their perceptions regarding the healthcare environment whilst in a Saudi hospital. In addition, they were interviewed about their views on issues in the environment where they were receiving care, the types of AIs they experienced and the impact of AIs on the care they received. They were also interviewed about AIs in general, manifestations of AIs from design issues and their reactions to discomfort in healthcare spaces. Responses were also obtained relating to patients' senses and their reaction to designed spaces as well as recommendations on how to reduce the impact of AIs.

Findings include the patients' thoughts regarding the impact of AIs, factors affecting their reactions to care spaces, the nature of their reactions, the physical and psychological efforts, the relationship between AIs and design-field issues. Issues and features of Healing aspects in design.

7.2 BACKGROUND OF PATIENTS

The 14 participants were invited to participate in the study because of the length of their hospital stay (King Fahd Hospital and Medical Tower - Case Study 1). A fundamental inclusion criterion is exposure to the hospital's environmental design issues and features that support the culture, beliefs and traditions of patients. Information gathered on the participants included their backgrounds, treatment plan, the space required for their therapy and diagnosis, and the duration of in-patient stay.

7.2.1 THE NATURE OF PATIENTS' TREATMENT PLANS

Figure 7.1 shows information about the types of care provided to the participants during their stay.

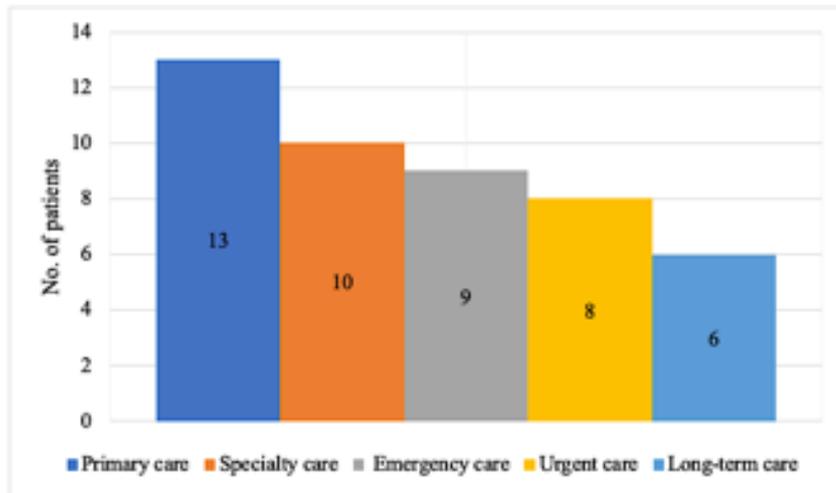


Figure 7.1: The nature of patients' treatment plans

The majority [n=13] of participants received care for primary care and each participant received more than one form of care service during their stay. Therefore, most patients visited the hospital for various reasons or health problems. The highest frequencies of care were received in speciality care [n=10], emergency [n=9] and urgent care [n=6] respectively. [n=6] of the patients received long-term care and were therefore exposed to care environment for a long-time. They were of particular interest for the study because they could describe what they found or experienced during longer periods.

7.2.2 CARE UNITS VISITED BY PARTICIPANTS

Figure 7.2 illustrates the number of units visited by patients whilst seeking hospital care. This captures their movements from the diagnostic stage through to therapeutic care. All 14 participants attended clinics, the pharmacy (for follow-up plans) and the inpatient medical wards. [n=12] participants visited the accident and emergency unit, [n=6] general surgery and [n=6] diagnostic imaging, with [n=1] visiting the anaesthetic, [n=1] labour and delivery, [n=1] renal, [n=1] endoscopy and [n=3] radiotherapy units. Most of the participants visited various medical and non-medical units for both diagnosis and treatment plans.

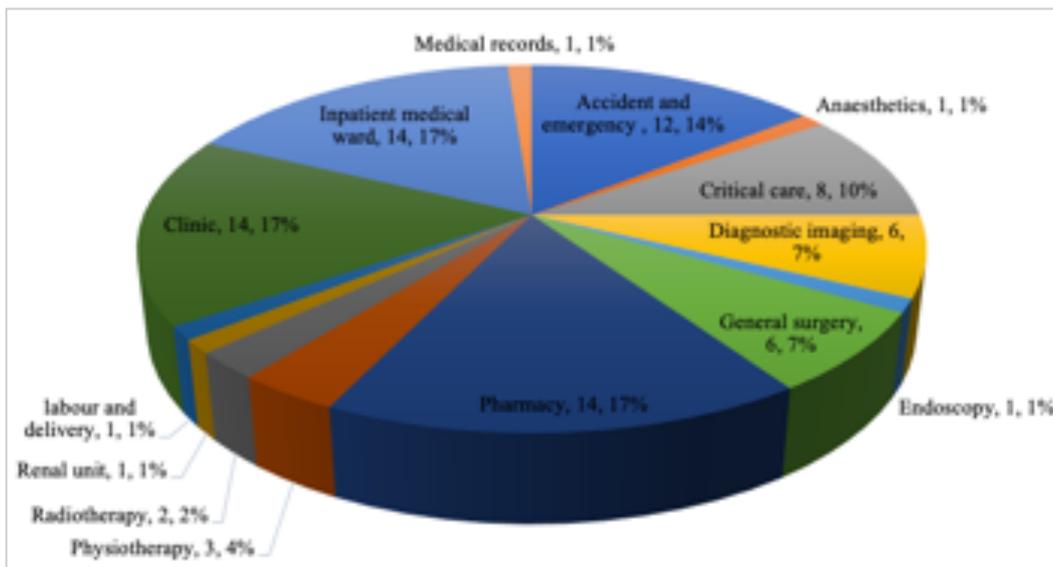


Figure 7. 2: Hospital units visited by respondents

7.2.3 LENGTH-OF-STAY OF PARTICIPANTS

Table 7.1 shows information about the duration of participants' in-patient stay. Three participants stayed in the hospital for 12 to 14 months, whilst the majority stayed no more than five months. Some patients were admitted to the hospital more than twice for different health problems. Overall, participants who stayed in hospital for a long-time were able to present their opinions, feelings and thoughts more clearly regarding the impact on them of the environmental issues.

Table 7.1: Duration of respondents' hospital stays

Length of stay (months)	No. of participants
≤ 3	8
4 – 6	3
7 – 11	1
≥ 12	2

7.3 PATIENTS' VIEWS REGARDING AIS

Participants were asked about how AIs affected them physically (body), psychologically (mind) and their overall healing processes (health), as reported in the following section.

7.3.1 THE IMPACT OF AIS ON PATIENTS' PSYCHOLOGICAL HEALTH

Figure 7.3 illustrates participants' views on the psychological impact of AIs on their health whilst answering the question: "What are your thoughts about AIs affecting the physical and psychological health of patients?". The bars represent the number of times each participant mentioned a psychological impact.

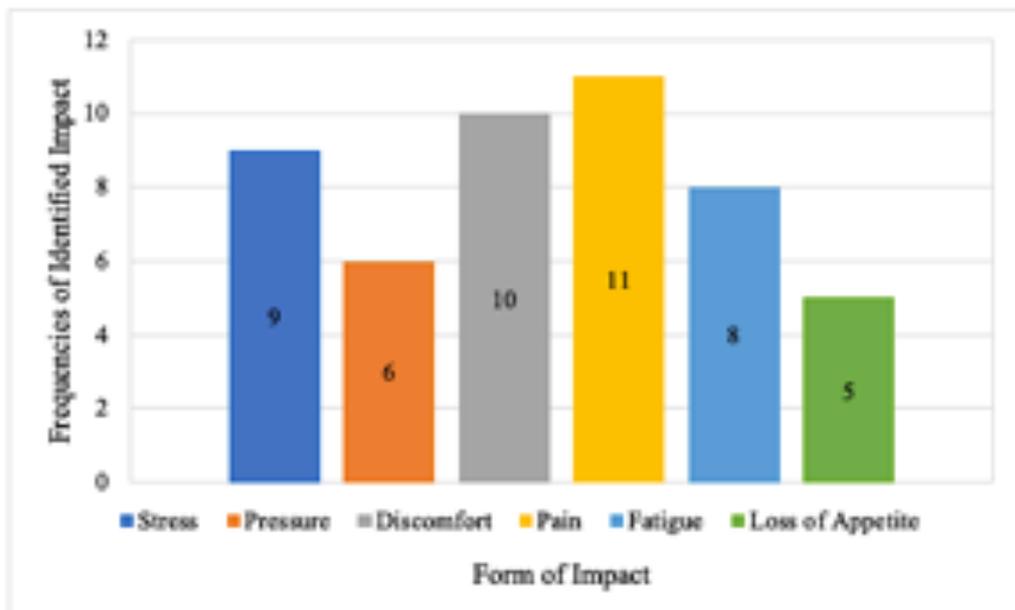


Figure 7.3: The psychological impact of AIs

Six psychological impacts of AIs were identified by respondents. Pain had the highest frequency. Discomfort, stress and fatigue were also reported by more than half the participants. Overall, each participant had clear thoughts about the psychological impact of AIs on their health, especially the pain factor which causes stress, leading to less sleep, fatigue and loss of appetite. In addition, Participant 1 said their stress appeared when they had a fall because of the nature of the hospital floor and there was no one to assist them at that time. Participant 7 stated their stress resulted from the feeling of being in an unsafe place, especially when they were in the toilet. Participant 1, who had a fractured arm, reported discomfort because of the uncomfortable position of his body in bed and also the desire to frequently scratch their plastered arm. Their injury also caused difficulty in going to the toilet. Participant 7 also experienced pressure as they could not fulfil their needs due to their plastered arm.

7.3.2 PARTICIPANTS' VIEWS ON THE IMPACT OF AIS ON PHYSICAL HEALTH

The bars represent the number of times each participant mentioned a physical impact. Participants mentioned six physical impact of AIs indicated in Figure 7.4.

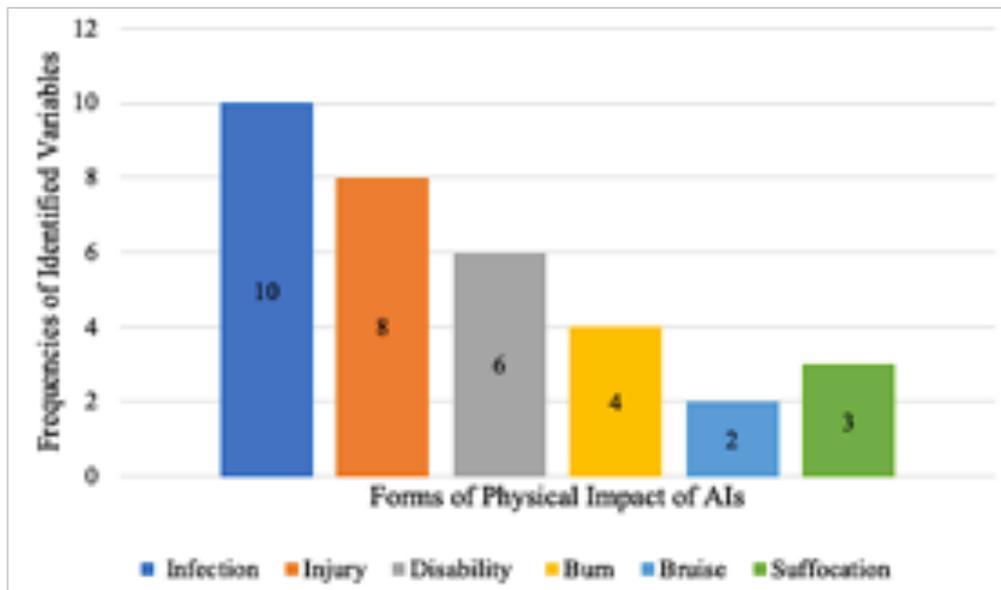


Figure 7. 4: Physical impact of AIs

Infections, the most frequent impact, resulted from patients' pre-existing conditions such as injuries and diseases, poor healthcare management and waste management. An example of injury is a participant, who had bone fractures as a result of fall, suffering additional injury to their knee and head due to hitting the sink and toilet door. Suffocation, the least frequent impact, happened in a fire.

In addition, unexpected impacts, 2 participants mentioned low income as a financial impact, as they could not work or monitor their businesses during their stay. The long stay time in hospital should be spent with family considered as social impact. However, it is necessary to understand and answer how these impacts could affect the healing process, how patients respond to them, and how designers could deal with these impacts when designing. There is a need to investigate further on patients with different locations, care, diagnoses and treatment types, ages and genders.

From previous Sections 7.1.4 and 7.1.5, four forms of AIs impact have on patient status: social, financial, physical and psychological impacts. Some patients shared their experiences in facing some of those AIs from others.

7.4 PATIENTS' FEELINGS ABOUT HOSPITALS

Figure 7.5 illustrates the experiences of participants regarding the question “In general, were there any incidents that have caused a negative reaction from you about Saudi healthcare facilities?”. Nine of the 14 participants experienced or could recall the impact of AIs and had a negative reaction caused by AIs during their stay in any healthcare facilities in the KSA, compared to five who did not.

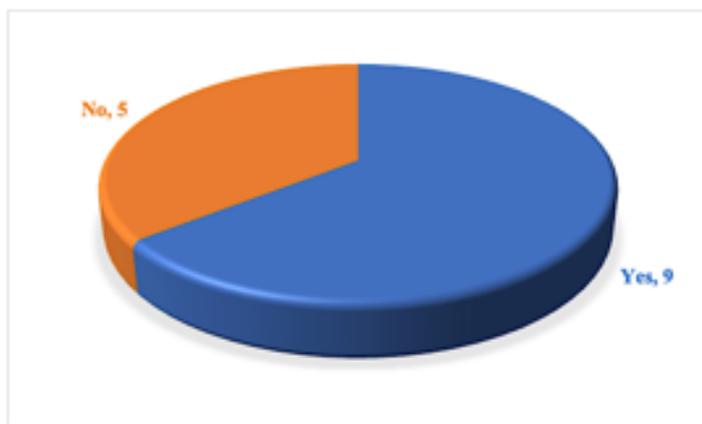


Figure 7.5: Patient experience in facing AIs and negative feelings within their care space

7.5 PARTICIPANTS' ADVERSE INCIDENT EXPERIENCES

Participants were asked: “Did you ever feel unsafe, stressed or at risk in relation to the design and components of your environment during this hospital stay?”. This question was divided into two sub-questions: “Please tell me more about that” and “Please describe how this may impacted you” to gain more information from participants who experienced negative reactions from issues relating to the designed environment and components.

All participants said they have experienced stressful feelings of discomfort and being unsafe or at risk of sickness from issues in relation to the environment. Some participants heard sounds from carts, alarms, wind, emergency calls and thunder. They found these stressful, causing them less sleep and to be scared by their experiences. The results of annoying sounds led to a loss of

tranquillity as they stated. One patient stated that they were waiting for their turn to die when they heard an emergency alarm (blue code).

Participants also felt unsafe seeing many electrical cables close to their beds, cracks in walls, stains on ceilings and roof leakages, as well as dirt, dust and rust on walls and equipment. They felt stressed about being infected from these. They also were afraid of being injured by the sharp edges on their dining Tables, trays and sinks in bathroom. They said they have lost the feeling of tranquillity in their space. In addition, participants were afraid of crashing or knocking their shoulders on the many fire extinguisher cabinets located on the walls whilst being moved on their beds or when using the corridors. Small windows, locked most of the time and causing darkness, made them feel stressed and claustrophobic like being in jail.

In addition, participants experienced discomfort during hospital waiting times e.g. whilst waiting for pain medication, laboratory test results, diagnoses and for responses by nurses to calls. Having to move over long distances to undertake imaging and other forms of specialised treatments which involved opening or closing many doors, made them feel exhausted, as it took much effort and time. Participants also mentioned experiencing excessive sweating or dry skin as the result of the frequent breakdown in air conditioning, ventilation and heating systems. (Participants 8) stated that the smell from the sewage unit made them stressed and lose the desire to eat.

Overall, all patients responded to the environmental issues according to the five senses, as well as physical effort. Therefore, these senses are considered a key part to the negative physical and psychological reactions to be avoided in design. Most patients repeatedly mentioned tranquillity and stress in their interviews.

7.6 DISCOMFORT IN THE DESIGNED CARE ENVIRONMENT AND COMPONENTS

This section presents the participants' responses to the question "Can you tell us what things in your designed environment and components made you uncomfortable or comfortable regarding your five senses and why?". The percentage of participants mentioning discomfort according to their five senses is indicated in Figure 7.6.

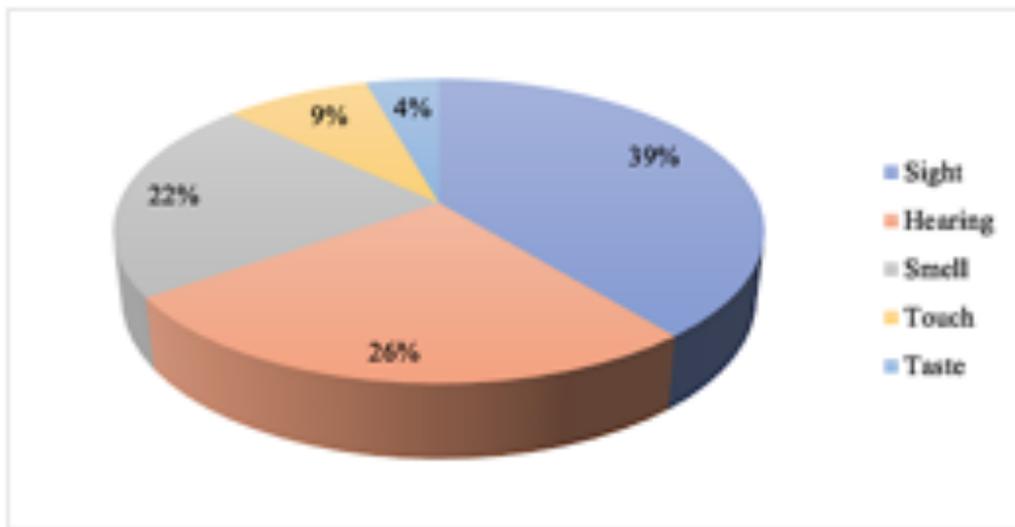


Figure 7.6: Patient sensory systems, discomfort in designed space elements and stressful components

A. Sight. this includes seeing images of people with different forms of diseases (e.g. throat cancer), signs with warning phrases (e.g. danger, do not approach) and the scary names of some departments (e.g. morgue, recuperation and room for washing the dead). Many of the participants had seen these while coming to the hospital or during admission. They also mentioned annoying and unpleasant colours from natural agents e.g. colours related to mouldy food, injuries, bruises or bodily fluids, such as ear wax and mucus. Alternatively, they recommended using comfortable elements and components in designs regarding sight. These include lighting without glare, images of comfort e.g. of seasons, sky, flowers, life under the sea, and access to the external environment (i.e. nature).

B. Hearing. Around a quarter of participants noted distressing sounds and voices from the environment. The stressful elements and components included: (1) external sources of noise e.g. traffic, generators, air conditioning units, sounds of treatment plants (sewage), ventilation outlets, the sound of air coming through gaps in the window and thunder, (2) interior sources of noise (e.g. equipment alarms/peeps, emergency calls (code blues), (3) healthcare providers

speaking loudly about patient's status beside their bed. Providing comfortable voices as part of design elements is recommended and these include: listening to the Qur'an, and natural sounds (water on rocks) or music as positive audio elements.

C. Smell. Participants detected unpleasant smells in the environment. These included: (1) smells within the space (e.g. detergents, sterilisers, blood, antiseptic and medication), (2) externally (e.g. car exhaust fumes, treatment plants, waste storage), and (3) pictures and the wall colours causing the patient to recall bad smells. On the other hand, providing sources of aroma and refreshing smells such as flowers and perfume were suggested.

D. Touch. Participants commented on uncomfortable surfaces and stressful components including sharp edges and rough-textured surfaces of walls, furniture and equipment, as well as some images with disgusting content that made them shudder. They recommended that the things in their spaces should be curved and covered by rubber, wooden or natural material.

E. Taste Stressful components that led to a loss of appetite included seeing images such as a doctor performing surgery, a mosquito sucking blood and the effects of diseases, as well as smelling unpleasant odours (e.g. detergents, sterilisers, blood, treatment plants, waste storage). The patients recommended using comfortable components in the environment recalling a pleasant memory, feeling and thinking.

7.7 PATIENTS' SATISFACTION LEVEL WITH THE ENVIRONMENT

In response to the question: "Were you fully satisfied by this hospital environment's atmosphere?", 86% of participants were not satisfied (Figure 7.7) with the performance of the facilities where they had received care, and most of the issues they identified had arisen from design issues. Therefore, the designed environment in this hospital needs to be improved with respect to: protecting the physical and psychological health of patients, and creating positive reactions through the sensory systems by design elements to support patient health. However, most participants were dissatisfied due to the loss of a tranquil feeling and the high level of stress produced by designed environment elements and components.

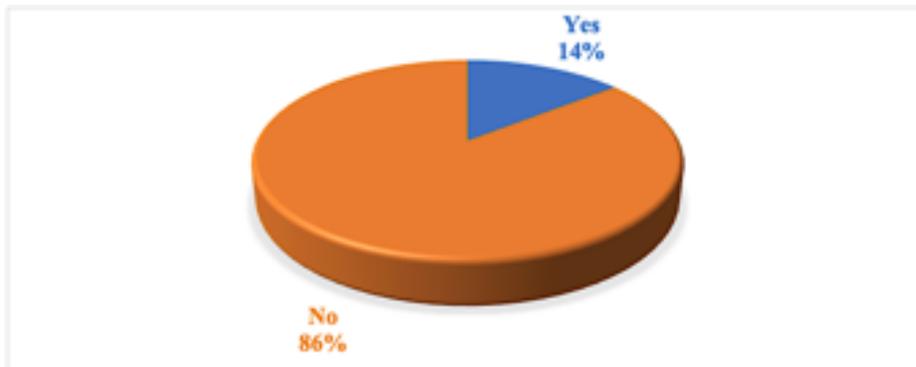


Figure 7.7: Hospital atmosphere design satisfaction level

7.8 FREQUENCY OF REPEATED WORDS IN INTERVIEWS

The word ‘stress’ was used most frequently by participants when talking about discomfort in the environment and stressful components (see Figure 7.8).

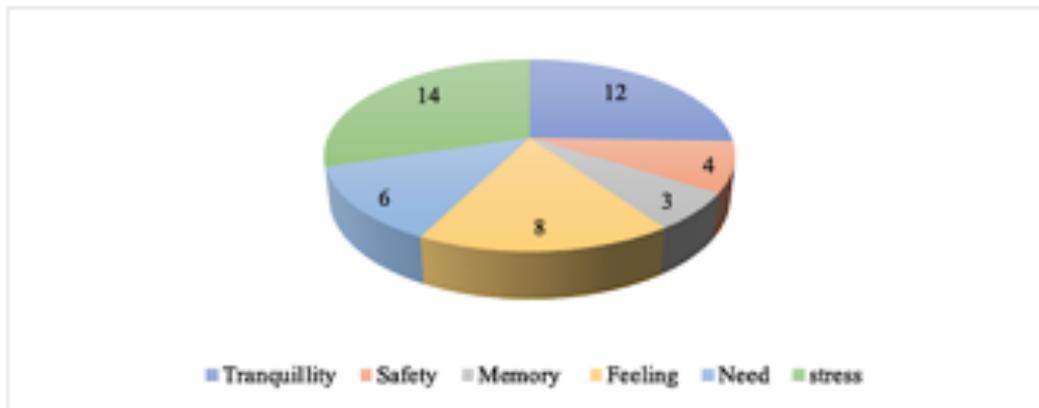


Figure 7.8: Frequency of words mentioned by patients

The second most frequently used was ‘tranquillity’ when they expressed their needs for the design space. ‘Feeling’ was noted predominantly when describing their reactions to the designed space. Participants mentioned the ‘need’ to present their recommendations for the designs as well as ‘safety’ and ‘memory’. ‘Memory’ was mentioned when smelling or seeing things that activated their memories. Overall, most participants used ‘stress’ to express the negative impacts of designed spaces, but they were looking for a sense of tranquillity in the design features.

7.9 EFFECTS OF DESIGN COMPONENTS OF DESIGNED HOSPITAL ON PATIENTS' SENSES

Two patients responded to the question: "Is there anything else you would like to tell us about your view on the design and components of this hospital in terms of your senses?". They complained about the difficulties in moving equipment; for example, moving the bed outside the room required changing the positions of the other beds, and because of narrow doorways, pushing the bed from the room to the corridor is too hard and takes a long-time.

7.10 FINDINGS FROM ANALYSIS OF THE INTERVIEWS WITH PATIENTS AND FROM RECORDED OBSERVATIONS

This section presents the findings of data analysis of interviews and notes recorded while visiting the case study 1. Key findings of this stage of study include five areas related to the design issues in patient environments. They are types of AIs impact, factors that affected the patients in presenting their thoughts and feelings, types of patients' effort expended in spaces, design defects and faults from patients' point of view and the stressful design elements. By tracking the design issues mentioned by participants, the links between those areas were presented in three conceptual frameworks, including the patients' senses and environmental aspects of design, Flaws in the design stage and the design issues identified in the operation stage and the sources of these flaws.

7.10.1 PATIENTS' THOUGHTS ABOUT THE IMPACT OF AIS

The conceptual framework (Figure 7.9) shows the patient thoughts about the types of AIs impact on patients. The middle area is linked to four types: (a) social impact, involving patient isolation from his or her family, friends and community because of limited space for them, (b) physical impact, including infection, disability, bone infarction and suffocation as a result of design issues, (c) psychological impact contains stress, discomfort, pain, fatigue and loss of appetite, and (d) financial impact, including low income for hired workers.

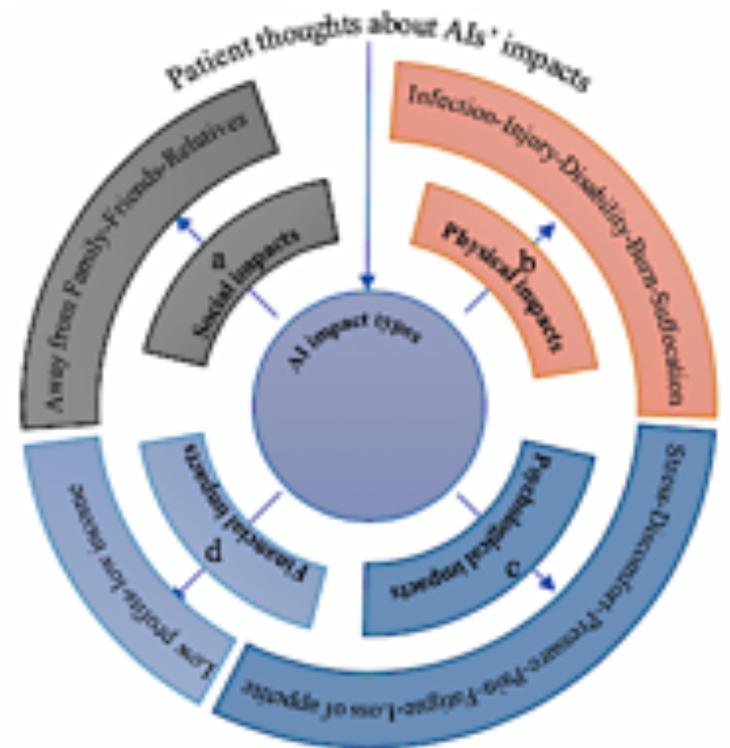


Figure 7.9: Conceptual framework 1 – Patients' thoughts about impact of AIs

7.10.2 FACTORS AFFECTING PATIENT REACTIONS TO DESIGNS

The conceptual framework (Figure 7.10) shows the five factors that affected the patients in presenting their thoughts and feelings about the designed environment. These five factors are: (a) knowledge of the size of space required, knowledge of the movement of equipment and the way infections spread; (b) memory recalling both negative and positive memories; (c) feelings expressing psychological and physical impacts; (d) exposure to the experiences of other patients in different hospitals regarding issues or features of the environment; and (e) religion included seeking a sense of optimism or tranquillity in design by listening to holy books and rejecting the sense of the pessimism from seeing negative images of serious health problems.



Figure 7. 10: Conceptual framework 2 - Factors affecting patient reactions

7.10.3 SOURCES OF PATIENTS' EFFORTS

The framework (Figure 7.11) shows the types of patients' effort expended using a space and moving to reach objects. There are two types of effort: (a) psychological effort is increased when patients felt unsafe, annoyed, in danger, scared, insecure, stressed, under pressure, and uncomfortable; (b) physical effort increased when patients needed to (1) move from one space to another, such as diagnostic units, toilets, nurse stations and emergency exits, (2) use items in the environment to open the toilet door, personal cabinet, windows and curtains, and (3) move to reach objects, get into or out of their bed, reach the toilet components such as the rail bar, soap box, or move from one place to another.



Figure 7.11: Conceptual framework 3 - Types of effort expended by patients

7.10.4 DESIGN DEFECTS AND FAULTS FROM PATIENTS' POINT OF VIEW

This section presents the design issues extracted from the interviews and from recorded observations from this case study. These issues are classified under eight types of design fields, as follows:

Architectural design issues: patients complained about:

1. small-sized windows that were closed and locked most of the time, so interactions with the outside environment were limited;
2. small and crowded toilet with a portable toilet chair, urinal and bins but lacking hand rails;
3. crowding in the patients' rooms with the three escort beds and garbage bins;
4. in-patient wards located near traffic, generators and mechanical equipment;
5. long distances to walk to reach the x-ray department; and

6. small doors to rooms so that it was hard to move the bed outside the room.

Construction design issues: patients and researcher noted cracks in the walls of the patients' rooms. in which a good environment for bringing the bacteria and insects that may lead to spreading of infection.

Mechanical design issues: Complaints related to:

1. high temperatures
2. poor ventilation because the air conditioning and ventilation system outlets are few and far away from the beds,
3. frequent breakdowns of air conditioning, ventilation and heating systems,
4. smell of the sewage plant, and
5. the lift door closing too quickly and therefore hitting the bed many times whilst getting into the lift.

Safety design issues: Difficulty or impossibility of evacuating patients from critical units located on the second and third floors in case of fire is noted by the researcher. An escape chute is a solution suggested by the researcher to the hospital administration.

Electrical design issues: Patients complained about random electrical cables near the beds that may lead to a fall or fire.

Material Specification issues: Patients complained about dirt, dust, rust and stains on the walls and ceiling. These issues may correlate to the criteria of selection materials to be anti dust.

Equipment planning issues: Patients complained about:

1. beds being too small to comfortably fit people
2. difficulty in changing the positioning of the bed,
3. waste containers including wound dressing materials located besides the bed head or on the walls,
4. sharp edges on the furniture in the rooms, and
5. delays in drug delivery and laboratory test results.

It is suggested to use the pneumatic tube and automated pharmacy systems as solutions for these issues.

Plumbing design issues: Patients complained about the water leakage from the roofs of their rooms and toilets. Those issues may create wet areas causing falls or bacterial growth.

7.10.5 STRESSFUL COMPONENTS AND ELEMENTS AFFECTING PATIENTS' SENSES

This study presents the stressful design elements occurring in the environment and affecting patient recovery in nine aspects of design, as detailed in 7.5 above. In which could be prevented at the early stage of design.

Figure 7.12 shows the links between two areas in the form of patients' senses and environmental aspects of design. *(A) Patient sensory systems* include (1) sight, (2) hearing, (3) smell, (4) touch, and (5) taste.

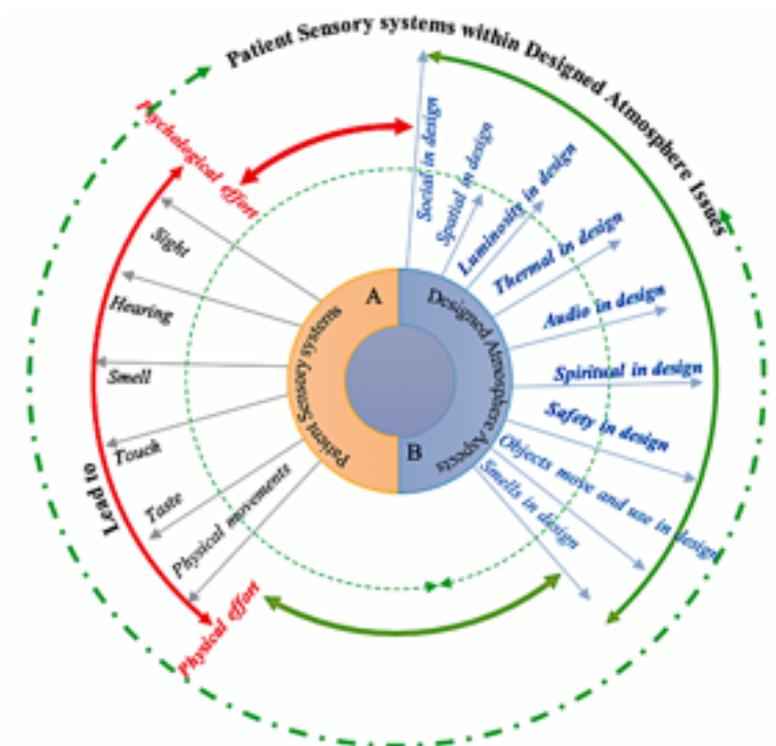


Figure 7.12: Conceptual framework 4. The link between patient sensory systems and design aspects

These senses react to the design elements of the environment atmosphere in physical and psychological ways both positively and negatively. **(B) healing Aspects of design elements** involve *social issues in design*: Inadequate space for the patient to connect with visitors; *spatial*: Inadequate spaces including patient room, toilet, lift, small-sized windows and doors, equipment surfaces with sharp edges, and objects obstructing movement within the corridors; *luminous*: darkness around them in MRI room and limited access for sunlight; *thermal in design*: Deficiency in critical systems that lead to sweating or dry skin; *audio in design*: Annoying sounds and voices in patients' space; *safety*: Random electrical cables around the patient bed, the lift does not fit the patient bed and sharp edges on some of equipment, medical waste bins close to patient bed and wet floors; *objects usage*: Spending time and effort to use and deal with objects in spaces; *Spiritual issues in design*: Lack of space and tools for ablutions and prayers, the direction of the toilet chairs facing the Qibla, and the bed was not facing the Qibla.

7.10.6 FLAWS AND THEIR SOURCES TRACKED TO THE DESIGN STAGE

Flaws in the design stage were identified by tracking the design issues identified by the patients in the operation stage. Flaws occurred in six phases of design (Figure 7.13) and the sources of these flaws were identified in three areas.

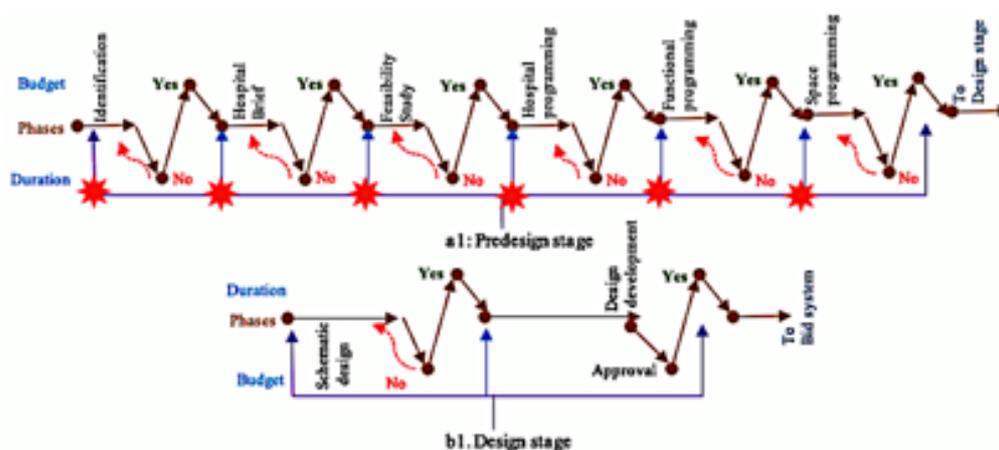


Figure 7.13: Sources of flaws in the design process

In the *identification phase*, there were flaws in hospital design principles relating to designing to support patient health. Flaws in the *hospital brief process* were the hospital project objectives

to reduce the adverse incidents and support the healing process. There were also flaws in desired outcome to decrease the spread of disease from one hospital to another or to other countries, and the lengthy stay of patients and to support healing process. There were also issues identifying the risks and the constraints in selecting suitable land taking account of climate conditions, the soil type and location. In the *feasibility study process*, flaws related to site analysis to study the impact of sunlight, green areas, air flow, noise level and amount of rain on the hospital building and patients' health. Also, no account was taken of the impact of environmental issues or features on the psychological and the physical health of the patients. Furthermore, geographic and the meteorological data in each region were not collected.,. In the *hospital programming* process, there were flaws in identifying specific design elements to meet the beliefs, culture, history and tradition in KSA. Considerations were required to include in the design the spaces and the tools to perform worship. *Functional programming* process flaws related to issues in mechanical services so that patients' beds could be easily moved and lifts could be readily accessed, and to avoid generator noise. There were flaws in the circulation requirement to closely link clinical, treatment and diagnostic departments/units horizontally and/or vertically. *Space programming process* includes flaws in appropriate conditions for critical services (e.g., air conditioning) to prevent their breakdown. There were issues in the relationship between spaces and emergency exists for patient evacuation. There were also flaws relating to the requirement to provide adequate and sufficient space for the comfort of and ease of use for patients and other users.

7.10.7 SOURCES OF FLAWS IN DESIGN PROCESSES

From design issues and stressful elements in operation stage mentioned by participants in case study 1, this study found, the design processes flaws may originate from *design team abilities issues* during the design processes. These sources of flaws including design skills in the inability to imagine the solutions with reactions, opinions and senses of patients in space. Design knowledge due to lack of communications and feedback with patients and users to realise the needs and the requirements for selecting the best solutions that consider healing aspects in design. Limited abilities to convey and present the feelings, ideas and desires of patients' sensory systems to design elements in space graphically and imaginably.

7.11 SUMMARY OF FINDINGS FROM INTERVIEWS WITH PATIENTS

Figure 7.14 shows the findings extracted from interviews with patients and visiting case study location to clarify the potential link between the design and recovery processes.

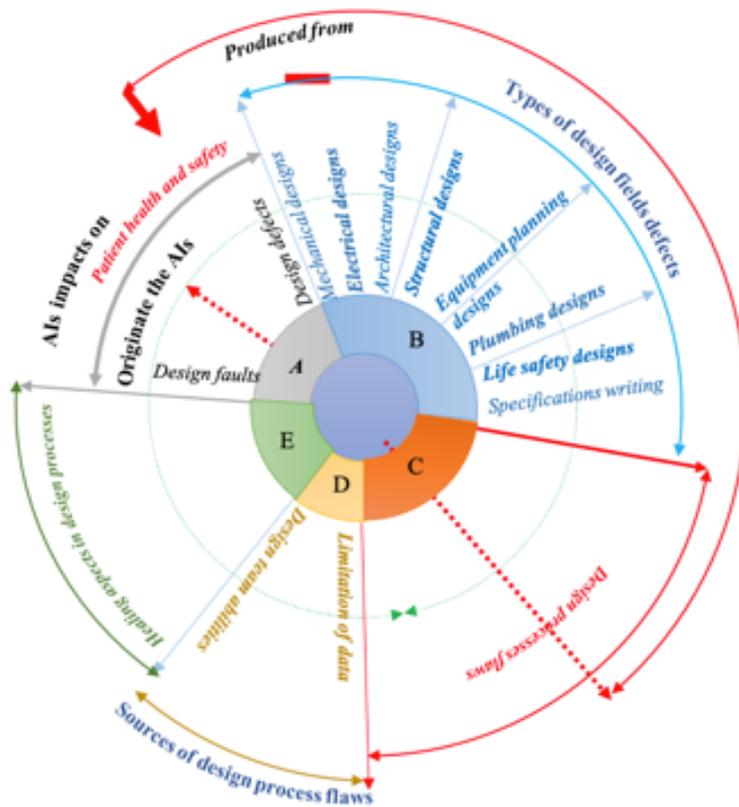


Figure 7.14: Conceptual framework - Summary of findings from patient interviews

This chapter described five main issues regarding the design of care spaces in hospital. They include:

- A. Design issues, defects and faults that initiated the ais affecting patient health and safety;
- B. The nature and effect of environmental issues that affected patients' senses psychologically and physically;
- C. The issues raised by patients related to eight design fields;
- D. By tracking these design issues, flaws could be identified as related to seven phases of the design stage;
- E. By tracking these design issues, this study found flaws sources may associate with:
 - I. Design teams' abilities,
 - II. Missing required data and information before or during the design phases;

F. Eight elements of the environmental aspects in design which may psychologically and physically affect the patient’s senses (Figure 7.12).

The next chapter will present the findings from the analysis of interviews with healthcare providers (Figure 7.15).

Stage 2	objectives	Data sources	outcomes
Phase 2	Objective 3	43 healthcare givers In case studies 1 and 2	identified: Type of Design field issues Design issues results (AIs) Design issues effects Stressful elements in design Healing aspects in design
Methods			
Interview questions			

Figure 7.15: Analysis of interviews with healthcare providers

8.0 ANALYSIS OF INTERVIEWS WITH HEALTHCARE PROVIDERS

8.1 INTRODUCTION

This chapter presents the analysis of interviews with 43 healthcare providers drawn from two case studies in Saudi's southern region: the King Fahad Hospital and Medical Tower (case study 1) and Prince Mishari Bin Saud Hospital (case study 3). Semi-structured interview questions method was applied in both case studies (Figure 8.1). The background of selected cases studies within research instruments can be found in Section 3.10.

Stage 2	Objectives	Data sources	Outcomes
Phase 2	Objective 3	43 healthcare givers In Case studies 1 and 3	identified: <ul style="list-style-type: none"> • Type of Design field issues • Design issues results (AIs) • Design issues effects • Stressful elements in design • Healing aspects in design
Methods			
Interview Questions			

Figure 8.1: Phase 2 of Stage 2 – analysis of interviews with healthcare providers

The analysis includes the background of healthcare givers and their views regarding the performance of the care environment in which they work. They were asked to identify and discuss the impact of design faults and their perceptions regarding flaws in the design process, design issues and AIs. Participants were interviewed further to understand the types of care services they provide, especially those who spend extended periods with patients. In addition, they also asked to discuss the impact of the different forms of AIs on patient health and AI circumstances in design issues. Their views were analysed in terms of design fields, risk levels, locations, care services, healing process and responsible parties. There was focus on the relationship between healing processes and design space such as therapeutic space requirements.

8.2 HEALTHCARE PROVIDERS' BACKGROUNDS

This section presents the participants backgrounds in terms of their numbers in each case study, professional background, therapeutic areas in which participants worked and responsibilities towards patients.

8.2.1 NUMBER OF PARTICIPANTS

Two groups of healthcare providers participated in the interviews. 24 healthcare providers were recruited from case study 1, 16 from case study 3. This is important to gain more data about patient outcomes from different healthcare givers' points of view. However, there is a need for further investigations with more participants that deal with patients directly in the designed environment in the occupancy stage. This is essential to gain more and various data about issues in care environments and features to help designers increase their knowledge on what makes patients uncomfortable, unsafe or feel they are in danger. In addition, the circumstances of the case studies involved were not considered before data collection and this affected the size of participants.

8.2.2 PROFESSIONAL BACKGROUND OF PARTICIPANTS

78% (n=32) of the respondents were nurses who undertake medical examinations, diagnosis and treatment plans as determined by physicians. About a quarter of participants were physicians [n=9].

8.2.3 PARTICIPANTS' WORK LOCATIONS

Figure 8.2 shows the different therapeutic areas in which participants worked. In case study 1, the largest number of participants were working in the obstetrics and gynaecology department, paediatric and adult intensive care units, and medical inpatients wards. Fewer participants dealt with male surgical wards, special care units and medical management departments. Only one participant was from the quality and patient safety department. Two participants were medical students. In case study 3, the largest number of participants were working in medical inpatient (male and female) wards and adult intensive care units. Fewer were from paediatric units in the ER and the quality and patient safety department. One each from a nursery unit and a nursing department. Most participants had dealt with long-term patients from ten different medical spaces.

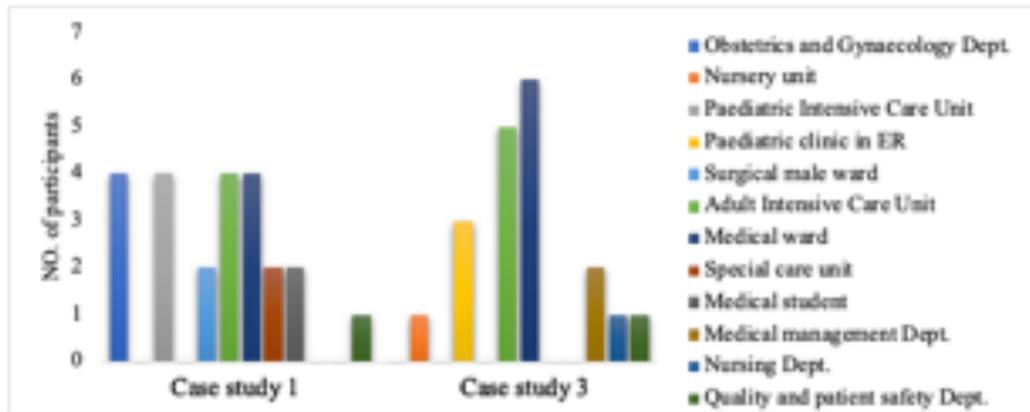


Figure 8.2: Participants within therapeutic areas

8.2.4 THE RESPONSIBILITIES OF HEALTHCARE GIVERS

Figure 8.3 shows information about the healthcare givers' responsibilities towards patients. In case study 1, the largest number of participants [n=10] provided primary and long-term care, while the second largest group provided specialty care [n=8]. Fewer participants [n=4] were responsible for emergency and urgent care and for monitoring patient safety. In case study 3, the largest number of participants dealt with patients through specialty care. A smaller number provided primary and emergency medical services, and long-term and urgent care. Only one respondent each provided hospice care and patient safety monitoring service. A large majority of participants in both case studies had responsibilities for providing speciality (15) and primary (13) care, followed by long-term care (n=12). Only two participants provided the service of monitoring patient safety and only one participant provided hospice care. However, no one provided for or dealt with patients with mental issues or prisoners.

However, to recognize more design issues from different points of views about patients' conditions, needs, wants and demands, another study needs to involve additional healthcare providers with more variety in the provision of healthcare services in different locations.

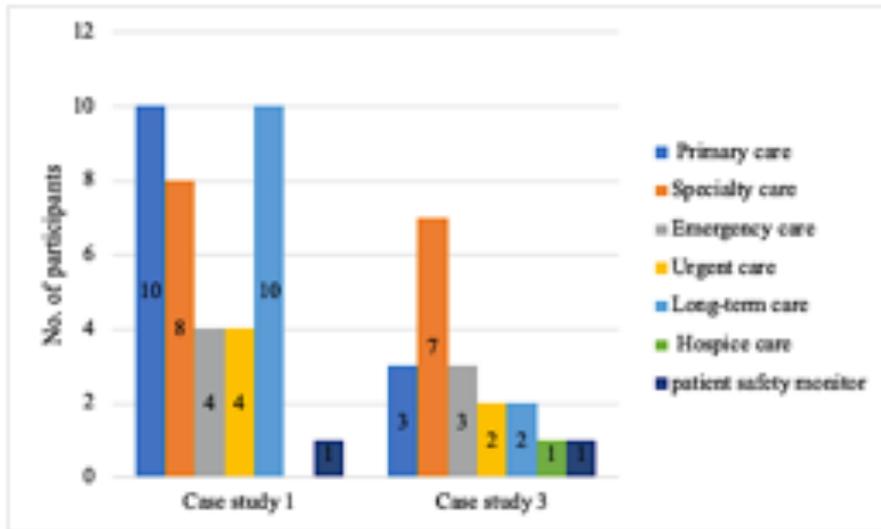


Figure 8.3: Forms of healthcare services provided by participants

8.3 PARTICIPANTS' VIEWS ON THE LINK BETWEEN DESIGN ISSUES AND AIS

Figures 8.4 and 8.5 illustrate the participants' responses to the question: "What are your thoughts about flaws in the architectural design (design stage) causing faults in the operation stage?". In case study 1, 46% of participants had no idea that issues at the design stage were related to issues in the operations stage. 29% thought there was no relationship between the two and only 25% believed that the issues were related. In case study 3, 47% of participants believed design issues were related to issues in the operations stage whereas 32% thought that there is no link between them. 20% of participants had no idea whether these issues were related. Overall, in both case studies, 35% of participants believed equally that these issues were related or not. Less than a third of them did not have any idea about the potential link between those issues.

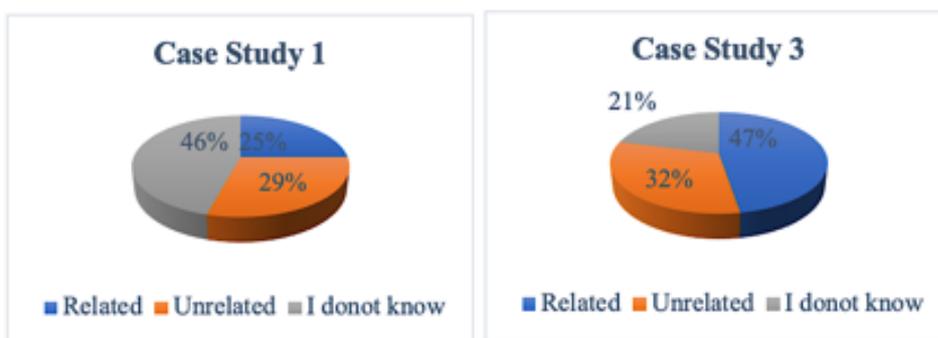


Figure 8.4: Participants' views on the link between design issues in the design and operation stages

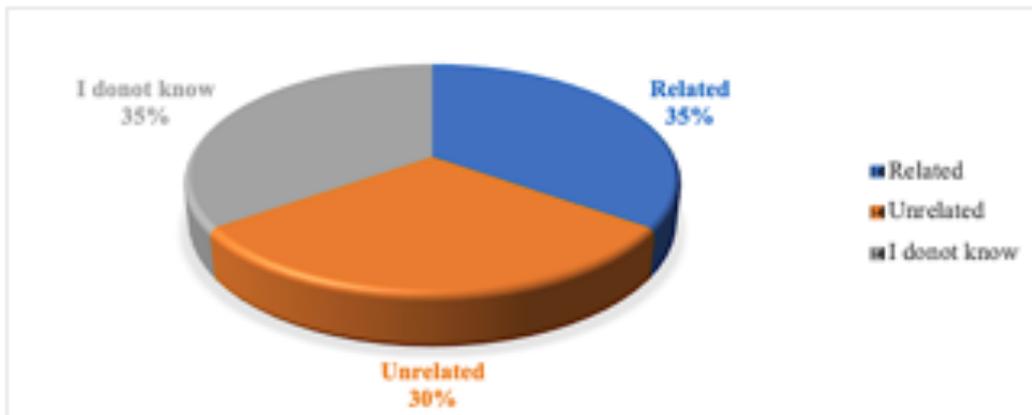


Figure 8.5: Case studies 1 and 3: Participants’ views on the links between design and occupancy stages

8.4 PARTICIPANTS’ VIEWS ON THE EFFECTS OF AIS ON PATIENTS

This section discusses the impact of AIs and design issues on psychological and physical health of patients, and AI circumstances within design issues. Healthcare givers were asked about their thoughts about how AI affect patients.

8.4.1 PARTICIPANTS’ VIEWS ON THE PHYSICAL IMPACT OF AIS ON PATIENT HEALTH

Figure 8.6 illustrates healthcare providers’ views on the physical impact of AIs on patient health in Case Studies 1 and 3.

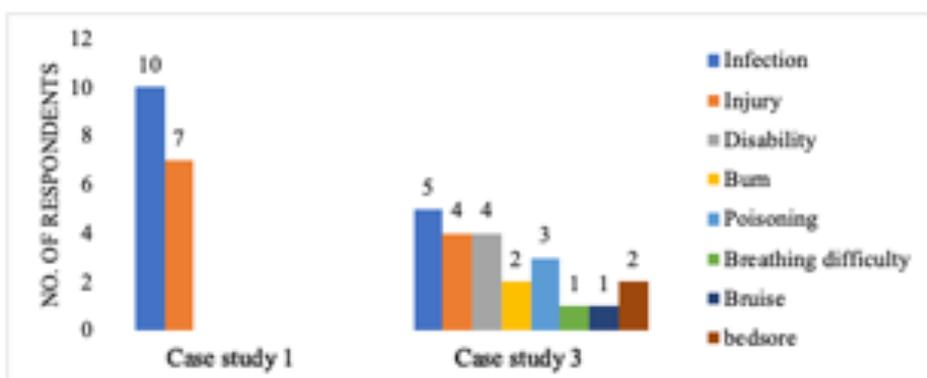


Figure 8.6: Participants’ views on the physical impact of Ais on patients

Participants in case study 1 mentioned two physical impacts of AIs: infections and injuries. However, participants in case study 3 mentioned eight different impacts as indicated in Figure 8.6. Infections, injuries and disabilities were the most common impacts reported. However, there is a need to investigate this further with participation from healthcare givers in order to understand how this impact affect patient health, how patients respond to them and how they impact healing processes.

Figure 8.7 In both case studies, infection was the most common impact mentioned by respondents (35%) and almost a third mentioned injury. One in 10 mentioned disability almost equal to poison. The least common impacts mentioned were bruises and burns (5%, respectively), followed by breathing difficulty and bedsore (3%, respectively).

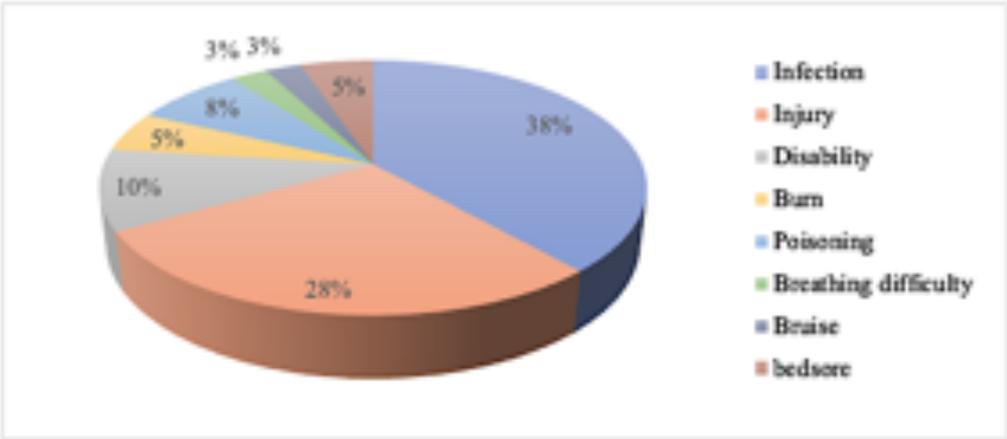


Figure 8. 7: Participants’ views on the impacts of AIs on patient in Case Studies 1 and 3

8.4.2 PARTICIPANTS’ VIEWS ON THE PSYCHOLOGICAL IMPACT OF AIS ON PATIENT HEALTH

Figure 8.8 illustrates the psychological impacts of AIs on patient health reported by two groups of healthcare givers in two Saudi hospitals. 41 healthcare providers mentioned their thoughts on AIs affecting the psychological health of patients.

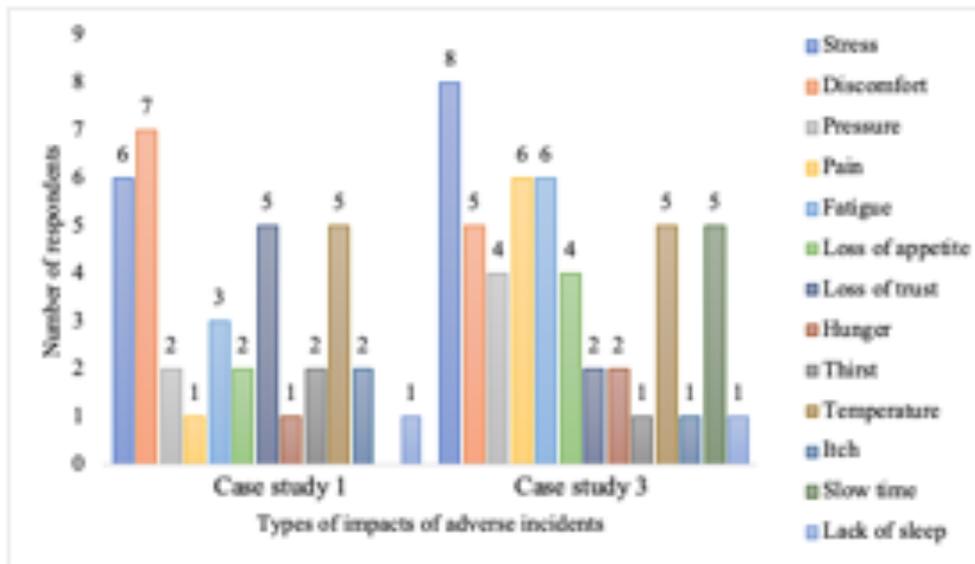


Figure 8.8: Participants’ views on the impact of AIs on psychological health

The participants in case study 1 mentioned 12 psychological impacts of AIs on patient health, as indicated in Figure 8.8. Discomfort, stress, loss of trust and temperature issues were the most commonly mentioned, with relatively few of the other impacts reported.

Participants in case study 3 mentioned 13 psychological impacts. However, stress, discomfort, pressure, pain, fatigue, loss of appetite, temperature issues and time passing slowly were the most common impact mentioned. Therefore, designers should deal with 13 types of psychological impacts during healthcare facility design to support patient’s healing processes. In order to understand and answer how these impacts affect healing processes, how patients respond to them and the results of these impacts, there is a need to investigate further.

8.4.3 ADDITIONAL FACTORS RELATING TO DESIGN ISSUES

Other factors mentioned by participants that could lead to design issues include changes to the existing space. Such changes are implemented to create a new medical unit to deal with different health problems (e.g. a burns unit) or expand an existing unit in order to accommodate new equipment (e.g. x-ray and laboratory departments) or more patients. The original spaces are then smaller and are only appropriate for fewer activities and are not sufficient for critical systems (e.g. ACs designed for specific capabilities to deal with certain areas that were not

included in new or expanded areas). Two parties are responsible for these: facility managers, who are not qualified to apply these changes and the design teams, who did not consider future growth in space requirements for patients and medical services. In addition, in Case Studies 1 and 3, participants mentioned the financial impact of AIs and design issues that led to an increase in:

- 6) the consumption of medical consumables/medications,
- 7) the cost of patient treatment,
- 8) consumption of medical supplies,
- 9) tasks for healthcare givers,
- 10) effort and time for healthcare providers

Findings also suggest AIs led to a decrease in lifespan of medical devices and equipment, and medical services delivery to other patients due to long-term patients being treated for the physical impacts of AIs.

8.5 PARTICIPANTS' VIEWS ON THE EFFECT OF HOSPITAL DESIGN ON PATIENTS/PATIENT CARE

This section presents the responses of 41 participants of 43 to the question: “Would you like to tell us about anything unsafe, stressful, or risky in this hospital’s design elements that affect patient health, safety or healthcare service provision?” Their responses were divided to nine themes as follows:

A. *AIs* that were outside the scope of the research, for example:

- a) patients’ behaviour, including refusing to take medications and comply with care instructions.
- b) hospital management issues including manpower skills and shortages.
- c) lack of resources such as medical supplies
- d) staffing issues, including the failure of management to listen to staff complaints, poor remuneration, the lack of motivation and delayed promotion.
- e) Human capital development issues such as poor skill development on a particular health problem and therapeutic area.

1. *Architectural design issues:*

Issues identified by participants included inadequate provision for people with physical and mobility challenges, medication rooms and isolation rooms, waste management, and storage provision for decommissioned equipment. They also indicated patients' rooms did not have adequate space for staff to work, especially during emergencies. Other issues raised by participants were circulation and movement difficulties including lengthy distances between patients' rooms and the diagnostic department, and insufficient shared space between unrelated medical departments. The location of the hospital being on a mountain lead to additional difficulties in transporting patients to the hospital. Many doors operated manually in the emergency department (ER) which obstruct and delay the movement of patients.

2. *Mechanical design issues:*

Participants indicated a number of issues including air conditioning systems that do not work consistently and break down regularly, leading to patient discomfort. As a result, hospital management needed to provide portable A/C as substitution. Most of these units are located them in the corridor, thereby obstructing movement and increasing noise levels. Also, there is lack of oxygen outlets for oxygen machines and an inefficient oxygen flow (low pressure) system. The lift is too small to fit a cardiac bed and the lift doors do not stay open long enough to allow a patient bed to safely enter. There is also a lack of infrastructure to support negative pressure in isolation rooms and to avoid the spread of infection.

3. *Plumbing design issues:*

Participants mentioned two issues regarding plumbing, viz. the lack of a drainage system in the toilets and a leakage from the ceiling which came from the above toilet flooring.

4. *Life safety design issues:*

Participants complained about the lack of emergency buttons in the toilet, shower or next to toilet chair. The emergency button system has the option or ability for nurses to cancel or turn the patient call off from the nurses' station. The nurse should have to turn it off from the patient's rooms, so that the patient call cannot be ignored from the nurses' station. From

architectural drawings observations of these case studies, it is observed that the lack of smoking zone and door stoppers to avoid spread of smoke in case of a fire.

5. ***Security design issues:***

Participants complained about the lack of a security door system to avoid unauthorized access to certain areas, such as intensive care and nursery units to ensure the security of babies and avoid kidnapping and infection.

6. ***Electrical design issues:***

Participants reported the following electrical design issues: light from the ceiling is directed right into patient eyes which causes discomfort, electrical sockets are uncovered and a combination of British and American electrical sockets which are not suitable for some types of medical equipment.

7. ***Specifications materials issues:***

The paintings and materials in the patient environment are stained, dusty and rust-ridden. These components should have higher quality specifications, including the requirement for materials to be made fireproof, dustproof, waterproof and rustproof as way to infection control.

8. ***Equipment design issues:***

Participants complained about the difficulty in moving or changing the position of the bed according to patients' demands. Also, the fire extinguishing cabinets and waste bins should be located within the walls to give more space in the rooms and corridors.

Other factors mentioned by participants that could lead to design issues include changes to the existing space. Such changes are implemented to create a new medical unit to deal with different health problems (e.g. a burns unit) or expand an existing unit in order to accommodate new equipment (e.g. x-ray and laboratory departments) or more patients. The original spaces are then smaller and are only appropriate for fewer activities and are not sufficient for critical systems (e.g. ACs designed for specific capabilities to deal with certain areas that were not included in new or expanded areas). Two parties are responsible for these: facility managers,

who are not qualified to apply these changes and the design teams, who did not consider future growth in space requirements for patients and medical services.

8.5.1 PARTICIPANTS' VIEWS ON DESIGN-RELATED AIS

Figure 8.9 illustrates the responses of 41 participants to the question: “Did AIs occur in this hospital in relation to design issues?”. Responses were coded into ‘Yes’, ‘No’, and ‘I do not know’.

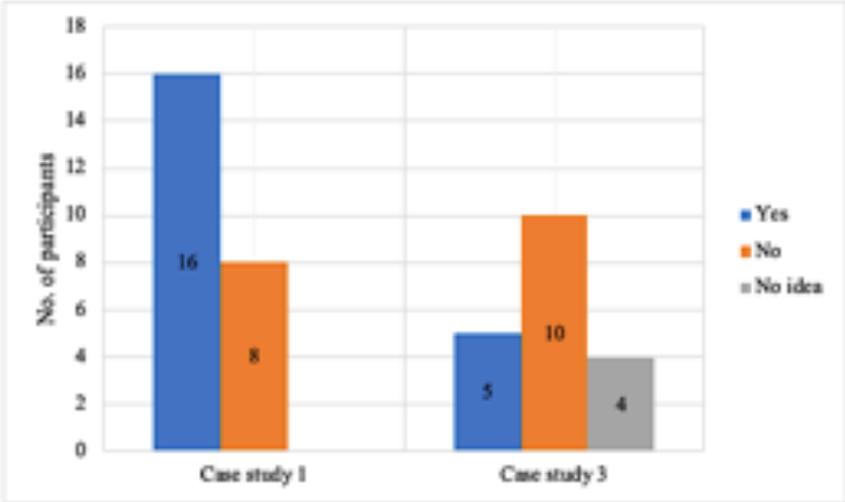


Figure 8.9: Participants’ views on the link between Ais and design issues

In case study 1, most participants recognized that AIs that could originate from design issues. In case study 3, almost half of the participants did not recognise that AIs could occur as a result of design issues. Overall, almost half of the participants acknowledged that AIs may be caused by design issues, however 18 of them did not (Figure 8.10).

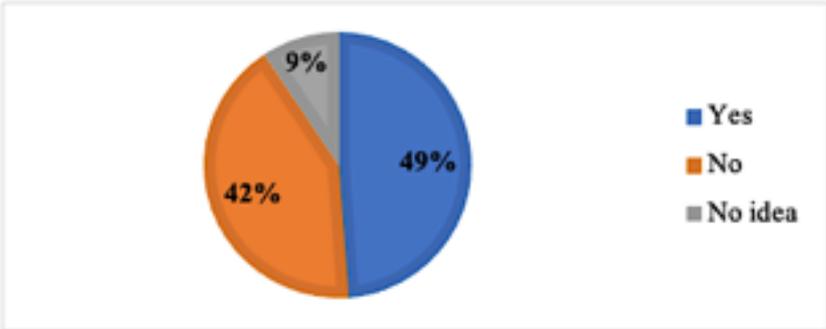


Figure 8.10: AIs associated with design issues in both case studies 1 and 3

Figure 8.11 illustrates the responses of 29 participants to the question responded to the question: “What types of AIs were there?” during their work in the two hospitals. Participants reported three types of AIs: falls, infections and medication errors. The participants mentioned infection as a type of AI, but it is considered one of the physical impacts of AIs.

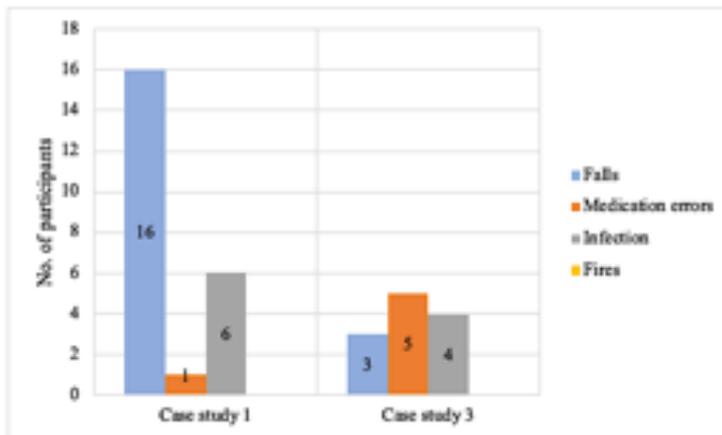


Figure 8.11: Types of AIs noted by participants

8.5.2 PARTICIPANTS’ VIEWS ON THE IMPACT OF AIS ON PATIENTS’ MINDS, BODIES AND BEHAVIOUR

Figure 8.12 illustrates the responses of 38 participants to the asked question: “Did these AIs impact patients’ minds, bodies and behaviour? If so, what were the results?”. The majority of participants from both case studies agree that there is an impact produced by AIs on:

B. the patient’s mind in the form of the loss of:

1. confidence in hospital healthcare services, and
2. trust in healthcare providers because of anger and stress.

C. the patient’s body; physical disability as a result of wounds or fracture caused by AIs (patient fell in the toilet because the non-slip floor material causing a leg fracture, and

D. the patient’s behaviour; patient refusal to take medication due to anger because of:

1. a new treatment plan (to deal with fractured leg),
2. extending their stay time at hospital

8.5.3 PARTICIPANTS PERCEPTIONS OF THE LEVEL OF HARM OF AIS ON PATIENT HEALTH

27 of the participants responded to the question: “What level of harm resulted from the AIs?” during their dealings with patients in the two hospitals. The responses were coded into ‘low’, ‘moderate’, ‘severe’ or ‘death’. Most participants agreed that the level of harm resulting from AIs was moderate, with fewer finding the level low. However, a smaller number found AIs had a low level of harm on patients. One participant in case study 1 emphasized the level of harm as ‘severe’. Overall, the AIs in designed environments have a harm level of between ‘low’ to ‘severe’.

8.5.4 RESPONSES REGARDING THE LOCATION OF AIS

37 of the participants responded to the question: “Where did the AIs occur in this hospital?”. Common areas in case study 1 were bathrooms, medical wards, labour and delivery and emergency departments. In case study 3, the common areas were the neonatal intensive care unit (NICU), intensive care unit (ICU), male medical ward (MMW), female medical ward (FMW) and operating theatres. However, most AIs occurred in toilet areas. Overall, most AIs occurred in the medical units where patients need special care.

8.5.5 THE IMPACT OF AIS ON PATIENTS AND HEALTHCARE SERVICES

41 of the participants responded to the question: “Were there the impacts of these AIs on the health (healing process), safety of patients or on the healthcare services provisions? If so, what were the impacts?”. 14 participants in case study 1 and two in case study 2 realized the AIs had an impact on the patient health, safety and care service as their answers yes. However, eight in case study 1 and 17 in case study 3 did not recognise any impact as their answers no idea (Figure 8.13).

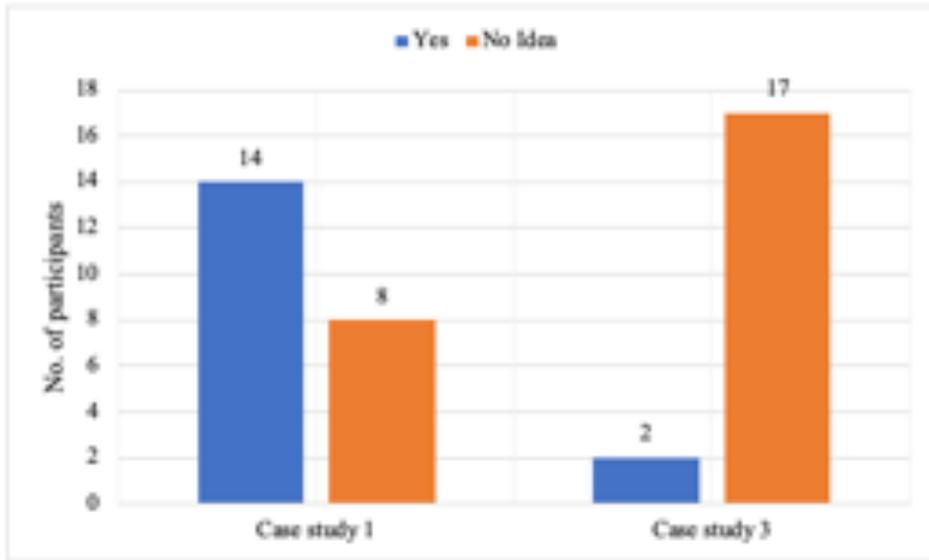


Figure 8.12: Participant responses to the adverse incidents' impacts

In both case studies, participants mentioned a number of AI impacts in response to the next question: “How did these AIs impact the healing process and safety of patients?”. Their responses suggest that the impact of AIs on *the healing process* include:

- 1) preventing healing,
- 2) delaying or applying new treatment for healing (e.g. a lack of the capacity of medical services to diagnose and treat the patient at the right time),
- 3) slowing healing processes (e.g. more time to deal with other medical issues or with new treatment and diagnosis plans caused by AIs);
- 4) increasing the cost of and time required for the healing process and healthcare services

Similarly, the participants noted the impact of AIs *on healthcare services* includes:

- 1) preventing the delivery of or delay in healthcare services (e.g. the lack of available spaces for new medical services and requirements)
- 2) patients moving to private hospitals because of the repeated failure of critical systems (ventilation, air conditioning and gas).

Participants in both case studies mentioned the use of occurrence variance reports for reporting AIs to the infection control office and patient safety and quality department to confirm the occurrences of AIs, as answer to the question: “How do you report the occurrence of AIs?”.

8.5.6 PARTICIPANTS’ VIEWS ON RESPONSIBILITY FOR AIS

37 of the participants responded to the question: “Who was responsible for these AIs originating from design faults that affected patients’ health during this hospitalization?”. In case study 1, most of participants blamed the maintenance and the construction teams, with fewer blaming other teams (Figure 8.14).

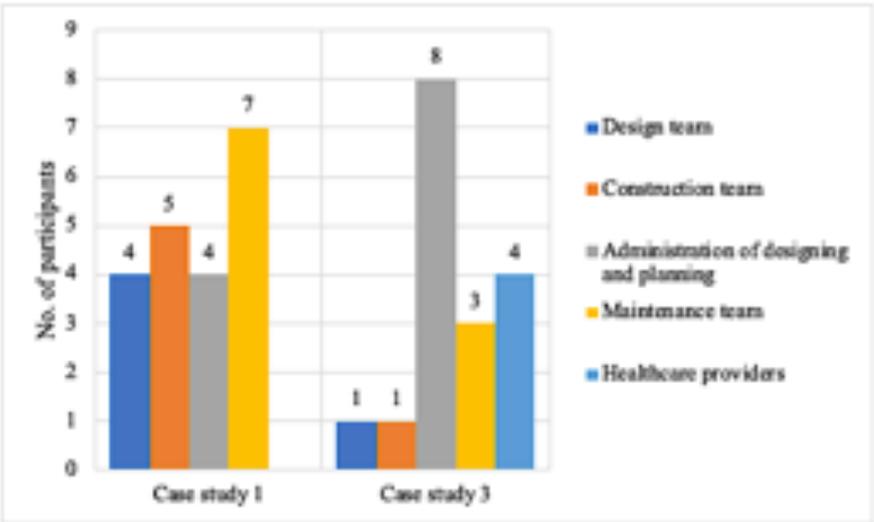


Figure 8.13: Participants’ views on responsible parties for design issues

In case study 3, the majority criticised the designing and planning administration. Overall, 28% of participants in both case studies considered the planning and design administration responsible for design issues, whilst 23% think the maintenance team was responsible. Fewer blamed the construction and design teams (see Figure 8.15).

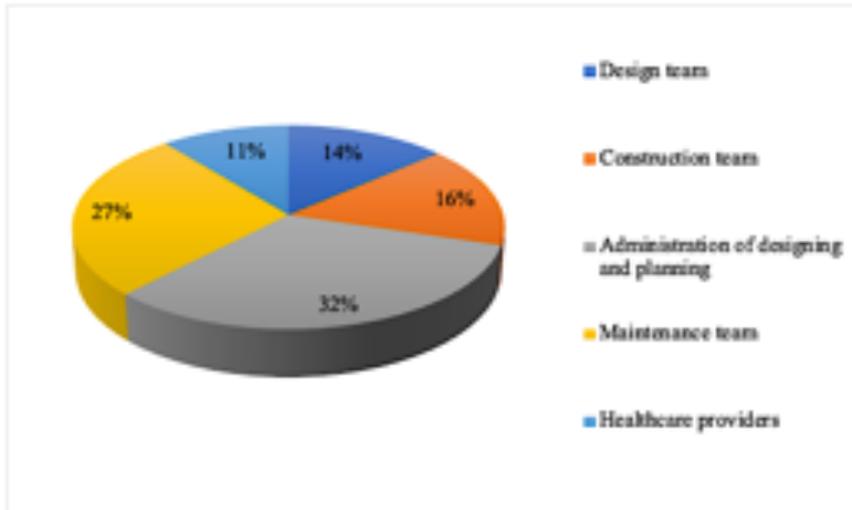


Figure 8. 14: Participants' views on responsible parties for design issues

8.6 HEALING PROCESS AND ISSUES IN THE DESIGNED ENVIRONMENT

This section shows the responses of three participants to the question: “Please briefly define the healing process in general?”. Their answers were that it is a natural restorative response that is systematic, in which it achieves the expected outcomes to satisfy patients and it is the process of the restoration of health from diseases.

Seven participants responded to the question: “Please briefly identify the healing space in general?”. Participants identified it in many terms:

- 1) the plan that satisfies the patient is achieved
- 2) giving patients the ability to fight disease physically and mentally;
- 3) protecting the patient from physical hazards;
- 4) helping patients to get the feeling of tranquillity and relaxation faster;
- 5) improve patient recovery;
- 6) free of anything that harms patients and spaces being quiet, clean and calm;
- 7) a place where the interaction between patients and safety produced positive health outcomes; promoting the healing process: providing medical or nursing care to patient safely
- 8) facilitate healthcare givers' work and healthcare service;
- 9) reduced medication errors, falls and infection
- 10) increase the wellbeing patients' families;

- 11) reduce and heal patient health problems
- 12) decrease future risks to protect and enhance recovery.

8.6.1 COMPLAINTS RECEIVED REGARDING DESIGN ISSUES

Relatively few of the 41 participants responding to the question “Did you receive any complaints about requirements and needs from patients related to the design, equipment and components of this hospital?” stated that they had (Figure 8.16).

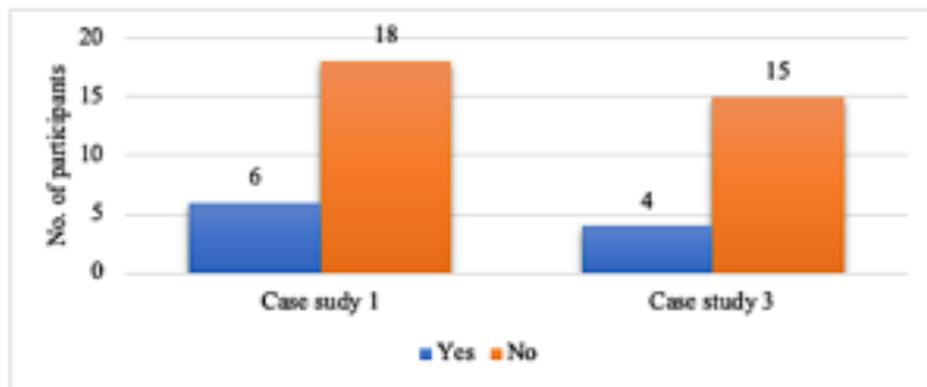


Figure 8. 15: Complaints received for design issues by participant

In both case studies, only 10 participants realized official complaints included the lack of bathrooms and lift numbers. They received unofficial complaints from patients which include deficiencies of the air conditioning system, inadequate patient room size and over-crowding with more than four beds per ward.

The isolation and discharge policies (e.g. JCI, CIBAHI), infection control policy and patient fall prevention policy (e.g. Essential Safety Requirements (ESR) and International Patient Safety Goals (IPSG)) were standards and procedures mentioned by the healthcare providers whilst responding to the question: “Do you have any standards, procedures or policies that were considered for patients’ health and safety at this hospital?”. They recommended that these standards should be considered in the design stage to deal with medical procedures, tools, equipment, advice and patient safety requirements.

The participants suggested five ways to present hospital data and information required in design in their responses to the question: “How can the responsible parties of hospital design respond

to these requirements when designing?”. In having an open channel between the hospital administration and the design team, this mechanism could include (1) the involvement of healthcare providers and patients in the future hospital design as sources of hospital data, (2) making a list of any design issues in the occupancy stage to send to the design team, (3) set high selection criteria for the maintenance contractor to appropriately operate and maintain the hospital,(4) design an official application for confidential complaints of staff, patients and visitors about the design issues and AI occurrences, and (5) consider new technology for the diagnosis and treatment equipment and spaces in future hospital design so as to avoid design changes in the occupancy stage.

8.6.2 PARTICIPATION IN HOSPITAL AND HEALTHCARE FACILITIES DESIGN

In response to the question “Have you participated in designing hospital buildings facilities?” only one of the 41 participants had an opportunity to participate in hospital design at an early stage (safety life design process) but not in KSA.

8.7 PARTICIPANTS’ SATISFACTION LEVEL WITH HOSPITAL DESIGN

Figure 8.17 illustrates the responses of 41 of the participants to the question “Were you fully satisfied by the hospital design in terms of patient safety, health requirements and needs?”

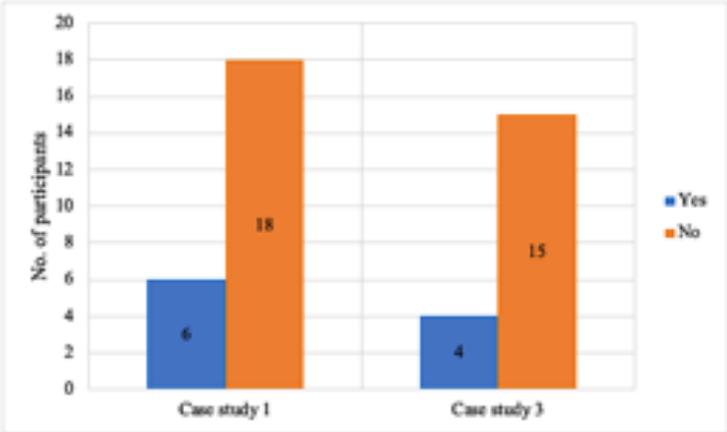


Figure 8.16: Satisfaction level with hospital design

A large number of participants in both case studies were not fully satisfied with the design of the hospitals. The participants voiced their dissatisfaction at the improper location of the

hospitals; in case study 1, the hospital was located on top of a mountain. In case study 2, respondents expressed their dissatisfaction with the hospital’s location in a valley, which led to ground-floor flooding with heavy rain, and small-sized patient rooms and lifts, especially the area around the patient beds which made movement difficult. In case study 1, they also mentioned the hospital building is too high (9 floors) causing stress to patients. It is not possible to monitor patients visually from the nurses’ station because of the solid walls between patients’ rooms and the nurses’ station.

8.7.1 PARTICIPANTS’ VIEWS ON THE FACTORS TO BE CONSIDERED FOR DESIGN

41 of the participants responded to the question “What are the main trigger factors that should be considered in the design of the healing environment in hospital buildings to support patient health?” (Figure 8.18).

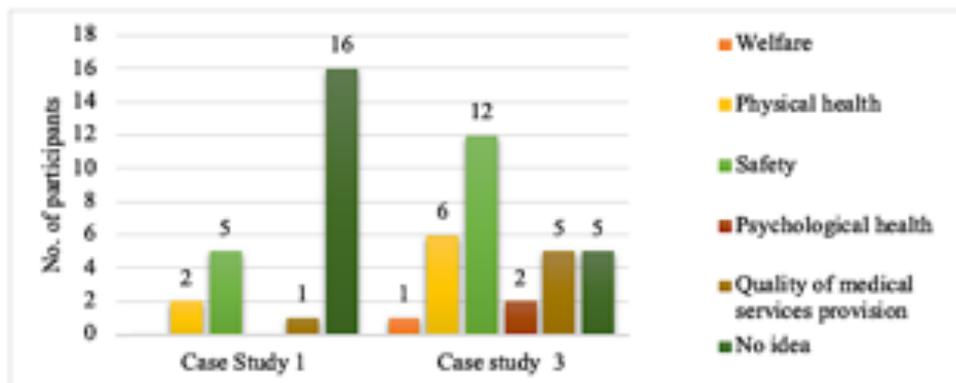


Figure 8.17: Main trigger factors in healing space

In case study 1, a very large number of participants had no idea about the main factors in healing space design but a small number mentioned safety and physical factors. Only one of them indicated Quality of medical services provision as the most important factor when designing the therapeutic space. In case study 2, a large number selected safety as the main factor, with fewer indicating physical health and the quality of medical services provision. A very small number of participants selected the welfare and psychological factors as important triggers in designing a health environment. Overall, it is clear that a large number of participants, in both case studies, had no idea about the main trigger factor in therapeutic spaces, but 31% of them

indicated safety as the most important factor, followed by physical health. Very few considered psychological health factor or welfare as a factor that designers should pay more attention to

8.8 PARTICIPANTS' VIEWS ON ENVIRONMENTAL ELEMENTS AFFECTING PATIENTS' SENSES

37 of the participants in both case studies responded to the question, "Can you tell us what things in patient environment make you uncomfortable/comfortable regarding your sensory systems (listed below) and why?". Participants were made to understand the need for the design team to consider participants' views in creating therapeutic atmosphere in hospital design. In both case studies, healthcare providers mentioned design elements and components that affect patients' senses positively and negatively.

Sight: Using dark colours and materials (e.g. wall and floor paint) that cause sadness and make things difficult to see; dirty or contaminated substances such as blood on the dark paint, and it is hard to clean and sterilise these walls. The paints and materials in patient environments should have the highest specifications, that materials are fireproof, dust-proof, waterproof and rust-proof as a way to control infections. There are small windows and a lack of green areas outside. In the patient rooms, the escort bed and garbage bins obstruct patient movement and affect patient safety. There was also difficulty moving or changing the position of the beds to face towards Qibla to let patients pray, as way of respecting the faith of patients.

Consequently, participants gave recommendations for more space, such as locating the fire extinguishing cabinets and the garbage bins inside the wall; frequently allowing sunlight in the room, which helps in fighting infections and provide TV or pictures on the ceiling above patient beds to eliminate boredom

Hearing: Annoying and scary voices or sounds (such as equipment alarms and peeps, especially in NICU and PICU) made patients uncomfortable or harmed babies' hearing. However, they suggested that providing therapeutic music would help them recall comfortable feelings.

Smell: Some of the air fresheners caused allergies and breathing difficulties in some patients, especially in the ICU. Some patients found the smell of sterilizers and medicines undesirable. They recommend using scents that could affect patients’ sense of smell positively.

Touch: Surfaces of rails and flooring should be anti-slip to avoid falls. To reduce the chance of spreading infection by the touching of the same tools or surfaces by several patients, doors and hand soap, paper towel and water dispensers should respond to patient needs without touching them.

Taste: Some patients mentioned that they did not like the colour of plates and the food Table. They recommended that patients should be given more choices when choosing their meal and the food trolley should have its own space to park in the main corridor.

41 of the participants to the question “What is the most important sense that should be considered by the design teams when designing healing spaces?”. In Case Study 1, they recognised sight, hearing and touch as most important. In Case Study 3, the hearing and smell senses were considered as the most important senses to be considered during design. Overall, hearing was felt to be the most important sense by 27% of participants and with smell at 24%. Sight and touch were the third most important senses but taste was the least important sense mentioned by participants (see Figure 8.19).

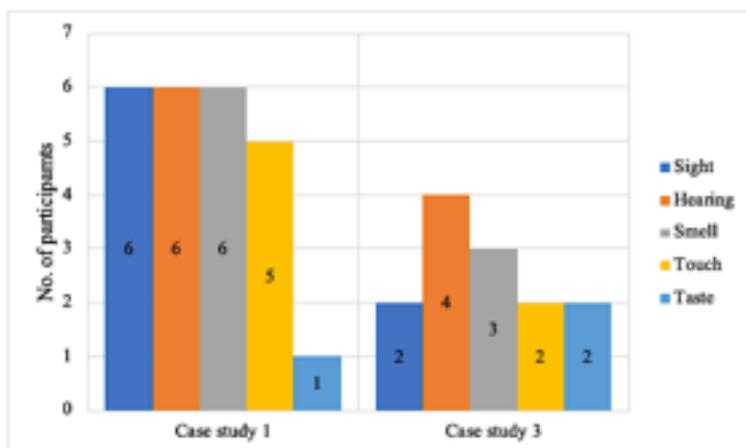


Figure 8.18: The most important sense to be considered

8.9 PARTICIPANTS' RECOMMENDATIONS

The participants in both studies mentioned a number of recommendations to reduce design issues: (1) avoid establishing new departments or extending the current units as this may affect the function and spaces of other departments; (2) consider future inpatient growth, equipment and advance technologies or possible addition of new treatment units in future hospital buildings; (3) designers of the hospital should provide more green areas to reduce stress; (4) conduct more studies and research to improve future hospital designs; (5) designers should be familiar with patients' needs and demands whilst designing; (6) patients, medical staff and community should be involved during early design stages; (7) create a mechanism to identify all hospital design issues at an early stage of occupancy, and (8) materials should be selected using strict criteria to gain a satisfactory level of quality.

8.10 FINDINGS OF ANALYSIS OF INTERVIEWS WITH CARE PROVIDERS

This section summarises the findings on four research areas which include: stressful design elements and patient sensory systems, healing aspects issues in design, design issues, design issue effects, design issue sources, and sources of design process flaws.

8.10.1 SENSORY SYSTEMS AND UNCOMFORTABLY DESIGNED COMPONENTS AND STRESSFUL ELEMENTS

Sight system, sight sense of patients conveyed uncomfortably designed space elements and stressful components in using dark colour and materials such as painting colour used on the walls and floor, that bring sadness. There are small windows that do not allow patients to see the green areas in outside environment. Patient surroundings are small and crowded spaces such as, small and crowded toilet with portable toilet chair, urinal and bins and lack of rails. The patient room with the escort bed and garbage bins, which obstructed the patient movement and affect patient safety. The difficulty to move or change the position of the bed as patient demand to the Qibla site to let patients pray. *Hearing system*, hearing sense of patient observed uncomfortable sounds and voices from designed spaces. Stressful elements and components the annoying and scary voices or sounds, such as equipment alarms and peeps, especially in NICU/PICU, that produced the uncomfortable feeling to patients or harmed babies' hearing system. However, they suggested that providing therapeutic music would help them to recall

memory for comfortable feelings. **Smell system**, smell sense of patient detected uncomfortable scents from designed spaces elements and stressful components. Participants mentioned that some of used fresheners materials caused allergy and difficulty in breathing to some patients, especially in the ICUs. Also, the smell of sterilizers and medicines are undesirable for some patients. **Touch system**, Touch sense of patient responded to uncomfortable surfaces in designed spaces elements and stressful components. Participants recognised that the surfaces of rails and flooring should be anti-slipping a to avoid falls and to reduce the chance of infection spreading by the touching of the same tools or surfaces by a number of patients. The hand soap, paper towel, water tap dispensers and doors should respond to patient needs without touching them. **Physical effort**, physical effort of patients increased within the move and the use of uncomfortable designed space elements and stressful components such as the long distance between patient rooms and the diagnosis department. Spending more time to transport patients from the road level to the hospital, they mentioned the hospital building is too tall (9 floors) causing stress to some patients. The difficulty in breathing for users and patients, because the high altitude of the hospital location (case study 1) where the level of oxygen is too low, and thus required more physical effort.

8.10.2 HEALING ASPECTS ISSUES IN DESIGN

Based on the previous section, this study found the components and elements can be categorised within the following healing aspects of design, which if they are considered in design may lead to support recovery processes.

Spatial issues in design: participants complained about the lack of bathrooms and lift numbers. The patient room size was inadequate and overcrowded with more than 4 beds. Besides the hospital there is a lack of visual monitoring/watching on patient from the nurse station because of the solid walls between the patient room and the control station. The location of hospital (Case study 2) is in a valley, which during heavy rain led to ground-floor flooding and prevented the care service in the emergency department (ER) on the ground floor. Many doors in the ER department also caused obstruction and delaying the patient movement.

Luminous issues in design: the direction of hospital (case study 2) not allowing to sunlight to be in the room most of the time to help in fighting infection, the light from the ceiling is directed

right into patients' eyes which causes discomfort. **Thermal issues in design:** a low level of comfort for patient body temperature because of the deficiency in the A/C system. **Audio issues in design:** the equipment alarms and peeps bring inconvenient feelings. **Social issues in design:** Inadequate spaces for visitors and the escort bed to give patients the feeling of consideration by providing social interaction spaces for his family. **Spiritual issues:** the difficulty to move or change the position of the bed as the patient demands to the Qibla site for praying as a way to respect patients' faiths and to reach the highest level of peace. **Security issues in design,** including lack of security door system to avoid unauthorized access to certain areas, such as intensive care units and nursery to ensure the security of babies.

8.10.3 THE LINK BETWEEN THE PATIENTS' SENSES AND DESIGN ASPECTS

Figure 8.20 shows the links between patients' senses and the environmental design issues. These issues increase the psychological and physical burden on patients, leading to longer recovery.

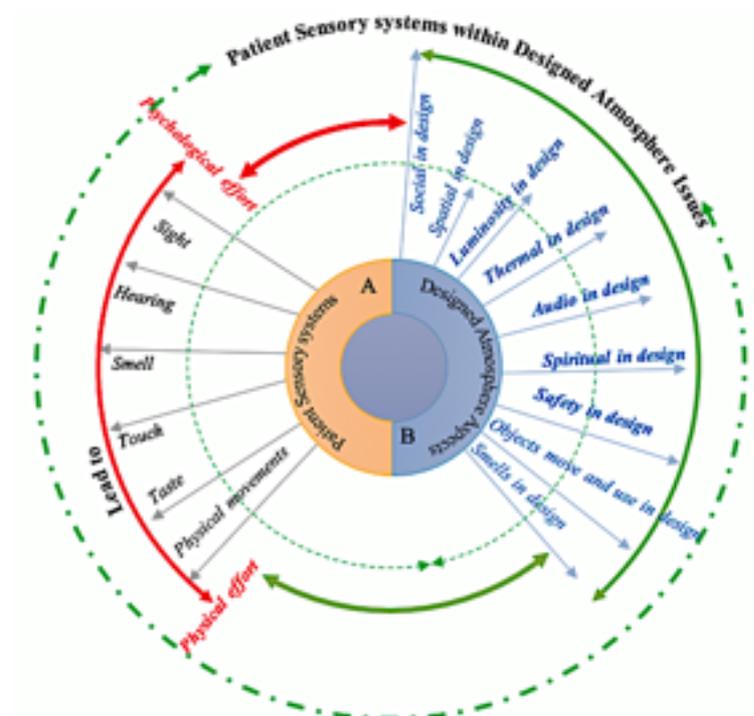


Figure 8.19: Conceptual framework - The link between the patients' senses and design aspects

8.11 THE LINKS BETWEEN AIS AND DESIGN FIELDS

Figure 8.21 shows the links between the three main research areas from the point of view of healthcare providers including (A) design issues involving design defect and faults that gave rise to the AIs; (B) issues in eight design fields (Section 8.5) and other issues related to hospital management, patient behaviour and healthcare providers, and (C) AIs originating from design issues, impacting patient health and care services provision.

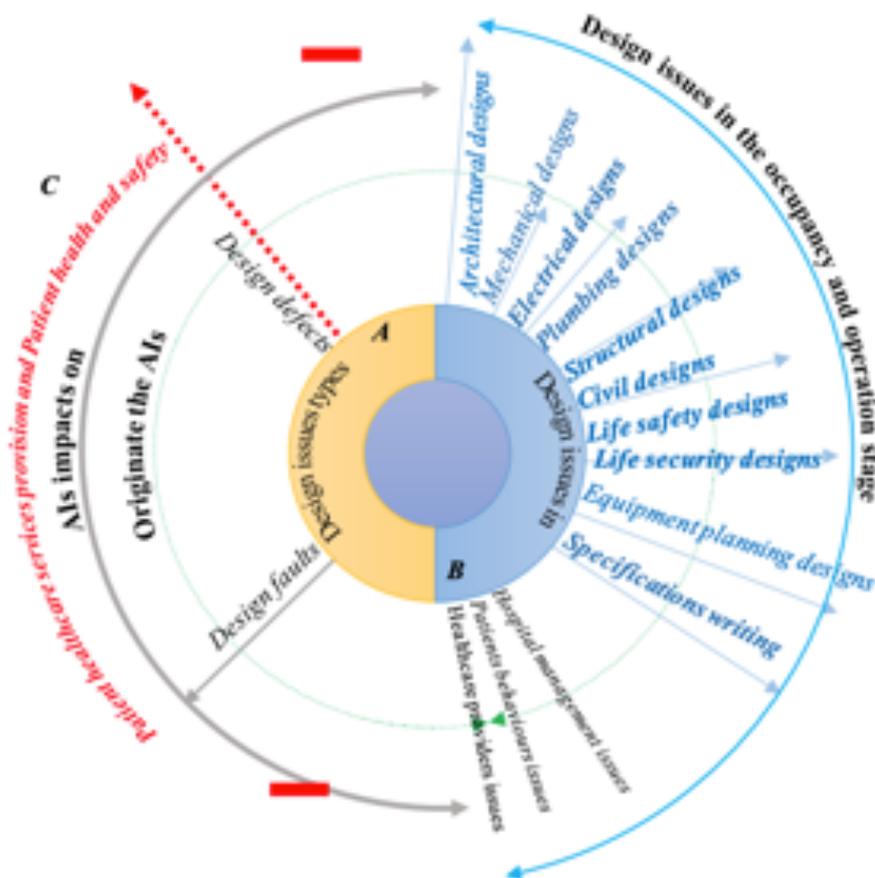


Figure 8.20: Conceptual framework - The link between AIs and design fields issues

8.11.1 HEALING ENVIRONMENT FACTORS IN DESIGN

Figure 8.22 shows the information about the main factors that should be considered in the design of a healing environment mentioned by the healthcare providers. The participants considered the most important factor with the highest agreement level is the safety factor.



Figure 8.21: Conceptual framework - Healing environment factors in design

8.12 FLAWS IN THE DESIGN STAGE

To avoid issues in future hospital design, flaws in the operation stage can be tracked back to the design issues in the phases of the design stage (Figure 8.23). This analysis confirmed some of the flaws already identified from findings of previous phases (see Chapters 6 and 7), however, additional flaws identified from the interviews of healthcare providers are as follows:

The preparing identification processes: including flaws in identifying the scope of medical services to avoid the changes during the construction and operation stages that lead to an inability to extend or provide newly required medical services.

The hospital projects brief processes: flaws in the identifications of the risks and the constraints to select suitable lands by considering the changes in climate conditions, and land location.

Feasibility study processes: flaw in site analysis to study the impacts of sunlight, green areas around the site, fresh air flow, noise level and amount of rain on the hospital building and patients' health. There is no heliport required for urgent evacuation of patients. Flaws in defining the initial and future space requirements of the medical care services. Flaw in the types of the data collection to identify the geographic and the meteorological data in each region. Flaws in the size of the land and the hospitals which did not cater for future expansion or to deal with the growth in patient numbers and the additional medical and non-medical care services.

Hospital building programming processes: flaw in identifying the specific design elements to meet the beliefs, culture, history and tradition conditions in Saudi. Flaw in Considerations required to present the religious elements in the design through specifying the spaces and the tools to perform the worships.

Hospital building functional programming processes: flaws in the flexibility of the structural design to deal with internal and external expansions for future requirements or in the construction and occupancy stages, in the case of change to the scope of services.

Hospital building space programming processes: flaw in Required volumes and the types of staff working to provide the adequate spaces and size for free movements and to avoid the disruptions during the provision of the medical care services.

Schematic design processes: flaws in the justifications presented for the quality of the selected material and systems specifications to meet patient health, safety and security standards. Unclear justifications in selection of specifications for some of the materials and systems used to prevent the construction and maintenance contractors altering the quality of materials selected. However, the only responsible person for those flaws in design processes is the responsibility of design team who provides the data and information collection for hospital designs requirements as part of their responsibilities in these processes. Another flaw is associated with the limited abilities of a designer to convey and present the feelings, ideas and desires of patients' sensory systems in the spaces.

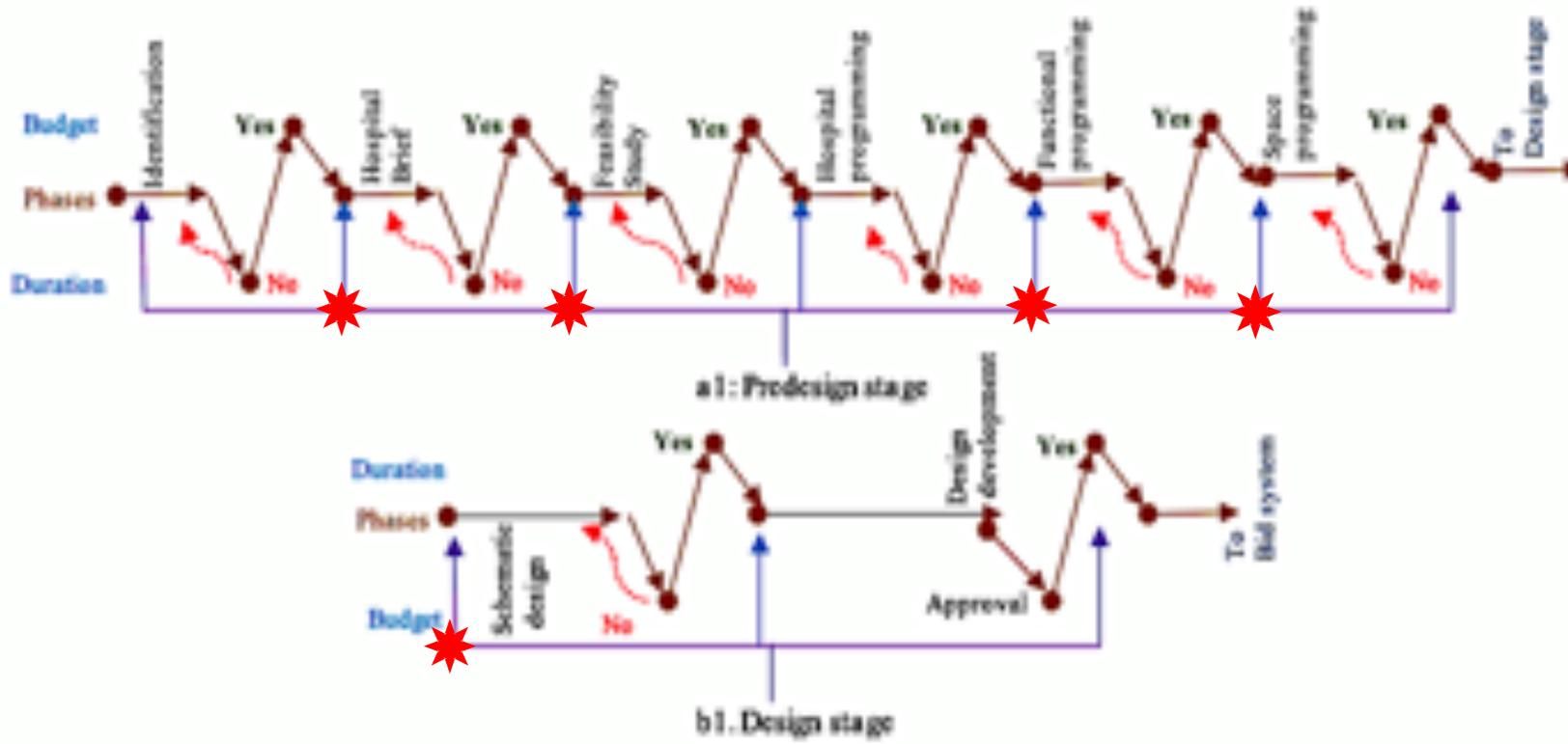


Figure 8.22: Sources of design issues within the design stage

8.13 SUMMARY OF FINDINGS FOR INTERVIEWS WITH HEALTHCARE PROVIDERS

Figure 8.24 summarises the findings have been extracted from semi-interviews with healthcare providers to define the potential link between design process and recovery process.

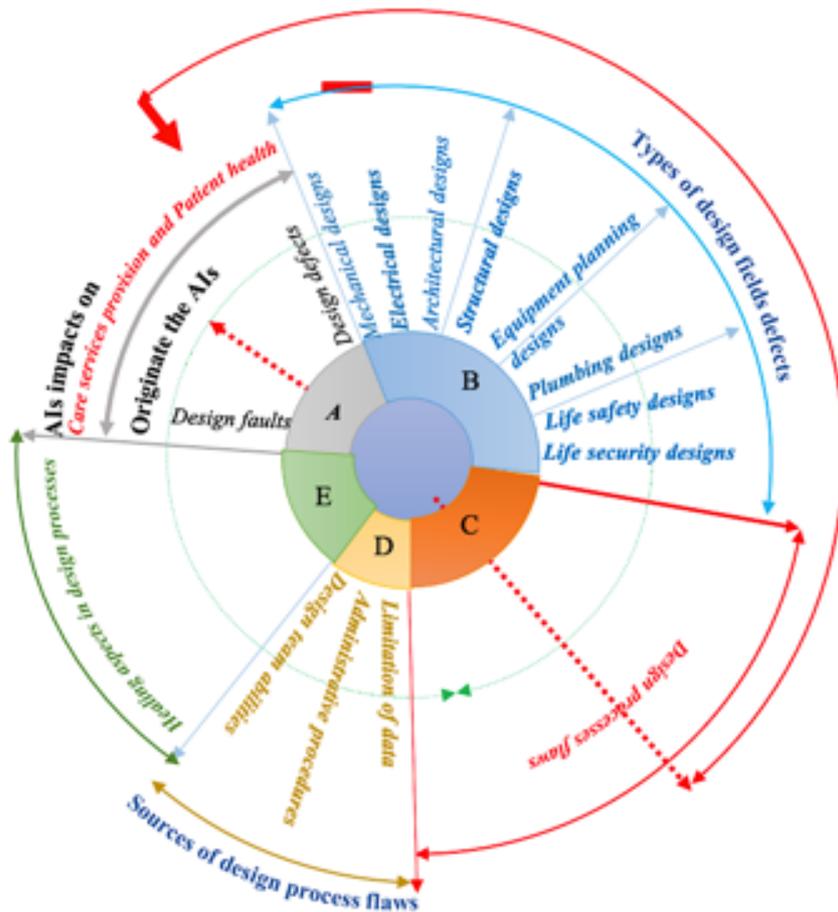


Figure 8. 23: Conceptual framework - Summary of findings from healthcare providers

This chapter defined five main issues areas in the designed spaces and those include: (A) design issues such as the defects and faults that initiated the AIs, which affect patient health , safety and care service; (B) types of design fields issues types occurred in the operation stage, include eight types of design fields; (C) By tracking these design issues, this study found flaws in early design stage within six phases; (D) By tracking these flaws in design phases, this study found sources of flaws are associated with design teams’ abilities, administration management and missing required data and information before or during the design phases; and (E) seven

elements affecting healing aspects in design that affecting patient sensory systems psychologically and physically.

The next chapter provides an analysis of the interviews of the design and maintenance teams (Figure 8.25).

Stage 2	objectives	Data sources	outcomes
Phase 3	Objective 2 and 3	38 participants from design and operation stages in case studies 1, 2, 3 and 4	Identified: Type of design field issues Design issues results (AIs) Design issues effects Design issues sources Healing aspects in design Missing factors in design stage Design issues solution Designer thinking issues Administration roles issues
Methods			
Interview questions			

Figure 8.24: Stage 2, Phase 3

9.0 INTERVIEWS WITH THE DESIGN AND MAINTENANCE TEAMS

9.1 INTRODUCTION

In Phase 3 of Stage 2, interviews were conducted with design and maintenance team members to investigate the elements of a healthcare facility in relation to AIs, using six case studies as detailed in Chapter 3: Section 3.10. These involved three tertiary Saudi hospitals, design and planning administrators of two healthcare facilities in two KSA regions and Engineering Affairs Administrations at Saudi Ministry of Health (Figure 9.1).

Stage 2	Objectives	Data Sources	Outcomes
Phase 3	Objective 2 and 3	38 participants from design and operation stages in case studies 1- 6	identified: <ul style="list-style-type: none"> • Type of Design field issues • Design issues results (AIs) • Design issues effects • Design issues sources • Healing aspects in design • Missing factors in design stage • Design issues solution • Designer thinking issues • Administration roles issues
Methods			
Interview questions			

Figure 9.1: Phase 3 of the second Stage of data analysis

The analysis includes a focus on and views of participants on the link between flaws in design processes and design issues, between AIs and design issues, and the impact of AIs and patient health. Participants were questioned in relation to hospital design issues, design process issues and AIs that originated from design issues. The focus on AIs and design issues includes design issues fields, parties responsible for design issues and the process for developing solutions to designs issues. Findings are reported in relation to healing processes and the care environment, including design elements affecting patient senses, patients' sensory systems and design considerations, sources of design issues, and ways of improving the healing potential of a care environment through the design process. There is emphasis on design thinking regarding creating a healing environment.

9.2 PARTICIPANTS FROM DESIGN AND MAINTENANCE TEAMS

A total of 38 participants were interviewed, which is made up of the members of three maintenance teams and two design teams. Maintenance team members were selected as a responsible party for operating and maintaining healthcare facilities in case studies 1, 3 and 4. Through their views, the research aims to identify design defects in the occupancy stage. Design team members were interviewed because they were responsible for designing the healthcare facilities. The background details of the 19 maintenance team members by location, hospital type and department in three case studies are detailed in Table 9.1. Table 9.2 provides background information of the design team members.

Table 9.1: Background information of maintenance team participants across the case studies

Attributes	Case Studies 1 & 3	Case Study 4
Catchment density	Low population Mountainous region	Moderate population Near the sea
Region	Southern	Eastern
City	Al Baha and Baljurashi	Jeddah
Hospital	Case study 1: King Fahd General Hospital (KFH); Case study 3: Prince Mishari General Hospital (PMH)	Case study 4: East Jeddah Hospital
Administration	General Maintenance	General Maintenance
Department	Biomedical, General Maintenance	General Maintenance
No. of Participants	KFH, [n=3]; PMH; [n=14].	[n=2]
Total [n=19]	17	2

Table 9.2: Background information of design team participants across the case studies

Attributes	Case Study 2	Case Study 5	Case Study 6
Region	Southern	Eastern	Central
City	Al Baha, Baljurashi	Jeddah	Al Riyadh
Administration	Engineering Affairs	Engineering Affairs	Engineering Affairs, Ministry of Health
Department	General Projects	General Maintenance, Project management, General Equipment, Housing.	General Maintenance, Project management, General Equipment, Studies & General Designs, Engineering Services.
No. of Participants	2	7	10
Total [n=19]	2	7	10

9.2.1 PARTICIPANTS ACROSS STAGES OF HOSPITAL DEVELOPMENT

Figure 9.2 presents the distribution of participants across the stages of the hospital development process. [n=19] of participants dealt with building maintenance and operations as maintenance engineers whilst 10 were involved in the predesign and design phases. [n=10] of them are involved in construction phase, working under the supervision of Plans and Designs Departments of their respective hospitals.

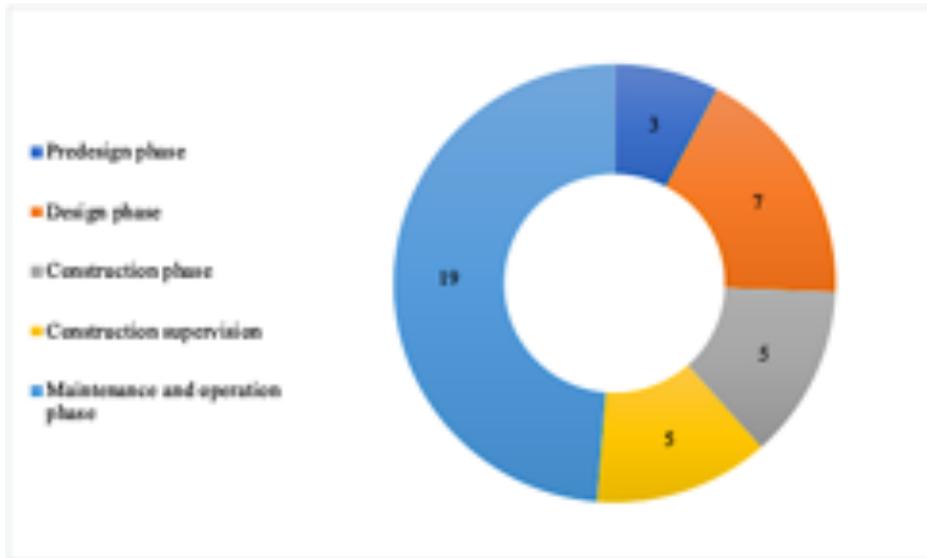


Figure 9.2: Participants across stages of hospital development

9.2.2 PROFESSIONAL EXPERIENCE AND QUALIFICATIONS OF PARTICIPANTS

Participants were asked: “How long have you worked in your present professional role?”. Table 9.3 illustrates the experience of 38 participants in different fields of engineering.

Table 9.3: Years of experience of participants

Years of Experience	Case Studies					
	1	2	3	4	5	6
< 5	-	-	2	-	2	4
6 – 10	2	-	8	-	-	2
11 – 15	-	-	2	-	-	1
16 – 20	-	1	2	2	5	1
> 20	1	1	-	-	-	2
Total= 38	3	2	14	2	7	10

The maintenance team members, in Case Studies 1, 3 and 4 have been working in their positions for a minimum five years to a maximum 20 years. In case Studies 2, 5 and 6, the design team members have been working in their positions for a minimum five years to a maximum 20 years. Four participants had worked for more than 20 years in their professional roles. Overall, participants have earned substantial knowledge and experience regarding their professional roles, responsibilities and duties related to controlling all stages, processes and procedures for designing, developing, maintaining and operating hospital building in Saudi Arabia.

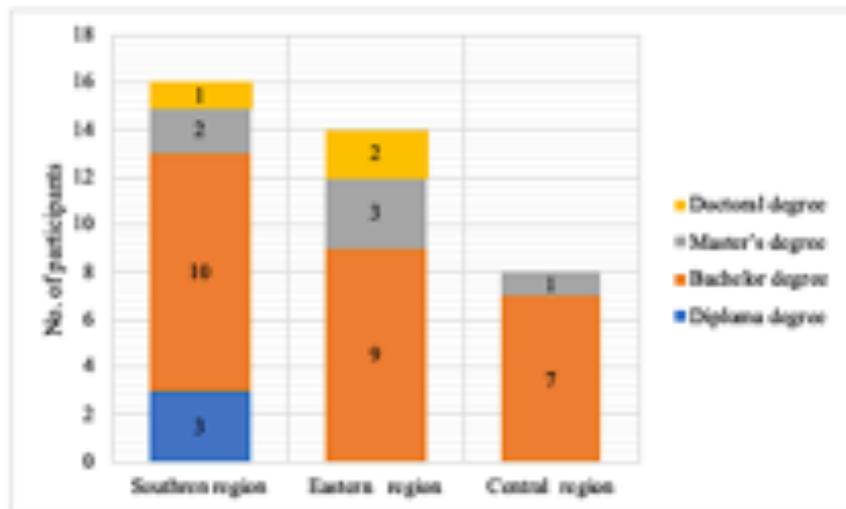


Figure 9.3: Qualifications per region

Figure 9.3 illustrates the qualifications of the participants in each case study. A substantial majority in all case studies had bachelor degrees with relatively fewer having master's or doctoral degrees or diplomas. In Southern region, [n=10] participants have bachelor's degrees and a small number of them have master's [n=2] and diploma degrees [n=3]. Only one of them has a doctoral degree. In Eastern region, [n=9] participants have bachelor's degrees and [n=3] of them have a master's degree, but [n=2] of them have a doctoral degree. In Central region, [n=8] participants have a bachelor's degree, but only one has a master's degree. It clear that most participants have a bachelor's degree with [n=27] and [n=7] of them has a master's degree. [n=3] of them have a diploma and only [n=3] of participants have a doctoral degree.

9.2.3 PARTICIPANTS' COGNATE TRAINING IN HOSPITAL DESIGN

In response to the question: “Have you studied design courses or participated in the design of hospital buildings during your study career?”, only 28% indicated that they had the requisite training on hospital design. Only [n=10] had studied or participated in hospital building design and development in their educational training (Figure 9.4).

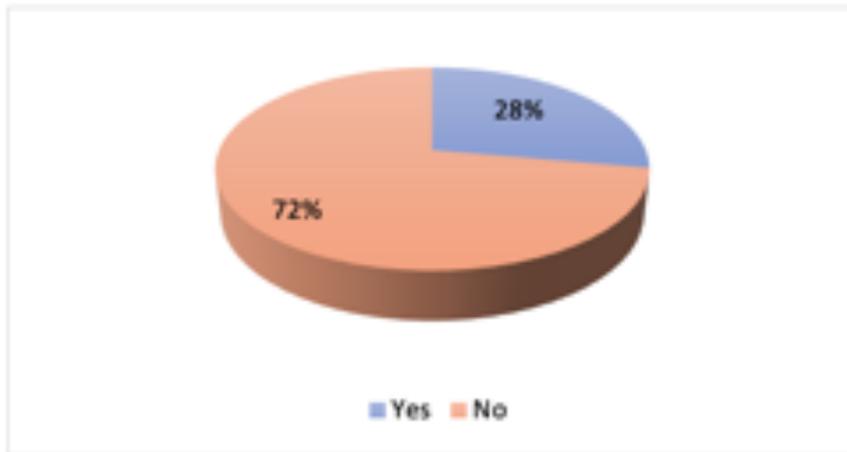


Figure 9.4: Participants' cognate training in hospital design

9.2.4 PARTICIPANTS' PROFESSIONS

Figure 9.5 illustrates the professions of participants in the six case studies. Most are electrical and medical equipment engineers and biomedical technicians, with fewer from the other seven professions. Seven participants were in architectural design fields and more than a fifth of them deal with equipment planning and maintenance.

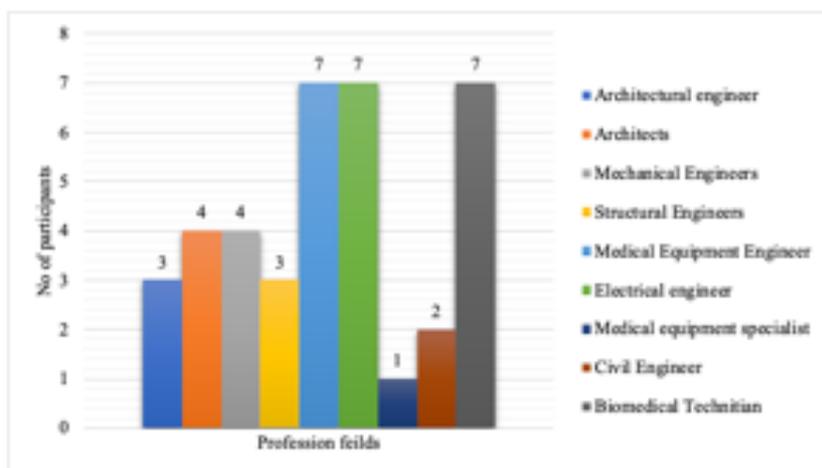


Figure 9.5: Participants' professions

9.2.5 PARTICIPANTS' KNOWLEDGE IN HOSPITAL DESIGN

Figure 9.6 illustrates participants' knowledge in hospital design. They were asked: "What does a general public hospital (150-500 beds) constitute in the Kingdom of Saudi Arabia?". Their responses were divided into five levels based on their knowledge level on how many elements of hospital design they could name. Half of the participants had a clear idea about hospital design elements and 35% of them has a knowledge level less than 20%.

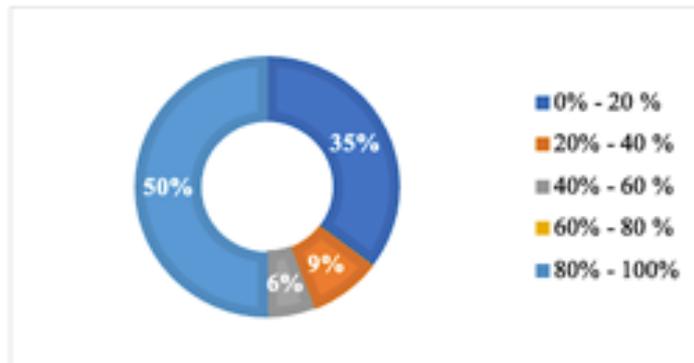


Figure 9.6: Participants' knowledge in hospital design

9.3 DESIGN STAGES OF SAUDI HOSPITALS IN USE

11 design team members from the departments of planning and design in the Engineering Affairs Administration mentioned the main stages of design and construction of new Saudi hospitals – this is summarised in Table 9.4.

Table 9.4: Project Lifecycle stages of Saudi healthcare facilities

Stage	Phase
Prodesign stage	Need identification
Design stage	Project brief
Bid system stage	Programming
Construction stage	Schematic design
Equipping stage	Design development
Operation stage	Approval stage
	Bid system stage
	Construction stage
	Equipping stage
	Delivery stage
	Operation stage

* Phases not mentioned by participants:

- Feasibility Study
- Functional programming

They identified these stages as follows: (A) Need identification, which involves the request for a new hospital with specific capacity of bed-number and estimated cost. This hospital is requested by the Health Affairs Administration in the region, then it is received by the Engineering Affairs General Administration (EAGA) at SMOH. EAGA must send the request to Finance department to authenticate and approve the estimated development budget. After that, the request, when approved by SMOH, is given to the Planning and Design General Administration (PDGA) to start the design stage. The design team will then be hired by SMOH. SMOH prepares the Project brief, whilst the design team undertake space programming, schematic design, full design development. SMOH's PDGA must approve the designs and other project documents, and coordinate the bid system, construction, equipping (managed by a different department that seldom contribute to the design), hospital delivery and operation and maintenance stages.

Feasibility study, care spaces programming and functional programming stages were not mentioned by participants. In addition, estimated cost does not involve the medical and non-medical equipment and furniture. The equipping stage starts at the end of construction stage. The Furniture and Equipment Administration (FEA) that is responsible for equipping and furnishing the new-built hospital is separate from the EAGA. FEA is under supervision of another administration, and is not involved in the early stages of design.

9.4 PARTICIPANTS' VIEWS ON DESIGN ISSUES AND ON AIS

Participants were asked "What are your thoughts about flaws in the design stage causing the design issues in the occupancy stage?". 62% (25) of the participants believed that design flaws and design issues are related to each other, whilst 15% (6) did not. 23% (9) had no idea whether the link between those issues existed.

In response to the question "What are your thoughts about the link between of the design issues and AIs in the hospital environment?", 67% (18) of respondents believed that the design issues and AIs in the patient environment are related to each other, but 22% (6) did not. 11% (3) participants had no idea whether these issues were related to each other.

Participants were asked “What are your thoughts about the subject of AIs affecting patient health?”. 62% (25) believed that the impact of AIs and patient health are related to each other, 15% (6) of them do not. 23% (9) had no idea whether these issues were related to each other.

9.5 PARTICIPANTS’ EXPERIENCE IN DEALING WITH DESIGN ISSUES

The participants answered the question “Have you had an experience in recognising any design issues (e.g. incorrect material selection, lack of space, lack of equipment, unavailable negative pressure and outlets) occurring in hospital buildings which impacted users?”. 79% (33) of participants experienced design issues, whilst 21% (6) of them did not.

Responding to the question “Have you had experience with design process flaws producing design issues that affect hospital buildings?”, 55% (21) participants had not experienced any flaws in the design process that produced issues in the occupancy stage. However, 32% (12) had. Only 13% (5) of them had no idea about issues with the design stage.

Overall, a considerable number had experienced design issues in hospital buildings that resulted from design flaws at an early stage of a design.

9.6 DESIGN ISSUES REPORTED BY PARTICIPANTS

In response to the question “Please provide more information about the design, equipment and component issues in this hospital environment that may lead to AIs which affect patient health or healthcare services provision”, participants mentioned the following design issues divided into 15 design fields.

Architectural design issues: Participants in all case studies noted design issues relating to:

3. *lack of available spaces*, such as clean and dirty utilities and a trolley washing area, which often lead to spread of infections and prevent the healthcare provision,
4. *insufficient space*, such as a lack of equipment storage meaning that the equipment is left in the corridors and obstructs the movements of users,
5. *inadequate and incorrectly-sized spaces*, such as the distance from floor to ceiling is too low, causing the need to avoid applying new systems through the ceiling and structural elements, thereby making movements of equipment and users a lot harder,

6. *inappropriate location of items*, such as situating generators besides the In-patients' building and the storage of uncontaminated and contaminated tools and materials in the same space. Also, inappropriate location of hospital buildings such as having critical buildings too close to crowded areas and highways, and
7. *inoperable and non-functional spaces*, such as the size of medication room that is too small for nurses to move around to prepare the medicine.

Construction design issues: These design issues include:

1. cracks occurred on the surfaces of internal and external walls due to soil expansion which led to the growth of bacteria and fungus within the cracks, thus resulting in spread of infections and giving uncomfortable feelings to patients,
2. limited load-bearing structures and many concrete steel walls between spaces that prevent the chance to extend current spaces in order to install new equipment and systems, or adding a newly acquired unit, and
3. missing terminals, waterproofing, isolation or expansion control systems resulting in rain-water leakage into the hospital building from the roof.

Mechanical design issues: Participants pointed critical issues which include:

1. miscalculations of the required negative pressure in spaces, such as in Burns and Isolation units and Dirty rooms. Furthermore, the dirty area in Sterilisation department requires negative pressure to control and prevent contaminated air from infectious patients and materials to spread outside. In Operating theatres, positive pressure is required to protect patients from the contaminated air coming from outside. The study also found contaminated air from the A/C and uncontaminated air from ventilation systems of the Isolation room and its toilet and kitchen are often collected and recirculated into other departments.
2. deficiency in the capacity of A/C system and its air flow, such as in patient, medical equipment rooms and the new expanded units. In order to solve these issues, the hospital management in Case Study 1 chose to locate the split A/C units on the floor of the corridor, which obstructed the movements of users and produced annoying sounds.
3. inappropriate location and insufficient area for the Heating (H), Ventilation (V), A/C system units situated next to the in-patient wards, where it is considered as a source of danger and annoyance. It is impossible to upgrade these systems or add new systems because of the current limited area, and

4. difficulty in controlling HVAC air flow from patient rooms as nurses need to call a maintenance team member to increase or decrease the level of air flows.

Civil design issues: Participants mentioned many design issues including:

1. difficulty in expanding the existing infrastructure, such as the drainage systems, roadways and car parking area for disabled outpatients or visitors in order to deal with an increase in the number of users due to space limitations and loss of current infrastructure designs; and
2. unavailability of drainage system for radioactive waste disposals in the radioactive therapy unit which can lead to serious health issues.

Safety design issues: Participants explained a lack of safety tools, spaces, equipment and systems in the patients' environment in four areas:

1. safety tools such as insufficient number of fire extinguishers [only two extinguishers were allocated for four zones. Types of extinguisher designed for each space are not adequate also e.g. one type of extinguisher cannot fight all types of fire e.g. chemical or electrical fires. The study also found inappropriate location and distribution of fire extinguishers, many of which are remote from users. In addition, fire hydrant cabinets were located on the wall inappropriately;
2. difficulties for firefighting vehicles to move around the buildings or find space to park
3. issues with fire system equipment include:
 - a) smoke detectors and fire sprinklers do not cover all the required areas,
 - b) the systems networks are located outside the walls rather than inside;
4. fire zone issues include inadequate flame and smoke barrier walls that can lead to spread of fire and smoke;
5. difficulty in implementing an evacuation plan for in-patients from the intensive-care units, because they are located in the upper floors (i.e. third level). In addition, the long distance between some departments and emergency points increases the time and effort to reach a safe place and;
6. the fire alarm system is not connected to some critical systems to turn them off in case of a fire to avoid smoke spreading. The alarm system is not connected to doors with pass codes such that they can be unlocked automatically and allow users to get out. These issues cause deaths, poison, burns and suffocations to patients and users.

Security Design Issues: Issues mentioned include:

1. a lack of security tools such as alarm points, fences and access control systems.
2. a deficiency in Closed-Circuit Television (CCTV) systems which do not cover all the hospital zones, exits and entrances. Case studies 1 and 3 have more than three entrances to the hospital building and the fences have some gaps that allow some insects, reptiles and undesirable persons to gain access to the hospital.
3. door locks do not link to the alarm system in the event of an emergency (e.g. crimes such as kidnapping or stealing) inside the hospital such that they could be locked automatically. These issues expose the patients to grave danger or make them feel insecure.

Electrical Design Issues: Participants reported:

1. an insufficient number of lights and inadequate light intensity, especially in the Operating room (OR) and medication rooms,
2. limited electrical sources, such as lack of outlets to operate some medical devices,
3. existing electrical outlets are not appropriate for some of the plugs of mobile equipment (USA/UK),
4. some outlets distribution and locations are not suitable for the amount and position of medical equipment,
5. Protection system design issues, including some critical equipment, especially in OR, X-ray and emergency departments, are not connected to the uninterrupted power supply to maintain their function when the power is cut off or the standby generators fail,
6. random electrical network located on the ceilings that can lead to electrical fire,
7. electrical panels with limited loads capacities that do not allow for installing new equipment,
8. unsuitable location of electrical panels where some of them are next to wet areas or in stores,
9. difficulty in tracking the route of electrical cables, which could cause fires, delays or stop the delivery of healthcare services.

Materials Specification Issues material standards are not mentioned in the contract specifications, so the quality of most materials is low. The study found the flooring type in the toilets could cause falls. Whilst the flooring used in the theatre rooms should be resistant to magnetic waves, this was not evident. Doors were expected to have a high degree of fire resistance and the paint should be easy to clean. This was not so either.

Specifications and Information Issues in Drawings and Tables: Two types of issues were mentioned by participants in terms of the writing of specifications and the lack of information in the drawings. They include:

1. Lack of quality standards in the specifications of the selection of material. In order to increase the quality level of these selected materials in patient environment, the following criteria for materials selection should apply to the specification: material application should prevent the growth of bacteria and fungi, and should be easy to clean and sterilise. Moreover, specified materials must not have limited availability in Saudi market.
2. Lack of information on drawings presented by the draftsmen (design development design stage) was found.
 - Architectural designs must indicate measurements, dimensions, space names, finishes and furnishings. Drawings must also show locations of equipment and scale of drawings.
 - Equipment planning designs must indicate installation and maintenance requirements, including mechanical and electrical requirements, water sources and the disposal of radiation wastes.
 - Mechanical designs must indicate smoke, heating, ventilation and air conditioning zones, types of pressure in the space, and the movement and treatment of internal and external airflow in the hospital buildings.
 - Similarly, electrical designs must indicate the numbers and positions of lightning rods, dimensions of the space between conductor cables (external protection), and the links between the equipotential bonding equipment and medical equipment and metallic parts.
 - Plumbing designs must present the sizes, types and locations of the medical gas and the drainage grids of waste systems
 - Construction design must indicate allowable load limitations
 - Civil designs must show roadways, sidewalks, exterior lightings and utility grids.

These deficiencies in design information often led to difficulty in providing new healthcare services or improving others because the design team cannot deal with modifications to current designs. The maintenance team could not read the drawings to deal with historical changes in critical system grids.

Equipment Planning Issues: Issues mentioned by participants include incorrect equipment location causing wrongful environmental conditions such as high temperature and humidity, which hastens equipment breakdown. The study found certain equipment are located where they are likely to cause to hazards areas e.g. radiation equipment is located close to the pregnancy clinic. Some equipment were also positioned to prevent easy movement of patients and users around them. Some care spaces lacked equipment store, area for sterilising used equipment, and waiting and changing rooms for patients and operators. In addition, the study found difficulties in installing new or advanced medical equipment due to space limitations and lack of power outlets in the designated spaces. Other findings include lack of modern medical equipment, whilst current equipment being used for diagnostic and therapeutic plans seem overworked. Some existing laboratory equipment are not able to give accurate results because of inappropriate conditions under which they work. Moreover, the study found difficulties in users' movements due to a lack of storage for damaged equipment many of which were stored in the corridors. These issues could impact patient health such as spread of infections caused by contaminated equipment and prevent or delay the provision of medical services because of damage in some diagnostic equipment in laboratory and X-ray units.

Maintenance system issues: Failures relating to the quality of repairing and the availability of materials. No spare parts available; short lifespan and unqualified workers.

Financial Planning System Issues: According to the participants, there are some issues with the financial planning system between the bidding phase and the construction stage. These issues include a lack of knowledge in estimating the budget of a new hospital building, and imprecise estimation of aesthetic elements in designs without a feasibility and functional study analysis. The study also found no direct communication between financial and project administrations to inform the financial department about scope variations. There is also a lack of financial planning framework to cover future changes or extensions in the scope of hospital services. Participants think the project budget should be approved after all design stages had been accomplished and before the bidding stage, not at the project request stage. This is so that the costs of design variations could be included in the budget. Without these, project estimates and project execution would fail. These could lead to delays in establishing new hospitals or delay critical elements of construction and operation stages.

Budget Approval Issues: The approval of an inadequate budget could lead to a lengthy delay in the hospital construction or operating stages. This could mean certain critical works and equipment were left out during construction to prevent a budget deficit. This issue delayed the provision of healthcare services on the approved schedule and increased the number of healthcare cases in the region.

Project Schedule Approval Issues: There are two explanations to this. The additional work in modifying the project site and changing the scope of construction work could consume more time than the approved schedule. This puts pressure on construction and equipment contractors to complete all additional tasks quickly to comply with the schedule, and could result in lower quality and could trigger more issues that may occur in the occupancy stage. The approval schedule does not include the time spent to find and approve a site for the proposed hospital project. Participants think the site of a hospital project should be defined and selected at an early stage of design not after the bidding stage.

Plumbing Design Issues: Several issues were mentioned by participants, including:

- insufficiency in the capacity of the medical gas system to deal with expansion and also new units requiring oxygen outlets,
- insufficient oxygen pressure level to adapt to the high demand for oxygen by equipment in intensive care units,
- lack of oxygen outlets in emergency departments,
- deficiency in the size of the oxygen network leading to reduced oxygen air flows,
- emergency water supply is unavailable to ensure water supply is maintained even if an emergency occurred to current water supply,
- inadequate capacity of the sewage treatment plant leading to poor management of waste water treatment. This causes bad smells and infection; especially, using poorly treated water on plants around the hospitals. In addition, the study found medical (radiological) and natural liquid wastes are mixed before reaching the treatment station because they use the same drainage network. Participants think the medical waste room should be located outside the hospital as they are considered a source of infections. This is because design standards for this kind of space are not applied where they are placed in spaces shared with the rest of the hospital. The study found plumbing issues were caused as a result of placing medical waste room in the space shared with the rest of the hospital. These include adverse effects

on patient health and episodic stoppages in healthcare services especially when the water source stopped to feed the sterilisation unit, laundry department, patient room and other units of the hospital.

9.7 SOURCES OF DESIGN ISSUES

Figure 9.7 illustrates parties who were responsible for the design issues in the development of hospital buildings. Participants mentioned 10 sources within the three stages of hospital development; six in the design stage, one in the construction stage and three in the occupancy stage. Sources of issues in the design stage include the design team, leadership and management of the design team, governing policies such as the roles of Study and Plan Administration in Saudi Arabia, design thinking, information and data availability (e.g. quality of the design brief) and, design inputs and outputs (e.g. design production). In addition, findings suggest errors, during the construction stage, often emanate from the construction teams. In the occupancy stage, sources include actions and outcome from various committees; particularly, committees on specifications and delivery committee, and the maintenance team.

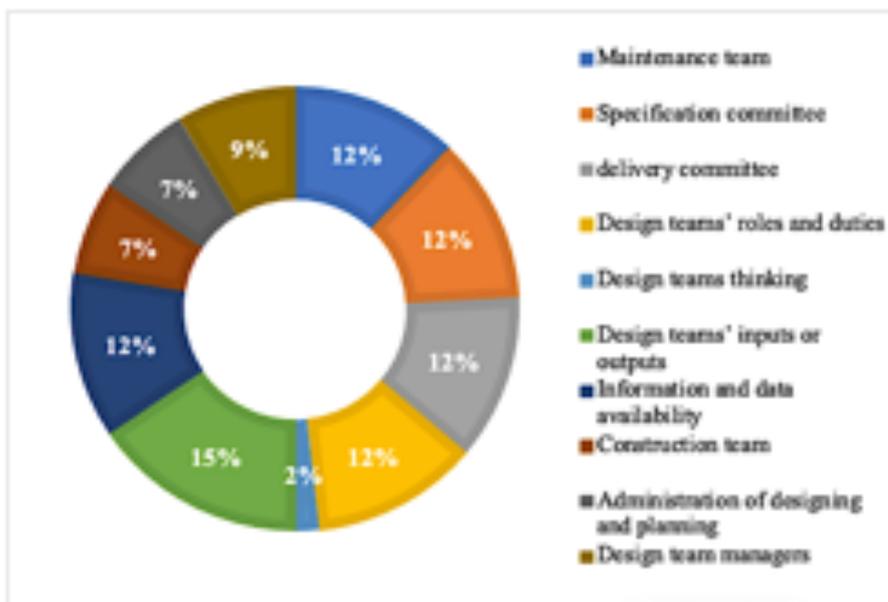


Figure 9.7: Sources responsible for design issues

In the design stage, less than a fifth of participants mentioned the design team inputs and outputs as being the major source of design issues and 12% held that the design team roles and duties and the unavailability of some information and data were equally responsible. Around

one in ten held the managers of the design team and the administration of Study and Plans liable. Only 2% of respondents considered the design team thinking as source of design issues.

In the construction stage, only the contract team was considered responsible for the design issues. *In the operation stages*, the participants equally blamed the delivery and specifications committees and the maintenance team.

9.8 SOLUTIONS AND RECOMMENDATIONS

Some of the participants provided eight strategies in two phases in the early stage of design to deal with the design issues arising in the occupancy stage:

Phase A comprises:

- 1) Investigation of current designs (including studying and analysing data on nature, sources, locations and impact of issues), while developing solutions in new builds
- 2) Creating value by working on several alternative solutions to the issues,
- 3) Evaluating proposed alternative solutions against existing solutions through multi-disciplinary discussions that includes users,
- 4) Achieving consensus for the best solutions and
- 5) Committing to the agreed solution.

Phase B: While implementing approved design solutions, two strategies were recommended. They include:

- 1) Monitoring the effectiveness and efficiency of the proposed solution and
- 2) Evaluating other solutions that could be considered in future hospitals.

Recommendations were given by participants on how to avoid or minimise design issues; in five areas:

- 1) improve the design team's experience in and knowledge of hospital design, including by studying the healthcare requirements and needs of the patient population, increasing their knowledge on diseases and involving medical experts and staff, design, construction and maintenance teams as well as end-users in the design stage;
- 2) explore information about design issues in existing hospitals and identify appropriate functions of the various elements of the hospital space,
- 3) visit and study the conditions of a hospital site before starting the design stage,

- 4) create a mechanism involving records and reports to provide all the required data or information about design issues, impacts, types, location and number, to help solve these issues and to change the way designer think about the requirements of the design elements in a care environment, and
- 5) institute a new committee that involves specialists in the design of healthcare facilities to review all outputs of designers and identify the design issues before the bidding and construction stages.

9.9 PATIENTS' SENSES AND ASPECTS OF THE HEALING ENVIRONMENT

This section presents the responses of participants in two areas: products and elements of space design, and patients' senses and healing aspects of the design of a healthcare environment. Participants were asked "What specific psychological and physical elements or components of patient environment do you think that designer should consider in dealing with patient's senses?". Table 9.5 shows the element (e.g. lighting and colour), systems (e.g. ventilation), components (e.g. equipment) and products (e.g. pictures and art) mentioned by participants to be consider during designing patients' spaces. Participant described the components and elements of space that the patients' senses respond to physically, psychologically and spiritually whilst in a hospital environment.

Table 9.5: Space design components and elements

Possible Design Elements	Examples
Materials	commodities (e.g. flowers, gift items, aesthetics brought into the hospitals by patients and visitors).
Artefacts	graphic symbols, paintings, art, pictures (owned by the hospitals)
Building services & systems	ventilation, lightings, lifts, equipment, tools, machines.
Environment	indoor and outdoor surfaces, green areas, space sizes, circulations, security, information, space control, room colours, sounds

Spatial issues in design: They identified:

- (1) patient body mass to determine the appropriate size of room and bed, their positions, directions, and patient's health condition and the required movement,
- (2) the space to deal with diagnostic and therapeutic plans of people with varying body sizes,
- (3) space components (such as fixtures and machines) to consider patients' attributes (such as age, sizes and heights) and equipment's own attributes (such as weight, noise, heights,

movement requirements, functional requirements, location and storage requirements) in spaces where patients are kept.

- (4) height of the space to deal with systems networks,
- (5) patient privacy,
- (6) shape of the space,
- (7) number of spaces available,
- (8) transportation of patients from one space to another, and
- (9) colour of the space.

These elements for spatial aspect in design reduce the physical efforts when patients use or move within spaces.

Lighting issues in design: Lighting needs to be considered for appropriate colour, intensity, location, distribution and temperature. It is also important to consider an appropriate location, size and shape of windows, to allow natural lighting into the patient space. Participants said it is important to avoid lighting colours that cause a sense of confusion or feeling trapped.

Thermal issues in design: Participants said it is important for them to achieve a high level of comfort whilst receiving care. They wanted natural or mechanical ventilation, and sunlight into their space. They also wanted easy control of air temperature and movement in their space.

Audio issues in design: They include providing comfortable sounds and voice sources in patient space such as sounds (water, birds singing, Quran recitation and music) that create emotions and evoke positive memories. These would trigger feelings of calm and happiness.

Social issues in design: Patients said they needed to be given a sense of consideration, self-worth, pertinence or belonging. They often feel isolated from external environment or community, when they do not receive support from outside the hospital. This may impact their psychological health. Elements of social design include: spaces that allow social interaction for family, friends, and dedicated places for parents to be near their children in intensive care units. Also, the opportunity to gain access to shopping and coffee stores.

Spiritual issues in design: This can be achieved by using symbols, commodities, arts, pictures and images, paintings colours selection, space and equipment for ablution and prayer, changing

the direction of the toilet chairs away from the direction of the Qibla and facilitate the movement of bed towards the Qibla.

Aesthetic issues in design: To increase the level of excitement in the space for patients by using attractive decorations, inscriptions, pictures, drawings and paint colours, inscription of Qur'anic verses and Hadiths, to recall patients thinking, memories and senses in feelings of pleasure and happiness; and preventing the feelings of time passing slowly and concentration on a sense of pain. These considerations can improve the psychological health in terms of aesthetic aspect in designs.

Facilitating patient independence in design: This includes allowing patients to control the components of their environment by allowing them to open curtains and windows, change TV channels, control the lights, use the internet, communicate with healthcare providers and managers for more information about their health conditions and treatment plans. They also need to be provided the opportunity to evaluate the hospital environment and its components as well as the quality of the medical services they receive.

Safety issues in design: This includes giving patients all the safety tools, equipment and evacuation requirements and plans, to guarantee their safety.

Security issues in design: This involves security components, tools and requirements to protect patients from theft or harm.

Issues regarding object usage in design: Patients think it is possible to reduce the spread of infections by limiting the need to touch care components and objects around them. They think avoiding physical operational contact will help e.g. using the remote-control systems in opening the toilet door or using the toilet accessories such as tissue paper, soap, sanitiser and hand dryer.

9.10 SOURCES OF FLAWS IN DESIGN STAGES

This section presents the responses of participants to the question “What prevented the application of these positive features, elements and considerations of healing aspects of design to the design process, leading to design issues in the occupancy stage?”. Their responses were divided into two main categories as follows.

Capability of the design team: Evidence suggests the design team did not have adequate capability. Their limitations include insufficient knowledge of hospital design requirements due to lack of communication with patients and end-users; thus, they did not understand their needs and requirements whilst selecting their considered best solutions. They were not highly proficient in digital design skills too e.g. they were deficient in using digital model software that facilitates collaborative design processes. Their communication with other team members was insufficient, and could not test their imaginations regarding reactions, opinions and senses of patients.

Also, there was the issue of fear. Some designers did not have confidence in their abilities because of the fear of punishments if they make mistakes. As a result, they depend on copying existing projects or examples on websites, for new projects. In addition, some designers were too afraid to defend their design solutions when confronted by higher authorities. This had meant, in a lot of instances, design outcomes were not a reflection of the designers' own opinions, rather instructions given to them by others. The true sources of the outcome may not necessarily be people who understood hospital design or design principles; rather, an imposition of some subjective opinions that may not justify actual investments in the project development processes.

The study also found a culture of lack of commitment to information sharing amongst the project team, especially between engineers and architects. This may be a universal issue; however, beyond these, there is the issue of time management. Designers work under tight schedules, and this induces stress, which prevents them from paying adequate attention to details – including ensuring they have found solutions to every design issues or faults before finalising.

Evidence from the study suggests designers do not have a universal understanding of sensory systems [that is, how patients feel or think or desire] whilst considering their designs of space and healing atmosphere. These would involve a careful consideration of design elements, components, materials and other factors, particularly how patients feel about the influences of the colour, space, size, nature of objects within their care spaces. One other problem that could turn out to be a solution to many other issues is stakeholder management: giving every stakeholder a valid voice by recognizing the importance of the contributions from the local

community, patients and healthcare providers; involving them in solving the design issues from different viewpoints.

Administrative issues [that is, the interface between the design team and project governance]: Evidence suggests a majority of the administrators did not have experience and functional knowledge in hospital design. They were not trained to review designs or on how to add value to the design process; however, it is a critical role they must perform on the job. Such administrator did not know how to value or remunerate design efforts. Whilst trying to learn their way through these, delays in payment of fees had often ensued.

Staff who perform design administration duties should not just know about hospital design; they should have functional knowledge in other critical engineering fields required for a hospital to function appropriate – including but not limited to medical equipment engineering, medical planning and life safety, security systems design, care experience design. In addition, project communication mechanism between different administrative departments is also deficient. For example, this study could not find an evidence of substantial communication between Study and Design Administration and Equipment and Furniture Administration at MOH throughout the design stage; also, between Engineering Affairs of the regions and General Projects Administration of MOH, to justify the need for a new hospital.

This study also found limited official documentations detailing scope changes in the design of medical care services and requirements, as should be done by managers to review and justify procurement variations. As noted earlier, the design team have limited scope within which they are allowed to create their outcomes. Most ideas have come from administrators who do not have professional qualifications to do so. Where designers occupy non-executive management roles, administrators are neither accountable for faulty design outcomes nor for consequential impact of malfeasances they may have caused. Not least, there is lack of policies and procedures on how to transfer knowledge about AIs that originated design issues from the hospital administrations, perhaps specifically to each of the regions, and in relation to high levels project administration involved in hospital design processes. Such database would help in defining design process flaws and to solve the issues emanating from them in future hospital projects.

9.10.1 INVITING INTERESTED PARTICIPANTS IN DESIGN STAGE

Three participants responded to the question “Which interested departments or participants involved in the design stage of a new hospital are not part of the design teams, and why?”. The participants mentioned groups and departments to participate in this stage such as doctors, the community, medical staff and administrators involved in statistics, equipment, infection control, hospital affairs, safety and security, radiology and IT. The interested participants outside the design teams should be invited at early stages of design to gain their beneficial inputs.

9.10.2 WAYS TO IMPROVE THE DESIGN OF A HEALING ENVIRONMENT

The participants provided seven recommendations for improving the design process in terms of creating healing environments. These are:

1. increase hospital budget
2. consider the points of view of all users
3. improve designers’ knowledge on patients’ reactions to environment design and components
4. build a database to present the analysis of current design issues and patients’ demands, history of the impact of reported AIs that originated from the design issues
5. improve knowledge about patient senses within design
6. involve construction and maintenance contractors in the design stages of new hospital design, and
7. include a designer with a creative mind in internal administration of design processes.

9.11 DESIGNERS’ THINKING

Participants responses regarding critical factors that should be considered in healing aspects of designing a care environment suggest three approaches to design thinking; in relation to design process and uses, and how designers select solutions to design issues (Section 13.4.7, Appendix D). They are design methods, thinking strategies, and hospital design principles.

Figure 9.8 illustrates the participants’ responses to the question “What are the main trigger factors that should be considered in the design of healing environments in hospital buildings to support patient health?”. Some participants selected and discussed more than one factor. The

most frequently selected factors were: quality of medical services provided, psychological health, safety and welfare of care receivers. Very few of participants identified security as a critical factor.

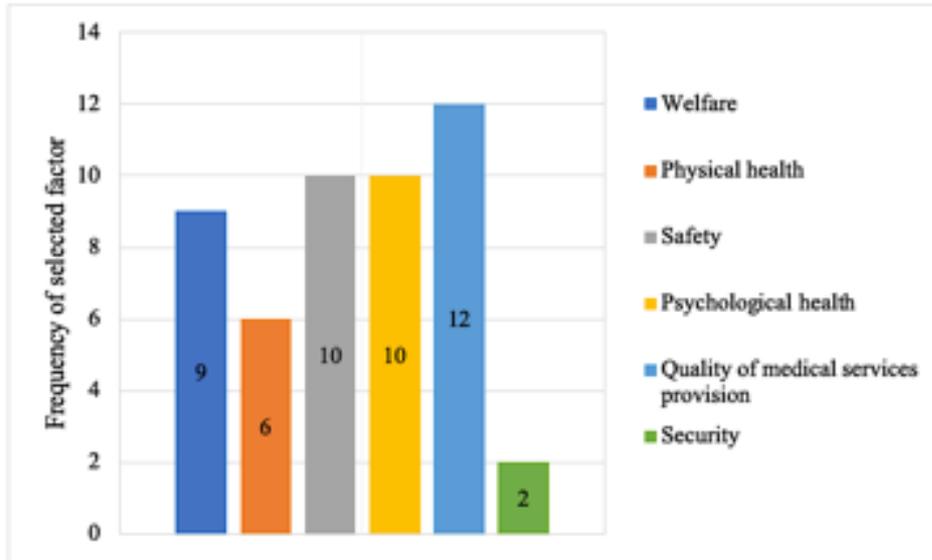


Figure 9.8: Main factors in creating a healing environment

9.11.1 DESIGN METHODS

Figure 9.9 illustrates the information of participants responses to asked question: “Please rate (comment on) the effectiveness of different forms of design processes in solving design issue that trigger AIs”. See Section 12.4.7 (Appendix D) for more information on the assessment process and outcome.

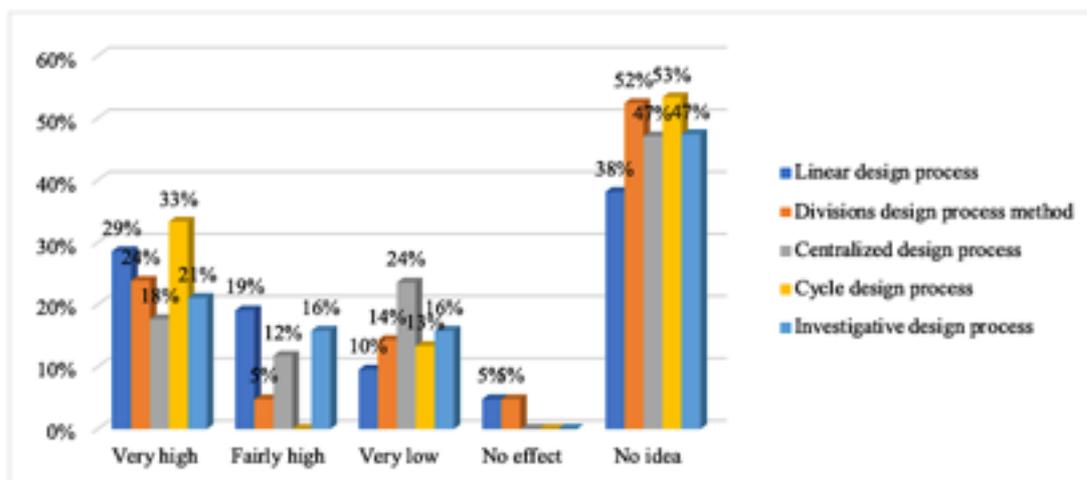


Figure 9.9: Effectiveness of design process methods

Participants identified four methods that designers could use at the start of designing a hospital building, including linear solutions, divisional solutions, centralized solutions, cyclical solutions and investigative solutions (details are provided in Section: 12.4.7(A) (Appendix D)). Figure 9.10 illustrates the responses of participants to rating the effectiveness of these design methods.

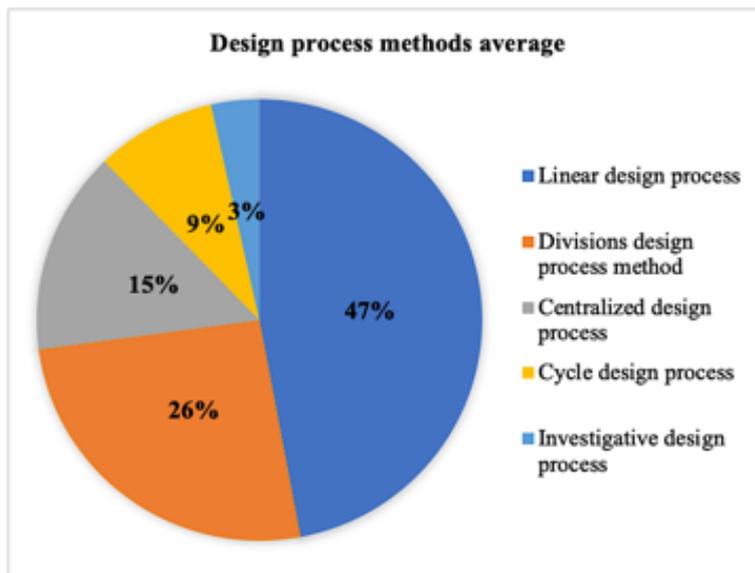


Figure 9.10: Design process methods selected by participants

The linear design method was rated as the most effective method by 47% of the participants, whilst 26% think divisional method is most effective. Only 3% of participants consider the investigative design process method has an effective way to solve the design issues.

9.11.2 DESIGN THINKING STRATEGIES

Figure 9.11 illustrates the responses of participants to the question “Please indicate the level of effectiveness of the design thinking strategies and techniques that you use in the design process to solve design issues and to consider patient healing processes?”. The four design strategies were identified: lateral solutions, visual solutions, design principles options and group discussions; detailed in Section 12.4.7(B) (Appendix D).

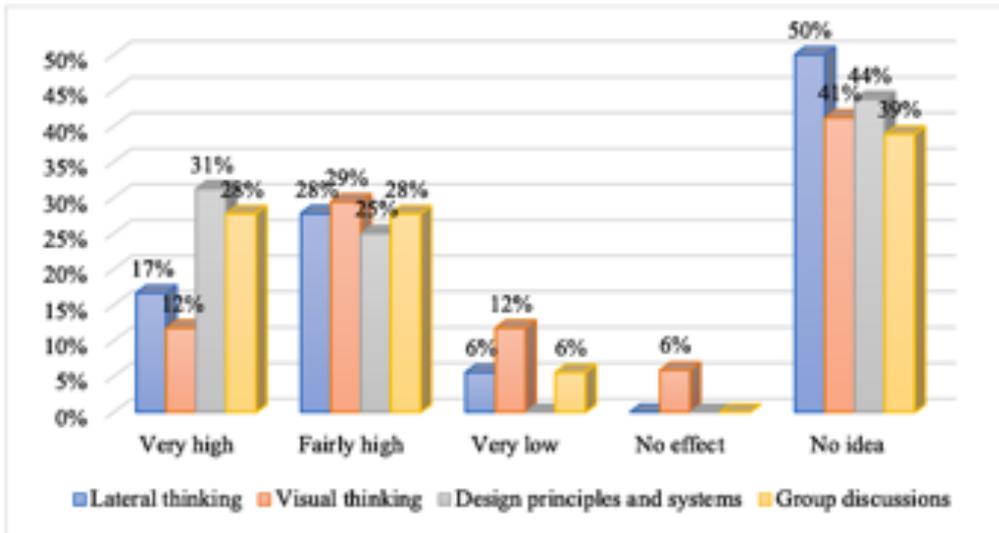


Figure 9.11: Design thinking strategies

Figure 9.12 illustrates the percentage of participants' responses rating the effectiveness of the four design thinking strategies to reach the best available solution at early stage of hospital design. Group discussion was rated as the most effective by 40% of participants, whilst 28% chose design standards. Lateral thinking was rated as least effective [by 11% of participants].

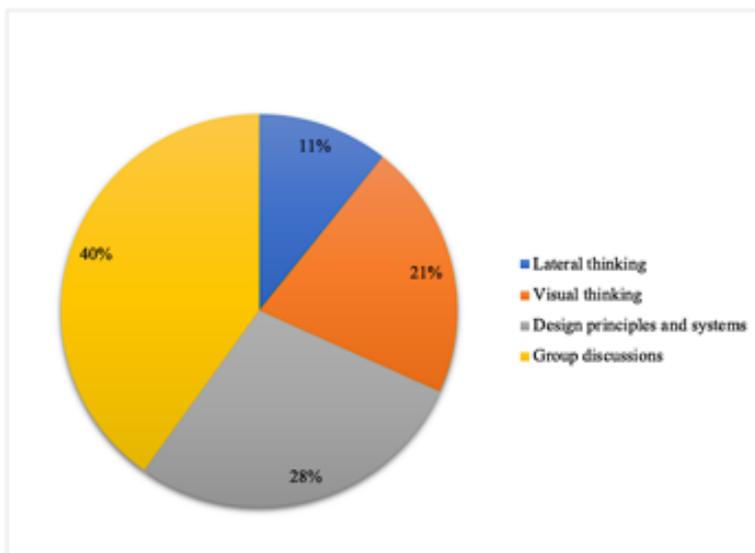


Figure 9.12 Design thinking strategies rating

9.11.3 DESIGN THINKING PRINCIPLES

Figure 9.13 illustrates participants' responses to the question "Please indicate the level of effectiveness of the principles of hospital design in the design process that influence the design of a hospital environment in order to support patients' healing processes?". Five principles of hospital design were identified: patient-focused care, evidence-based design, salutogenic design, lean healthcare and hospital systems (see detailed descriptions in Section 12.4.7(C) (Appendix D)).

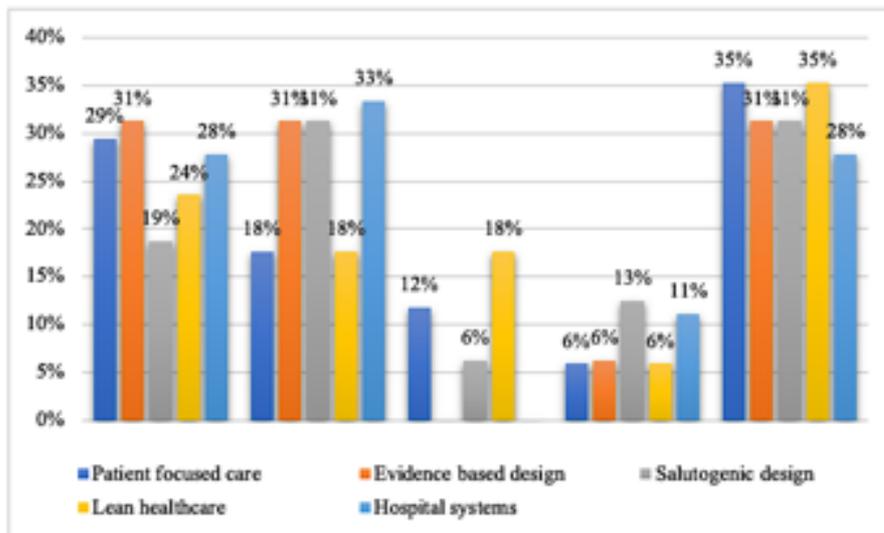


Figure 9.13: hospital design principles

Figure 9.14 illustrates participants' responses on the effectiveness of the five approaches to hospital design principles. Patient-focused care was rated the most effective principle by 42% of participants, followed by evidence-based design by 30% of participants. Only 7% of participants considered hospital design systems principle to be effective.

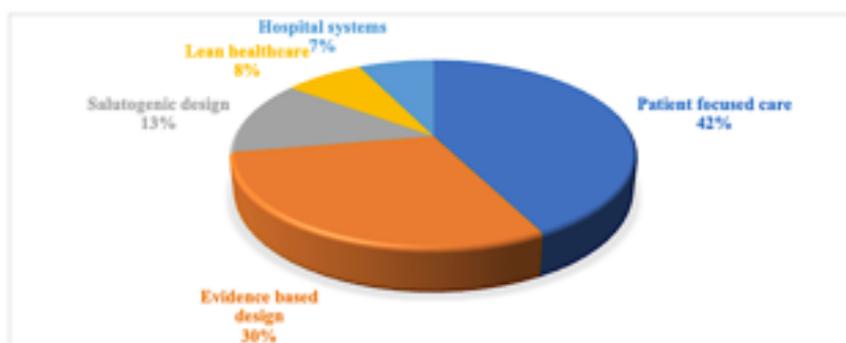


Figure 9.14: Ratings of hospital design principles

9.12 SUMMARY OF FINDINGS [INTERVIEWS WITH DESIGN AND MAINTENANCE TEAMS]

This section summarises the findings in five research areas regarding participants' views on hospital design issues, strategies for solving design issues, healing aspects of design elements, issues in designers' thinking and process flaws in the predesign and design stages

The participants identified three main design issues and the relationships between them. These are:

1. the ***impact of AIs on patient health***: more than 62% of participants believed that AIs have a physical and psychological impact on patient health,
2. ***AIs and design issues***: 62% of participants believed AIs originated from design issues and;
3. ***flaws in the design process and design issues***: 67% of the respondents considered design issues as the source of flaws in design process, during early stages of design.

In the three case studies, three main design issues were faced by participants:

- A. ***design issues in hospitals***; almost 80% of participants had experienced design issues,
- B. ***design process flaws***: 32% of them recognized that design issues resulted from flaws in design processes at the early stage of design and
- C. ***AIs originating from design issues***: 32% identified the link between AIs in the occupancy stage and design issues.

Figure 9.15 shows the solutions suggested by participants to resolve design issues. The first stage involves:

- i. ***study*** i.e. gaining knowledge of the existing design issues by spending enough time and paying more attention to:
 - classification of design issues: classify design defects or faults in order to determine the way to deal with historical design issues or new issues that emerge in the course of developing a new design;
 - sources of design issues to identify the design role types e.g. whether culpability is the designers' or the design administrators' or as a result of lack of (or faulty)

information given to the designer and upon which design decision have been premised;

- impact of the design issue to classify the level of damage in order to select the methods, strategies, principles to solve the issues;
- engagement of victims of design issues during design so as to gather information;
- visiting the location of the design issue to have a first-hand knowledge of the problems;
- obtaining the holistic knowledge on the background of the design issues to better understand the circumstances as to whether they are caused by events within or external to the project's system;
- interviews involving current users and viewing current designs and reports, and;
- reviewing design standards and existing hospital design designs to recognize other ways of dealing with similar issues.

ii. **analysis i.e.** identifying details of the elements of design issue and structuring them separately in terms of space: size, function, use, operations, conditions, systems, components, locations, activities, information and data flows, relationships, supporting services, movements, safety and security and construction requirements.

iii. **solution strategies** i.e. using outcomes of analyses. Two strategies were recommended to designers in order for them to select and test the best solutions:

- a. **solution evaluation:** i.e. discussing potential solutions with the design teams and interested groups to ensure all design solutions reflect all design issues and requirements as drawings and
- b. **gaining the consensus** of participants regarding possible best solutions from the design team and all interest-groups

iv. **decision making** i.e. applying the best design solutions with all justifications to support the selected solution and getting approval for the solution.



Figure 9.15: Conceptual framework - Strategies for solving design issues

The second stage involves two processes needed to test and evaluate approved solutions once implemented, so as to test their effectiveness. These are monitoring the effectiveness of the selected solution through the point-of-view of end-users and beneficiaries, and re-evaluating the solutions to be considered in future hospitals as though best solution options.

Figure 9.16 shows the relationship between patients' senses and environmental design issues. Findings suggest they increase patients' burdens psychologically and physically, thereby leading to longer recovery. Thus, healing aspects of design involve social, spatial, luminous, thermal, audio, spiritual and safety, security, aesthetic, freedom, objects usage and movement and technological aspects in design.

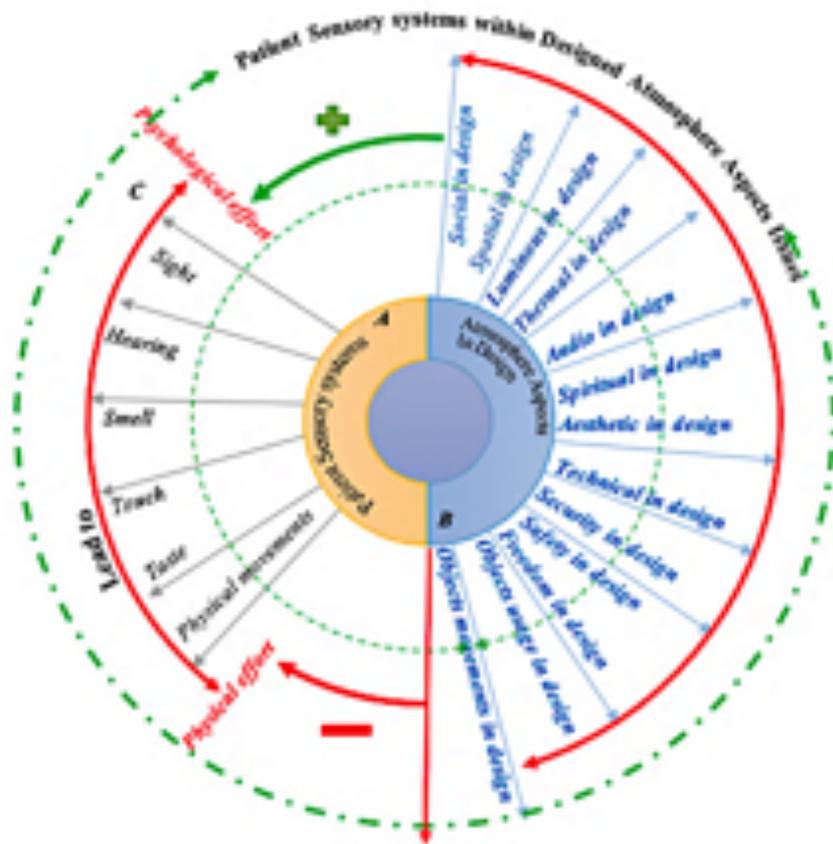


Figure 9.16: Conceptual framework - The link between patients' senses and environmental aspects of design

Furthermore, three aspects of design thinking in relation to healing were discussed by participants. They include:

1. **design methods:** a majority of participants identified linear design process as the most effective method of solving design issues rather than other methods that create unified and several solution options but depend on all inputs of all responsible parties;
2. **design thinking strategies:** majority of participants identified the use of group discussions as a most valuable strategy to stimulate their thinking for achieving their best solutions. They do this rather than lateral, visual and design standards that create several solutions to design issues, which will be compared with other solutions and be evaluated robustly whilst communicating mental images to specific design issues;
3. **design principles:** majority of participants identified patient-focused care as the best principle in hospital design. The intention behind the principle is to control design thinking such that designer can design a care environment that is responsive to patient health. This

is because this principle considers patients' requirements in terms of emotional support, physical comfort, flow of information and communication with family, carers and access to care. Participants have chosen this rather than design principles that include consideration for patients' mind, safety, satisfaction, and other factors that reduce time and cost as though the latter are less effective in controlling designers' thinking during the design stage (Section 12.4.7, Appendix D).

Following responses provided by participants, the research tracked sources of design issues from the pre-design and design stages such that the research can gain a clear understanding of their manifestations in project's post-design life. By tracking design issues in 15 design fields (see Section 9.5), Figure 6.17 presents the placements of design issues within the phases of design processes (red start) leading to design issues in the operation stage.

- *Flaws in need identification processes:* This is caused by the owner i.e. projects Administration at the regional and central offices of the MOH. They could occur when needs' data are incomplete or inaccurate, thereby creating outcomes that cannot meet the actual requirements of the proposed new hospital, nor are able to reflect solutions to current design defects in existing hospital designs. Descriptions of hospital needs must deal with the requirements of new diseases and illnesses so as to provide appropriate diagnosis and treatment plans. Future planning requirements must be included such that the new build is able to accept more patients and must be able to provide new technologies for future diagnosis and treatment requirements. Moreover, hospital design principles must support healing processes of patients in addition to providing high quality care services. Needs documentation must limit immediate scope changes so as to avoid complications during construction and occupancy. This is critical because such omissions can lead to an inability to extend or provide new medical services required, if at all, at a much higher cost. Not only this, design must be care-specific, particularly to therapeutic and diagnostic plans; such that a new hospital is known by its ability to serve specific needs of patients. Site selection criteria to ease access issues is also important.

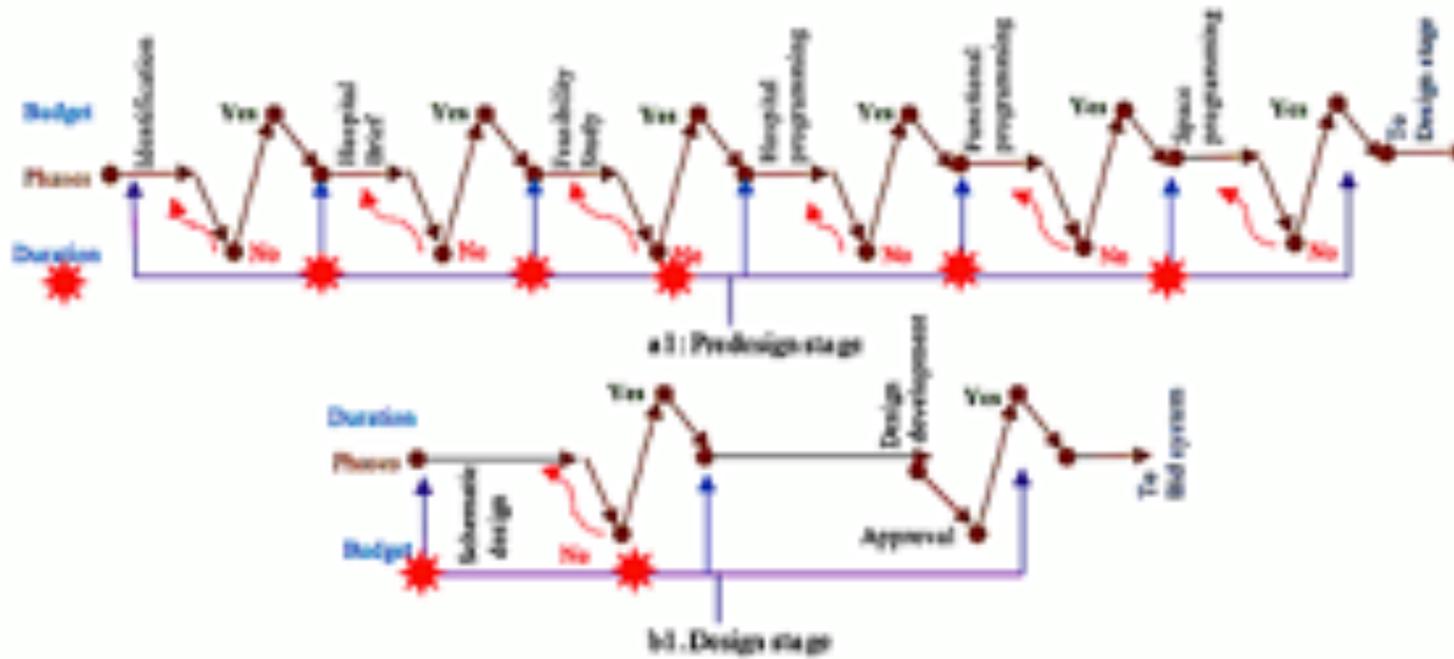


Figure 9.17: Sources of flaws in the design process

- *Flaws in project briefs:* Justification for a new hospital needs the flexibility to extend the new-build vertically and horizontally in the future. In addition, such briefs must consider accessibility to medical care services for all types of patients. Also, the objectives of a hospital project must include new and advanced medical equipment that can help in managing current diseases, reduce adverse incidents and support healing processes. The brief must state the desired outcomes such that the facility can provide complete diagnostics and therapeutic care, without having to refer patients to another hospital. Another desired outcome is the desire to reduce pressure on hospital services by ensuring inpatient stays are not prolonged unnecessarily. Site must be suitable, and must consider changes in climatic conditions, topographic conditions, location issues and how to manage medical and non-medical waste-flows. Hospital budget estimates must avoid errors and omissions; must include estimates of medical care requirements in the various scope of hospital services. Estimated project durations must be accurate too; including float allowances for variabilities and unforeseen circumstances. In addition, participants think it is important to invite interested participants, such as healthcare providers and maintenance and construction workers and equipment contractors to define and achieve the hospital's optimum requirements. Not least, the design team must take responsibility for all design data, rather than relying on the design administration teams.

- *Flaws in feasibility study processes (relies on outputs from previous stages as its inputs):*
 Flaws were found in eight processes:

 1. Site analysis must consider appropriate sunlight, green areas, fresh air flow, noise level and amount of rain in relation to their impact on hospital building shape and location and patient health.
 2. Operability e.g. heliport required for urgent evacuation of patients.
 3. Additionality e.g. learning from current design issues rather than repeating same issues in new designs because of the desire for repetitive creation.
 4. Flexibility i.e. identifying future scope of services identification as per the possible requirement to expand or add new services.

5. Data integrity i.e. consider all types of data collected in terms of geographic and the meteorological data in each region, as way to create healing aspects in design. Study found there are many instances where location-specific data were jettisoned whilst creating new hospitals.
 6. Technical competence i.e. originality of creative propertization should be taken seriously e.g. copying and pasting old designs and specifications as new development proposals should be avoided.
 7. Functionality i.e. Care spaces and their programming requirements must be designed to achieve a high level of efficiency in their function.
 8. Site selection i.e. Whilst selecting new hospital sites, consideration must be given to future expansion and growth.
- *Flaws in Hospital building programming process*, including actions that negate the following:
 1. Presentation of healing aspects in design to support physical and psychological health of patients must be involved in the program goals as the main expectation outcomes.
 2. Contributions required, in this phase, from critical stakeholders so as to accurately present the anticipated functions, needs and requirements in spaces and achieve maximum care service demands. This means the design team would not just rely on design standards only.
 3. Identifying the elements of healing aspects of design to meet the beliefs, culture, history and traditional conditions of Saudi Arabia.
 4. Avoiding or minimising the cross points within the movement of dead and living objects in vertical and horizontal traffic; spaces programming for circulations must prevent disruption of care service and must support infection control.
 5. Considerations required to respect spiritual elements of designs by specifying spaces or tools dedicated to worship.
 6. Selection criteria for the design and construction teams must meet a high level of cognate and management experience, technical knowledge, financial stability and reputation relating to healthcare development.

7. Development budgets must be firm and must avoid multiple approval stages through several administrative processes and procedures.
8. Proposed project durations must be accurate to avoid delays in activating full capacity operation of the hospital.

- *Flaws in Hospital building functional programming processes; including in:*

1. Support areas must be able to control infections (e.g. janitorial, clean and dirty rooms), provide complete diagnostics (e.g. laboratory and imaging departments) and therapeutic plans (e.g. medication room) and must enhance the capacities of critical systems.
2. Activity assessments [i.e. movability analyses] are required to identify the volumes and activities of infection controls standards, communications and critical systems, patients, visitors, end-users and staff within their work and communication spaces.
3. Flexibility in structural design to deal with internal and external expansions in the future or changing and improving scope of service. For example, flexibilities in mechanical services spaces (lift) to easily move and access the patient bed to/in the elevators and for abilities to increase capacities of the critical systems in the future without major changes in design.
4. Circulation requirements must provide direct link between the treatment and diagnosis departments both horizontally and vertically in a short distance to avoid wasting time and effort of patients and healthcare providers.
5. Needs of future growth required to accommodate new cases of diseases and illnesses, increase in staff, equipment, services, to provide new types of diagnoses or treatment plans.
6. Flow planning is required to consider segregation, disruption, control and discharge of living and dead objects (e.g. patients, equipment, supplies, medications, patient information and the waste movements).
7. Space assignment is required to deal sufficiently with number of cases of illness and diseases in each region.

- *Flaws in hospital building space programming processes. They involve:*

1. determining the types of medical treatment plans (e.g. drugs, chemical, radiation therapies and palliative treatment) and medical diagnosis plan (blood test, x-ray, heart and breathing rate), and number of served patients that the proposed hospital will serve
2. providing adequate areas and suitable conditions to prevent breakdown of equipment and critical systems (e.g. medical gas, ventilation and heating), by considering the requirements, standards, installation processes and sources to operate them.
3. providing adequate spaces for free movements for healthcare providers, to avoid disruptions during the provision of medical care services e.g. by considering the number and types of staffs (resource) required to work at a time.
4. dealing with spaces for new equipment and technologies for diagnosis and treatment plans must take place in this stage to avoid modifying or changing designs in future extensions.
5. identifying waste management data required to plan waste circulations [e.g. disposal and storage] to limit possible infections coming through them.
6. interrelationships between space distribution and emergency exits must be sensitive to patient evacuation.
7. nurse substations must be located near the patients they serve.
8. patients and their support persons must be able to access spaces for comfort with ease.
9. estimated hospital development budget and schedule must accommodate potential changes in the identified scope of medical care services.

In addition, findings on *flaws in schematic design processes* suggest they were caused by lack of opportunities to correct flaws in predesign processes, in which schematic designs are meant to account for site selection and conditions, floor, roof, hospital sections, elevations, critical systems, equipment, landscaping plans, illustration of specific space functions and specifications of materials. Flaws in *Schematic design processes* include outcomes that negate the following:

1. sharing accurate information about the relative sizes and adjacencies of functional spaces, to be subjected to objective criticism and correction.
2. limiting the contributions of critical stakeholders outside the design team to the design stage with a chance to review inputs from previous stages.

3. inadequate and unclear descriptions and justifications in adopting design standards (e.g. mixing American and British standards) to address shapes and sizes of hospital spaces.
4. simulating movability in all design presentations to stakeholders.
5. presenting local customs and religion as design elements on internal walls and external elevation designs.
6. showing future expansion planning to deal with potential growth in patients and care services, showing considerations for the conditions of the selected site and the host community.
7. quality of justifications presented for selected materials and system's specifications to meet patient health, safety and security standards.
8. reviewing and re-defining functionality, usability, adjacencies, security, safety and aesthetics requirements of design plans few times before the final approval.
9. evacuation planning of patients from space to space or floor to others for avoiding escape difficulties.
10. consideration of components of patient environments, which must reflect the physical and psychological conditions of patients.
11. justifications for material selection and systems in the specification, to avoid possible manipulations by construction and maintenance contractors.

Flaws in design development process occurred due to errors and omissions of some details in the final drawings (perhaps due to production or transmission issues). See examples in Section 9.6 (under *Specifications and Information Issues in Drawings and Tables*).

In summary, this chapter presents the background information of maintenance and design teams' participants across six case studies and stages of hospital design development as well as their professional experience, qualifications, professions and knowledge levels. In addition, it shows the participants' views on design issues, AIs, design process flaws and healing aspects in design. Moreover, design methods, thinking strategies, and hospital design principles were presented as measurement to identify thinking issues in design processes. Finally, the summary of findings was presented as shown in Figure 9.18.

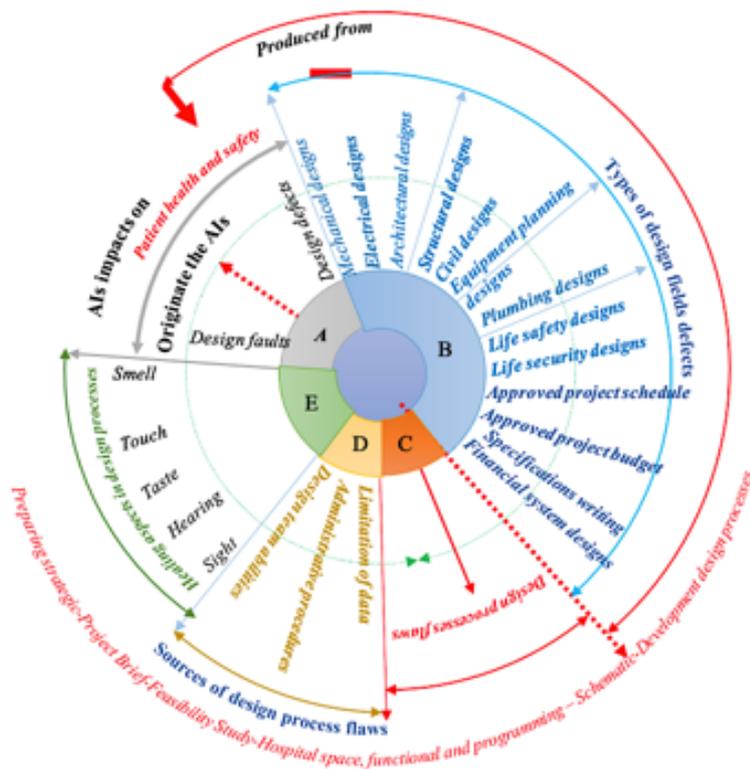


Figure 9.18: Conceptual framework 4: summary of findings within the research

This chapter has defined five areas where AIs emanate from in the designed spaces. These include design issues caused by defects and faults, and initiate the AIs that affect patient health and the care services they receive. Findings have also been reported on 12 types of design-field issues that occurred in the operation stage. By tracking these design issues, this study found flaws in the 8 phases of predesign and design stages. The study also found sources of flaws that associate with design teams' abilities, administrative management, and loss required data during the design phases. Findings reported in the chapter are also related to 13 elements that affect healing aspects of design. The next chapter provides an analysis of the questionnaire completed by participants from the design and operation stages (Figure 9.19).

Stage 2	objectives	Data sources	outcomes
Phase 3	Test hypotheses	32 participants from design and operation stages in 4 case studies	understand the difference between the lowest and highest variables values of the design healing aspects
Methods	Questionnaires		

Figure 9.19: Chapter 10: Phase 1 of Stage 3 - sources of data analysis and findings

10.0 ANALYSIS OF QUESTIONNAIRES

10.1 INTRODUCTION

In Phase 1 of Stage 3 of data collection, a questionnaire survey was formulated to further investigate the findings of previous stages, largely qualitative data from interviews, observations, and case studies. A copy of the questionnaire is available in Part C of Appendix D. The aim was to test the research hypotheses, to understand the statistical nuances in the variables regarding healing aspects of designs, design process flaws and their sources and to define the impact of design issues. In addition, the analysis is to help investigate impacts of AIs on patient health and the relationships between the findings in each research area, as well as identify critical factors affecting patient recovery from the design to operation stages. This section discusses findings from the data analysis in three ways: descriptive, correlational, and inferential analyses.

10.2 SAMPLE SIZE

The questionnaires were distributed to 180 participants. 86 responses were received, out of which 76 were acceptable, with a response rate of 42.2%. 10 responses were rejected because their choice in the level of agreement to every statement was similar, which means that they answered without reading the contents of the survey. 46 accepted the invitation to be part of the survey but later refused to answer. Refusing to respond to the questionnaire may be related to the effort and time to read and evaluate 132 statements within 15 areas of investigation in the survey, criticism of the source of design issues as weakness in the abilities and thinking strategies of designers and managers at senior level within the Saudi Ministry of Health may be a sensitive topics and the survey includes new concepts, such as the healing process and sensory systems affected by design process issues that may not relate to maintenance fields or may need more explanation.

The questionnaire was formulated based on the results of six phases of qualitative data collection interviews and participant observation (see Sections: 13.4.1-13.4.4 in Appendix D).

10.3 DESCRIPTIVE STATISTICS

To define the highest and lowest values in the findings of each research area and to identify the most important missing factors leading to design issues in the operation stage, the quantitative data obtained were analysed, and to identify their mean, standard errors, variances and standards deviation for each statement (item). The weighted mean and standard deviations were calculated from the sum of variables means in each area of investigation to evaluate the level of agreements on the research areas as shown in Part C of Appendix D. The Microsoft Excel Programme was used to compute the data.

10.4 SCORING SYSTEMS

Each statement in the second section of the questionnaire was evaluated and scored using participants' agreement in line with their rating on the five-point Likert scale (Table 10.1).

Table 10. 1: Mean criteria used for scoring

Likert Scale	Interval scale	Deference	Description	Interval level of weighted mean	
1	1.00 – 1.79	0.79	Strongly Disagree	1.00 – 2.59	Low
2	1.80 – 2.59	0.79	Disagree		
3	2.60 – 3.39	0.79	No Opinion	2.60 – 3.39	Moderate
4	3.40 – 4.19	0.79	Agree	3.40 – 5.00	High
5	4.20 – 5.00	0.80	Strongly Agree		

The Likert scale ranged from (1) to (5): (1) Strongly disagree; (2) Disagree; (3) No opinion (neither agree nor disagree); (4) Agree; and (5) Strongly agree to evaluate each statement. To define the highest and lowest values of the scale, the deference (rang) was calculated in two steps by subtracting the highest level (5) from the lowest level (1) = 4, then dividing by 5 which equals 0.80. In order to determine the range of the scales from the lowest to highest value, 0.80 was added and to observe and interpret the mean given to each variable by respondents. The weighted mean ($\sum\mu$) and standard deviation ($\sum\mathcal{S}$) were calculated to evaluate the level of agreement on each area of investigation

10.5 BACKGROUND OF PARTICIPANTS

Questionnaires were completed by 32 members of design teams and 44 members of maintenance teams from five case studies, as presented in Table 10.2. Therefore 34% were members of design teams and 66% of maintenance and operations teams (Figure 10.1).

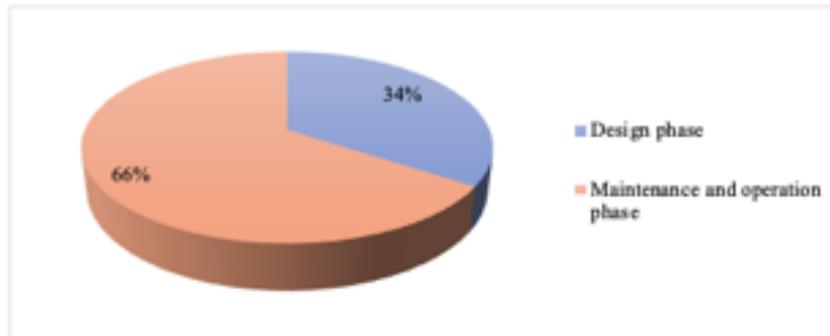


Figure 10.1: Roles of participants in hospital building phases

In Case Studies 2, 3 and 4, the design teams members participated under the direction of the Deputy Assistant Director of Health Affairs for Engineering and Projects affairs and the Director of Engineering Management (responsible for managing the design, construction and maintenance departments). In Case Study 1, maintenance teams members participated under the direction of the Engineering Management Department in each hospital, including the General and Biomedical Maintenance Departments. The two groups reflected all the administration and departments that are responsible for the main stages of designing and operating hospital buildings in healthcare affairs in each region and SMOH. Thus, participants were considered as a valuable source for identifying the level of agreement for research findings about the types, impacts of design issues and AIs in the occupancy stage and the types of design flaws and sources in the early design stages. Table 10.2 shows types of participants group for healthcare affairs at different administration levels in the regions and at a senior level of the Saudi Ministry of Health.

Table 10.2: Background of participants

Region	Case Studies	Administration	Departments	Participants group	No. of participants
Southern Region: Al Baha City	King Fahad Hospital (KFH) and Medical Tower (Case Study 1)	Engineering Management	Biomedical Maintenance & General Maintenance	Maintenance team	30
	Engineering Affairs General Administration (Case study 2)			Design team	6
Baljurashi City	Prince Mishari General Hospital (Case study 3)	Engineering Management	Biomedical Maintenance & General Maintenance	Maintenance team	14
Eastern Region: Jeddah City	Engineering Affairs General Administration (Case study 5)			Design team	3
Central region: Al Riyadh City	Saudi MOH organisation (Case study 6)	Engineering Affairs	Equipment General administration, Studies and Designs, Information and Statistics & Quality and patient safety	Design team	23
				<i>Total for Design team</i>	32
				<i>Total for Maintenance team</i>	44

Figure 10.2 illustrates the years of experience of participants. In the design team, 13 participants had less than five years of experience and four each with less than 10 years and more than 20 years of experience. In contrast, in the maintenance team 13 participants have less than 5 years and 13 more than 10 years and only four have more than 20 years.

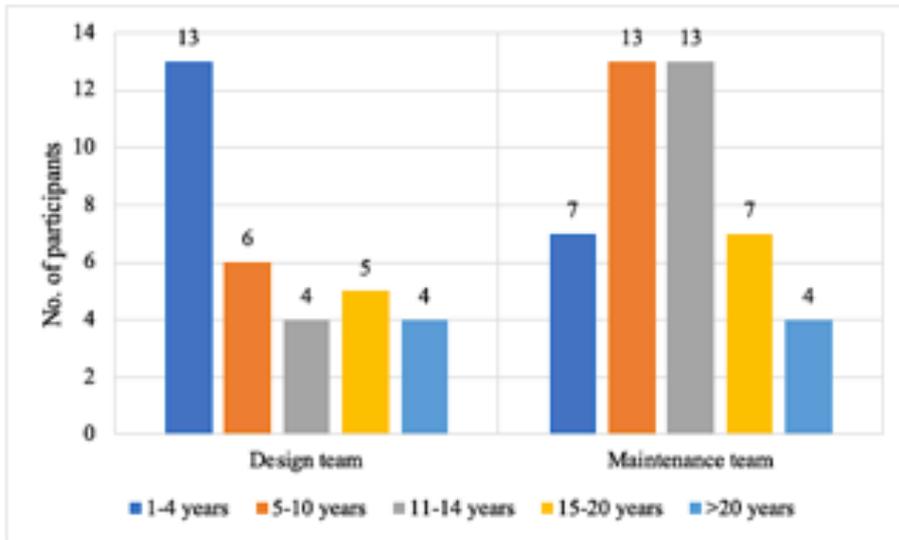


Figure 10.2: Years of experience of participants in each team

Overall, around a quarter of participants have less than 5 years of experience and a quarter have less than 10 years (Figure 10.3). 22% have more than 10 years of experience, more than one fifth have less than 15 years and only 11% of them have more than 20 years.

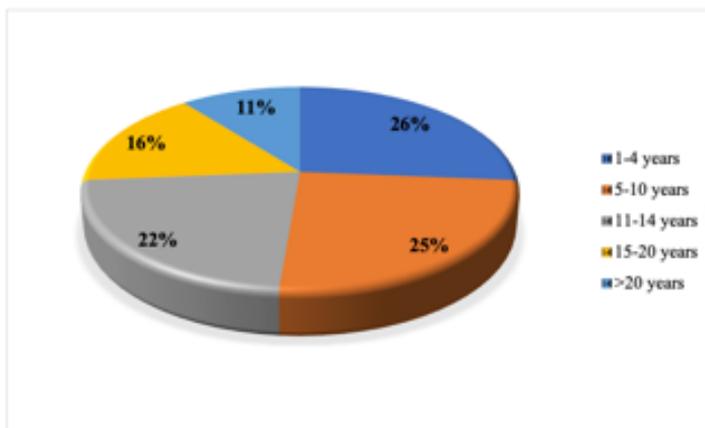


Figure 10.3: Number of years of participants' experience

Figure 10.4 illustrates the educational qualifications of participants in both teams. The educational qualifications are divided into four levels: the majority of participants in both teams have bachelor's degrees. A fair number of participants from the maintenance team had diplomas, in contrast to the design team.

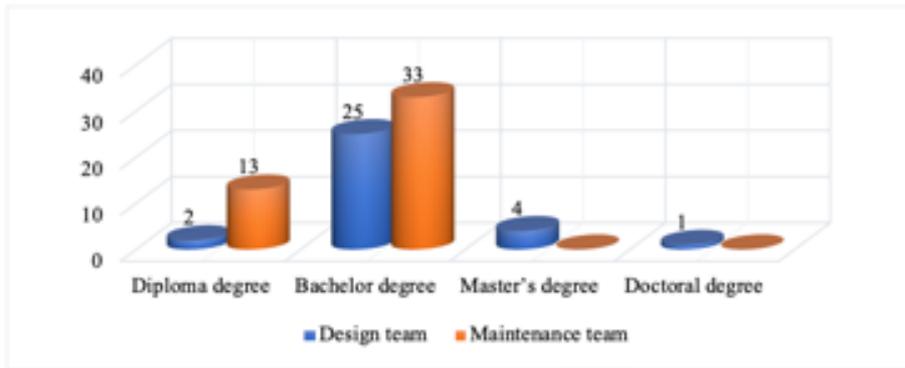


Figure 10.4: Participants' educational qualifications

Figure 10.5 illustrates the professions of the design teams' members. Most respondents worked as architectural and electrical engineers, with fewer as mechanical engineers and architects.

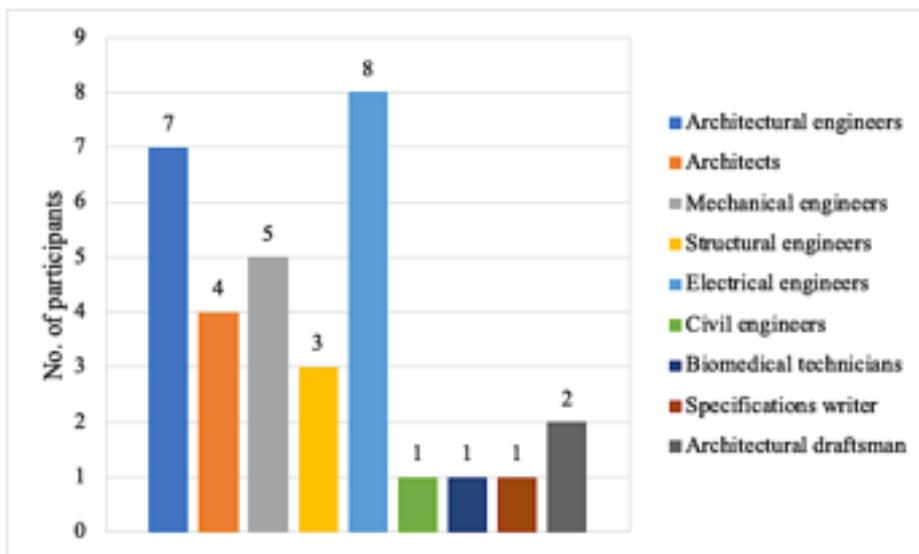


Figure 10.5: Design team's professional background

Figure 10.6 illustrates the professional background of participants who are members of maintenance teams. Most of the participants worked as biomedical engineers and technicians and the second-largest group worked as electrical engineers.

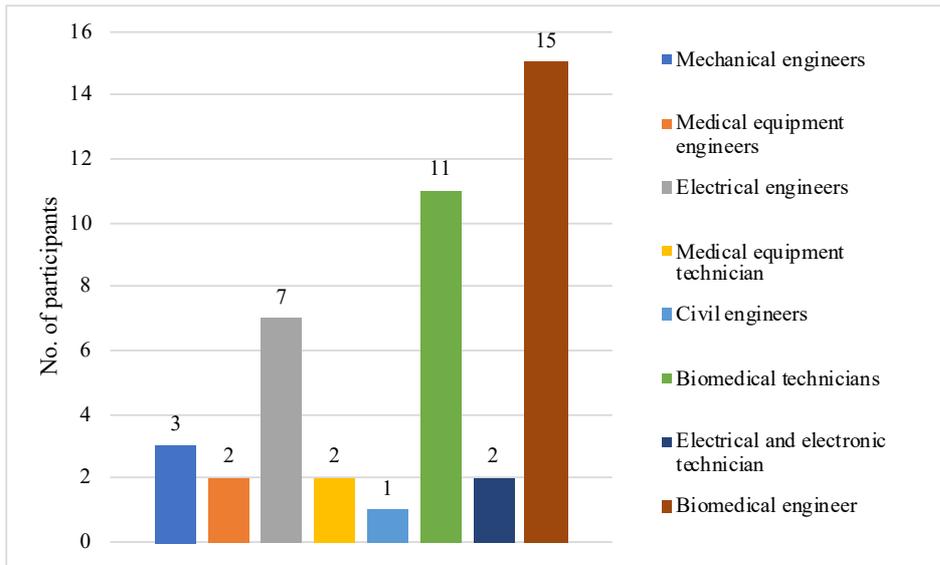


Figure 10.6: Maintenance team's professional background

10.6 DESCRIPTIVE ANALYSIS OF RESEARCH CONCEPTS

10.6.1 NATURE OF DESIGN ISSUES IN OCCUPANCY STAGE

Participants' opinions were analysed to confirm the concepts of the research and their scope. Table 10.3 indicates that the weighted mean of the research concept definitions on design issues' cycle is 3.17 (out of 5) and the standard deviation is 0.0729. This indicates a high degree of agreement; suggesting, participants' knowledge level on the research concepts is clear and well clustered around the mean.

Table 10.3: Degree of agreement of participants on the definitions of research concepts

#	Statements	Mean	Standards deviation	Cases	Rank
1	Adverse Incidents from Design Defects (AIsDD)	3.105	0.9030	76	4
2	Types of AIsDD	3.171	0.9001	76	2
3	Design faults (DFs)	3.092	0.9118	76	5
5	Physical impact of AIsDD	3.250	0.8812	76	1
6	Psychological impact of AIsDD	3.144	0.9049	76	3
<i>Overall Mean</i>		3.172	<i>Level of significance</i>	High	
<i>Standard deviation</i>		0.073			

In addition, the means of the six items showed a limited difference, indicating that most participants agreed on the suggested concepts as detailed in Section 13.4 - 13.5 (Appendix D). Items 5 and 6, the impact of AIsDD on the physical and psychological health of patients were ranked high with the mean scores of 3.250 and 3.144 respectively. Examples of physical impact of AIsDD include infection, injury, disability, burn, breathing difficulty. Examples of

psychological impact of AIsDD include stress, pressure, pain, fatigue, hunger, thirst, pain, temperature, itching, time passing slowly and loss of appetite and confidence Item 2, types of that cause DDs in Saudi hospitals were also ranked high for consideration in the research analysis [mean score, 3.17]. Examples of such AIs include falls, medication and medical errors, infection and fires. Items 1 and 3, (AIs that originate from the design issues, and types of design issues resulting in the inability to provide diagnosis or treatment services for more patients and for specific diseases and illnesses due to flaws in design process) were ranked fifth and sixth, and with a high level of significance; with a mean score of 3.10 and 3.09 respectively.

Participants' opinions were evaluated on specific impact of design issues on patient recovery and the quality of healthcare services they receive. Table 10.4 indicates the overall mean of the impact of design issues is 3.279 and the standard deviation is 0.0777.

Table 10.4: Agreement on the impact of design issues

#	Statements:	Mean	Standards deviation	Cases	Rank
<i>Design issues:</i>					
1	Impede delivery of healthcare services	3.253	0.9876	75	4
2	Add new healing processes	3.276	0.9605	76	2
3	Extend the healing process	3.407	0.9406	76	1
4	Increased cost and time	3.197	0.8947	76	5
5	Patient discontinuing treatment	3.263	0.8697	76	3
<i>Weighted mean</i>		3.279	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.078			

There is a little difference in the means of the 5 items, indicating that most participants agree on the impact of design issues. Item 3, Extending the healing process (e.g. more time to deal with other medical issues or apply new treatment and diagnosis plans caused by AIs) is ranked first with the highest mean, 3.407. Item 2, Preventing the delivery of, or delay in the application of new healing processes (e.g. lack of capacity of medical services to diagnose and cure the patient a timely) has second highest rank with a mean score of 3.27. Item 5, Patient discontinuing their treatment because of repeated failure of critical systems (e.g. ventilation, air conditioning and gas systems, discomforts leading patients to move to private hospitals) has the third rank with a mean score of 3.26. Item 1, Preventing the delivery of, or delay in, healthcare services (e.g. lack of spaces for new medical services and requirements) has the fourth rank with a mean score of 3.25. Item 4, Increased cost and time for healthcare services or stopped healing processes (e.g. spreading of flame and smoke exposing patient to death) has the fifth rank with the lowest mean score of 3.19.

10.7 TYPES OF DESIGN ISSUES

Participants' opinions about types of design issues were also explored. Table 10.5 shows the mean scores of all the types of design issues is 3.218 and standard deviation is 0.086. Most participants agree on the design issues presented in the questionnaire. Item 6 (Life security design issues including lack of alarms points, fences, access control systems, deficiency in closed-circuit television and more than three main entrances) was ranked first with the highest mean of 3.328. Item 5 (Life safety design issues including difficulty in evacuation plans for inpatients from critical units, lack of fire system protections and inadequate flame and smoke barrier walls) has second rank with a mean score of 3.315. Item 12 (Hospital schedule approved issues including the miscalculation of the duration to find and approve a new hospital site, changing in the scope of services and additional tasks) has the third rank with a mean score of 3.293. Item 11 (Hospital budget approval issues including inadequate approved budget leading to cancelling some works or systems during the construction stage to prevent a budget deficit from occurring) has the fourth rank with a mean score of 3.289.

Table 10.5: Degree of Agreement of participants on types of design issues

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Architectural design	3.1316	1.0996	76	10
2	Construction design	3.1447	1.0027	76	8
3	Mechanical design	3.1053	1.0780	76	11
4	Civil design	3.2105	0.9841	76	7
5	Safety design	3.3158	1.0226	76	2
6	Security design	3.3289	1.0118	76	1
7	Electrical design	3.1053	1.0402	76	12
8	Specifications writing	3.2763	0.9179	76	5
9	Equipment planning	3.2763	1.0145	76	6
10	Plumbing design	3.1447	0.9339	76	9
11	Hospital budget approval?	3.2895	1.0042	76	4
12	Hospital schedule approval?	3.2933	1.0368	75	3
<i>Weighted mean</i>		3.2185	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.0869			

Item 8 (Specifications issues for materials and equipment including selection of low-quality criteria to resist growth of bacteria, fire, dust and rust, available in Saudi market) has the fifth rank with a mean score of 3.276. Item 9 (Equipment planning issues including lack of medical equipment, electrical and mechanical work sources and supporting spaces and equipment location close to wet area) has the sixth rank with a mean score of 3.276.

Item 4 (Civil design issues including lack of drainage system in some toilets, drainage system for radioactive waste disposals and some water leakages from the ceiling) has the seventh rank

with a mean score of 3.210. Item 2 (Construction design issues including cracks occurring on the internal and external wall surfaces, limited structural load and missing terminal and water isolations layers) has the eighth rank with a mean score of 3.144. Item 10 (Plumbing design issues including medical (radiology) and normal liquid waste mixed and water leakages from ceiling in critical areas) has the ninth rank with a mean score of 3.144. Item 1 (Architectural design issues including unavailable, insufficient, inadequate and inoperable required spaces) has the tenth rank with a mean score of 3.13.

Item 3 (Mechanical design issues including miscalculation of required pressure types, deficiency in heating, ventilation and air-condition system and oxygen systems capacity and small areas for mechanical services) has the eleventh rank with a mean score of 3.105. Item 7 (Electrical design issues including limited power sources, inadequate lighting, insufficient electricity protection systems and limited load capacities of panels) has the twelfth rank with the lowest mean score of 3.105.

10.8 FLAWS IN THE PREDESIGN STAGE

10.8.1 DESIGN PROCESS (INPUTS) FLAWS

Participants' opinions were evaluated on flaws in preparing the identification of need process. Table 10.6 shows the weighted mean of flaws in the identification process is 3.568 and the standard deviation is 0.0829, suggesting a minor difference in the means scores of all the eight items. Item 8 (Number of served patients to save patient time to be diagnosed or treated in the right time and right way) has the highest rank with the highest mean, 3.684. Item 2 (Hospital needs descriptions to deal with new cases of diseases and illnesses to provide perfect treatment and diagnosis plans within spaces and with equipment) has second rank with a mean score of 3.631. Item 5 (Scope of medical services to avoid the changes during the construction and the occupancy and operation stages that lead to an inability to extend or provide new required medical services) has the third rank with a mean score of 3.605. Item 7 (Land and location selection criteria to ease reach and access) has the fourth rank with a mean score of 3.605. Item 4 (Hospital design principles to support healing processes of patients in addition to providing high quality the medical care services) has the fifth rank with a mean score of 3.586. Item 3 (Future planning requirements to accept more patients and provide a new technology for treatment and diagnosis plan requirement) has the sixth rank with a mean score of 3.513. Item 6 (Therapeutic or diagnostic plans for the ability to serve certain patients with specific health

problems) has the seventh rank with a mean score of 3.513. Item 1 (Data and information in requesting and designing a new hospital to solve current design defects and faults with existing hospital buildings or consider the current design features) has the eighth rank with a mean score of 3.434.

Table 10.6: Degree of agreement of participants on flaws in need identification process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Justification and significations for hospital needs	3.434	1.2684	76	8
2	Hospital needs descriptions	3.631	1.0812	76	2
3	Future planning requirements	3.513	1.1009	74	6
4	Hospital design principles	3.586	1.1635	75	5
5	Medical services scope	3.605	1.1556	76	3
6	Therapeutic or diagnostic plans	3.486	1.2054	76	7
7	Land and location selection criteria	3.605	1.1085	76	4
8	The number of served patients	3.684	1.1455	76	1
		<i>Weighted mean</i>	3.568	<i>Level of significance</i>	High
		<i>Standard deviation of the means</i>	0.083		

Table 10.7 shows the weighted mean of the flaws in the hospital projects brief process occurred is 3.581 and the standard deviation is 0.0960. Most participants agree on the flaws in the projects briefing processes as presented in the questionnaire. Item 5 (Hospital budget estimation to avoid missing medical care service requirements in the scope of hospital during previous processes that could lead to additional cost later) was ranked first with the highest mean score of 3.720. Item 6 (Project duration estimation due to missing necessary future tasks, such as modifying the site, equipping and finishing, which lead to less quality and additional errors during the construction and delivery stages because the construction contractors need to achieve the implementations date faster with accomplishing the missing tasks) has second rank with a mean score of 3.666.

Table 10.7: Degree of agreement on flaws in the project briefing process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Justifications and significations for hospital needs	3.600	1.0397	75	4
2	Hospital project objectives	3.560	1.1179	75	5
3	Desired outcomes	3.533	1.1190	75	6
4	Identification of the risks and the constraints	3.631	1.0688	76	3
5	The hospital budget estimation	3.720	0.9664	75	1
6	The project duration estimation	3.666	1.1068	75	2
7	Inviting interested participants	3.533	1.0946	75	7
8	Data and information collection	3.407	1.1096	76	8
		<i>Weighted mean</i>	3.582	<i>Significance Level</i>	High
		<i>Standard deviation of the means</i>	0.096		

Item 4 (Identifications of risks and constraints to select suitable lands considering the changes in climate conditions, soil type and land location and how to manage medical and non-medical waste flows) has the third rank with a mean score of 3.631. Item 1 (Justifications and significance of hospital needs in the flexibility to extend current hospital structures vertically, horizontally or both and in the accessibility to healthcare services for all types or groups of patients) has the fourth rank with a mean score of 3.600. Item 2 (Hospital project objectives to include new, advanced medical equipment, controlling the current disease, reducing adverse incidents and supporting the healing process) has the fifth rank with a mean score of 3.560. Item 3 (Desired outcomes to decrease transformed disease cases from hospital to others or to other countries, pressure on hospital services and the prolonged stay of patients and to support healing process) has the sixth rank with a mean score of 3.533. Item 7 (Inviting interested participants, such as healthcare providers and maintenance and construction workers and equipping contractors to define and achieve the maximum of hospital requirements, demands and needs) has the seventh rank with a mean score of 3.533. An item 8 (Data and information collection for hospital designs requirements. This data collection should be provided by design teams as part of their responsibilities in these processes because the current data is provided by administrative employers who are unqualified to collect data) has the eighth rank with a mean score of 3.407.

Participants' opinions regarding flaws in the feasibility study process were also evaluated. Table 10.8 shows the weighted mean of these flaws is 3.576 and the standard deviation is 0.185. Most of participants agreed on the flaws as presented in the questionnaire.

Table 10.8: Degree of agreement on flaws in the feasibility study process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Site analysis	3.5394	1.1825	76	4
2	Helipport required	3.8684	1.0372	76	1
3	Studies of designed environments issues and features	3.8026	1.1077	76	2
4	Scope of services identified	3.6756	1.0217	74	3
5	Types of data collection	3.3947	0.9808	76	7
6	Copying and pasting	3.3815	1.1884	76	8
7	Space and its programming requirements	3.4605	1.1365	76	6
8	The selected size of land and the hospitals	3.4868	1.1943	76	5
<i>Weighted mean</i>		3.5762	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.1852			

Item 2 (Helipport required for urgent evacuation of patients) has the highest mean score (3.868). Item 3 (Studies on the impact of designed environments issues or features, in the occupancy stage, on the psychological and the physical healing process of the patient) has second rank with a mean score of 3.802. Item 4 (Scope of services identified to define initial and future requirements of the medical care services spaces designs while supporting the recovery process in the predesign processes) has the third rank with a mean score of 3.675. Item 1 (Site analysis to study the impact of sunlight, green areas around the site, fresh air flow, noise level and amount of rain on the hospital building and patients' health) has the fourth rank with a mean score of 3.539.

Item 8 (Selected size of lands and the hospitals to accept future expansion and to deal with growth in patient numbers and additional medical and non-medical care services) has the fifth rank with a mean score of 3.486. Item 7 (Inviting interested participants, such as healthcare providers and maintenance and construction workers and equipping contractors to define and achieve maximum hospital requirements, demands and needs) has the sixth rank with a mean score of 3.460. Item 5 (Types of data collection to identify the geographic and the mereological data in each region, as way to create healing environments) has the seventh rank with a mean score of 3.394. Item 6 (Copying and pasting the designs and specifications of the existing hospitals to other regions, leading to copying the current defects and faults in designs occurring in treatment and diagnosis plans, requirements and technologies) has the eighth rank with a mean score of 3.381.

Participants' opinions on flaws in the hospital building programming process is shown in Table 10.9. The weighted mean of all measured variables is 3.6486 and the standard deviation is 0.1418. Item 4 (Flows and circulations required in hospital spaces to minimise crossing points

within the movement of patients, care givers, waste and supplies (dead and living objects), vertically and horizontally) has the highest mean score of 3.881. Item 2 (Contributions required, in these processes, by the interested participants to accurately present all functional and need requirements in spaces to achieve maximum demands for providing perfect medical services) has the second highest rank and a mean score of 3.720.

Table 10.9: Degree of agreement on flaws in the hospital building programming process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Presentation of program goals	3.7105	1.05597	76	3
2	Contributions required	3.7200	1.07250	75	2
3	Identifying the specific design elements	3.6447	1.20779	76	5
4	Flows and circulations	3.8815	1.03237	76	1
5	Belief considerations	3.6315	1.01773	76	6
6	Hospital budgeting estimates	3.6800	0.96085	75	4
7	Hospital schedule estimates	3.4078	1.09760	76	8
8	Criteria selection for design teams	3.5131	1.20547	76	7
<i>Weighted mean</i>		3.6487	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.1418			

Item 1 (Presentation of program goals to present the wishes, expectations, aesthetics and therapeutic design factors supporting the physical and psychological health of patients within healing aspects of designs) has the third rank and a mean score of 3.710. Item 6 (Hospital budgeting estimations because the budget sources is not available in hand and it needs time to be approved through many administrative processes and procedures) has the fourth rank with a mean score of 3.680. Item 3 (Identifying the specific design elements to meet the beliefs, culture, history and traditional conditions in Saudi) has the fifth rank with a mean score of 3.644. Item 5 (Considerations required to present religious elements in design through specifying the spaces and tools to perform the worships) has the sixth rank and a mean score of 3.631. Item 8 (Criteria selection for design teams, construction and maintenance contractors to meet high level of experience, background, technical knowledge, financial position and reputation in designs and construction fields in in healthcare facilities design) has the seventh rank with a mean score of 3.513. Item 7 (Hospital schedule estimation leads to establishing and operating the hospital on specific time without full functions, due to excluding some work and equipment in diagnosis and treatment plans spaces) has the eighth rank and a mean score of 3.407

Similarly, Table 10.10 evaluates participants' opinions regarding flaws in the hospital building functional programming process. The weighted mean is 3.5700 and standard deviation, 0.0779.

Most of the participants agree on all eight items presented in the questionnaire. Item 6 (Future growth needs required to accommodate cases of new diseases and illnesses, staff increases, and new equipment, services, treatments and diagnoses plans, and technologies) ranks highest with mean score of 3.689. Item 5 (Circulation requirements to the link between clinical, treatment and diagnosis departments horizontally and vertically in short distance) ranks second with a mean score of 3.635. Item 1 (Supporting and main spaces required to provide adequate number of spaces for medical units, clinics, diagnostic testing and supporting spaces, such as janitorial, medication and clean and dirty utilities rooms) ranks third with a mean score of 3.621.

Table 10.10: Degree of agreement on flaws in the hospital building functional programming process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Supporting and main spaces required	3.621	1.2789	74	3
2	Activity assessment required	3.581	1.0727	74	4
3	Flexibility in the structural design	3.472	1.2300	74	7
4	Mechanical services spaces	3.472	1.1007	74	8
5	Circulation requirement	3.635	0.9872	74	2
6	Future growth needs	3.689	1.0718	74	1
7	Flow planning	3.567	1.0214	74	5
8	Space assignment	3.520	1.0049	75	6
<i>Weighted mean</i>		3.570	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.078			

Item 2 (Activity assessment required to identify infection controls, communications and critical systems and patients, visitors, users and medical staff volumes and activities within care spaces) ranks fourth rank with a mean score of 3.581. Item 7 (Flow planning required to consider the segregation, distribution, control and discharge of patients or users, equipment, supplies, medications, patient information and waste movements) ranks fifth with a mean score of 3.567. Item 8 (Space assignment required to deal sufficiently with illnesses, diseases, psychology case volumes in each region) ranks sixth rank with a mean score of 3.520. Item 3 (Flexibility in structural design to deal with internal and external expansions in future requirements or in construction, operations and occupancy stages, in case of scope services changes) ranks seventh with a mean score of 3.472. Item 4 (Mechanical services' spaces to easily move and access patient bed to/in elevators, avoid generator noise and increase critical systems capacities in the future) ranks eighth, with a mean score of 3.472.

Opinions of participants regarding flaws in the hospital building space programming process are reported in Table 10.11. The weighted mean of and standard deviation of all 10 forms of

flaws are 3.671 and 0.096, respectively. Item 5 (Waste management data types and amounts required to study and analyse the spaces dedicated to each of them, to plan their circulations, flows for disposal and storage and to limit infection sources from them, by minimising cross-points between them and other forms of circulation) ranks highest, with a mean of 3.80. Item 2 (Required types, number, measures of the equipment to provide adequate areas and suitable conditions of critical systems services (e.g. AC) to prevent their breakdown) ranks second, with a mean score of 3.763. Item 3 (Required volumes and types of staff working to provide adequate spaces and size for free movement and to avoid disruptions during the provision of care services) ranks third, with a mean score of 3.756. Item 4 (Capacity required for all critical systems (e.g. medical gas, ventilation and heating) in future extension to deal with new equipment, technology of diagnosis and treatment plans spaces) ranks fourth, with a mean score of 3.746. Item 9 (Hospital budget estimation to review and check within potential changes in identified scope of medical services in previous processes) ranks fifth, with a mean score of 3.684.

Table 10.11: Degree of agreement on flaws in space programming process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Types of patients served	3.552	1.0506	76	9
2	Required types, number, measures of equipment	3.763	1.0049	76	2
3	Required volumes and the types of staff	3.756	0.9765	74	3
4	Capacity required for all critical systems	3.746	1.0792	75	4
5	Waste management data types and amounts	3.800	1.0397	75	1
6	Interrelationships required amongst space locations	3.631	0.9776	76	7
7	Number and location of nurse stations	3.657	1.0399	76	6
8	Accessibility requirement	3.618	1.0828	76	8
9	Hospital budget estimation	3.684	0.8975	76	5
10	Hospital schedule estimation	3.506	0.9497	75	10
<i>Weighted mean</i>		3.672	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.097			

Item 7 (Number and location of nurse stations required to observe and serve specific number of patients directly) ranks sixth, with a mean score of 3.657. Item 6 (Interrelationships required between location of spaces and emergency exits to deal with patient evacuation) ranks seventh (mean score, 3.631). Item 8 (Accessibility requirement to provide adequate areas of spaces for comfort and ease of use to patients and users) has the eighth rank with a mean score of 3.618. Item 1 (Types of patients served, to determine the types of medical treatment plans, such as drugs, chemicals, radiation therapies and palliative cares) ranks ninth, with a mean score of 3.552. Item 10 (Architectural design issues, including unavailable, inadequate and inoperable required spaces) ranks tenth, with a mean score of 3.506.

10.8.2 DESIGN PROCESS (OUTPUTS) FLAWS

Table 10.12 reports on the causes of flaws during the schematic design process. The weighted mean of all causes of flaws is 3.336, with a standard deviation of 0.121. Mean scores show considerable agreement amongst all participants for all 11 items evaluated. Item 3 (Inadequate and unclear descriptions and justifications in the using and selecting of specific standards to address hospital spaces and size precisely on the hospital design plans or maps) ranks highest, with a mean score 3.473.

Table 10.12: Degree of agreement on the causes of flaws during the schematic design process

#	Statement	Mean	Standards deviation	Cases	Rank
<i>Lack of opportunities to avoid the design issues because of:</i>					
1	Sharing functional spaces accurately	3.355	1.1742	76	6
2	Limiting contributions and discussions	3.447	1.2044	76	3
3	Inadequate and unclear descriptions	3.473	1.1132	76	1
4	Showing accessibilities and circulations	3.328	1.1241	76	7
5	Presenting local customs and religion	3.407	1.0090	76	5
6	Showing future expansion planning	3.413	1.0792	75	4
7	Low quality of justification	3.473	1.1602	76	2
8	Extending design reviews to non-design parties	3.250	1.1210	76	9
9	Presenting evacuation planning	3.131	1.0996	76	11
10	Presenting components of patient environments	3.263	1.1120	76	8
11	Unclear justifications in selection of specifications	3.157	1.0961	76	10
<i>Weighted mean</i>		3.337	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.122			

Item 7 (Low quality of justifications presented for the selected material and systems specifications to meet patient health, safety and security standards) ranks second, with a mean score of 3.473. Item 2 (Extending contributions and discussions to interested participants outside the design team in the pre-processes of design stage to review previous inputs) ranks third, with a mean score of 3.44. Item 6 (Showing future expansion planning to deal with future growth in patients and, medical and non-medical care services with the conditions of selected sites) ranks fourth with a mean score of 3.413. Item 5 (Presenting local customs and religion as design elements on internal (walls) and external (elevations) designs to add or improve these elements) ranks fifth, with a mean score of 3.407.

Item 1 (Sharing relative sizes and adjacencies of functional spaces accurately, and presenting same for discussion, criticism and correction) is ranked sixth rank, with a mean score of 3.355. Item 4 (Showing flows, accessibilities and circulations for patients as well as patients' information and medical care service lines during planning, from one space to another on the designs, to realize cross-points amongst spaces, personnel and patients) ranks seventh, with a

mean score of 3.328. Item 10 (Presenting components of patient environments, which reflect the considerations of physical and psychological conditions of patients to know how much is evaluated) ranks eighth, with a mean score of 3.263. Item 8 (Extending opportunities to key stakeholders to partake in design review processes, to redefine functionalities, usability, adjacencies, security, safety and aesthetics requirements of design elements and plans before the final approval) ranks ninth, with a mean score of 3.250.

Item 11 (Unclear justifications in selection of specifications for some of the materials and systems used to avoid the manipulations by construction and maintenance contractors) has the tenth rank with a mean score of 3.157. Item 9 (Presenting the evacuation planning of patients from space to space or level to others for avoiding escape difficulties) has the eleventh rank with a mean score of 3.131.

Participants' opinions were evaluated on the flaws in the design development process. Table 10.13 indicates that the weighted mean of the design development processes flaws is 3.049 and the standard deviation is 0.061, which indicates a high degree of agreement on this finding.

Table 10.13: Degree of agreement on the flaws in the design development process

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in</i>					
1	Layout of the architectural designs	3.0132	1.3711	76	7
2	Layout of the equipment planning designs	2.9737	1.3562	76	9
3	Layout of the mechanical designs	3.0000	1.3565	76	8
4	Layout of the electrical designs	2.9605	1.3510	76	10
5	Layout of the plumbing designs	3.0526	1.3053	76	5
6	Layout of the construction designs	3.0526	1.2743	76	6
7	Layout of the civil designs	3.1351	1.2749	74	1
8	Layout of the safety designs	3.1184	1.3162	76	2
9	Layout of the security plans	3.0658	1.2684	76	4
10	Specifications writing in drawings and tables	3.1184	1.2855	76	3
		<i>Weighted mean</i>	3.0490	<i>Level of significance</i>	High
		<i>Standard deviation of the means</i>	0.0620		

Table 10.13 shows that there is a little difference between the means scores of agreements for the 10 items. This indicates that the most of participants agree on the flaws in the design development process. Item 7 (Layout of the civil designs to present some of the roadways, sidewalks, exterior lighting and utility grid and future infrastructure expansion grid) has the first rank with highest mean score (3.135). Item 8 (Layout of the life safety designs to present of occupancy loads areas, fire extinguishing locations, alarms and initiating devices and wall construction types and firefighting vehicles roads and evacuation planning) has second rank

with a mean score of 3.118. Item 10 (Specifications writing in drawings and Tables to be in an understood language, to select the materials criteria and to describe the spaces functions and using previous specifications of existing hospitals buildings) has the third rank with a mean score of 3.118. Item 9 (layout of the life security plans to present some access control points and surveillance systems zones) has the fourth rank with a mean score of (3.065). Item 5 (Layout of the plumbing designs to present some of size, types and locations of the medial gas and the waste systems drainage grids) has the fifth rank with a mean score of 3.0526. An item 6 (Layout of the construction designs to present some of the allowable load limitations details) has the sixth rank with a mean score of 3.05263. Item 1 (Layout of the architectural designs to present some measurements, dimensions, spaces names, finishes, furnishings, locations of some equipment and scale of drawings) has the seventh rank with a mean score of 3.0131. An item 3 (Layout of the mechanical designs to present the smoke, the heating, ventilating, air conditioning zones and the pressure type in the space, the movement and treatment of the internal and external air in the hospital buildings) has the eighth rank with a mean score of 3.00. Item 2 (Layout of the equipment planning designs to present some equipment installation requirements, such as outlets, mechanical and electrical works, water sources and disposal of radiation waste) has the ninth rank with a mean score of 2.973. An item 4 (Layout of the electrical designs to present some numbers and positions of lightings rods and dimensions of spaces between conductor cables (external protection) and the links between the equipotential bonding equipment and medical equipment and metallic parts on the plan) has the tenth rank with a mean score of 2.960.

10.9 SOURCES OF PROCESS FLAWS

Participants' opinions about the flaws in the administration of Saudi hospital designs were evaluated as sources of flaws in the design process. Table 10.14 indicates that the weighted mean of the administration flaws occurred is 3.636 and the standard deviation is 0.0859, which indicates a high degree of agreement.

Table 10. 14: Degree of agreement on the flaws in administration

#	Statements	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	The quality control programmes	3.6579	1.1611	76	4
2	Insufficient training	3.6316	1.1871	76	5
3	Experience and knowledge deficiency	3.5526	1.2795	76	11
4	Hiring unqualified designers and engineers	3.6216	1.2573	74	6
5	Education system deficiency of the design team	3.8056	1.1943	72	1
6	Low motivation and salary	3.7237	1.1843	76	3
7	Lack of experience	3.5921	1.2012	76	8
8	Timeframe of the design process	3.5200	1.1896	75	12
9	Unavailability of some engineering fields	3.7567	1.0956	74	2
10	Lack of communication	3.5921	1.1335	76	9
11	Lack of written official letters	3.6184	1.0828	76	7
12	Allowing interventions to modify the designs	3.5658	1.1235	76	10
<i>Weighted mean</i>		3.6365	<i>Level of significance</i>	High	
<i>Standard deviation of the means</i>		0.0859			

Table 10.14 shows that there is a little difference between the mean scores of agreements for the 12 items. This indicates that most of participants agree on the design issue presented. Item 5 (Education system deficiency of the design team where most of the participated designers in had not been assigned or given any chance to design one of the healthcare facilities during the university study journey in the KSA) has the first rank with the highest mean (3.805). Item 9 (Lack or unavailability of some engineering fields required in design stages, such as medical equipment engineers, architects medical planning and life safety and security systems designers) has second rank with a mean score of 3.756.

Item 6 (Low motivation and salary for design team (MOH) and delay in fees payments to consultant offices team) has the third rank with a mean score of 3.723. Item 1 (Quality control programmes to reduce or define the design processes flaws produced and the design issues and faults in the occupancy stage) has the fourth rank with a mean score of (3.657). Item 2 (Insufficient training for engineers and designers to deal with the healthcare facilities design requirements, standards, demands and the conditions of medical care services) has the fifth rank with a mean score of 3.631. An item 4 (Hiring unqualified designers and engineers in the hospital designs fields of critical systems) has the sixth rank with a mean score of 3.621. Item 11 (Lack of written official letters involving the changes in the hospital scope of medical care services and requirements, by managers or designers, to review and examine) has the seventh rank with a mean score of 3.618. An item 7 (Lack of experience in some of the responsible managers in some engineering fields in the design stages to review or define the design issues in the early stage of design) has the eighth rank with a mean score of 3.5921. Item 10 (Lack of communications between the different departments in hospital design stages and others,

especially between the study and design administration and the equipment and furniture administration, at MOH level and between engineering affairs in regions and general projects administration in the MOH) has the ninth rank with a mean score of 3.592. An item 12 (Allowing interventions to modify the designs by unspecialised and unqualified managers in the hospital design requirements processes) has the tenth rank with a mean score of 3.565. Item 3 (Experience and knowledge deficiency of designers and engineers in the designed hospital, building issues and requirements) has the eleventh rank with a mean score of 3.552. An item 8 (Some responsible parties not considering the timeframe of the design process in estimating the hospital schedule) has the twelfth rank with the lowest mean score of 3.520.

Participants' opinions were evaluated on flaws in the design team's abilities. Table 10.15 indicates that the weighted mean of the design team abilities flaws occurred is 3.2415 and the standard deviation is 0.0833.

Table 10.15: Degree of agreement on flaws in the design team's abilities

#	Statements:	Mean	Standards deviation	Cases	Rank
	<i>Issues in:</i>				
1	Collecting data and information	3.3553	1.0159	76	1
2	Design thinking strategies	3.2632	0.9573	76	5
3	Design knowledge	3.3467	1.0066	75	2
4	Design skills	3.1974	1.0586	76	9
5	Confidence in their abilities	3.1579	0.9805	76	10
6	Selfishness	3.2933	1.1123	75	3
7	Weakness of the personality	3.2500	1.0083	76	6
8	Time management	3.2800	1.0209	75	4
9	Limited abilities to convey ideas in designs	3.0658	1.0111	76	11
10	Design process method	3.2105	0.9283	76	8
11	Inviting interested participants	3.2368	1.0049	76	7
	<i>Weighted mean</i>	3.2415	<i>Level of significance</i>	High	
	<i>Standard deviation of the means</i>	0.0834			

There is a little difference between the means scores of agreement levels for the 11 items, indicating that most of the participants agree on the issues of the design team's abilities. Item 1 (Collecting data and information required for solving design issue strategies, to define design issues sources in the occupancy stage, to analyses issues and create multiple solutions by testing them) has the first rank with the highest mean (3.355).

Item 3 (Design knowledge due to lack of communications and feedback with patients and users to realise the needs and the requirements for selecting the best solutions) has second rank with a mean score of 3.346.

Item 6 (Selfishness in sharing information and data about the design of hospitals with new engineers and architects by some expert engineers) has the third rank with a mean score of 3.293. Item 8 (Time management lead to expose designers to stress causing less pay attention to details in solving the design issues during the design process) has the fourth rank with a mean score of (3.280).

Item 2 (Design thinking strategies include insufficient use of mental images, evaluation, group discussions and strategies to solve design issues) has the fifth rank with a mean score of 3.263. An item 7 (Weakness of the personality of some engineers in the discussion and the defence for their design solutions provided to avoid the interventions from persons with high authority, but with low qualifications in the design components of hospital design) has the sixth rank with a mean score of 3.250. Item 11 (Recognising the importance of inviting the interested participants from local community and hospital users to contribute in solving the design issues) has the seventh rank with a mean score of 3.236. An item 10 (Lack of experience in some of the responsible managers in some engineering fields in the design stages to review or define the design issues in the early stage of design) has the eighth rank with a mean score of 3.210. Item 4 (Design skills in the ability to use some software, insufficient communication with other members, inability to imagine the solutions with reactions, opinions and senses of patients in space) has the ninth rank with a mean score of 3.197. Item 5 (Some designers do not have enough confidence in their abilities to design the hospital buildings by themselves; because of the fear of punishment for making mistakes, they depend on data from existing projects or random examples from websites) has the tenth rank with a mean score of 3.157. Item 9 (limited abilities to convey and present the feelings, ideas and desires of patients' sensory systems to design elements in space graphically and imaginably) has the eleventh rank with a mean score of 3.065.

10.10 PATIENT SENSORY SYSTEMS AND HEALING DESIGN ASPECTS

Participants' opinions were evaluated on the five senses of patients that should be considered. Table 10.16 indicates that the weighted mean is 3.999 and the standard deviation is 0.1855.

Table 10. 16: Degree of agreement on reactions of patients' senses to space design elements

#	Statements	Mean	Standards deviation	Cases	Rank
1	Sight	4.1578	0.8493	76	2
2	Hearing	4.1710	0.9001	76	1
3	Smell	4.0657	0.9428	76	3
4	Touch	3.8133	1.1705	75	4
5	Taste	3.7894	1.1698	76	5
		<i>Weighted mean</i>	<i>Level of significance</i>	High	
		<i>Standard deviation of the means</i>	0.1855		

Table 10.16 shows that there is a little difference between the means scores of agreement for the five items. This indicates that the most of participants agree on the senses that could be affected. Item 2 refers to hearing sense of patients as they observed uncomfortable sounds and voices from designed spaces. Stressful elements and components that affected the healing process including hearing noise of traffic, generators, air conditioning units from external spaces, as well as hearing equipment alarms and peeps and emergency calls sounds (blue code). This has the highest rank with a mean score of 4.17.

Item 1 refers to patients' sense of sight such as seeing images of disease symptoms (e.g. images of cancer of the throat), signages with warning phrases (e.g. danger; do not getting close, forbidden to approach or touch) or the scary names of some departments (e.g., departments of morgue, recuperation and laundry for washing the dead). This was ranked second, with a mean score of 4.16.

Item 3 refers to patients' sense of smell. Participants have reported uncomfortable scents around them in the hospital and this had caused them stress, and had affected their healing process. Examples of such smell that originated from the hospital's internal system include smell from detergents, sterilizers, blood, antiseptic and medicines. Smell from external areas include vehicles' exhausts, treatment plants and waste storage rooms smell. This is ranked third with a mean score of 4.07.

Item 4 refers to patients' sense of touch. Participants have reported this as uncomfortable surfaces such as sharp and rough surfaces or texture of furniture, equipment and on the walls. This is ranted fourth with a mean score of 3.81.

Item 5 refers to patients' sense of taste, leading to their loss of appetite and how this had affected their healing process. Example of these include items that irritate patients, such as seeing horror images around them or imagining surgical procedures, blood-sucking organisms, side-effects of disease and smelling bad things directly (e.g., smells of detergents, sterilizers, blood, treatment plants and waste storage rooms). This is ranked fifth, with a mean score of 3.79.

10.11 HEALING ASPECTS OF DESIGN

Participants' opinions were evaluated on aspects of design that support healing. Table 1017 indicates that the weighted mean is 3.9144 and the standard deviation is 0.09831.

Table 10.17: Degree of agreement on the healing aspects of design

#	Statement	Mean	Standards deviation	Cases	Rank
<i>Issues in:</i>					
1	Spatial design	4.0263	0.9377	76	1
2	Luminal design	3.9737	0.8481	76	5
3	Thermal design	3.9868	0.9451	76	3
4	Audio design	3.9868	0.8405	76	4
5	Social design	3.8816	0.9929	76	6
6	Spiritual design	3.8684	0.9429	76	8
7	Aesthetic design	4.0000	0.7659	76	2
8	Technology design	3.8816	0.9517	76	7
9	Safety design	3.8290	0.9576	76	9
10	Security design	3.7105	0.9496	76	10
		<i>Weighted mean</i>	3.9145	<i>Level of significance</i>	High
		<i>Standard deviation of the means</i>	0.0983		

Table 10.17 shows that there is a little difference between the means scores of agreement levels for the 10 items. This indicates that the most of participants agree on the aspects of healing design elements and components. Item 1 (Spatial design is to address patient body size, space functions, space components, space height, space access, space shape, space number, space relations and space colours) has the first rank with highest mean score (4.026). Item 7 (Aesthetic in design is to increase the level of excitement in space for a patient and prevent the feelings of time passing slowly and concentration on a sense of pain by using attractive decorations, inscriptions, pictures, drawings and painting colours, Arabic fonts for some Quranic verses and Hadiths) has second rank with a mean score of 4.00. Item 3 (Thermal in design is to reach a high level of comfort for patient body temperature by providing a natural or mechanical ventilation, allowing the sunlight to access patient space and easily control the air movement and temperature in the space) has the third rank with a mean score of 3.986. Item 4 (Audio in design is to transport patients to interesting places and a time that brings the feelings

of calm and happiness by providing convenient sounds and voice sources in the patient space) has the fourth rank with a mean score of (3.986).

Item 2 (Luminous in design is to provide the sense of consistency to eyes and skin of patient by providing the appropriate colour, strength, distribution, temperature and distance of lighting and allowing natural lighting access to patient space) has the fifth rank with a mean score of 3.973. An item 5 (Social in design is to give patients the feeling of consideration, importance and pertinence or belonging by providing social interaction spaces for his family, friends and special places for parents near their child in intensive care units and spaces or tools to access to shopping and coffee stores) has the sixth rank with a mean score of 3.881. Item 8 (Technology in design is to reach the highest level of the patient freedom and to control the space components by providing freedom of positions to opening the curtains, windows and controlling the lighting) has the seventh rank with a mean score of 3.881. An item 6 (Spiritual in design is to create a spiritual space to reflect faith, culture, history, customs and traditions and to reach the highest level of tranquillity by using symbols, commodities, art, pictures and images and providing space and tools to do ablution and pray, respecting the direction of the Qibla and to facilitate the movement of the bed to the Qibla) has the eighth rank with a mean score of 3.868. Item 9 (Safety in design is to give patients a sense of safety in the absence or impossibility for any adverse incident occurrence by providing all the safety tools, equipment and evacuation requirements and plans necessary) has the ninth rank with a mean score of 3.828. An item 10 (Security in design is to provide a sense of security to patients in applying all security sectors designs to protect patient from theft, infringement and harm and to reduce the fear of bad things or potential crimes) has the tenth rank with a mean score of 3.710.

10.12 CRONBACH'S ALPHA RELIABILITY ESTIMATE

Table 10.18 shows the Cronbach's Alpha's reliability estimate for all items exceeds 0.88 (see Sections: 13.6.4-5 in Appendix E). The calculated values of Cronbach's alpha for all research areas (see appendix D: Part D), which are more than 0.88%. These high values of Cronbach's alpha indicate excellent internal consistency of the items in used scale. In other words, more than 90 % of variance in the scores is a reliable variance, therefore, less than 10 % is errors variance. However, it is noted for Area C (C2.2: Phase 2: Design development processes flaws) that alpha is more than .80 %, but it can be considered as a good reasonable target (George and Mallery 2016).

Table 10.18: Cronbach's alpha for all research area

Research area	Part	Sum of item variances	Variance of total scores	Cronbach's Alpha Reliability Estimate	No. of items
Design issues nature in occupancy stage	Research concepts definitions	1055.5	4952.0	0.9442	6
	Design issues Impacts in occupancy stage	1009.8	3965.8	0.9317	5
Design fields types	Design fields types issues in occupancy stage	1875.2	17327.8	0.9729	12
Flaws from the predesign Stage:					
Design process (Input) flaws	The preparing identification processes flaws	836.4	4841.2	0.9454	8
	Flaws in projects brief processes	701.9	4162.6	0.9502	8
	Flaws in feasibility study processes	723.6	3906.2	0.9312	8
	Flaws in hospital building programming processes	763.7	4155.0	0.9328	8
	Flaws in hospital building functional programming processes	674.4	3780.6	0.9390	8
	Flaws in hospital building space programming processes	1129.9	7894.0	0.9521	10
Design process (Output) flaws	Flaws in schematic design processes	771.5	5690.8	0.9509	11
	Flaws in design development processes	250.5	1220.2	0.8830	10
Sources of Process Flaws	Administration flaws	919.3	7439.4	0.9561	12
	Design team's skill issues	1806.1	15201.0	0.9693	11
Patient sensory systems and Healing aspects of design	Sensory systems' reactions	919.3	3538.2	0.9252	5
	Healing aspects of design	1743	13006.8	0.9622	10

10.13 RESEARCH HYPOTHESES TESTING

Null Hypothesis [Ho]: There is no a significant relationship between design and maintenance decisions in the research observation areas.

A significant relationship exists across the design and maintenance teams on all the items. Spearman’s rank correlation coefficient (Rs) was calculated for all evaluation at $\alpha = 0.05$ (see Part E of Appendix D). The association does not imply causation. Rs values ranged from -1 to +1. If $R_s > 0$ or < 0 , the null hypothesis in each area that $p = 0$ will be rejected, suggesting correlation exists between the two groups. Correlation in the agreement level in the variables was calculated by using the criteria shown in Table 10.19.

Table 10. 19: Criteria for interpreting correlation results

Rs Value	Description of correlation	Level of confidence	Level of significance
Rs = 0	no correlation	0%	$\alpha = 0.05$
0.10 – 0.19	very weak	10% - 19%	$\alpha = 0.00250$
0.20 – 0.39	weak	20% - 39%	
0.40 – 0.59	moderate	40% - 59%	
0.60 – 0.79	strong	60% - 79%	
0.80 – 0.99	very strong	80% - 99%	
Rs = 1.00	perfect	100%	

Table 10.20 shows the number of observations, Rs, t-statistics, p-value and correlation levels of the variables which were used to test the hypotheses and decide whether to reject or accept it.

Table 10.20: Outcomes of rank correlation analysis

Areas covered in the questionnaire	n	Rs	t-stat	p-value	Correlation
Design issues’ sources	6	0.714	2.916	0.043	Strong
Design issues’ impact in occupancy stage	5	0.600	1.875	0.134	Strong
Design field types’ issues in occupancy stage	12	-0.224	-0.744	0.473	Weak
Flaws in preparing identification processes	8	0.429	1.286	0.245	Moderate
Flaws in projects brief processes	8	-0.524	-1.768	0.127	Moderate
Flaws in feasibility study processes	8	0.500	1.633	0.153	Moderate
Flaws in hospital programming processes	8	-0.048	-0.116	0.910	Very weak
Flaws in hospital functional programming processes	8	0.071	0.175	0.866	Very weak
Flaws in building space programming processes	10	-0.218	-0.648	0.535	Very weak
Flaws in schematic design processes	11	0.555	2.402	0.039	Moderate
Flaws in design development processes	10	-0.200	-0.589	0.572	Very weak
Administration flaws	12	0.042	0.1329	0.896	Very weak
Design team’s skill issues	11	0.673	3.686	0.005	Strong
Sensory systems’ reactions	5	0.800	3.849	0.031	Very strong
Healing Aspects of designs	10	-0.273	-0.833	0.428	Very weak
All variables	132	0.753	10.071	0.0001	Strong

The results indicate that the fifteen research areas had correlation levels ranging from very weak to very strong. show causes of design issues have suggest strong correlation (Rs = 0.714,

$p = 0.043$). As a result, the alternative hypothesis is accepted. Similarly, results also show a strong correlation on the relationship between design issues and their impact during occupancy ($R_s = 0.600$, $p = 0.134$). Some variables have moderate correlations: Flaws in preparing needs identification processes ($R_s = 0.429$, $p = 0.2458$); Flaws in project briefing processes ($R_s = -0.524$, $p = 0.1274$) and; Flaws in feasibility study processes ($R_s = 0.500$, $p = 0.1536$). Those with weak correlations include: Flaws in hospital programming processes ($R_s = -0.048$, $p = 0.9107$); Flaws in functional programming processes ($R_s = 0.071$, $p = 0.8662$) and; Flaws in space programming processes ($R_s = -0.218$, $p = 0.5352$).

In addition, and in relation to flaws in outputs of design processes, Flaws in the development of schematic design processes indicate a moderate correlation ($R_s = 0.555$, $p = 0.0397$). However, Flaws in design development processes shows a weak correlation ($R_s = -0.200$, $p = 0.5720$). In relation to sources of Flaws in design processes, Flaws in administrative processes is weak ($R_s = 0.042$, $p = 0.8969$). However, Flaws resulting from design teams' limitation is strong ($R_s = 0.673$, $p = 0.005$). Results under reactions sensory systems indicate strong correlation ($R_s = 0.800$, $p = 0.0310$), whilst Healing aspects of design aspects is weak ($R_s = -0.200$, $p = 0.5720$).

The null hypothesis in each aspect of the evaluation assumes $p = 0$. Results of all evaluations combined suggest a strong correlation ($R_s = 0.7535$, $p = 0.0001$), as can be observed in Figure 10.7 which illustrates the strong correlation in all areas of the evaluations, both in the built environment and healthcare domains. As correlation is significantly different from 0 in all cases, the null hypothesis is rejected.

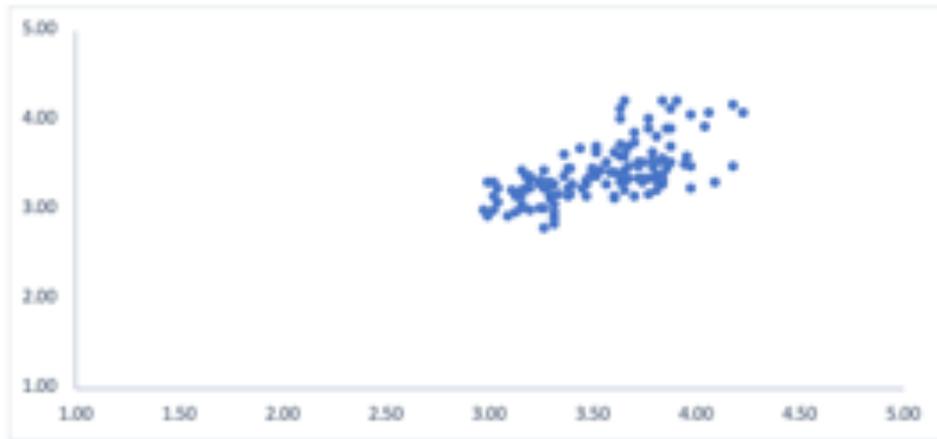


Figure 10.7: Correlation levels of means of participants' agreement in all research areas

Figure 10.7 represents the differences in the Spearman's rank correlation coefficient for each area, which indicates the very strong correlation (0.80 - 0.99) in Area 14 (Patients' sensory systems' reactions to the designed care environment). Area 1 (Issues in design concepts), Area 2 (Impact of Design issues in occupancy stage) and Area 13 (Flaws caused by design team's limitations) have strong correlation (0.60 - 0.79). Moderate correlations are presents in Area 4 (Flaws in preparing need identification processes), Area 5 (Flaws in project briefing processes), Area 6 (Flaws in feasibility study processes) and Area 10 (Flaws in the development of schematic design processes). Weak association exists in Areas 3 (Types of design field issues in occupancy stage), Area 9 (Flaws in building space programming processes), Area 11 (Flaws in design development processes) and Area 15 (Healing aspects of design). A very weak relationship appears in Area 7 (Flaws in hospital programming processes), Area 8 (Flaws in hospital functional programming processes) and Area 12 (Flaws in administrative processes). Overall, Patients' sensory systems' reactions to the designed care environment has the highest correlation, whilst Flaws in administrative processes leading to issues in design processes has the lowest level of correlation.

A final hypothesis was also tested, which states: There is no statistically significant difference between design (x) and maintenance (y) team's agreement on the research findings of 15 areas.

Hypothesis 1 [H1]: The mean of maintenance team's agreement is the same as mean of design team's agreement in the research observation areas.

Statistical question: What is the difference in the opinions of participants from maintenance and design teams?

Table 10.21 presents the hypothesis conditions, inputs and outputs of Z-Test used for evaluating the significance in the difference between the mean scores of maintenance and design teams' opinions regarding design issues circumstances in context of Saudi hospital designs.

Table 10.21: inputs and outputs to test hypothesis with inferential statistics

Test statistics	Hypothesis conditions	Sample 1	Sample 2
$z = \frac{(X_1 - X_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$	The standard deviation is known The mean is known Independent samples The number of both samples >30	0.298261 $X_1 = 3.55$ Maintenance team $n = 44$	0.309551 $X_2 = 3.39$ Design team $n = 32$
Z score	$(X_1 - X_2)$	3.35	
p-value	Significant level (α)	0.005/+1.96	

As p-values = 0.001, the H_0 is rejected because there is enough evidence to support the alternative claim that the mean of both teams is different. The mean of the opinions of participants from the maintenance team is slightly higher than that of design teams. This was not expected because both teams deal with hospital building environment. A potential explanation is that members of the maintenance team deal with design issues directly whilst the role of the design team is limited to the design stage only. The difference between the means of both teams is low as shown in Figures 10.8. Most importantly, Table 10.21 indicates the level of agreement on the findings ranging from moderate ($X_1=3.39$) to high ($X_2=3.55$).

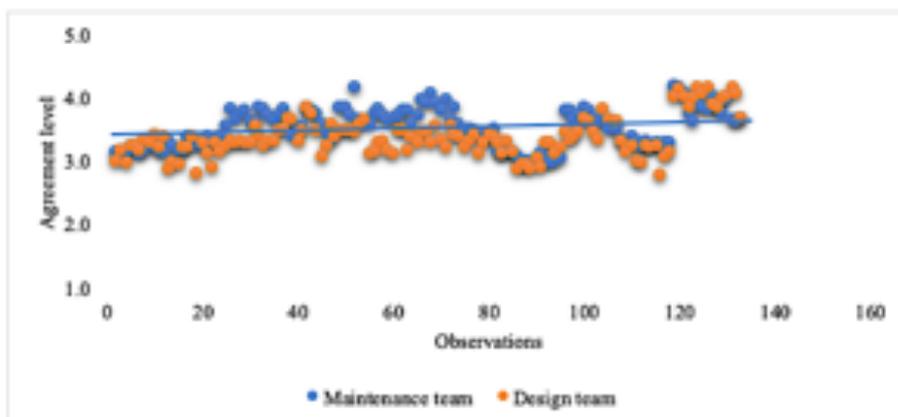


Figure 10.8: The difference between means of design and maintenance teams

10.14 SUMMARY OF QUANTITATIVE ANALYSIS

This chapter presents the background of participants in terms of their roles in the lifecycle stages of hospital development, their experience, education, professional fields and their level of knowledge in hospital components, locations and operations. After descriptive statistical analysis, opinions of participants from design and maintenance teams were presented in two stages. First, the operation stage: circumstances of design issues include causes, impact and types of design issues and reactions of patients' sensory systems towards the designed care environment. Second, the predesign stage which includes phases such as preparing need identification, project briefing, feasibility study, hospital building programming, hospital building functional programming and hospital building space programming processes. The design stage was analysed also, including flaws in the development of schematic design processes, design development, administrative issues, design teams' skill issues and healing aspects of design. These 15 areas were analysed to measure the difference between the lowest and highest variables values and define the impact of design issues and AIs on patient health in the occupancy stage, and the relationships between the findings in each research area to clarify the most important factors affecting patient recovery process. Finally, two research hypotheses were tested and reported. Descriptive and inferential analyses were used to achieve the objectives of set out for the chapter. In particular, the views of the 76 participants in the questionnaire survey was used to validate the findings of the previous stages of the data collection (interviews, case studies and participant observations) which had suggested some causal relationships between design issues and AIs in hospitals' occupancy stage. Findings from this chapter shows a conclusive confirmation of the relationships.

11.0 IMPLICATIONS OF FINDINGS

11.1 INTRODUCTION

This chapter discusses key findings from this study by drawing strength from existing literature to see where the findings sit in scholarly discussions in the broad areas of construction, architecture and healthcare management. First, the chapter discusses the findings in line with the stated research objectives and hypotheses, as shown in Figure 11.1.

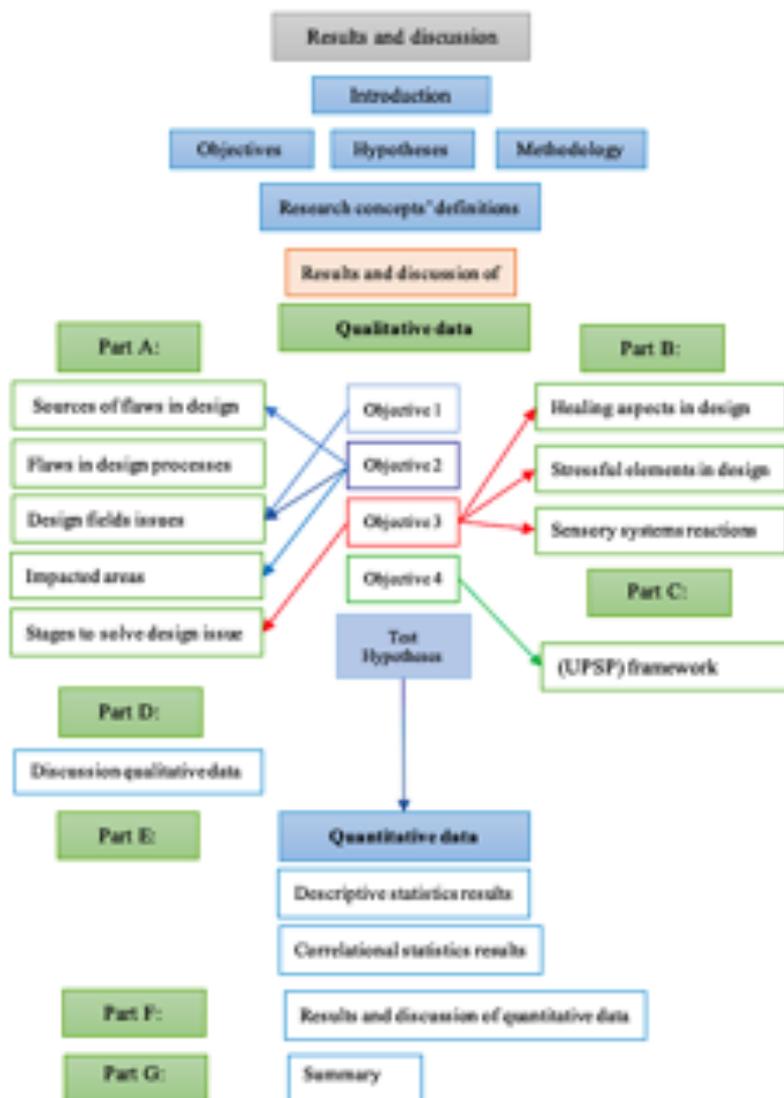


Figure 11.1: Conceptual map of Chapter 11 - key findings of the study

In *Objective 1* of the research, the study sought to analyse current design processes of public hospitals in the KSA and identify design issues that manifest in them during the operation stage. *Objective 2* sought to identify the effects of design issues on patient health and safety and identify the roles of the parties responsible for preventing design issues during the design process. *Objective 3* sought to analyse the supportive features and stressful elements that impact patient recovery and identify their direct and indirect effects on patients' physical and psychological health, and finally; *Objective 4* sought to develop a framework towards hospital design in public hospitals in the KSA so that patient recovery is fostered.

The research hypotheses sought to determine the relationship between design and maintenance decisions in the areas observed for the research, as to whether the opinions of participants from the design and the maintenance teams are the same regarding the effects of design processes and the manifestation of design issues during hospital facilities' operations.

For this study, data were gathered from five groups of participants in two categories:

- Participants who have had direct roles in patient care environment in relation to the four main phases of hospital operations e.g. post-treatment patients, healthcare providers, medical managers and technicians, and
- Participants who have had indirect connections with patients' care processes in hospital operations e.g. the design and maintenance teams.

Participants and their opinions varied according to their physical location, employment positions and job responsibilities. More importantly, an overarching finding from this research is that improving hospital design processes will lead to commensurate improvement in protecting, supporting patient recovery and providing a complete care service in the context of Saudi general hospital designs. The findings are the result of using seven methods of data collection in three stages in eight case studies at four cities located in three regions of KSA (Section 3.10). Evidence from this data collection was to establish the relationship between flaws in the design process and their impact on patient recovery from the points of view of different types of participants in the main areas of investigation. These include patients' recovery and their immune systems and design issues related to adverse incidents (DIAs) and their impact on patient recovery and care services. Specific keywords in these include faults, defects, issues and flaws in design processes, involving designers, maintenance teams and

design managers, patients' reactions to design issues and healing aspects of design. Data, analyses and findings on these have been reported in Chapters 4 to 10.

11.2 REVISED DEFINITIONS OF RESEARCH CONCEPTS

To better understand and communicate the current findings of this study and to avoid confusions, specific concepts in both the built environment and the healthcare domains have been revised in line with the research findings.

11.2.1 BUILT-ENVIRONMENT DOMAIN

From participant observations and interviews with medical managers, design issues (DIs) can be divided into two types: design defects (DDs) and design faults (DFs). These design issues were produced by flaws in the design stage and have an impact on patient recovery and the care service provided to patients by hospitals (Section 13.2.9, Appendix B).

Design defects (DDs) are defects in designs causing an inability to provide complete diagnosis, treatment and supporting services for patients and deal with common and exceptional health problems, and causing design defect-related adverse incidents (DDAIs). Design faults (DFs) are the inability of design solutions to provide the diagnosis or treatment services for patients and cases with specific diseases and illnesses owing to flaws in the design process.

Several previous scholarly classifications of design defects did not consider the context of hospital design. For example, Georgiou (2010) defines defects generally as “a component having a shortcoming and no longer fulfils its intended function” (p. 371), and Low and Wee (2001) described them as “a failure or shortcoming in the function, performance, statutory or user requirements of the structure, fabric, services or other facilities” (p. 368). Neither author mentions design defects in relation to source and specificity of project environment. Patent and latent defects are two types of defects classified in terms of the timing of their occurrence during the inspection and operation stages without elaborating their sources and impact (Low and Wee 2001, Rhodes and Smallwood 2002, Isa et al. 2011, Ismail et al. 2011). However, Low and Chong (2004) support the classification of the types of design issues in this study as caused by shortcomings in the design stage process of facilities where the DDs and DFs are considered the result of flaws in the design process. These definitions introduce another

concept, namely the design process flaws, as faults in the design process that produce DDs and DFs in the operation stage and arise from issues in the design team's skills, knowledge and thinking strategies. Such flaws also result from a lack of information to support requests made to designers and issues in the abilities of the design management team. These issues are classified as sources of process flaws (SOPF).

11.2.2 HEALTHCARE DOMAIN

Findings of Stages 1, 2 and 3 provide support for additional types of AIs, their impact and consequences that are related to hospital design issues within patient recovery and care services. As discussed in Section 2.4, AIs in the healthcare domain are defined as incidents in which harm befalls a patient's recovery plan during the provision of healthcare (AIHW 2015). AIs may involve infection, patient falls resulting in injury or problems with medication and medical-device errors (AIHW 2015). AIs may impact patients physically, psychologically and financially as a result of pain, stress and prolonged stays in hospitals (Adams et al. 2009). AIs occurring in hospitals can be viewed from five different angles: medical (Esmail 2005), sociological (McDonald et al. 2000), psychological (Parker and Lawton 2006), management problems (Moullin 2002) and hospital design issues (Brady et al. 2009). In this study, DIAIs originate from DDs and DFs in different design fields (e.g. Architectural, mechanical and civil design fields) in the operation stage of the hospital and include 16 types (Figure 11.11). They have both physical and psychological impacts on patient recovery and healthcare service provision; thus, they represent design issues related to AIs in the context of Saudi hospital design issues.

11.3 PART A: MANAGING PAIN AND STRESS FROM DIAIS

In order to achieve Research Objectives 1, 2 and 3, this section presents the key findings of the data analyses through four mechanisms: (1) sources of flaws in design stages and the flaws in the predesign and design phases, (2) flaws in design processes and design issues, (3) areas impacted by design faults and defects, and (4) design processes to resolve current design issues as the research problem. These mechanisms are presented as ways to manage pain and stress as results design issues and DIAIs. Based on previous data analysis findings, Figure 11.2 shows the three mechanisms were identified: the sources of design process flaws (inputs of design

teams) and the flaws in the outputs of design stages, flaws in design stages with design issues and design issues with the impacted areas.

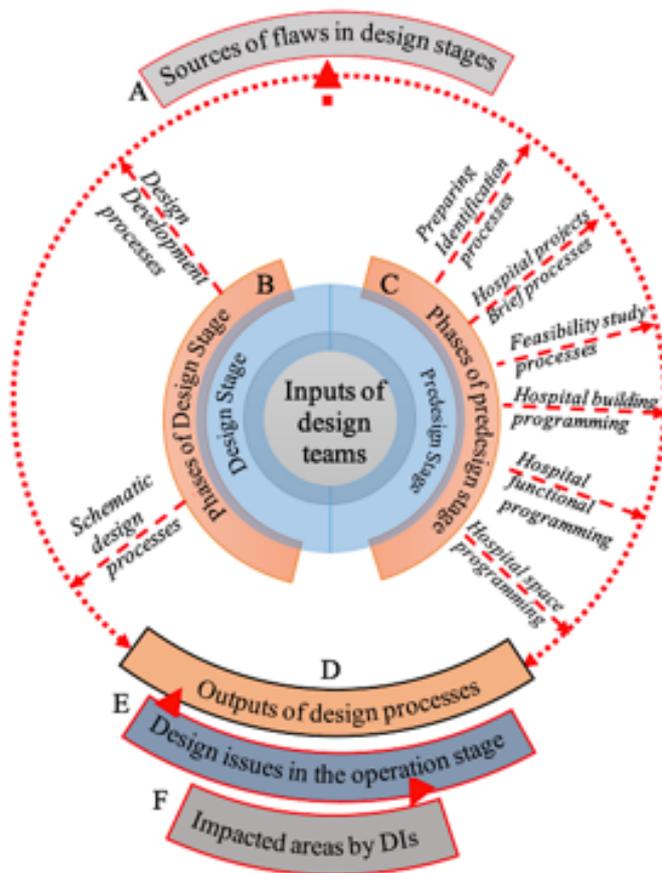


Figure 11.2: Conceptual framework - The links between design inputs and outputs

The fourth mechanism presents process to resolve the current design issues in two stages: the pre-design stage, which includes preparing identification, hospital projects brief, feasibility study, hospital building programming, hospital functional programming and hospital space programming phases; and design stage, which has two phases: schematic design phases and detail design development.

In addition, Figure 11.2 demonstrates how flaws in the pre-design and design phases can be traced back to the source of the flaws in the design process. Evidence presented in this study demonstrates that the majority of design issues that occurred in the operation stage arose from flaws in the outputs of the design process. Three areas impacted by those design issues are patient health, safety and care service.

11.3.1 SOURCES OF FLAWS IN THE DESIGN PROCESS

This study identified sources of flaws in design processes as though they relate to *role issues* of responsible parties (administrative flaws) in managing the design team, *issues* in design thinking, issues in the *abilities* of the *design team*, and *limitations* in the data and information required for medical planning and hospital designing (Figure 11.3).

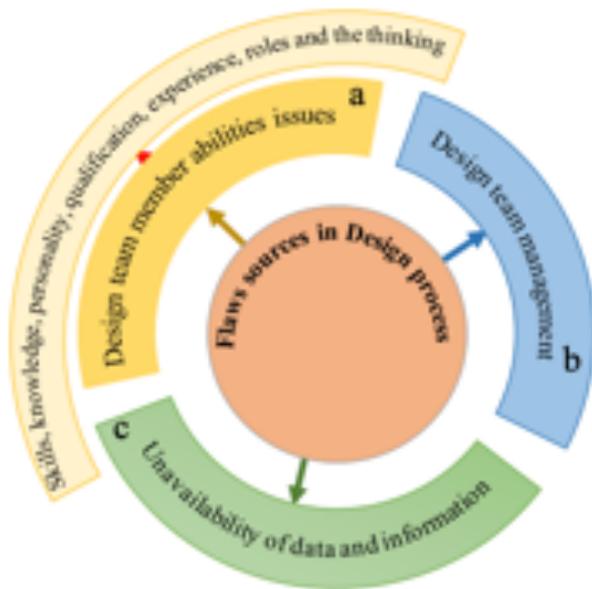


Figure 11.3: Conceptual framework - Sources of design process flaws

As shown in Figure 11.4 illustrates dotted arrows pointing back from flaws in design processes to three main sources of design process flaws. majority of flaws in the design process are related to administrative flaws.

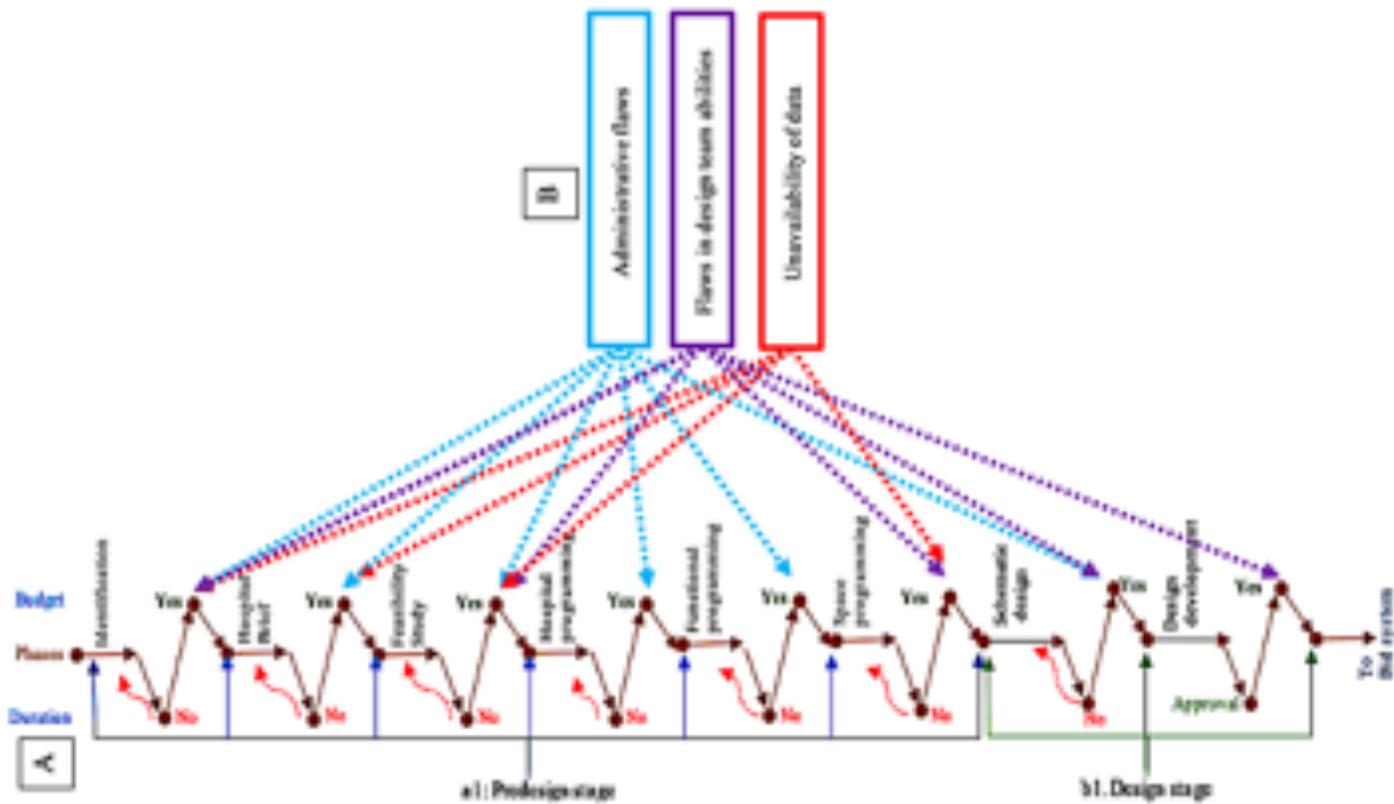


Figure 11.4: The links between sources of flaws in the design process and outputs of the design stage phases

11.3.2 ADMINISTRATIVE FLAWS

This study found the following administrative flaws in design teams in the SMOH and regional management that lead to flaws in the design process:

- Ineffective quality control programmes to define and reduce design processes flaws and design issues and faults at the operation stage.
- Insufficient training for engineers and designers to deal with healthcare facilities' design requirements, standards, demands and conditions of medical-care services.
- Experience and knowledge deficiencies of designers and engineers concerning the designed hospital, building issues and requirements.
- Hiring unqualified designers and engineers for the design of critical systems.
- Education system deficiency in the design team, where most of designers had not been given the chance to design healthcare facilities during university study.
- Low motivation and poor salary for design team members and delays in fee payments to the consultant team.
- Lack of experience in some managers in some engineering fields at the design stages responsible for reviewing and defining design issues at the early design stage.
- Some responsible parties not considering the timeframe of the design process when estimating the hospital schedule.
- Lack of some engineering specialties required at the design stages such as medical equipment engineers, architects, medical planners and life safety and security systems designers.
- Lack of communication between departments at hospital design stages, especially between the study, design, equipment and furniture administrations at the MOH level and between engineering affairs in regions and general projects administration in the MOH.
- Lack of official letters concerning changes in the hospital's scope of medical care services and requirements by managers or designers.
- Allowing interventions to modify the designs by unspecialised and unqualified managers in the hospital design requirements processes.

11.3.3 ISSUES IN DESIGNERS' THINKING DURING THE DESIGN PROCESS

These issues were assessed in terms of the selection of design methods, thinking strategies and hospital design principles. This study found differences in the opinions of participants about which method was the most effective (Figure 11.5).

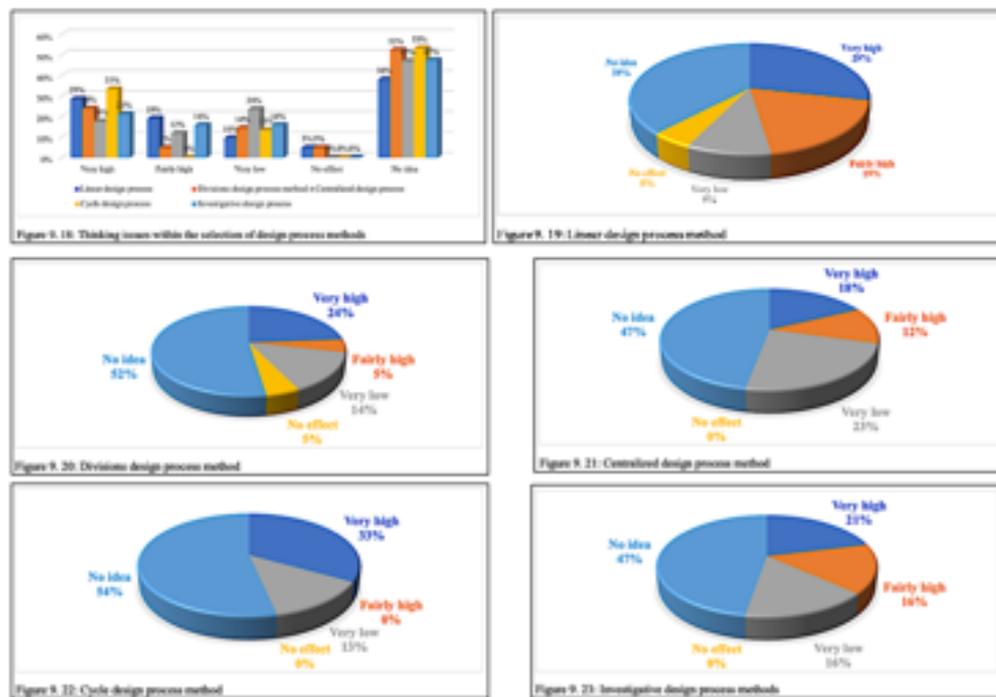


Figure 11.5: Methods of design process

Most participants selected *linear design process* as the best method to deal with design issues followed by *divisions design process*. On other hand, the *investigative design process* method was considered to have the lowest level of effectiveness. From these results, there are two issues involved in selecting the best way to solve a design problem or to create a new design: (1) accepted design solution does not depend on inputs from stakeholders; thus, design outcomes seldom emerge from collaborative effort (2) a lack of options to solve design issues without focusing at preparing the programming stage.

Regarding the most effective thinking process (Figure 11.6), most participants rated *group discussion* as the best strategy to achieve the most valuable solution to deal with a design issue. This is followed by the *design standards* and *visual thinking* strategies. From these results, the only strategy to avoid flaws in the design process was to have conversations with other designers, experts or interested parties in order to implement the most valid solution.

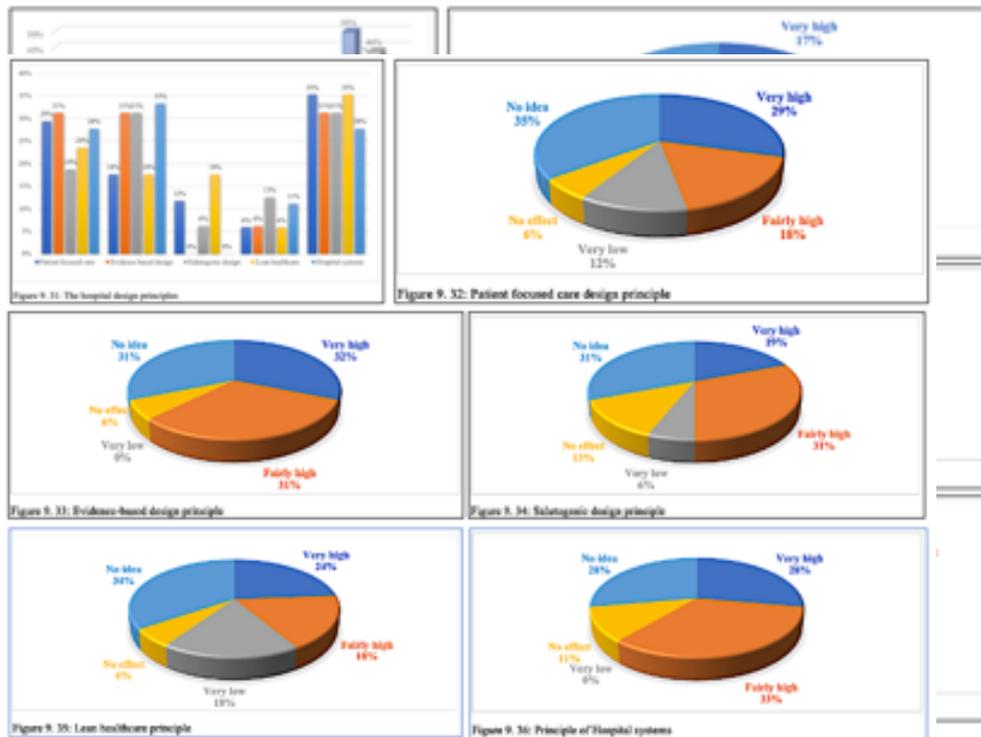


Figure 11.7: Hospital design principles

With regard to the most effective focus when designing a healthy space (Figure 11.7), most participants strongly believed that *patient-focused care in design thinking* was the best principle followed by *evidence-based design* and *salutogenic hospital design*. From these results, this study found two issues affecting the selection of design principles: (1) a lack of concern for lowering healthcare costs by reducing waste and patient wait-time, and improving patient safety and (2) a lack of concern for creating an environment appropriate for the delivery of care services.

11.3.4 ABILITIES OF THE DESIGN TEAM

Flaws in design team abilities that led to design processes flaws at the design stage were identified as follows:

- Difficulty collecting the required data and information, defining design issues sources at the operation stage, analysing issues and creating multiple solutions by testing them.
- Design thinking strategies issues that include insufficient use of mental images (imagination), evaluation, group discussions and strategies to solve design issues.
- Insufficient design knowledge due to the lack of communication with and feedback from patients and users in order to understand the needs of and the requirements for selecting the best solutions.
- Insufficient skills in the use of some software, insufficient communication with other design team members, inability to imagine solutions with reactions, opinions or a sense of patients in space.
- Some designers did not have enough confidence in their abilities to design the hospital buildings by themselves. Because of a fear of making mistakes, they depended on copying existing projects or examples from websites.
- Selfishness by some expert engineers in sharing information about the design of hospitals with new engineers and architects.
- Rather than provide solutions that work, designers often try to avoid interventions from authorities by simply agreeing to whatever they have been told.
- Designers' poor time management resulting in stress, causing them to pay less attention to details in solving design issues.
- Limited abilities to convey the feelings, ideas and desires of patients' sensory systems to design elements graphically in space.
- Design process methods used that depend on available programming process data, not on the investigation method that would provide a fuller understanding of the design issues.

Lack of recognition of the importance of inviting interested participants from the local community and hospital users to contribute to solving design issues.

11.3.5 LACK OF DATA

The lack or unavailability of data and information was found to be the second factor that led to flaws in design processes. Limitations in 11 types of data required for medical planning and the design of hospitals were identified:

- Measuring and monitoring of patients' physical and psychological symptoms.
- Methods, stages and equipment for diagnosis and treatment, such as medical records, interviews, physical and visual examinations and diagnostic testing spaces (e.g. laboratory and imaging departments).
- Conditions and behaviours of the diseases and illnesses as the cause of health problems within all spatial components of the design.
- The way in which diseases spread in hospitals.
- Procedures, types and plans for the treatment of diseases, such as drug, chemical, radiation, palliative-care and surgery therapies.
- Predicting the course of the disease before they manifest into deadly symptoms.
- Stages of follow-up for patients after their main treatment: blood tests, imaging tests and physical examinations.
- Patients' variabilities (e.g. size, gender, culture and health issues).
- Movement of users, materials and equipment as contaminated or uncontaminated mediums within hospital shared spaces.
- Functions, types and number of activities related to spaces of the therapeutic and diagnostic plans.
- The movement of patient data and information.

11.4 DESIGN PROCESS FLAWS AND DESIGN ISSUES

By tracking the sources of design defects and faults identified from data analyses of stages 1 and 2 of data collection in this study at the operation stage as shown in Figure 11.8, this study found 71 flaws in eight phases spanning the predesign to the design stages (Section 13.5, Appendix D). These flaws were caused by design teams, administrative issues and unavailability of data. Predesign stage included flaws in eight processes identified in Phase 1: *need identification processes* (Table 13.67); eight process flaws were identified in Phase 2: *project brief processes* (Table 13.68); eight process flaws were identified in Phase 3: *feasibility*

study processes (Table 13.69); eight process flaws were identified in Phase 4: *hospital building programming* (Table 13.70); eight process flaws were identified in Phase 5: *hospital functional programming* (Table 13.71) and 10 process flaws were identified in Phase 6: *hospital space programming* (Table 13.72). In addition, the design stage included 11 sources of flaws in Phase 1: *schematic design processes* (Table 13.73) and 10 causes of flaws in Phase 2: *development design processes* (Table 13.74). This study found 13 types of design field issues (Tables 13.55-59) in operation stage as a result of 71 flaws in design processes at the design stages. The sources of these flaws at the design stages could be used to avoid future design issues that impact patient health physically and psychologically and the care services they receive.

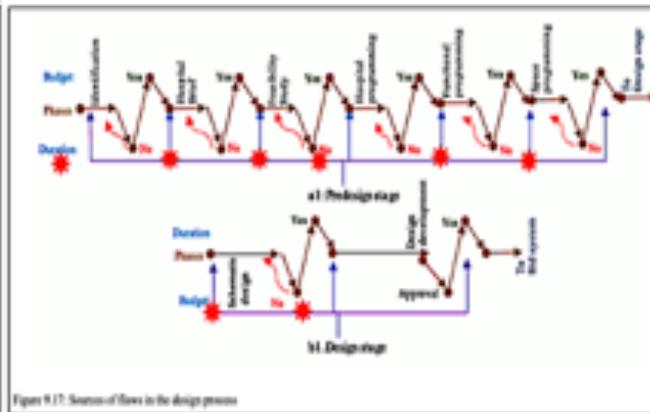
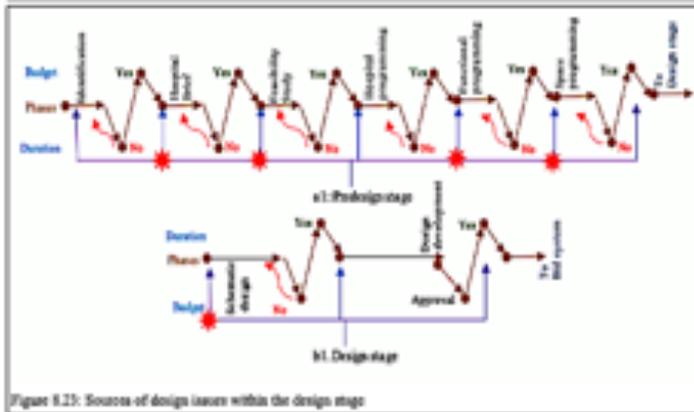
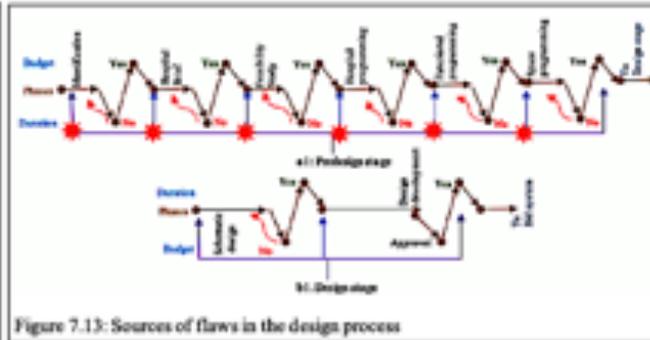
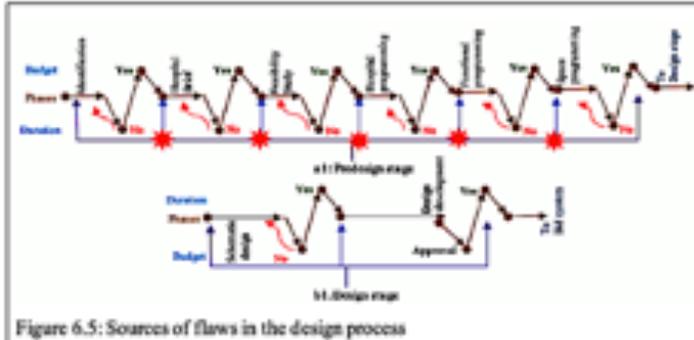
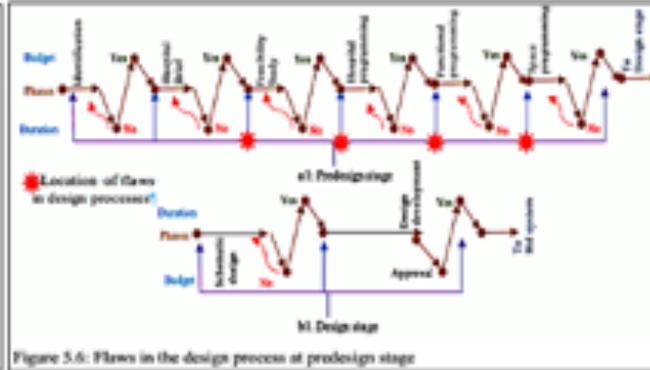
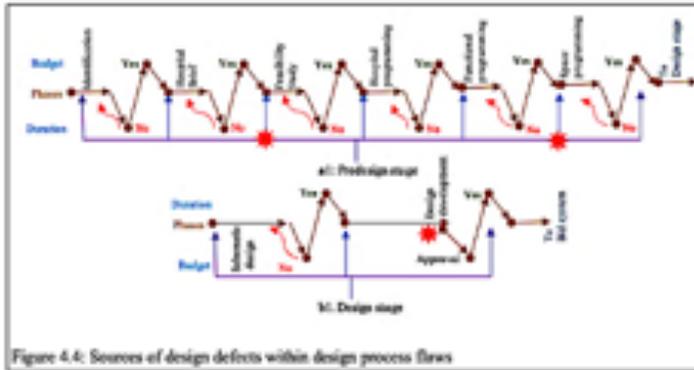


Figure 11.8: Sources of flaws within the design process

11.4.1 FLAWS IN THE DESIGN PROCESS AND DESIGN FIELDS

This study presents evidence regarding the relationship between flaws in predesign and design stages and the operations phase of hospital facilities in Saudi Arabia. From data analyses of stages 1 and 2 of data collection as shown in Figure 11.9. Figure 11.10 presents the link between the flaws of the predesign (Figure 11.10: a1) and design stages (Figure 11.10: b1) and the following 13 types of issues relating to design fields.

- Architectural design issues such as unavailable, insufficient, inadequate and inoperable spaces.
- Construction design issues such as cracks occurring in internal and external wall surfaces, limited structural loads and missing terminal and water isolation layers.
- Mechanical-design issues including the miscalculation of the required pressure, deficiency in heating, ventilation and air-conditioning (HVAC), the capacity of oxygen systems and limited areas for mechanical services.
- Civil-design issues including lack of drainage systems in some toilets, inadequate, insufficient drainage systems for radioactive waste disposal and water leakage from the ceiling.
- Safety design issues including inadequate, missing evacuation plans from critical units for inpatients, lack of fire system equipment and inadequate flame and smoke barrier walls.
- Security design issues including lack of alarm points, fences, access control systems, a deficiency in the closed-circuit television and more than three main entrances to the hospital buildings.
- Electrical design issues including limited electrical sources, inadequate lighting, insufficient electrical protection systems and limited load capacities of panels.
- materials and equipment specifications issues including low quality selection criteria for materials resistant to the growth of bacteria, fire, dust and rust that are not available in Saudi market.
- Equipment planning issues including lack of medical equipment, electrical and mechanical work sources and support spaces and equipment located close to wet areas.
- Plumbing design issues including the mixing of medical (radiology) and normal liquid waste and water leakages from ceiling in critical areas.

- Hospital budget issues including inadequate approved budget leading to cancellation of some work or systems during the construction stage to prevent a budget deficit.
- Hospital schedule issues including miscalculation of the time spent to find and approve a new hospital site and the change in the scope of services and additional tasks.
- Financial-planning system issues including estimation of the budget before feasibility and functional analyses not considering future changes or extensions in the scope of services.

Most design defects and faults were related to flaws in the hospital building functional programming and space programming processes as shown in Figure 11.10. Three issues relating to design fields are associated with hospital financial planning as a result of flaws at the design stages. The participants in Stage 3 confirmed this finding where Phase 6: hospital space programming processes flaws has the highest value impact leading to design issues in operation stage with weighted mean of 3.671 with a standard deviation of 0.096.

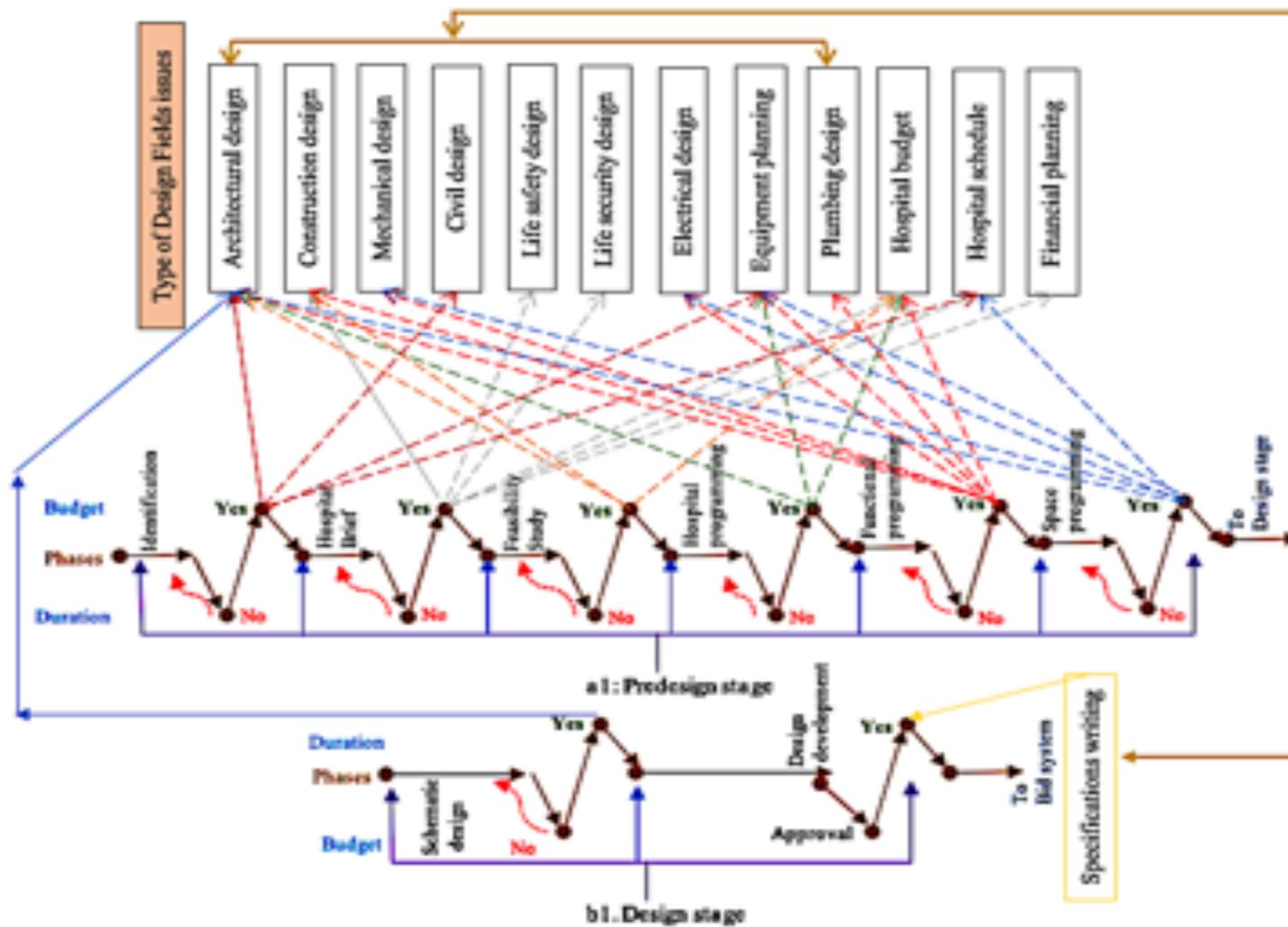


Figure 11.10: The link between flaws in the design process and design fields

11.5 DESIGN ISSUES AND AREAS IMPACTED IN THE OPERATION STAGE

Figure 11.11 shows the links between DDs and DFs in the operation stage and the areas they impact. Evidence from this study shows design issues involving design defects and faults have often led to DIAIs. The study has presented 13 types of such issues in design fields, produced by flaws at the design stage and those DIAIs that impact patient health, safety and healthcare services.

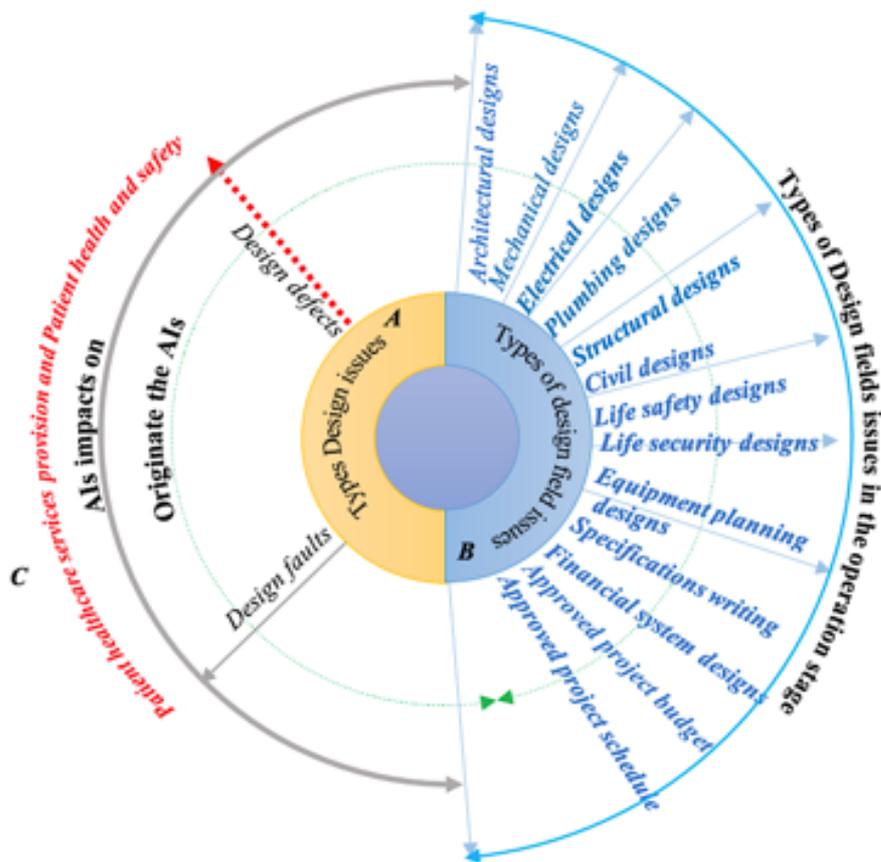


Figure 11.11: Conceptual framework - Links between areas impacted and design defects and faults

In addition, Figure 11.12 shows the links between the design fields issues, types of DIAIs and the areas impacted by the design issues in the operation stage. (A) 13 types of design field issues produced by flaws at the design stages; (B) 16 types of DIAIs associated with the DDs and DFs in design fields and (C) those design issues affecting patient health, safety and healthcare services. In this study, most DIAIs originated from design issues in the field of architectural designs.

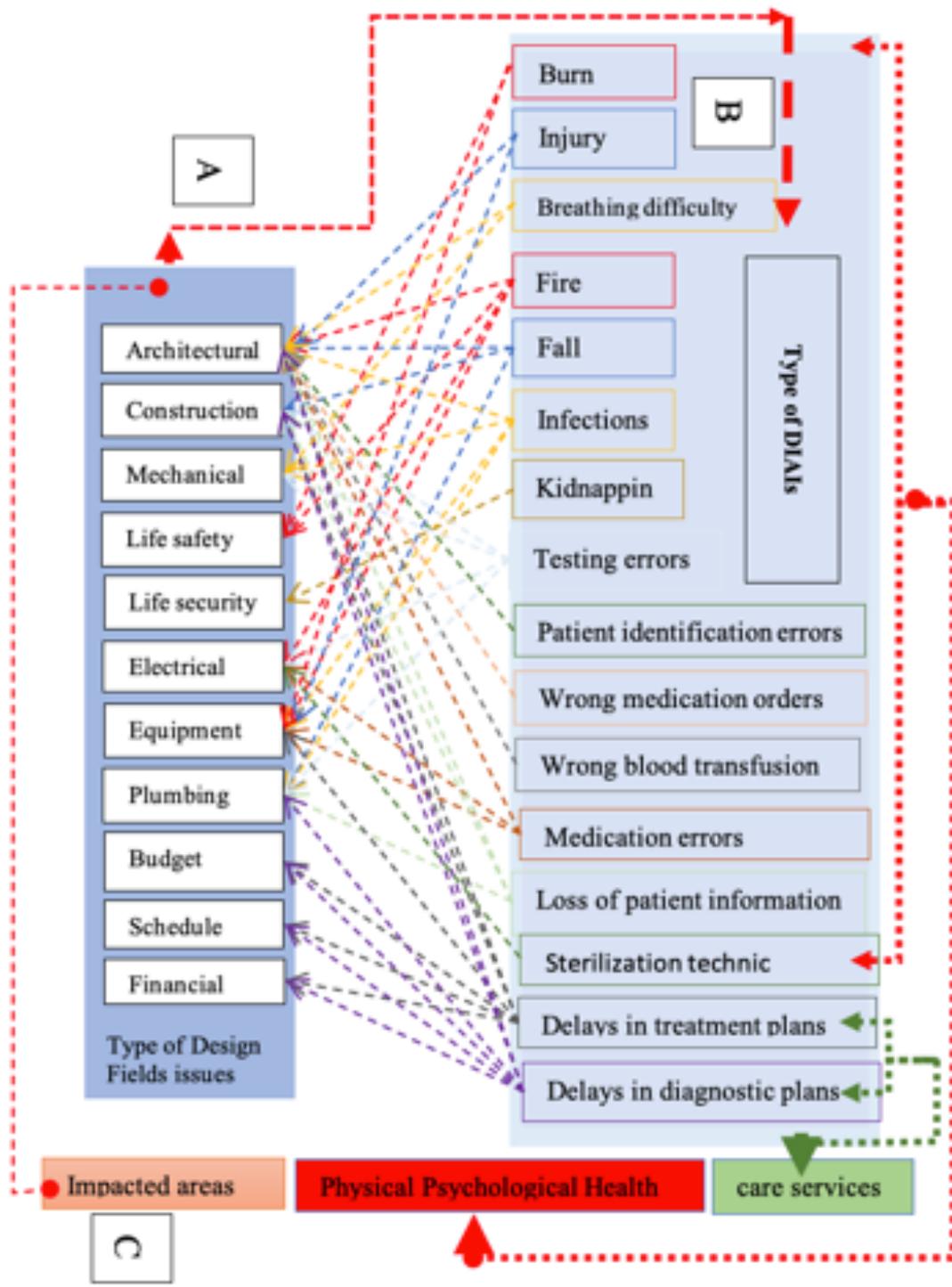


Figure 11.12: links between DIAs and design field defects, and the areas impacted

11.5.1 ADVERSE INCIDENT OUTCOMES AND DESIGN ISSUES

As noted previously, there were 16 types of DIAIs resulting from the design stage (also see Table 13.60 – Concept C, Section 13.4.3).

Injury was associated with four design issues: Safety design resulted in injuries with the position of a fire hydrant cabinet with sharp edges on a wall which a patient may hit. Poor mechanical design in a lift meant that the door repeatedly hit patients' beds because it closed too quickly. Equipment issues resulted in sharp edges on devices and furniture in patient rooms. The specifications for materials led to slippery flooring in toilets that caused patient falls.

Burns occurred due to fires from overheating medical devices due to lack of environment condition consideration (ventilation, A/C systems capacity) and specifying materials such as those low fire resistance. Burns from fires resulted from mechanical design issues due to inadequate ventilation and AC capacity which led to an excessive electrical load on medical devices

Fires causes death, burns and suffocation in patients and users because of issues safety equipment and fire evacuation plans. These issues included an insufficient number of extinguishers, limited extinguisher types unable to extinguish all types of fire and the inappropriate location and distribution of fire extinguishers. Firefighting vehicles had difficulty moving around buildings or finding space to park. Fire system equipment issues included smoke detectors and fire sprinklers not covering all required areas, pipe and cable networks located on the outside walls which could be exposed to fire damage. Fire zone issues included inadequate and insufficient flame and smoke barrier walls (Gypsum board) that led to the spread of fire and smoke. Long distances between some medical and emergency departments required excessive time and effort to reach safe points. Fire alarm systems were not connected to some critical systems to send alert to take action to safe patient. Some areas were without fire protection or sprinkler systems. Medical devices were improperly stored in high-temperature environments, and walls of patient rooms did not reach the roof in order to limit the spread of fire and smoke. The difficulty or impossibility of evacuating patients from the critical units located on the second and third floors in case of fire was noted; thus, an escape chute would be a potential solution to improve the evacuation plan. Random electrical cables were located around beds. There was a lack of ramps to evacuate patients, a lack of smoking

zones and door stops to avoid the spread of smoke. Random electrical cables were located directly on ceilings, leading to electrical fires. Electrical panels were located next to wet areas, and the doors did not have high fire resistance.

Patient falls were associated with a lack of rails, small and crowded toilets with portable toilet chairs and crowded patient rooms. Small doors made it difficult to move beds outside of rooms and slippery floors may lead to patient falls.

Fever and pain resulted from patients contracting **infections** associated with vertical cross-contamination (e.g. medical waste being transported in lifts together with patients) and a lack of isolation rooms with or without negative pressure. There was a lack of support systems and areas to control infection such as air locks, immediate sterilization, and dirty, clean, janitorial utilities and biohazard rubbish. There was a lack of space to store medical waste. There were miscalculations of the pressure required to avoid spreading infections, such as in the burns unit, isolation, dirty utility rooms and the dirty area in the sterilisation department, where negative pressure is required to prevent the contaminated air produced from infectious patients and used materials from spreading out of the room. In the operating theatres and delivery rooms, positive pressure is required to protect patients from contaminated outside air. Water leakage from the ceilings in some operating theatres was considered a source of infection that caused issues with patient health led to cancelling operations. Another source of infections was waste containers containing wound dressing materials located beside beds or on the walls. There was a lack of drainage system in the toilets. There were cracks in patient room walls, and dirt, dust, rust and stains on the walls and ceilings, which led to bacteria and fungus growing in cracks and sharp corners, resulting in infections to patients. Mixing contaminated air from central air-conditioning and uncontaminated air from ventilation systems, led to the spread of infections. The contaminated exhaust air in toilet of isolated patient did not recirculate through filtration system (UV and HEPA). The movement of infected patient cross the waiting area in ER. There was a lack of space for sterilising used equipment. The capacity of the sewage treatment plant was low, leading to the treatment of waste in inappropriate ways. This was especially prevalent when using contaminated water was used to water plants around the hospitals. Medical and normal liquid waste was mixed before reaching the same treatment station because they used the same drainage network. A medical waste room outside a hospital was a source of infections because design standards for this kind of space were not applied (inadequate AC, area for sterilising medical waste bins).

Kidnapping incidents were associated with seven design issues. Some door locks did not link to the alarm system in emergency cases such as a kidnapping in the nursery unit. There was a deficiency in the CCTV systems did not cover all hospital zones and a lack of security equipment including alarm buttons and fences with low high. There was a deficiency in access control systems and difficulty monitoring entrances of hospitals in case of kidnapping.

Errors in test result resulted from issues occurred in medical devices due design issues such as software deficiencies, error codes in device memory, errors in photographs of X-ray and the loss of medical devices and computer system data. These issues resulted in imprecise results for the diagnosis or treatment of health problems. Testing result errors were associated with issues in design including failures in support systems such as power supply and keeping damaged, expired or recalled medical devices together with functioning equipment in the same area. Equipment was stored in unclean environments or close to wet areas (located next to or under wet toilets) lead to expose them to damage. Medical devices exposed to direct sunlight and moisture. There was a lack of storage for equipment and existing storage was inappropriate conditions such as a high temperature, humidity, low light and insufficient ventilation. Deficiency in the AC system capacity in medical equipment rooms and in additional or modifying units led to an increase in temperature, impacting equipment and leading to them breakdown. Some laboratory equipment was not connected to uninterruptible power supply points to prevent loss advices data.

The loss of patient information, incomplete patient information, patient identification errors and delays in presenting patient files were DIAIs associated with a lack of spaces required for active and inactive medical records, data processing, collection, medical coding, medical transcription and mortality recording procedures in medical records. In order to create more space to store patient files, mobile shelving systems could not be used because their weight exceeded the structural load allowed. Other issues related to loss of patient information were backup system failures or damage because of power shutdowns and the exposure of computer systems components to harmful environment conditions.

Medication errors, wrong medication orders and delays in medication were associated with issues in design such as small medication rooms that make preparation of medications difficult and a lack of medication rooms. One medication room served two different medical units. Due to insufficient lighting in medication rooms, healthcare providers had difficulty reading

medication information. A deficiency of AC systems led to increases in temperature and a reduction in medication potency. Distractions by visitors, patients and employees during the healthcare provider's movements with medication because of long distances between medication rooms and nurse stations, hospital chemists and patient rooms may lead to a loss of medication and patient information.

Blood transfusion errors were correlated with design issues including a lack of required spaces to detect infectious diseases in blood. The overcrowding of devices in different sections of the laboratory caused difficulty in staff movement in each section. AC systems did not work efficiently with an increase in temperature produced by current medical equipment as well as the additional electrical loads increasingly led to breakdowns. High pressure work environment where too many pathological samples are kept, the laboratory's sizes and functions were not able to cope with demands, and processes are inappropriate to respond to clinics and medical units' requests. In addition, a long distance between the laboratory and blood collection areas increased the potential level of errors in the analysis of samples. A lack of required infrastructure prevented installing advanced and specialised laboratory equipment that could help in identifying and diagnosing diseases. These issues affect both patient health and care services and may lead to transfusions of the wrong type of blood or blood with blood-borne diseases.

Sterilisation errors were sources of infection. Errors in sterilisation system were associated with decontaminated instruments (noncritical) and medical instruments (critical and semi-critical). There was a lack of the required areas and equipment such as receiving dirty items, trolley washing, sterilised trolley, shoes rack areas (using their personal shoes only within the dirty area), washer disinfectors, autoclaves and airlocked areas. Sometimes contaminated medical instruments were used on patients because not all processes (cleaning, disinfecting and sterilising) and methods (steam, dry heat, chemical methods) of sterilisation were applied in the supply and sterilisation centre. There were problems of contaminated instruments appearing in a sterile department or else coming into contact with uncontaminated instruments from other departments when transported to the sterilisation department. The lack of control of the movement of staff between the dirty, clean and packaging areas (which did not have an airlock area) was a problem to avoid infection. There was a lack of areas to receive contaminated instruments and for washing contaminated instrument trolleys that bring contaminated tools to

the dirty area. These issues with sterilisation techniques in supply and sterilisation centres led to the spread of infections in hospital environments.

Power shutdowns were associated with some critical equipment and computer systems not connecting to the uninterruptible power supply or the standby generators were not responding. This was especially important in the operating theatres, x-ray and emergency departments to avoid the breakdown of these equipment and systems when they are being used on patients.

Breathing difficulty incidents were associated with site analysis issues such as a lack of oxygen on hospitals' upper floors or when mountainous locations required more physical effort when moving patients.

11.5.2 HEALTHCARE SERVICE OUTCOMES AND DESIGN ISSUES

As indicated in Figure 11.11, there were two care service outcomes (diagnostic and therapeutic services) linked to design issues in the hospital buildings (for more details, see Appendix D: Section 13.4.3: Concept C).

Delays in diagnostic plans were associated with a lack of diagnostic equipment such as electrocardiograms, cardiotocography, ultrasound, echocardiograms, brain and nerve monitoring devices and interventional ultrasound and tissue cutting rooms. There was a lack of space to measure bladder pressure as a part of diagnosis plans. There was a lack of space for screening clinics and oral and visual exam spaces. There was difficulty in expanding some diagnostic areas to install new devices or increase the amount of existing equipment because of existing structural walls, as well as difficulty in providing new medical equipment or systems because their weight was more than the allowable structural load. It was sometimes impossible to extend hospital buildings vertically because of critical systems on the roof, and horizontally because of surrounding residential and commercial buildings. Hospitals situated on mountains required more time to transport patients from road level to the hospital. Those issues in design led to delays in the provision of diagnostic services.

Delays in treatment plans were related to lack of therapeutic spaces such as burn units, obesity clinics and respiratory therapy units. There was a lack of therapeutic equipment such as shockwave lithotripsy, ultraviolet equipment and mobile x-ray alcoves. Not using advanced

technology when performing operations to reduce medical errors was a problem. Time was wasted transporting patients to the cardiac surgery unit because patient beds could not easily enter the lift. Water leakage from ceilings in some rooms was a serious issue for patient health and equipment function, sometimes leading to cancellation of treatment. The number of operation rooms was often too low, so many cases were transferred to other hospitals or were subject to long wait times. There was a lack of some important medical gases, especially in NICUs and PICUs. The limited load capacities of electrical panels did not allow the installation of new equipment or the expansion of medical space. There was a lack of support spaces for storage equipment, waste collection, mechanical services, medication rooms and nursing stations. The space to increase the activities and functions of exam, diagnosis and treatment was inadequate. There was a lack of future planning for extending current buildings or designing new spaces. There was often insufficient linkage between medical and nonmedical departments. There was a lack of support areas for electrical and mechanical services, patient waiting rooms, resting areas as well as spaces for adding new equipment or systems. The size of the lifts often did not allow patient beds to enter or be extended. Bed capacity in intensive care units was often too low to accept new patients for treatment. Inefficient monitoring of patients was a problem. There was often insufficient space in patients' rooms for staff to work, especially during emergency calls. Many doors in ER departments obstructed and delayed patient movement. There was a lack of oxygen outlets and inefficient oxygen flow due to low pressure. These issues led to stoppages or delays in treatment plans.

11.6 MECHANISM OF AREAS IMPACTED BY DESIGN ISSUES

The DDs and DFs that were produced by flaws in the design process impacted two main areas: patient recovery processes and healthcare services that involve incomplete or unavailable diagnostic and therapeutic plans (Figure 11.13).

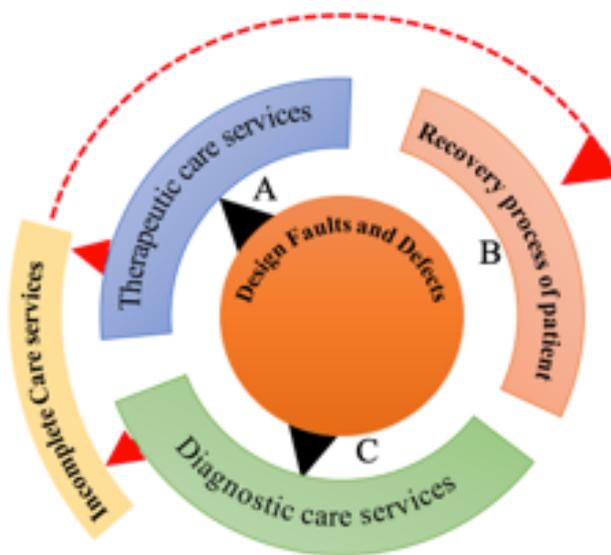


Figure 11.13: Conceptual framework - Impact of design issues on care services

DDs and DFs are linked to two impacted areas: therapeutic care services and diagnostic care services. These issues in design led incomplete care services that indirectly affected patient recovery. The area most impacted by design issues was healthcare services involving incomplete or unavailable diagnostic and therapeutic plans.

11.6.1 DIAI IMPACT ON PATIENT RECOVERY

This study found these 13 design issues (DDs and DFs) led to 14 types of DIAIs and affecting two types of healthcare services (Figure 11.12). DIAIs cause pain and stress that tend to increase respiratory rate, fever, heart rate, blood pressure and oxygen demands, which can affect the immune system (Kehlet 1998, Torpy et al. 2007, Pasero et al. 1999). As a result, this will lead to poor recovery, increase the risk of infections and patient discomfort and cause delays in patients returning to normal activities and thus increase healthcare service expenses (Gouin and Kiecolt-Glaser 2011, Linton 2000). (as discussed in section 4.21).

These DIAIs had an impact on four areas related to patient's situations: physical, psychological, social and financial. The physical impacts of DIAIs included infections, injury, disability, infectious disease, burns, poison, breathing difficulty, bruises and bedsores. Psychological impacts involved stress, pressure, discomfort, pain, fatigue, loss of appetite, anger, loss of privacy, low levels of patient satisfaction, loss of trust in the care service, lack of sleep and

time passing slowly. The social impact included feelings of isolation from friends and community due to either excessive duration of stay in hospital as a result of AIs or limited space for interaction in hospital. The financial impact, related to patients who could not work or monitor their businesses. DIAs associated with pain and stress slowed or stopped the healing process, required new treatment plans to deal with the physical impact of DIAs and lengthened time spent in hospital.

11.6.2 DESIGN ISSUES AND THE PROVISION OF HEALTHCARE SERVICES

Design issues had an indirect impact on the recovery process by providing incomplete or unavailable diagnostic and therapeutic plans (Figure 11.13). This study found that design defects and faults affected healthcare services in two ways: delaying, stopping or avoiding the provision of healthcare because of inadequate or unavailable spaces and equipment for diagnosis and treatment services. The healthcare service could not be provided correctly or on time; and reducing the quality of the healthcare and increasing costs because the design issues prevented the delivery of services or provided incomplete services. There are 11 reasons that explain how these issues in design affect healthcare services:

- Unavailability of spaces for healthcare providers to rest, have a meeting to discuss critical cases or to select the best treatment plan for patients.
- The number of operating rooms was too low, and many cases were transferred to other hospitals.
- Unavailability of waiting areas that led to many guests waiting inside the unit or at main entrances thereby obstructing patients.
- A long and indirect route to the operating theatres from other areas of the hospital.
- The difficulty applying patient safety standards and policies of the JCIA and CIBAHI due to a lack of negative pressure (e.g. in the labour and delivery rooms, dirty and clean rooms) to control infections.
- Inadequate lift sizes for patient beds.
- Lack of bedrooms to accommodate patients.
- Lack of capital equipment (CTS/MRS) required by doctors to complete diagnostic plans.
- No ability to expand the facilities to accommodate the modern medical equipment which is necessary.

- No ability to increase the capacities of mechanical and electrical services to deal with the thermal load produced by new medical equipment due to a lack of space for support services.
- Lack of required infrastructure preventing the installation of advanced and specialised laboratory equipment.

There were a number of indirect ways affecting healthcare services. When DIAs resulted in prolonged stays, there were increases in the consumption of medical consumables, the cost of patients' treatment, tasks for healthcare givers. There were also decreases in the lifespan of medical devices and equipment, delays in the delivery of medical services to other patients due to long-term patients being treated for the physical impacts of DIAs and designed-environment issues that included changes in designs to accommodate new departments that the hospital manager requested. These changes in designs were implemented to create a new medical unit to deal with specific health problems (e.g. a burns unit) or expand an existing unit in order to accommodate new equipment (e.g. x-ray and laboratory equipment) or more patients. Therefore, these changes led to other issues that affected the medical services of other units, such as spaces with fewer activities and functions, when the area became smaller and attained a less sufficient level of critical systems (e.g., AC) because they were designed with specific capabilities to deal with certain areas that were not included in new or expanded areas. There were two parties responsible for these issues: the healthcare facility managers, who were unqualified to apply these changes, and the design teams, who did not consider the future space requirements for patients and medical services. The occurrence of DIAs produced by design issues had impacts on the patient psychology in terms of the loss of confidence in hospital healthcare services and trust in healthcare providers, as well as an impact on patient behaviour, such as refusing to take medication as the result of anger due to a new treatment plan or lengthening their stay in hospital.

Design defects and faults also affected the care service in direct ways. The design issues included

- a lack of supporting spaces, such as equipment stores, areas for sterilising used equipment, waiting and changing rooms for patients and operators;
- difficulty in installing new or advanced medical equipment because of a lack of space, electrical and mechanical work;

- a lack of medical equipment in the sufficient quantity needed for applying diagnostic or therapeutic plans to new health problems;
- existing laboratory equipment not giving precise results because of inadequate ventilation and air-conditioning systems. These issues in the equipment planning designs have prevented or delayed the medical services provision because of damage in some diagnostic equipment in laboratory and x-ray units.

Financial-planning issues included an inadequate budget leading to stoppages in hospital construction or operations due to cut-backs by the MOH to prevent the budget deficit. This issue delayed the provision of healthcare services on schedule and increased cases of health problems in the region.

Construction stage issues included the changing of designs by unqualified managers, leading to delays when additional work became necessary during the construction stage to deal with changes in the scope of hospital services. These additional tasks consumed more time than the approved schedule and added more pressure on construction and equipment contractors to complete their new additional tasks quickly within the approved schedule. This resulted in low quality and increased design and material issues at the operation stage. The approved schedule did not include the time spent finding and approving the hospital project site. The hospital project land should have been defined and selected at an early stage of design, not after the bidding stage. These issues led to delays in the provision of healthcare services and to their low quality.

This study presents the impacts of design process flaws on the healing process of patients and the provision of healthcare services at the operation stage. DIAs affecting the recovery process had physical (e.g., injury) and psychological (e.g., stress), which led to delays in the main healing process because of the new health problem produced by DIAs. The way to deal with both health problems is through complete care services that lead to diagnoses and treatment of those health issues. When hospitals suffering from a lack of required space and equipment attempt to apply the diagnostic and therapeutic plans, this leads to delays in healthcare service provision because of a lack of consideration of the number of disease cases or an increase in patients, increased cost of healthcare service provisions to deal with this growth with limited

scope of services, prolonged patient stays in hospital, transporting patients to other regions or countries that can provide the required services, stoppages in healthcare service provision due to loss of trust in hospital services and an overall lack of healthcare service provision as a result of an inability to extend the capacities of the current hospital building. Those issues in design provide incomplete services to deal with patient recovery processes or fail to provide them altogether.

11.7 DESIGN PROCESS TO SOLVE CURRENT DESIGN ISSUES

Figure 11.14 shows the recommended design process to solve the current design issues in two stages within four phases:

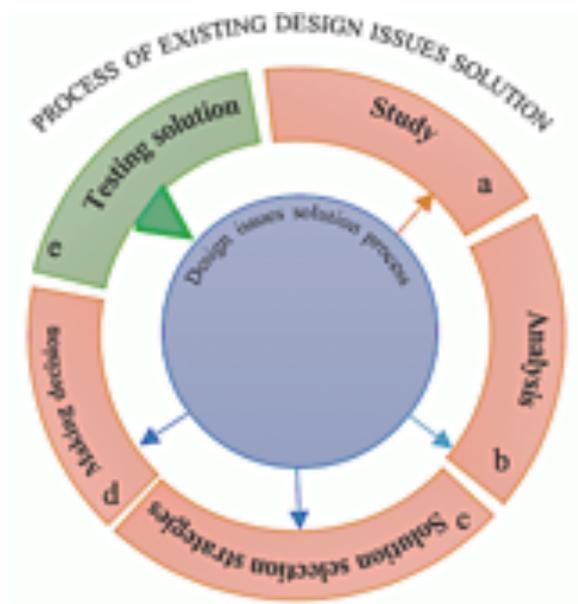


Figure 11.14: Conceptual framework - Recommended process to solve design issues

Stage 1 includes three phases. Phase 1 is the study process, which involves gaining knowledge of the existing design issues by paying more attention to

- 1) classification of the design issue, in order to determine the best way to deal with the existing design issue or a new design issue request;
- 2) the sources of the design issues, in order to identify the designers' roles;
- 3) the impacts of the design issues, in order to classify the level of damage and select the methods, strategies and principles to solve the issue;
- 4) the victims of the design issues, in order to involve them in the design issue requirements;

- 5) visiting the location of the design issue, in order to inspect the design issue's links with other locations, critical systems capacities, users and equipment activities;
- 6) the background of the design issues, in order to provide better understanding of circumstances surrounding them;
- 7) interviews involving current users and viewing current designs and reports of a building
- 8) reviewing design standards and existing hospital design maps to determine alternative ways in dealing with similar issues.

Phase 2 is the analysis phase: identifying the details of the design issue elements and structure separately in relation to space: sizes, functions, usages, operations, conditions/systems, components, locations, activities, information and data flows, relationships, supporting services, movements, safety and security and construction.

Phase 3 is selection of the method of design process, of thinking strategies and of hospital design principles: Having collected the required data and analysed them to create solutions, two recommended strategies are used to select and test the best solutions arising from the analysis of the data: An evaluation of solutions is carried out by discussing these solutions with design teams and interested groups to ensure the solutions reflect all 13 healing aspects of design. Consensus is then sought for the best solution from design teams and concerned groups. Phase 4 is decision making: applying the best solution in designs with all justifications to support the solution selected and getting the approval to implement the solution by considering the costs, benefits and patient reactions of the chosen solution.

Stage 2 is to test the effectiveness of the solution. Having implemented the approved solution, two processes are needed to test and evaluate the solution which has been implemented: (a) monitoring the effectiveness, performance and influence of the solution to the design issues by feedback from the users and beneficiaries and (b) re-evaluating the solutions to be considered in future hospitals as the best solution that leads to a hospital environment that is free of defects and faults in design.

11.8 FLAWS IN THE DESIGN STAGES AND HEALING ASPECTS IN DESIGN

Based on previous data analysis findings of stages 1 and 2 of data collection, this study identified 13 healing aspects in design elements as shown in Figure 11.15.

Patients basic senses are sight, hearing, smell, touch, taste and physical movements. These senses react to the design elements of the healing aspects physically and psychologically and both positively and negatively.

This study found flaws in the design stages (pre-design and design stages) are linked to healing aspects in design in order to support recovery, prevent stressful elements and provide healing features. According to the Figure 11.16, this study found issues and features in the 13 healing aspects of design (Section 13.4.4 - Concept D). This study identified 13 aspects of healing aspects of design elements viz. social, spatial, lighting, thermal, audio, spiritual, safety, security, aesthetic, freedom, object usage and object movement and privacy that the patients' senses reacted to. These issues lead to an increase in the psychological and physical harm that affects recovery.

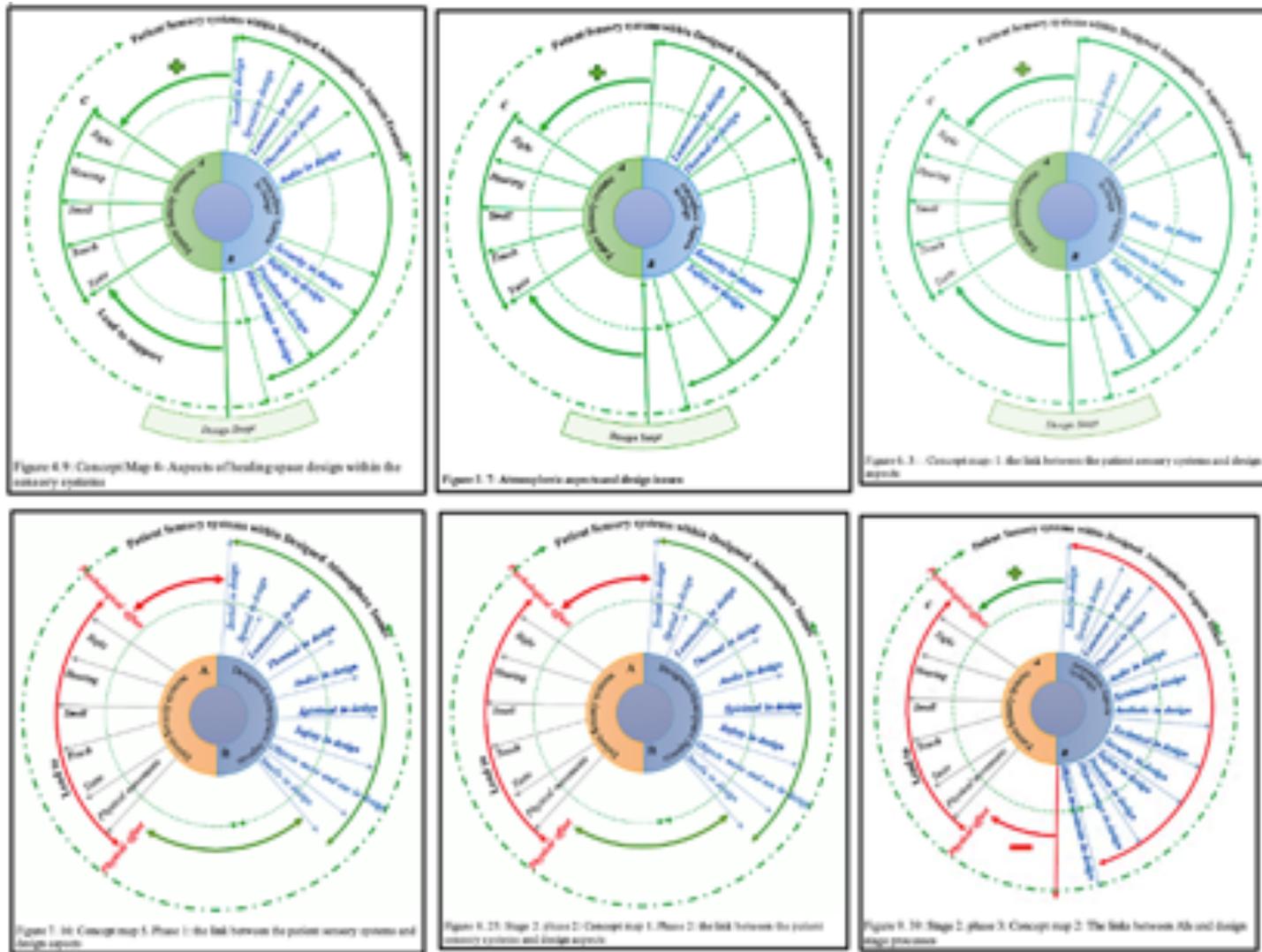


Figure 11.15: Patient sensory systems and healing aspects in designs

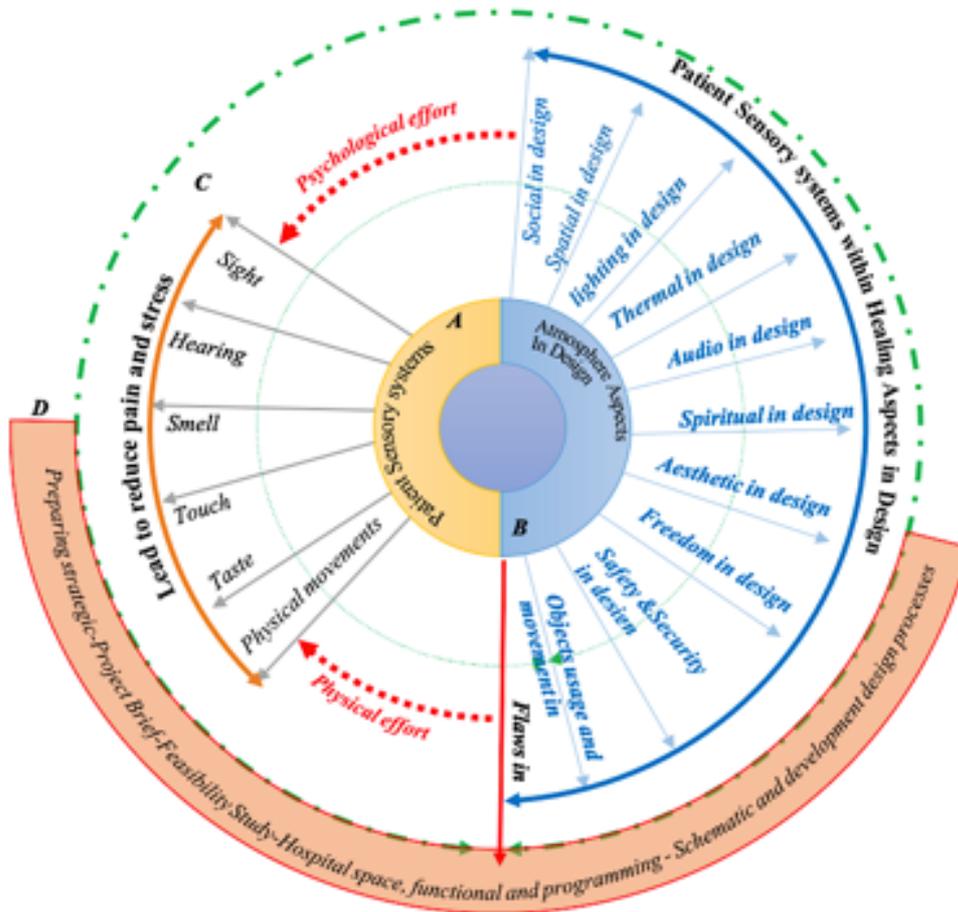


Figure 11.16: Conceptual framework - links between senses and 13 aspects in design

Most flaws in the design process affected spatial aspects in the operation stage as shown in Figure 11.17 (Table 13.67-74, Section 13.5).

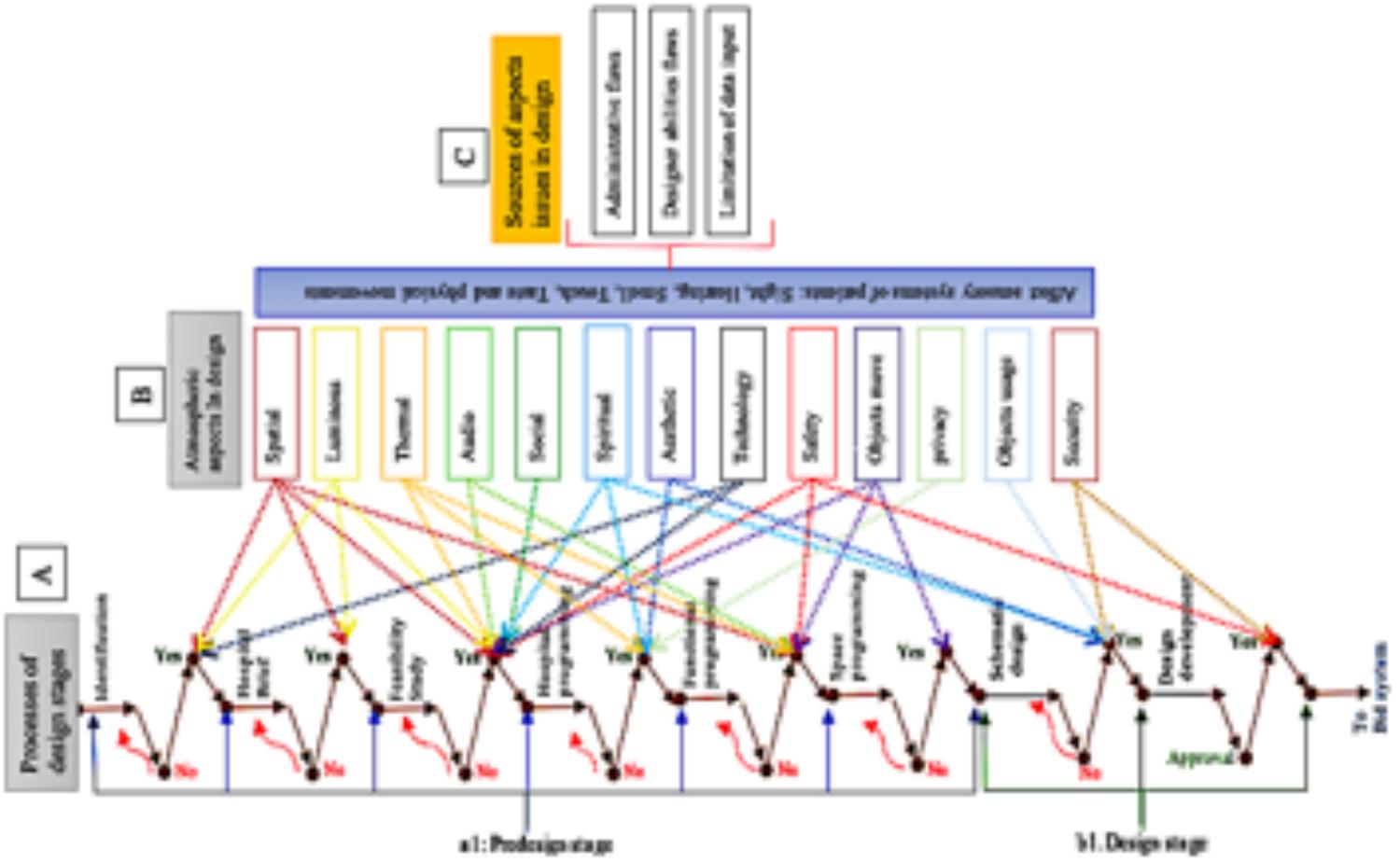


Figure 11.17: The link between flaws in the design process and design issues

11.8.1 FLAWS IN THE PHASES OF THE PREDESIGN STAGE

Within the *preparing identification process*, this study demonstrates the following flaws: - the description of hospital requirements for space and equipment to deal with new or specific diseases and illnesses to provide complete diagnosis and treatment; future planning requirements to accommodate more patients and provide new technology for treatment and diagnosis. These flaws were associated with technology and spatial aspects in designs.

The *hospital project briefs process* includes flaws in the objectives of a hospital project to include new, advanced medical equipment for controlling current diseases, reducing adverse incidents and supporting the healing process; decrease the spread of diseases to other hospitals or to other countries, the pressure on hospital services and the prolonged stay of patients.

The *feasibility study process* includes flaws in the study of the impact of designed-environment issues or features in the operation stage on the psychological and the physical recovery of the patient and on the care services, identifying the scope of services to define the initial and future requirements of the medical-care service spaces' designs supporting the recovery process in the predesign processes and the data collection to identify the geographic and the mereological data in each region to create healing environments.

The *hospital-building programming process* includes flaws in presentation of program goals to present the expectations, aesthetics and the therapeutic design factors supporting the physical and psychological health of patients within the healing designs aspects; identifying the specific design elements to meet the beliefs, culture, history and tradition conditions (mereological data) in Saudi Arabia and considerations required to present the religious elements in the design through specifying the spaces and tools for worship.

Hospital-building functional programming processes include flaws in flexibility in the structural design to deal with the internal and external expansion in future requirements or in the construction, operation and operation stages, in the case of changes to the scope of services; mechanical services spaces to easily move and access patients' beds to/in elevators, to avoid the generator noise and to increase the critical systems capacities in the future; circulation requirement to link between the clinical, treatment and diagnosis departments/units horizontally and/or vertically in the hospital buildings and flow planning required to consider

the segregation, the distribution, the control and the discharge of the patients, , equipment, supplies, medications, patient information and the movement of waste.

Hospital-building space programming processes include flaws in number and work responsibilities of staff, providing adequate space and size for free movement and avoiding disruptions during the provision of medical care services and accessibility requirements to provide adequate spaces for the comfort and ease of use to the patients and users.

11.8.2 FLAWS IN THE PHASES OF THE DESIGN STAGE

Schematic design processes include flaws in presenting the local customs and religion as design elements on internal and external walls on plans to improve these elements; the justifications for specifications of the materials and systems to meet patient health, safety and security standards; limiting review of, and redefining, the functionality, usability, adjacencies, security, safety and aesthetics requirements in design plans before the final approval by community members, the evacuation planning for patients; and presenting the components of patient environments, in which are reflected the considerations of the physical and psychological conditions of patients to know how much is evaluated.

Design development processes include flaws in the civil design layout of some of the roadways, sidewalks, exterior lighting, utility grids and future infrastructure expansion; layout of the life safety designs to present of operation loads areas, fire extinguishing locations, alarms and initiating devices, types of wall construction, roads of firefighting vehicles and evacuation planning and layout of the life security plans to provide access to control points and surveillance system zones.

11.9 STRESSFUL ELEMENTS AFFECTING PATIENTS' SENSES

The following five patient senses (as detailed in Chapters 4-9) that should be considered and respected by responsible parties and design teams at an early stage of design:

- Sight: images of disease, signage with warning phrases or frightening names of some departments

- Hearing: external noise from traffic, generators and air conditioning units, as well as hearing equipment alarms, beeps and emergency calls.
- Smell: unwanted smells internal and external to the hospital
- Touch: sharp and rough surfaces of furniture, equipment and walls.
- Taste: Stressful components led to loss of desire to eat that affected the healing process, such as seeing a doctor performing surgery, a mosquito sucking blood and disease side-effects and smelling bad things directly (e.g., detergents, sterilizers, blood, treatment plants, waste storage rooms) (Tables 13.61-62, Section 13.4.4,).

In addition, this study found two types of patient harm related to DIAs and stressful elements in design. Firstly, patient effort related to DIAs included physical harm, such as infection, injury, disability, burn, poison, breathing difficulty, bruise, bone infection, suffocation and bedsores, and psychological harm, such as stress, discomfort, pressure, pain, fatigue, loss of appetite, loss of trust, hunger, thirst, temperature issues, itch, time passing slowly, feeling unsafe, annoying, insecure, in danger, scared and lacking sleep. Secondly, patient harm related to DIAs and stressful elements in design included psychological harm that increased when patients felt unsafe, annoyed, in danger, scared, insecure, stressed, under pressure, and uncomfortable and physical harm that increased when patients needed to move from one space to another, such as diagnostic units, toilets, nurse stations and emergency exits; use designed environment components when patients spent effort in opening the toilet door, personal cabinet, windows and curtains and moving to reach objects when patients wanted to get in or out of their beds or reach the toilet components such as the rail bar, soap box, or move from one place to another.

11.9.1 THERAPEUTIC SPACE DESIGN AND THE RECOVERY PROCESS

To achieve the highest levels of comfort, enjoyment, security, safety, well-being and harmony for the patients' body, brain, behaviour and spirit within the environment, 11 aspects of hospital design were identified that support the healing process by offering a sense of peace to patients (Tables 13.63-66, Section 13.4.5):

- Spatial design is to address patient body size, functions, components, height, access, shape, number, relations and colours.

- Lighting design is to provide a sense of consistency to the eyes and skin of patients by providing the appropriate colour, strength, distribution, temperature and distance of lighting and to allow natural lighting reach to patient spaces.
- Thermal design is to provide natural or mechanical ventilation, allowing sunlight to access patient spaces and to easily control ventilation.
- Audio design is to transport patients to interesting places and times that brings feelings of calm and happiness by providing convenient sounds and voice sources in patient spaces.
- Social design is to give patients a feeling of consideration, importance and pertinence or belonging by providing social interaction spaces for their family and friends, and special places for parents near their children in intensive care units and spaces or tools to access shopping and cafes.
- Spiritual design is to create a spiritual space to reflect faith, culture, history, customs and traditions and to reach the highest level of tranquillity by using symbols, commodities, art, images, space and tools to do ablution and pray, respecting the direction of the Qibla and to facilitate the movement of the bed to the Qibla.
- Aesthetic design is to increase the level of excitement in spaces for a patient and prevent feelings of time passing slowly and concentration on a sense of pain by using attractive decorations, inscriptions, pictures, drawings, painting colours and Arabic fonts for some Quranic verses and Hadiths.
- Technology design is to reach the highest level of patient freedom and to control spatial components by providing positions to open the curtains, windows and control the lighting.
- Security design is to provide a sense of security to patients by applying all security sectors' designs to protect patients from theft, infringement and harm and to reduce the fear of bad things or potential crimes.
- Object-usage design is to limit patient movements and physical effort and to reduce infection. By using the remote-control technologies, such as toilet accessories, a patient can use environmental components and objects without touching them.
- Lack of privacy leads to patients feeling uncomfortable and refusing to continue their treatment.

11.9.2 REACTIONS TO ELEMENTS OF SPACE DESIGN

This study designed a simple conceptual framework (Figure 11.18) for a designer to understand the reactions of patients to environmental design elements and components that should be considered.



Figure 11.18: Conceptual framework - reactions of a patient to environmental design elements

This framework includes (1) the factors affecting the brain, (2) the stage of the brain reading the design elements, (3) physical elements and (4) psychological elements. The middle area is titled “Patient healing process factors”. This area is linked to three factors of patients’ reactions: (A) The body is linked to the five senses as reactions to the output of the design elements and components; (B) the brain reads and translates sensory inputs which are affected by four factors viz. knowledge, experience, education and memory (1). After the brain processes the sensory input originating from the space’s output (2), the brain orders the body to respond in two ways: physically (3), as movement, and (4) psychologically, as emotional reactions. Those reactions are also affected by the spirit, a desire for a sense of tranquillity in the designed environment.

11.10 THE PROPOSED FRAMEWORK

The problem under consideration is to minimise or prevent design defects and faults occurring in future hospital buildings and to identify the sources of the current design issues that lead to:

- Impeding the delivery of or causing delays in examination, diagnostic, therapeutic and follow-up plans.
- Impeding the delivery of or causing delays in the application of recovery processes.
- Increasing the cost and time of recovery processes, healthcare services, critical systems and patient expenses.
- Patients escaping.
- Design faults that impact care services.
- Design defects leading to DIAI occurrence that impacts the recovery process.
- Issues in healing aspects stemming from design.

The aim is to protect and support the recovery process by improving the design stage of hospital buildings through:

- Providing a safer and healthier environment.
- Providing the best, most complete and most effective diagnostic and therapeutic plans to deliver healthcare services.
- optimising design elements, components and tools and enabling design teams to support the recovery process at the early stages of hospital design.

Improvements need to be made at the design stage of Saudi hospitals to protect and support the recovery process, to provide complete healthcare services and to improve the existing quality of healthcare systems.

Saudi hospital buildings suffer from design issues which may be caused by flaws in the design process in the early stages of design. This study proposes a framework (Figure 11.19) of integrated solutions for protecting and supporting patient recovery and providing complete services (ISPSPP) for the predesign and design phases. This would implement research findings to analyse the design process, resources and patient health and safety requirements to prevent design defects and faults in the operation stage of hospitals. ISPSPP requires the involvement of three main groups as sources of data for the design stages. The first group

includes the community, nurses, patients, doctors, allied healthcare service professionals and SMOH administrators. This group can convey the knowledge required to protect and support the recovery process and meet healthcare service needs to the second group, namely, the design teams, including architects and engineers in various different fields of design. The third group includes construction and maintenance engineers, who can share knowledge of design issues that have occurred in the construction and operation stages. The design teams need to improve their knowledge, skills and abilities in healthcare facility design and establish a strong relationship with stakeholders from the first and third groups to design a safe and therapeutic environment. The managers of design teams need to avoid administrative flaws when dealing with and selecting members of the design teams (Tables 13.75-76, Section 13.5.3).

In the design stage, the design team needs to communicate with the first group to understand the physical and psychological health issues of patients, their reactions to the design of space and the requirements of providing complete diagnostic and therapeutic plans in design and communicate with the second group to understand the nature of the design issues. By implementing this knowledge in the design stages, the design teams can design hospitals that are free of design issues and simultaneously create a therapeutic environment through consideration of appropriate physical and psychological aspects to support the healing process. The framework (Figure 11.19) shows the map for improving the design stage of hospital buildings based on finding of this study. First, the SMOH invited the first and second groups to participate in the predesign phase processes (inputs). This stage involves six phases (Tables 13.67-72, Section 13.5.1) and requires critical data and information for 71 different processes. These critical data encompass 11 knowledge areas (Table 13.77, Section 13.5.3) for protecting recovery from design defects and faults in 13 design fields and providing complete diagnostic and therapeutic plans for healthcare services.

For supporting recovery, avoiding uncomfortably designed space elements and stressful components that affect the healing process (Tables 13.63-66, Section 13.4.5) should be avoided and therapeutic elements and components should be created in consideration of 13 healing aspects. Second, for the design stage as outputs of predesign stage, the hospital building design requirements were presented in plans for the demands of patients and healthcare services in terms of spaces, supporting spaces and services, equipment, operation requirements, objectives, scope of services, policies and regulations and professions within two design phases.

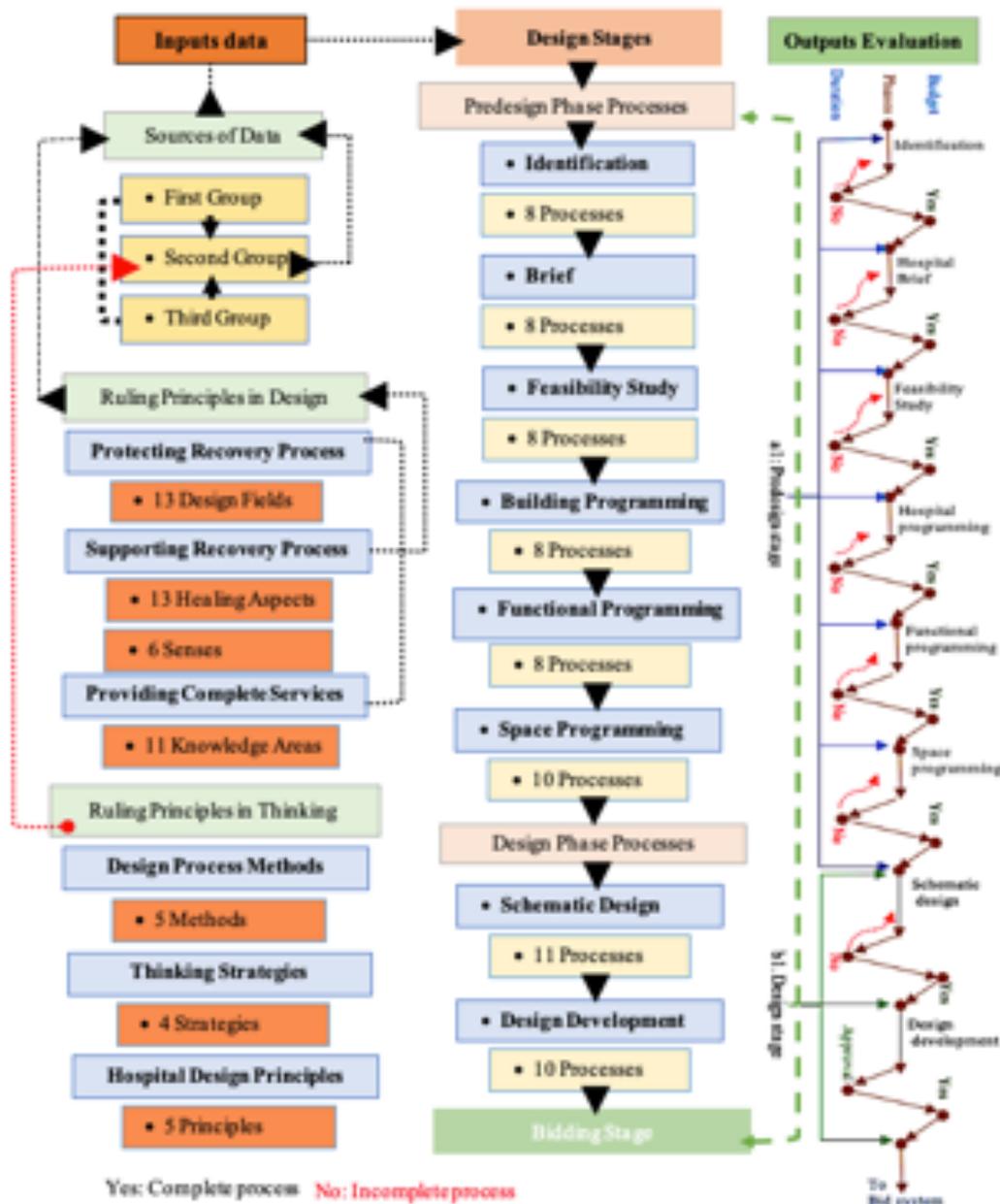


Figure 11.19: The ISPSPP framework

Then, the SMOH assigned the second and third groups to the schematic design and development design phases. This stage starts with the schematic design phase for the layout of spaces and equipment to be tested by the first and third groups. This stage consisting of site, floor, roof, hospital sections, elevations, critical systems, equipment, landscaping plans and illustration the function of spaces and specifications of materials. To prevent the occurrence of design issues in the operation stage, this phase must consider 11 factors (Table 13.73, Section 13.5.2). The last stage is the development design phase, in which the final design drawings and

documents in details obtained as the results of the previous phase. To avoid missing details in the final drawings, missing details in ten types of design drawings and documents in this phase must consider (Table 13.74, Section 13.5.2).

During the design processes, three main ways of thinking should be considered by design teams to avoid sources of flaws in the design stages: the design process methods, thinking strategies and hospital-design principles (Section 13.4.7). In the operation stage of hospitals buildings, the decrease in cost, waiting time of diagnostic and therapeutic services provision, number of complains about the quality-of-care services, length of patient stays, number of changes requested by in the scope of healthcare services and designs are suggested by this study as critical measurements to test the ISPSPP framework outcomes. At each design phase, the estimated hospital budget and construction timeline should be reviewed by the second team to avoid delays in the healthcare services provision, as the scope of healthcare services may have changed or improved.

The ISPSPP framework, presents a summary of the processes, procedures, methods, principles and theories used to improve the design processes in three areas. Firstly, input data arises from three sources. main trigger factors in design including protecting, supporting recovery process and providing complete care services; ruling principles to solve design issues or create a new design including the selection of the design process methods, thinking strategies and hospital design principles and avoiding administrative flaws and improving design team abilities, skills and knowledge. Secondly, there is the implementation of processes of design phases in predesign and design stages. Thirdly, outputs monitoring and evaluations produce future hospitals based on the main trigger factors in design. During the output's evolutions, two response involved to act: "Yes", which means the design teams can move to next stage of design because all inputs of each process are completed; or "No", which means the outputs of the design stage are not approved for missing design process inputs, and the design team need to review and revise all requirements for each process in that stage. By applying this framework in future hospital designs, design faults and defects affecting patient health and care services can be avoided, and with current hospital buildings, design issues and their sources can be identified.

11.11 DISCUSSION OF FINDINGS

11.11.1 FLAWS AT THE DESIGN STAGES LEADING TO DESIGN DEFECTS AND FAULTS IN THE OPERATION STAGE

This study identified 71 process flaws in 7 phases spanning the predesign and the design stages as the main source of the defects and faults in the operation stage of hospital buildings. The present study confirmed findings from other studies suggesting that the majority of defects occurred in the operation stage through flaws generated during the design process (Ransom 1981, Seeley 1987, The BRE 1991, Richardson 1991, Assaf et al. 1996, Josephson and Hammarlund 1999, Watt 1999, Manning 2005, Findlaw 2011). Compared to previous studies, it must be pointed out that the flaws identified in most of the studies on design process issues are most common during design development processes e.g. see Ramly et al. (2006), Al-Shiha (1993), Al-Hammad et al. (1997), Hassanain et al. (2013), Assaf et al. (1996); whereas this current study found design issues are triggered by issues in every design phase, not just the design development phase. This study has been emphatically clear that different design flaws usually occur in different design phases and in each element of design issues. Findings in this study include flaws in preparing need identification, hospital briefs, feasibility studies, hospital building programming, hospital building functional programming, hospital building space programming and schematic design phases. These flaws may be the result of tracking various types of design issues in the operation stage, and focusing on the effects of design issues on patient health, safety and healthcare provision issues as the source of design process flaws.

This study found those flaws in the design phases were related to responsible parties in the design team, the abilities and thinking strategies of design team members, as well as lack of data and information required at the early stages of planning and designing Saudi healthcare facilities. These findings concur with previous findings (Al-Shiha 1993, Assaf et al. 1996, Al-Hammad et al. 1997, Al-Khatam 2003, Hoe 2009, Razak and Jaafar 2012, Buys and Roux 2014, De Silva and Ranainghe 2010, Hassanain et al. 2013). However, conducting interviews and a questionnaire with relevant participants could be behind the additional sources of design process flaws identified, which provided a specific, clear understanding about the design defects that related to skills, personalities and thinking strategies leading to flaws at the design stage.

11.11.2 DESIGN FIELD ISSUES

Based on this study, DIAIs originate from two types of design issues viz design defects and faults, identified in a number of design fields. In line with previous studies, this study confirmed five types of design field issues with different design defects in each field. These are specification writing /information issues in brief materials, electrical design issues, construction design issues, architectural design issues and specification/information issues in drawings (Al-Shiha 1993, Assaf et al. 1996, Al-Hammad et al. 1997, Al-Khatam 2003, Hoe 2009, Razak and Jaafar 2012, Buys and Roux 2014, De Silva and Ranainghe 2010, Hassanain et al. 2013). The design field issues found in those studies related to other facilities, and the sources of these design defects were in the design, site management, construction and operation stages. By tracking those design issues, flaws in the design stage, plumbing, mechanical, civil, life safety, life security, equipment planning, hospital budget, hospital schedule and financial planning were identified as new types of design field issues in the context of Saudi hospital design. These additional field issues in design were identified because of the involvement of interested parties in the planning of, designing and operating Saudi hospitals and who deal directly with designed environments of patient with patient himself in this study. These design issues in different fields may initiate DIAIs in hospitals (Moullin 2002, West 2006, AIHW 2015).

11.11.3 AREAS IMPACTED BY DESIGN ISSUES

Healthcare services, patient safety, security and health are the areas impacted by those design issues within different fields of design. Firstly, they had social, physical, psychological and financial impacts on patients that increased pain and stress factors. Those factors may affect the immune systems and slow the recovery process. This study found these impacts were the result of (DIAIs) associated with the DDs and DFs of design fields. This study confirmed falls (Hanger et al. 1999, Grasso et al. 2001, Capezuti et al. 2002), infections (Shirani et al. 1986, McManus et al. 1992, McManus et al. 1994, Thompson et al. 2002) and medication errors (Cook et al. 2000) associated with mechanical, architectural, electrical design and specification issues. Those 13 identified types of design issues adverse incidents (DIAIs) associated with the DDs and DFs in 11 types of design fields issues.

Secondly, the provision of healthcare services was impacted by design issues that led to the prevention or delay of diagnostic and therapeutic plans of patient, which indirectly impacted

patient recovery processes as well as healthcare services expenses (Gouin and Kiecolt-Glaser 2011, Linton 2000). This study found the lack or unavailability of the space and equipment required contributed to this.

11.11.4 SOLUTIONS TO EXISTING DESIGN ISSUES

Based on this study, the suggested design process to resolve current design issues can be in two stages within four phases, as described in Section 11.7. Although a similar conclusion to Stage 1 was reached by Reekie (1972), this study presents a second stage for measuring the validity of solutions in terms of protecting, supporting recovery process and providing complete healthcare services.

11.11.5 HEALING ASPECTS IN DESIGN

This study found 13 healing aspects of design elements involving social, spatial, luminous, thermal, audio, spiritual, safety, security, aesthetic, freedom, object usage, movement, privacy, and technological aspects of design. Patient sensory systems reacted to these aspects in positive and negative ways. From the fact that stress and pain impact the immune systems, the consideration of these healing aspects at the design stage led to a decrease in psychological (stress) and physical (pain) harm and effects the healing process. These aspects of design were supported by previous research identifying the specific design elements to cater for the beliefs, culture, history and traditions in Saudi Arabia (Hermann et al. 2016; Mahmoodi, Zilber 1993, Arneill and Frasca-Beaulieu 2003, Ogbonna and Harris 2008, Hashiguchi et al. 2005, Grumet 1993, Pattison and Robertson 1996, Carpman and Grant 2016, Gallagher and Edelstein 2004, Eberhard 2009, Ulrich 1991, Ulrich 1999, Ulrich et al. 1993).

11.12 THE LINK BETWEEN DESIGN PROCESSES AND RECOVERY PROCESSES FOR IMPROVING THE DESIGN STAGE

Figure 11.20 presents a summary of the key findings in five areas: (A) DIAIs that originate from design issues and that areas they impact, (B) design fields issues produced by flaws in the design stage, (C) flaws in the predesign and design processes, (D) sources of flaws in the design process, and (E) healing aspects in design.

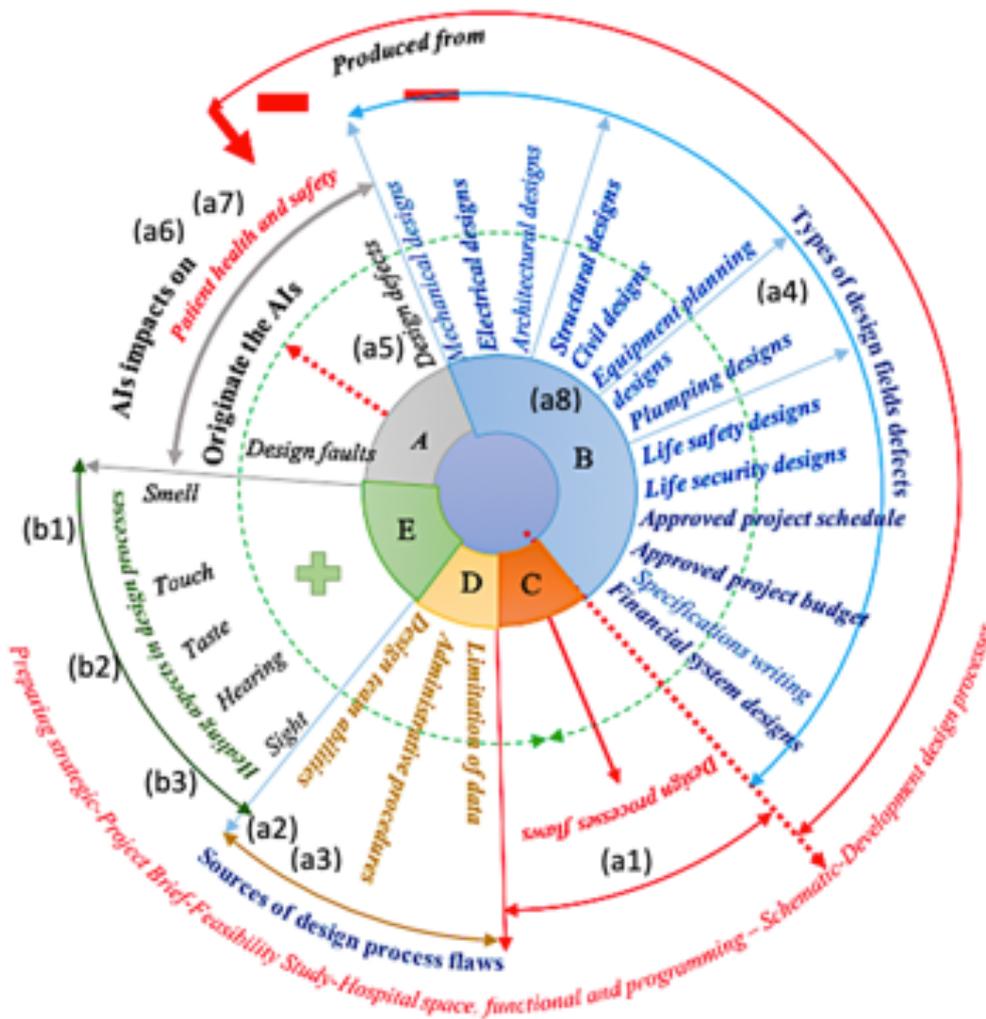


Figure 11.20: Summary of key findings

These identified areas can improve the design stage processes of future hospitals to ensure that they are free of design defects and faults and simultaneously to provide complete diagnostic and therapeutic plans and create a therapeutic hospital for supporting patient recovery.

To achieve the aim of this research, which is to fill the knowledge gap between design and recovery processes through solving design issues that lead to DIAs and impact patient health and safety and the quality of healthcare services, this study found 11 areas that link the built environment and healthcare systems domains. Through grounded theory methodology, including theories and data analysis from seven methods, the extracted data were grouped into categories and then to concepts to deal with the research areas.

The conceptual framework documented in Figure 11.19 represents the key findings of data analyses under two concepts of managing the pain and stress that negatively and positively affect recovery processes in physical and psychological matters.

It is important to minimise or avoid the impact of DDs and DFs to manage the pain and stress produced by DIAIs. This involves tracking flaws in the design process (labelled C); linking design process flaws (a1) and the sources of these flaws (labelled D) involves designers' abilities issues (a2) and administrative issues (a3); types of design fields issues (labelled B: a4) originated by design process flaws and producing design defects and faults (a5); and design process flaws (a1); impacted areas by DIAIs (labelled A) involves recovery processes(a6) and diagnostic and therapeutic plans (a7); design issues' solutions and missing factors in the current hospital design (a8).

Managing pain and stress as reasons to visit and stay in hospital includes consideration of senses (labelled E) and uncomfortably designed components and stressful elements (b1), reactions of patients' senses (b2) and healing aspects in spaces design (b3) to support recovery process. As a result of these identified areas, the study proposed a framework of integrated solutions for protecting, supporting patient recovery and providing complete services (ISPSPP) as strategies to avoid flaws in design processes that may initiate design defects and faults in the operation stage.

11.13 RESULTS AND DISCUSSION OF QUANTITATIVE DATA

11.13.1 DESCRIPTIVE STATISTICS RESULTS

The main aim of Figure 11.21 is to determine the participants' opinions (design, maintenance and management teams) on the all-design issues aspects issues in context of Saudi hospitals, which indicates a high degree of agreement level on the research areas findings.

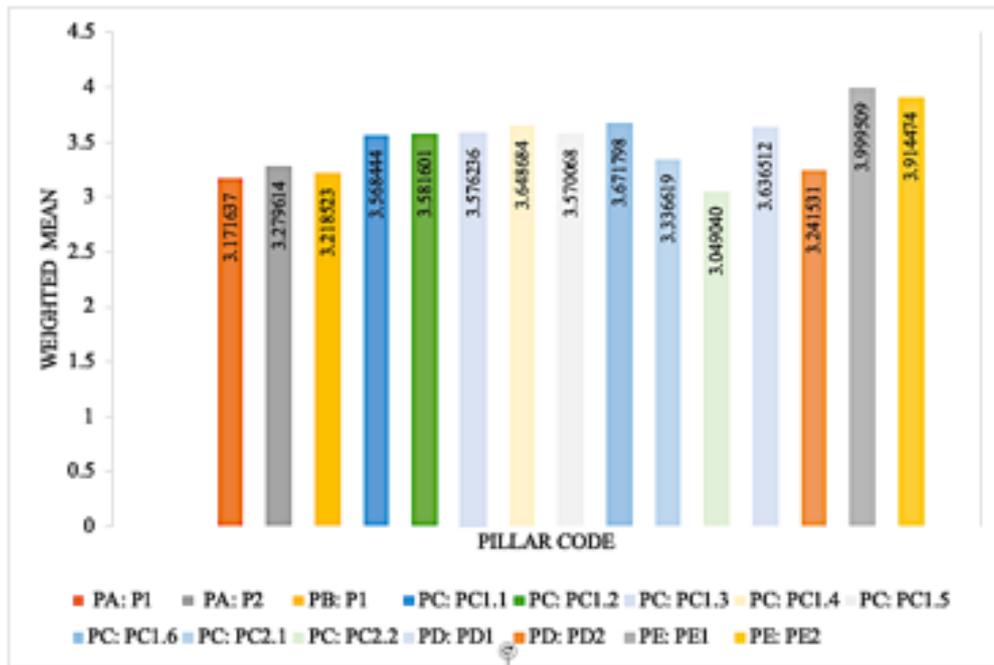


Figure 11. 21: Mean scores of impact value of all pillars

This Figure shows that there is a little difference between the means scores of agreement levels for the 15 areas. This indicates that the most of participants agree on the identified flaws in design processes, sources of these flaws, types of design fields issues, impacted areas by those design issues and mechanisms of patient reactions to design aspects. Together, the present findings confirm the difference between the smallest and highest impact values of the types of design issues, impacts and results in (1) the operation stage including 4 areas: DIs course, and DIs impacts, design fields issues and sensory system reactions within the design issues circumstances area, and (2) the design stage including 4 areas: predesign phases, design phases, sources of design-processes flaws and the design healing aspects, as shown in Table 11.1.

Table 11.1: Degree of agreement of both teams' members on the design issues course in the design and operation stage.

Stage	Areas	Research areas name	Area code	Mean	R1	R2
Operation stage	Design issues circumstances	Design Issues Course	A: Part 1	3.171	4	14
		Design issues Impacts in operation stage	A: Part 2	3.279	2	11
		Design fields types issues in operation stage	B: Part 1	3.218	3	13
		Sensory systems reactions	E: Part E1	3.999	1	9
Design stage	Pre-design phases	Phase 1: The preparing identification processes flaws	C: Part C1.1	3.568	6	6
		Phase 2: The hospital projects brief processes flaws	C: Part C1.2	3.581	3	7
		Phase 3: Feasibility study processes flaws	C: Part C1.3	3.576	4	4
		Phase 4: Hospital building programming processes flaws	C: Part C1.4	3.648	2	8
		Phase 5: Hospital building functional programming processes flaws	C: Part C1.5	3.570	5	3
		Phase 6: Hospital building space programming processes flaws	C: Part C1.6	3.671	1	10
	Design phases	Phase 1: Schematic design processes flaws	C: Part C2.1	3.336	1	15
		Phase 2: Design development processes flaws	C: Part C2.2	3.049	2	5
	Source of design flaws	PART D1: Administration flaws	D: Part D1	3.636	1	12
		PART D2: Design team abilities flaws	D: Part D2	3.241	2	1
	Healing design aspects	PART E2: Healing design aspects	E: Part E2	3.914	1	2

11.13.1.1 IN THE OPERATION STAGE (DESIGN ISSUES CIRCUMSTANCES AREA)

Area E: Part E1 (Sensory systems reactions: uncomfortably designed space elements and stressful components that affected the healing process) has the first impact value on patient reaction with the highest mean score (3.99). This pillar involves uncomfortably designed space elements and stressful components affecting patient reactions to designed environment through six factors: sight, hearing, smell, touch, test and physical movements factors. Sight factor with mean score of 4.1710 with standard deviation of 0.9001 has the highest impact value on patient reaction and the taste with mean score of 3.78 and standard deviation of 1.1698 has the lowest impact value.

Area A: Part 2 (impacts of design issues on the recovery process and the healthcare services provision) has second value with a mean score of 3.27 and the standard deviation is 0.077. This pillar involves five impacted areas by design issues: the delivery the healthcare services, adding new healing processes, expanding the healing process, increased cost and time and lead to patient escaping. Concept of *DDAIs have physical and psychological impact* with mean score of 3.40 with standard deviation of 0.940 has the highest value and *concept of Design faults*

(DFs) with mean score of 3.19 and standard deviation of 0.894 has the lowest value. Expanding the healing process impact with mean score of 3.40 with standard deviation of 0.940 has the highest value and Increased cost and time impact with mean score of 3.19 and standard deviation of 0.894 has the lowest value.

Area B: Part 1 (Design fields types issues) has the third value with a mean score of 3.723 and the standard deviation is 0.086. This pillar involves 13 types of design fields issues identified: architectural, construction, mechanical, civil, life safety, life security, electrical design, specifications writing, equipment, plumbing design, budget approved, schedule approved and financial planning system. Design issues in Life security field with mean score of 3.328 with standard deviation of 1.011 has the highest value and design issues in Electrical design with mean score of 3.105 and standard deviation of 1.040 has the lowest value.

Area A: Part 2 (the research concept definitions or design issues course) has fourth value with a mean score of 3.17 and the standard deviation is 0.072. This pillar involves eight concepts of the research areas: Design Defects Adverse Incidents (DDAIs), DDAI types, Design faults (DFs), Design defects (DDs), Physical impacts of DDAIs, Psychological impacts of DDAIs, Design process flaws (DPFs) and DDAIs impacts. Concept of DDAIs have physical and psychological impact with mean score of 3.40 with standard deviation of 0.940 has the highest value and concept of Design faults (DFs) with mean score of 3.19 and standard deviation of 0.894 has the lowest value.

11.13.1.2 IN THE DESIGN STAGE

The presented results are divided into four areas: predesign process flaws, design process flaws, sources of design stage flaws, and healing design aspects considerations.

Research area of Predesign process flaws involves flaws in six phases of processes: the preparing identification processes, the hospital projects brief processes, feasibility study processes, hospital programming processes, hospital functional programming processes and hospital space programming processes. *Phase 6: hospital space programming processes flaws* with weighted mean of 3.671 with standard deviation of 0.096 has the highest value impact leading to design issues in operation stage and *phase 1: the preparing identification processes*

flaws with the weighted mean of 3.5684 with standard deviation of 0.0829 has the lowest value impact.

Research area of Design process flaws involves flaws in design process of two phases: phase 1: Schematic design process and phase 2: design development process, where the phase one has the highest value of causing design issues with weighted mean of 3.0490 and with standard deviation 0.0619.

Research area of Sources of design stage flaws involves two main sources of flaws in design stage: administration issues and design teams' issues. Issues in design abilities and skills with weighted mean of 3.2415 with standard deviation of 0.0833 has highest value impact leading to occurrence of flaws in design process than the issues in administration managers of design team.

Research area of Healing design aspects considerations involves twelve aspects in design stage in order to support recovery processes physically and psychologically. these aspects in design are spatial, luminous, thermal, audio, social, spiritual, aesthetic, technology, safety, security, objects usage and privacy. consideration of Spatial design aspect with highest mean score (4.026) with standard deviation of 0.9377 has highest value impact in order to support patient health and security aspect consideration with mean score of 3.710 and standard deviation of 0.94961 has the lowest value impact, as shown in Figure 11.20 which shows the mean scores of agreement level on the healing aspects in design. Overall, sensory systems reactions of patients factor with weighted mean of 0.1855 with standard deviation of 0.18552 has the highest value among the 15 research areas and Phase 2: Design development processes flaws with weighted mean of 3.0490 with standard deviation of 0.0619 has the lowest value.

11.14 TESTING OF RESEARCH HYPOTHESES

11.14.1 CALCULATING AND REPORTING CRONBACH'S ALPHA RELIABILITY

the calculated values of Cronbach's alpha for all research areas (see appendix D: Part D), which are more than 0.88%. These high values of Cronbach's alpha indicate excellent internal consistency of the items in used scale. In other words, more than 90 % of variance in the scores

is a reliable variance, therefore, less than 10 % is errors variance. However, it is noted for Area C (C2.2: Phase 2: Design development processes flaws) that alpha is more than .80 %, but it can be considered as a good reasonable target (George and Mallery 2016).

11.14.1.1 RESEARCH HYPOTHESES TESTING: FROM CORRELATIONAL STATISTICS

Null Hypothesis [Ho]: There is no significant relationship between design and maintenance teams' decisions in the research observation areas.

The null hypothesis in each area that $p = 0$ is rejected because the correlation is significant different from zero and the correlation between two groups exists. However, the results of all pillars together indicate that there is evidence to suggest a very strong (0.60 - 0.79) correlation ($r_s = 0.7535$) between the both groups' agreement ($p = 0.0001 < 0.05$) at 97% statistical significance level, as shown in Figure 11.22.

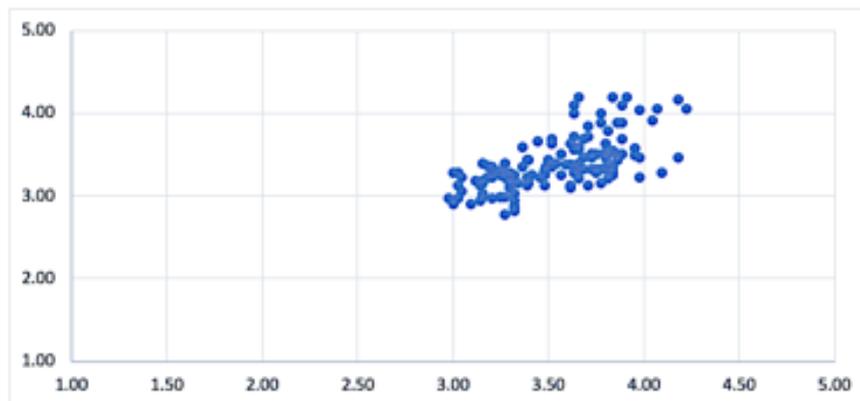


Figure 11. 22: Correlation level of means of both groups' agreement in all research areas

Figure 11.22 shows a strong correlation between the groups' agreement on all areas of both built environment and healthcare domains circumstances in the context of Saudi hospital design process issues.

11.14.1.2 RESEARCH HYPOTHESES TESTING: FROM INFERENCE STATISTICS:

Hypothesis 1 [H1]: The mean of maintenance team's agreement is the same as mean of design teams' agreement in the research observation areas.

Comparing the p-values to the significant level: $0.001 < 0.005$, the H_0 is rejected. At 5%, We have enough evidence to support the alternative claim that the mean of both teams is different, and the mean of maintenance team's agreement level is slightly higher than the mean of design team's agreement levels. This was not expected because both teams dealing with hospital building environment. The potential reason to explain this rejection is that maintenance team dealing with design issues directly but the role of the design team dealing with design stage only. Overall, the difference between means of both teams' agreement levels on research observation areas is very low as shown in the Figure 11.23.

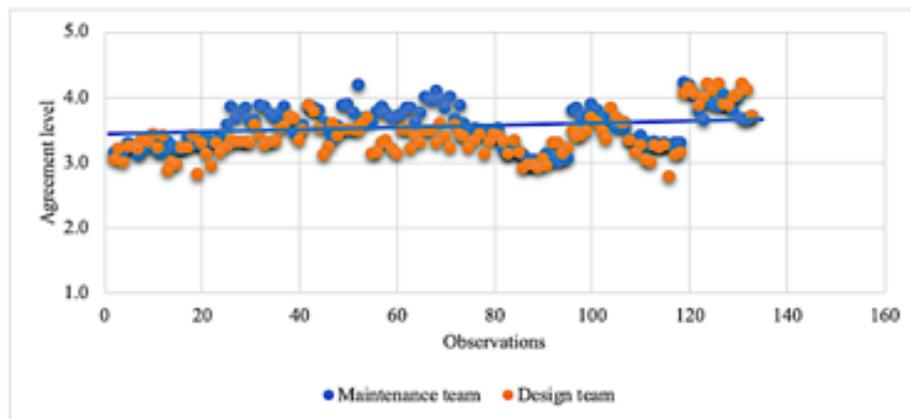


Figure 11.23: Difference between the means of maintenance and design teams' opinions

11.15 SUMMARY OF RESULTS AND DISCUSSION

This chapter presents the key findings of this study for discussion through four perspectives: (A) two main mechanisms to manage the pain and stress; (B) proposed ISPSPP framework; (C) the highest and lowest value impacts of design issues on patient health, safety and healthcare service, (D) the test of the research hypotheses.

Firstly, mechanism for managing pain and stress as result of DIAI impact to protecting recovery process and providing a complete care service including mechanism of occurred design process flaws and design issues, mechanism of occurred design process flaws and responsible parties in design stage, mechanism of designers thinking issues during design processes (objective 1), mechanism of design faults and defects in the operation stage and flaws in design stages within types of design fields issues (objective 2), mechanism of DIAI impact on patient recovery processes, mechanism of design issues and the healthcare services provision, mechanism of indirect impact of incomplete care services and recovery process, mechanisms of occurred design issues effects and impacted areas, mechanism of DIAIS outcomes and design issues, mechanism of healthcare services outcomes and design issues, mechanism of design process to resolve the current design issues (objective 3). (2) mechanisms for managing pain and stress as reasons to visit and stay in a hospital to supporting healing processes including, mechanisms of patient sensory systems and healing aspects of design element, mechanism of uncomfortably designed components, stressful elements and sensory systems, mechanism of therapeutic space designs aspects and recovery processes, mechanism of patient sensory systems reactions to space design elements, mechanism of factors affecting patient sensory systems reactions to space design elements and mechanism of flaws in the design stages and healing aspects in design (objective 3).

Secondly, the ISPSPP Framework presents the summary of processes, procedures, methods, principles and theories in order to improve the design processes in three areas: inputs data, types of interested groups, main trigger factors in design including protecting, supporting recovery process and providing complete care services and ruling principles to solve design issues and create a new design (objective 4).

Finally, this chapter presents the highest and lowest value impacts or considerations of identified factors in the findings of design issues in the operation and design stage. Fourthly,

two hypotheses were tested and reported: the null hypothesis [Ho] in each area that $p = 0$ is rejected because the correlation is significant different from zero and the correlation between two groups exists and alternative hypothesis [H1] is rejected because the mean of both teams is different.

12.0 CONCLUSION

12.1 INTRODUCTION

In this section, ten areas were presented: addressing the research aim and objectives through reviewing the introduction, methodology and results chapters, the original contribution to knowledge, findings extracted from 13 chapters, research significance, limitations, future researches for the researcher and other, recommendations, impacted areas by this research findings in academic, policy, economic, social, technological, environmental, legal, importance of research claims and research scope.

12.2 ADDRESSING THE RESEARCH AIM AND OBJECTIVES

the aim of this study is to develop a framework for hospital design that can protect and simultaneously facilitate the recovery of patients and provide complete healthcare services in public hospitals in the KSA. To achieve this aim, four objectives have been set. these objectives achieved through investigating 18 research areas of each objective and reporting the hypotheses as follows:

Object 1: to analyse the current design processes of public hospitals in the KSA and identify the design issues during the operation stage, this study identified the missing factors and flaws in design stage that lead to design issues in the operation stage. To achieve this objective, the study sought to find out the parties responsible for causation factors of design issues in the design stage, their sources and how they are dealt with by the SMOH.

Object 2: to identify the effects of design issues on patient health and safety and identify the roles of the parties responsible for preventing design issues during the design process. The study explored the manifestation of design issues in the operation stage by looking into why and how did design issues occur in the occupancy stage, how designers can deal with them, their effects on patient recovery and; how they transform into adverse incidents (AIs). In addition, the study investigates the types and locations of AIs, the impact (and risk levels) of AIs on patient recovery and healthcare services, how designers can prevent AIs as well as stress aspects of design that affect patient recovery.

Object 3: to analyse supportive features that impact patient healing and identify their direct and indirect effects on physical and psychological health. The study identified features (i.e. healing aspects in design) supporting patient recovery, and of stress aspects of design. It sought to know how these aspects of design protect and facilitate healing process of patients simultaneously, and how patients react to them. The study also looked into how designers can understand patient sensory systems' reactions to design elements and components.

Object 4: to develop a framework towards hospital design in public hospitals in the KSA so that patient recovery is fostered and protected. This study proposed the ISPSPP framework, presents a summary of the processes, procedures, methods, principles and theories used to improve design processes in three areas. First, **input** data for design development were looked at from three sources – care receivers and service providers, the project team (design, construction and maintenance inclusive) and the design administration. The study found the main trigger factors to create optimal solutions in design to include protecting and supporting recovery process and providing complete care services. A set of overarching principles to solve design issues or create new design solutions include the selection of the design process methods, thinking strategies and hospital design principles and avoiding administrative flaws and improving design team abilities, skills and knowledge. Secondly, there is the **implementation** of processes of design phases in predesign and design stages. Thirdly, **outputs** monitoring and evaluations produce future hospitals based on the success recorded on previous processes.

The study used multiple methodologies and methods to achieve its objectives, involving different groups of participants that included design, construction, architecture, maintenance, care providers, public administrators and health and safety management personnel

Based on rating scale, scoring systems, statistical formulae techniques used for quantitative data analysis, two hypotheses were tested and reported: the null hypothesis [Ho] in each area that $p = 0$ is rejected because the correlation is significant different from zero and the correlation between two groups exists and alternative hypothesis [H1] is rejected because the mean of both teams is different. The hypotheses helped to identify the most important factors in the design stage leading to design issues in the occupancy stage.

12.3 CONTRIBUTION TO KNOWLEDGE

This research project contributes to extant literature by promoting patient health and safety by urging complete care service to be at the heart of hospital design. It examines the establishment of an environment that can be embedded in the early stages of hospital design in order to provide a safe and protective environment that affects the psychological and physical health of patients positively. The research problem was identified from flaws in the current design process of hospitals, and the research gap is to present a bridge between the built environment and the healthcare domain, with a view to improving the design features of hospitals in KSA and to create better hospitals in future that are free of design defects and faults.

Contributions of knowledge of this study covered six major areas:

- **Research areas:** This study investigated two domains using three management tools. First, the built environment domain, which includes construction and design management. The domain focuses on the stages of designing, constructing, equipping and operation and maintenance. The design stage is the first stage of project development and involves the predesign and design stages. Findings from this study target parties that are responsible for those stages, design thinking, design issues and the healing aspects of the design. The second domain is the healthcare domain, which includes safety and healthcare management, involving patient safety and health management. This domain covers adverse incidents (AIs) originating from design issues (DIs), DIs' impact on the patient healing process and on patients' senses in reacting to designed space issues and features. Through these two domains, this study discusses the potential links between six concepts in the design and operation stages. In the operation stage, these include: patient healing processes and AIs, design issues and the occurrence of AIs, aspects in design that support the recovery process and design issues and care services. The concepts in the design stage include flaws in design processes and design issues, physical and psychological aspects of the design process and healing processes, design process flaws and their sources.
- **Research gaps:** The study creates an indirect link between design processes in the built environment and the healing processes of the healthcare domain and uses research

interventions to improve design, to support healing and to provide a complete examination, diagnostic and therapeutic planning.

- Avoiding design issues is identified as a **Research problem**. The study focuses on how the creation of an environment that is conducive to fewer AIs can be embedded in the early stages of the hospital design process in order to provide a safe and protective atmosphere that will affect the psychological and physical health of patients positively. In addition, the focus here is on fostering supportive events within the patient environment that will facilitate recovery.
- **Research methodology**: The research was premised on certain claims and hypotheses, and these had triggered the adoption of pragmatic paradigm and a mixed method approach for data collection. This process involved three stages, eight methods, six forms of participants, eight case studies drawn from four locations in the KSA.
- **The overarching finding**: a framework for managing patient recovery through design solution was proposed. The framework has been drawn from recommendations, research hypotheses have been created, and tested and a framework as design solution for protecting and supporting patient recovery and the provision of complete care services was proposed. This framework can be measured from two perspectives. First, through healthcare service measurements e.g. analysis that shows a reduction in the number of design defects, number and risk levels of AIs, length of patient stays, pain medication use, patient and healthcare satisfaction and the quality-of-care services provided by hospitals. Second, healing aspects of the care space can be assessed according to the level of patient comfort, mental status, general well-being, anxiety, depression, pain, sleep disorder, infection, stress behaviour, weight gain (e.g. patients in Neonatal Intensive Care Unit Paediatric (NICU) and Intensive Care Unit (PICU)), heart rate, respiration issues and blood pressure.
- The sixth area of contribution stems from this study identifying the variables of design issues in the occupancy stage by type, impact, process (e.g. flaws in pre-design inputs and design process outputs), source, element and interaction with patient sensory systems. Therefore, these findings can be implemented in teaching future architects and design teams, shaping future practitioners and influencing policies, design standards, practice

guidelines for healthcare facilities, and impacting community confidence positively. In addition, the implication of the findings from this study is such that future patient experience in local systems will improve, and will raise more intriguing questions in hospital design for further investigations.

12.4 SUMMARY OF KEY FINDINGS

Emphasis was placed in Chapter One on the need for hospitals to be free from design issues and that design solutions must support healing. These were highlighted as an important common area between built environment and healthcare domains. Acknowledging design issues at early stage of the hospitals design is essential and is associated with improvements in design processes for future public hospitals in KSA by putting patient recovery and complete healthcare services provision as the design priority.

A review of the previous literature was presented in Chapter Two shows many events can impact a patient's recovery process under the following assumptions:

- AIs can have direct or indirect effects on patient recovery through their interaction with the environment.
- The resulting incidents can be traced back to design defects that potentially affect patients both the physical (pain) and psychological (stress) aspects of patient's healing process.
- Design defects can be avoided by paying more attention at the early stages of main design processes.
- Design defects can be traced back to flaws in design process.
- The indirect relationship between the design process and healing processes of patients in the occupancy stage can be explain through AIs originating from design defects and affecting patient safety and health. These defects are caused by flaws in design processes.
- Creating appropriate care spaces to support healing processes through consideration of design aspects as positive events can be implemented by paying more attention to healing aspects of design at the early stages of design processes.

Chapter Three contains a detailed analysis of the pros and cons of the various methods used in collecting data for this study. The tools were literature review, participants observation, archival study, interviews and questionnaires. Mixed-method approaches were used in this study so as to increase the reliability as well as the validity of the data collected. Inductive and deductive approaches were implemented to achieve the aim and objectives of the research. In particular, inductive approaches were used to identify the causes, impact and sources of design defects in order to define and address the design defects. This was adopted in the first stage of data collection by applying qualitative methods.

In addition, a deductive approach using quantitative methods (questionnaire) was applied to measure the relationship between environmental issues and: (1) AIs and their impact on patient health, (2) effects of design defects and AIs, (3) patient reactions and AIs, (4) flaws in design processes and design defects, (5) sources of flaws in design stages and (6) healing aspects of design that can be linked to issues in Saudi hospitals' design processes.

Chapter Four presents the framework for the analysis of literature reviews. The research gaps and problem cycle were presented in five areas: sources of flaws, design process flaws, types of design issues, areas impacted by design issues and stress and healing aspects of design in the operation stage.

In Chapters Five to Nine, the extracted data from the eight sources named above were analysed within these five areas Chapter Ten validates findings from Chapter Five to Nine by analysing participants' opinions on the impact of design issues and participants' considerations of identified factors regarding the manifestation of design issues in relation to patient healing during hospital's operation and design stages. Two hypotheses were tested and reported.

Chapter Eleven presents the key findings of this study for discussion through two mechanisms: first, managing pain and stress as result of the impact of DIAIs to protecting recovery process and providing complete care services; and managing pain and stress as reasons to visit and stay in a hospital to support healing processes.

12.5 SIGNIFICANCE OF THE STUDY

- Encouragement of responsible decision-making among participants in every stage of designing a new hospital, by addressing the ways that design can support patient health.
- Increased knowledge amongst design professionals about the relationship between design and patient health, with a view to improving design.
- Creating future hospitals that are free from design flaws.
- Improving hospitals by shifting their design towards patient health and safety rather than just a location for medical services

12.6 LIMITATIONS

Several limitations have been noted while gathering data for this research. The first limitation was during the translation of the interviews and questionnaires from English language to Arabic, and the answers from Arabic to English. Some data may have been lost inadvertently or become inaccurate during to translation issues. Also, some participants withdrew their participation in the interview because they were not willing to describe negative issues in case this jeopardises their future healthcare. Some fear of victimization could have meant that some of the opinions given by some participants were not entirely accurate. There is no way the researcher could have deciphered this. In addition, some participants said “This interview contains many boring questions”. As the research for intended for a purpose, and not to entertain participants, the researcher was not able to meet their requirement is making the data collection more interesting.

Some questionnaires received were not included in the analysis because they were submitted to the researcher by the manager of design team and not directly by participants. The view of the researcher was that such participants may have been manipulated; however, this may not be entirely true. Another reason for refusing to respond to the questionnaire may be related to the effort and time to read and evaluate 132 statements within 15 areas of investigation in the survey. Some of the statements in the research instrument read like a criticism of the source of design issues as weakness in the abilities and designers’ thinking strategies and managers at a very senior level within the Saudi Ministry of Health. This may have added sensitivity to the research instrument, although the survey had intention to elicit new concepts such as the healing process and sensory systems affected by design issues which may not relate to

maintenance fields or may need more of contextual explanations by participants. Information regarding to participants such as nationality, age and gender, was not included in instruments of data collection. Not least, the research is a trained architect and a public offer, whose understanding and primary knowledge of the research problem may have triggered some personal bias

Finally, time also proved to be a constraint during the conduct of this research, especially the time needed to study, analyse, test and evaluate the redesigned projects and the ISPSPP framework. In addition, the research come not meet the required time needed for building database for design issues cycle in Saudi healthcare facilities to reduce DIAIs, to improve patient health and safety, provide healing environment for patient and reduce the processes and costs of redesigning, restoration and operation as required to develop design standards for new Saudi public healthcare facilities.

12.7 RECOMMENDATIONS

Directions as well as recommendations for future research were provided, targeting Saudi MOH, Ministry of Education, Design team management and design teams, hospital management, medical equipment and furniture producers. These recommendations are presented in order to protect and support recovery process of patients by improving the design processes of KSA hospitals.

12.7.1 DIRECTIONS FOR FUTURE RESEARCH

This study focuses on design issues that occurred in the operation stage as a result of flaws in the design stage. These design issues caused the AIs' impact on the recovery process of patients and affected the care services; therefore, further studies using, for example, research action design, are needed to answer the following questions in order to define, evaluate and other design issues for Saudi MOH's healthcare facilities:

- What are the design issues that occurred in healthcare facilities because of flaws in procurement, construction and operations stages or flaws by users or medical managers who engaged in modifying the design (unqualified mangers)?
- What about design issues affecting patients with specific conditions, such as prison, mental patient, or those having no hope to be treated?

- How improving design can reduce AIs caused by health providers, the management system of the healthcare organisation or the, psychological and physical behaviour of patients?
- Beyond general hospitals, what are the design issues that occur from flaws in predesign and design stages in other types of Saudi healthcare facilities e.g. specialist hospitals such as children hospitals, cancer centres, orthopaedic hospitals, ophthalmological hospital, medical research centres?
- How about a medical masterplan for KSA and a national guideline on hospital design?

12.7.2 FUTURE DIRECTIONS FOR THIS STUDY

The ISPSPP framework is intended for implementation; thus, the next stage of the research is to create an application with programming experts to test the ISPSPP and use the framework to detect design defects and faults in current and future Saudi hospital designs. After setting the inputs using extant design data, the outputs can be read and evaluated as programming maps showing whether there are design flaws, where they are and how they can be resolved. These programming maps can present the design issues, their sources from the input stage, as well as their impacts on patient health, safety and the provision of healthcare services in numbers or percentages to alert the SMOH to act before bidding and the construction stages. This can be made into developing a national guideline for the designing of General Hospitals in the KSA.

12.7.3 RECOMMENDATION FOR SMOH

In order to provide the necessary data and information to the Designs and Plans General Administration of the SMOH that is responsible for planning and designing healthcare facilities in Saudi, the SMOH should open external and internal channels with certain departments and ministries as shown in Tables 11.2 and 11.3.

Table 12.1: Internal channels for providing data to the design stage

Internal channel at MOH	Information and data types for design stage
Research and Studies General Administration	Current studies and researches in new standards, regulations, measures, principles and advanced technology in diagnosis and therapeutic plans. Evaluation of Existing hospital building to identify the issues and features of their designs.
Patient Rights and Relations General Administration	Any complain related to design issues originating AIs which have a negative impact on patient health and safety.
Safety and Security General Administration	The reasons, causes, results, impacts and corrective actions for DIAs. Safety and security standards and requirements.
Information and Statistics General Administration	The numbers, sizes, types of current and future hospitals buildings.
Financial affairs General Administration	The procedures and criteria to approve and establish a new hospital.
Infection control General Administration	The required criteria to control infection within hospital design such as used materials, devises and equipment. The types, course, way of spreading infection.
Quality and Patients Safety General Administration	Types, causes, results, impacts, risk level of occurred AIs. Patient safety and health standards, requirements and regulations.
Hospitals Affairs General Administration	types of Diseases and illnesses cases and numbers for each region. Patient types and types of diagnostic and therapeutic plans and requirements.
Legal Affairs General Administration	Any lawsuit regarding of the design issue (e.g., death and burning)
Planning - General Administration	Criteria, needs, justifications, goals and demands to plan for future hospitals
Equipment General Administration	Advanced medical and non-medical equipment requirements for space, supporting services and installation standards and regulations.
Maintenance General Administration	Any current issues related to design deficiency

Table 12.2: External channels for providing data to the design stage

External channel outside MOH	Information and data types for design stage
Joint commission international Accreditation	
The Canadian Council on Health Services Accreditation	
The Australian Council for Health Care Standards	Current demands, standards, regulations and recommendations related to design.
The he Saudi Central Board for Accreditation of Healthcare Institutions (CIBAHI)	
Food and Drug Authority	The AIs related to equipment planning issues. Standards and regulations to design, provide spaces and install equipment.
General Authority for Meteorology and Environment	The weather conditions for each region or area in KSA.
The Saudi Geological Survey	The type of soil.
Saudi Commission for Tourism and National Heritage	Design elements of cultural heritage and the origination of Saudi national identity in hospital for each region.

12.7.4 RECOMMENDATION FOR THE MINISTRY OF EDUCATION

A large majority of participants dealing with hospital design, construction and operation were not involved in hospital building when they were students and only 28% of them had studied or participated in hospital building design. Moreover, this deficiency of the education system of the design team members had the highest value impact as the source of flaws in the design process. Therefore, the engineering and science faculties (construction and architecture departments) in Saudi universities should give an opportunity to students to participate in or assign them to designing one or two types of the healthcare facilities or provide a short course about hospital building and systems design, including the users' needs and requirement with explaining the way of design thinking in using the methods, processes, strategies and principles to solve design issues or create a new designs for hospital buildings.

12.7.5 RECOMMENDATIONS FOR THE ADMINISTRATION OF DESIGN TEAMS

In order to reduce or define flaws in design processes that produce the design issues and faults in the operation stage, the administration should apply adequate quality control program through a committee that involves experts in all engineering fields of hospital design.

Moreover, hiring qualified designers and engineers in hospital designs and critical systems should follow strict criteria such as experience and knowledge in healthcare facilities design or should provide sufficient training for them to deal with the requirements of healthcare facilities design, standards, demands and the conditions of medical care services. Same principle applies to site selection.

Findings from this research suggest the SMOH should provide professionals who are required in the design stage, such as medical equipment engineers, architects medical planning (specialised in healthcare facilities designs), internal designers and life safety and security systems designers to make contributions during design development.

In addition, the SMOH should develop communications channels between the different departments in the hospital design stages, especially between the study and design administration and the equipment and furniture administration at the MOH level and between engineering affairs in regions and general projects administration in the MOH.

It is equally important for the SMOH to limit the use of authority as manager to modify designs without sufficient justifications and qualification.

Not least, the SMOH hierarchy should encourage the participation of participants from the local community, end-users, maintenance and construction teams to contribute to solving design issues whether through a thorough analysis of existing hospitals or while designing future hospitals.

12.7.6 RECOMMENDATION FOR DESIGN TEAM MEMBERS

The data and information required for solving design issues [e.g. to define sources of design issues in the operation stage, or to analyse them and to create multiple solutions to design issues], should include:

1. The signs and symptoms of the patient physical and psychological trauma.
2. The methods, stages and equipment for diagnosis and treatment plans including clinical history (medical records), interview exam, physical exam, visual exam and diagnostic testing spaces such as laboratories and imaging departments
3. The conditions and behaviours of the diseases and illnesses as cause of health problems within space components and designs.
4. The way of spreading and number of current diseases, illnesses and viruses
5. The procedures, types and plans for the treatment of disease such as medication, chemical, radiation, palliative care and surgery
6. Predicting the course of the disease after and before it appears
7. The follow-up for patients after the main treatment: blood tests, imaging tests and physical examinations. Movability analyses of patients across these elements are important also.
8. Type, size, gender, culture and health issues of patients
9. The movements lines of users, materials and equipment as contaminated or uncontaminated objects within corridors in a hospital
10. Spaces functions and activities types and amount
11. Patient's data and information movements

12. The designers should use the design thinking strategies that include sufficient use of imaginations, group discussions and evaluation of solutions suggested to solve design issues.
13. Designer should increase design knowledge of hospitals by means of communication with and feedback from patients and users to understand the needs and the requirements for selecting the best solutions.
14. Designer should improve their design skills in the ability to use software, communication with other members of design teams, ability to imagine the solutions with reactions, opinions and senses of patients in spaces.
15. Designer should improve their abilities to convey and present the reactions of patients to the design elements.

12.7.7 RECOMMENDATION FOR HOSPITAL MANAGEMENT

To provide the data and information required for solving design issues or recognizing the features in existing hospital design and avoiding these issues in future hospitals, the Saudi hospital management should raise any issues in design-to-design teams with detailed descriptions of the field, cause, impact and source of design issues with explanation on how this issue impact patient health, safety, security and their reactions.

12.7.8 RECOMMENDATION FOR MEDICAL EQUIPMENT AND FURNITURE PRODUCERS

Besides providing essential information for installing and using equipment, the equipment and furniture companies should consider the following aspects:

- Decrease the level of equipment alarms, especially in the NICU
- Improve size and colour of equipment
- Provide equipment that is free from sharp edges with soft surfaces
- Provide equipment that is made of antibacterial materials
- Presents the environment condition of equipment in details in which the equipment operate

12.8 DOMAINS IMPACTED BY THE RESEARCH

Findings from this study may influence seven domains as follows:

12.8.1 ACADEMIC DOMAIN

The purpose, objectives, gaps and problems of this research have been built upon existing knowledge to achieve a better understanding of research areas as well as build new knowledge, ideas, and create a better understanding of hospital design process. This research has led the researcher to being more confident in applying critical thinking and research methods during the PhD journey and their everyday life and faith. This research will lead to future research in other fields of hospitals design and management. The researcher has covered an enormous range of issues, principles, theories and strategies surrounding patients' healing process from a range of issues relating to AIs – their causes, sources and impact, design defects, design process flaws, therapeutic architecture and environment, design thinking roles multiple teams in hospital design

12.8.2 POLICY DOMAIN

This study presents the critical importance of missing factors in hospital design stages such as lack of community participation in the early stage of hospital design, which may impact decision makers at the high level of MOH in predesign process (preparing strategic direction, project brief and feasibility study). Such involvement is to recognize current and future demands, requirements in designing a new hospital and considering patients' physical and psychological demands. The study concentrated on improving design process to designing and developing the therapeutic environments that are free from design defects, supporting patients' healing process. These are within the mandates of MOH's vision, mission and objective in establishing new hospitals. In addition, the study claims applying required standards, policies and requirements for health and safety in Saudi hospitals will improve design processes and outcomes. Policy implications of this include isolation and discharge policies, infection control policies and patient fall prevention policies (e.g. Essential Safety Requirements (ESR) and International Patient Safety Goals (IPSG), the Joint Commission International (JCI) and the domestication of the Canadian Council on Health Services Accreditation (CCHSA) standards, the Australian Council for Health Care Standards (ACHCS) and the Saudi Central Board for Accreditation of Healthcare Institutions (SCBAHI) standards).

12.8.3 ECONOMIC DOMAIN

Knowing patients' requirements and future demands in the early stage of hospital design will help them avoid the cost required for any additions or expansions in hospitals spaces. This study has shown there are evitable costs that associate with ineffective running of public hospital hospitals, episodic renovations or variations to infrastructure and hospitals' critical systems. Solving these problems will help KSA to create the therapeutic environments that will increase Saudi public hospitals' reputation and make them to be in a competitive position with private hospitals.

12.8.4 SOCIAL DOMAIN

AIIs that originate from hospital design process are produced by design defects and flaws. They delay healing process and prevent the provision of healthcare to patients and lead to prolonged hospital stay. Improvements in design process will reduce the period of hospital stays and allow patients to return to their normal life. Their productivity will increase and the financial gain from this will help them to support their family and community. When patients stay longer in hospitals than necessary, the costs on healthcare facilities and caregivers must rise. Such time and resources taken by prolonged stay had meant other patients requiring care are not able to access care. In addition, patients' beliefs, principles and values are considered in designing therapeutic environment as part of their community atmosphere. The additionality of this to community aesthetics is significant.

12.8.5 TECHNOLOGY DOMAIN

The study encourages the deployment of responsive advanced medical technologies in Saudi hospitals. It is important they are considered at the very early stages of hospital design processes so as to reduce the costs, optimise hospital stays and support patients' healing processes. They are also important in providing communication tools to give patients the sense of freedom to control their choices in their care spaces.

12.8.6 ENVIRONMENTAL DOMAIN

This research considered the solution of proper waste management design in the early stage of design process as way to prevent infections from hospital wastes, by recognising internal and

external movements of wastes, collection, storage and disposal of both medical and normal wastes in order to avoid their impact on the environment.

12.9 THE ADDITIONALITY OF THE RESEARCH

This study found the indirect link between design processes of hospital building and the recovery processes of patients as research gap. This link was identified by tracking the 16 types of design fields issues in operation stage. These issues in design have physical, psychological, social and financial impact on patient status in direct way and had affected the diagnostic and therapeutic services. These identified design issues impacted recovery processes by increasing the pain and stress, in which led to an increase respiratory rate, fever, heart rate, blood pressure and oxygen demand, which can affect the immune system to response to the treatment plan.

12.10 RESEARCH SCOPE

This study provides evidence from eight case studies. Most studies discuss the design issues from the cost and maintenance perspectives and not meeting the following conditions of this research scope:

- Issues in design presented by previous studies did not have a clear explanation how the impact on the patient recovery process or care services
- Most previous studies claimed design issues occurred due to flaws in construction, site management, maintenance stages and wrong usage of materials or design components.
- Most previous studies claim AIs originated from sources related to patient, visitors and healthcare providers' behaviours or issues with healthcare providers procedures in dealing with patients.

In contrast, the focus of this study is only on flaws at the design stage and their sources that led to defects and faults in the operation stage, causing issues with patient health and care services. On other hand, this study cannot confirm the findings premised on previous studies as outlined above, rather new concepts were developed to identify types of design issues, sources of flaws in the predesign and design stages, and elements of comfort and stress in hospital, and how patient react to designs. Nonetheless, the additionality of the insights drawn from this study can be explained as follows:

- This study investigated in a common area between the built-environment and healthcare sector domains within three areas of management. This area includes three investigation areas: construction, architecture and patient health and safety management.
- Construction management involves issues in design and operation stages.
- Architecture management involves issues with predesign and design phases that produce design issues in the operation stage.
- Patient health and safety management involves issues with adverse incidents due to design issues that impact patient recovery and care services.
- To achieve the research objectives, this study had to deal with eleven sub-investigations areas within two concepts: pain and stress management, and the implications of patients' extended stays in Saudi hospitals.

12.11 IMPLEMENTATION

Implementation of the findings of this study can have a significant impact on Saudi hospital designs processes. They can be used as a standard checklist for defining the required data and information in design stages, design issues relating to defects and faults, and how design can facilitate healing right from the early stages of the design process. In addition, the findings on design flaws can be used to evaluate and measure the current design process in order to protect and simultaneously facilitate patient recovery and providing complete care service by minimising the occurrence of design issues. Finally, this study expects to benefit participants in the planning and design process, companies who provide critical systems, medical and non-medical furniture, equipment and materials for hospitals, patient health and safety, and investors in healthcare facilities sector.

12.12 CONCLUSION OF THE STUDY

This study investigates the relationship between hospital design, development and operational stages and patient recovery in public hospitals in the Kingdom of Saudi Arabia. It examines environmental design issues in relation to stakeholders' satisfaction by analysing events that support patient's healing and recovery as well as the effectiveness of care services. To achieve these, the study focuses on patient health recovery causations [that is, factors, requirements,

needs and causes that influence patients' health] and the role played by the current design process in Saudi's public hospitals.

Inductive and deductive approaches were used within the context of mixed method research. Case studies were drawn from three Saudi cities to examine patient treatment and diagnosis plans in extant hospital design models. Analysis also covered how their designed spaces facilitate medical intervention. In addition, data were collected through three stages using seven tools within six phases. Stage 1 involved a literature review and archival study. Stage 2 involved the analyses of nine incidents reports and 80 architectural designs. In addition, qualitative data was collected via interviews with 39 medical managers and technicians on 24 re-design projects. A total of 14 patients, 41 healthcare providers, 23 members of design teams and 18 members of maintenance teams were also interviewed. In Stage 3, 76 responses to a questionnaire survey, obtained from maintenance and design teams, were analysed.

Qualitative and quantitative data were collected and analysed in the study. The qualitative analysed by raw data model for the categorisation system to analysis raw data in five steps: main topics, sub-headings, main categories, main concepts and final key findings within research areas. The quantitative dated were analysed using nominal and ordinal scales, illustrated with graphs and charts, and were presented in descriptive and inferential statistical analysis. The study found AIs originated from 13 elements of design defects and faults and had impacted patient health and the care services provided. Findings also suggest AIs were evident in 12 aspects of atmospheric design that support patient recovery. By tracking these design issues from the occupancy stage back to the design stage, the study found 71 process flaws in seven development phases spanning the planning and design stages. The flaws were related to issues in the shortcomings of design teams' abilities and administrative management procedures, and the lack of required data and information before or during the design phase.

Implementation of the findings can have a significant impact on Saudi hospital designs. They can be used as a standard checklist for defining design issues relating to defects and faults, and how design can facilitate healing right from the early stages of the design process. In addition, the findings on design flaws can be used to evaluate and measure the current design process in order to protect and simultaneously facilitate patient recovery by minimising the occurrence of design issues and AIs. The outcomes of this investigation can lead to improvements in the design of future public hospitals in Kingdom of Saudi Arabia (KSA) by putting patient

recovery and complete healthcare services provision back at the heart of the hospital design process.

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13.0 APPENDIXES

13.1 APPENDIX A: RECRUITMENT MATERIALS

13.1.1 CURTIN UNIVERSITY REQUIREMENTS

13.1.1.1 PART A: RECRUITMENT LETTERS

Part A: Interview questions with Post-treatment patient (face to face): RECRUITMENT LETTER FROM ADMISSIONS AND DISCHARGE OFFICE TO POST-TREATMENT PATIENTS

Date:
From: Admissions and discharge office at (the name of hospital)
Re: Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process.

Dear: (the name of post-treatment patient)

We are writing to let you know about an opportunity to participate in a research study about improving Saudi hospitals' design process to fully support patients' recovery process. Eng. Abdullah Al Ghannadi at the Curtin University of Technology is conducting this study that will improve future hospital buildings design in KSA to design and create the healing environments that are free of design defects, which were produced from design process flaws and originated the adverse incidents on patients' environments, and to support the healing process of patients' physical and psychological aspects to their bodies, minds and souls.

You have been invited to participate in this study because the length of your previous stay during the treatment plan in this hospital that may have given you the most exposure to the hospital environment's design issues. Therefore, we believe you may be interested in describing your experience to the researcher regarding what types of uncomfortable, unsafe and unusual design in your environment, design you have had complaints and what helped you and harmed you. Should you wish to have further information about the study before making a decision as to whether you wish to be contacted, please contact the researcher via telephone or mail, as shown below.

Please be aware that, even if you are eligible, your participation in this research study is completely voluntary. There will be no consequences to you whatsoever if you choose not to participate, and your regular medical care will not be affected by this choice. If you do choose to participate, the study will involve interview questions.

Knowing what is involved will help you decide if you want to take part in the study. Please find the attached file contains the participant information and consent forms, read it carefully and ask questions about anything that you do not understand or want to know more about.

This project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007). There are no foreseeable risks from this research project.

This letter is being sent by an on behalf of the researcher who has not shared any of your private information without permission from you. If you decide to participate in this study, we will contact you to book an appointment with you to make a request for the researcher to conduct an interview with you in the training and education department (TED) at (the name of hospital).

Thank you for considering this request.

Sincerely,

Director of Admissions and Discharge Office

- Abdullah Mohammed A. Al Ghannadi
- PhD Candidate in Construction management
- Department of Construction management
- School of Built Environment
- Curtin University of Technology
- Tel : +91 812228591 Australia
- E-mail: a.ghannadi@postgrad.curtin.edu.au

Part B: Interview questions with Healthcare Givers: RECRUITMENT LETTER FROM MEDICAL ADMINISTRATION TO HEALTHCARE GIVERS

Date:
From: Medical Administration Office at (the name of hospital)
Re: Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process.

Dear: (the name of healthcare givers)

We are writing to let you know that a study is being planned that may be of interest to you. Eng. Abdullah Al Ghannadi at the Curtin University of Technology is conducting this study that will improve future hospital buildings' design in KSA to design and create the therapeutic environments that are free of adverse incidents originating from design defects produced by design process flaws in the early stage of design, and impacting patients' health and safety, and supporting the healing process of patients in respect to their physical and psychological aspects of their bodies, minds and souls in hospital environments.

You have been invited to participate in this study because of your direct involvement and interaction with patients' environments during their treatment plan and stay in this hospital as healthcare providers. Therefore, we believe you may be interested in describing your experience to the researcher about what types of uncomfortable, unsafe and unusual design in your environment's design you and your patients have had complaints about, and what helped them and harmed them, and what environment design issues prevented you from providing care to patient. Should you wish to have further information about the study before making a decision as to whether you wish to be contacted, please contact the researcher via telephone or mail, as shown below.

Please be aware that, even if you are interested, your participation in this research study is completely voluntary. There will be no consequences to you whatsoever if you choose not to participate. If you do choose to participate, the study will involve interview questions.

Knowing what is involved will help you decide whether you want to take part in the study. Please find the attached file, contains the participant information and consent forms, read it carefully and ask questions about anything that you do not understand or want to know more about.

This project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007). There are no foreseeable risks from this research project.

This letter is being sent by an on behalf of the researcher who has not shared any of your private information without permission from you. If you decide to participate in this study, we will contact you to book an appointment with you to make a request for the researcher to conduct an interview with you in the meeting room at (the name of department).

Thank you for considering this request.

Sincerely,

Director of Medical Administration

- Abdullah Mohammed A. Al Ghannadi
- PhD Candidate in Construction management
- Department of Construction management
- School of Built Environment
- Curtin University of Technology
- Tel : +91 812228591 KSA
- Tel : +61 812228591 Australia
- E-mail: a.ghannadi@postgrad.curtin.edu.au

Part C: Interview questions with Responsible parties and design team of the hospital design process: ENGINEERING AFFAIRS AND PROJECT MANAGEMENT ADMINISTRATION TO RESPONSIBLE PARTIES AND DESIGN TEAMS

Date:
From: Engineering Affairs and Project Management Administration Office at MOH
Re: Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process.

Dear (the name of one of responsible parties and design team of hospital design process and maintenance team members)

We are writing to let you know that a study is being planned that may be of interest to you. Eng. Abdullah Al Ghannadi at the Curtin University of Technology is conducting this study that will improve future hospital buildings design in KSA to design and create the therapeutic environments that are free of adverse incidents, originating from design defects produced by design process flaws, and impacting patients' health and safety, and supporting the healing process of patients in respect to their physical and psychological aspects of their bodies, minds and souls in hospital environments.

You have been invited to participate in this study because of your duties, roles and responsibilities in the stages and process of designing and establishing new hospitals/healthcare facilities at the Saudi Ministry Of Health. Therefore, we believe you may be interested in sharing your experience with the researcher in terms of what difficulties or challenges you encounter in solving design problems during the design process, and what missing factors, data and information required you may need in making decisions to solve design defects and what design features helped you in creating a therapeutic environments in hospitals buildings. Should you wish to have further information about the study before making a decision as to whether you wish to be contacted please contact the researcher via telephone or mail, as shown below.

Please be aware that, even if you are interested, your participation in this research study is completely voluntary. There will be no consequences to you whatsoever if you choose not to participate. If you do choose to participate, the study will involve an interview.

Knowing what is involved will help you decide whether you want to take a part in the study. Please find the attached file contains the participant information and consent forms, read it carefully and ask questions about anything that you do not understand or want to know more about.

This project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007). There are no foreseeable risks from this research project.

This letter is being sent by an on behalf of the researcher who has not shared any of your private information without permission from you. If you decide to participate in this study, we will contact you to book an appointment with you to make a request for the researcher to conduct an interview with you in the department (the name of dept.).

Thank you for considering this request.

Yours sincerely

Assistant Agency for Engineering Affairs and Project Management

- Abdullah Mohammed A. Al Ghannadi
- PhD Candidate in Construction management
- Department of Construction management
- School of Built Environment
- Curtin University of Technology
- Tel : +91 812228591 KSA
- Tel : +61 812228591 Australia
- E-mail: a.ghannadi@postgrad.curtin.edu.au

Distributed Questionnaires forms to the Responsible parties and design team of the hospital design process: ENGINEERING AFFAIRS AND PROJECT MANAGEMENT ADMINISTRATION TO RESPONSIBLE PARTIES AND DESIGN TEAMS

Date:
From: Engineering Affairs and Project Management Administration Office at MOH
Re: Towards Improving in the Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process.

Dear (the name of one of responsible parties and design team of hospital design process and maintenance team members)

I am inviting you to complete a brief (15-17)-question online survey that will take about 12-15 minutes. As part of a doctoral degree in construction management department at Curtin University of Technology, I am carrying out a study to improve future hospital buildings' design in KSA for design and create the therapeutic environments that are free of adverse incidents (AIs) impacting patients' health and safety that originating from produced design defects by design process flaws, and supporting the healing process of patients in respect to their physical and psychological aspects of their bodies, minds and souls in the hospital environments.

I am interested in measuring the strength of the association between design process flaws in the design stage and the healing process issues of patients in the occupancy stage, by evaluating the effectiveness of how design process flaws produce design defects and by evaluating to what extent/degree the AIs originating from design defects have impacted the healing process.

Having given your permission from your previous participation in the first stage of this study entitled 'Towards Improving in the Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process'. I selected your name. At that time, you indicated your interest in being contacted for the second stage of this study and future study. There are no foreseeable risks from this research project.

You can cease involvement in this study any time during the survey and afterwards up to 01-01-2018. I have attached a copy of a sheet about that provides you with detailed information and consent forms. This project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007). There are no foreseeable risks from this research project. If you have any concerns or questions about your rights as a participant or about the way the study is being conducted, you can contact:

Human Research Ethics Office
Curtin University of Technology
Kent St, Bentley WA 6102
Telephone: +61 8 9266 9266
Fax: +61 8 9266 3131
E-mail: hreo@curtin.edu.au

We would like to thank you in advance for your time and consideration. In one week, we will send you a one-time follow-up questionnaire.

The following link will lead you to the online survey. (http://)

- Abdullah Mohammed A. Al Ghannadi
- PhD Candidate in Construction management
- Department of Construction management
- School of Built Environment
- Curtin University of Technology
- Tel : +91 812228591 KSA
- Tel : +61 812228591 Australia
- E-mail: a.ghannadi@postgrad.curtin.edu.au

13.1.1.2 PART B: RESEARCH INTEGRITY TRAINING

Yes No

6. I have completed the appropriate Research Integrity Training through Blackboard and achieved a grade of at least 80%.

Yes No*

*Candidate cannot not be approved until the unit is passed

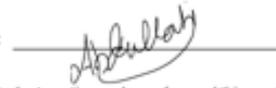
7. I have completed the Originality Checking/Turnitin component of the Research Integrity Training on Blackboard and have discussed the results of the originality/similarity report with my supervisor.

Yes No

Student Declaration of Accuracy

Please sign below to confirm that the information provided by you on this application form is accurate and true.

Signature of Student



Date

6/04/2016

(DDMMYY)

On completion of all student sections, please forward this application form to your Supervisor. The Supervisor, Chairperson of Thesis Committee, and Head of Enrolling Area will complete as appropriate for forwarding to the Graduate Research School to commence the Faculty approval process.

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GRS.Training @

To: Abdullah Alghamdi

RE: Providing the SOL Research Integrity Training Certs

Hi Abdulfah,

I confirm you have passed the Research Integrity training.

Last Name	First Name	Username	Last Access	Total	Max Total	Arts and H	Biomedical	Engineering
Al Ghamdi	Abdullah	Mohammx.13859803	25 April 2017	Pass	84.21653%	--	--	16.00

I confirm you have active access to the Research Integrity training on blackboard, so you should be able to access it. In order to provide evidence of your result for your ethics appli

Sample Screen Shots – How to find/print the Pass result

- Select a web browser other than Explorer - It does not display Blackboard reliably. For example, try Chrome or Firefox.
- Login to Student OASIS, then open Blackboard. Look under the Heading My Units, select "Research Integrity – HDR"
- In the left hand menu, select 'My Grades' and then 'All' (your name will be displayed in the top right hand corner)
- When taking a screen shot, ensure the following 3 pieces of information are included:
 1. The name of the training appears at the top of the left hand menu "Research Integrity – HDR",
 2. Your name - which appears in the top right hand corner of the Blackboard screen,
 3. 'Pass'.

13.1.1.3 PART C: RESEARCH DATA MANAGEMENT PLAN



Research Data Management Plan

Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process

Supervisor	Murty Subram
Date Management Plan Edited by	Abdulrahman Mohammed A. Al-Shamir
Modified Date	20/07/2017
Date Management Plan ID	201708-00010
Faculty	Architecture

1 Research Project Details

1.1 Research project title

Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process

1.2 Research project summary

The design and planning process of hospital affect the safety and health of the patient during the occupancy stage. A lack of attention to the inter-relationship between hospital design and patient health, early in the planning process, may lead to adverse incidents, such as medication errors, the spread of disease, death and psychological suffering such as stress and isolation. While studies have found evidence that hospital design can affect patient health, there is little understanding of the full impact of the design process on the occupancy stage, or how the process can be managed further promote patient's wellbeing and recovery process. This preliminary paper aims to report on ongoing doctoral research in the Construction Management Department of Curtin University of Technology, School of Built Environment, which investigates the design and the occupancy stages of public hospitals in the Kingdom of Saudi Arabia (KSA). Inductive and deductive approaches are employed, along with case studies, questionnaires, and interviews with designers as well as users of public hospitals in three cities in KSA. The investigation is expected to generate a feedback loop with view to improve hospital design by putting patient's wellbeing and recovery process back at the heart of designing hospitals.

1.3 Keywords

design team, hospital design, hospital occupancy, patient safety and patient recovery

2 Research Project Data Details

2.1 Research project data summary

To collect data in this study, for exploring the impacts of designed hospital environment issues on patient's health to improve current design process, at early stage of establishment of new hospitals in KSA to support patient's recovery process, the inductive and deductive approaches both are applied in following two stages:

First stage (Inductive tool) includes 400-700 literature reviews, archival studies involving 40-70 adverse incidents reports from hospital patient safety departments, 1-6 statistical records from Statistics and Indicators and organization of accreditation standards (Saudi Central Board for Accreditation of Healthcare Institutions), 10-20 architectural maps, 30-40 images, and 10-10 interview questions, for three case studies in the KSA. High-priority design (HFD) and grounded Theory (GT) data analysis will be used as the data analysis methods to transform the data.

Second stage (Inductive tool) includes 1-10-100 Questionnaire forms, for three case studies. In this stage, the descriptive statistics and inferential methods are used to analyse and transform the data within using Rating Scale to test and measure the level of relationship importance between the health care and the built environment domains.

2.2 Will the data be identifiable

- Re-identifiable** – identifiers have been removed and replaced by a code, but it is possible to re-identify an individual

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MICHAEL, MOON, MCE) will over 10 years' experience in academic research in the UK and Australia within the area of Construction Management, Construction Procurement and Construction Planning & Scheduling, APSCD (Senior Lecturer, Supervised Dr Elizabeth Kent (Dr Supervisor) and Abdulrahman Mohammed A. Al-Shamir (Researcher), he worked for 12 years as an architect engineer for health care facilities, facility management and safety manager, as a hospital safety officer, and as the chair of a hospital environment safety and risk management committee as well as he has conducted more than three studies.

2.3 Data dissemination

Final report of the research will be presented to Ministry of Health, KSA, for possible applications of its findings and recommendations. A manuscript will be submitted to the report and sent for publication in one of the most influential journals. Presentations of findings and recommendations will be made to responsible parties for hospital design process and patients' health and safety in the Kingdom's healthcare sector to ensure acceptance and utilization of findings. Requests for data sharing that come before the end of the embargo period will be considered on a case-by-case basis by the main supervisor.

2.7 Embargo period

The research data will be embargoed from open sharing until the final publication of all journal articles associated with the research project, or one year after the conclusion of the research project, whichever comes sooner.

2.3 Will data, including identifiers, be sent overseas?

No

2.4 Data organisation and structure

In order to organise and structure the research data, new main folders will be used (Research methodology chapter) will be built to group specific folders names. It also Data Collection Stage 1-Qualitative data Data collection-Curtin Analysts a .git under the built folders, the data is located in two drives (external and internal drives) to ensure that files are backed-up without duplication. The files under the specific folders will be identified by: name of data collection stage (e.g. data collection and analysis) subject matter (both methods and data sources), date (for adding, editing and changing), and draft number (e.g. 01 to main draft 01 on 01 from draft 01 to final draft 01 of either name given or ID registration). The data generated in this project are mostly stored as digital data. Thus, all digital data will be sorted and organised in a simple hierarchical structure. Respondents data identification. Codes will be assigned to each respondent, so that the data of questionnaire and interview records are named according to the respondent's code. Hierarchical of hierarchical data will be sorted by respondents' code and stored in a single file folder. During the analysis stage for qualitative and quantitative data, it will be saved as Word 2012 files, Excel 2010 files, Photoshop 2015 (.psd) and AutoCAD 2010 design formats. The versions of analysis data will be date stamped on a daily basis for easy identification.

3 Research Project Data Storage, Retention and Dissemination Details

3.1 Storage arrangements

The storage arrangements to secure, protect and prevent data loss or restore lost data, the all digital data will be stored into external (hard disk/USB drive and data) and internal drives (network drive, e-mail and personalizing drive) with high capacity of storage spaces on a daily basis, and saved in secure password. Also, physical data (questionnaire forms, reports and record) will be kept in secure locked cabinets in Construction Management Department at the Curtin University. The collecting data of questionnaire will be stored securely into the Survey Monkey website. Only the investigator, his supervisor and his main supervisor will be able to have an access to the research data. At the end of data collection stage, data will be downloaded onto the Co-investigator's laptop and backed-up regularly into an external drive on a daily basis. The external USB drive will remain in a cabinet in the main supervisor's office. At the completion of analysis process, all data will be transferred to Curtin's Research Data Drive. This will be updated Day by Day. At the end of the data storage period, the data is going to be safely destroyed.

3.2 Estimated data storage volume

Physical data: One folder. Digital data: During the project, at least 2 TMBB of data storage will be required. After finishing the project, the files maps, photos and reports form will be deleted, i.e., only 50MB will be needed.

3.3 Safeguarding measures

The physical data will be stored in a fireproof cabinet in the main supervisor's office. Upon completion, the main supervisor will work with central Records and Information Management to find a suitable long-term storage location.

Upon return to Curtin University, all digital data will be transferred to Curtin's R Drive, updated regularly and maintained according to Curtin Information Technology Services security and safeguarding protocols.

3.4 Retention requirements

7 years (if other research with outcomes that are classified as World)

3.5 Collaboration

The research team:

DR Jane Matthews (the chairperson), A/PROF Murty Subram (Main Supervisor) Fookus (MBA, PhD, PGCertHRP, PhD,

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13.1.1.4 PART D: CONSENT FORM FOR ALL PARTICIPANTS

Post-treatment patient
Design team

Medical managers
Maintenance team

Healthcare providers
Responsible parties of design



Improving Hospital Design process

CONSENT FORM

HREC Project Number:	
Project Title:	Towards Improving In Design Process Of Public Hospitals In The Kingdom Of Saudi Arabia To Fully Support Patient's Recovery Process
Principal Investigator:	Associate Professor Monty Sutrisna, Head of Department, Construction Management Department
Student researcher:	N/A
Version Number:	1 (healthcare provider and post-treatment patient)
Version Date:	10/02/2017

- I have read the information statement version listed above and I understand its contents.
- I believe I understand the purpose, extent and possible risks of my involvement in this project.
- I voluntarily consent to take part in this research project.
- I have had an opportunity to ask questions and I am satisfied with the answers I have received.
- I understand that this project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007).
- I understand I will receive a copy of this Information Statement and Consent Form.

Participant Name	
Participant Signature	
Date	

Declaration by researcher: I have supplied an Information Letter and Consent Form to the participant who has signed above, and believe that they understand the purpose, extent and possible risks of their involvement in this project.

Researcher Name	Abdullah Mohammed A. Al Ghamdi
Researcher Signature	
Date	

Note: All parties signing the Consent Form must date their own signature.



Improving Hospital Design process

Please insert the following tick box at the top of your questionnaire.

I have received information regarding this research and had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part.

CONSENT TICK BOXES

I do I do not consent to being audio-recorded

I do I do not consent to data linkage

I do I do not consent to be contacted about future research projects that are related to this project

I do I do not consent to the storage and use of my information in future ethically-approved research projects related to this project

13.1.1.5 PART E: ETHICS OFFICE APPROVAL



Office of Research and Development
GPO Box U1987
Perth Western Australia 6845
Telephone +61 8 9256 7833
Facsimile +61 8 9256 2552
Web research@curtin.edu.au

07-Sep-2017

Name: Monty Sutrisna
Department/School: Department of Construction Management
Email: Monty.Sutrisna@curtin.edu.au

Dear Monty Sutrisna

RE: Ethics Office approval
Approval number: HREC2017-0607

Thank you for submitting your application to the Human Research Ethics Office for the project **Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process**.

Your application was reviewed through the Curtin University Low risk review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research* (2007).

Approval is granted for a period of one year from **07-Sep-2017 to 06-Sep-2018**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorized to work on this project:

Name	Role
Al Ghamdi, Abdullah Mohammed A	Student
Sutrisna, Monty	Supervisor

Approved documents:
 Document

Standard conditions of approval

- Research must be conducted according to the approved proposal
- Report in a timely manner anything that might warrant review of ethical approval of the project including:
 - proposed changes to the approved proposal or conduct of the study

- unanticipated problems that might affect continued ethical acceptability of the project
- major deviations from the approved proposal and/or regulatory guidelines
- serious adverse events

- Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
- An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
- Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
- Changes to personnel working on this project must be reported to the Human Research Ethics Office
- Data and primary materials must be retained and stored in accordance with the [Western Australian University Sector Disposal Authority \(WASDA\)](#) and the [Curtin University Research Data and Primary Materials policy](#)
- Where practicable, results of the research should be made available to the research participants in a timely and clear manner
- Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny: the Human Research Ethics Office must be informed of any constraints on publication
- Approval is dependent upon ongoing compliance of the research with the [Australian Code for the Responsible Conduct of Research](#), the [National Statement on Ethical Conduct in Human Research](#), applicable legal requirements, and with Curtin University policies, procedures and governance requirements
- The Human Research Ethics Office may conduct audits on a portion of approved projects.

Special Conditions of Approval
None

This letter constitutes low risk/high/able risk approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at ethics@curtin.edu.au or on 9266 2794.

Yours sincerely

Amy Berwater
Acting Manager, Research Integrity

13.1.1.6 PART F: PARTICIPANT INFORMATION STATEMENT

Post-treatment patient
Design team

Medical managers
Maintenance team

Healthcare providers
Responsible parties of design



Hospital Design and Patients' Recovery Process

PARTICIPANT INFORMATION STATEMENT

HREC Project Number:	12565
Project Title:	Towards Improving In Design Process Of Public Hospitals In The Kingdom Of Saudi Arabia To Fully Support Patient's Recovery Process
Chief Investigator:	Associate Professor Monty Sutrisna, Head of Department, Construction Management Department
Student researcher:	
Version Number:	3 (Post-Treatment Patient- Interview Questions)
Version Date:	26-07-217

What is the Project About?

- This study is to achieve a better understanding of the inter-relatedness of hospital design and patient health, early in the planning and designing process, to prevent adverse incidents (AIs), such as medication errors, the spread of disease, death, and psychological suffering, and how the design process can be managed to further promote patient wellbeing and recovery process.
- This study focuses on how the creation of a conducive environment can be embedded in the early stages of the hospital design process in order to provide a safe, protective and therapeutic atmosphere that positively affects the psychological and/or physical health of patients and prevent AIs originating from produced design defects by design process flaws.
- This study focuses on fostering supportive events within the patient environment to facilitate the healing process.
- This study is to fill the research gap between the design process in the built environment domain and healing process issues of patients in the health care domain.
- This study is to solve the research problem that produced design defects by design process causing AIs that impact patient health where these AIs can be prevented by improving design process.
- Little research has been conducted in the KSA into the impact of healthcare facility design on the psychological and physical health of patients, and it is expected that this study will help to bridge the gap in this important area. Improving the design process to create therapeutic environments that are free of design defects and create positive events in supporting patients' healing and recovery is central aim to this research.
- This research project intends to gather information from post-treatment patients, healthcare givers and design team in three distinct cities in the KSA and at high level of Ministry of Health (MOH).

Who is doing the Research?

- The project is being conducted by Abdullah Mohammed A. Al Ghamdi
- This research project is funded by a grant from MOH through Cultural Attaché Office at Saudi Royal Embassy to obtain a Doctor of Philosophy at Curtin University.

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Hospital Design and Patients' Recovery Process

- access to the code to match your name and hospital and administration's name if it is necessary to do so. Any information we collect will be treated as confidential and used only in this project unless otherwise specified. The following people will have access to the information we collect in this research: the research team and, in the event of an audit or investigation, staff from the Curtin University Office of Research and Development.
- Electronic data will be password-protected and hard copy data (including audio tapes) will be in locked storage.
- The information we collect in this study will be kept under secure conditions at Curtin University for 7 years after the research has ended and then it will be kept indefinitely.
- The results of this research may be presented at conferences or published in professional journals. You will not be identified in any results that are published or presented.

Will you tell me the results of the research?

- A summary of the project's overall results should be sent to participants individually.
- We will write to you at the end of the research in about 14 months and let you know the results of the research. Results will not be individual but based on all the information we collect and review as part of the research.

Do I have to take part in the research project?

- Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to take part and then change your mind, that is okay, you can withdraw from the project. You do not have to give us a reason; just tell us that you want to stop. Please let us know you want to stop so we can make sure you are aware of any thing that needs to be done so you can withdraw safely. If you choose not to take part or start and then stop the study, it will not affect your relationship with the University, staff or colleagues.
- There will be no consequences to you whatever if you choose not to participate, and your regular medical care will not be affected by that choice.
- If you chose to leave the study we will use any information collected unless you tell us not to.

What happens next and who can I contact about the research?

- If you would like to obtain further information or answer questions, please feel free to contact the researcher:
 - Abdullah Mohammed A. Al Ghamdi
 - PhD Candidate in Construction management
 - Department of Construction management
 - School of Built Environment
 - Curtin University of Technology
 - Tel: (+966) 0566837767 KSA
 - Tel: (+61) 0451258858 Australia
 - E-mail: ahghamdi@hotmali.com
 - E-mail: ajahghamdi@postercad.curtin.edu.au
 - Associate Professor Monty Sutrisna
 - Head of Department, Construction Management Department
 - Department of Construction management
 - School of Built Environment
 - Curtin University of Technology

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Hospital Design and Patients' Recovery Process

PARTICIPANT INFORMATION STATEMENT

HREC Project Number:	12565
Project Title:	Towards Improving In Design Process Of Public Hospitals In The Kingdom Of Saudi Arabia To Fully Support Patient's Recovery Process
Chief Investigator:	Associate Professor Monty Sutrisna, Head of Department, Construction Management Department
Student researcher:	
Version Number:	3 (Post-Treatment Patient- Interview Questions)
Version Date:	26-07-217

What is the Project About?

- Any costs of being involved in the project and any payment: There will be no costs to you and you will not be paid for participating in this study.
- Why am I being asked to take part and what will I have to do? You have been invited to participate in this study because the length of your previous stay during the treatment plan in this hospital that may have given you the most exposure to the hospital environments design. Therefore, we believe you may be interested in describing your experience and feelings to the researcher regarding what types of uncomfortable, unsafe and unusual things in your environment's design issues you have had complaints about and what helped you and harmed you.
- The study will involve interview questions.
- The study will take place at a mutually convenient location.
- There will be no cost to you for taking part in this research and you will not be paid for taking part.
- We will make a digital audio recording so we can concentrate on what you have to say and not distract ourselves with taking notes.
- Optional Consent Future Research: We would like you to consider allowing us to send you information about future research projects. Once you receive the information it is your choice if you decide to take part or not.
- We would like you to consider letting us share the information we collect during this research with other researchers working in this area.
- Are there any benefits to being in the research project? Sometimes, people appreciate the opportunity to discuss their opinions and feelings.
- We hope the results of this study will allow us to improve Saudi public hospital design process to:
 - Avoid design process flaws
 - Reduce design defects
 - Prevent adverse incidents
 - Create and design a therapeutic environment that supports patients' physical and psychological healing process to reduce the length of hospital stays.
- Are there any risks, side-effects, discomforts or inconveniences from being in the research project? There are no foreseeable risks from this research project.
- We have been careful to make sure that the questions in the interview with you as post-treatment patient do not cause you any distress. But, if you feel anxious about any of the questions, you do not need to answer them.
- During the research project we may find out new information about the risks and benefits of this study. If this happens we will tell you the new information and what it means to you. It may be that this new information means that you can no longer be in the study or you may choose to keep going or to leave the study. You might be asked to sign a new consent form to let us know you understand any new information we have told you.
- Apart from giving up your time, we do not expect that there will be any risks or inconveniences associated with taking part in this study.

Who will have access to my information?

- The information collected in this research will be re-identifiable (coded). This means that the stored information will be re-identifiable which means we will remove identifying information on any data or sample and replace it with a code. Only the research team have

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Improving Hospital Design Process

- E-mail: Monty.Sutrisna@curtin.edu.au
- If you decide to take part in this research we will ask you to sign the consent form. By signing it is telling us that you understand what you have read and what has been discussed. Signing the consent indicates that you agree to be in the research as described. Please take your time and ask any questions you have before you decide what to do. You will be given a copy of this information and the consent form to keep.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number XXXXXX). In addition, this study has gained the permission from General Directorate for Research and Studies and been approved by the Scientific Research Committee from Education, Training Centre & Academic affairs to conduct this study at Saudi Ministry of Health. Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

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13.1.2 SAUDI MINISTRY OF HEALTH REQUIREMENTS

13.1.2.1 PART A: RECRUITMENT LETTERS

ROYAL EMBASSY OF SAUDI ARABIA
CULTURAL ATTACHE OFFICE
CANBERRA

مكتب المندوبية الثقافية
السعودية
كانبرا

In The Name of Allah, The Compassionate, The Merciful
(Arabic)

Royal Embassy of Saudi Arabia
Cultural Attaché Office
Canberra

Statement for task facilitation
01/02/1438 H, corresponding to 01/11/2016

To Whom It May Concern

The Cultural Attaché Office at the Royal Embassy of Saudi Arabia in Australia acknowledges that the external student, Abdullah Muhammad Abdullah Al Ghamidi (National ID 1038851745), has been sent by the Ministry of Health to study for a PhD degree in Construction Management, at Curtin University of Technology, Australia. The student is currently present at the seat of the mission and his financial support has started on 26/04/1436H, corresponding to 15/02/2015. His scholarship will expire on 26/04/1440H, corresponding to 02/01/2019.

In view of the student's need to gather information from the Kingdom, pertaining to his PhD thesis, and in accordance with the recommendation of the student's academic supervisor at the university, we hope that the relevant authorities shall assist the aforementioned student, and facilitate his task in obtaining the information required for scientific research.

This information is correct in as far as the information registered in the study affairs system, at the above set date, and has been provided at the request of the student.

May God grant us success.

Acting Cultural Attaché
Royal Embassy of Saudi Arabia
[signature]
Dr. Abdel Fatah Bin Jassid Al Bostany
[seal of the Cultural Attaché Office, Royal Embassy of Saudi Arabia]

بسم الله الرحمن الرحيم
يبدو مكتب المندوب الثقافي في سفارة المملكة العربية السعودية في أستراليا بأن المبتعث عبدالله محمد عبدالله الغامدي (رقم الهوية الوطنية 1038851745)، منحت من وزارة الصحة لدراسة الدكتوراه في تخصص Construction Management بجامعة Curtin University of Technology في أستراليا، وهو متواجد حالياً في مقر البعثة، وقد بدأ الصرف على المبتعث من تاريخ 15/02/2015 هـ الموافق 26/04/1436، وستنتهي بعثته في تاريخ 02/01/2019 هـ الموافق 26/04/1440.

ونظراً لضرورة المبتعث للتوابع معلومات متعلقة بروساة الدكتوراه من المملكة وتوصية المشرف الأكاديمي للمبتعث في الجامعة بذلك، فنأمل من الجهات ذات العلاقة التكرم بمساعدة المبتعث المشار إليه أعلاه، وتسهيل مهمته في جمع المعلومات المطلوبة لأغراض البحث العلمي.

هذه المعلومات صحيحة حسب بيانات نظام الشؤون الدراسية في التاريخ المحدد أعلاه، وبناءً على طلب المبتعث لم ندرج هذه الإفادة.

والله الموفق.

لئام باصائل الملحقة الثقافية
بسفارة المملكة العربية السعودية في كانبرا

د. عبدالفتاح بن جاسيد البستاني

Ref No: _____ Date: _____ Attachments: _____
Tel: +61 2 62891170 Fax: +61 2 62329978 P.O. Box 1206, DICKSON, ACT 2602, AUSTRALIA

M. O. H.
General Directorate of Health Affairs Al - Baha
Subjective Operating Program
King Fahad Hospital Al Al-Baha

وزارة الصحة
المديرية العامة لشؤون الصحة بمنطقة الباحة
برنامج التشغيل الذاتي بمستشفى الملك فهد
بالباحة

2030
مركز التعليم والتدريب والبحوث الأكاديمية والبحوث
Education, Training Center & Academic Affairs

SCIENTIFIC RESEARCH COMMITTEE

To : Engr. Abdullah Mohammed A. Al Ghamidi
Curtin University of Technology
Australia

From : Dr. Abdulmajid Al Mawazini
Chairman of Scientific Research Committee
Consultant Pediatric Cardiologist

Date : 24 November 2016

Subject: Approval of Research Proposal

Knolly be informed and accommodate in your department the following Researchers to conduct their approved research study by the Scientific Research Committee as follows:

Proposal Title
Towards improving in design process of public hospitals in the Kingdom of Saudi Arabia to fully support patient's recovery process.

Noting that this research will be monitored by the research committee during this period and research committee has all rights to modify or cancel this approval if the researchers are not committed to the hospital policies & patient's rights.

The Researchers/Investigators are as follows:

- Engr. Abdullah Mohammed A. Al Ghamidi

The final article for this research should be presented to the research committee.

NOTE - This proposal is only to complete the study of the mentioned Researchers.
- For Publications in any medical journals, they must apply for special approval from research committee.

Kind regards
Cc: File

المرافق: _____ التاريخ: _____
P.O.Box 204 ص.ب. 204 FAX (017) 7251732 هاتف (017) 7254000
الرقم: _____ مسترئال: _____

Translated

Certification of Translation Accuracy

Translated document: Statement for task facilitation
Project #: 17062049
Source language: Arabic Target language: English

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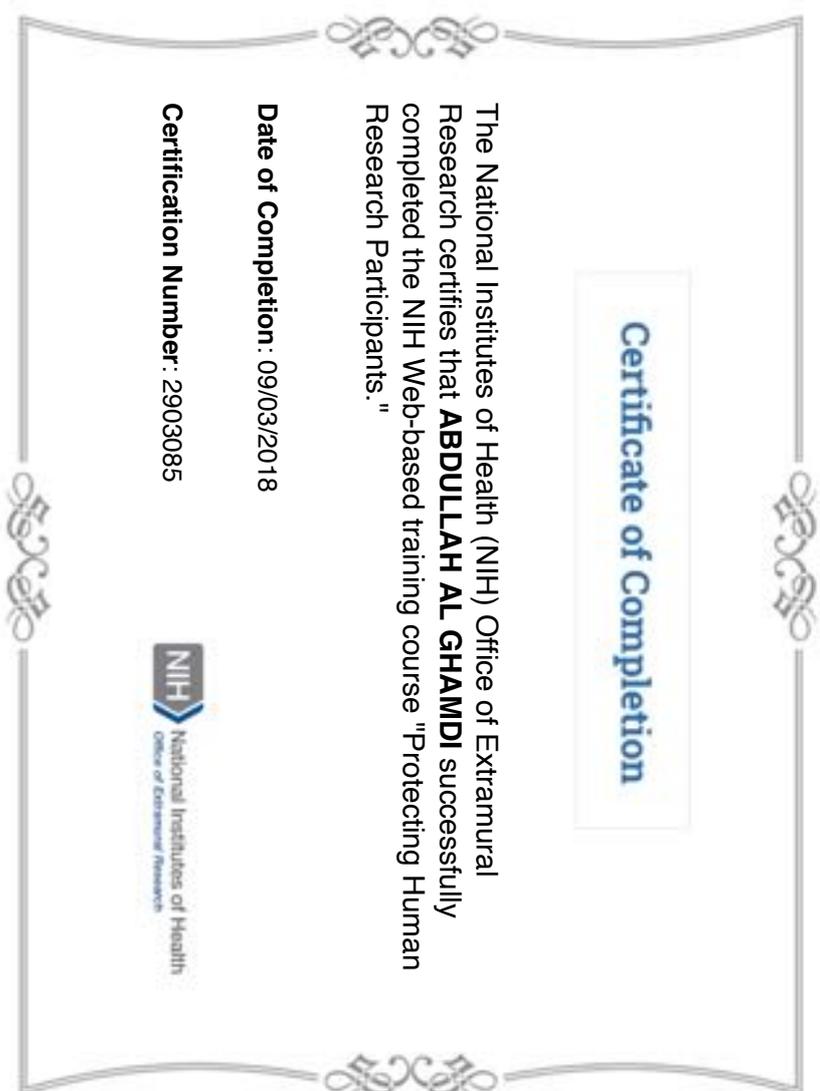
Thursday, April 20, 2017

TRANSLATED S.R.L.
Chief Operating Officer (COO)
TRANSLATED SRL

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Local offices: Via Napoli, 29 00141 Rome (RM) Italy
Contacts: Tel: +39 06 90 234 001 Fax: +39 06 230 230 100 E-mail: info@translated.net

13.1.2.2 PART B: RESEARCH INTEGRITY TRAINING



13.1.2.4 PART D: SAUDI MINISTRY OF HEALTH APPLICATIONS

المملكة العربية السعودية Kingdom of Saudi Arabia Directorate of Health Affairs - إدارته Medical Research and Studies Department	
RS-MoH Cover Letter	
باحث <input type="checkbox"/> طالب <input type="checkbox"/>	باحث <input type="checkbox"/> طالب <input type="checkbox"/>
التوجه: <input type="checkbox"/> منشآت <input type="checkbox"/> غير منشآت <input type="checkbox"/>	
(للطلبة فقط) →	
رقم السجل المعتمدين: 10350803 رقم السجل المعتمدين: 1038851745	
Title of the Proposed Research عنوان البحث المقترح	
Principal Investigator الباحث الرئيس	
Affiliation: رقم الهاتف: 0544212144	
E-Mail: Co-Researchers	
Tel.No: رقم الهاتف: 0544212144	
E-Mail: Co-Researchers	
Approval/Authorization for Research الموافقة/الإذن للبحث	
Gov. Health Ministry وزارة الصحة السعودية	
E-mail: research.jeddah@moah.gov.sa Telle: (012 - 63477334)	

المملكة العربية السعودية Kingdom of Saudi Arabia Directorate of Health Affairs - إدارته Medical Research and Studies Department	
RS-MoH Cover Letter	
باحث <input type="checkbox"/> طالب <input type="checkbox"/>	
التوجه: <input type="checkbox"/> منشآت <input type="checkbox"/> غير منشآت <input type="checkbox"/>	
رقم السجل المعتمدين: 10350803 رقم السجل المعتمدين: 1038851745	
Title of the Proposed Research عنوان البحث المقترح	
Principal Investigator الباحث الرئيس	
Affiliation: رقم الهاتف: 0544212144	
E-Mail: Co-Researchers	
Tel.No: رقم الهاتف: 0544212144	
E-Mail: Co-Researchers	
Approval/Authorization for Research الموافقة/الإذن للبحث	
Gov. Health Ministry وزارة الصحة السعودية	
E-mail: research.jeddah@moah.gov.sa Telle: (012 - 63477334)	

المملكة العربية السعودية Kingdom of Saudi Arabia Directorate of Health Affairs - إدارته Medical Research and Studies Department	
GDRS-MOH Cover Letter	
Student Name: Student Name: Architectural Engineer	اسم الطالب / التلميذ: اسم الطالب: محمد عبدالعظيم العبدالله
Affiliation at KSA: King Fahd General Hospital at Alhaha City	مكان العمل بالمملكة: مستشفى الملك فهد العام بالحاه
Country: Australia	بلد البحث (جهة): أستراليا
Degree: Master Ph.D	الدرجة: ماجستير دكتوراه
Research Title: Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process	عنوان البحث باللغة العربية: تطوير عملية بناء وعلاج المرضى في مستشفيات المملكة العربية السعودية لدعم عملية التعافي الكاملة للمريض
Ministry of Health (M.O.H) Approval: Ministry of Health (M.O.H) Approval: 10350803 (Saudi) and 1038851745 (Foreign)	موافقة وزارة الصحة السعودية: موافقة وزارة الصحة السعودية رقم: 10350803 (سعودية) و 1038851745 (أجنبية)
E-mail: handodah9@hotmail.com	البريد الإلكتروني: handodah9@hotmail.com
Tel: 1038851745	رقم الهاتف: 1038851745

13.1.2.5 PART E: ETHICS OFFICE APPROVAL

المملكة العربية السعودية وزارة الصحة Ministry of Health الوكالة المساعدة للتخطيط والتعزيز المؤسسي الإدارة العامة للبحوث والدراسات	
٢٠١٤/١١/١٩ الموافق ٢٠١٤/١١/١٩	
خطاب إلهاء مهمته علمية	
سعادة / الملحق الثقافي السعودي - مكاتبرا بأستراليا	
المحترم	
السلام عليكم ورحمة الله وبركاته،،،،،	
إشارة إلى موضوع الخطاب/ عيادته محمد عبدالعظيم العبدالله، لدراسة درجة الدكتوراه في تخصص "المسهم معلمي" بمتطلبات العلوم الإنسانية بجامعة كيرتن للتكنولوجيا بأستراليا، رقم الهوية الوطنية (10350803)، والرقم الأكاديمي (1038851745) بعنوان الرسالة:	
" نحو تطوير عمليات التصميم للمستشفيات السعودية المعاصرة لدعم عمليات تكفاء وعلاج المرضى"	
لجهة بحثكم، علماً بأن الطلاب المذكور قد أتم مهمته في جمع البيانات الإحصائية وذلك من تاريخ (١٠ سبتمبر ٢٠١٤م) وحتى تاريخ (٣٠ نوفمبر ٢٠١٤م) ولمدة ثلاثين شهراً، في المنشآت التالية:	
١- مستشفى الملك فهد الطبي بالرياض ٢- مستشفى سعودي لقطاع والدواء ٣- المركز السعودي لاعتماد المنشآت الصحية (سباحي) ٤- الإدارة العامة للأمن والسلامة بوزارة الصحة ٥- الإدارة العامة لجودة وسلامة المرضى بوزارة الصحة ٦- الإدارة العامة للتجهيزات والأحلال بوزارة الصحة ٧- الإدارة العامة للتشريع الهندسية بوزارة الصحة ٨- مستشفى الملك فهد العام بمشقة الرياض ٩- مستشفى الأمير مشاري بالبحرين بمنطقة الرياض	
وقد أعطي هذا الخطاب بناءً على طلبه لتقديمه للتخطيط الثقافي السعودي في أستراليا.	
وتفضلوا بتحويل أمهات التحيات	
مدير عام الإدارة العامة للبحوث والدراسات	
ص. عذاري بنت فيصل العتيبي	
e-mail: research@moah.gov.sa	

13.2 APPENDIX B: DATA COLLECTION TOOLS

13.2.1 PHASE 1: LITERATURE REVIEW DATA

Table 13.1: Causes of design defects (Al-Farra 2011)

Country	Causes of building defects in occupancy stage	Quoted source
UK	Inappropriate materials applied to buildings, poor decisions and poor rectification work processes. Most of defects are due to biological, meteorological, geochemical and other natural hazards, human intervention 20% of the defects found were accounted for by poor design decisions. 20% were accounted to materials and workmanship 58% of defects resulted from faulty design. 35% from operation and installation. 12% from poor materials and systems. Structural movement due to poor structural design. Installation method. Site conditions.	(Watt 2009) (Ransom 2002) (Seeley 1987) (Establishment 1991); (Richardson 2002)
Sweden	A study of seven buildings showed that 32% of all defect costs originated from the client and design. 45% from site management. 20% from materials and machine. 44% of defect costs were due to lack of knowledge 50% due to lack of motivation.	(Josephson and Hammarlund 1999)
Saudi Arabia	A survey of 11 major groups of defects through a literature review and interviews showed that defects were mostly generated by design, specifications, materials and equipment.	(Assaf, Al-Hammad et al. 1996)

Table 13.2: Design Defects types within possible design process flaws

References	Structural design defects
(Al-Shiha 1993)	Structural cracks in columns and beams, walls
(Assaf, Al-Hammad et al. 1996)	Water seepage from external wall, window, roof, or from ceiling
Al-Hammad et al. (1997).	Possible Flaws in design stage
Al-Khatam (2003)	Ignore design of expansion / contraction / settlement joint and special construction joint
Ali, Keong et al. (2013)	Ignore the effects of the environment and the loads on structural elements and weather conditions on the materials used
Ahzahar, Karim et al. (2011)	Ignore the difference in the adjacent soil layers and variation in soil conditions:
Tayeh, Al-Hallaq et al. (2016)	Ignoring the dynamic loads impact on the stability of the structural building (elevators, air conditioners and generators):
Tayeh, Al-Hallaq et al. (2017)	Exceeding the allowable deflection limits
Razak and Jaafar (2012)	Ignoring the design for wind effects and design for earthquakes loads effects on the structure
(Buys and Le Roux 2013)	Inadequate concrete cover on structural elements
(Shah Ali 2009)	Designing inadequate expansions joint which don't lead to required purpose between finished faces, ceiling and wall
(Ali, Kamaruzzaman et al. 2010)	Improperly locating conduits and pipe openings at critical structural locations (sleeves)
(De Silva and Ranasinghe 2010)	Not specifying to the allowable load limits
(Hassanain, Assaf et al. 2013)	
(Gibson 1979)	
(Fixit Institute 2010)	
(Cook and Hinks 1992)	
(Ishak, Chohan et al. 2007)	
(Chew 2005)	
(Abdellatif and Othman 2006)	

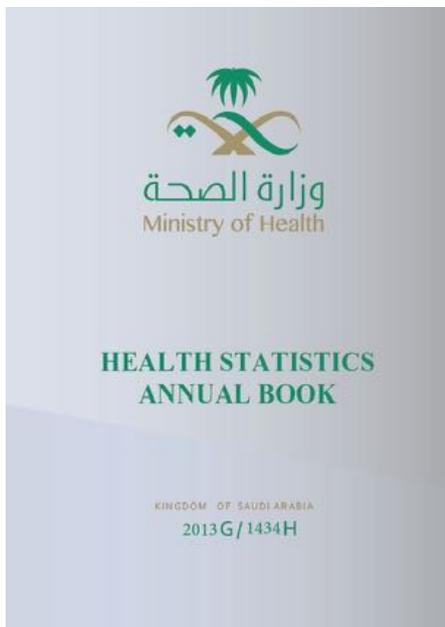
References	Architectural design defects
(Al-Shiha 1993) (Assaf, Al-Hammad et al. 1996) (Al-Hammad, Assaf et al. 1997) Al-Khatam (2003) Razak and Jaafar (2012) (Buys and Le Roux 2013) (Shah Ali 2009) (Ali, Kamaruzzaman et al. 2010) (De Silva and Ranasinghe 2010) (Hassanain, Assaf et al. 2013)	Difficulty in the movement and transport of users and equipment Possible Flaws in design stage Designing narrow stairs, passage and doors that obstruct the transport of equipment; Selecting of exterior finishing material not relating to climatic condition; Using painting with dark colour and collecting dust and cannot resist high level of heat and humidity, in which it requires effort and time to be clean and sterilised. Ignore the effect of local weather conditions at the building site for the design of the external shapes to avoid the collection of moisture, water or dust
Type of drawings	Design drawing defects
Construction Drawings	lack cross sections, details of structural elements, joints, plumbing, drainage and electrical connections
Structural Drawings	Building design drawings did not show the cross section and detailed references clearly on the drawings; poor detailing; The drawings of this field do not fit the drawings of other fields
Architectural Drawings	
Civil Drawings	
Mechanical Drawings	
references	Possible Flaws in design stage
(Al-Shiha 1993) (Assaf, Al-Hammad et al. 1996) (Al-Hammad, Assaf et al. 1997) Al-Khatam (2003) Razak and Jaafar (2012) (Buys and Le Roux 2013) (Shah Ali 2009) (Ali, Kamaruzzaman et al. 2010) (De Silva and Ranasinghe 2010) (Hassanain, Assaf et al. 2013) (Ramly, Ahmad et al. 2006)	Lack of references Conflicts between drawings in each design field: most of designers are designed their section separately of other section and without participating or consulting other interested or related designers. In such situation, the changes in the architectural drawings do not fit the civil and mechanical drawings this led to interventions from unqualified people to solve the conflicts in occupancy stage. the designer leaves the details of his vision to be worked out by draughtsman who are either inexperienced or unqualified

Table 13.3: Sources of design process flaws

References	Administration and staff flaw during design stage
(Lee and Scott 2009) (Lee 1987) (Al-Shiha 1993) (Assaf, Al-Hammad et al. 1996) (Al-Hammad, Assaf et al. 1997) Al-Khatam (2003) Razak and Jaafar (2012) (Buys and Le Roux 2013)	Inadequate (QA/QC) programs during design stage Lack of technical updating and adequate training of staff and lack of awareness of construction technology Lack of technical background and experience of the designer Ignore the designer to the properties, characteristics and behaviours of materials Misjudgement of environmental and climatic conditions. Poor communication and coordination between members of the design team and the team of maintenance and implementation
(Shah Ali 2009) (Ali, Kamaruzzaman et al. 2010) (De Silva and Ranasinghe 2010) (Hassanain, Assaf et al. 2013) (Patton 1980)	Bad feedback and lack of maintenance and construction teams to discuss construction/design defects between the design, supervision and implementation staff Lack of local specifications and standards related of building design requirements
(Lee 1987)	Lack of information of functional requirement of buildings in brief projects. Lack of design criteria to select materials and construction systems. Ignore the site conditions and building position
(Gibson 1979) (Ramly, Ahmad et al. 2006) (Ishak, Chohan et al. 2007)	Little awareness of user activities in occupancy stage lack of information on the social, satisfaction level and thinking of users. Design thinking Fault led to faulty in design decision as common faults
(Al-Farra 2011)	Hiring incompetent and unqualified construction professionals

13.2.2 PHASE 2: DOCUMENTS OF ARCHIVAL STUDY

13.2.2.1 PART A: INFORMATION & STATISTICS GENERAL ADMINISTRATION AND STUDIES & DESIGNS GENERAL ADMINISTRATION



المملكة العربية
السعودية
وزارة الصحة

الإدارة العامة للمشروعات والمصروفات

الهيكل التنظيمي لإدارة الدراسات والتصاميم



13.2.2.2 PART B: FOOD AND DRUG AUTHORITY

MDS-G25

Guidance on Requirements for
Storage, Handling and Transportation of
Medical Devices



Version Number: 1.0
Version Date: 10/4/2018

This guidance document has been published after being distributed for public comments dated on 8/3/2018 for 30 days.

Page 1 of 14

Safe Usage and Adverse Event Investigation of Medical Devices

Presented By
Eng. Khalil Al-Ghamdi

المركز السعودي
للسلامة المرضية
SAUDI CENTER FOR
PATIENT SAFETY

Al Hammadi Hospital
Riyadh – AlNuzhah
11 October 2018

المنطقة الصحية السعودية
المنطقة الصحية للتحقق والتطوير
بالأهـم نهـم

Ref: WU1943

Kingdom of Saudi Arabia
Saudi Food & Drug Authority

المملكة العربية السعودية
المنطقة الصحية للتحقق والتطوير

Medical Devices Sector
Executive Department of Surveillance & Biometrics

القطاع الأجهزة والمنشآت الطبية
الإدارة التنفيذية الرقابة والتحريات الحيوية

SRED Weekly Update: 23-Oct-18

Dear,
SRED team is pleased to inform you that **79** new FSCA results posted on [SFDA website](#).
(Please note: below list of FSCA results for the period of 10/15/2018 to 10/21/2018
In order to view more details, click the links and for ECR alerts see the attachments)

NOTE:
FSCA / Recalls are classified into three categories, representing the potential risk to public health:
Class I - High Risk, Class II - Medium Risk and Class III - Low Risk.
FSA (Field Safety Action) - A communication to customers and/or users sent out by a manufacturer or its representative in relation to a Field Safety Corrective Action.

Hospital Name		Type	Medical Device	Prod Date	Manufacturer	Distributor	Class	URL	Related Recalls
Active Implantable Devices		New	Inpella Heart Pumps	#####	ABDULBQ by	Gulf Medical Co.	FSN	JACA	
Anaesthetic and respiratory device		New	CONTAINERS, Oxygen tanks	10/04/2018	CRVO SHIP USOM S.A.S.	N/A	FSN	JACA	
New	FMS (per ILS, GMM) Tablets starting from serial number 010/113 until serial number 11180	10/04/2018	General Medical Merate SpA.		Bio Standards	FSN	JACA	NHL	
New	SpO2 Controller "SP2C" of the ventilator SOPHE	10/01/2018	Fritz Stephan GmbH		Al Khateeb United Trading Est.	FSN	JACA		

Reporting & Investigation of Medical Devices Incidents & Adverse events

Presented By
Eng. Ahmed Al-Qarni

وزارة الصحة
Ministry of Health

Riyadh
25 October 2018

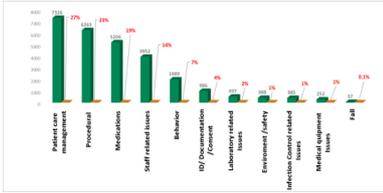
المنطقة الصحية السعودية
المنطقة الصحية للتحقق والتطوير
بالأهـم نهـم

SFDA Copyright © 2018

13.2.2.3 PART C: QUALITY AND PATIENTS SAFETY GENERAL ADMINISTRATION



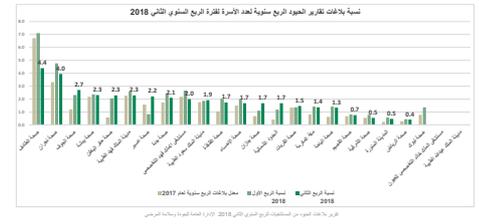
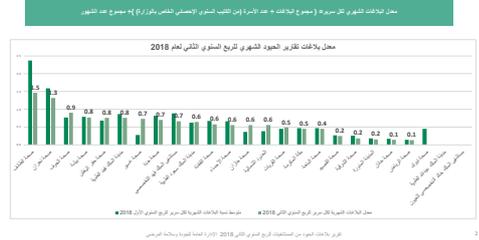
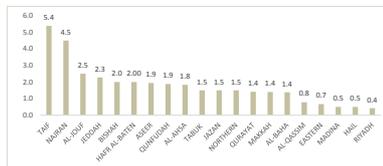
3-Top OVRs Categories:



Participating Region /Hospitals (16):

Al Taif, Najran, Al-Jouf, Hfr Al-Baten, Aseer, Jeddah, Qunfudah, Al-Ahsa, Northern, Qurayaz, Al-Qasim, Eastern, Madinah, Hal, KFSH, Riyadh.

4- Mid Year OVR Rate by Regions Q1+Q2:



Quality and Patient Safety General Administration OVR Report - Midyear 2018

1-Total OVR:



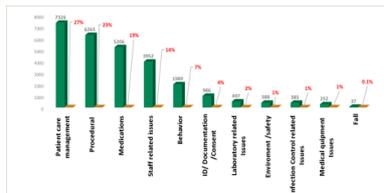
2-OVR Rate Per / Bed:



The Equation = Total No OVRs / No of Beds.



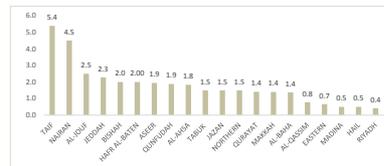
3-Top OVRs Categories:



Participating Region /Hospitals (16):

Al Taif, Najran, Al-Jouf, Hfr Al-Baten, Aseer, Jeddah, Qunfudah, Al-Ahsa, Northern, Qurayaz, Al-Qasim, Eastern, Madinah, Hal, KFSH, Riyadh.

4- Mid Year OVR Rate by Regions Q1+Q2:



13.2.2.4 PART D: QUALITY AND PATIENTS SAFETY GENERAL ADMINISTRATION



Quality and Patient Safety General Directorate

Patient Safety Events Reported 2016-2017

Sentinel Events:

Sentinel event is defined as "any event leading to serious patient harm or death and is caused by healthcare rather than the patient's underlying illness" (CBAHI, 2015). Sentinel events occur mainly because of defects in the healthcare system. In 2016 and 2017, a total of 301 (153 in 2016) and (148 in 2017) Sentinel Events reported from the ministry of health (MOH) and private hospitals in Saudi.

The top four reported Sentinel Events categories were: Unexpected patient death (120 cases), maternal death (79 cases), Unexpected loss of a limb or a function (32 cases) respectively, retained instrument or sponge (27 cases).

- Top Four Sentinel Events:
- 1- Unexpected death.
 - 2- Maternal death.
 - 3- Unexpected Loss of Limb or Function.
 - 4- Retained Instrument or Sponge.



إدارة الجودة وسلامة المرضى
وحدة المخاطر وسلامة المرضى
تقرير المخاطر النصف سنوي لعام
2018

Regional Mid-Year Risk Assessment Report 2018

Region: All MOH hospitals - HASSA

Introduction:

Risk management is a process of identifying, analyzing, managing and monitoring risks that can result in loss to the organization. Risks are identified from external and internal sources. This report presents risk identified from Jan -Jun 2018 with taking in consideration historical events that may reoccur and risk identified in other organizations.

Risk Registers Received: (each healthcare facility should submit (one register)

- Total of ...11...out of ...12...= 91.6%
- Total Number of Risks Identified: 447

Risk by Level:

Risk Level	Total	%
Extreme	42	9.3%
High	160	35.7%
Moderate	155	34.6%
Low	90	20.1%

Risks by Type:

Risk Type	Total	%
Operational - Clinical	299	67%
Human Resource	36	8%
Financial	14	3.1%
Regulatory/ Legal	20	4.4%
Environmental Risk	23	5.1%
Technology	25	5.5%
Strategic Risks	30	6.7%

المملكة العربية السعودية
وزارة الصحة
الإدارة العامة للجودة
وسلامة المرضى

التقرير الشهري لاستكمال التقييم الذاتي لمعايير ESR على موقع سباهي لشهري جون يوليو 2018

شهر يوليو 2018	شهر جون 2018	المنطقة
100%	100%	القرية
100%	85%	جدة
100%	33%	الباحة
95%	80%	المدنية المنورة
95%	75%	عسير
92%	67%	حائل
90%	60%	نجران
82%	67%	الرياض
80%	40%	الأحساء
75%	67%	تبوك
71%	71%	الطائف
69%	44%	المنطقة الشرقية
65%	60%	جازان
60%	40%	القطيف
57%	57%	حفر الباطن
33%	67%	مكة المكرمة
29%	0%	بيشة
24%	43%	القصيم
20%	30%	الحدود الشمالية
0%	25%	الجوف

From 85-100 From 75-84 From 0-74



Quality & Patient Safety Department
Risk & Patient Safety Unit

Regional Mid-Year Risk Assessment Report 2018

Region: Riyadh

Introduction:

Risk management is a process of identifying, analyzing, managing and monitoring risks that can result in loss to the organization. Risks are identified from external and internal sources. This report presents risk identified from Jan -Jun 2018 with taking in consideration historical events that may reoccur and risk identified in other organizations.

Risk Registers Received: (each healthcare facility should submit (one register)

- Total of 27 out of 39 = 69.23 %
- Total Number of Risks Identified: 3941

Risk by Level:

Risk Level	Total	%
Extreme	4	0.076
High	93	2.34
Moderate	790	20.05
Low	3,054	77.49

13.2.3 PROFESSIONAL LEVELS AND POSITIONS OF PARTICIPANTS

Table 13.4: Professional level descriptions and positions of participants

Professional level	Duties in treatment plan of patient	Positions
Obstetrician	She deals and manages the pregnancy and childbirth and performs operations.	Head of Labour and Delivery Department
Gynaecologist	She sees patient in the outpatient clinics and on the inpatient female wards.	Head of Obstetrics and Gynaecology clinics
Paediatrician	He deals with and manages the pregnancy and childbirth and works in outpatient clinics.	Head of Paediatric Clinic
Neonatologist	He diagnoses and treats new-borns, works in children wards and outpatient clinics.	Head of neonatal intensive care unit
Respiratory physiology technician	He works on investigations that help the diagnosis of difficulty and disorders in breathing, such as asthma and emphysema.	Head of Respiratory treatment (RT) unit
Paediatrician	He specialises in the diagnosis and treatment of childhood illnesses and works in outpatient clinics and on hospital wards with performing operations.	Paediatric intensive unit
Psychiatrist	He specialises in the diagnosis and treatment of mental health problems and he can prescribe medicines, uses psychological (talking) treatments to help his patients.	Head of Psychological Clinic
Surgeons	They specialise in operating on particular parts of patient body.	Head of General Surgery Clinic Head of Endoscopy Department
Senior consultant	He is a senior consultant in major and minor operations.	Head of Theatre Department
Anaesthetists	In General Surgery Clinic, they give local or general anaesthetics to patients, monitors the condition of patients when they undergo surgery treatment and runs outpatient pain management.	Member of Anaesthetic department
	In Surgery Clinic, he handles minor surgical procedures, follow-up post-operative appointment and consultation.	Member of Anaesthetic department
Optometrist	He performs eyesight tests and examinations and prescribes contact lenses or glasses to patients.	Member of Ophthalmology clinics
Ophthalmologist	He specialises in the medical and surgical management of eye health problems and handling minor surgical procedures	Head of Ophthalmology
Dental surgeon	He specialises in surgery of the teeth, the gums and the jaws bones	Head of Dental Surgery Clinic
Orthopaedic surgeon	He is a senior consultant dealing with surgical means to treat spine disorders, sports injuries and non-surgical treatment such as using exercises and medication	Head of Orthopaedic Clinics
Cardiologist	He is senior consultant and diagnoses, assess and manage patients with diseases of the heart and vascular system (circulation).	Head of Cardiology clinic
Cardiographers	He works in the cardiac (heart) department of hospitals, helping to operate machines that monitor heart function.	Member of Cardiology clinic
Cardiac physiologists	He carries out investigations into the functions of the heart and the equipment fitted to help the heart.	Head of Cardiology clinic
Urologist	He diagnoses and treat diseases of the urinary tract in both men and women, as well anything involving the reproductive tract in men.	Head of Urology clinic

Dermatologist	-	Head of Dermatology clinic
Internal medicine physician	He is a leader of a multidisciplinary team who dealing with ill adult patients with life-threatening single and multiple organ system failure.	Head of Adult intensive care unit
Intensive care specialist	He is a specialist in recognising, managing the disturbances associated with severe medical, surgical, obstetric illness and the diagnoses and treats the circumstances that cause them	Member of Adult intensive care unit
Paediatrician	He specialises in the diagnosis and treatment of childhood illnesses	Member of Accident and Emergency Department
Surgeon	He specialises in operating on particular parts of the body.	Head of Accident and Emergency Department
Emergency doctor	-	Member of Accident and Emergency Department
Radiologist	He works with an advance technology to produce X-rays, CT (computed tomography) scans, MRI (magnetic resonance imaging) scans and other medical images	Head of Radiology department
Medical Imaging Technologists	He assists clinical radiologists and other doctors diagnose, monitor or treat a patient's injury or illness.	Member of Radiology department
Biomedical scientist	They carry out a range of laboratory tests to help doctors in their diagnosis and treatment of patients and they work in pathology laboratories.	Head of Laboratory department
Laboratory staff		Member of Laboratory department
Medical laboratory assistant		Head of infection control department
Physiotherapist	He treats the physical problems caused by illness, aging, accidents, particularly, those that affect the muscles, bones, heart, circulation and lungs.	Head of Physical therapy department
Sterile services manager	They are responsible for supplying sterile equipment to department, units and ward and making sure all medical equipment, tools and instruments are not contaminated.	Head of Central Sterile Services Department
Sterile services technician		Member of Central Sterile Services Department
Health records staff	They work with paper and computerised health records	Members of Medical records Department
Neurosurgeons	He deals with the diagnosis and treatment of health problems that affect the brain and nervous system	Head of Neurology and Brain clinics

13.2.4 PHASE 3-1: PART A: INPUTS FROM FIRST INTERVIEW QUESTION WITH MEDICAL MANAGERS

Table 13. 5: Design requirement in the Obstetrics and Gynaecology Clinics

Current unit design	Proposed unit design elements
Unavailable	Male and Female Staff Changing and Lockers Rooms With 2 Toilets
Unavailable	Male & Female Patients Waiting Area With 2 Toilets
Unavailable	Male & Female Waiting Area With 2 Toilets
Unavailable	Equipment Room Storage (2)
Unavailable	Clinic (1)
4 Available	LD. Room (15) (Failed; No Spaces)
Unavailable	F. Doctor on Call Office
Unavailable	M. Doctor on Call Office
Not Enough	Dirty Utility Rm.
1 Available	Clean Utility Rm.
Unavailable	Medication Room (1)
Unavailable	Head Nurse Office
Unavailable	Medical Waste
1 Available	Nurse/Station Control Room (2)
Unavailable	Janitorial Rm.
Unavailable	Ultrasound Rooms (2)
Unavailable	Conference Room (Discussion Urgent Cases);
Unavailable	Air Lock + Toilet in Each LD. Rm.
Unavailable	Bed Parking
Unavailable	Patient Waiting Area

Table 13.6: Design requirement of Labour and Delivery Department

Previous unit design	Current unit design elements	Proposed unit design elements
6 exam room	5 exam rooms	5 exam rooms
Inadequate	Women waiting area	Women waiting area
Inadequate	Unavailable	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Unavailable	Electrocardiogram (ECG)
Unavailable	Unavailable	Ultrasound
Unavailable	Nurse office	Nurse office
Inadequate	Nurse station	Nurse station
Unavailable	Female staff changing room	Female staff changing room
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Blood extraction
Unavailable	Unavailable	W. Waiting blood extraction
Unavailable	Dirty utility (crossing)	Dirty utility
Unavailable	Unavailable	Clean utility
Unavailable	Unavailable	Janitorial room (CIBAH)
Cardiotocography	Unavailable	Cardiotocography (CTG)
Vitality indicator room	Unavailable	Vitality indicator room
Unavailable	Unavailable	Trophy scope room
Unavailable	Unavailable	Treatment room
Unavailable	Doctor lounge	Doctor lounge
Unavailable	Doctor office	Doctor office

Table 13. 7: Design requirement in the Paediatric Clinic

Previous unit design	Current unit design elements	Proposed unit design elements
7 Exam Rooms	7 Exam Rooms	Exam Rooms (8)
Inadequate	Women waiting area	Women waiting area
Inadequate	(unavailable)	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Unavailable	Ultrasound Rm.
Unavailable	Nurse office	Nurse office
Unavailable	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Children Blood extraction Rm.
Unavailable	Unavailable	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Unavailable	Unavailable	Equipment storage
Vitality indicator Rm.	available	Vitality indicator Rm.
Unavailable	Unavailable	Monitoring vitality signs
Unavailable	Unavailable	ECHO Room (echocardiogram)
Unavailable	Unavailable	Treatment Rm.
Unavailable	Doctor lounge	M. and F. Doctor lounge (2):
Unavailable	Doctor office	Doctor office (2):

Table 13. 8: Design requirement in Paediatric Intensive Care Unit

Current unit design	Proposed unit design elements
Unavailable	Equipment Room Storage
6 Available	PICU Room (12)
1 Available	Isolation Room (2)
Available	Clean Store
Unavailable	Male & Female Staff Lounge with Toilets.
Unavailable	PICU Director Office
Unavailable	Doctors' Rm.,
Unavailable	Sub Nurse Station (8) For 12 Beds
Unavailable	Dirty Utility Rm.
Unavailable	Clean Utility Rm.
1 Available	Medication Room (2)
1 Available	Nurse/ Control Station Room (2)
Unavailable	Doctor on Call Office
Unavailable	Doctor Lounge
Unavailable	Janitorial Rm.,
Unavailable	Female and male changing and lockers Room

Table 13. 9: Design requirement in Neonatal Intensive Care Unit

Current unit design issues	Proposed unit design elements
Unavailable	Equipment room storage
24 available	NICU room (44)
1 available	Isolation room (4)
1 available	Clean store (2)
Unavailable	Male & female staff lounge with toilets.
Unavailable	NICU director office
Unavailable	Doctors office rm.
Unavailable	Sub nurse station (14) for 44 beds
Inadequate	Dirty utility rm.
Inadequate	Clean utility rm.
1 available	Medication room (2)
Unavailable	Head nurse office (2)
Unavailable	Medical waste (2)
Unavailable	Department manager
1 available	Main nurse/station control room (2)
Unavailable	Male & female changing and locker rm.
Unavailable	Male doctor on call office
Unavailable	Female doctor on call office
Unavailable	Doctor lounge
Unavailable	Respiratory therapy rm.
Unavailable	Janitorial rm.

Table 13. 10: Design requirement of the Psychological Clinics

Previous unit design	Current unit design elements	Proposed unit design elements
1 Exam Rooms	Unavailable	Exam Rooms (2)
Unavailable	Unavailable	Women waiting area
Unavailable	Unavailable	Men waiting area
Unavailable	Unavailable	Nurse station

Table 13. 11: Design requirement in the General Surgery Clinic

Previous unit design	Current unit design elements	Proposed unit design elements
3 exam rms.	5 exam rooms	Exam rooms (6)
Unavailable	Unavailable	Dressing wound clinic
Unavailable	Unavailable	Tumours sampling extraction Rm.
Unavailable	Unavailable	Anaesthesia clinic?
Inadequate	Women waiting area	Women waiting area
Inadequate	(unavailable)	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Nurse office	Nurse office
Inadequate	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Men Blood extraction Rm.
Unavailable	Unavailable	Men waiting blood extraction
Unavailable	Unavailable	Women Blood extraction Rm.
Unavailable	Unavailable	Women waiting blood extraction
Unavailable	Dirty utility	Dirty utility
Unavailable	Available	Clean utility
Unavailable	Unavailable	Janitorial room (CIBAH)
Unavailable	Available	Treatment rm.

Table 13. 12: Design requirement in the operation Department

Operations area	
Current unit design	Proposed unit design elements
Inadequate	Male Changing and Lockers rooms with 2 Toilets
Inadequate	Female Changing and Lockers rooms with 2 Toilets
Unavailable	Male Waiting Area With 2 Toilets
Unavailable	Female Waiting Area With 2 Toilets
Inadequate	Nurse/Station Control Rm
Available	Head of Department
Available	Head of Nurse
Available	Doctors Office 2
Unavailable	Equipment Store
Inadequate	Staff Lounge
Unavailable	Conference Rm.
5 Operations Rms	10 Operations Rooms (Digitals) With:
5 Scrub Areas	10 Scrub Areas
4 Clean Stores	7 Clean Utilities
2 Sterile Stores	4 Sterile Stores
Unavailable	Main Sterile Store
Unavailable	X-Ray Equipment and Beds Parking
Unavailable	Satellite Laboratory Rm.
Unavailable	Equipment Room Storage (3)
Inadequate	Anaesthetic Work Office
Patient holding/preparing area	
Current unit design	Proposed unit design elements
Unavailable	Nurse/Station Control Rm
2 Beds Inadequate	Patient Holding/Preparing Area 5 Beds
Unavailable	Medication Rm.
Unavailable	Janitorial Rm.
Unavailable	Nurse/Station Control Rm 2
Patient Recovery Area	
Current unit design	Proposed unit design elements
Unavailable	Medication Room 2
Unavailable	Nurse/Station Control Rm 2
Unavailable	Immediate Sterilization Area
6 Beds Inadequate	13 Beds for Patient Recovery

Table 13. 13: Design requirement in the Gastroenterology (GI) Department

Current unit design	Proposed unit design elements
Inadequate (1)	Procedure Room (2)
Unavailable	Instrument Processing. (2)
Unavailable	Male patient Changing and Lockers Rooms with 1 Toilet
Unavailable	Female patient Changing and Lockers rooms with 1 Toilets
Unavailable	Male staff Changing and Lockers rooms with 1 Toilets
Unavailable	Female staff Changing and Lockers rooms with 1 Toilets
Unavailable	Female waiting Room with 1 Toilets
Unavailable	Mail waiting Room with 1 Toilets
Unavailable	Equipment room Storage
Unavailable	Dirty Utility Rm.
Unavailable	Clean Utility Rm.
Unavailable	Medication Room (1)
Unavailable	Head Nurse Office
Unavailable	Medical Waste
Inadequate 1	Nurse/Station Control Room (1)
Unavailable	Information Disk
Unavailable	Janitorial Rm.
Unavailable	Step Up Area
Unavailable	Male & Female Exam Room
Unavailable	Male Lounge Rm.
Unavailable	Pantry

Table 13. 14: Design requirement in the Ophthalmology clinics

Previous unit design	Current unit design	Proposed design elements
4 Exam Rooms	5 Exam Rooms	Exam Rooms (6)
Inadequate	Women waiting area	Women waiting area
Inadequate	Unavailable	Men waiting area
Inadequate	Available	Women toilet
Inadequate	Available	Nurse station
Unavailable	Available	Female staff changing Rm.
Unavailable	Available	Male staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Male staff toilets
Unavailable	Dirty utility	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Available	Available	Laser Rm.
Available	Available	Lasik Rm.
Available	Available	Reflection Rm.
Unavailable	Available	Visual field Rm.
Unavailable	Available	Contact lenses rom
Unavailable	Available	Doctor office
Unavailable	Available	Recover area
Unavailable	Available	Reception
Unavailable	Available	Anaesthetic Work Office
Unavailable	Available	2 operation room
Unavailable	Available	3 sterile stores

Table 13. 15: Design requirement in the Dental Surgery Clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
3 Exam Rooms	available	Exam Rooms (3)
Unavailable	Unavailable	Patient Women waiting area
Unavailable	Unavailable	Patient Men waiting area
available	available	Nurse station
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Unavailable	Unavailable	X-Ray Room 2
Unavailable	Unavailable	Dental Air Compressor Rm.

Table 13. 16: Design requirement in the Orthopaedic Clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
3 Exam rooms	4 Exam Rooms	Exam Room (4)
Inadequate	Available	Women waiting area
Inadequate	Available	Men waiting area
Inadequate	Available	Women toilet
Unavailable	Available	Nurse office
Unavailable	Available	Nurse station
Unavailable	Available	Female staff changing Rm.
Unavailable	Available	Female staff toilets
Unavailable	Unavailable	Dirty utility
Unavailable	Available	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Unavailable	Available	Treatment Rm.
Unavailable	Unavailable	Doctor office (1)
Unavailable	Unavailable	Head of department office
Unavailable	Available	Gypsum plaster Rm.

Table 13. 17: Design requirement in the Cardiology clinic

Previous clinic design element	Current clinic design element	Proposed clinic design element
2 Exam Rms.	3 Exam Rooms	Exam Rooms (6)
Inadequate	Women waiting area	Women waiting area
Inadequate	Men waiting area	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Inadequate	Electrocardiogram (ECG) (1)
Unavailable	Inadequate 1	Echocardiogram (ECHO) (3)
Unavailable	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Unavailable
Unavailable	Female staff toilets	Unavailable
Unavailable	Dirty utility	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Unavailable	Female Doctors lounge	Unavailable
Unavailable	Male Doctors lounge	Unavailable
Unavailable	Doctor office	Unavailable
Unavailable	2 stores	Unavailable

Table 13. 18: Design requirement in the Internal medicine clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
8 Exam Rooms	5 Exam Rooms	Exam Rooms (7)
Inadequate	Women waiting area	Women waiting area
Unavailable	(unavailable)	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Nurse office	Nurse office
Inadequate	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Unavailable	Unavailable	ECHO (echocardiogram)
Unavailable	Unavailable	Treatment Rooms (2)
Unavailable	Unavailable	Equipment storages (2)
Unavailable	Unavailable	health Education Officer

Table 13. 19: Design requirement in the Neurology and Brain clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
6 Exam rooms	7 Exam Rooms	Exam Rooms (3)
Inadequate	Women waiting area	Women waiting area
Inadequate	Men Unavailable	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Unavailable	Brain monitoring devices Rm.
Unavailable	Unavailable	Nerve monitoring devices Rm.
Unavailable	Nurse office	Nurse office
Inadequate	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Blood extraction
Unavailable	Unavailable	men waiting blood extraction
Unavailable	Dirty utility (common)	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Unavailable	Treatment Room 2	Treatment Room (1)
Unavailable	Doctor office	Doctor office

Table 13. 20: Design requirement in the Urology clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
2 Exam rooms	7 Exam Rooms	Exam Rooms (7)
Unavailable	Available	Women waiting area
Unavailable	Available	Men waiting area
Unavailable	Available	Women toilet
Unavailable	Available	Men toilet
Unavailable	Unavailable	Men monitoring exam Rm.
Unavailable	Unavailable	women monitoring exam Rm.
Unavailable	Nurse station	Nurse station (2)
Unavailable	Unavailable	Female staff changing Rm.
Unavailable	Unavailable	Female staff toilets
Unavailable	Dirty utility	Dirty utility
Unavailable	Available	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Shock Wave Lithotripsy	Unavailable	Unavailable (SWL)

Table 13. 21: Design requirement in the adult intensive care unit

Current clinic design element	Proposed clinic design element
Unavailable	Equipment Room Storage
Inadequate 11	ICU Adults Room (22)
Inadequate 1	Isolation Room (4)
Inadequate 1	Clean Store (2)
Unavailable	Male & Female Staff Lounge with Toilets.
Unavailable	ICU Director Office
Unavailable	Doctors office Rm..
Unavailable	Sub Nurse Station (14) For 22 Beds
Inadequate	Dirty Utility Rm.
Inadequate	Clean Utility Rm.
Inadequate 1	Medication Room (2)
Unavailable	Head Nurse Office (2)
Unavailable	Medical Waste Room (2)
Unavailable	Department Manager
Inadequate 1	Main Nurse Station/Control Room (2)
Unavailable	Male & Female changing and locker Rm.
Unavailable	Male Doctor on Call Office
Unavailable	Female Doctor on Call Office
Unavailable	Doctor Lounge
Unavailable	Respiratory therapy Rm.
Unavailable	Janitorial Rm.

Table 13. 22: Design requirement in the Dermatology clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
4 exam rooms	3 exam rooms	Exam rooms (4)
Unavailable	Women waiting area	Women waiting area
Unavailable	(unavailable)	Men waiting area
Unavailable	Women toilet	Women toilet
Available	Available	Ultraviolet rm.
Unavailable	Nurse office	Nurse office
Unavailable	Nurse station	Nurse station
Unavailable	Female staff changing rm.	Female staff changing rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Minor operation rm.
Unavailable	Unavailable	Equipment store
Unavailable	Dirty utility	Dirty utility
Unavailable	Unavailable	Clean utility
Unavailable	Unavailable	Janitorial room (CIBAHI)
Inadequate 2	Unavailable	Laser room (3)

Table 13. 23: Design requirement in the Accident and Emergency Department

Observation area	
Current unit design element	Proposed unit design element
Inadequate 3	Male Observation room (6)
Inadequate 3	Female Observation Room (6)
Unavailable	(4) Paediatric Observation Paediatric Room required (6)
Unavailable	(4) OB/Gyne Observation Rooms required (6)
Unavailable	Pharmacy
Unavailable	Screening Clinic
Unavailable	Visual Triage (Infl)
Inadequate 1	Triage (2)
Unavailable	Dictation room
available	Isolation Rm.
Unavailable	Police office Rm.
Inadequate 1	Stretcher bay (9)
Available 1	3 Nurse station
Unavailable	Control rm.
Available	Female waiting area
Unavailable	Male waiting area
Available	Female toilet
Available	Male toilet
Examination	
Current unit design element	Proposed unit design element
Inadequate 2	Male Examination (2) with toilet (6) f
Inadequate 2	Female Examination (3) (6) with toilet, f
Unavailable	Male staff changing and lockers room
Unavailable	Female staff changing and lockers room
Unavailable	Manager on Call Office
Unavailable	Doctor Lounge
Unavailable	ER, Manager Office
Unavailable	Rest area
Resuscitation area	
Current unit design element	Proposed unit design element
Unavailable	7 beds
Unavailable	Isolation Rm.
Unavailable	Temporary body store
Operation unit	
Current unit design element	Proposed unit design element
Unavailable	Procedures Rm.
Unavailable	2 holding beds
Unavailable	Clean store
Unavailable	Visitor lounge with toilet
Unavailable	Dirty utility
Unavailable	Meeting Room with toilet
Unavailable	Psycho patient Rm.
Unavailable	Initorial rm.
Unavailable	Mobile x-ray alcove
Unavailable	Laboratory
Unavailable	Equipment store rm.
Unavailable	Medication room 2
Unavailable	Clean Store
Unavailable	X-RAY Unit with changing and control rooms

Table 13. 24: Design requirement in Radiology department

Current unit design element	Proposed unit design element
Inadequate 1	Reception area (2)
Inadequate	Male waiting area with toilet
Inadequate	female waiting area with toilet
Unavailable	Pool & Transcript Section
Unavailable	Male staff lockers Room with toilet
Unavailable	Female staff lockers Room with toilet
Unavailable	Viewing and Charting area
Unavailable	Active medical records area
Unavailable	Technician office
Inadequate 2	X-Ray (4) With toilet, Changing and control Rms
Available	Mammography with dressing Rm.
Unavailable	Data Processing Area
Inadequate 1	Nurse station (2)
Unavailable	Pantry
Unavailable	Clean line
Unavailable	File store
Unavailable	Clean utility
Unavailable	Dirty utility
Unavailable	Female patient area with toilet
Unavailable	Male patient area with toilet
Unavailable	Male staff lounge
Unavailable	female staff lounge
available very old	Angiography suite with toilet, Changing and control Rms
Unavailable	Observation Post-Procedure area (2 beds)
Unavailable	Clean supply store
available	Computer Rm.
Unavailable	Scrub-Up area
Unavailable	Interventional Ultrasound Room with toilet
available	Ultrasound Room with toilet (3)
Unavailable	Head Unit Office
Unavailable	Secretary Office
Unavailable	Meeting Rm.
Inadequate 1	Consultation Room (5)
Unavailable	Janitorial Rm.

Table 13. 25: Design requirement in the Physical therapy unit

Current unit design element	Proposed unit design element
Inadequate space	Physical exercises area (GYM)
Unavailable	Male Arm and Leg Treatment Rm.
Unavailable	Female Arm and Leg Treatment Rm.
Unavailable	Security Office
Available	Stores Room
Unavailable	Janitorial Rm.
Unavailable	Male Patient Waiting Area with Toilet
Unavailable	Female Patient Waiting Area with Toilet
Available	Nurse Station Rm.
Available	Dirty Utility
Available	Clean Utility
Unavailable	Manager Office
Unavailable	Meeting Rm.
Available	Doctors Rm.
Unavailable	Male Staff Lounge Rm.
Unavailable	Therapy Pool Area
Unavailable	Patient Changing and Lockers Rm.
Unavailable	Male Physical Therapy Rooms (4)
Unavailable	Female Physical Therapy Rooms (2)
Available	Staff Toilet
Unavailable	Single Patient Therapy Rooms (2)

Table 13. 26: Design requirement in the Laboratory Department

Current unit design element	Proposed unit design element
Not Available	Female & Male Reception and Lobby
Unavailable	Male & Female Waiting Area With 2 Toilet
Unavailable	Male & Female Exam Room With 2 Toilet
Unavailable	Male Sample Collection
Inadequate 1	Female Sample Collection
Available	T.B. Lab 2
2 Available	Offices 4
Available	Laboratory Director Office
Unavailable	Chief Tech. & Secretary Office
Unavailable	Wash Room with Toilet
Unavailable	Female and Male staff Changing and lockers rooms
Unavailable	Male & Female Staff Lounges with Toilets.
Available	Cold Room with Store
Available	Clinical Chemistry and Haematology Laboratory
Unavailable	Workshop
Available	Urine/Stool Analysis Laboratory
Available	Chemistry Laboratory
Available	Blood Bank
Unavailable	Reception Blood Bank
Unavailable	Storage
Unavailable	Storage Acids
Not Available	Flammable Storage
Available	Histopathology Cytology
Unavailable	Tissue Cutting Rm.
Unavailable	Tissue Processing Rm.
Available	Pathologist Office
Unavailable	Biohazard/ Biohazard Rubbish
Not Available	Cleaning Room and Water Supply
Unavailable	Janitorial Rm.
Unavailable	Sterilization area
Available	Bacteriology Laboratory
Available	Blood Culture Laboratory
Available	Stool Culture Laboratory
Unavailable	Mycology Laboratory
Unavailable	Polymerase Chain Reaction Lab 3
Unavailable	Virology Lab 2
Unavailable	Media Preparation Storage
Unavailable	Microbiology Laboratory
Unavailable	Microbiologist Office
Available	Special Chemistry Laboratory
Available	Reporting Rm.
Available	Serology Laboratory

Table 13. 27: Design requirement in the Central Sterile Services Department

Current unit design element	Proposed unit design element
Unavailable	Dirty receiving area
Unavailable	Trolley washing area (7)
Unavailable	Trolley clean area (3)
Unavailable	Janitorial Rm.
Unavailable	Shoes rack areas (2)
Available	Washing and decontamination area
Unavailable	Washer disinfectant area (3)
Available	Cleaning and packaging area
Unavailable	Air lock Rm.
Unavailable	Technician Rm.
Available	C.S.S.D. Manager
Available	Sterilised storage area for Operation Dept.
Available	Main sterilised storage and supply store
Unavailable	Female lounge
Unavailable	Male lounge
Available	Changing and lockers Room for male staff with toilet
Available	Changing and lockers Room for Female staff with toilet

Table 13. 28: Design requirement in the Medical Records Department

Current unit design element	Proposed unit design element
Inadequate 3	Trolley Parking (10)
Inadequate 1	Analyses Office (3)
Inadequate 2	Assembly Office (4)
Unavailable	Medical Coding Office
Unavailable	Medical Transcription Office
Inadequate 1	Tracing Office (2)
Unavailable	Collection Area (2)
Unavailable	Mortality Recording Office
Unavailable	Supervisor Office
Unavailable	Medical Record Head Office
available	Documentation Quality Professional
Unavailable	Janitorial Rm.
available	Male Staff Toilet
available	Female Staff Toilet

13.2.5 PHASE 3-1: PART B, INPUTS OF PARTICIPANTS FROM QUESTIONS 2-4

Table 13. 29: Inputs of participants from Obstetrics and Gynaecology Clinic and Labour and Delivery Department

(1) Obstetrics and Gynaecology Clinic and (2) Labour and Delivery Department (2 participants)

Professional level: Obstetrician and gynaecologist
Duties: She deals and manages the pregnancy and childbirth and performs operations
She works in outpatient clinics and on the inpatient female wards
Positions: Head of Labour and Delivery Department- Head of OB/GYNE clinic

Q1:
For space requirement in treatment and diagnostic plans, see Tables 12.4-6
have mentioned the issues (defect and faults), to redesigning obstetrics and gynaecology clinic and labour and delivery unit (see Layout, 1 and 2), they explained how these issues effected patient care services in many areas: (1) some cases cannot be accepted in the unit or to the related inpatient ward (male medical wards), because there are no available beds, (2) lack of some diagnostic devices in unit and the clinic; (3) lack of spaces to store some medical waste (placenta membranes and medical consumptions) in the in both unit and clinic that caused infection. Second area, (1) difficulty in patient movements because of storing some devices in the corridors; (a) presenting so many companions inside the unit or waiting at the main entrance of unit means that they obstruct patient coming to enter the unit, (b) a long and indirect way from the unit to the operations unit in case of emergency surgical intervention needed or to bring the patient from ER department to the unit in short time. Third area: (1) the difficulty to apply the patient safety standards and policies of JCIA and CIBAHL, due to the lack of the negative pressure in the LD rooms, and dirty and clean rooms to control infection. Fourth area is unavailable spaces for healthcare givers to rest or have a meeting to discuss critical cases and select the best treatment plan. Therefore, these areas result in the difficulty or delay in medical services and make patient angry. Note: the main focus of this study is patient; in case that the design issues impacted healthcare providers activities to deal with patient health problems, these issues will be slightly included in this study. Other study will be recommended to study the link between design issues and healthcare givers duties.

Q2
they blamed the designer of this current unit in many ways: (1) lack of experience in the field of hospital design; (2) lack of knowledge in patients and doctors' need, think and wants, and different stages types of treatment and diagnosis plans within and equipment, tools, waste and patients' movements, and the required levels and number of medical professionals and their activities in spaces, and level, , quantity and stage of disease cases. How would you recommend improving the design process in terms of safer, healthy environments that are free from design issues and supporting the healing process?
To improve hospital design to be design defects free, they required mentoring/watching the patient steps, from the begging of his/her visit till the end and after, in following recommendations of spaces, tools and equipment, process.

Table 13. 30: Inputs of participants from Paediatric Clinic, Paediatric intensive unit (PIU) and neonatal intensive care unit (NICU)

Paediatric Clinic, Paediatric intensive unit (PICU), neonatal intensive care unit (NICU) (4 participants)

Professional level: Paediatrician, Neonatologist, Respiratory physiology technicians (graduated from Australia with master's degree)

Duties: Paediatrician deals with and manages the pregnancy and childbirth and works in outpatient clinics. Neonatologist diagnoses and treats new-borns, works in children wards and outpatient clinics. Respiratory physiology technician works on investigations that help the diagnosis of difficulty and disorders in breathing, such as asthma and emphysema. Paediatrician specialises in the diagnosis and treatment of childhood illnesses and works in outpatient clinics and on hospital wards with performing operations.

positions

Head of Paediatric Clinic - Paediatric intensive unit- Head of neonatal intensive care unit-head of RT unit

Q1

For space requirement in treatment and diagnostic plans, see Tables 12.6-8

Participants from the NICU, PICU units and clinics and RT unit, justified the reasons behind these design issues (see layouts, 3,4 and 5) as following: (1) limited capacity to accept additional cases due to lack of beds number; (2) no way to evacuate children on the bed with medical equipment, in case of a fire, through the stairs or lifts that may cause suffocation, burn, posing or death; (3) no chance to monitoring patients from the nurse station because all walls build in bricks and these stations are too small to accommodate the nurse number to perform their activities; (4) patient room designed for 2 beds capacity, but know it serves 4 beds, which leading to difficulty in patient, healthcare givers, equipment movements and spread of infections, especially responding to blue cod, (5) low pressure of oxygen flow causes breakdown of some medical equipment that required high pressure to function accurately, that exposed children to danger, (6) a lack of some very important types of gases used in treatment plan, that expand the children veins. These gases save children lives; (7) lack of some spaces to sterilize the used respirators equipment to avoid infection, (8) lack of spaces to store some devices to avoid parking them in the corridors, (9) lack of spaces for healthcare givers to take rest and perform their duties again; (10) the security system needs to be upgraded to protect babies from kidnaping (1 case occurred) ; (11) the painting colour in the children room are recommended to be enjoyable rather than bleak/depressing besides allowing to the sunlight to visit most of children's' rooms. However, these design issues lead to delay, difficulty or stop children healthcare services and expose them to danger,

Q2

To respond to why these design issues occurred in patient environment, they recognised the following causes belong to the designer's issues: (A) lack of designer knowledge in terms of : (1) the 3 levels of kid's health problem status to determine their needs in treatment plan within different level of spaces, (2) the types, functions, locations and needs of medical equipment and how to use them, (B) ignoring the increase in the children number in future. (C) the most focus in design is not including the healthcare providers activities.

How would you recommend improving the design process in terms of safer, healthy environments that are free from design issues and supporting the healing process?

In order to solve these design issues, they mentioned some recommendations: (1) the designer should consider the size, health problem level and the age of children in designing spaces and its components, such as the size of clinic and toilets, and its elements, and painting colour and pictures that reflect the happiness; (2) respect the parents privacy especially during feeding baby in the units; (3) in the clinic the playground should be near by the parents waiting area to watch their kids; (4) medical gas types should be known by designer (mechanical engineers).

Table 13. 31: Inputs of participants from Psychological Clinic

<p>(4) Psychological Clinic (1 participant)</p> <p>Professional level: Psychiatrist</p> <p>Duties specialises in the diagnosis and treatment of mental health problems and he can prescribe medicines, uses psychological (talking) treatments to help his patients.</p> <p>positions Head of Psychological Clinic</p> <p>Q1 For space requirement in treatment and diagnostic plans, see Table 12.9 Responding to why these design defect and faults existing in this clinic (see layout, 6), that lead patient to refuse continuing his/her treatment plan, the doctor explain that in different ways: (1) no consideration of doctor agender in clinic where the most of female patient do not want to deal with male doctors (culture aspect); (2) no concerning of the privacy and feelings of patient, who has psychological ill, during his/her movements inside the hospital or during the walk to the clinic for following 2 ways: (a) patient waiting area and entrance of clinic are shared with other patients within different clinics; (b) my patient needs to walk for long distance from car parking passing through many clinics to reach my clinic. These reasons make patient be recognised by others and he/she does not want that. In addition to that, some of the patients suffering from not having kids, so the playground is close to the clinic, which make them sad (?)</p> <p>Q2 The design issues occurred because the designer should know the Saudi culture, that most people have a special deal and behave with those patient type which make them feeling different in abnormal way How would you recommend improving the design process in terms of safer, healthy environments that are free from design issues and supporting the healing process? It is important that the engineer knows how the psychological feelings of my patients: no one knows that he is psychologically ill. Not seeing him while he is waiting in the clinic. Or when the patient enters or exits the clinic. Some patients have psychological problems related to the inability to have children; I hope that the clinic is far from the site of children's playground.</p>

Table 13. 32: Inputs of participants from Internal medicine clinics

<p>Internal medicine clinics (confusing) (3 participant)</p> <p>Professional level: Physician</p> <p>Duties Physician diagnoses and manages complex medical problems.</p> <p>positions Head of Internal medicine clinics</p> <p>Q1 For space requirement in treatment and diagnostic plans, see Table 12.17 Having mentioned the design issues and faults through the new requirement in redesigning the unit (see layout, 7), the physician in this unit complained about the difficulty to know the patient history, because the delay in bringing the patient file or it is missing which makes it too hard for me to define the best way to diagnose the health problem; however, the only responsible for this is medical records department as he mentioned. This situation leads the research to investigate this issue is related to design issue in medical records department or not, because the delay or lost these files related to design issues.</p> <p>Q2 To respond to reasons causing these design issues, the participant mentioned that the designer has a lack of knowledge about the main function for some of department spaces</p>
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Table 13. 33: Inputs of participants from Neurology and Brain clinics

<p>Neurology and Brain clinics (1 participant)</p> <p>Professional level: Neurosurgeons (Saudi surgeon)</p> <p>Duties he deals with the diagnosis and treatment of health problems that affect the brain and nervous system of patient.</p> <p>positions Head of Neurology and Brain clinics</p> <p>Q1 For space requirement in treatment and diagnostic plans, see Table 12.18 Why do you think these design issues occurred in this hospital or in your department? Having mentioned the design issues and the required design elements to redesigning the unit (see layout, 8), the surgeon pointed to missing factor causing these issues and missing components in his clinic. The factor is a lack of designer/ engineer knowledge level in terms of (1) the types of treatment plan, (2) the roles and responsibilities in diagnosing and treating the health problems from medical perspective, and (3) the activities of the department. (designer should deal with patient in design as a doctor and patient)</p> <p>Q2 In order to solve the design issues, the doctor mentioned 3 recommendations: (1) healthcare should be invited to be part of design team (as I did); (2) increase the designer knowledge in: (a) how doctors deal with patients and diseases, (b) know what the current and advance technology and techniques in medical equipment and the new methods, plans and procedures to diagnose and treat patient, by studying and researching and reading books in the field of hospital designs. However, the participant in this study (during explaining to him the purpose of this study), confirmed that designer should concentrate on the skin sense as the most important part in patient sensory systems, in which can read and translate all design elements and components from the nerve system connected to the skin through the body then to the brain. (7)</p>
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Table 13. 34: Inputs of participants from General Surgery Clinic, operation Department and Gastroenterology (GI) Department

<p>General Surgery Clinic, Theatres Department and Gastroenterology (GI) Department (4 participants)</p> <p>Professional level: Surgeons - Anaesthetist</p> <p>Duties: In operation and Endoscopy unit, they specialise in operating on particular parts of patient body. He is a senior consultant in major and minor operations. Anaesthetist gives local or general anaesthetics to patients, monitors the condition of patients when they undergo surgery treatment and runs outpatient pain management in General Surgery Clinic. in Surgery Clinic, he is handling minor surgical procedures, follow-up post-operative appointment and consultation.</p> <p>Positions: Head of Psychological Clinic- head of General Surgery Clinic- head of Endoscopy Department (graduated from Australia)- member of Anaesthetic department.</p> <p>Q1: For space requirement in treatment and diagnostic plans, see Tables 12.10-12 Besides the requirement, needs and design issues, in the operations and gastroenterology units and surgery clinics (see layout, 9, 10 and 11), were mentioned by surgeons and anaesthetist, they confirmed that: (1) all critical medical equipment and tools must connected to the USP points to avoid the breakdown of them when they being used on patients, (2) the pressure inside the operation must be positive to protect patient from potential infection from outside, (3) using advance technology in performing operation will reduce the medical errors and safe medical staff effort and time (digital operation room), (3) water leakage from ceilings in some rooms is serious issues that causes issues with patient health and equipment, some times that lead to cancel the operations, (4) the number of operation rooms is to low, so many cases was transferred to other hospitals, and (5) some medical instruments were refused to be used on patient, because they seemed not applied to all processes of sterilisation (where). Visit the SSC.</p> <p>Q2: observations the designer was not aware of many factors: (1) Size -types and functions of equipment in spaces; (2) movement of the patient within the department; (3) procedures and plans used to deal with the patient; (4) : (a) the movement of doctors, equipment and waste distributed/crossed with the movement of the patient on bed; (b) movement sterilized equipment and tools: (c) movement of each types of medical waste such as hazardous, infection, general and radioactive waste: (7) mixed the tracks of recovery, preparation, exam, sterilisation zones, and dirty areas within the unit; (8) the sterile rooms far away from the operation rooms and should be part of it.</p>
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Table 13. 35: Inputs of participants from Ophthalmology clinics

Ophthalmology clinics (2 participants)
Professional level: Ophthalmologist / Optometrist
Duties: Optometrist performs eyesight tests and examinations and prescribes contact lenses or glasses to patients. Ophthalmologist specialises in the medical and surgical management of eye health problems, and handling minor surgical procedures
Positions: Head of Ophthalmology clinic- consultant
Q1: For space requirement in treatment and diagnostic plans, see Table 12.13
Q2: Designer not awarding the differences in the function for each space in the unit.

Table 13. 36: Inputs of participants from ENT clinics

ENT clinics (2 participants)
Professional level: ENT specialist and Audiologists
Duties: An ENT specialises in diseases that affect the ears, nose and throat, as well as the head and neck. Audiologist identifies and assesses hearing and balance disorders and he provides appropriate rehabilitation and management, and he works closely with ear nose and throat (ENT) consultants.
Positions: Head of ENT clinics
Q1: For space requirement in treatment and diagnostic plans, see Table 12.-
Q2: Observations: Size and function of medical equipment within the clinic size

Table 13. 37: Inputs of participants from Dental Surgery Clinic

Dental Surgery Clinic (1)
Professional level: Dental surgeon
Duties: specialises in surgery of the teeth, the gums and the jaws bones
Positions: Head of Dental Surgery Clinic
Q1: For space requirement in treatment and diagnostic plans, see Table 12.14
Q2: Observation: The location of the equipment (air compressor)

Table 13. 38: Inputs of participants from Orthopaedic Clinics

Orthopaedic Clinics (1 participant)
Professional level: orthopaedic surgeon
Duties: I use surgical means to treat spine disorders, sports injuries and use non-surgical treatment such as using exercises and medication.
Positions: Head of Orthopaedic Clinics
Q1: For space requirement in treatment and diagnostic plans, see Table 12.15

Table 13. 39: Inputs of participants from Cardiology clinic

Cardiology clinic (3 participants)
Professional level: Cardiologist, Cardiographers and Cardiac physiologists
Duties: Cardiologist diagnoses, assesses and manages patients with diseases of the heart and vascular system (circulation). (senior consultant level). Cardiographer works in the cardiac (heart) department of hospitals, he helps to operate machines that monitor heart function. Cardiac physiologist carries out investigations into the functions of the heart and the equipment fitted to help the heart.
Positions: Head of Cardiology clinic/ Cardiac Surgery unit- doctors
Q1: For space requirement in treatment and diagnostic plans, see Table 12.18
Q2: The use of equipment and their size, lift size. Way for watching

Table 13. 40: Inputs of participants from Urology clinic

<p>Urology clinic (1) Professional level: Urologist Duties: Urologist diagnoses and treats diseases of the urinary tract in both men and women. he also diagnoses and treats anything involving the reproductive tract in men Positions: Head of Urology clinic Q1: For space requirement in treatment and diagnostic plans, see Table 13.19 Q2: Patient condition during his visit in the clinic; measuring pressure</p>

Table 13. 41: Inputs of participants from Dermatology clinic

<p>Dermatology clinic Professional level: Dermatologist Duties: He diagnoses and treats diseases of skin, hair, and nail Positions: Head of Dermatology clinic Q1: For space requirement in treatment and diagnostic plans, see Table 13.21 Q2: The way to treat patient and equipment used</p>

Table 13. 42: Inputs of participants from Adult intensive care unit

<p>Adult intensive care unit (2) Professional level: Internal medicine physician and intensive care specialist Duties: He is a leader of a multidisciplinary team who dealing with ill adult patients with life-threatening single and multiple organ system failure. Specialist recognises, manages the disturbances associated with severe medical, surgical, obstetric illness, and he diagnoses and treats the circumstances that cause them Positions: Head of Adult intensive care unit Q1: For space requirement in treatment and diagnostic plans, see Table 13.20 Lack of required spaces: We have just 12 beds we need more, the department working with full capacity Q2: Some patient needs the kidney dialysis unit in his room, but there is no availability/ Infrastructure of water supply and drain net to install this unit</p>
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Table 13. 43: Inputs of participants from Accident and Emergency Department

<p>Accident and Emergency Department (3) Professional level: Paediatrician, surgeon, Duties: Specialises in the diagnosis and treatment of childhood illnesses. specialises in operating on particular parts of the body. Dr. Ahmed Positions: Head of Accident and Emergency Department, emergency doctors Q1: For space requirement in treatment and diagnostic plans, see Table 13.22 Q2: Types of emergency patients</p>
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Table 13. 44: Inputs of participants from Radiology department

<p>Radiology department (2)</p> <p>Professional level: Radiologists, Medical Imaging Technologists</p> <p>Duties: He works with an advance technology to produce X-rays, CT (computed tomography) scans, MRI (magnetic resonance imaging) scans and other medical images to assist clinical radiologists and other doctors diagnose, monitor or treat a patient's injury or illness</p> <p>Positions: Head of Radiology department</p> <p>Q1: For space requirement in treatment and diagnostic plans, see Table 12.23. Some sections in second floors and some in first and third floor. Some sections must be connected to the ER and Medical clinic Building. Lack of radiology devices and spaces</p> <p>Q2: Procedures of the department. Patient, staff needs and requirement in spaces. Mechanical, electrical services spaces. Doors not protected</p>

Table 13. 45: Inputs of participants from Laboratory Department

<p>Laboratory Department (3 participants)</p> <p>Professional level: Biomedical scientist, Laboratory staff and Medical laboratory assistant</p> <p>Duties: They carry out a range of laboratory tests to help doctors in their diagnosis and treatment of patients and they work in pathology laboratories</p> <p>Positions: Head of Laboratory department/Head of infection control department</p> <p>Q1: For space requirement in treatment and diagnostic plans, see Table 13.25</p> <p>Besides the required requirement and design issues (see Layout, 20), mentioned by the participants in those departments, they justified the need of redesign the department in many ways: (1) current area cannot accommodate all the modern medical equipment to identify some of diseases. So, some devices located in the internal corridors of the department due of the lack of required spaces to operate them ; (2) the overcrowding of the devices within the sections of the laboratory causing many issues; (a) difficult to movement of staff within each section; (b) the A/C system is not working appropriately/in efficiency way to adapting the new increase in the temperature of the thermal load producing by these equipment, that lead to breakdown some of them, and (c) additional electrical load increased to operate the new device, that may cause a fire ; (3) this department deals with too much requests of testing (blood tests) from the ER Dept. and 68 clinics with the new extended medical sections and clinics, in which increase the potential level of errors in samples analysis results (4) lack of required infrastructure avoids installing advance and specialized laboratory equipment that help in identifying and diagnosing diseases. These issues affect both patient health and care services</p> <p>Q2: Having mentioned the needs, requirements and design issues, the participant justified these issues in his department as results of low level of experience and knowledge in many areas: (1) types and stages of symbols to analyses them, (2) the way to collect them, (3) type and function of laboratory equipment to test and analysis the symbols and diseases; (4) type, functions and activities of each section in the department (5) type of used material and produced waste in sections, (6) lack of pay attention to future extensions for hospital department or patients number. However, all these factors lead to delay in presenting the outcomes of results or lack of data needed to help doctor to diagnose the health problems.</p>
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Table 13. 46: Inputs of participants from Physical therapy department

<p>Physical therapy department (1)</p> <p>Professional level: Physiotherapist</p> <p>Duties: he treats the physical problems caused by illness, ageing, accidents, particularly, those that affect the muscles, bones, heart, circulation and lungs.</p> <p>Positions: Head of Physical therapy department</p> <p>Q1: For space requirement in treatment and diagnostic plans, see Table 13.24. Lack of equipment and spaces. Crossing 2 departments to reach this department</p> <p>Q2: Patient privacy. Treatment type</p>

Table 13. 47: Inputs of participants from Medical records Department

<p>Medical records Department (2 participants)</p> <p>Professional level: Health records staff (2)</p> <p>Duties: organise, retrieve and archive patient records on the wards and in outpatient clinics. They work with paper and computerised health records</p> <p>Positions: Head of Medical records Department - 1 technician</p> <p>Q1: For space requirement in treatment and diagnostic plans, see Table 13.27</p> <p>Most of the design issues and lack of required spaces and furniture in this department is the reason behind the losing files and wasting time to find them. In addition, that the researcher faced issues in the redesigning for this department to applying the idea of using the mobile shelving system to gain spaces for both active and inactive files, because the structural load of flooring cannot stand the weight of the new system</p> <p>Q2: Files movement; staff movement and activities; types of patient files; components of the department</p> <p>Why the doctors cannot see the files on screen?</p>

Table 13. 48: Inputs of participants from Central Sterile Services Department

<p>Central Sterile Services Department (3 participants)</p> <p>Professional level: Sterile services manager</p> <p>Duties: He is responsible for supplying sterile equipment to department, units and wards and making sure all medical equipment, tools and instruments are not contaminated.</p> <p>Positions: Head of Central Sterile Services Department- 2 technicians</p> <p>Q1: For space requirement in sterilisation plans, see Table 13.27</p> <p>Observation: the lack of designer knowledge level in many areas: (1) the type of washing equipment and machine required to clean and sterilise the tools and instruments coming from different departments; (2) the movements of : (a) contaminated instruments inside the department and its way to others, and (b) the movements of uncontaminated instruments from other department to the sterilisation department; (d) the movement of staff through the dirty and clean and packaging areas; (3) lack of areas to receiving uncontaminated tools, for washing instrument trolley that brings the uncontaminated tool, and for staff requirements. However, these issues lead to spread the infection</p> <p>Q2: Sources of infections. Stages of sterilising tools. Types of washing equipment. Movements of instruments and staff inside the department. pressure</p>
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13.2.6 SECOND KEYS TECHNIQUE OF INTERVIEWS DATA ANALYSIS

Design elements of previous unit		Design elements of current unit	Requirements of participants
6 Exam Room	●	5 Exam Rooms	5 Exam Rooms
Inadequate	●	Women Waiting Area	Women Waiting Area
Inadequate	●	Unavailable	Men Waiting Area
Inadequate	●	Women Toilet	Women Toilet
Unavailable	●	Unavailable	Electrocardiogram (ECG)
Unavailable	●	Unavailable	Ultrasound
Unavailable	●	Nurse Office	Nurse Office
Inadequate	●	Nurse Station	Nurse Station
Unavailable	●	Female Staff Changing Room	Female Staff Changing Room
Unavailable	●	Female Staff Toilets	Female Staff Toilets
Unavailable	●	Unavailable	Blood Extraction
Unavailable	●	Unavailable	W. Waiting Blood Extraction
Unavailable	●	Dirty Utility (crossing)	Dirty Utility
Unavailable	●	Unavailable	Clean Utility
Unavailable	●	Unavailable	Janitorial Room(CIBAHI)
Cardiotocography (CTG)	●	Unavailable	Cardiotocography (CTG)
Vitality Indicator Room	●	Unavailable	Vitality Indicator Room
Unavailable	●	Unavailable	Trophy scope Room
Unavailable	●	Unavailable	Treatment Room
Unavailable	●	Doctor Lounge	Doctor Lounge
Unavailable	●	Doctor Office	Doctor Office

Figure 13.1: Design issues in the obstetrics and gynaecology clinics

Current unit design issues	Requirements of participants
Unavailable ●	Male and Female Staff Changing and Lockers Rooms With 2 Toilets
Unavailable ●	Male & Female Patients Waiting Area With 2 Toilets (Inside the Department)
Unavailable ●	Male & Female Waiting Area With 2 Toilets (Outside the Department on The Way to O.R.);
Unavailable ●	Equipment Room Storage (2)
Unavailable ●	Clinic (1)
4 Available ●	LDR Room(15) (Failed; No Spaces)
Unavailable ●	F. Doctor on Call Office
Unavailable ●	M. Doctor on Call Office
Not Enough ●	Dirty Utility Rm.
1 Available ●	Clean Utility Rm.
Unavailable ●	Medication Room(1)
Unavailable ●	Head Nurse Office
Unavailable ●	Medical Waste
1 Available ●	Nurse/Station Control Room(2)
Unavailable ●	Janitorial Rm.
Unavailable ●	Ultrasound Rooms (2)
Unavailable ●	Conference Room(Discussion Urgent Cases);
Unavailable ●	Air Lock + Toilet in Each LDR Rm.
Unavailable ●	Bed Parking
Unavailable ●	Patient Waiting Area

Figure 13.2: Design issues of labour and delivery department

Previous unit design issues	Current unit design	Design issues
7 Exam Rooms	7 Exam Rooms	Exam Rooms(8)
Inadequate	Women waiting area	Women waiting area
Inadequate	(unavailable)	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Unavailable	Ultrasound Rm.
Unavailable	Nurse office	Nurse office
Unavailable	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Children Blood extraction Rm.
Unavailable	Unavailable	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room(CIBAIII)
Unavailable	Unavailable	Equipment storage
Vitality indicator Rm.	available	Vitality indicator Rm.
Unavailable	Unavailable	Monitoring vitality signs
Unavailable	Unavailable	ECHO Room(echocardiogram)
Unavailable	Unavailable	Treatment Rm.
Unavailable	Doctor lounge	M. and F. Doctor lounge (2):
Unavailable	Doctor office	Doctor office (2):

Figure 13.3: Design issues in the Paediatric Clinic

Current unit design	Design issues
Unavailable	Equipment Room Storage
6 Available	PICU Room(12)
1 Available	Isolation Room(2)
Available	Clean Store
Unavailable	Male & Female Staff Lounge with Toilets.
Unavailable	PICU Director Office
Unavailable	Doctors' Rm..
Unavailable	Sub Nurse Station (8) For 12 Beds
Unavailable	Dirty Utility Rm.
Unavailable	Clean Utility Rm.
1 Available	Medication Room(2)
1 Available	Nurse/ Control Station Room(2)
Unavailable	Doctor on Call Office
Unavailable	Doctor Lounge
Unavailable	Janitorial Rm.
Unavailable	Female and male changing and lockers Room

Figure 13.4: Design issues in the paediatric intensive care unit

Current unit design issues	Requirements of participants
Unavailable	Equipment Room Storage
24 Available	NICU Room(44)
1 Available	Isolation Room(4)
1 Available	Clean Store (2)
Unavailable	Male & Female Staff Lounge with Toilets.
Unavailable	NICU Director Office
Unavailable	Doctors office Rm.
Unavailable	Sub Nurse Station (14) For 44 Beds
Inadequate	Dirty Utility Rm.
Inadequate	Clean Utility Rm.
1 Available	Medication Room(2)
Unavailable	Head Nurse Office (2)
Unavailable	Medical Waste (2)
Unavailable	Department Manager
1 Available	Main Nurse/Station Control Room(2)
Unavailable	Male & Female changing and locker Rm.
Unavailable	Male Doctor on Call Office
Unavailable	Female Doctor on Call Office
Unavailable	Doctor Lounge
Unavailable	Respiratory therapy Rm.
Unavailable	Janitorial Rm.

Figure 13.5: Design issues in the neonatal intensive care unit

Operations area	
Current unit design	Design issues and requirements
Patient holding/preparing area	
Current unit design	Design issues and requirements
Unavailable	Nurse/Station Control Rm
2 Beds Inadequate	Patient Holding/Preparing Area 5 Beds
Unavailable	Medication Rm.
Unavailable	Janitorial Rm.
Unavailable	Nurse/Station Control Rm 2

Figure 13.9: Design issues of Patient holding and preparing area

Unavailable	Conference Rm
5 Operations Rms	10 Operations Rooms(Digitals) With:
5 Scrub Areas	10 Scrub Areas
4 Clean Stores	7 Clean Utilities
2 Sterile Stores	4 Sterile Stores
Unavailable	Main Sterile Store
Unavailable	X-Ray Equipment and Beds Parking
Unavailable	Satellite Laboratory Rm.
Unavailable	Equipment Room Storage (3)
Inadequate	Anaesthetic Work Office

Figure 13.8: Design issues of Theatre area

Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Men Blood extraction Rm.
Unavailable	Unavailable	Men waiting blood extraction
Unavailable	Unavailable	women Blood extraction Rm.
Unavailable	Unavailable	women waiting blood extraction
Unavailable	Dirty utility	Dirty utility
Unavailable	available	Clean Utility
Unavailable	Unavailable	Janitorial Room(CIBAHI)
Unavailable	available	Treatment Rm.

Figure 13.7: Design issues in the General Surgery Clinic

Current unit design issues	Proposed requirements
Inadequate 1 ●	Procedure Room(2)
Unavailable ●	Instrument Processing. (2)
Unavailable ●	Male patient Changing and Lockers Rooms with 1 Toilet
Unavailable ●	Female patient Changing and Lockers rooms with 1 Toilets
Unavailable ●	Male staff Changing and Lockers rooms with 1 Toilets
Unavailable ●	Female staff Changing and Lockers rooms with 1 Toilet
Unavailable ●	Female waiting Room with 1 Toilets
Unavailable ●	Mail waiting Room with 1 Toilets
Unavailable ●	Equipment room Storage
Unavailable ●	Dirty Utility Rm.
Unavailable ●	Clean Utility Rm.
Unavailable ●	Medication Room(1)
Unavailable ●	Head Nurse Office
Unavailable ●	Medical Waste
Inadequate 1 ●	Nurse/Station Control Room(1)
Unavailable ●	Information Desk
Unavailable ●	Janitorial Rm.
Unavailable ●	Step Up Area
Unavailable ●	Male & Female Exam Room
Unavailable ●	Male Lounge Rm.
Unavailable ●	Pantry

Figure 13.11: Design issues in the Gastroenterology (GI) Department

Previous clinic design element	Current clinic design element	Proposed clinic design element
3 Exam Rooms ●	available	Exam Rooms (3)
Unavailable ●	Unavailable	Patient Women waiting area
Unavailable ●	Unavailable	Patient Men waiting area
available ●	available	Nurse station
Unavailable ●	Unavailable	Janitorial Room(CIBAHI)
Unavailable ●	Unavailable	X-Ray Room 2
Unavailable ●	Unavailable	Dental Air Compressor Rm.

Figure 13.12: Design issues in the Dental Surgery Clinic

Previous unit design	Current unit design	Proposed design elements
4 Exam Rooms	5 Exam Rooms	Exam Rooms(6)
Inadequate	Women waiting area	Women waiting area
Inadequate	Unavailable	Men waiting area
Inadequate	Available	Women toilet
Unavailable	Available	Nurse station
Unavailable	Available	Female staff changing Rm
Unavailable	Available	Male staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Male staff toilets
Unavailable	Dirty utility	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room(CIBAHI)
Available	Available	Laser Rm.
Available	Available	Lasik Rm.
Available	Available	Reflection Rm.
Unavailable	Available	Visual field Rm.
Unavailable	Available	Contact lenses rom
Unavailable	Available	Doctor office
Unavailable	Available	Recover area
Unavailable	Available	Reception
Unavailable	Available	Anaesthetic Work Office
Unavailable	Available	2 operation room
Unavailable	Available	3 sterile stores

Figure 13. 13: Design issues in the Ophthalmology clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
3 Exam rooms	4 Exam Rooms	Exam Rooms(4)
Inadequate	Available	Women waiting area
Inadequate	Available	Men waiting area
Inadequate	Available	Women toilet
Unavailable	Available	Nurse office
Unavailable	Available	Nurse station
Unavailable	Available	Female staff changing Rm.
Unavailable	Available	Female staff toilets
Unavailable	Unavailable	Dirty utility
Unavailable	Available	Clean Utility
Unavailable	Unavailable	Janitorial Room(CIBAHI)
Unavailable	Available	Treatment Rm
Unavailable	Unavailable	Doctor office (1)
Unavailable	Unavailable	Head of department office
Unavailable	Available	Gypsum plaster Rm.

Figure 13.14: Design issues in the Orthopaedic Clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
2 Exam Rms. ●	3 Exam Rooms	Exam Rooms(6)
Inadequate ●	Women waiting area	Women waiting area }
Inadequate ●	Men waiting area	Men waiting area }
Inadequate ●	Women toilet	Women toilet }
Unavailable ●	Inadequate	Electrocardiogram (ECG) (1)
Unavailable ●	Inadequate 1	ECHO (3)
Unavailable ●	Nurse station	Nurse station
Unavailable ●	Female staff changing Rm. }	Unavailable ●
Unavailable ●	Female staff toilets }	Unavailable ●
Unavailable ●	Dirty utility	Dirty utility }
Unavailable ●	Unavailable	Clean Utility }
Unavailable ●	Unavailable	Janitorial Room(CIBAHI) }
Unavailable ●	Female Doctors lounge }	Unavailable ●
Unavailable ●	Male Doctors lounge }	Unavailable ●
Unavailable ●	Doctor office }	Unavailable ●
Unavailable ●	2 stores }	Unavailable ●

Figure 13.15: Design issues in the Cardiology clinic

Previous clinic design element	Current clinic design element	Proposed clinic design element
8 Exam Rooms ●	5 Exam Rooms	Exam Rooms(7) ●
Inadequate ●	Women waiting area	Women waiting area }
Unavailable ●	(unavailable)	Men waiting area }
Inadequate ●	Women toilet	Women toilet }
Unavailable ●	Nurse office	Nurse office }
Inadequate ●	Nurse station	Nurse station
Unavailable ●	Female staff changing Rm. }	Female staff changing Rm. }
Unavailable ●	Female staff toilets }	Female staff toilets }
Unavailable ●	Unavailable	Dirty utility }
Unavailable ●	Unavailable	Clean Utility }
Unavailable ●	Unavailable	Janitorial Room(CIBAHI) }
Unavailable ●	Unavailable	ECHO (echocardiogram)
Unavailable ●	Unavailable	Treatment Rooms(2)
Unavailable ●	Unavailable	Equipment storages (2)
Unavailable ●	Unavailable	health Education Officer }

Figure 13.16: Design issues in the Internal medicine clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
6 Exam rooms	7 Exam Rooms	Exam Rooms (3)
Inadequate	Women waiting area	Women waiting area
Inadequate	Men Unavailable	Men waiting area
Inadequate	Women toilet	Women toilet
Unavailable	Unavailable	Brain monitoring devices Rm.
Unavailable	Unavailable	Nerve monitoring devices Rm.
Unavailable	Nurse office	Nurse office
Inadequate	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Blood extraction
Unavailable	Unavailable	men waiting blood extraction
Unavailable	Dirty utility (common)	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room(CIBAHI)
Unavailable	Treatment Room2	Treatment Room(1)
Unavailable	Doctor office	Doctor office

Figure 13.17: Design issues in the Neurology and Brain clinics

Previous clinic design element	Current clinic design element	Proposed clinic design element
2 Exam rooms	7 Exam Rooms	Exam Rooms(7)
Unavailable	Available	Women waiting area
Unavailable	Available	Men waiting area
Unavailable	Available	Women toilet
Unavailable	Available	Men toilet
Unavailable	Unavailable	Men monitoring exam Rm.
Unavailable	Unavailable	women monitoring exam Rm.
Unavailable	Nurse station	Nurse station (2)
Unavailable	Unavailable	Female staff changing Rm.
Unavailable	Unavailable	Female staff toilets
Unavailable	Dirty utility	Dirty utility
Unavailable	Available	Clean Utility
Unavailable	Unavailable	Janitorial Room(CIBAHI)
Shock Wave Lithotripsy	Unavailable	Unavailable (SWL)

Figure 13.18: Design issues in the Urology clinics

Current clinic design element	Proposed clinic design element
Unavailable	Equipment Room Storage
Inadequate 11	ICU Adults Room(22)
Inadequate 1	Isolation Room(4)
Inadequate 1	Clean Store (2)
Unavailable	Male & Female Staff Lounge with Toilets.
Unavailable	ICU Director Office
Unavailable	Doctors office Rm.
Unavailable	Sub Nurse Station (14) For 22 Beds
Inadequate	Dirty Utility Rm.
Inadequate	Clean Utility Rm.
Inadequate 1	Medication Room(2)
Unavailable	Head Nurse Office (2)
Unavailable	Medical Waste Room(2)
Unavailable	Department Manager
Inadequate 1	Main Nurse Station/Control Room(2)
Unavailable	Male & Female changing and locker Rm.
Unavailable	Male Doctor on Call Office
Unavailable	Female Doctor on Call Office
Unavailable	Doctor Lounge
Unavailable	Respiratory therapy Rm.
Unavailable	Janitorial Rm.

Figure 13.19: Design issues in the adult intensive care unit

Previous clinic design element	Current clinic design element	Proposed clinic design element
4 Exam rooms	3 Exam Rooms	Exam Rooms(4)
Unavailable	Women waiting area	Women waiting area
Unavailable	(unavailable)	Men waiting area
Unavailable	Women toilet	Women toilet
Available	Available	Ultraviolet Rm
Unavailable	Nurse office	Nurse office
Unavailable	Nurse station	Nurse station
Unavailable	Female staff changing Rm.	Female staff changing Rm.
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Minor operation Rm.
Unavailable	Unavailable	Equipment store
Unavailable	Dirty utility	Dirty utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Janitorial Room (CIBAHI)
Inadequate 2	Unavailable	LASER ROOM(3)

Figure 13.20: Design issues in the Dermatology clinics

Current unit design element	Proposed unit design element
Observation area	
Inadequate 3	Male Observation room (6)
Inadequate 3	Female Observation Room (6)
Unavailable	(4) Paediatric Observation Paediatric Room required (6)
Unavailable	(4) OB/Gyne Observation Rooms required (6)
Unavailable	Pharmacy
Unavailable	Screening Clinic
Unavailable	Visual Triage (fail)
Inadequate 1	Triage (2)
Unavailable	Dictation room
available	Isolation Rm.
Unavailable	Police office Rm.
Inadequate 1	Stretcher bay (9)
Available 1	3 Nurse station
Unavailable	Control rm.
Available	Female waiting area
Unavailable	Male waiting area
Available	Female toilet
Available	Male toilet

Figure 13.21: Design issues of observation section in ED

Resuscitation area	
Current unit design element	Proposed unit design element
Unavailable	7 beds
Unavailable	Isolation Rm.
Unavailable	Temporary body store
Operation unit	
Current unit design element	Proposed unit design element
Unavailable	Procedures Rm.
Unavailable	2 holding beds
Unavailable	Clean store
Unavailable	Visitor lounge with toilet
Unavailable	Dirty utility
Unavailable	Meeting Room with toilet
Unavailable	Psycho patient Rm.
Unavailable	Janitorial rm.
Unavailable	Mobile x-ray alcove
Unavailable	Laboratory
Unavailable	Equipment store rm.
Unavailable	Medication room 2
Unavailable	Clean Store
Unavailable	X-RAY Unit with changing and control rooms

Figure 13.22: Design issues of resuscitation and operation units in ED

Examination	
Current unit design element	Proposed unit design element
Inadequate 2 ●	Male Examination (2) with toilet (6) f ●
Inadequate 2 ●	Female Examination (3) (6) with toilet. f ●
Unavailable ●	Male staff changing and lockers room
Unavailable ●	Female staff changing and lockers room
Unavailable ●	Manager on Call Office
Unavailable ●	Doctor Lounge
Unavailable ●	ER. Manager Office
Unavailable ●	Rest area

Figure 13.23: Design issues of examination section in ED

Current designed elements	Proposed elements
Inadequate 1 ●	Reception area (2)
Inadequate ●	Male waiting area with toilet
Inadequate ●	female waiting area with toilet
Unavailable ●	Pool & Transcript Section
Unavailable ●	Male staff lockers Room with toilet
Unavailable ●	Female staff lockers Room with toilet
Unavailable ●	Viewing and Charting area
Unavailable ●	Active medical records area
Unavailable ●	Technician office
Inadequate 2 ●	X-Ray (4) With toilet, Changing and control Rms
Available ●	Mammography with dressing Rm.
Unavailable ●	Data Processing Area
Inadequate 1 ●	Nurse station (2)
Unavailable ●	Pantry
Unavailable ●	Clean line
Unavailable ●	File store
Unavailable ●	Clean utility
Unavailable ●	Dirty utility
Unavailable ●	Female patient area with toilet
Unavailable ●	Male patient area with toilet
Unavailable ●	Male staff lounge
Unavailable ●	female staff lounge
available very old ●	Angiography suite with toilet, Changing and control Rms
Unavailable ●	Observation Post-Procedure area (2 beds)
Unavailable ●	Clean supply store
available ●	Computer Rm.
Unavailable ●	Scrub-Up area
Unavailable ●	Interventional Ultrasound Room with toilet
available ●	Ultrasound Room with toilet (3)
Unavailable ●	Head Unit Office
Unavailable ●	Secretary Office
Unavailable ●	Meeting Rm.
Inadequate 1 ●	Consultation Room (5)
Unavailable ●	Janitorial Rm.

Figure 13.24: Design issues in Radiology department

Current unit design element	Proposed unit design element
Inadequate space	Physical exercises area (GYM)
Unavailable	Male Arm and Leg Treatment Rm.
Unavailable	Female Arm and Leg Treatment Rm.
Unavailable	Security Office
Available	Stores Room
Unavailable	Janitorial Rm.
Unavailable	Male Patient Waiting Area with Toilet
Unavailable	Female Patient Waiting Area with Toilet
Available	Nurse Station Rm.
Available	Dirty Utility
Available	Clean Utility
Unavailable	Manager Office
Unavailable	Meeting Rm.
Available	Doctors Rm.
Unavailable	Male Staff Lounge Rm.
Unavailable	Therapy Pool Area
Unavailable	Patient Changing and Lockers Rm.
Unavailable	Male Physical Therapy Rooms(4)
Unavailable	Female Physical Therapy Rooms(2)
Available	Staff Toilet
Unavailable	Single Patient Therapy Rooms (2)

Figure 13.25: Design issues in the Physical therapy unit

Current unit design element	Proposed unit design element
Unavailable	Dirty receiving area
Unavailable	Trolley washing area (7)
Unavailable	Trolley clean area (3)
Unavailable	Janitorial Rm.
Unavailable	Shoes rack areas (2)
Available	Washing and decontamination area
Unavailable	Washer disinfectant area (3)
Available	Cleaning and packaging area
Unavailable	Air lock Rm.
Unavailable	Technician Rm.
Available	C.S.S.D. Manager
Available	Sterilised storage area for Operation Dept.
Available	Main sterilised storage and supply store
Unavailable	Female lounge
Unavailable	Male lounge
Available	Changing and lockers Room for male staff with toilet
Available	Changing and lockers Room for Female staff with toilet

Figure 13.26: Design issues in the Central Sterile Services Department

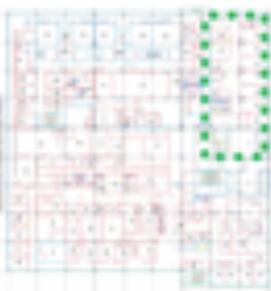
Current unit design element	Proposed unit design element
Not Available	Female & Male Reception and Lobby
Unavailable	Male & Female Waiting Area With 2 Toilet
Unavailable	Male & Female Exam Room With 2toilet
Unavailable	Male Sample Collection
Inadequate 1	Female Sample Collection
Available	T B Lab 2
2 Available	Offices 4
Available	Laboratory Director Office
Unavailable	Chief Tech. &Secretary Office
Unavailable	Wash Room with Toilet
Unavailable	Female and Male staff Changing and lockers rooms
Unavailable	Male & Female Staff Lounge with Toilets
Available	Cold Room with Store
Available	Clinical Chemistry and Haematology Laboratory
Unavailable	Workshop
Available	Urine/Stool Analysis Laboratory
Available	Chemistry Laboratory
Available	Blood Bank
Unavailable	Reception Blood Bank
Unavailable	Storage
Unavailable	Storage Acids
Not Available	Flammable Storage
Available	Histopathology Cytology
Unavailable	Tissue Cutting Rm.
Unavailable	Tissue Processing Rm.
Available	Pathologist Office
Unavailable	Biohazard/ Biohazard Rubbish
Not Available	Cleaning Room and Water Supply
Unavailable	Janitorial Rm.
Unavailable	Sterilization area
Available	Bacteriology Laboratory
Available	Blood Culture Laboratory
Available	Stool Culture Laboratory
Unavailable	Mycology Laboratory
Unavailable	Polymerase Chain Reaction Lab 3
Unavailable	Virology Lab 2
Unavailable	Media Preparation Storage
Unavailable	Microbiology Laboratory
Unavailable	Microbiologist Office
Available	Special Chemistry Laboratory
Available	Reporting Rm.
Available	Serology Laboratory

Figure 13.27: Design issues in the Laboratory Department

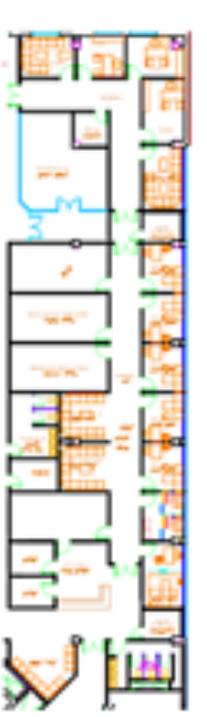
Current unit design element	Proposed unit design element
Inadequate 3 	Trolley Parking (10)
Inadequate 1 	Analyses Office (3)
Inadequate 2 	Assembly Office (4)
Unavailable 	Medical Coding Office
Unavailable 	Medical Transcription Office
Inadequate 1 	Tracing Office (2)
Unavailable 	Collection Area (2)
Unavailable 	Mortality Recording Office
Unavailable 	Supervisor Office
Unavailable 	Medical Record Head Office
available 	Documentation Quality Professional
Unavailable 	Juniorial Rm.
available 	Male Staff Toilet
available 	Female Staff Toilet

Figure 13.28: Design issues in the Medical Records Department

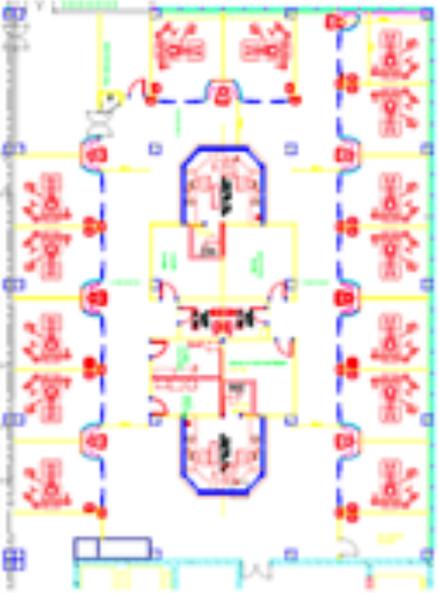
13.2.7 THIRD KEYS TECHNIQUE OF PHASE 3-2: PARTICIPANT OBSERVATION OUTCOMES WITHIN THE LAYOUTS OF CASE STUDY 1 IN CASE STUDY 2

Current designed elements	Proposed elements
Usable zone	Mater and Funder Staff Changing and Lockers Kana With 2 Toilets
Usable zone	Mater & Funder Patients Waiting Area With 2 Toilets (inside the Department)
Usable zone	Mater & Funder Waiting Area With 2 Toilets (Outside the Department on The Way in O.R. Units)
Usable zone	Equipment Room Storage (2)
Usable zone	Circle (1)
Usable zone	LAB Room (15) of which Two Spaces zone
Usable zone	F. Doctor on Call Office
Usable zone	MC Doctor on Call Office
Usable zone	Diary Utility Room
Usable zone	Clean Utility Room
Usable zone	Maintenance Room (1)
Usable zone	Hand Nurse Office
Usable zone	Medical Waste
Usable zone	Nurse Station Control Room (2)
Usable zone	Horizontal Bus
Usable zone	Combiner Room (Discussion Layout Change) zone
Usable zone	Air Lock + Foyer in Each LAB Room
Usable zone	Hot Parking
Usable zone	Patients Waiting Area
Extension area	Proposed redesigning elements
 <p style="text-align: center;">Figure 13.1: Mater and delivery department</p>	

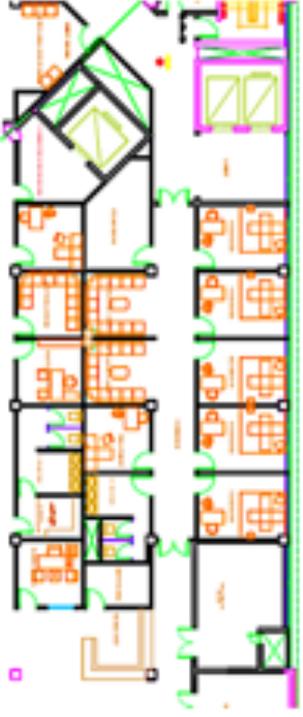
Layout 13.2: Labour and Delivery Department

Paediatric Clinic		
Previous designed elements	Current designed elements	Proposed elements
7 Exam rooms	7 Exam rooms	Exam rooms (8)
Reception	Women waiting area (unavailable)	Women waiting area
Reception	Men waiting area	Men waiting area
Reception	Women toilet	Women toilet
Unavailable	Unavailable	Unisex room
Unavailable	Nurse office	Nurse office
Unavailable	Nurse station	Nurse station
Unavailable	Female staff changing room	Female staff changing room
Unavailable	Female staff toilets	Female staff toilets
Unavailable	Unavailable	Children Blood extraction room
Unavailable	Unavailable	Dietary utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Autoclave room (CIBAMH)
Unavailable	Unavailable	Equipment storage
Unavailable	Unavailable	Unisex indicator room
Unisex indicator room	Unavailable	Monitoring utility signs
Unavailable	Unavailable	ECHO room (echocardiogram)
Unavailable	Unavailable	Treatment room
Unavailable	Doctor lounge	M. and F. Doctor lounge (2) excluded
Unavailable	Doctor office	Doctor office (2) excluded
Proposed redesigning elements	Current designed elements	
		

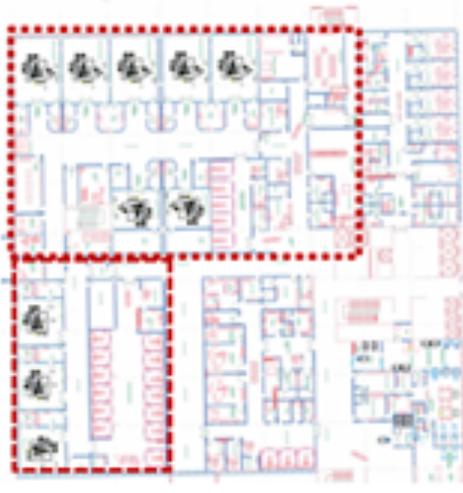
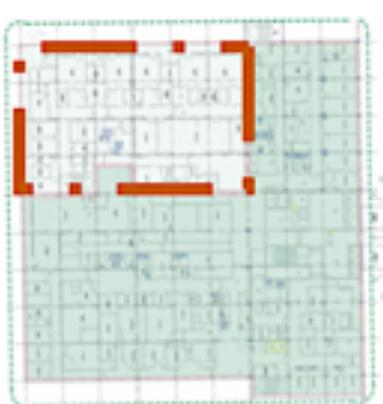
Layout 13.3: Paediatric Clinics

Paediatric Intensive Care Unit																																			
<p>Extension area</p> 	<table border="1"> <thead> <tr> <th>Current designed elements</th> <th>Proposed elements</th> </tr> </thead> <tbody> <tr> <td>Unvariable</td> <td>Equipment Room Storage</td> </tr> <tr> <td>6 Available</td> <td>PICU Room (12)</td> </tr> <tr> <td>1 Available</td> <td>Isolation Room (2)</td> </tr> <tr> <td>Available</td> <td>Clean Store</td> </tr> <tr> <td>Unvariable/Fixed</td> <td>Male & Female Staff Lounge with Toilets.</td> </tr> <tr> <td>Unvariable</td> <td>PICU Director Office</td> </tr> <tr> <td>Unvariable</td> <td>Doctors' Room</td> </tr> <tr> <td>Unvariable</td> <td>Sub Nurse Station (8) For 12 Beds</td> </tr> <tr> <td>Unvariable</td> <td>Dirty Utility Room</td> </tr> <tr> <td>Unvariable</td> <td>Clean Utility Room</td> </tr> <tr> <td>1 Available</td> <td>Medication Room (2)</td> </tr> <tr> <td>1 Available</td> <td>Nurse Control Station Room (2)</td> </tr> <tr> <td>Unvariable</td> <td>Doctor on Call Office</td> </tr> <tr> <td>Unvariable</td> <td>Doctor Lounge</td> </tr> <tr> <td>Unvariable</td> <td>Auxiliary Room</td> </tr> <tr> <td>Unvariable/Fixed</td> <td>Female and male changing and lockers room</td> </tr> </tbody> </table>	Current designed elements	Proposed elements	Unvariable	Equipment Room Storage	6 Available	PICU Room (12)	1 Available	Isolation Room (2)	Available	Clean Store	Unvariable/Fixed	Male & Female Staff Lounge with Toilets.	Unvariable	PICU Director Office	Unvariable	Doctors' Room	Unvariable	Sub Nurse Station (8) For 12 Beds	Unvariable	Dirty Utility Room	Unvariable	Clean Utility Room	1 Available	Medication Room (2)	1 Available	Nurse Control Station Room (2)	Unvariable	Doctor on Call Office	Unvariable	Doctor Lounge	Unvariable	Auxiliary Room	Unvariable/Fixed	Female and male changing and lockers room
Current designed elements	Proposed elements																																		
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1 Available	Nurse Control Station Room (2)																																		
Unvariable	Doctor on Call Office																																		
Unvariable	Doctor Lounge																																		
Unvariable	Auxiliary Room																																		
Unvariable/Fixed	Female and male changing and lockers room																																		
<p>Proposed redesigning elements</p> 	<p>Current designed elements</p> 																																		

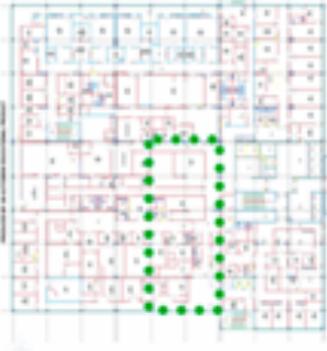
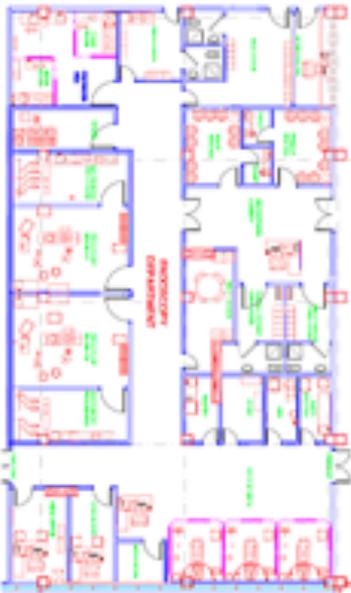
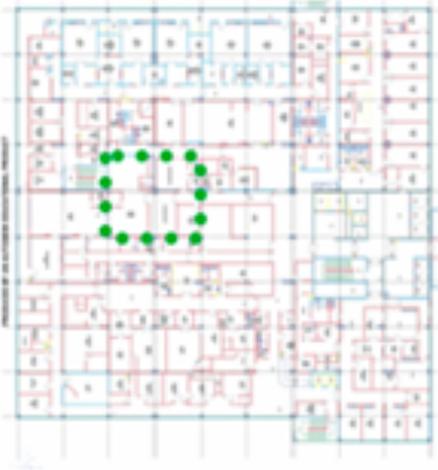
Layout 13 4: Paediatric intensive care unit

General Surgery Clinic		
Previous designed elements	Current designed elements	Proposed elements
3 Exam rooms available	5 Exam rooms available	Exam rooms (6)
Unavailable	Unavailable	Dressing/wound clinic
Unavailable	Unavailable	surround sampling extraction room
Unavailable	Unavailable	Anaesthetists Clinic?
inadequate	Women waiting area (unavailable)	Women waiting area
inadequate	Women toilet	Men waiting area
Unavailable	Nurse office	Women toilet
inadequate	Nurse station	Nurse office
Unavailable	Female staff changing room	Nurse station
Unavailable	Female staff toilets	Female staff changing room
Unavailable	Unavailable	Female staff toilets
Unavailable	Unavailable	Men Blood extraction room
Unavailable	Unavailable	Men waiting blood extraction
Unavailable	Unavailable	women Blood extraction room
Unavailable	Unavailable	women waiting blood extraction
Unavailable	Diary utility available	Diary utility
Unavailable	Unavailable	Clean Utility
Unavailable	Unavailable	Junctional room (CIBAHU)
Unavailable	available	Treatment room
Current designed elements		Proposed redesigning elements
		

Layout 13.7: General Surgery Clinic

Operations Department	
Current designed elements	Proposed elements
	Operations area
Inadequate	Male Changing and Lockers Rooms With 2 Toilets
Inadequate	Female Changing and Lockers Rooms With 2 Toilets
Unavailable	Male Waiting Area With 2 Toilets
Unavailable	Female Waiting Area With 2 Toilets
Inadequate	Nurse/Station Control Rm
Available	Head of Department
Available	Head of Nurse
Available	Doctors Office 2
Unavailable	Equipment Store
Inadequate	Staff Lounge
Unavailable	Conference Room
5 Operations Rms	10 Operations Rooms (Ogital) With:
5 Scrub Areas	10 Scrub Areas
4 Clean Stores	7 Clean Utilities
2 Sterile Stores	4 Sterile Stores
Unavailable	Main Sterile Store
Unavailable	X-Ray Equipment and Beds Parking
Unavailable	Satellite Laboratory Room
Unavailable	Equipment Room Storage (3)
Inadequate	Anaesthetic Work Office
	Patient holding/preparing area
Unavailable	Nurse/Station Control Rm
2 Beds	Patient Holding/Preparing Area 5 Beds
Unavailable	Medication Room
Unavailable	Janitorial Rm.
Unavailable	Nurse/Station Control Rm 2
	Patient Recovery Area
Unavailable	Medication Room 2
Unavailable	Nurse/Station Control Rm 2
Failed	Immediate Sterilization Area
6 Beds	13 Beds for Patient Recovery
Proposed redesigning elements	Current designed elements
	

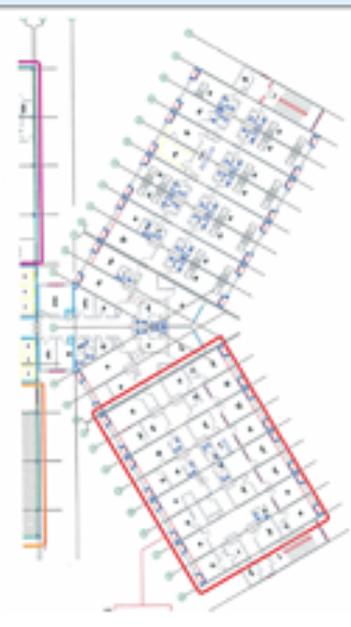
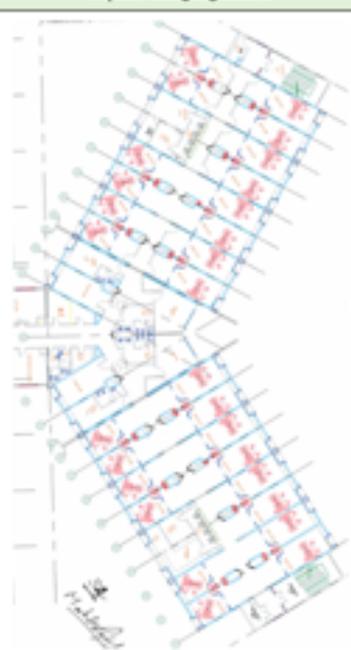
Layout 13.8: Theatre Department

Gastroenterology (GI)/Endoscopy Department	
Current designed elements	Proposed elements
Available 1	Procedure Rm. (2)
Unavailable	Instrument Processing. (2)
Unavailable	Male patient Changing and Lockers Rooms With 1 Toilet
Unavailable	Female patient Changing and Lockers Rooms With 1 Toilet
Unavailable	Male staff Changing and Lockers Rooms With 1 Toilets
Unavailable	Female staff Changing and Lockers Rooms With 1 Toilets
Unavailable	Female waiting room with 1 Toilets
Unavailable	Male waiting room with 1 Toilets
Unavailable	Equipment Room Storage
Unavailable	Dry Utility Room
Unavailable	Clean Utility Room
Unavailable	Medication Room (1)
Unavailable	Head Nurse Office
Unavailable	Medical Waste
Available 1	Nurse/Station Control Rm. (1)
Unavailable	Information Desk
Unavailable	Janitorial Rm.
Unavailable	Strip Up Area
Unavailable	Male & Female Exam Room
Unavailable	Male Lounge room
Unavailable	Pantry
Extension area	
	
Proposed redesigning elements	Current designed elements
	

Layout 13.9: Gastroenterology (GI) Department

Ophthalmology clinics			
Previous designed elements	Current designed elements	Proposed elements	
4 Exam rooms	5 Exam rooms	Exam rooms (6)	<div style="display: flex; justify-content: space-around;"> <div style="width: 45%;"> <p style="text-align: center;">Proposed redesigning elements</p>  </div> <div style="width: 45%;"> <p style="text-align: center;">Current designed elements</p>  </div> </div>
Inadequate	Women waiting area (unavailable)	Women waiting area	
Inadequate	Available	Men waiting area	
Inadequate	Available	Women toilet	
Unavailable	Available	Nurse station	
Unavailable	Available	Female staff changing room	
Unavailable	Available	Male staff changing room	
Unavailable	Female staff toilet	Female staff toilets	
Unavailable	Female staff toilet	Male staff toilets	
Unavailable	Dirty utility	Dirty utility	
Unavailable	Dirty utility	Clean Utility	
Unavailable	Unavailable	Jarabial room (CIRAH)	
Available	Available	Laser room	
Available	Available	Lauk room	
Available	Available	Reflection room	
Unavailable	Available	Visual field room	
Unavailable	Available	Contact lenses room	
Unavailable	Available	Doctor office	
Unavailable	Available	Recover area	
Unavailable	Available	Reception	
Unavailable	Available	Anaesthetic Work Office	
Unavailable	Available	2 operation rooms	
Unavailable	Available	3 sterile stores	

Layout 13.10: Ophthalmology clinics

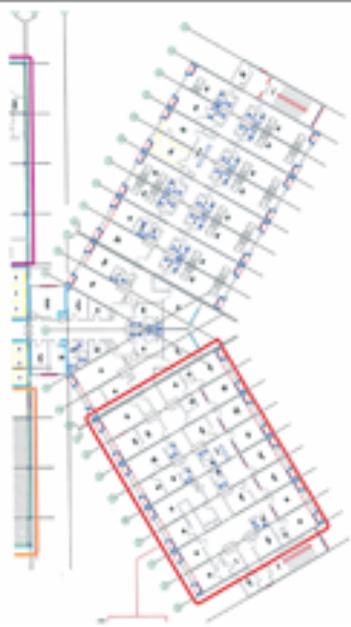
Adult Intensive Care Unit	
Current designed elements	Proposed elements
Unavailable	Equipment Room Storage
11 Available	ICU Adult Room (22)
1 Available	Isolation Room (4)
1 Available	Clean Store (2)
Unavailable	Male & Female Staff Lounge with Toilets
Unavailable	ICU Director Office
Unavailable/deferred	Doctors office Room
Unavailable (inside the room)	Sub Nurse Station (4) For 22 Beds
Inadequate	Dirty Utility Room
1 Available	Clean Utility Room
Unavailable	Medication Room (2)
Unavailable	Head Nurse Office (2)
Unavailable	Medical Waste Room (2)
1 Available	Department Manager
Unavailable/deferred	Main Nurse Station/Control Room (2)
Unavailable	Male & Female changing and locker room
Unavailable	Male Doctor on Call Office
Unavailable	Female Doctor on Call Office
Unavailable/deferred	Doctor Lounge
Unavailable	Respiratory therapy room
Unavailable	Isolation Room
Extension area	
	
Proposed redesigning elements	Current designed elements
	

Layout 13.17: Adult intensive care unit

Radiology department	
Current designed elements	Proposed elements
1 Available	Reception area (7)
Available	Male waiting area with toilet
Available	Female waiting area with toilet
Available	Food & Thromboplastic Section
Available	Male staff lockers room with toilet
Available	Female staff lockers room with toilet
Available	Waiting and Changing area
Available	Active medical records area
Available	Technician office
2 Available	X-Ray (4) With toilet, Changing and control Rooms
Available	Mammography with dressing room
Available	Fluor. Processing Area
1 Available	Stores station (3)
Available	gender
Available	Clean line
Available	File area
Available	Clean utility
Available	Dairy utility
Available	Family patient area with toilet
Available	Male patient area with toilet
Available	Male staff lounge
Available	female staff lounge
available, very old	Angiography suite with toilet, Changing and control Rooms
Available	Observation Post-Procedure area (2 beds)
Available	Clean supply area
Available	Computer room
Available	Scrub-Up area
Available	Immunisation (Immunised room with toilet)
Available	Head Out Office
Available	Secretary Office
Available	Meeting room
1 available	Consultation Room (5)
Available	Analgesic Room

Proposed redesigning elements	Current designed elements
	

Layout 13.20: Radiology department

Physical Therapy Department	
Current designed elements	Proposed elements
Inadequate	GYM
Unavailable	Male Arm and Leg Treatment Room
Unavailable	Female Arm and Leg Treatment Room
Unavailable	Security Office
Available	Stores Room
Unavailable	Janitorial Room
Unavailable	Male Patient Waiting Area with Toilet
Unavailable	Female Patient Waiting Area with Toilet
Available	Nurse Station Room
Available	Dirty Utility
Available	Clean Utility
Unavailable	Manager Office
Unavailable	Meeting Room
Available	Doctors Room
Unavailable	Male Staff Lounge Room
Unavailable	Therapy Pool Area
Unavailable	Parent Change and Lockers Room
Unavailable	Male Physical Therapy Rooms (4)
Unavailable	Female Physical Therapy Rooms (2)
Available	Staff Toilet
Unavailable	Single Patient Therapy Rooms (2)
Extension area	Proposed redesigning elements
	
	Current designed elements
	

Layout 13.21: Physical therapy unit

Laboratory Department	
Current designed elements	Proposed elements
Not Available	Female & Male Reception and Lobby
Not Available	Male & Female waiting Area With 2 Toilets
Not Available	Male & Female Exam Room With Sinks
Not Available	Male Sample Collection
1 Available	Female Sample Collection
Available	TB Lab 1
2 Available	Office 4
Available	Laboratory Director Office
Not Available	Chief Tech Advisory Office
Not Available	Wash Room with Toilet
Not Available	Female and Male staff Changing and lockers room
Not Available	Male & Female Staff lounge with Tables
Available	Cold Box With Store
Available	Clinical Chemistry and Hematology Laboratory
Not Available	Work Shop
Available	User/Staff Analysis Laboratory
Available	Chemistry Laboratory
Available	Blood Bank
Not Available	Reception Blood Bank
Not Available	Storage
Not Available	Storage Area
Not Available	Pharmaceutical Storage
Available	Histopathology Outlay
Not Available	Three Office Room
Not Available	Tissue Freezing Room
Available	Pathologist Office
Not Available	Bio Hazard Bio Hazard Facilities
Not Available	Chemical Room and Waste Storage
Not Available	Isolated Room
Not Available	Storage room
Available	Bacteriology Laboratory
Available	Blood Culture Laboratory
Available	Social Culture Laboratory
Available	Myology Laboratory
Not Available	Physiotherapy Chair Reaction (for Lab 3)
Not Available	Virology Lab 2
Not Available	Media Preparation Storage
Not Available	Microbiology Laboratory
Not Available	Microbiologist Office
Available	Special Chemistry Laboratory
Available	Reporting Room
Available	Storage Laboratory
Proposed redesigning elements	
Current designed elements	
Available	
Available	Working & Assistance

Layout 13.22: Laboratory Department

13.2.8 CERTIFICATE OF APPRECIATION



CERTIFICATE OF APPRECIATION

This certificate is awarded to:

Eng. Abdullah Mohammed A. Al Ghamdi
Ph.D. Student

For redesigning with development and extension (10) projects

(Accident and Emergency, Operations, Laboratory, Central Sterilization and Supply, Medical Records, Radiology, and Labor and Delivery Departments; and Pediatric Intensive Care, Adult Intensive Care and Neonatal Intensive Care Units)

at the King Fahd General Hospitals, during his Ph.D. Journey and under the supervision of A/ Prof. Monty Sutrisaa, at Curtin University of Technology, Australia.

Below are some details of his contributions in the projects:

- Identifying design defects and studying needs and movements of patient, staff, equipment and medical devices
- Reviewing more than 87 maps of local and international hospitals projects to apply the current hospitals standards
- Collecting data and information from managers, healthgivers and maintenance team for redesigning each department and unit
- Applying the Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI) and the Joint Commission International (JCI) standards
- Redesigning and providing a plan to transform and implement the all developing projects
- Presenting identifications and justification for all projects to Ministry of Health that approved 70 million SAR to implement these projects

We really appreciate the time and effort you put into these developing projects.

stamp

Mr. Fahad bin Abdullah bin Sultan bin Mubarak
GENERAL DIRECTOR OF HEALTH AFFAIRS AT AL BAHIA



13.2.9 SUGGESTED CONCEPTS DEFINITIONS IN THE CONTEXT OF DESIGN ISSUES CIRCUMSTANCES

Table 13. 49: Definitions of suggested concepts in the context of research investigation areas

#	<i>Design issues (DIs) occurring in occupancy stage are classified as design faults and defects.</i>
1	<i>Design defect (DDs) as a type of design issue is an inability to provide complete and perfect diagnosis and treatment services for more patients, to deal with common health problems and initiate adverse incidents of DDs (DDAIs), as a result of flaws in design processes in design stage.</i>
2	<i>Design faults (DFs) as a type of design issue is an inability to provide diagnosis or treatment services for more patients and for specific disease and illness cases, due to a lack of missing flaws in design process during the design stage.</i>
3	<i>DDAIs types initiated by DDs in Saudi hospitals including patient falls, medication and medical errors, infections and fires.</i>
4	<i>Physical impacts of DDAIs can be infection, injury, disability, burn, breathing difficulty and bruising.</i>
5	<i>Psychological impacts of DDAIs can be stress, pressure, pain, fatigue, hunger, thirst, pain, temperature, itch, time passing slowly and loss of appetite and confidence.</i>
6	<i>Design Defects Adverse Incidents (DDAIs) originated from the DDs and DF within different design fields types in the occupancy stage of the hospital.</i>
7	<i>DDAIs reduce the physical and psychological health (recovery process), has financial and social impacts on patients negatively.</i>
8	<i>Flaw of Design Process (FODP) is a faulty in design processes during design process, producing DD and DF in occupancy stage, due to the lack of design team skills, knowledge and thinking strategies selection, information and data and management team abilities as Sources of Design Process Flaws (SODPF).</i>

13.3 APPENDIX C: DATA COLLECTION TOOLS: STAGE 2

13.3.1 PHASE 1: INTERVIEW QUESTIONS WITH POST-TREATMENT PATIENTS

Part A: Guideline of Topics and Questions for Interviews with Post-treatment Patient

Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process
 تم تطوير عملية التصميم المعماري للمرافق الصحية العامة في المملكة العربية السعودية لدعم عملية التعافي من المرض

"Welcome to our survey!"
 أهلاً وسهلاً بكم في استبياننا

The main aim of this study is to improve the design process of public hospitals in KSA to support the healing process of patients, by creating healing environments that are free of design issues originated from design process flows, by minimizing or avoiding the adverse incidents caused by design issues that may delay or stop the healing process or prevent the provision of medical care services and by creating positive events.
 الهدف الرئيسي من هذا البحث هو تحسين عملية التصميم المعماري للمرافق الصحية العامة في المملكة العربية السعودية لدعم عملية التعافي من المرض، من خلال خلق بيئات تعافٍ خالية من مشكلات التصميم التي قد تؤخر أو توقف عملية التعافي، أو تمنع تقديم الخدمات الطبية، وذلك من خلال تقليل أو تجنب المشكلات السلبية الناتجة عن تدفق عمليات التصميم المعماري، وذلك من خلال خلق أحداث إيجابية قد تسرع أو توقف عملية التعافي، أو تمنع تقديم الخدمات الطبية.

The information you provide in this investigation will be kept strictly confidential and only used for research objectives.

المعلومات التي توفرها في هذا الاستبيان ستظل سرية تماماً ولن تستخدم إلا لأغراض البحث العلمي.

Guideline of Topics and Questions for Interviews with Post-Treatment Patients
 دليل أسئلة للمقابلات مع المرضى بعد العلاج

PART I: POST-TREATMENT PATIENT'S BACKGROUND	
Participant code:	رقم المريض
Gender:	الجنس
Age:	العمر
Household income in riyals:	الدخل المنزلي بالريال
Would you like to receive further information on this study?	هل ترغب في تلقي مزيد من المعلومات عن هذا البحث؟
Yes <input type="checkbox"/> No <input type="checkbox"/>	نعم <input type="checkbox"/> لا <input type="checkbox"/>
Other (please specify):	أخرى (الرجاء التحديد):

INTRODUCTION OF RESEARCH GAP AND PROBLEM

1. What are your thoughts about the effect of AIA affecting the physical and psychological healing process of patients in delivering or designing the healing processes or preventing the delivery of the healthcare service? (Part 2 of the research problem)

ما هي أفكارك حول تأثير التصميم المعماري على عملية التعافي الجسدية والنفسية للمرضى في تقديم أو تصميم عمليات التعافي، أو منع تقديم الخدمات الصحية؟ (الجزء الثاني من مشكلة البحث)

Examples: AIA impacts on the physical healing process. AIA impacts on the psychological healing process. AIA impacts on the financial position.

أمثلة: التصميم المعماري يؤثر على عملية التعافي الجسدية. التصميم المعماري يؤثر على عملية التعافي النفسية. التصميم المعماري يؤثر على الوضع المالي.

Infection: Stress. Patient exposed to AIA had stayed in hospital for long time in which cost MHR extra expenses in proceeding.

عدوى: التوتر. المريض المعرض للتوتر قد يبقى في المستشفى لفترة طويلة مما يؤدي إلى نفقات إضافية.

Injury: Discomfort. Medical consumables.

إصابة: عدم الراحة. المستلزمات الطبية.

Disability: Pain. Medications. Other.

إعاقة: ألم. أدوية. أخرى.

Room: Quiet. Other.

غرفة: هدوء. أخرى.

Fooding: Hygiene. Other.

طعام: نظافة. أخرى.

Other: Loud speeches. Other.

أخرى: صراخ عالٍ. أخرى.

Your thoughts: (is this subject important to be studied and why?)

أفكارك: (هل هذا الموضوع مهم للدراسة ولماذا؟)

PATIENT'S BACKGROUND

Part A: General Questions

1. What was the subreason of your treatment in this hospital?

ما كان السبب الفرعي لعلاجك في هذا المستشفى؟

Primary cause: Specialty care. Urgent case. Long-term case.

السبب الأساسي: رعاية متخصصة. حالة طارئة. حالة طويلة الأمد.

Other: Emergency case. Other.

أخرى: حالة طارئة. أخرى.

2. Which administration department did you visit during your treatment? (please specify)

أي قسم إداري زرت خلال علاجك؟ (الرجاء التحديد)

Accident and emergency (A&E). Ambulance. Critical care. Diagnostic.

الطوارئ. سيارة إسعاف. العناية الحرجة. تشخيص.

Pharmacy. Physiotherapy. Radiology. Rehabilitation. Other.

صيدلانية. علاج طبيعي. أشعة سينية. إعادة تأهيل. أخرى.

3. How long were treated/ staying in this hospital during the treatment plan?

كم زلت في المستشفى خلال خطة العلاج؟

Days. Weeks. Months. Years.

أيام. أسابيع. أشهر. سنوات.

4. Please describe your needs, requirements and wishes in the hospital environment's design in respect to your stay in the following aspects:

الرجاء وصف احتياجاتك ومتطلباتك ورغباتك في تصميم بيئة المستشفى من حيث التصميم المعماري فيما يتعلق ببقائك في الجوانب التالية:

Atmosphere design aspects: Elements affecting atmosphere aspects in design.

الجوانب التصميمية للبيئة: عناصر تؤثر على جوانب التصميم المعماري.

Spatial design aspects: Considering the stress, dimensions of the furniture and noise, and patient "feel" requirements and aim to decrease the physical effort in relocating the things positions to be reachable for patients.

الجوانب التصميمية المكانية: مراعاة التوتر، أبعاد الأثاث والضوضاء، ومتطلبات المريض وأهدافه لتقليل الجهد البدني في نقل الأشياء لتكون في متناول المريض.

Other: Adaptation of distribution lights, colour, and size and shape of windows for natural light to give patient the relaxing and warming feelings to the patient.

أخرى: التكيف مع توزيع الإضاءة، اللون، والحجم والشكل النوافذ للضوء الطبيعي لتعطي المريض الشعور بالراحة والدفء.

Thermal in design: Considering patient body comfort in providing natural ventilation, air movement and air temperature (air sound/noise) lowered than in temperature outside the library.

التصميم الحراري: مراعاة راحة جسم المريض في توفير التهوية الطبيعية، حركة الهواء ودرجة الحرارة (الضوضاء) أقل من درجة الحرارة خارج المكتبة.

Audio in design: Providing convenient sounds, voices and music sources containing a calm feeling of nature.

الصوت في التصميم: توفير أصوات مناسبة، أصوات طبيعية وموسيقى تحتوي على إحساس بالهدوء والطبيعة.

Visual in design: Providing social interaction with family and outside community.

المرئية في التصميم: توفير تفاعل اجتماعي مع العائلة والمجتمع الخارجي.

Spiritual in design: Using of common/ conventional, graphic symbols, icons reflecting patients beliefs and values.

الروحاني في التصميم: استخدام رموز وعلامات تقليدية، رموز بصرية تعكس معتقدات المريض وقيمه.

Aesthetic in design: Using art, picture and sculpture to give patients the feelings of beauty.

الجمالي في التصميم: استخدام الفن، الصور والنحت لتعطي المريض إحساساً بالجمال.

Techniques in design: Providing more choices for patients to control their environment or contact with the outside world (internet services) in using devices with touch screens.

التقنيات في التصميم: توفير خيارات أكثر للمريض للتحكم في بيئته أو التواصل مع العالم الخارجي (خدمات الإنترنت) باستخدام أجهزة اللمس.

PART II: THE NATURE OF THE ADVERSE INCIDENTS IMPACTS ON PATIENTS' HEALTH

1. Were there any events/incidents you can recall that has caused a negative reaction to you?

هل تذكر أي أحداث/حوادث سببت لك رد فعل سلباً؟

2. In general, were there any events/incidents originating from the design or components of your environment during your hospital stay?

بشكل عام، هل تذكر أي أحداث/حوادث نشأت من تصميم بيئتك أو مكوناتها خلال إقامتك في المستشفى؟

Components: Materials, conventional, graphic symbols, icons, equipment, paintings, art, pictures, surface touch, spaces, green area and machines.

المكونات: مواد، تقليدية، رموز بصرية، أيقونات، معدات، لوحات، فن، صور، أسطح اللمس، مساحات، مناطق خضراء وآلات.

3. Did you ever develop any infections, experience falls/slips/trips or others (such as error in medication) as result of a type of events/incidents that related to the components and design of this hospital design concept?

هل أصبت بأي عدوى، أو سقطت/انزقت/انزقت، أو غيرها (مثل خطأ في الدواء) نتيجة نوع من الأحداث/الحوادث المتعلقة بمكونات وتصميم هذا المستشفى؟

4. Please tell me more about that.

الرجاء تخبرني بمزيد من التفاصيل.

5. How did these events/incidents affect the use of your treatment plan in this hospital?

كيف أثرت هذه الأحداث/الحوادث على استخدام خطة العلاج في هذا المستشفى؟

6. What were the causes of these incidents in relation to the design or components of the environment?

ما كانت أسباب هذه الحوادث في ضوء تصميم البيئة أو مكوناتها؟

7. Were you hurt or did stay in the hospital longer than necessary because of events/incidents?

هل أصبت بجرح، أو بقيت في المستشفى لفترة أطول مما ينبغي بسبب أحداث/حوادث؟

8. Where did these events/incidents occur in this hospital and when?

أين وأينما حدثت هذه الأحداث/الحوادث في هذا المستشفى؟

9. How did you respond to these events/incidents? And what was the cause of health/illness?

كيف استجبت لهذه الأحداث/الحوادث؟ وما كان سبب المرض/المرض؟

10. Were there consider of these events/incidents on your (physically, psychological and financially)?

هل كانت هناك اعتبارات لهذه الأحداث/الحوادث على (جسدياً، نفسياً، ومالياً)؟

11. Did these events/incidents impact your healing process and safety of you? If so, what were they?

هل كانت هذه الأحداث/الحوادث تؤثر على عملية تعافيك وأمانك؟ وإذا كان الأمر كذلك، فما كانت أسبابها؟

12. How did these events/incidents impact your healing process and safety?

كيف كانت هذه الأحداث/الحوادث تؤثر على عملية تعافيك وأمانك؟

1. Please describe how these events/incidents physically, psychologically and financially impacted your health/healing process.

الرجاء وصف كيف أثرت هذه الأحداث/الحوادث جسدياً، نفسياً، ومالياً على صحتك وعملية تعافيك.

2. Who was the responsible for these events/incidents that affected your health during this hospitalization? How were these events/incidents reported in this hospital?

من كان المسؤول عن هذه الأحداث/الحوادث التي أثرت على صحتك خلال إقامتك في المستشفى؟ وكيف تم الإبلاغ عن هذه الأحداث/الحوادث في هذا المستشفى؟

3. How would you recommend reducing this impact of the events/incidents in terms of solving environment design issues in the early stage of the hospital design process?

كيف ستوصي بتقليل هذا التأثير من أحداث/الحوادث من خلال حل مشكلات التصميم المعماري في المراحل الأولى من عملية التصميم المعماري للمستشفى؟

4. Was there anything [else] that seemed unusual about the hospital environment's design and components or anything that potentially may cause events/incidents during your stay in this hospital?

هل لاحظت شيئاً [غيره] يبدو غير عادي في تصميم بيئة المستشفى أو مكوناتها، أو أي شيء قد يسبب أحداث/الحوادث خلال إقامتك في هذا المستشفى؟

5. Please tell me more about that.

الرجاء تخبرني بمزيد من التفاصيل.

6. Please describe how this may impacted you.

الرجاء وصف كيف قد أثرت عليك.

7. Were there anything [else] that seemed unusual about the hospital environment's design and components or anything that potentially may cause events/incidents during your stay in this hospital?

هل لاحظت شيئاً [غيره] يبدو غير عادي في تصميم بيئة المستشفى أو مكوناتها، أو أي شيء قد يسبب أحداث/الحوادث خلال إقامتك في هذا المستشفى؟

8. Please tell me more about that.

الرجاء تخبرني بمزيد من التفاصيل.

9. Please describe how this may impacted you.

الرجاء وصف كيف قد أثرت عليك.

10. Were you fully satisfied by this hospital environment's atmosphere factors?

هل كنت راضياً تماماً عن عوامل الجو في بيئة المستشفى؟

Yes. No.

نعم. لا.

11. If yes, please tell me more about that.

إذا كان الأمر كذلك، الرجاء تخبرني بمزيد من التفاصيل.

12. Please describe how this affected you.

الرجاء وصف كيف أثرت عليك.

13. Is there anything else you would like to tell us about view on design the design and components of this hospital in terms of considering your sensory system and their aspects?

هل هناك أي شيء آخر ترغب في تخبرنا به عن رأيك في تصميم بيئة المستشفى ومكوناتها، من حيث مراعاة نظام الحواس الخمس وأجزاءها؟

14. How would you describe the importance of gaining an extra knowledge from these questions areas to consider when designing Saudi public hospitals?

كيف ستوصف أهمية الحصول على مزيد من المعرفة من هذه الأسئلة كمنهجية إضافية عند تصميم المستشفيات العامة في المملكة العربية السعودية؟

Not at all important. Slightly important. Important. Very important.

لا شيء على الإطلاق. مهم قليلاً. مهم. مهم جداً.

Thank you for completing these questions. The time and effort you have spent is too greatly appreciated!

شكراً لك على إكمال هذه الأسئلة. الوقت والجهد الذي بذرتهم هما موضع تقدير كبير!

13.3.2 PHASE 2: INTERVIEW QUESTIONS WITH HEALTHCARE PROVIDERS

Guideline of Topics and Questions for Interviews with Healthcare Givers:			
PART A: HEALTHCARE GIVERS' BACKGROUNDS			
1. Profession types			
2. What are the therapeutic areas do you work in?			
3. What are your responsibilities/duties?			
PART B: PARTICIPANT THOUGHTS ON DESIGN ISSUES AND AI CIRCUMSTANCES			
1. What are your thoughts about the flaws in the architectural design processes (design stage) causing faults in the occupancy stage?			
Related	Unrelated	No idea	
2. What are your thoughts about design issues triggering adverse incidents (AI) in hospital environments?			
Related: 2-4	Unrelated: 3-4	No idea: 1-7	
3. What are your thoughts about AI affecting the physical and psychological health of patients in the occupancy stage?			
AI impacts on the physical healing process		AI impacts on the psychological healing process	
Infection	Stress	AI impacts on financial position	
Injury	Discomfort		
PART C: AI CIRCUMSTANCES WITHIN DESIGN ISSUES			
1. Would you like to tell us about anything, useful, stressful, or risky in this hospital's design elements or components that affect patient health, safety, or healthcare service provision?			
2. Circumstances of the AI in patient space			
Patient behaviour issues			
Hospital management issues			
Healthcare provider issues			
Designed environments issues			
PART D: THE AI CIRCUMSTANCES IMPACTS ON PATIENT HEALTH			
1. Please briefly identify adverse incidents (AI) in general.			
2. Did AI related to previous design issues occur in this hospital?			
Yes: 15-7		No: 8-10	
3. What types of AI were there?			
4. Did these AI impact patients' mind, bodies, and behaviour? If so, how? What were the results?			
Yes: 16-18		No: 7-1	
Body	Mind	Behaviour	
5. What level of harm resulted from the AI?			
Low	Moderate	Severe	Death
Other:			
6. Where did the AI occur in this hospital?			
7. Were there impacts of these AI on the health (healing process) and safety of patients or on the healthcare service provision? If so, what were the impacts?			
8. How did these AI impact the healing process and safety of patients?			
9. How were the impacts, notes, results, and causes of AI reversed as they originated from design issues?			
1. Who do you think was responsible for these AI originating from design defects/faults that affected patients' health during this hospitalization?			
		No idea	
PART E: HEALING PROCESS AND DESIGNED ENVIRONMENT ISSUES			

1. Please briefly define the healing process in general.
2. Please briefly identify the healing space in general.

COMPLAINTS RECEIVED FOR DESIGN ISSUES

1. Did you receive or receive any complaints, requirements and needs from patients related to the design elements, equipment, and components of this hospital?	
Yes	No
a. Please describe the nature of these complaints.	
2. Do you have any standards, procedures or policies that were considered for patients' health and safety at this hospital?	
Yes	No
a. Please tell me more about that.	
b. Please describe how these may impact the experience of A/E in this hospital.	
3. How can the parties responsible for hospital design respond to these requirements when designing?	
4. Have you participated in designing hospital buildings/healthcare facilities?	
Yes (0-1)	No (0-1)
If yes, what was your role in the design?	
Safety life design for the evacuation of patients (Philippines)	

PART F: HEALING ENVIRONMENT REQUIREMENT

1. Were you fully satisfied by this hospital design in terms of patient safety, health requirements and needs?	
Yes (0-4)	No (0-15)
a. Please tell me more about that.	
b. Please describe how these affected patient care.	

2. What are the main trigger factors (listed below) that should be considered in the design of the healing environments in hospital buildings to support patient health?				
Welfare	Physical health	Safety	Psychological health of patient	Quality of medical services provision
No idea				

3. Can you tell us what things in your environment make you uncomfortable/comfortable regarding your sensory systems (listed below) and why?	
--	--

Sensory systems input	Uncomfortable/comfortable elements in patient environment
Sight	
Hearing	
Smell	
Touch	
Taste	

4. What is the most important part of patient sensory systems that should be considered by the design teams when designing healing spaces?				
Sight	Hearing	Smell	Touch	Taste

5. How would you recommend reducing the impact of A/E in terms of solving design issues in the early stage of the hospital design process?	
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13.3.3 PHASE THREE TOOL: INTERVIEW QUESTIONS WITH DESIGN AND MAINTENANCE TEAMS

Guideline of Topics and Questions for Interviews with Design and Maintenance Teams

Towards Improving the Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process
تحسين عملية التصميم المعماري للمستشفيات العمومية في المملكة العربية السعودية لتدعيم عملية التعافي الكامل للمريض

The main aim of this study is to improve the design process of public hospitals in KSA to support the healing process of patients. To create healing environments that are free of design defects (inspired from design process errors), by maintaining or avoiding the adverse incidents caused by design defects that may delay or stop the healing process or prevent the provision of medical care services and by creating healthy events.

The information you provide in this investigation will be kept strictly confidential and only used for research objectives.

الهدف الرئيسي من هذا البحث هو تحسين عملية التصميم المعماري للمستشفيات العمومية في المملكة العربية السعودية لتدعيم عملية التعافي الكامل للمريض. من خلال خلق بيئات تعافٍ خالية من عيوب التصميم (التي تلهمها أخطاء عملية التصميم المعماري)، عن طريق الحفاظ على أو تجنب الحوادث السلبية الناتجة عن عيوب التصميم المعماري التي قد تؤخر أو توقف عملية التعافي، أو تمنع تقديم الخدمات الطبية، وعن طريق خلق أحداث صحية.

معلوماتك التي توفرها في هذا التحقيق ستظل سرية تماماً وستستخدم فقط لأغراض البحث.

Guideline of Topics and Questions for Interviews with the Following Design Teams in KSA (represented by the KSA) in the design process (representing teams in each case):
دليل مقابلات مع فرق التصميم المعماري التالية في المملكة العربية السعودية (متمثلة بالكويت) في عملية التصميم المعماري (تمثل الفرق في كل حالة):

1. Architectural Design Team
 2. Mechanical Design Team
 3. Electrical Design Team
 4. Structural Design Team
 5. Landscape Design Team
 6. Interior Design Team
 7. Construction Management Team
 8. Facility Management Team
 9. Maintenance Team
 10. Patient Safety Team
 11. Infection Control Team
 12. Quality Assurance Team
 13. Regulatory Affairs Team
 14. Sustainability Team
 15. Research and Development Team
 16. Marketing and Communications Team
 17. Human Resources Team
 18. Finance and Administration Team
 19. Information Technology Team
 20. Legal and Compliance Team

THE DESIGN OF THE BUILDING AND THE DESIGN OF THE BUILDING PROCESS
تصميم المبنى وتصميم عملية التصميم المعماري

1. How do you describe the design process of public hospitals in KSA?
 2. How do you describe the design process of public hospitals in KSA?
 3. How do you describe the design process of public hospitals in KSA?
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 19. How do you describe the design process of public hospitals in KSA?
 20. How do you describe the design process of public hospitals in KSA?

2

INTERVIEW TOPICS AND QUESTIONS
مواضيع وأسئلة المقابلة

1. How do you describe the design process of public hospitals in KSA?
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INTERVIEW TOPICS AND QUESTIONS
مواضيع وأسئلة المقابلة

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 19. How do you describe the design process of public hospitals in KSA?
 20. How do you describe the design process of public hospitals in KSA?

3

1. Organization Working Status
1. وضع عمل المنظمة

1. How do you describe the design process of public hospitals in KSA?
 2. How do you describe the design process of public hospitals in KSA?
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1. Organization Working Status
1. وضع عمل المنظمة

1. How do you describe the design process of public hospitals in KSA?
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 20. How do you describe the design process of public hospitals in KSA?

4

Part A: The causes, results and sources of design defects in hospital buildings.
الجزء أ: الأسباب والنتائج ومصادر عيوب التصميم المعماري في المباني الصحية.

1. How do you describe the design process of public hospitals in KSA?
 2. How do you describe the design process of public hospitals in KSA?
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 19. How do you describe the design process of public hospitals in KSA?
 20. How do you describe the design process of public hospitals in KSA?

Part B: The impact, types and results and severity values of design defects in hospital buildings.
الجزء ب: الأثر، الأنواع والنتائج ودرجات خطورة عيوب التصميم المعماري في المباني الصحية.

1. How do you describe the design process of public hospitals in KSA?
 2. How do you describe the design process of public hospitals in KSA?
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 20. How do you describe the design process of public hospitals in KSA?

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13.4 APPENDIX D: CATEGORIZATIONS OF DATA FOR STAGES 1 AND 2 (FIRST KEY TECHNIQUES)

13.4.1 CONCEPT A: DIAIS CIRCUMSTANCES

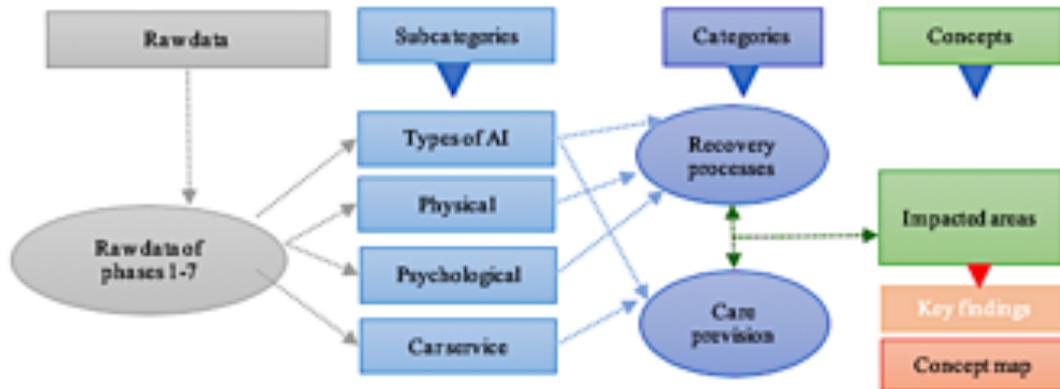


Figure 12. 29: Key findings of impacted areas concept by design issues

Table 13. 50: AI circumstances in Stage 1. Phase 2

Types of occurred AIs	Fall, fire, medication and medical errors, patient identification errors, wrong medication orders, slips/trips, wrong blood transfusion, incomplete patient information, medication errors, testing error, clinical errors,
Physical impact of AIs	Infection, death, burn, injury,
Psychological impact of AIs	Stress, low satisfaction and experience level of patient
Impact on care services	Delays in treatment plans and medication provisions

Table 13. 51: AI circumstances in Stage 1. Phases 3 and 4

Types of occurred AIs	A fire, infections and kidnaping
Physical impact of AIs	Infection, burn, poisoning, death
Psychological impact of AIs	Depression, anger, and loss of privacy
Impact on care services	Delaying, stopping and avoiding the healthcare provisions because of inadequate, unavailable spaces and equipment to provide for diagnoses and treat services. The healthcare service cannot be provided in a right way and time (links and distance). Reducing the quality of the healthcare services and increasing their costs because the design issues prevent the delivery of complete services (11 evidences)
Impact on recovery processes	Extended or added a new healing process

Table 13. 52: AI circumstances in Stage 2. Phase 1

Types of occurred AIs	Fall and fire
Physical impact of AIs	Infection, injury, disability, burn and suffocation
Psychological impact of AIs	Stress, pressure, discomfort, pain, fatigue and loss of appetite
Social (unexpected)	Patient isolation from his or her family, friends and community because of limited space for them and the long stay time in hospital should be spent with
Financial (unexpected)	Low income as a financial impact, as patients could not work or monitor their business.
Impact on care services	Long stay
Impact on recovery processes	Extended or added a new healing process

Table 13. 53: AI circumstances in Stage 2. Phase 2

Types of occurred ais	Medical errors, infection and patient falls
Physical impact of ais	Injury, disability, poisoning, breathing difficulty, bruise and bed sore
Psychological impact of ais	Stress, discomfort, pressure, pain, fatigue, loss of appetite, loss of trust, hunger and lack of sleep, loss of confidence in hospital healthcare services, and trust in healthcare providers
Financial	Low income as a financial impact, as patients could not work or monitor their business.
Impact on care services	(a) an increase in (1) the consumption of medical consumables, medications, (2) the cost of patients treatment, (3) the consumption of medical supplies, (4) tasks for healthcare givers, (5) effort and time; (b) decreases in (1) the lifetime/span of medical devices and equipment, and (2) the delivery of medical services to other patients due to long-term patients being treated for the physical impacts of ais, and (c) designed environment issues which include (1) changes in current space designs to accommodate new departments that the hospital manager requested. These changes in designs are implemented to create a new medical unit to deal with different health problems (e.g. Burn unit) or expand an existing unit in order to receive new equipment (e.g. X-ray and laboratory equipment) or more patients. Therefore, these changes lead to other issues which affect the medical services of other units such as spaces with less activities and functions when the area becomes smaller and with less sufficient level of critical systems (e.g. A/c) because they were designed with specific capabilities to deal with certain areas that were not included in new or expanded areas.
Impact on recovery processes	Applying (1) a new treatment plan (to deal with a fractured leg), as well as (2) expanding his/her stay time at hospital

Table 13. 54: AI circumstances in Stage 2. Phase 3

Types of occurred ais	Infections, medication errors, fires
Physical impact of ais	Deaths, poisoning, burns, cancer, and suffocations

13.4.2 CONCEPT B: DESIGN ISSUES CIRCUMSTANCES

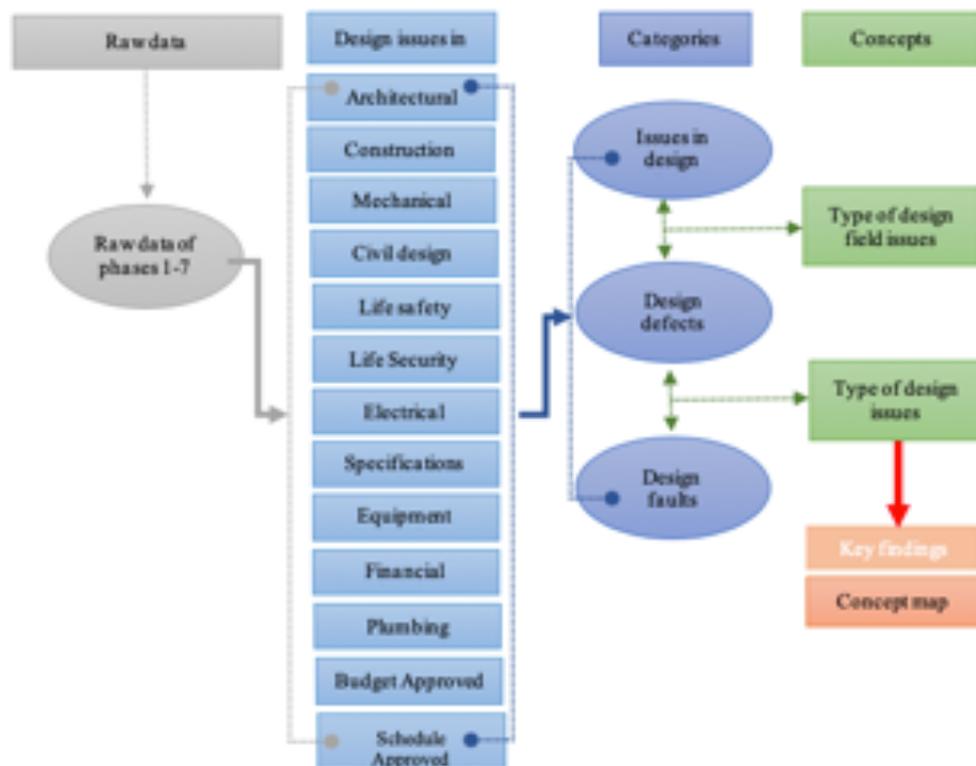


Figure 13.30: Key findings of design fields issues concept

Table 13. 55: Type of design field issues in Stage 1, Phase 2, from archival review

Type of design field issues	Design issues
Equipment planning	Sharp edges, software deficiency, device memory, error in photographs and loss of device data
Electrical design	Lack of light and power shutdown
Mechanical design	Supporting systems failures (medical gas, vacuum, ventilation, mechanical systems)
Architectural design	Exposure medical devices to: direct sunlight, dirt and non-clean environment, moisture, high temperature and humidity
Life safety design	Lack of building exits, fire alarms, fire sprinklers and smoke-control systems

Table 13. 56: Type of design field issues in Stage 1, Phases 3 and 4, from medical managers view

<p>Architectural design issues</p> <p>Architectural design defects (DDs) and faults (DFs) as design issues. These issues involved: a lack, unavailability of: (1) required exam, diagnosis and treatment spaces in each project, (2) supporting spaces for (a) storage equipment, (b) collecting waste, (c) mechanical service, (d) medication rooms, nurse stations, (3) inadequate spaces for (a) the activities and (b) functions of exam, diagnosis and treatment spaces, the growth of patient number and user, (3) many crossing points in most movements lines types vertically and horizontally, (4) lack of future planning for extending the current building or designing new spaces, (5) insufficient linkage between medical and nonmedical departments and others, (6) lack of supporting areas for (a) electrical and (b) mechanical services and (c) machines, (d) patient waiting, (e) healthcare (f) changing, (g) resting and (h) managing and new equipment or systems, (7) the size of the lifts is not allow to patient bed to get in and cannot be extended, (7) low beds capacity, (8) inefficient way to mentoring, watching patient directly and (9) lack of oral and visual exam space,</p>
<p>Construction design issues</p> <p>Structural designs issues occurred in the redesigned projects as shown in the layouts, these issues related to: (1) the difficulty in expanding some areas of projects because the existing of concrete steel walls between spaces, (2) difficulty to provide new medical equipment or systems because their weight is more than the allowable structural load, (3) impossibility to extend the hospital building, (a) vertically because the critical systems units existing on the roof and (b) horizontally because it surrounded by residential and commercial buildings,</p>
<p>Mechanical design issues</p> <p>These common mechanical design issues included: (1) miscalculation of required pressure types in spaces, such as in the burn unit, isolation and dirty rooms and dirty area in sterilisation department, where is required negative pressure to control and avoid the contaminated air produced from infectious patient and materials to spread out of the rooms, (2) in the operation and delivery rooms required the positive pressure to protect patient from outside uncontaminated air, (3) deficiency in the A/C system capacity and air flow, such as in the patient, medical equipment rooms and the new expanded units, that lead to increase the temperature level impacting users and equipment functions and (4) a lack of some very important types of gases used in treatment plan, that expand the children veins, which serve children levies</p>
<p>Life safety design issues</p> <p>The current safety design issues in these case studies involved: (1) difficulty in the evacuation plan for inpatients from paediatric, neonatal and adults intensive units, because they are located in upper floors (third level), (2) a long distance between some departments and emergency spend time and effort to reach safe point. These issues cause death, poisoning, burn and suffocation to patients and users.</p>
<p>Life security design issues</p> <p>The main security design issue mentioned by participants is the doors locks do not link to the alarm system in emergency case such kidnapping</p>
<p>Electrical design issues</p> <p>In terms of electrical design issues, participants reported the following issues; (1) some critical/capital/medical equipment, especially, in the OR, X-Ray and emergency departments are not connecting to the uninterruptible power supply points to maintain their function when the power is cut out from main source, or the standby generators are not responded, (2) limited loads capacities of electrical panels that not allow to install new or more equipment.</p>
<p>Equipment planning issues</p> <p>From the layout that shows many unavailable and inadequate required medical equipment to help in testing, diagnosing and treating patients and identify diseases in all 15 projects</p>
<p>Plumbing design issues</p> <p>The only serious issues in plumbing design, is water leakage from ceilings in some operation rooms that causes issues with patient health and equipment, sometimes that lead to cancel the operations and spread of infections.</p>

Table 13. 57: Type of design field issues in Stage 2, Phase 1, from patient view

<p>Architectural design issues</p> <p>Patients complained about the (1) small-sized windows that were closed and locked most of the time, so interactions with the outside environment were limited; (2) small and crowded toilet with a portable toilet chair, urinal and bins but lacking hand rails; (3) crowding in the patient room with the three escort bed and garbage bins; (4) in-patient wards being located near traffic, generators and mechanical places; (5) long trip to reach the x-ray department; and (6) small room door that made it hard to move the bed outside the room.</p>
<p>Construction design issues</p> <p>Patients noted cracks on the patient room walls.</p>
<p>Mechanical design issues</p> <p>Complaints reflected (1) the high temperature and (2) low ventilation because the air conditioning and ventilation system outlets are few and far away from the beds, (3) frequent breakdowns of air conditioning, ventilation and heating systems, (4) the smell of the sewage station, and (5) the lift door hits the bed many times before getting in the lift because its door closes too quickly.</p>
<p>Life Safety design issues</p> <p>Difficulty or impossibility of evacuating patients from the critical units located on the second and third floors in case of fire is noted by researcher. An escape chute is a solution suggested by a researcher.</p>
<p>Electrical design issues</p> <p>Patients complained about random electrical cables around the bed.</p>
<p>Specifications writing materials issues</p> <p>Patients complained about dirt, dust, rust and stains on the walls and ceiling.</p>
<p>Equipment planning issues</p> <p>Patients complained about (1) the small size of the bed that does not fit the body, (2) difficulty in changing the bed positions, (3) waste containers included wound addressing materials located besides the bed head or on the walls, (4) sharp edges in the room furniture, and (5) delays in drug delivery and laboratory test results. It is suggested to use the pneumatic tube and automated pharmacy systems as solutions for these issues.</p>
<p>Plumbing design issues</p> <p>Patients complained about the water leakage from the roofs of their rooms and toilets.</p>

Table 13. 58: Type of design field issues in Stage 2, Phase 2, from healthcare providers view

<p>Circumstances of the AIs that were Out of research scope</p> <p>The participants provided information about some causes in the hospital's affecting patient health which were not involved in the research scope: a) Patient behaviour issues included refusing to (1) take medicines and (2) follow medical investigations and procedures and (3) listen to doctors' advice. b) Hospital management issues included (1) shortages in human resources at the professional level (e.g. consultant or specialist) and types (e.g. surgeons, paediatricians) and volumes (needed number (process flow)). (4) Lack of resources, including (1) medical supplies, (2) manpower (e.g. porter, cleaner), (3) lack of personal patient medical supplies and (4) Lack of motivation, such as (1) failure to listen to staff complaints and (2) lack of appreciation such as promotion. (c) Healthcare provider issues involved (1) lack of individual training and (2) education in a particular health problem and therapeutic area.</p>
<p>Architectural design issues</p> <p>Participants mentioned architectural design issues in many areas including (A) a lack of spaces including (1) a ramp to evacuate patients, (2) (a) medication rooms and (b) isolation rooms, (c) dirty and clean room numbers, (2) broken equipment storage and (3) insufficient space in patients' room for staff to work, especially during emergency calls. (B) Spaces relationships included (1) the long distance between the patient room and the diagnosis department and (2) the main entrance and corridor of specific medical departments are associated with other medical departments. (C) Space location issues included (1) the hospital being situated on a mountain leading to (a) more time to transport patients from the road level to the hospital, (b) breathing difficulty for users and patients due to the high altitude of the hospital, which required more physical effort. (D) Many doors in the ER department obstruct and delay patient movement.</p>
<p>Mechanical design issues</p> <p>Participants complained about (1) air condition system (A/C) not consistently working, with regular breakdowns, which led to (a) patient being uncomfortable, especially in the summertime. Therefore, hospital management provided portable A/C as a substitution and located them in the corridor, which (1) obstructed movement and (c) increased noise levels; (2) lack of oxygen outlet and (3) inefficient oxygen flow (low pressure); (3) the size of the lift is too small to fit the cardiac bed and the lift doors are unable to stay open until the normal patient bed is inside; (4) lack of negative pressure in isolation to avoid spread of infection.</p>
<p>Civil design issues</p> <p>Unavailability of a drain system in the toilets, with leakage from the ceiling which came from the above toilet flooring, leading to the spread of infection (Case Study 1)</p>
<p>Lift safety design issues</p> <p>Lack of (1) call bell system points in the toilet shower and chair; (2) lack of ramps to evacuate patient; (3) lack of smoking zone and door stoppers to avoid spread of smoke; (4) with the option/ability for nurses to cancel or turn the patient call off from the nurse station desk, the nurse should leave the station to respond to the call and turn it off from patient rooms, which would not provide the chance to ignore the patient call from the nurse station.</p>
<p>Lift security design issues</p> <p>Lack of security door system to avoid unauthorized access to certain areas, such as intensive care units and nursery to ensure the security of babies and avoiding infection.</p>
<p>Electrical design issues</p> <p>(1) The light from the ceiling is directed right into patient eyes which causes discomfort, (2) electrical sockets are uncovered and (3) different types of sockets which are not suitable for some medical equipment (British and American).</p>
<p>Other sources (please specify): Why?</p> <p>Other factors mentioned that could lead to the designed environment issues include (1) changes in current space designs to accommodate new departments that the hospital manager requested. These changes in designs are implemented to create a new medical unit to deal with different health problems (e.g. burn unit) or expand an existing unit in order to receive new equipment (e.g. x-ray and laboratory departments) or more patients. Therefore, these changes lead to other issues affecting other units that include: (1) spaces with less activities and functions when the area becomes smaller and with less sufficient level of critical systems (e.g. A/C) because they were designed with specific capabilities to deal with certain areas that were not included in new or expanded areas. There are two parties responsible for these issues: healthcare facility managers, who are unqualified to apply these changes and the design teams, who did not consider the future space requirements for patient and medical services.</p>

Table 13.59: Type of design field issues in Stage 2, Phase 3, from maintenance and design teams view

Architectural design issues

According to architectural designs issues occurred in the occupancy stage, participants, in all case studies, realised design issues include: unavailable, insufficient, inadequate and inoperable required spaces; (1) unavailable spaces, such as clean and dirty utilities and trolley washing area, which lead to spread of infections and prevent healthcare provision, (2) insufficient spaces, such a lack of equipment storage that lead to park the equipment in the corridors, which obstruct the movements of users, (3) inadequate spaces area and height, such as the space height from the floor to ceiling is low, that avoid applying any new systems through the ceiling and the structural elements occur in the space that makes the equipment and users movements harder, (4) inappropriate space location, such as generators besides the inpatient's wards building, hospital building location close to the crowded areas and roads that considered as source of annoying and the mixed uncontaminated and contaminated tools and materials store in the same space that lead to infection and (5) inoperable and unfunctional spaces, such as the size of medication room is small that make nurse movement too hard to prepare the medicine, which may lead to medication errors. One medication room for two medical units

Construction design issues

According to structural designs issues occurred in the occupancy stage, participants, in all case studies, realised design issues includes; (1) cracks occurred on the internal and external walls surfaces because the soil expanding, in which lead to growing bacteria and fungus within cracks resulting in infection spread and giving uncomfortable feelings to patient, (2) limited structural load and the many concrete steel walls between spaces, that avoid the chance to extend/ increase the current spaces area in order to install new equipment and systems, or adding a new required unit and(3) missing terminal and water isolations/control layers cause rain water leakages from final roof to inside the hospital building, which leads to spread of infections and damage.

Mechanical design issues

Design issues in mechanical field, participants pointed to many issues include: (1) miscalculation of required pressure types in spaces, such as in the burn unit, isolation and dirty rooms and dirty area in sterilisation department, where is required negative pressure to control and avoid the contaminated air around infectious patient and materials to go outside in the operation room required the positive pressure to protect patient from uncontaminated air outside. A mixing between the contaminated air returned from A/C and the uncontaminated air from the ventilation systems in (a) the isolation room and its toilet and(b) kitchen with other departments, which lead to spread of infections and undesirable smell. (2) deficiency in the A/C system capacity and air flow, such as in the patient, medical equipment rooms and the new expanded units, that lead to increase the temperature level impacting users and equipment functions. In order to solve these issues, they (hospital management in case 1) located the split air conditions units on the corridors floor, which obstruct the user movements and produced annoying sounds (3) inappropriate location and insufficient area HVAC system units where location is next to the inpatient wards, in which considered as source of danger and annoying. it is impossible to upgrade these systems or add new systems, because the limited current area and (4) difficulty in controlling and VAC air flow from patient rooms, they (nurses) need to call maintenance team member to increase or decrease the level of air flows. civil, mechanical/structural, constructional/ architectural engineer, architect

Civil design issues

In the field of civil designs, participants mentioned many design issues including (1) difficulty to expand the existing infrastructure, such as drainage systems, roadways and car parking area for disable outpatients or visitors to deal with an increase in users' numbers, because of limited areas and missing the maps of current infrastructure; and (2) unavailability of drainage system for radioactive waste disposals in the radioactive therapy unit which can lead to serious health issues.

Life safety design issues

From aspects of life safety design issues, participant found out a lack of safety tools, spaces, equipment and systems in patient designed environment in four areas: (1) safety tools issues include: (a) the insufficient amount of extinguishers such as two extinguishers for four zones; (b) extinguishers type, one extinguisher type cannot fight other types of fire, such chemical or electrical fires; (c) inappropriate location and distribution for them, it takes a long distance from areas to reach the fire extinguishers location to use; and (d) position of fire hydrant cabinet located on the wall; (2) the difficulty for firefighting vehicles to move around the buildings or finding space to park; (3) fire systems equipment issues include: (a) smoke detectors and fire sprinklers do not cover all the required areas; (b) the networks of the systems located outside the walls; (4) fire zones issues include: (a) inadequate and insufficient flame and smoke barrier walls that lead spread of fire and smoke; (5) difficulty in applying (a) the evacuation plan for inpatients from intensive units, because they are located in upper floors (third level); (b) a long distance between some departments and emergency spend time and effort to reach safe point and (6) fire alarm system is not connected to some critical systems, to turn them off in case of a fire for avoiding smoke spreading and this system is not connected to doors with pass codes to be unlocked automatically and allow to users to get out. These issues cause death, poisoning, burn and suffocation to patients and users. (1) without fire protection systems and (6) without sprinklers systems: confidential, official letter required)

Life Security Design Issues

Life security design issues mentioned by participants includes (1) lack of security tools; (c) alarms points, fences, access control systems; (2) deficiency in CCTV systems that do not cover all hospital zones, exits and entrances; (3) more than three entrances to reach the hospital building; (4) the fences have some gaps that allow to some insects, reptiles and bad persons access to hospital and (5) the doors locks do not link to the alarm system in emergency case (e.g. kidnaping, stealing or committing crimes inside the hospital) to be locked automatically. These issues expose patients to danger or make them feel unsafe.

Electrical Design Issues

In terms of electrical design issues, participants reported the following issues (1) insufficient lights with low number and light strength of lighting units; (2) limited electrical sources, such as (a) lack of the outlets to operate some medical devices; (b) the existing electrical outlets do not adapt some of mobile equipment plugs (USA/UK); (c) some outlets distribution and locations are not suitable for the medical equipment numbers, directions and positions; (3) inadequate lighting amount, especially in the OR and medication rooms that may lead to medication or medical errors; (4) protection system issues: (3) random electrical network located on the ceilings, that lead to electrical fire; (5) unsuitable electrical panels locations were some of them next to wet areas or in stores and (8) difficulty to track the electrical cables ways. Most of these issues cause fires, delay or stop the healthcare services delivery.

Specifications Writing Materials Issues

In the delivery stage, the ministry health committee member uses high quality standards to approve the materials used in hospitals; the construction contractor argues that standards are not mentioned in the contract specifications, so the quality of most materials is low, such as the flooring type in toilets cause falls resulting in injury to patient, the flooring used in the theatre room should be electrical power resistant (cloths); the doors should be with high rate of fire resistant and paint material should be easy to be cleaned.

Specifications/Information Issues in Drawings/Tables (8 Participants)

Two types of issues were mentioned by participants in terms of specifications writing and lack of information in drawings: (A) Lack of quality standards in material selection specifications. In order to increase the quality level of these selected materials in patient environment, the following materials selection criteria should apply to the specification: (1) fire material of gaps to (a) avoid the growth of bacteria and fungi and(b) easy to clean and sterilize; (2) availability of these materials in Saudi market. (B) lack of information presented by the draft men on drawings (design development design stage) include : (1) Layout issues of the architectural designs to present (a) some of measurements, dimensions, spaces names, finishes and furnishings, (b) locations of some equipment and (c) scale of drawings; (2) Layout issues of the equipment planning designs to present some of installing equipment requirements, such as outlets, mechanical and electrical works, water sources and disposal of radiation waste lines; (3) Layout issues in the mechanical designs to present (a) the smoke, the heating, ventilating, air conditioning zones within the air flows and (b) the pressure type in the space (c) the movement and treatment of the internal and external air in the hospital buildings; (4) Layout issues in the electrical designs to present (a) some of numbers and positions of lightings rods and(b) dimensions of spaces between conductor cables (external protection) and (c) the links between the equipotential bonding equipment and medical equipment and metallic parts on the plans; (5) Layout issues of the plumbing designs to present (a) some of size, types and locations of the medial gas and (b) the waste systems drainage grids; (6) Layout issues in the construction designs to present (a) some of the allowable load limitations details and (7) Layout of the civil designs to present some of the roadways, sidewalks, exterior lighting and utility grids. These layouts issues as lack of information on the maps lead to difficulty to provide new healthcare services or improve others, because the design team cannot deal with changing or modifying the current design issues and maintenance team cannot read the drawings to deals with expanding the critical systems grids our points without fully understanding of maps components.

Equipment Planning Issues

Participants, in the three case studies, mentioned some issues regarding the equipment planning designs. These issues include: (1) equipment location issues: (a) faulty in choosing the current medical equipment location where the improper environmental conditions, such as high level of temperature and humidity, leads to the equipment breakdown; (b) the equipment spaces locations are next to or under the wet areas such as toilets; (c) radiational equipment space located close to pregnant exam clinic; (d) incorrect position of some equipment avoid the easy movement of patient and users around them and(2) lack of supporting spaces include: (a) equipment store, (b) area for sterilizing the used equipment and (c) waiting and changing rooms for patients and operators, (3) difficulty in installing the new or advance medical equipment, because of (a) unavailable spaces, (b) electrical and (b) mechanical works sources; (4) lack of some new required medical equipment and the current equipment numbers for applying required diagnostic or therapeutic plans to new health problems; (5) some of existing equipment in laboratory do not give precise results because inadequate ventilations and air condition systems and (6) difficulties in users' movements due to the lack of storage for damaged equipment that parked in the paths. These issues in the equipment planning could impact patient health such as spread of infection caused by contaminated equipment and avoid or delayed the medical services provision because of damaging in some diagnostic equipment in laboratory and X-ray units.

Maintenance system issues. OUT OF RESEARCH SCOPE

Failures relating to the quality of repairing and the availability of materials. No spare parts available; short lifespan; unqualified workers

Financial Planning System Issues

Strange way to estimate the cost of the new hospitals

There are some issues with financial planning system mentioned by participants, at early stage before bidding phase to construction stage. These issues include: (1) Lack of current and future knowledge of estimating a new hospital building budget; (2) Exaggerating in aesthetic elements in designs without feasibility and functional study analysis; (3) unavailable direct connections between financial and project administrations to inform the financial department about the chances in the hospital project; (4) lack of financial planning to cover any future changes or extensions in the hospital services scope and (5) the budget should be approved after all design stages and before bidding stage, not at the request stage as first stage, to involve any changes during the all hospital design stages to the cost. This missing process leads to ignoring some costs of works, tasks, equipment and systems, in which produced uncompleted construction, equipping and furnishing stages, because of the inadequate budget. These issues lead to delay in establishing the new hospitals or parts of construction and operation stages, which avoid the provision of healthcare to the patient in future.

13.4.3 CONCEPT C: DIAIS AND DESIGN FAULTS AND DEFECTS

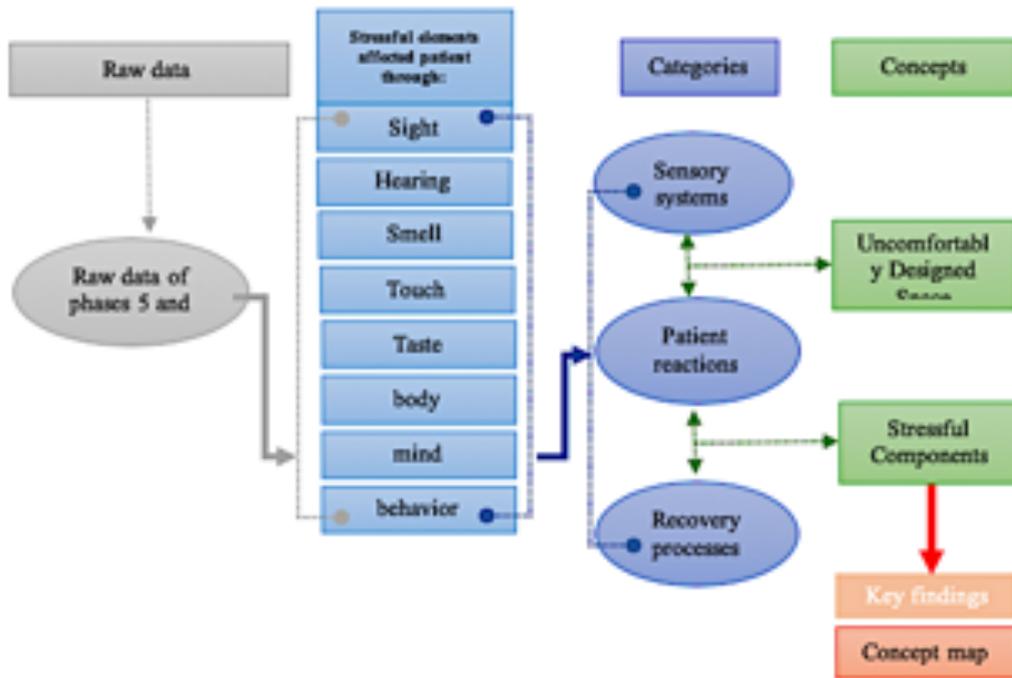


Figure 13.31: Key findings of stressful elements concept in design

Table 13. 60: link between DIAIs and Design issues (faults and defects)

<p>Injury: Sharp edges in the room devices and furniture, (2) the lift door hits the bed many times before getting in the lift because its door closes too quickly, and (3) position of the fire hydrant cabinet located on the wall in corridors related to injuries, as well as, (4) flooring type in toilets cause falls resulting in injury to patient.</p>		
<p>Burns: related to fires and overheating of medical devices because of (design issue) such as the lack of environment condition consideration (ventilation, A/C systems capacity), the used materials with low rate of fire resistant and are not fireproof.</p>		
<p>Fire: Most case fires that cause death, poisoning, burn and asphyxiation to patients and users related to safety tools issues and evacuation plan in case of fire include; (1) insufficient amount of extinguishers such as two extinguishers for four zones; (2) extinguishers type, one extinguisher type cannot fight other types of fire, such chemical or electrical fires; (3) inappropriate location and distribution for them, it takes a long distance from areas to reach the fire extinguishers location to use; and (4) difficulty for firefighting vehicles to move around buildings or finding space to park; (5) fire systems equipment issues include; (6) smoke detectors and fire sprinklers do not recover all the required areas; (7) the networks of the systems located outside walls; (8) fire zones issues include; (9) inadequate and insufficient flame and smoke barrier walls that lead spread of fire and smoke; (10) difficulty in applying (11) the evacuation plan for inpatients from intensive units, because they are located in upper floors (third level); (12) a long distance between some departments and emergency spend time and effort to reach safe point and (13) fire alarm system is not connected to some critical systems, to turn them off in case of a fire for avoiding smoke spreading and this system is not connected to doors with pass codes to be unlocked automatically and allow to users to get out. (14) some areas without fire protection systems and without sprinklers systems, (15) lack of building exits, fire alarms, and (16) smoke-control systems to control or limit a fire, as well as (17) the walls not reaching the roof after ceilings to resist the passage of fire and smoke. (18) difficulty in the evacuation plan for inpatients from paediatric, neonatal and adults intensive units, because they are in upper floors (third level), (19) Difficulty or impossibility of evacuating patients from the critical units located on the second and third floors in case of fire is noted by researcher. An escape chute is a solution suggested by a researcher. (20) random electrical cables around the bed, a lack of spaces including (21) a ramp to evacuate patients, (22) lack of smoking zone and door stoppers to avoid spread of smoke, (23) random electrical network located on the ceilings, that lead to electrical fire; (24) unsuitable electrical panels locations were some of them next to wet areas or in stores and (25) the doors should be with high rate of fire resistant. Most of these issues cause fires, delay or stop the healing processes or healthcare services delivery.</p>		
<p>Fall: (1) small and crowded toilet with a portable toilet chair, urinal and bins but lacking hand rails; (2) crowding in the patient room with the three-scoot bed, medical equipment and garbage bins, (3) small room door that made it hard to move the bed outside the room, (4) slippery and wet floor, (5) lack of rails cause fall.</p>		
<p>Breathing difficulty: high altitude of hospital and it located on mountain which required more physical effort.</p>		
Medication errors	wrong medication orders	Delay of medication
<p>(1) size of medication room is small that make nurse movement too hard to prepare the medicine, which may lead to medication errors. (2) One medication room for two medical units, (3) Insufficient lights with low number and light strength of lighting units, (4) high temperature reducing medication potency that may lead to medication errors, (5) long distance between the medication room and internal chemist and patient room, (6) lack of medication room</p>		
patient identification errors	incomplete patient information	Loss of patient information
<p>lack of (1) active medical records, (2) data processing, (3) collection, (4) medical coding, (5) medical transcription, (6) mortality recording areas and (7) mobile shelving systems (8) backup system failed (power shutdown) or damaged (x-ray) lead to the difficulty to know the patient history, because the delay in bringing the patient file (chemist, medication records and treatment plans) from medical record and radiology department or it is missing (paper), stolen and lost (computer system) which makes it too hard for doctors to evaluate, analyse treatment results and plan or define the best way to diagnose and cure the health problem.</p>		
<p>Blood transfusion errors: Lack of (1) blood extraction, (2) reception blood bank rooms, (3) mycology, (4) polymerase chain reaction, (5) virology, (6) microbiology laboratories and (7) media preparation storage and (8) tumours sampling extraction. These spaces are fit define the infectious diseases within the blood (8) the over-crowding of the devices in the different sections of the laboratory causing many issues; (9) difficulty in movement of staff in each section; (10) the A/C system is not working efficiently in adapting the new increase in the temperature of the thermal load producing by medical equipment, that lead to break down some of them, and (10) additional electrical load increased to operate the new device, that may cause a fire; (11) this department deals with too many requests of testing (blood tests) from the ER department and 68 clinics with the new extended medical sections and clinics, thus increasing the potential level of errors in samples analysis results; (13) lack of required infrastructure prevents installing advanced and specialised laboratory equipment that help in identifying and diagnosing diseases. These issues affect both patient health and care services.</p>		

Testing results errors: electrical issues, software deficiencies, error codes in device memory, errors in photographs, loss of medical device and computer system data resulting from: (1) failures in supporting systems such as (2) power supply, (3) keeping damaged, expired or recalled medical devices in one area where (4) dirt and non-clean environment, (5) close to wet areas, exposure of medical devices to (6) direct sun-light and moisture, (7) lack of equipment storage and existing storages with harm conditions such as (8) high temperature and (9) humidity, (10) low light and ventilation, (11) Lack of tumours sampling extraction Rm. (12) deficiency in the A/C system capacity, such as in the medical equipment rooms and the new expanded units, that lead to increase the temperature level impacting users and equipment functions and lead to the equipment breakdown; (13) the equipment spaces locations are next to or under the wet areas such as toilets, (14) difficulties in users' movements due to the lack of storage for damaged equipment that parked in the paths, (15) some of sections in the h are not connecting to the uninterruptible power supply points to maintain their function when the power is cut out from main source These issues existing in laboratory lead to low equipment functions and do not give precise results

Delays in diagnostic plans: Lack of (1) diagnostic equipment and (2) spaces such as electrocardiogram (ECG), cardiocotography (CTG), ultrasound, echocardiogram (ECHO), and brain and nerve monitoring devices, interventional ultrasound and tissue cutting rooms, Lack of (3) the space to measure the bladder pressure as way for diagnosis plan, (4) lack of screening clinic, (5) oral and visual exam spaces to define infectious diseases, (6) the difficulty in expanding some diagnostic areas, to install new devices or increase the number of existing equipment in dealing with new diseases or growth of patient number, because the (7) existing of concrete steel walls between spaces, (8) difficulty to provide new medical equipment or systems because their weight is more than the allowable structural load, (9) impossibility to extend the hospital building, (10) vertically because the critical systems units existing on the roof and (11) horizontally because it surrounded by residential and commercial buildings, (12) the hospital being situated on a mountain leading to more time to transport patients from the road level to the hospital

Delays in treatment plans: Lack of therapeutic (1) spaces such as burn units, obesity clinic, respiratory therapy unit and (2) equipment such as Shock Wave Lithotripsy, Ultraviolet, Mobile x-ray alcove, X-Ray, (3) no using advance technology in performing operations to reduce the medical errors, safe medical staff effort and time and dealing with complex cases (digital operation room), (4) the lift size that the patient bed cannot get in the lift easily and in the cardiac surgery unit, (5) water leakage from ceilings in some rooms is serious issues that causes issues with patient health and equipment, sometimes that lead to cancel the operations, (6) number of operation rooms is too low, so many cases were transferred to other hospitals, (7) the lack of bedrooms to accept more patients, (8) lack of some very important types of gases used in treatment plan, that expand the children veins, which save children's levies, especially in the NICU and PKU, (9) limited loads capacities of electrical panels that do not allow to install new or more equipment or expand the medical space, lack of (10) supporting spaces for (a) storage equipment, (b) collecting waste, (c) mechanical service, (d) medication rooms, nurse stations, (11) inadequate spaces for (a) the activities and (b) functions of exam, diagnosis and treatment spaces within the growth of patient number and user, (12) many crossing points in most movements lines types vertically and horizontally, (13) lack of future planning for extending the current building or designing new spaces, (14) insufficient linkage between medical and nonmedical departments and others, (15) lack of supporting areas for (a) electrical and (b) mechanical services and (c) machines, (d) patient waiting, (e) healthcare (f) changing, (g) resting and (h) managing and new equipment or systems, (16) the size of the lifts is not allowed to patient bed to get in and cannot be extended, (17) low beds capacity in intensive care units, (18) inefficient way to monitoring, watching patient directly, (19) a lack of some very important types of gases used in treatment plan, that expand the children veins, which save children levies, (20) some critical/capital/medical equipment, especially, in the OR, X-Ray and emergency departments are not connecting to the uninterruptible power supply points to maintain their function when the power is cut out from main source, or the standby generators are not responded, (21) limited loads capacities of electrical panels that not allow to install new or more equipment, (22) insufficient space in patients' room for staff to work, especially during emergency calls, Many doors in the ER department obstruct and delay patient movement, (23) lack of oxygen outlet and (24) inefficient oxygen flow (low pressure)

Infection: (1) cross of contamination and decontamination lines, (2) lack of isolation rooms and some of the current room without negative pressure, (3) supporting systems, (4) air lock, (5) immediate Sterilization. Lack of spaces to control infection such as (6) Dirty, (7) Clean, (8) Janitorial utilities, (9) Biohazard/ Biohazard Rubbish areas. (10) lack of spaces to store medical waste (placenta membranes and medical consumptions). (11) miscalculation of required pressure types in spaces, such as in the burn unit, isolation, dirty rooms and dirty area in sterilisation department, where is required negative pressure to control and avoid the contaminated air produced from infectious patient and used materials to spread out of the room. (12) in the operation and delivery rooms, the positive pressure is required to protect patient from outside uncontaminated air. (13) deficiency in the A/C system capacity and air flow. (14) water leakage from ceilings in some operation rooms that causes issues with patient health and equipment, sometimes that lead to cancel the operations and spread of infections. (15) waste containers included wound addressing materials located besides the bed head or on the walls, (16) lack of drain system in the toilets, (17) cracks on the patient room walls, (18) sharp corners, (19) dirt, dust, rust and stains on the walls surfaces and ceiling, in which lead to growing bacteria and fungus within cracks and corners resulting in infection spread and giving uncomfortable feelings to patient, (20) A mixing between the contaminated air returned from central A/C and the uncontaminated air from the ventilation systems in (a) the isolation room and its toilet and (b) kitchen with other departments, which lead to spread of infections and undesirable smell. (21) unavailability of drainage system for radioactive waste disposals in the radioactive therapy unit which can lead to serious health issues, (22) lack of area for sterilising the used equipment. (23) lack of the capacity of sewage treatment plant that lead to treat the waste in inappropriate way causing bad smell and infection, especially, (24) using uncompleted treatment water to water the plants around the hospital; (25) the medical (radiology) and normal liquid waste mixed before reaching the treatment station because they use the same drainage network and (26) the medical waste room outside the hospital consider as source of infections because design standards for this kind of space are not applied (A/C, area for sterilising cleaners and medical waste bins)

Sterilisation techniques (infection): decontaminated instruments (noncritical) and medical instruments (critical and semi-critical) are realised, because (A) lack of required areas such as (1) dirty receiving, (2) trolley washing, (3) trolley clean, (4) shoes rack areas (using their personal shoes within the dirty area to clean area and outside the department), (5) washer disinfectors (dry heat) and (6) autoclaves (steam), (6) air lock areas. Sometimes contaminated instruments, medical instruments coming to theatre units were refused (with blood and dust) to be used on patient, because they seemed not applied to (7) all processes (cleaning, disinfecting and sterilising) and (8) methods (steam, dry heat, chemical methods) of sterilisation in the supply and sterilisation centre. the crossing movements of: (8) a contaminated instrument inside the sterile department and their way back to other sections, (9) uncontaminated instruments from other departments to the sterilisation department (contaminated objects lines with staff line), (10) no controlling the movement of staff among the dirty, clean and packaging areas (no air lock areas) to avoid infection. lack of areas to (11) receive contaminated tools (received in the dirty area), (12) for washing instrument trolley that brings the contaminated tool. However, these issues in sterilisation techniques lead to the spread of infections.

Kidnapping: Due to (1) the door locks do not link to the alarm system in emergency case such as kidnaping in nursery unit. (2) deficiency in CCTV systems, and lack of security tools; (3) alarms points, (4) fences (with gap and without CCTV) and (5) access control systems to just allow healthcare providers entering specific places. (6) Difficulty to mentoring and controlling entrances (3-4 entrances) of hospital. These issues expose patients to danger and make them insecure.

Power shutdowns:

Critical medical equipment and tools must be connected to the USP points to avoid the breakdown of them when they are being used on patients. some critical/capital/medical equipment, especially, in the OR, X-Ray and emergency departments are not connecting to the uninterruptible power supply points to maintain their function when the power is cut out from main source, or the standby generators are not responding.

13.4.4 CONCEPT D: UNCOMFORTABLY DESIGNED COMPONENTS AND STRESSFUL ELEMENTS

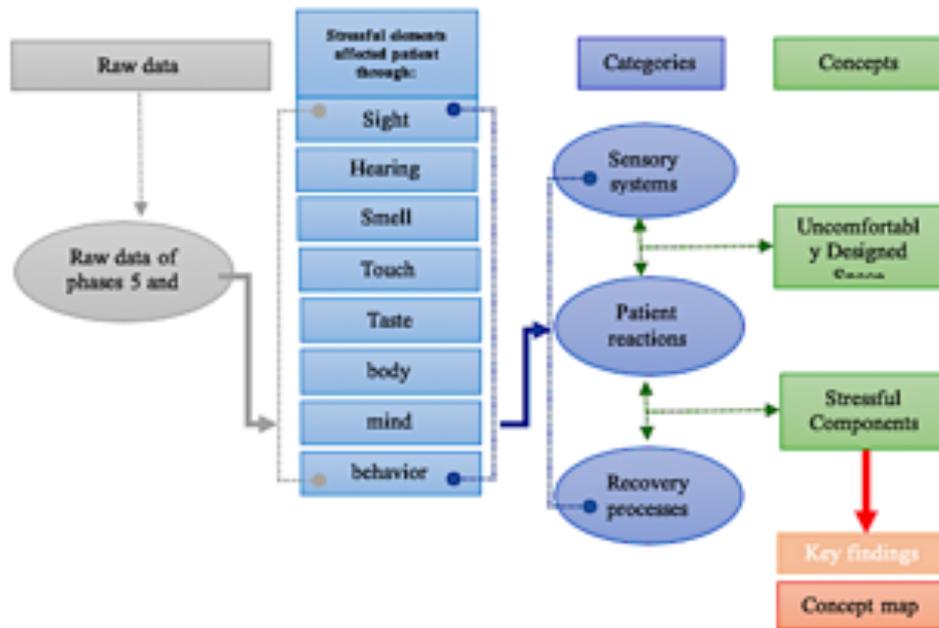


Figure 13. 32: key findings of stressful elements concept in design

Table 13. 61: Stressful elements in design from patient view

<p>Sight: Patients complained about seeing elements in their environment that made them feel uncomfortable and unsafe: (1) images with disease cases (e.g. throat cancer images); (2) signage with warning phrases (e.g. danger, do not get close, forbidden to approach); (3) the scary name of some departments (e.g. departments of morgue, recuperation and laundry for washing the dead patients); (4) the annoying and unpleasant colours (colours related to moulding food or fruit and colours related to injuries, bruises or bodily fluids, such as ear wax and mucus); (5) random electrical cables around the bed; (6) stains, dirt, dust, blood and rust on the ceiling, walls and equipment; (7) water leakage from the roof; (8) cracks on the walls; (9) small and locked windows that gave patient feelings of being suffocated, such as in jail; (10) extinguisher cabinets located on the walls obstructed movement in the corridors, and (11) the lighting had uncomfortable colours and glare made patient eyes tired.</p>
<p>Hearing: negative elements that affected patients' hearing and made them uncomfortable were (1) external sources of annoying noise, including traffic, generators, air conditioning units, sounds of treatment plants (sewage), air coming through windows and ventilation outlet gaps and thunder; (2) the interior sources of uncomfortable noise involved equipment alarms and emergency calls such as code blue, and (3) healthcare providers speaking loudly during discussions of the patient status besides patient beds.</p>
<p>Smell: Patients mentioned sources of unwanted smells in the designed spaces that made them feel uncomfortable: (1) the internal unwanted smells included smells of detergents, sterilisers, blood, antiseptic and medicines; (2) the external smells included car exhaust, treatment plants, waste storage room smells, and (3) the images/pictures and the walls colours that prompted the patients' memory to remember bad smells.</p>
<p>Touch: negative elements that affected patients' hearing and made them uncomfortable were design components they did not want to include: the rough, grey/dark-coloured surfaces of the walls and furniture, sharp edges, and some images with disgusting content made them get or recall feelings of a shudder.</p>
<p>Taste: patients losing their appetite, including graphic images, such as a doctor performing surgery, a mosquito sucking blood and disease side-effects.</p>
<p>Physical effort: Patients had difficulty (1) moving from the bed to the toilet, (2) trying to open and close the room and toilet door, and (3) moving a long distance (design fault) to reach the x-ray department.</p>

Table 13. 62: Stressful elements in design from healthcare provider's view

(Sight): (1) using dark colour and materials such as painting colour used on walls and floor, that bring (a) sadness and is hard to see; (2) dirty or contaminated things on dark paint, such as blood and it is hard to clean and sterilise these walls. These inpatient environments should have highest specifications: fireproof, dustproof, waterproof and rustproof, as a way to infection control. There are small windows and lack of green areas in outside environment, (3) small and crowded spaces: (a) small and crowded toilet with portable toilet chair, urinal and bins and lack of rails and(b) the patient room with the escort bed and garbage bins, which lead to obstruct the patient movement and affect patient safety and (4) difficulty to move or change the position of the bed as patient demand to the Qibla site to let patients pray

Hearing: annoying and scary voices or sounds, such as equipment alarms and peeps, especially in NICU/PICU, that produced the uncomfortable feeling to patients or harmed babies' hearing system. However, they suggested that providing or therapeutic music help them to recall memory for comfortable feelings

Smell: some of used fresheners materials cause allergy and difficulty in breathing to some patients, especially, in the ICUs besides that the smell of sterilizers and medicines are undesirable for some patients.

Touch: surfaces of rails and flooring should be anti-slipping as the required to avoid falls and to reduce the chance of infection spreading by the touching of the same tools or surfaces by number of patients, such as patient can use the hand soap, paper towel, water tap dispensers and doors should respond to patient needs without touching them

Taste: do not like some colour of plates and the food table

Physical effort: (1) the distance between patient rooms and the diagnosis department, (b) difficulty in breathing for users and patients, because the high altitude of the hospital location where the level of oxygen is too low, that required more physical effort, (a) spend more time to transport patient from the road level to the hospital, they mentioned the hospital building is too high (9 floors) causing (1) stress to patient

13.4.5 CONCEPT E: HEALING DESIGN ASPECTS

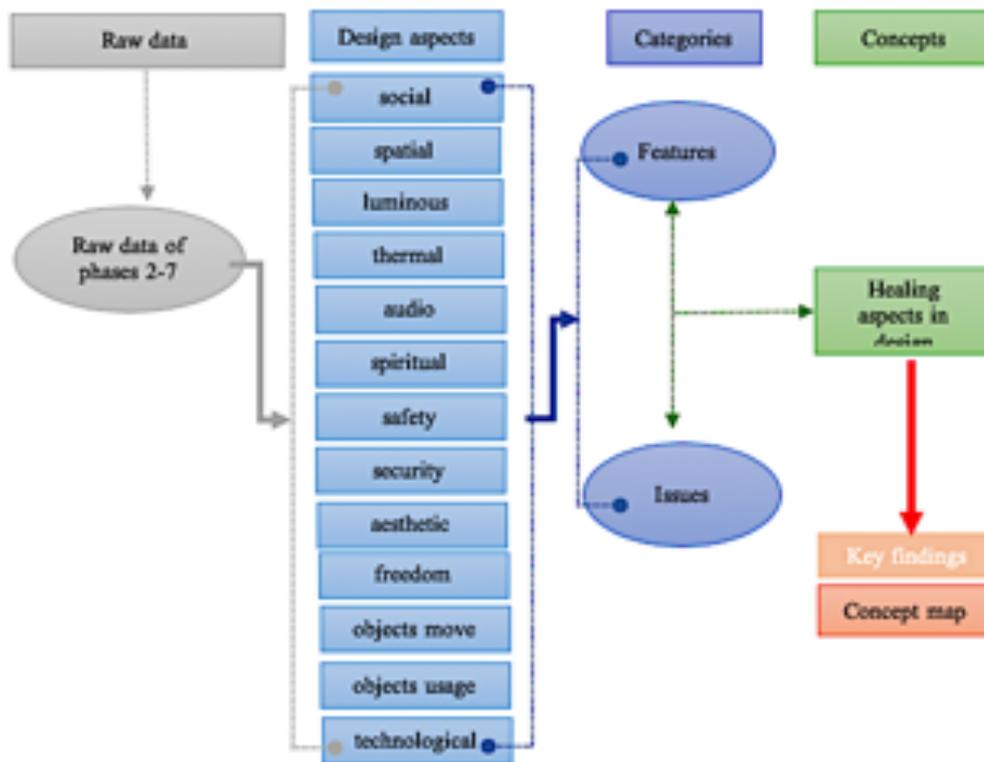


Figure 13.33: key findings of healing aspects concept in design

Table 13. 63: Healing aspects of design aspects in Stage 1, Phases 3 and 4, from medical manager view

healing design aspects	Elements affecting healing aspects in design
Spatial issues	The number of operation rooms is too low, so many cases was transferred to other hospitals, the lift size that the patient bed cannot get in the lift easily and in the cardiac surgery unit; the lack of bedrooms to accept more patients
Luminosity issues	(1) darkness around them in (E) in MRI room, (2) limited access for sunlight
Thermal issues	The A/C system is not working efficiently that may increase patient body temperature.
Object movements in design	Difficulty in patient movements because of storing some devices in the corridors and a long and indirect way from the unit to the operations unit takes long-time, especially, in case of emergency surgical intervention needed for patient or to bring the him from emergency department (ER) to the unit in long-time
Safety issues	The difficulty to apply the patient safety standards and policies of JCIA and CHAHI to control infections
Life security design issues	The doors locks do not link to the alarm system in emergency case such kidnaping in nursery unit
Objects usage	Spending time and effort to use and deal with objects in spaces
Privacy	No concerning of the privacy and feelings of patient, who has psychological ill, during his/her movements inside the hospital or during the walk to the clinic. Lack of private room for temporary body, psycho patient and prisoner patient.

Table 13. 64: Healing aspects of design in Stage 2. Phase 1, from patient view

healing design aspects	Elements affecting healing aspects in design
Spatial issues	(1) Inadequate spaces including patient room, toilet, lift; (2) small-sized windows and doors; (3) equipment surfaces with sharp edges, and (4) objects obstructing movement within the corridors
Luminosity issues	(1) darkness around them in (E) in MRI room, (2) limited access for sunlight
Thermal issues	Deficiency in critical systems that lead to sweating or dry skin
Audio issues	Annoying sounds and voices in patients' space
Social issues	Inadequate space for the patient to connect with visitors
Spiritual issues	(1) Lack of space and tools for ablutions and prayers, (2) the direction of the toilet chairs facing the Qibla, and (3) the bed was not facing the Qibla
Aesthetic issues	Lack of aesthetic appeal and many stressful elements in the hospital building
Object movements in design	Difficulty with (1) patient, (2) equipment, (3) waste, (4) patient data and (5) information movement
Safety issues	(1) Random electrical cables around the patient bed, (2) the lift does not fit the patient bed and (3) sharp edges on some of equipment, medical waste bins close to patient bed, wet floors
Objects usage	Spending time and effort to use and deal with objects in spaces
Smells	Bad smelling sources in patient-designed components

Table 13. 65: Healing aspects of design in Stage 2. Phase 2, from healthcare providers view

Atmosphere design aspects	Elements affecting atmospheric aspects of design
Spatial issues	(1) lack of bathrooms and (2) lift numbers, (3) patient room size where was inadequate and (4) overcrowded with more than 4 beds, the hospital building is too high (9 floors) causing (1) stress to patient besides there is a lack of visual monitoring/watching (DD) on patient from the nurse station, because the solid walls between patient room and control station. (1) the hospital was in a part valley (2) small size of patients' rooms and lifts, lack of visual monitoring/watching (DD) on patient from the nurse station, location of hospital being situated on a mountain where lead to : (a) spend more time to transport patient from the road level to the hospital, (b) difficulty in breathing for users and patients, because the high altitude of the hospital location where the level of oxygen is too low, that required more physical effort.; (D) many doors in the ER department which obstruct and delay patient movement.
Luminous issues	Allowing to sunlight to be in the room most of the time, that help in fighting infection, the light from the ceiling is directed right into patients' eyes which causes discomfort
Thermal issues	(1) deficiency of A/C system
Audio issues	Equipment alarms and beeps
Social issues	Inadequate spaces for visitors and the escort bed
Spiritual issues	(4) the difficulty to move or change the position of the bed as patient demand to the Qibla site for let patients pray as a way to respect patients' faiths
Aesthetic issues	Lack of green areas
Object movements	Difficulty in (1) patient and (2) equipment movements. The patient room with the escort bed and garbage bins, which lead to obstruct the patient movement, move and access for the patient to lifts, many doors in the ER department which obstruct and delay patient movement, the movement around patient bed too difficult.
Safety issues	Garbage bins, lack of rails, (2) dirty or contaminated things on the dark painting such blood and hard to clean and sterilise walls. These paintings and materials in the patient environment should have highest specifications, that materials are made as fireproof, dustproof, waterproof and rust proof as a way to infection control, as they recommended
Smells in design	Used fresheners materials cause allergy and difficulty in breathing to some patients, that the smell of sterilizers and medicines are undesirable for some patients
Security issues	Lack of security door system to avoid unauthorized access to certain areas, such as intensive care units and nursery to ensure the security of babies

Table 13. 66: Healing aspects of design in Stage 2, Phase 2, from design and maintenance teams view

Atmosphere design aspects	Elements affecting atmosphere aspects of design
	<p>Spatial: (1) patient body to deal with its size, position, direction, health condition and movement, (2) space functions to deal with diagnostic and therapeutic plans activities, (3) space components to deal with their size, height, movement, functions, usages, requirements, location and storage in spaces, (4) space height to deal with systems networks, (5) space access to deal with patient privacy, (6) space shape, (7) space number, (8) space relations to deal with patient transportations to other spaces, and (9) space colours. These elements for spatial aspect in design reduce the physical efforts when patients use or move within spaces.</p>
	<p>Luminous: (1) providing the appropriate colour, strength, distribution, temperature and distance of lightings, (2) allowing natural lighting access to patient space through appropriate location, size and shape of the windows and (3) preventing the incandescent lightings colours that cause a sense of suffocation and confusion. Recognising these luminous elements give patients a sense of calm and warmth and they avoid the sense of discomfort to eyes and skin.</p>
	<p>Thermal: To reach a high level of comfort for patient body or skin, to avoid the drop or increase in body temperature cause the feeling of cold and shiver or feeling heat and sweat that causes skin to dry. The following elements should be considered in space design: (1) providing a natural or mechanical ventilation, (2) allowing the sunlight to access patient space and (3) easily controlling the air movement and temperature in the space.</p>
	<p>Audible: (1) sounds (water, birds singing) and (2) voices (Quran recitation) and music to create emotions and evoke memories positively by contacting patients to interesting places and time that bring the feelings of calm and happiness.</p>
Social	<p>Providing to a patient the feeling of consideration, importance, pertinence or belonging, avoiding her or him in space to feel isolated from external environment or community, to supports his or her psychological health are within design element in social design. These elements include: (1) social interaction spaces for his family, friends and special places for parents near their child in intensive care units and (2) spaces or tools to access to shopping and coffee stores.</p>
Spiritual	<p>Creating spiritual space to reflect the faith, culture, history, customs and traditions in a patient environment to reach the highest level of tranquility. These factors can be achievable in-patient environment design: (1) using symbols, commodities, art, pictures and images, (2) paintings colours selection, (3) space and tools to do abtution and pray (4) changing the direction of the toilet chairs away from the direction of the Qibla and (5) facilitate the movement of the bed to the Qibla.</p>
Aesthetic	<p>To increase the level of excitement in space for patient by: (1) using attractive decorations, inscriptions, pictures, drawings and painting colours, Arabic fonts for some Quranic verses and Hadiths in patient environment, to recall patients thinking, memories and senses in feelings of pleasure and happiness., and (2) preventing the feelings of time passing slowly and concentration on a sense of pain. These considerations lead to improve the psychological health in terms of aesthetic aspect in designs.</p>
Technologies/ Patient freedoms /Object movements	<p>To reach the highest level of the patient freedom in space to control the components of his or her environment is freedom of positions to: (1) opening the curtains and the windows, changing the TV channels, controlling the lightings, browsing the web sites, (2) checking the results of the analysis and treatment plan, (3) communicating with healthcare providers and managers to have more information about his or her health condition treatment, (4) giving the patient the opportunity to evaluate the designed hospital environments and its components as well as quality level of the provided medical service.</p>
Safety	<p>Giving the patient a sense of safety in the absence or impossibility for any AI occurrence in his or her designed environment can be achieved by providing all the safety tools, equipment and evacuation requirements and plans, which guarantees the patient safety in space.</p>
Security	<p>Providing a sense of security to patients in applying all security sectors designs. These sectors in designs involve security components, tools and requirements to protect patient from theft, infringement a harm. These considerations lead to reduce the fear of bad things or crimes could occur in patient spaces.</p>
Objects usage	<p>Limiting patient touches, movements to use or operate the environment components and objects to reduce infection spreading and physical efforts can be achievable by using the remote-control systems in opening the toilet door or using the toilet accessories such as, tissue paper, soap, sanitiser and hand dryer, that they should respond to patient without touching them.</p>

13.4.6 CONCEPT F: FLAWS IN DESIGN PROCESSES LEADING TO ISSUES IN DESIGN AND ATMOSPHERIC ASPECTS

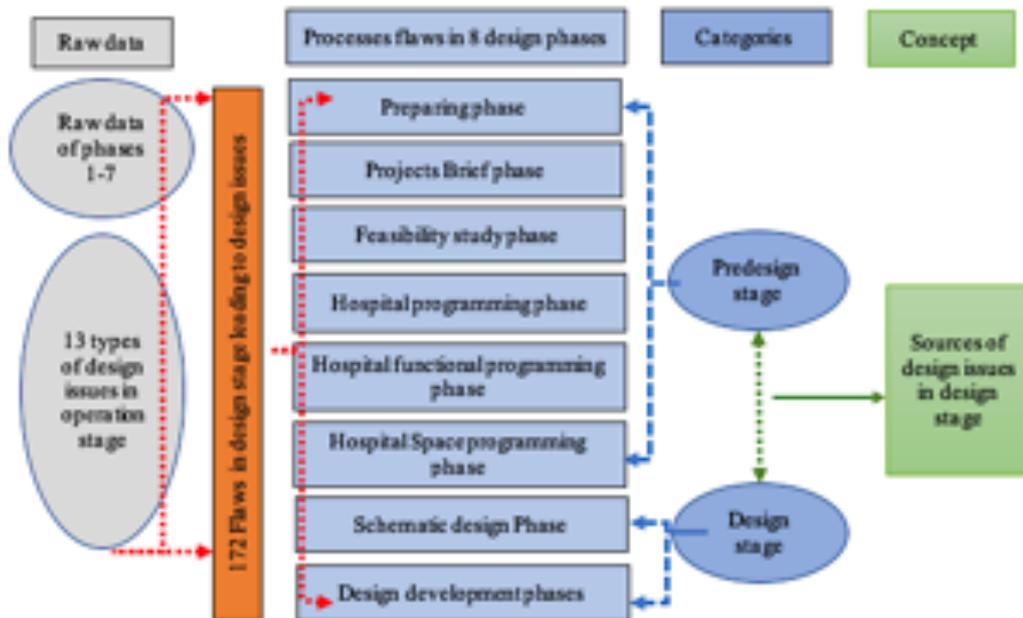
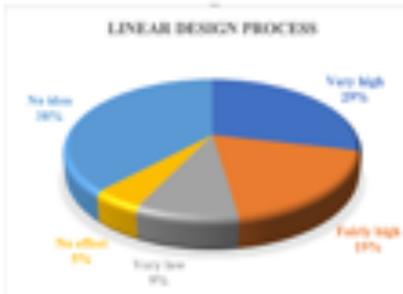


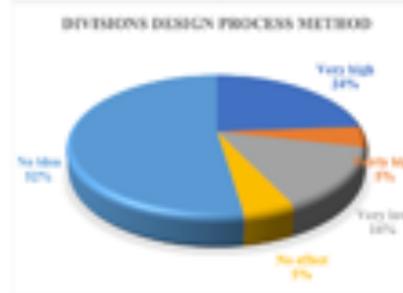
Figure 13. 34: key findings of sources of design issues concept in design stage

13.4.7 CONCEPT G: THINKING METHODS IN DESIGN PROCESS

G.1) THE DESIGN PROCESS METHOD								
Please indicate the level of effectiveness of the design process type, as listed below, that you use in order to solve design issues originated. NM*							Total	Mean
Type of the design process methods	Strengths and weakness of the design process method							
Linear design process	Quick to solve design problems, but the options are limited in all processes							
Effectiveness levels in solving design issues	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
	6	4	2	1	8	21	54	
Divisions design process method	Several options to solve design issues, but the test for a solution is not available in all processes							
Effectiveness levels in solving design issues	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
	5	1	3	1	11	21	36	
Controlled design process	Several options to solve design issues, but the design problem may not be fully understood							
Effectiveness levels in solving design issues	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
	3	2	4	0	8	17	17	
Cycle design process	There are many options to solve design issues, but it focused on preparing the programming stage							
Effectiveness levels in solving design issues	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
	3	0	2	0	8	13	16	
Investigative design process	Unified solution for the design issues, but it is depending on all inputs of the available responsible parties							
Effectiveness levels in solving design issues	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
	4	3	3	0	9	19	4	
						93		

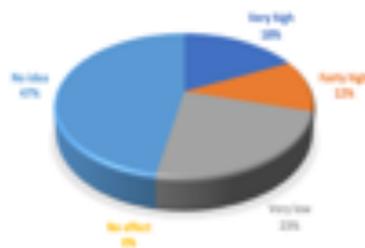


The chart pie above shows in percentage the ranking effectiveness levels of Linear design process methods on solving design issues. It is clear that 38% / almost two-fifth of respondents have no idea about the effectiveness levels in this design process method and a very small number, 5%, believe that this method has no effect to solve the design issues. Almost a third/29% of them believe that this method has very high effect. Nearly one in ten of participants believe that this method has low effect. Almost a fifth/19% of them believe that this method has fairly high effect on the design issues. Overall, this method was ranked as very high effect with 29% and fairly high effect with 19% as a quick method to solve design issues, but 9% think it has a low effect and 5% think it does not have any effect because the options of solutions are limited in this method. No idea choice is highest level of responses, because the majority of the participants work in occupancy stage as member of maintenance teams and it is observed in the next questions.



The chart pie above shows in percentage the ranking effectiveness levels of Divisions design process method on solving design issues. It is clear that more than half (52%) of participants has no idea for the use of this method. Almost a quarter (24%) of them believes that method has very high effect on solving design issues, and less than a fifth (14%) believes it has very low effect. Only 5% of participants think that it has fairly high effect, but with same percentage, they believe that it has no effect on design issues to be solved. Overall, this method was considered as very high effect with 24% and fairly high effect with 5%, because this method provides several options to solve design issues, but 14 of participants consider this method with very low and no effect for the difficulty of testing all provided solutions.

CENTRALIZED DESIGN PROCESS



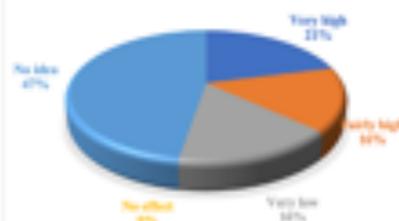
The chart pie above shows in percentage the ranking effectiveness levels of Centralized design process method on solving design issues. It is clear that 23% / less than a quarter of respondents believe that method has very low effect. But, almost a fifth/18 of them considered it as very high level of effectiveness, and less than a fifth believes that has fairly high effect. The majority of them do not have any idea if this method has effect or not. Over all, this method considers as very high and fairly high effective way, because it presents several options to solve design issues, but it considers as very low effective method because the design issues may not be fully understood from one-point view.

CYCLE DESIGN PROCESS



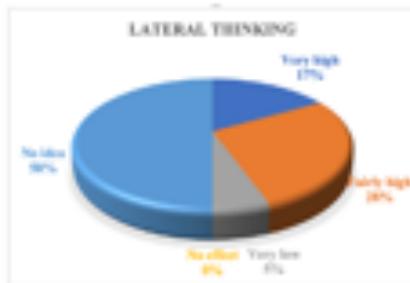
The chart pie above shows in the percentage of the effectiveness levels ranking of cycle design process method on solving design issues. It is clear that 33% / more than a third of respondents considers this method with very high effect, but 13%/less than fifth of them believe that method has very low effect. Over all, excluding the maintenance teams responds; this method considers with very high level of effectiveness, because it produces many options to solve design issues, but 13% of them believes that it has very low effects because its focus is only for preparing the space programming stage.

INVESTIGATIVE DESIGN PROCESS



The chart pie above shows in percentage the effectiveness ranking levels of investigative design process methods on solving the design issues. It is clear that 21% / more than fifth of respondents considers this method as very high effect, 16%/less than fifth believe that it has fairly high effect. But, 16%/less than fifth believe that it has very low level of effectiveness. Over all, this method has very and fairly effect to deal with design issues, because it provides unified solution, but it is depended on all inputs of the available responsible parties, so 16% of participants recognises it as very low effect

ON THE EFFECTIVENESS OF SOLVING DESIGN PROBLEMS THROUGH DESIGN THINKING STRATEGIES								
Please indicate the level of effectiveness of the design thinking strategies and techniques, as listed below, that use in the design process to solve design issues and to consider the healing process?								
Design thinking strategies	The options for solving design issues in term of design thinking strategies					Total	Mean	
Lateral thinking	Generating several solutions for a problem in comparison with other solutions to evaluate the appropriate solution							
	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
Effectiveness levels in solving design issues	3	5	1	0	9	18	56	
Visual thinking	Using drawing tools by a designer to communicate with the problem in mental images to solve it							
	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
Effectiveness levels in solving design issues	2	5	2	1	7	17	27	
Design standards thinking	Depending on the design principles and standards to engage in problem solving							
	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
Effectiveness levels in solving design issues	5	4	0	0	7	16	19	
Group discussions	Using the conversation with other designers, experts or interested people to solve the design problems							
	<input type="checkbox"/> Very high	<input type="checkbox"/> Fairly high	<input type="checkbox"/> Very low	<input type="checkbox"/> No effect	<input type="checkbox"/> Don't know			
Effectiveness levels in solving design issues	3	5	1	0	7	16	13	
						69		



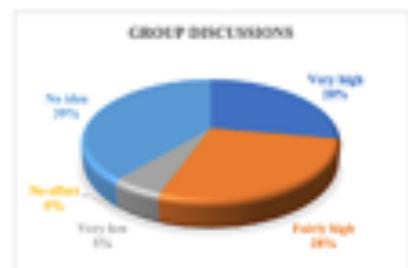
The chart pie above shows in percentage of the rated effectiveness levels of lateral thinking strategy to find the best design issues solution. It is clear that 17% / less than a fifth of respondents believes this strategy has a very high effect and Almost a third/28% of them believes that this strategy has fairly high effect. but 5% believe that this strategy has a very low effect to reach the best solution. A half of them have no idea if this strategy has or not any effect. Over all, this strategy was rated as a very high (17%) and fairly effect (28%), because it has ability to generate several solutions and evaluate them in comparison with other solutions to select the appropriate solution.



The chart pie above shows in percentage of the rated effectiveness levels of lateral thinking strategy to find the best design issues solution. It is clear that 17% / less than a fifth of respondents believes this strategy has a very high effect and Almost a third/28% of them believes that this strategy has fairly high effect. but 5% believe that this strategy has a very low effect to reach the best solution. A half of them have no idea if this strategy has or not any effect. Over all, this strategy was rated as a very high (17%) and fairly effect (28%), because it has ability to generate several solutions and evaluate them in comparison with other solutions to select the appropriate solution.

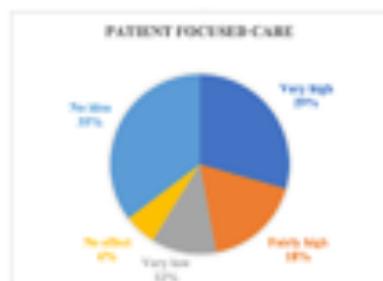


The chart pie above shows in percentage the ranking effectiveness levels of Design standards thinking as best way to reach most effective solution for the design issues. It is clear that 31% / of respondents consider this strategy as a very high effective way and 25 % of them believe that it has fairly high effect. But, 44% of them have no idea about this strategy. Over all, this strategy was ranked as very high effect with 31 % and fairly high effect with 25%, because it depends on the design hospital standards to engage in designer to choose the best solution.

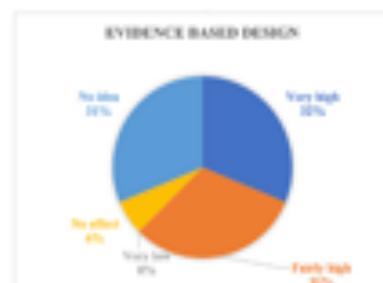


The chart pie above shows in percentage the ranking effectiveness levels of group discussions thinking strategy as best way to reach most effective solution for the design issues. It is clear that 28% /of respondents consider this strategy as a very high effective way and a fairly high effect with same percentage. Only 5% of them consider it as very low level of effectiveness. But, 39% of them have no idea about this strategy. Over all, this strategy was ranked as very high effect with 28% and fairly high effect with 28%, because this strategy uses the conversation with other designers, experts or interested people to implement the most valid solution.

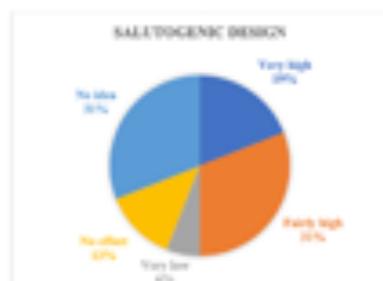
Q3 THE DESIGN PRINCIPLES								
Please indicate the level of effectiveness of hospital design principles in the design processes, as listed below, that influence hospital design environments to support the healing process?								
Hospital design principles	Factors and aspects of the design principles					Total	Mean	
Patient focused care	Supporting emotional support, physical comfort, information and communication flow, continuity and transition, care coordination, the involvement of family and carers, and access to care							
Effectiveness levels in solving design issues	<input type="radio"/> Very high	<input type="radio"/> Fairly high	<input type="radio"/> Very low	<input type="radio"/> No effect	<input type="radio"/> Don't know			
	5	3	2	1	6	17	3.6	
Evidence based design	Making hospitals safer and more healing for patients and better places for staff to work							
Effectiveness levels in solving design issues	<input type="radio"/> Very high	<input type="radio"/> Fairly high	<input type="radio"/> Very low	<input type="radio"/> No effect	<input type="radio"/> Don't know			
	5	5	0	1	5	16	3.7	
Subsidiary design	Creating an environment that stimulates the mind in order to create pleasure, creativity, satisfaction, and enjoyment, it is the relationship between health, stress, and coping							
Effectiveness levels in solving design issues	<input type="radio"/> Very high	<input type="radio"/> Fairly high	<input type="radio"/> Very low	<input type="radio"/> No effect	<input type="radio"/> Don't know			
	3	5	1	2	5	16	3.6	
Lean healthcare	Reducing waste and patient wait times, improving patient safety, lowering healthcare costs							
Effectiveness levels in solving design issues	<input type="radio"/> Very high	<input type="radio"/> Fairly high	<input type="radio"/> Very low	<input type="radio"/> No effect	<input type="radio"/> Don't know			
	4	3	3	1	6	17	3.6	
Hospital systems	Creating an environment for services delivery and for the commissioning teams to enable and initiate the services							
Effectiveness levels in solving design issues	<input type="radio"/> Very high	<input type="radio"/> Fairly high	<input type="radio"/> Very low	<input type="radio"/> No effect	<input type="radio"/> Don't know			
	5	6	0	2	5	18	3.8	
						84		



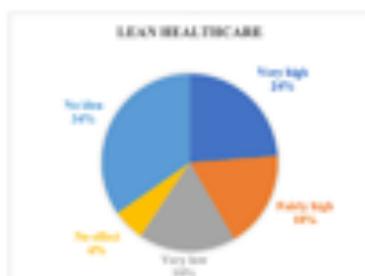
The chart pie above shows in percentage the effectiveness levels of patient focused care principle as main factor controlling designer thinking to design hospital buildings. It is clear that different 5 levels of effectiveness presented by the participants. 29% of them agree that this principle has very high effect and 18% believe that it can be considered with fairly high effect. But, 12% of them considered it with very low effect. Only 6% of participants agreed that principle does not have any effect in designing. However, 35% of participants admitted that they don't know about this principal usage in hospital designs. Over all, this principle was ranked as very high effect with 29 % and fairly high effect with 18% as important principle, because it is a way that respects and support the emotional and physical comfort for patient, and its focus involves patient family and the ease access to care.



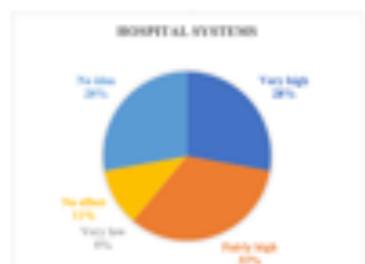
The chart pie above shows in percentage the effectiveness levels of patient evidence-based design principle as main factor controlling designer thinking to design hospital buildings. It is clear that different 5 levels of effectiveness presented by the participants. 32% of them agree that this principle has very high effect and 31% believe that it can be considered with fairly high effect. Only 6% of participants agreed that principle does not have any effect in designing. However, 31% of participants admitted that they don't know about this principal usage in hospital designs. Over all, this principle was ranked as very high effect with 32 % and fairly high effect with 31% as important principle, because it is a way that focus on safe and healing environment, and its focus involves a better place for staff to work



The chart pie above shows in percentage the effectiveness levels of patient salutogenic design principle as main factor controlling designer thinking to design hospital buildings. It is clear that different 5 levels of effectiveness presented by the participants. 19% of them agree that this principle has very high effect and 31% believe that it can be considered with fairly high effect. But, 6% of them considered it with very low effect. On other hand, 13% of participants agreed that principle does not have any effect in designing. However, 31% of participants admitted that they don't know about this principal usage in hospital designs. Over all, this principle was ranked as very high effect with 19 % and fairly high effect with 31% as important principle, because it is a way that focus on creating an environment to encourage the patient mind in order to create pleasure, creativity, satisfaction and enjoyment to cope the stress.



The chart pie above shows in percentage the effectiveness levels of patient lean healthcare design principle as main factor controlling designer thinking to design hospital buildings. It is clear that different 5 levels of effectiveness presented by the participants. 24% of them agree that this principle has very high effect and 18% believe that it can be considered with fairly high effect. But, 18% of them considered it with very low effect. On other hand, 6% of participants agreed that principle does not have any effect in designing. However, 34% of participants admitted that they don't know about this principal usage in hospital designs. Over all, this principle was ranked as very high effect with 24 % and fairly high effect with 18% as important principle, because it is a way that focus on reducing waste and patient wait time, and improving patient safety, and lowering healthcare costs.



The chart pie above shows in percentage the effectiveness levels of patient lean healthcare design principle as main factor controlling designer thinking to design hospital buildings. It is clear that different 5 levels of effectiveness presented by the participants. 28% of them agree that this principle has very high effect and 33% believe that it can be considered with fairly high effect. On other hand, 6% of participants agreed that principle does not have any effect in designing. However, 24% of participants admitted that they don't know about this principle usage in hospital designs. Over all, this principle was ranked as very high effect with 28 % and fairly high effect with 33% as important principle, because it is a way that focus only on healthcare services delivery and provision.

13.5 CONCEPT H: PHASES FLAWS OF DESIGN STAGES

13.5.1 PROCESSES FLAWS OF PREDESIGN PHASES (INPUTS)

Table 13. 67: Flaws in the preparing identification processes

Phase 1: The preparing identification processes flaws caused by the owner (projects administration at MOH/regions), that led to the design defects and faults in the occupancy stage:

- 1 Data and information in the requesting and designing of a new hospital to solve the current design defects and faults with the existing hospital or consider the current design features.
- 2 Hospital needs descriptions to deal with new disease and illness cases requirements to provide the perfect treatment and diagnosis plans within spaces and with equipment.
- 3 Future planning requirements to accept more patients and provide a new technology for the treatment and the diagnosis plan requirement.
- 4 Hospital design principles to support the healing processes of patients in addition to providing high quality the medical care services.
- 5 Medical services scope to avoid the changes during the construction and the operation stages that lead to an inability to extend or provide new required medical services.
- 6 Therapeutic or diagnostic plans for the ability to serve certain patients with specific disease, illness or health problems.
- 7 Land and location selection criteria to ease reach and access to the land location.
- 8 The number of served patients to save patient time to be diagnosed or treated

Table 13. 68: Flaws in the hospital projects brief processes

Phase 2: The hospital projects brief processes flaws caused by the owner (projects administration at MOH/regions) that lead to the design defects and faults in the occupancy stage:

- 1 Justifications and significations for hospital needs in the flexibility to extend the current hospital vertically, horizontally or both and in the accessibility to healthcare services for all types or groups of patients.
- 2 Hospital project objectives to include new, advanced medical equipment, controlling the current disease, reducing the adverse incidents and supporting the healing process.
- 3 Desired outcomes to decrease: the transformed disease cases from hospital to others or to other countries, the pressure on hospital services and the prolonged stay of patients and to support healing process
- 4 Identifications of the risks and the constraints to select suitable lands considering the changes in climate conditions, the soil type and land location and how to manage the medical and non-medical waste flows.
- 5 The hospital budget estimation to avoid some missing medical care services requirements in the services scope of hospitals during the previous process that lead to additional cost later.
- 6 The project duration estimation due to missing some necessary future tasks, such as modifying the site, equipping and finishing, which lead to less quality and more errors during the construction and delivery stages because the construction contractors need to achieve the implementations date faster with accomplishing the missing tasks.
- 7 Inviting interested participants, such as healthcare providers and maintenance and construction workers and equipping contractors to define and achieve the maximum of hospital requirements, demands and needs.
- 8 Data and information collection for hospital designs requirements. This data collection should be provided by design teams as part of their responsibilities in these processes because the current data is provided by administrative employers who are unqualified to collect data.

Table 13. 69: Flaws in the feasibility study processes

Phase 3: Feasibility study processes (outputs of previous processes inputs) flaws caused by the design team/consultant offices (at MOH/regions), that lead to the design defects and faults in the occupancy stage:

- 1 Site analysis to study the impacts of sunlight, green areas around the site, fresh air flow, noise level and amount of rain on the hospital building and patients' health.
- 2 Heliport required for urgent evacuation of patients.
- 3 Studies of the impacts of designed environments issues or features, in the occupancy stage, on the psychological and the physical healing process of the patient.
- 4 Scope services identified to define the initial and future requirements of the medical care services spaces designs while supporting the recovery process in the predesign processes.
- 5 Types of the data collection to identify the geographic and the meteorological data in each region, as way to create healing environments.
- 6 Copying and pasting the designs and specifications of the existing hospitals to other regions, leading to copying the current defects and faults in designs occurring in treatment and diagnosis plans, requirements and technologies.
- 7 Space and its programming requirements to achieve the high level of the efficiency in the function of the spaces within the supporting areas requirements in the hospital designs.
- 8 The selected size of the lands and the hospitals to accept the future expansion and to deal with the growth in patient numbers and the additional medical and non-medical care services.

Table 13. 70: Flaws in Hospital building programming processes

Phase 4: Hospital building programming processes flaws caused by the design team/consultant offices (in MOH/regions), that lead to the design defects and faults in the occupancy stage:

- 1 Presentation of program goals to present the wishes, dreams, expectations, aesthetics and the therapeutic design factors supporting the physical and psychological health of patients within the atmosphere designs aspects.
- 2 Contributions required, in these processes, by the interested participants to accurately present the functions, needs and requirements in spaces to achieve maximum demands for providing complete medical care services.
- 3 Identifying the specific design elements to meet the beliefs, culture, history and tradition conditions in Saudi.
- 4 Flows and circulations required in hospital spaces to minimise crossing points within the movement of patients, healthcare givers, waste and supplies (dead and living objects), vertically and horizontally.
- 5 Considerations required to present the religious elements in the design through specifying the spaces and the tools to perform the worships.
- 6 Hospital budgeting estimations because the budget sources are not available in hand and it needs time to be approved through many administrative processes and procedures.
- 7 Hospital schedule estimation leads to establishing and operating the hospital on specific time without full functions, due to excluding some work and equipment in diagnosis and treatment plans spaces.
- 8 Criteria selection for design teams, construction and maintenance contractors to meet the high level of experience, background, technical knowledge, financial position and reputation in designs and construction fields in in healthcare facilities design.

Table 13. 71: Flaws in hospital building functional programming processes

Phase 5: Hospital building functional programming processes flaws caused by the design team/consultant offices (in MOH/regions), that lead to the design defects and faults in the occupancy stage:

- 1 Supporting and main spaces required to provide adequate number of spaces for the medical units, clinics, diagnostic and testing and supporting spaces, such as the janitorial, the medication and the clean and the dirty utilities rooms.
- 2 Activity assessment required to identify the infection controls, communications and critical systems and patients, visitors, users and medical staff volumes and activities within spaces.
- 3 Flexibility in the structural design to deal with the internal and external expansions in the future requirements or in the construction, operation and occupancy stages, in case of scope services changed.
- 4 Mechanical services spaces to easily move and access the patient bed to/in elevators, to avoid the generator noise and to increase the critical systems capacities in the future.
- 5 Circulation requirement to link between the clinical, treatment and diagnosis departments/units horizontally and/or vertically in the hospital buildings in short distance.
- 6 Future growth needs required to accommodate the new disease and illness cases, the increase in the staff, equipment, services, treatments and diagnoses plans and technologies number.
- 7 Flow planning required to consider the segregation, the distribution, the control and the discharge of the patients, equipment, supplies, medications, patient information and the waste movements.
- 8 Space assignment required to deal sufficiently with illness, disease, psychology case volumes in each region.

Table 13. 72: Flaws in hospital building space programming processes

Phase 6: Hospital building space programming processes flaws caused by the design team/consultant offices (in MOH/regions), that lead to the design defects and faults in the occupancy stage:

- 1 The patients type served to determine the medical treatment plans types, such as drug, chemical, radiation therapies and palliative care.
- 2 Required types, numbers, measures of the equipment to provide adequate areas and suitable conditions of critical systems services (e.g., AC) to prevent their breakdown.
- 3 Required volumes and the types of staffs working to provide the adequate spaces and size for free movements and to avoid the disruptions during the provision of the medical care services.
- 4 Capacity required for all critical systems (e.g., medical gas, ventilation and heating) in the future extension to deal with the new equipment, technology of diagnosis and treatment plans spaces.
- 5 Waste management data types and amounts required for studying and analysing the spaces to plan their circulations, flows for disposal and storage them and to limit the infection sources through minimising the crossing points with other circulations.
- 6 Interrelationships required between the spaces locations and emergency exists to deal with the patients' evacuation.
- 7 The number and location of nurse stations required to observe and serve specific number of patients directly.
- 8 Accessibility requirement to provide adequate and sufficient areas of spaces for comfort and ease of use to the patients and users.
- 9 Hospital budget estimation to review and check within the potential changes in the identified scope of medical care services in the previous processes.
- 10 Hospital schedule estimation to review and check within the potential changes in the identified scope services or additional tasks in the previous processes.

13.5.2 PROCESSES FLAWS OF DESIGN PHASES (OUTPUTS)

Table 13. 73: Flaws during Schematic design processes

Phase 1: Schematic design processes flaws caused by the design team/consultant offices that lead to the design issues

Lack of opportunities to correct predesign process flaws in the schematic design drawings (design processes outputs) consisting of site, floor, roof, hospital sections, elevations, critical systems, equipment, landscaping plans and illustration the function of spaces and specifications of materials, to avoid appearance of design issues, is because of flaws in:

- 1** Accurately sharing the relative sizes and the adjacencies for the functional spaces to be discussed and criticized for correction.
- 2** Limiting contributions and discussions with the interested participants outside the design team in the pre-processes of design stage to review the previous inputs.
- 3** Inadequate and unclear descriptions and justifications in the using and the selecting of specific standards to address the hospital spaces size precisely on the hospital design plans.
- 4** Showing the flows, the accessibilities and the circulations for the patient and his or her information and medical care services lines in planning from space to others on maps to realize the crossing points among them.
- 5** Presenting the local customs and religion as design elements on internal (walls) and external (elevations) designs on the maps to add or improve these elements.
- 6** Showing the future expansion planning to deal with future growth in the patients and medical and non-medical care services with the conditions of the selected land on the plans.
- 7** The low quality of the justifications presented for the selected material and systems specifications to meet patient health, safety and security standards.
- 8** Limiting review and re-define of the functionality, usability, adjacencies, security, safety and the aesthetics requirements in design plans before the final approval by community members.
- 9** Presenting the evacuation planning of patients from space to space or level to others for avoiding escape difficulties.
- 10** Presenting the components of patient environments, in which are reflected the considerations of the physical and psychological conditions of patients to know how much is evaluated.
- 11** Unclear justifications in selection of specifications for some of the materials and systems used to avoid the manipulations by construction and maintenance contractors.

Table 13. 74: flaws in the Design development processes

Phase 2: Design development processes flaws caused by the design team/consultant offices, that lead to the design defects and faults:

- 1 Layout of the architectural designs to present some measurements, dimensions, spaces names, finishes, furnishings, locations of some equipment and scale of drawings.
- 2 Layout of the equipment planning designs to present some equipment installation requirements, such as outlets, mechanical and electrical works, water sources and disposal of radiation waste.
- 3 Layout of the mechanical designs to present the smoke, the heating, ventilating, air conditioning zones and the pressure type in the space, the movement and treatment of the internal and external air in the hospital buildings.
- 4 Layout of the electrical designs to present some numbers and positions of lightings rods and dimensions of spaces between conductor cables (external protection), the links between the equipotential bending equipment, medical equipment and metallic parts on the plan.
- 5 Layout of the plumbing designs to present some of size, types and locations of the medial gas and the waste systems drainage grids.
- 6 Layout of the construction designs to present some of the allowable load limitations details.
- 7 Layout of the civil designs to present some of the roadways, sidewalks, exterior lighting, utility grid and future infrastructure expansion grid.
- 8 Layout of the life safety designs to present of occupancy loads areas, fire extinguishing locations, alarms and initiating devices, wall construction types, firefighting vehicles roads and evacuation planning.
- 9 Layout of the life security plans to present some access control points and surveillance systems zones.
- 10 Specifications writing in drawings and tables to be in an understood language, to select the materials criteria and to describe the spaces functions (and using specifications of existing hospitals buildings).

13.5.3 CONCEPT I: SOURCES OF FLAWS IN DESIGN PROCESSES

Table 13. 75: Administrative flaws in design stage

PART A: Administration flaws of the design/consultant offices team (in MOH/regions), that lead to design processes flaws in design stage:

Quality control programmes to define and reduce the design processes flaws produced and the design issues and faults in the occupancy stage.

Insufficient training for engineers and designers to deal with the healthcare facilities design requirements, standards, demands and the conditions of medical care services.

Experience and knowledge deficiency of designers and engineers in the designed hospital, building issues and requirements.

Hiring unqualified designers and engineers in the hospital designs fields of critical systems.

Education system deficiency of the design team where most of the participated designers in had not been assigned or given any chance to design one of the healthcare facilities during the university study journey in the KSA.

Low motivation and salary for design team (MOH) and delay in fees payments to consultant offices team.

Lack of experience in some of the responsible managers in some engineering fields in the design stages to review or define the design issues in the early stage of design.

Some responsible parties not considering the timeframe of the design process in estimating the hospital schedule.

Lack of some engineering fields required in design stages, such as medical equipment engineers, architects medical planning and life safety and security systems designers.

Lack of communications between the different departments in hospital design stages and others, especially between the study, design administration, the equipment and furniture administration, at MOH level and between engineering affairs in regions and general projects administration in the MOH.

Lack of written official letters involving the changes in the hospital scope of medical care services and requirements, by managers or designers, to review and examine.

Allowing interventions to modify the designs by unqualified managers in the hospital design requirements processes.

Table 13. 76: Design team abilities flaws during the design stage

PART B: Design team abilities flaws (in MOH/regions, that lead to design processes flaws in design stage:

- 1 Collecting data and information required for solving design issue strategies, to define design issues sources in the occupancy stage, to analyses issues and create multiple solutions by testing them.
- 2 Design thinking strategies include insufficient use of mental images, evaluation, group discussions and strategies to solve design issues.
- 3 Design knowledge due to lack of communications and feedback with patients and users to realise the needs and the requirements for selecting the best solutions.
- 4 Design skills in the ability to use some software, insufficient communication with other members, inability to imagine the solutions with reactions, opinions and senses of patients in space.
- 5 Some designers do not have enough confidence in their abilities to design the hospital buildings by themselves. Because of the fear of punishment for making mistakes, they are depending on the copy of existing projects or examples on the websites.
- 6 Selfishness in sharing information and data about the design of hospitals with new engineers and architects by some expert engineers.
- 7 The weakness of the personality of some engineers in the discussion and the defence for their design solutions provided to avoid the interventions from persons with high authority, but with low qualifications in the design components of hospital design.
- 8 Time management lead to expose designers to stress causing less pay attention to details in solving the design issues during the design process.
- 9 Limited abilities to convey and present the feelings, ideas and desires of patients' sensory systems to design elements in space graphically and imaginably.
- 10 Design process method used that depends on the available programming process data, not on the investigation method, that provides full understanding about the design issues.
- 11 Recognising the importance of inviting the interested participants from local community and hospital users to contribute in solving the design issues.

Table 13. 77: Lack or unavailability of data

PART C: a lack or unavailability of data and information that lead to design processes flaws in design stage:

- 1 The measuring and monitoring the signs and symptoms of the patient physically and psychologically
- 2 The methods, stages and equipment of diagnosing and treatment plans in spaces, such as clinical history (medical records), interview, physical and oral exam and diagnostic testing spaces such as laboratory and imaging apartments
- 3 The conditions and behaviours of the diseases and illnesses as cause of health problems within all space components and design
- 4 The way of the spreading, extending and cases number of current diseases, illnesses and viruses
- 5 The procedures, types and plans of the disease treatment such as drug, chemical, radiation, palliative care and surgery therapies
- 6 Predicting the course of the disease after and before it appears
- 7 The stages of follow-up for patients after main treatment: blood tests, imaging tests and physical exam
- 8 Type, size, gender, culture and health issues of patients
- 9 The movements lines of users, materials and equipment as contaminated or uncontaminated objects within corridors in hospital
- 10 Spaces functions and activities types and amount
- 11 Patient data and information movements

13.6 APPENDIX E: DATA COLLECTION TOOLS: STAGE 3: PHASE 1

13.6.1 PART A: QUESTIONNAIRE DESIGN

LR	P.O.	MM	P	HP	MD	A.S.
literature review	Participant observation	Medical Manager	Patient	Healthcare Providers	Design and Maintenance Teams	Archival study:

Table 13. 78: Sources of questionnaire statements

		Sources of Findings						
Research concepts definitions		LR	P.O.	MM	F	HP	MD	A.S.
Design Defects Adverse Incident	Added		*					
DDAAs types	Added	*			*	*		*
Design faults	Added		*				*	
DDAAs' impacts	Added	*		*	*	*	*	*
Physical impacts	Added	*			*	*		*
Psychological impacts	Added	*		*	*	*		
Design defects	Added	*	*	*	*	*	*	*
Design process flaws	Added		*			*		*
Design issues impacts in occupancy stage		LR	P.O.	MM	F	HP	MD	A.S.
Delivery the healthcare services	Added			*	*	*		
Adding new healing processes	Added			*	*	*		
Expanding the healing process	Added			*	*	*		
Increased cost and time	Added			*		*		
Patient escaping	Added					*		
Types of design field issues in the occupancy stage		LR	P.O.	MM	F	HP	MD	A.S.
Architectural design	Modified		*				*	
Construction design	Modified		*				*	
Mechanical design issues	Modified		*				*	
Civil design issues	Modified		*	*		*	*	
Life safety design issues	Added		*		*	*	*	
Life security design issues	Added		*		*	*	*	
Electrical design issues	Modified		*				*	
Specifications writing issues	Modified		*				*	
Equipment planning issues	Added		*				*	
Plumbing design issues	Added		*				*	
Hospital budget approved issues	Added		*				*	
Hospital schedule approved issues	Added		*				*	
Financial planning system issues	Added		*				*	
Predesign process (inputs) flaws		LR	P.O.	MM	F	HP	MD	A.S.
preparing identification processes flaws								
Justifications and significations	Added		*					
Hospital needs descriptions	Added		*					
Future planning requirements	Added		*					
Hospital design principles	Added		*					
Medical services scope	Added		*	*				
Therapeutic or diagnostic plans	Added		*	*			*	
Land and location selection criteria	Added		*	*			*	
The number of served patients	Added		*	*			*	
Hospital projects brief processes flaws		LR	P.O.	MM	F	HP	MD	A.S.
Hospital needs	Added		*	*				
Hospital project objectives	Added		*	*				
Desired outcomes	Added		*	*				
Identifications of the risks	Added		*	*				
Hospital budget estimation	Added		*	*				
Hospital duration estimation	Added		*	*				
Inviting interested participants	Added		*	*				
Data and information collection	Added		*	*				

Feasibility study processes flaws		LR	P.O.	MM	P	HP	MD	A.S.
Site analysis	Modified	*	*					
Heliport required	Added		*					
Designed environments issues	Added		*					
Scope services identified	Added		*	*		*		*
Types of the data collection	Added		*	*				
Copying and pasting	Added		*				*	
Space programming requirements	Added		*					
size of the lands and the hospitals	Added		*				*	
Hospital programming processes flaws		LR	P.O.	MM	P	HP	MD	A.S.
Presentation of program goals	Added		*				*	
Contributions required	Added		*	*		*	*	
Identifying the design elements	Added		*				*	
Flows and circulations required	Added		*				*	
Belief considerations required	Added		*				*	
Hospital budgeting estimations	Added		*				*	
Hospital schedule estimation	Added		*				*	
Criteria selection for design teams	Added		*				*	
Hospital functional programming flaws		LR	P.O.	MM	P	HP	MD	A.S.
Supporting spaces required	Added		*					*
Activity assessment required	Added		*					*
Flexibility in the structural design	Added		*					*
Mechanical services spaces	Added		*					*
Circulation requirement	Added		*			*		*
Future growth needs required	Added		*	*				*
Flow planning required	Added		*					*
Space assignment required	Added		*					*
Hospital space programming flaws		LR	P.O.	MM	P	HP	MD	A.S.
The patients type served	Added		*	*		*		
Types, numbers, measures	Added		*	*		*		
Volumes and the types of staffs	Added		*	*		*		
Capacity of all critical systems	Added		*	*		*		
Waste management data	Added		*	*		*		
Interrelationships among spaces	Added		*	*		*		
Number of nurse stations	Added		*	*		*		
Accessibility requirement	Added		*	*		*		
Hospital budget estimation	Added		*	*		*		
Hospital schedule estimation	Added		*	*		*		
Design process (outputs) flaws		LR	P.O.	MM	P	HP	MD	A.S.
Schematic design processes flaws								
sharing the functional spaces	Added		*				*	
Limiting contributions	Added		*				*	
Inadequate and unclear descriptions	Added		*				*	
Showing the accessibilities	Added		*				*	
Presenting the local customs	Added		*				*	
Showing the future expansion	Added		*				*	
low quality of the justifications	Added		*				*	
Limiting review	Added		*				*	
Presenting the evacuation planning	Added		*				*	
components of environments	Added		*				*	
Unclear selection of specifications	Modified	*	*				*	

Design development processes flaws		LR	P.O	MM	P	HP	MD	A.S
architectural designs	Modified	*	*				*	
equipment planning designs	Added		*				*	
mechanical designs	Modified	*	*				*	
electrical designs	Modified	*	*				*	
plumbing designs	Added		*				*	
construction designs	Modified	*	*				*	
civil designs	Added		*				*	
life safety designs & life security plans	Added		*				*	
Specifications writing in drawings	Modified	*	*				*	
Sources of process flaws: Administration flaws		LR	P.O	MM	P	HP	MD	A.S
quality control programmes	Selected	*	*				*	
Insufficient training	Selected	*	*				*	
Experience and knowledge	Added		*				*	
Hiring unqualified designers	Selected	*	*				*	
Education system deficiency	Added		*				*	
Low motivation and salary	Added		*				*	
Lack of experience	Added		*				*	
Timeframe of the design process	Added		*				*	
Unavailability of some fields	Added		*				*	
Lack of communications	Selected	*	*				*	
Lack of written official letters	Added		*				*	
Allowing interventions	Added		*				*	
Design team abilities flaws		LR	P.O	MM	P	HP	MD	A.S
Collecting data required	Added		*				*	
Design thinking strategies	Added		*				*	
Design knowledge	Added		*				*	
Design skills	Added		*				*	
Confidence in their abilities	Added		*				*	
Selfishness	Added		*				*	
Weakness of the personality	Added		*				*	
Time management	Added		*				*	
Limited conveying ideas in designs	Added		*				*	
Design process method used	Added		*				*	
Inviting the interested participants	Added		*				*	
Sensory Systems Reactions		LR	P.O	MM	P	HP	MD	A.S
Sight sense	Added				*	*		
Hearing sense	Added				*	*		
Smell sense	Added				*	*		
Touch sense	Added				*	*		
Taste sense	Added				*	*		
Physical effort	Added				*	*		
Healing design aspects		LR	P.O	MM	P	HP	MD	A.S
Spatial design	Added		*		*	*		
Luminous in design	Added		*		*	*		
Thermal in design	Added		*		*	*		
Audio in design	Added		*		*	*		
Social in design	Added		*		*	*		
Spiritual in design	Added		*		*	*		
Aesthetic in design	Added		*		*	*		
Technology in design	Added		*		*	*		
Safety & Security in design	Added		*		*	*		
Objects usage in design	Added		*		*	*		
Privacy in design	Modified	*	*		*	*		

5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1

5	4	3	2	1
5	4	3	2	1
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5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1

5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1

5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1

Thank you for completing these questions. The time and effort you have spent is greatly appreciated!
 Please send the completed questionnaire to abdullah@hrc.sa

13.6.2.2 PART A: QUESTIONNAIRE IN ENGLISH

Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process

"Welcome to our survey!"

Please read the following information carefully before answering the questions. Your responses are confidential and will be used for research purposes only. The information provided in this questionnaire is for research purposes only and will not be used for any other purpose.

Consent of Subject and Declaration for Participation with the Following: I have read and understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part.

Demographic Data:

Age	Gender	Education	Occupation

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1

CONSENT FORM

HREC Project Number: HRE2017-0607

Project Title: Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process

Principal Investigator: Associate Professor Monty Sutrisna, Head of Department, Construction Management Department

Student researcher: Abdullah Mohammed A. Al Ghamsi

Version Number: 07/09/2017

I have read, the information statement version listed above, and I understand its contents.

I believe I understand the purpose, extent and possible risks of my involvement in this project.

I voluntarily consent to take part in this research project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I understand that this project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007).

I understand I will receive a copy of this Information Statement and Consent Form.

Participant Name	
Participant Signature	
Date	
Site Name	

Declaration by researcher: I have supplied an Information Letter and Consent Form to the participant who has signed above, and believe that they understand the purpose, extent and possible risks of their involvement in this project.

Researcher Name: Abdullah Mohammed A. Al Ghamsi

Researcher Signature: _____

Date: _____

Note: All parties signing the Consent Form must date their own signature.

Please insert the following tick box at the top of your questionnaire.

I have received information regarding this research and had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part.

CONSENT TICK BOXES

<input type="checkbox"/> I do	<input type="checkbox"/> I do not	consent to being audio-recorded
<input type="checkbox"/> I do	<input type="checkbox"/> I do not	consent to date linkage
<input type="checkbox"/> I do	<input type="checkbox"/> I do not	consent to be contacted about future research projects that are related to this project
<input type="checkbox"/> I do	<input type="checkbox"/> I do not	consent to the storage and use of my information in future ethically-approved research projects related to this project

Towards Improving in Design Process of Public Hospitals in the Kingdom of Saudi Arabia to Fully Support Patient's Recovery Process

Demographic Data:

Age	Gender	Education	Occupation

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

Consent to participate in the survey:

I do	I do not
<input type="checkbox"/>	<input type="checkbox"/>

5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1
5	4	3	2	1

13.6.3.1 MEAN SCORES OF 15 RESEARCH AREAS OF DESIGN ISSUES IN OPERATION AND DESIGN STAGES

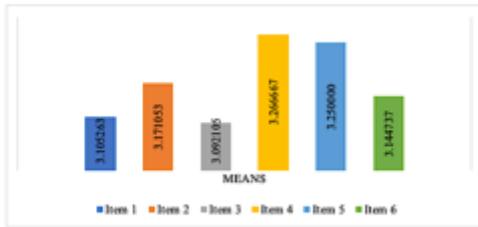


Figure 10.7: Mean scores of concepts of design issues in occupancy stage

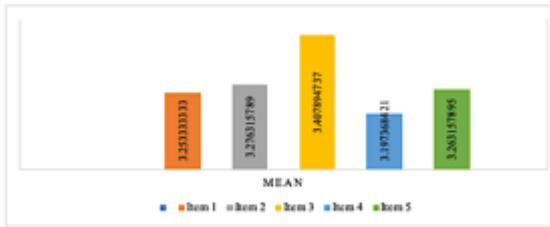


Figure 10.8: Agreement level on impact of designs on patient recovery and care services

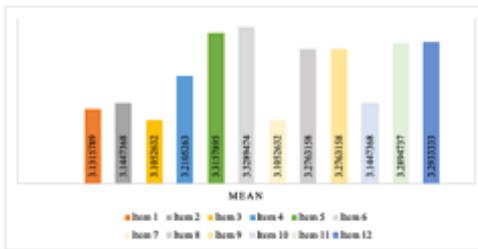


Figure 10.9: Mean scores of agreement level on the design fields types issues

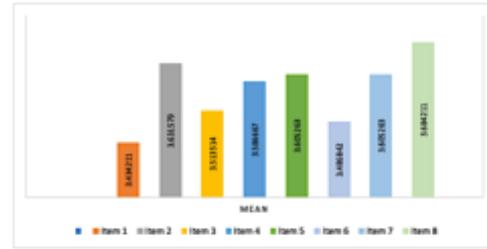


Figure 10.10: Mean scores of agreement level on the preparing identification processes flows

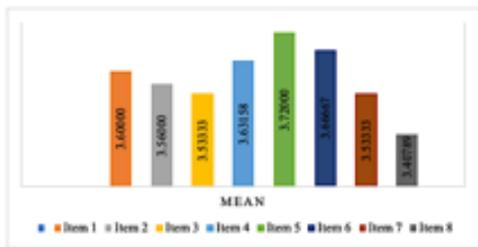


Figure 10.11: Mean scores of agreement on flaws in project briefing processes

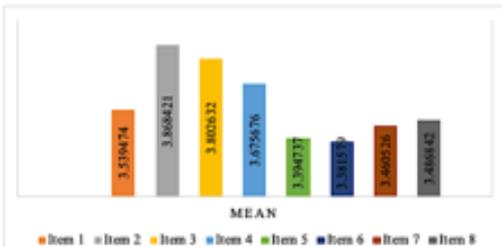


Figure 10.12: Mean scores of agreement level on flaws in feasibility study processes

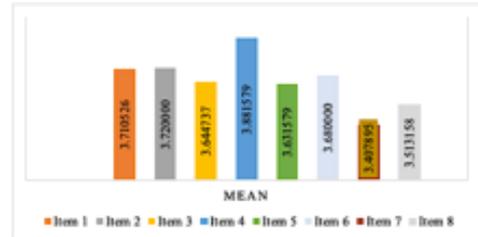


Figure 10.13: Mean scores of agreement level on flaws in hospital building programming processes

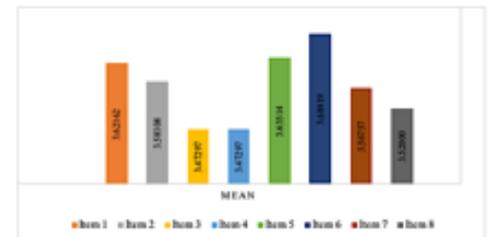


Figure 10.14: Mean scores of agreement on flaws in functional programming processes of hospital building

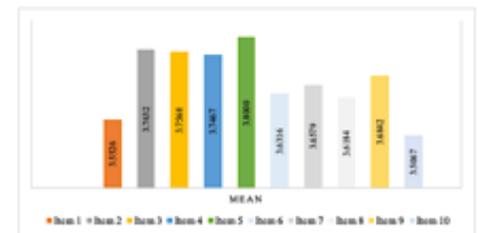


Figure 10.15: Mean scores of agreement on flaws in space programming processes of hospital building

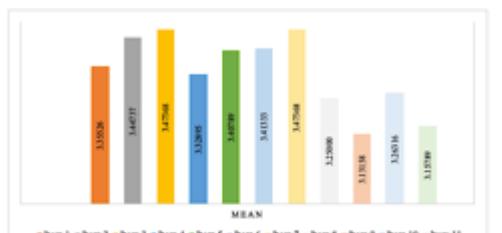


Figure 10.16: Mean scores of agreement level on the causes of flaws during the schematic design phase

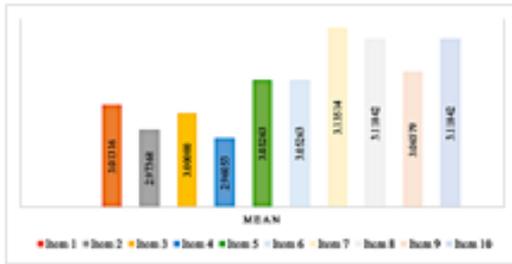


Figure 10.17: Mean scores of agreement level on the design development processes flows

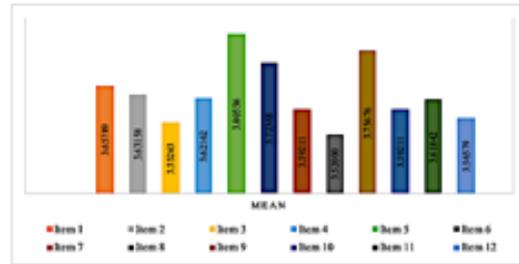


Figure 10.18: Mean scores of agreement level on the administration flows

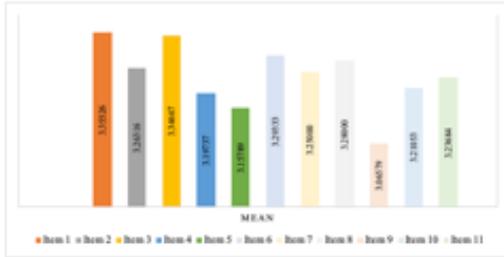


Figure 10.19: Mean scores of agreement level on the designer abilities flows

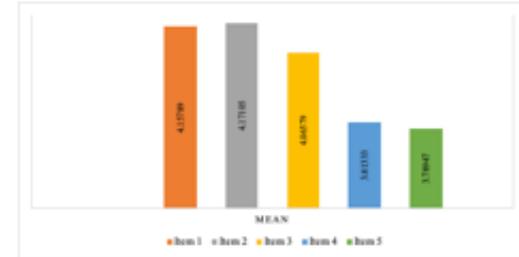


Figure 10.20: Mean scores of agreement level on the sensory systems reactions

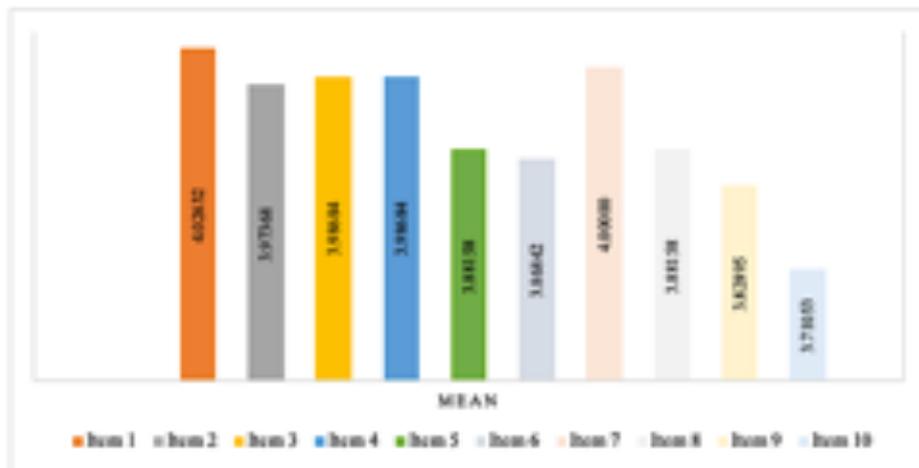


Figure 10.21: Mean scores of agreement level on the healing aspects in design

Pillar A: Part 2							Pillar A: Part 2									
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Total scores	Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Total scores		
Agreement level	Strongly Disagree	3	2	5	3	2	3	18	Agreement level	Strongly Disagree	4	4	2	3	2	15
	Disagree	15	15	10	9	11	12	72		Disagree	7	7	7	9	9	39
	Neutral	32	31	37	34	34	37	205		Neutral	40	37	36	40	38	191
	Agree	23	24	21	23	24	19	134		Agree	14	20	20	18	21	93
	Strongly Agree	3	4	3	6	5	5	26		Strongly Agree	10	8	11	6	6	41
Cases	76	76	76	75	76	76		Cases	75	76	76	76	76			
Mean	3.105263	3.171053	3.092105	3.266667	3.250000	3.144737		Mean	3.253333	3.276316	3.407895	3.197368	3.263158			
Standard Deviation	0.903016388	0.900194911	0.911813308	0.92024282	0.881286938	0.904860171		Standard Deviation	0.987671755	0.96053713	0.940604509	0.894721362	0.869765042			
Rank	5	3	6	1	2	4		Rank	4	2	1	5	3			
Weighted the mean	3.171637	Level						Weighted the mean	3.279614	Level						
Std. Deviation of mean	0.07297416							Std. Deviation of mean	0.07776991							
Variance	160.2	156.7	197.2	171.5	181.7	188.2		Variance	209	185.7	178.7	223.7	212.7			
sum of the item variances	1055.5							sum of the item variances	1009.8							
variance of total scores	4952							variance of total scores	3965.76							
# items	6							# items	5							
Cronbach's a	0.94422456							Cronbach's a	0.93171296							

Pillar B: Part 1														
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Statement 12	Total scores	
Agreement level	Strongly Disagree	8	6	9	5	5	4	7	4	6	5	6	6	71
	Disagree	10	9	7	8	6	8	9	7	7	8	5	5	89
	Neutral	29	35	33	36	35	33	36	34	29	39	33	34	406
	Agree	22	20	21	20	20	21	17	26	28	19	25	21	260
	Strongly Agree	7	6	6	7	10	10	7	5	6	5	7	9	85
Cases	76	76	76	76	76	76	76	76	76	76	76	75		
Mean	3.131579	3.144737	3.105263	3.210526	3.315789	3.328947	3.105263	3.276316	3.276316	3.144737	3.289474	3.293333		
Standard Deviation	1.099601204	1.002715611	1.078009862	0.984083865	1.022552705	1.011772806	1.040242887	0.91794966	1.014543368	0.933865763	1.004201699	1.036800345		
Rank	10	8	11	7	2	1	12	5	6	9	4	3		
Weighted the mean	3.21852339	Level												
Std. Deviation of mean	0.08693388													
Variance	95.7	155.7	135.2	169.7	157.7	138.7	152.2	191.7	147.7	210.2	167.2	153.5		
sum of the item variances	1875.2													
variance of total scores	17327.76													
# items	12													
Cronbach's a	0.97285155													

Pillar B: Part 1														
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Statement 12	Total scores	
Agreement level	Strongly Disagree	8	6	9	5	5	4	7	4	6	5	6	6	71
	Disagree	10	9	7	8	6	8	9	7	7	8	5	5	89
	Neutral	29	35	33	36	35	33	36	34	29	39	33	34	406
	Agree	22	20	21	20	20	21	17	26	28	19	25	21	260
	Strongly Agree	7	6	6	7	10	10	7	5	6	5	7	9	85
Cases	76	76	76	76	76	76	76	76	76	76	76	75		
Mean	3.131579	3.144737	3.105263	3.210526	3.315789	3.328947	3.105263	3.276316	3.276316	3.144737	3.289474	3.293333		
Standard Deviation	1.099601204	1.002715611	1.078009862	0.984083865	1.022552705	1.011772806	1.040242887	0.91794966	1.014543368	0.933865763	1.004201699	1.036800345		
Rank	10	8	11	7	2	1	12	5	6	9	4	3		
Weighted the mean	3.21852339	Level												
Std. Deviation of mean	0.08693388													
Variance	95.7	155.7	135.2	169.7	157.7	138.7	152.2	191.7	147.7	210.2	167.2	153.5		
sum of the item variances	1875.2													
variance of total scores	17327.76													
# items	12													
Cronbach's a	0.97285155													

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS													
Part C1													
C1: DESIGN PROCESS (OUTPUTS) FLAWS													
Phase 1: The preparing identification processes flaws													
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Statement 12	Total scores
Agreement level	Strongly Disagree	8	5	5	6	6	5	5	5	5	5	5	45
	Disagree	10	6	9	7	7	11	7	7	7	7	7	64
	Neutral	16	15	14	15	14	21	16	16	14	14	14	125
	Agree	25	36	35	31	33	20	33	31	31	31	31	244
	Strongly Agree	17	14	11	16	16	19	15	19	15	19	19	127
Cases	76	76	74	75	76	76	76	76	76	76	76		
Mean	3.434211	3.631579	3.513514	3.586667	3.605263	3.486842	3.605263	3.684211					
Standard Deviation	1.268443	1.081260	1.100974	1.163561	1.155612	1.205470	1.108500	1.145548					
Rank	8	2	6	5	3	7	4	1					
Weighted the mean	3.568444	Level											
Std. Deviation of mean	0.08291659												
Variance	44.7	155.7	138.2	100.5	117.7	48.2	122.2	109.2					
sum of the item variances	836.4												
variance of total scores	4841.2												
# items	8												
Cronbach's a	0.94540905												

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS													
C1: DESIGN PROCESS (OUTPUTS) FLAWS													
Phase 2: The hospital projects brief processes flaws													
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Statement 12	Total scores
Agreement level	Strongly Disagree	1	5	3	2	0	1	2	4	18			
	Disagree	12	8	12	11	8	13	13	12	12	89		
	Neutral	19	16	18	17	24	17	19	22	152			
	Agree	27	32	26	29	24	23	25	25	211			
	Strongly Agree	16	14	16	17	19	21	16	13	132			
Cases	75	75	75	76	75	75	75	76					
Mean	3.600000	3.560000	3.533333	3.631579	3.720000	3.666667	3.533333	3.407895					
Standard Deviation	1.03975049	1.117913114	1.119040773	1.068857399	0.96646472	1.106898923	1.0946224	1.10968221					
Rank	4	5	6	3	1	2	7	8					
Weighted the mean	3.581601	Level											
Std. Deviation of mean	0.09601099												
Variance	91.5	110	71	97.2	113	76	72.5	70.7					
sum of the item variances	701.9												
variance of total scores	4162.64												
# items	8												
Cronbach's a	0.95014977												

13.6.4 PART D: CRONBACH'S ALPHA TEST

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS										
C1: DESIGN PROCESS (OUTPUTS) FLAWS										
C1.3		Phase 3: Feasibility study processes flaws								
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Total scores	
Agreement level	Strongly Disagree	5	3	3	2	3	5	5	6	32
	Disagree	9	4	6	7	9	14	9	7	65
	Neutrally	21	16	19	21	28	19	23	26	173
	Agree	22	30	23	27	27	23	24	18	194
Strongly Agree	19	23	25	17	9	15	15	19	142	
Cases	76	76	76	74	76	76	76	76	76	
Mean	3.539474	3.868421	3.802632	3.675676	3.394737	3.381579	3.460526	3.486842		
Standard Deviation	1.182548541	1.037202716	1.107787427	1.021791445	0.980869646	1.18846798	1.136553732	1.194358082		
Rank	4	1	2	3	7	8	6	5		
Weighted the mean	3.57623578	Level								
Std. Deviation of mean	0.18519491									
Variance	59.2	138.7	101.2	104.2	132.2	45.2	70.2	72.7		
sum of the item variances	723.6									
variance of total scores	3906.16									
# items	8									
Cronbach's a	0.93114758									

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS										
C1: DESIGN PROCESS (OUTPUTS) FLAWS										
C1.4		Phase 4: Hospital building programming processes flaws								
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Total scores	
Agreement level	Strongly Disagree	3	2	4	1	2	0	3	4	19
	Disagree	7	8	10	8	8	8	13	11	73
	Neutrally	17	20	19	15	22	26	24	25	168
	Agree	31	24	19	27	28	23	22	14	188
Strongly Agree	18	21	24	25	16	18	14	22	158	
Cases	76	75	76	76	76	75	76	76	76	
Mean	3.710526	3.720000	3.644737	3.881579	3.631579	3.680000	3.407895	3.513158		
Standard Deviation	1.05597714	1.072506536	1.207796311	1.032370802	1.017737429	0.960855475	1.097605048	1.205469989		
Rank	3	2	5	1	6	4	8	7		
Weighted the mean	3.648684	Level								
Std. Deviation of mean	0.14181787									
Variance	119.2	90	64.7	122.2	109.2	117	69.7	71.7		
sum of the item variances	763.7									
variance of total scores	4154.96									
# items	8									
Cronbach's a	0.93279495									

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS										
C1: DESIGN PROCESS (OUTPUTS) FLAWS										
C1.5		Phase 5: Hospital building functional programming processes flaws								
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Total scores	
Agreement level	Strongly Disagree	6	2	7	4	1	2	2	2	25
	Disagree	10	11	8	10	7	10	8	8	72
	Neutrally	13	19	19	20	27	21	25	28	172
	Agree	22	26	23	27	22	21	24	23	188
Strongly Agree	23	16	17	13	17	21	15	14	136	
Cases	74	74	74	74	74	74	74	75		
Mean	3.621622	3.581081	3.472973	3.472973	3.635135	3.689189	3.567568	3.520000		
Standard Deviation	1.278941158	1.072786115	1.230023644	1.100721718	0.987238078	1.071750273	1.021429043	1.004853089		
Rank	3	4	7	8	2	1	5	6		
Weighted the mean	3.57006757	Level								
Std. Deviation of mean	0.07798406									
Variance	55.7	80.7	49.2	79.7	114.2	82.2	99.7	113		
sum of the item variances	674.4									
variance of total scores	3780.64									
# items	8									
Cronbach's a	0.93899143									

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS											
C1: DESIGN PROCESS (OUTPUTS) FLAWS											
C1.6		Phase 6: Hospital building space programming processes flaws									
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Total scores
Agreement level	Strongly Disagree	1	0	0	0	0	0	2	0	2	5
	Disagree	14	11	11	11	11	12	12	11	7	107
	Neutrally	18	16	13	22	16	19	22	19	25	28
	Agree	28	29	33	17	25	30	22	26	29	27
Strongly Agree	15	20	17	25	23	15	20	18	15	11	179
Cases	76	76	74	75	75	76	76	76	76	75	
Mean	3.552632	3.763158	3.756757	3.746667	3.800000	3.631579	3.657895	3.618421	3.684211	3.506667	
Standard Deviation	1.050647252	1.004900274	0.976586322	1.07920558	1.03975049	0.977644861	1.039905529	1.082800139	0.897560045	0.94972732	
Rank	9	2	3	4	1	7	6	8	5	10	
Weighted the mean	3.67179848	Level									
Std. Deviation of mean	0.09654517										
Variance	93.7	115.7	143.2	98.5	101.5	118.7	89.2	82.7	146.2	140.5	
sum of the item variances	1129.9										
variance of total scores	7894										
# items	10										
Cronbach's a	0.9520733										

PILLAR C		PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS											
Part C2		C2: DESIGN PROCESS (PROCESSES OUTPUTS) FLAWS											
C2.1		Phase 1: Schematic design processes flaws											
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Total scores	
Agreement level	Strongly Disagree	6	4	2	2	1	3	3	5	3	5	37	
	Disagree	12	16	16	19	16	13	15	19	16	15	175	
	Neutrally	20	15	17	21	20	21	18	22	29	23	235	
	Agree	25	24	26	20	29	26	23	20	16	20	17	246
	Strongly Agree	13	17	15	14	10	12	17	12	10	12	10	142
Cases	76	76	76	76	76	75	76	76	76	76	76		
Mean	3.355263	3.447368	3.473684	3.328947	3.407895	3.413333	3.473684	3.250000	3.131579	3.263158	3.157895		
Standard Deviation	1.174211195	1.204377979	1.113237731	1.124137096	1.008994636	1.07920558	1.160157279	1.121011448	1.099601204	1.111976271	1.096085539		
Rank	6	3	1	7	5	4	2	9	11	8	10		
Weighted the mean	3.33661882	Level											
Std. Deviation of mean	0.12169393												
Variance	54.7	51.7	73.7	61.7	110.7	78.5	55.2	60.7	80.7	62.7	81.2		
sum of the item variances	771.5												
variance of total scores	5690.8												
# items	11												
Cronbach's a	0.95087334												

PILLAR C: PREDESIGN STAGES PHASES PROCESSES FLAWS		C2: DESIGN PROCESS (PROCESSES OUTPUTS) FLAWS										
C2.2		Phase 2: Design development processes flaws										
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Total scores	
Agreement level	Strongly Disagree	15	15	16	15	13	12	11	11	10	10	128
	Disagree	15	15	11	14	13	14	11	13	17	14	137
	Neutrally	10	13	16	17	17	17	20	23	18	23	174
	Agree	26	23	23	19	23	24	21	14	20	15	208
	Strongly Agree	10	10	10	11	10	9	11	15	11	14	111
Cases	76	76	76	76	76	76	74	76	76	76		
Mean	3.013158	2.973684	3.000000	2.960526	3.052632	3.052632	3.135135	3.118421	3.065789	3.118421		
Standard Deviation	1.371066943	1.356207302	1.356465997	1.350958075	1.30531975	1.274307517	1.274881937	1.316227997	1.268442891	1.285478954		
Rank	7	9	8	10	5	6	1	2	4	3		
Weighted the mean	3.04903983	Level										
Std. Deviation of mean	0.06196037											
Variance	42.7	23.2	26.7	9.2	25.2	32.7	27.2	21.2	19.7	22.7		
sum of the item variances	250.5											
variance of total scores	1220.24											
# items	10											
Cronbach's a	0.88301391											

PILLAR D		PILLAR D: SOURCES OF PROCESS FLAWS												
Part D1		PART D1: Administration flaws												
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Statement 12	Total scores	
Agreement level	Strongly Disagree	4	4	6	5	3	4	7	4	2	4	2	3	48
	Disagree	9	12	12	11	8	9	7	13	7	8	9	10	115
	Neutrally	17	12	14	14	17	15	13	16	22	22	25	23	210
	Agree	25	28	22	21	16	24	32	24	19	23	20	21	275
	Strongly Agree	21	20	22	23	28	24	17	18	24	19	20	19	255
Cases	76	76	76	74	72	76	76	75	74	76	76	76		
Mean	3.657895	3.631579	3.552632	3.621622	3.805556	3.723684	3.592105	3.520000	3.756757	3.592105	3.618421	3.565789		
Standard Deviation	1.161064243	1.187064786	1.279528422	1.257336854	1.194339807	1.18432748	1.201972064	1.189594526	1.095580297	1.133462325	1.082800139	1.123512662		
Rank	4	5	11	6	1	3	8	12	2	9	7	10		
Weighted the mean	3.63651204	Level												
Std. Deviation of mean	0.08592843													
Variance	74.2	83.2	47.2	54.2	91.3	79.7	106.2	54	94.7	74.7	88.7	71.2		
sum of the item variances	919.3													
variance of total scores	7439.44													
# items	12													
Cronbach's a	0.95610422													

PILLAR D: SOURCES OF PROCESS FLAWS		PART D2: Design team abilities flaws											
Statement Code	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Statement 11	Total scores	
Agreement level	Strongly Disagree	4	4	3	6	5	6	4	5	7	4	5	53
	Disagree	8	9	10	8	9	7	9	6	9	7	7	89
	Neutrally	31	32	30	37	38	34	37	37	38	41	38	393
	Agree	23	25	22	15	17	15	16	17	16	17	17	200
	Strongly Agree	10	6	10	10	7	13	10	10	6	7	9	98
Cases	76	76	75	76	76	75	76	75	76	76	76		
Mean	3.355263	3.263158	3.346667	3.197368	3.157895	3.293333	3.250000	3.280000	3.065789	3.210526	3.236842		
Standard Deviation	1.015925816	0.957335484	1.006644591	1.058549156	0.980511861	1.112257667	1.008298897	1.02086344	1.011078979	0.928307269	1.004900274		
Rank	1	5	2	9	10	3	6	4	11	8	7		
Weighted the mean	3.2415311	Level											
Std. Deviation of mean	0.08336967												
Variance	128.7	156.7	117	159.7	183.2	127.5	166.7	173.5	177.7	232.2	183.2		
sum of the item variances	1806.1												
variance of total scores	15201.04												
# items	11												
Cronbach's a	0.96930434												

PILLAR E		PILLAR E: PATIENT SENSORY SYSTEMS AND HEALING DESIGN ASPECTS										
PART E1		PART E1: SENSORY SYSTEMS REACTIONS										
Statement Code		Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Total scores					
Agreement level	Strongly Disagree	0	0	0	4	5	9					
	Disagree	5	6	8	9	6	34					
	Neutrally	7	7	7	8	13	42					
	Agree	35	31	33	30	28	157					
	Strongly Agree	29	32	28	24	24	137					
Cases		76	76	76	75	76						
Mean		4.157895	4.171053	4.065789	3.813333	3.789474						
Standard Deviation		0.84935476	0.900194911	0.942840055	1.170508475	1.169795304						
Rank		2	1	3	4	5						
Weighted the mean		3.999509	Level									
Std. Deviation of mean		0.18552801										
Variance		246.2	228.7	207.7	128	108.7						
sum of the item variances		919.3										
variance of total scores		3538.16										
# items		5										
Cronbach's a		0.92521961										
PART E2		PILLAR E: PATIENT SENSORY SYSTEMS AND HEALING DESIGN ASPECTS										
PART E2		PART E2: HEALING DESIGN ASPECTS										
Statement Code		Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7	Statement 8	Statement 9	Statement 10	Total scores
Agreement level	Strongly Disagree	1	0	0	0	1	1	0	2	1	1	7
	Disagree	5	4	6	4	7	7	3	2	5	6	49
	Neutrally	11	16	16	15	15	12	13	21	21	24	164
	Agree	33	34	27	35	30	37	41	29	28	28	322
	Strongly Agree	26	22	27	22	23	19	19	22	21	17	218
Cases		76	76	76	76	76	76	76	76	76	76	
Mean		4.026316	3.973684	3.986842	3.986842	3.881579	3.868421	4.000000	3.881579	3.828947	3.710526	
Standard Deviation		0.937709041	0.848114524	0.945070312	0.840530325	0.992869313	0.942933087	0.765941686	0.951729727	0.95761033	0.94960749	
Rank		1	5	3	4	6	8	2	7	9	10	
Weighted the mean		3.914474	Level									
Std. Deviation of mean		0.098318034										
Variance		189.2	189.2	148.7	198.7	137.2	192.2	266.2	154.7	134.2	132.7	
sum of the item variances		1743										
variance of total scores		13006.8										
# items		10										
Cronbach's a		0.96221464										

13.6.5 PART E: SPEARMAN'S RANK CORRELATION COEFFICIENT

Design Issues Course						N					
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2	T					
						6					
						10					
3.16	3	3.03	5	-2	4	Rs	0.714	TS	2.9167	P	0.0434
3.16	4	3.19	3	1	1	df	4				
3.16	5	3.00	6	-1	1	L.C	90%				
3.28	1	3.25	1	0	0	p value	0.043				
3.25	2	3.25	2	0	0	a	0.050				
3.11	6	3.19	4	2	4	result	p<a	p#0			
Design issues Impacts in occupancy stage						N					
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2	T					
						6					
						14					
3.18	3	3.35	3	0	0	Rs	0.600	TS	1.8750	P	0.1341
3.25	2	3.31	4	-2	4	df	4				
3.39	1	3.44	1	0	0	L.C	90%				
3.18	4	3.22	5	-1	1	p value	0.134				
3.16	5	3.41	2	3	9	a	0.050				
Design fields types issues in occupancy stage						result	p<a	p#0			
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2	N					
						12					
						350					
3.32	4	2.88	11	-7	49	Rs	-0.224	TS	-0.7449	P	0.4734
3.25	10	3.00	8	2	4	df	10				
3.20	11	2.97	9	2	4	L.C	90%				
3.20	12	3.22	4	8	64	p value	0.473				
3.39	2	3.22	5	-3	9	a	0.050				
3.27	8	3.41	1	7	49	result	p<a	p#0			
3.32	5	2.81	12	-7	49						
3.27	9	3.28	2	7	49						
3.39	3	3.13	7	-4	16						
3.32	6	2.94	10	-4	16						
3.30	7	3.28	3	4	16						
3.40	1	3.16	6	-5	25						
Phase 1: The preparing identification processes flaws						N					
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2	T					
						8					
						48					
3.57	8	3.25	8	0	0	Rs	0.429	TS	1.2860	P	0.2458
3.84	2	3.34	3	-1	1	df	6				
3.67	5	3.31	5	0	0	L.C	90%				
3.77	4	3.32	4	0	0	p value	0.2458				
3.82	3	3.31	6	-3	9	a	0.050				
3.64	6	3.28	7	-1	1	result	p<a	p#0			
3.64	7	3.56	1	6	36						
3.86	1	3.44	2	-1	1						
Phase 2: The hospital projects brief processes flaws						N					
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2	T					
						8					
						128					
3.84	1	3.26	8	-7	49	Rs	-0.524	TS	-1.7682	P	0.1274
3.73	3	3.32	6	-3	9	df	6				
3.68	5	3.32	7	-2	4	L.C	90%				
3.73	4	3.50	4	0	0	p value	0.1274				
3.84	2	3.55	3	-1	1	a	0.050				
3.64	6	3.71	1	5	25	result	p<a	p#0			
3.44	8	3.66	2	6	36						
3.49	7	3.34	5	2	4						
Phase 3: Feasibility study processes flaws						N					
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2	T					
						8					
						42					
3.57	5	3.50	5	0	0	Rs	0.500	TS	1.6330	P	0.1536
3.86	1	3.88	1	0	0	df	6				
3.82	2	3.78	2	0	0	L.C	90%				
3.79	3	3.52	4	-1	1	p value	0.1536				
3.61	4	3.09	8	-4	16	a	0.050				
3.48	7	3.25	7	0	0	result	p<a	p#0			
3.36	8	3.59	3	5	25						
3.55	6	3.41	6	0	0						

Phase 5: Hospital building functional programming processes flaws							N	8				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	78				
3.84	1	3.30	5	-4	16	Rs	0.071	TS	0.1759	P	0.8662	
3.75	4	3.33	4	0	0	df	6					
3.66	7	3.20	6	1	1	L.C	90%					
3.70	6	3.13	8	-2	4	p value	0.8662					
3.73	5	3.50	1	4	16	a	0.050					
3.82	2	3.50	2	0	0	result	p<a	p#0				
3.82	3	3.20	7	-4	16							
3.61	8	3.39	3	5	25							
Phase 6: Hospital building space programming processes flaws							N	10				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	215				
3.75	8	3.28	9	-1	1	Rs	-0.303	TS	-0.9438	P	0.3729	
3.98	2	3.47	4	-2	4	df	8					
3.95	4	3.48	3	1	1	L.C	90%					
4.09	1	3.28	9	-8	64	p value	0.3729					
3.95	5	3.58	1	4	16	a	0.050					
3.82	7	3.38	7	0	0	result	p<a	p#0				
3.98	3	3.22	11	-8	64							
3.66	9	3.56	2	7	49							
3.86	6	3.44	6	0	0							
3.59	10	3.39	6	4	16							
Phase 1: Schematic design processes flaws							N	11				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	98				
3.45	6	3.22	8	-2	4	Rs	0.555	TS	2.4024	P	0.0397	
3.52	1	3.34	4	-3	9	df	9					
3.50	3	3.44	1	2	4	L.C	90%					
3.48	4	3.13	10	-6	36	p value	0.0397					
3.48	5	3.31	6	-1	1	a	0.050					
3.40	7	3.44	2	5	25	result	p<a	p#0				
3.52	2	3.41	3	-1	1							
3.20	8	3.31	7	1	1							
3.14	11	3.13	11	0	0							
3.20	9	3.34	5	4	16							
3.16	10	3.16	9	1	1							
Phase 2: Design development processes flaws							N	10				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	198				
3.091	2	2.906	9	-7	49	Rs	-0.200	TS	-0.5893	P	0.5720	
2.977	10	2.969	6	4	16	df	8					
3.023	6	2.969	7	-1	1	L.C	90%					
3.000	8	2.906	10	-2	4	p value	0.5720					
3.045	3	3.063	5	-2	4	a	0.050					
3.136	1	2.938	8	-7	49	result	p<a	p#0				
3.024	5	3.281	1	4	16							
3.000	9	3.281	2	7	49							
3.023	7	3.125	4	3	9							
3.045	4	3.219	3	1	1							
PART D1: Administration flaws							N	12				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	274				
3.80	3	3.47	7	-4	16	Rs	0.042	TS	0.1329	P	0.8969	
3.82	2	3.38	11	-9	81	df	10					
3.66	8	3.41	10	-2	4	L.C	90%					
3.73	5	3.47	8	-3	9	p value	0.897					
3.88	1	3.69	2	-1	1	a	0.050					
3.80	4	3.63	4	0	0	result	p<a	p#0				
3.68	7	3.47	9	-2	4							
3.64	9	3.35	12	-3	9							
3.70	6	3.83	1	5	25							
3.52	11	3.69	3	8	64							
3.61	10	3.63	5	5	25							
3.52	12	3.63	6	6	36							
PART D2: Design team abilities flaws							N	11				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	72				
3.36	2	3.34	1	1	1	Rs	0.673	TS	3.6866	P	0.0050	
3.34	3	3.16	6	-3	9	df	9					
3.41	1	3.26	2	-1	1	L.C	90%					
3.32	4	3.03	9	-5	25	p value	0.005					
3.27	9	3.00	10	-1	1	a	0.050					
3.32	5	3.26	3	2	4	result	p<a	p#0				
3.27	10	3.22	5	5	25							
3.30	6	3.26	4	2	4							
3.27	11	2.78	11	0	0							
3.30	7	3.09	8	-1	1							
3.30	8	3.16	7	1	1							
PART E1: SENSORY SYSTEMS REACTIONS							N	5				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	4				
4.23	1	4.06	2	-1	1	Rs	0.800	TS	3.8490	P	0.0310	
4.18	2	4.16	1	1	1	df	3					
4.07	3	4.06	3	0	0	L.C	90%					
3.77	4	3.87	5	-1	1	p value	0.031					
3.64	5	4.00	4	1	1	a	0.050					
						result	p<a	p#0				
PART E2: HEALING DESIGN ASPECTS							N	10				
MT	Rank	DT	Rank	DIFF (Y-X)	DIFF*2		T	166				
3.9091	3	4.1875	1	2	4	Rs	-0.006	TS	-0.0171	P	0.9867	
3.8864	4	4.0938	4	0	0	df	8					
3.8409	6	4.1875	2	4	16	L.C	90%					
4.0455	1	3.9063	8	-7	49	p value	0.987					
3.8864	5	3.8750	9	-4	16	a	0.050					
3.7727	7	4.0000	7	0	0	result	p<a	p#0				
3.9773	2	4.0313	6	-4	16							
3.6591	9	4.1875	3	6	36							
3.6364	10	4.0938	5	5	25							
3.7045	8	3.7188	10	-2	4							

