School of Civil and Mechanical Engineering

Globalisation of Engineers: African Professional Engineering Education Perspectives

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number ENG-40-14.

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Abstract

The concept 'globalisation of engineers' is related to developing engineers with competencies for working in international settings, a topic that has been explored in the literature for more than three decades. The concept, which arose in the Global North, includes training engineers who can integrate well in other contexts or those who can work effectively with people from other countries and cultures, (often this has been about working in developing countries in the Global South). This thesis raises the argument that the existing discourse for developing global engineers is founded on the Global North perspective of engineering education practice, and that this North to South bias raises questions about how globalisation should be understood in the Global South, and in particular as explored in this thesis, the African context.

Globalisation training is an important strategy for building industry capacity for self- sustaining economic development, which is important for African countries. But, the literature that proposes different approaches to developing global competencies, clearly shows lack of contributions from Africa, with the exception of South Africa and parts of North Africa. The thesis, therefore, addresses the relevance of the globalisation discourse to Africa. The main research question being: What is the relevance of the concept of globalisation of engineers to African engineering education? The four (4) research sub-questions are: What is the history and significance of the global engineer concept from an African perspective? How influential are existing local and international engineering education and accreditation systems in developing engineers in Africa that meet global standards? In what ways is current engineering education environment supportive or inhibitive to the development of African global engineers? What are the implications of the findings of sub-questions 1, 2 and 3 for the future of global engineering education in Africa?

A literature review of the current state of engineering education in Africa in relation to the globalisation discourse identified four main areas of discrepancies in engineering education practice between African (with a focus on the Sub-Saharan Africa) and the Global North contexts, which are curriculum and pedagogy, accreditation, professional body involvement and collaboration between countries and organisations. The discrepancies formed the impetus to understand the underlying contextual factors associated with differences, in an African engineering education system. This impetus led to application of qualitative research methodology, and social theoretical framework of Bourdieu.

Qualitative data in the form of transcribed interviews and focus groups, and documents were collected and analysed from Tanzania. Tanzania was selected as a case study of the African context because of its relevance to the context, accessibility of data and convenience. Bourdieu's theory of practice was selected as the theoretical framework to explain the nature of discrepancies between the North and South, because of its ability to explain practices within the social world and the reasons behind those practices. Data was hence analysed analytically through Bourdieu's framework, using the concepts of field, habitus, and capital, where engineering education practice was viewed as a field. The field concept allowed the identification of the possible positions (structure) that actors or agents entering the field can take. Those positions are defined by type and amount of capital (values) required to operate in them and the rules to obtain that capital.

The research was able to trace the dominated positions of African engineering education context in the field against the dominant position of the Global North context. The relationship between the contexts explains the domination of the Global North perspective in the field. Bourdieu's framework also provided the ability to examine engineering education practice and engineering practice as two separate fields, in order to explore the gaps in competence that are relevant for Africa, in terms of capital and behaviours (habitus). These fields were not found to have the same goals and capital, which is also a common finding in the engineering education literature from the Global North. However, what was particular to Africa, was the fact that on entering the industry, graduates are met with two working environments: the international one, that values competencies for engineering workplace; and a local one (local firms and projects) that valued marks (good performance). All this is relevant for considerations of the globalisation of engineering education in that it maps the position of an African engineer.

When it comes to the concept of 'globalisation of engineers', a Sub-Saharan African country like Tanzania finds itself at the dominated position in the engineering education field insofar as they cannot demonstrate program accreditation, nor do they have outcome-based engineering education. In order for African nations to improve their position in the field, they would need to either play by the Global North rules or to contend them. This is important but difficult to achieve for African institutions who have been struggling to be part of international mutual accreditation agreements such as the Washington accord. Strategies currently being tried include receiving guidance from the Global North and entering partnerships with other Southern countries.

In conclusion, the thesis provided an analysis of globalisation of engineers that is empirically and theoretically grounded, and considers the context in which the competencies are developed (in this case Africa) and applied in the workplace; which is in line with current recommendations from recent literature in developing engineers for practice.

This thesis makes theoretically- and empirically- based contributions to two areas: application of theory in engineering education research and developing engineers for practice. First, applying Bourdieu's theory provides a way of looking at engineering education as an area of social practice (field) that is influenced by different powers (economic, political, social etc.), and show that these influences differ widely between Global North and Africa. The dominant positions of the Global North context in engineering education is explained as is the dominated position of Africa and most of the Global South. Second, the thesis adds to the discussion around developing competencies for practice that is inclusive of the other contexts. Industry practice in any context can be viewed as a field using the lens of Bourdieu's and using the notions of capital, rules and habitus the gaps can be explained, where certain practices are explored in terms of field, capital and habitus in order to propose curriculum, accreditation and methods of teaching and learning, to that are relevant to industry.

Published Works by the Author Incorporated into the Thesis

1. Matemba, E., & Lloyd, N. (2019). *Constructing the Bourdieusian field of engineering education: Engineering education transformation as a field phenomena*. Paper presented at the Eighth Research in Engineering Education Symposium, 10-12 July, Cape Town. Available on https://www.sasee.org.za/wp-content/uploads/REES-2019-proceedings.pdf

   A version of this paper was partly incorporated in Chapter 6. The authors retain the copyrights of the paper.

2. Matemba, E., & Lloyd, N. (2017). Internationalization of Professional Engineers: A review of globalisation of engineering and accreditation- challenges from an African perspective. International Journal of Engineering Education (IJEE), 33(6), 2083-2097.

   Sections of this paper were partially incorporated as paragraphs in Chapter 2 and 3. A Table was also used in Chapter 3. Permission to use the material was obtained from the IJEE, who hold copyrights (see Appendix A).

Attribution of Authorship to jointly authored papers

Matemba, E., & Lloyd, N. (2019). *Constructing the Bourdieusian field of engineering education: Engineering education transformation as a field phenomena.* Paper presented at the Eighth Research in Engineering Education Symposium, 10-12 July, Cape Town. Available on https://www.sasee.org.za/wp-content/uploads/REES-2019-proceedings.pdf

	Conception and design of the project	Analysis and interpretation of research data and/or literature	Drafting significant parts of the work or	Critically revising work it so as to contribute to the interpretation	Total % contribution
Co- Author: Natalie Lloyd	15%	20%	35%	30%	25%
Co Author 1 Acknowledgement: I acknowledge that these represent my contribution to the above research output. Signed: Natalie A Lloyd Digitally signed by Natalie A Lloyd Date: 2020.05.29 16:56:55 +10'00'					

Matemba, E., & Lloyd, N. (2017). Internationalization of Professional Engineers: A review of globalisation of engineering and accreditation- challenges from an African perspective. International Journal of Engineering Education (IJEE), 33(6), 2083-2097.

	Conception and design of the project	Analysis and interpretation of research data and/or literature	Drafting significant parts of the work or	Critically revising work it so as to contribute to the interpretation	Total % contribution
Co- Author: Natalie Lloyd	10%	15%	35%	25%	25%
Co Author 1 Acknowledgement: I acknowledge that these represent my contribution to the above research output. Signed: Natalie A Lloyd Digitally signed by Natalie A Lloyd Date: 2020.05.29 16:57:29 +10'00'					

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Dedication

To my amazing husband Moses, and our children Melvin and Ethan who have believed in me, supported me and cheered me through the PhD journey.

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1.0 Introduction

The thesis presents doctoral research that explores the relevance of the existing concept developing global engineers to the African engineering education context. This first chapter introduces the thesis, providing an overview of the research including motivation, the perceived gap and research questions. Drawing from the perspectives of African participants with lived experiences, it aims to cultivate a deeper understanding of the contextual issues related to developing global engineers in Africa, and their implications. The chapter starts by introducing the context of the research which is focused around the discussion on 'globalisation of engineers'. The discussion is however mostly from the Global North[1] context with the growing incentive for the concept of globalisation for Africa, which is the Global South[2]. It sets up the argument for this research – which states: *the existing discourse on globalisation of engineers originates from the Global North perspective and may not be applicable to Africa.*

1.1 Context of the research

1.1.1 Understanding the term 'globalisation of engineers'

In the changing world that is fuelled by economic globalisation and revolution in information technology, engineering is becoming more complicated with the current engineering job market being multicultural, multidisciplinary and of changing global environments, therefore demanding engineers with broad skills beyond just their technical abilities (Hoyer, 2013; Nguyen, 1998; Sheppard, Macatangay, Colby, & Sullivan, 2009). The demand puts pressure on engineering education institutions to reform their programs in order to develop engineering graduates with transferable competencies that enable them to readily and proactively contribute to the global engineering community in a variety of processes and locations (Nguyen, 1998) – also known as developing global competence (Lohmann, Rollins, & Joseph Hoey, 2006; Parkinson, 2009).

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[1] The Global North "represent the economically developed and industrialised societies of Europe, North America, Australia, Israel, South Africa, amongst others." (Odeh, 2010, p. 338)

[2] Global South, previously 'Third World' refers to the regions of Latin America, Asia, Africa, and Oceania, where most countries are low-income economies and often politically or culturally marginalised, while the Global North (Dados & Connell, 2012).

‘Globalisation of engineers’ or globalisation of engineering education is therefore defined here to refer to the process of developing engineers with global competence, those who possess transferable competencies that enable them to practice effectively in the global working environments that the industry has become, as described in (Allan & Chisholm, 2008; Jesiek, Zhu, Woo, Thompson, & Mazzurco, 2014; RAE, 2007). Some of those transferrable competencies – often referred to as global skills or competencies, or competencies of the 21st century have been highlighted by number of researchers (Allan & Chisholm, 2008; Bourn & Neal, 2008; Chan & Fishbein, 2009; De Graaff, 2001; Hedberg, 2001; Nguyen, 1998; Parkinson, 2009) to include:

- high-level problem solving,
- team culture,
- multicultural awareness and communication
- creative thinking and innovation,
- entrepreneurship,
- critical thinking,
- ethics,
- lifelong learning, and
- research.

Those global competencies therefore are what define a global engineer. This definition of global engineer aligns with a global citizen definition that states:

> A globally competent person must be able to identify cultural differences to compete globally, collaborate across cultures, and effectively participate in both social and business settings in other countries. (Hunter, White, & Godbey, 2006, p. 283)

Note that the definition points out an integral notion of working across different cultures or in other countries, which is becoming more crucial for engineering work (Allan & Chisholm, 2009). This definition is supported by the definition of a globally competent engineer by Downey et al. (2006) who define global competence as *working with people who solve problems* *differently*. The concept of 'globalisation of engineers' therefore refers to the necessity to train engineers with skills and attributes to succeed in this complex engineering working environment the environment that has traversed borders and cultures – or global engineers. The discussion gained significance in engineering education in the late 20th century (Dodrige, 1999; Ibrahim & Cockrum, 1993) following some significant changes in the world caused by the emergence of globalisation and information technology (Vest, 2005). Since then, there has always been a general consensus in engineering education around the world that a global dimension is crucial to the future of engineering education (Burns & Chisohlm, 2011), because of the opportunities and challenges that the future job markets present.

There has been ambiguity in the meaning of the globalisation concept not only in engineering education but in the wider Higher Education (Cambridge & Thompson, 2004) since the concept started developing in the 1990s following development of global markets. The reason why the globalisation concept is ambiguous is because of how it has been used in the past by international education, businesses, and even governments to suit their own agenda (Hunter et al., 2006). Higher Education institutions from the Global North have used the term *global* in their curriculum to sell their programs with international content, and these institutions often promote their graduates as global citizens (Clifford & Montgomery, 2014; Rizvi & Lingard, 2010) for employability purposes. The concepts global skills, global competencies and the like have been used as a strategy for promoting engineering programs internationally in order to secure international students (Bourn & Neal, 2008). But this move is more related to internationalisation (Altbach & Knight, 2007, p. 290), rather than globalisation of education.

When it comes to international education, the two terms globalisation and internationalisation have therefore often been confused in Higher Education, because although the terms have different meanings, they are both responding to the effects of the globalisation. The ambiguity of the definitions has been explained by Cambridge and Thompson (2004) and also by Teichler (2004) where internationalisation of education is related to international comparative in education or comparison between education systems, while globalisation of education, a concept that has evolved from internationalisation of education, is related to education that can result to internationalism or global-mindedness. The latter explanation of global mindedness, which is also seen in (Bourn, 2011), is more relevant to the 'globalisation of engineers' that this research is attuned to, and therefore a global-minded engineer is referred to here as a global engineer.

1.1.2 Motivation for the concept of 'globalisation of engineers'

The concept of 'globalisation of engineers' was already prevailing around the world by the end of the 20th century. As introduced before, major reviews and transformations in engineering education worldwide occurred in the 1990s (Brown, 1998; Engineers Australia, 1996; Wulf, 1998; Yeargan & Hernaut, 2001). These efforts were motivated by industrial pressures for change in the end of the 20th century, in order to prepare for the competition in the 21st century, to meet "increasing demands on the education systems for the skilled people it needs to compete in global markets in the 21st century" (Mackenzie, 1999, p. 270). There were predictions that the effect of globalisation on engineering will increase rapidly in the next century and this incited discussions about how to develop the engineer of the 21st century (Ibrahim & Cockrum, 1993; Nguyen, 1998). The early discussions had a common motivation relating to building industry capacity to becoming or remaining competitive in the global markets for economic development.

Activities of the engineering education actors during this time shows the recognition of an important role of engineers in economic development by the government, Higher Education and engineering education society (Engineers Australia, 1996; Mackenzie, 1999; Wulf, 1998). For example, the foreword of the 1996 report *Changing the Culture: Engineering Education into the Future*, stated that "The contribution of engineers to society is critical to sustainable development, to responsible wealth creation and to international competitiveness." (Engineers Australia, 1996, p. 6). The report called for engineering education to be a frontrunner in addressing the new demands for competency for the global society, industry and market. Although the concept of 'globalisation of engineers' has recently developed into being about community and social issues such as poverty, climate change, and sustainability (Bourn, 2018); the main motivation has remained the global competitiveness for economic development responding to the changing job markets.

There are reports showing national debates and studies on the state of globalisation and the capability of engineering education to respond to these changing demands for engineers due to the global job market between the 1990s and the 2000s in particular from developed nations such as European countries (especially UK) (Brown, 1998; RAE, 2007)(Brown, levy, NAE), North America (US and Canada) (Grandin & Hirleman, 2009; Parkinson, 2009), Australia (Engineers Australia, 1996; King, 2008). The engineering education literature shows this common trend of responding to globalisation occurring in the Global North, as will be discussed further in the next chapter (Chapter 2). This however was not there in the Global South, particularly in Sub-Saharan African countries which, around that time of developments of the global markets, (1990s to 2000s) had not seen similar trends in engineering education. Therefore, before exploring the applicability of the concept of globalisation of engineers to Africa, this research tries to explain the value of the concept to Africa, in particular Sub-Saharan Africa.

1.1.3 The rationale for 'globalisation of engineers' in Africa

According to the discussion above 1.1.2, the main motivation for globalisation of engineers is building, retaining or improving industry capacity, in order to be competent in the global markets in the changing world (RAE, 2007), which is linked to building sustainable economic development of a country. On the same impetus of sustainable economic development, the engineering industry in Africa, which has recently become more globalised, feels the pressures for global competitiveness and the demands for engineers with global skills (UNESCO, 2010). A study in Africa has suggested that building global engineering capacity will enable African countries and regions to proactively engage in the global industry (Mhilu, Ilemobade, & Olubambi, 2008), for economic development (UNESCO, 2010). The job market for engineers in Africa is to a certain extent becoming global, meaning that engineers get employed by local and international companies. African engineers may now work for multinational companies, may work internationally, and may work with international engineers including other African nationals on projects within their countries. Engineering graduates in Africa are therefore faced with roles that require them to have global competencies.

In African countries, the significance of engineering education to its current industrialisation aspirations is increasingly apparent as it shows in the emerging discussion, which is centred on building industry capacity and the role of engineering for sustainable development. In a report on *Capacity Building for Africa Sustainability in Africa* (UNESCO, 2010), Botha (2010) explained that, African leaders (countries) gathered to discuss the need to build engineering capacity in order to take opportunities in the global market. The current developments towards improving engineering education to improve industrial capacity although contextual to African countries, resemble those in the UK, US, Canada and Australia in the 1990s and later in the early 2000s (Ibrahim & Cockrum, 1993). Further, in Africa, the situation is more urgent now because economic and social concerns for globalisation are even more close to home with more job markets opening up (Mhilu, Ilemobade, & Olubambi, 2008).

Economic development depends on the ability of nations to control and develop their industries and therefore the need for a strong local capacity. “Economic development, and indeed human development, can be stimulated by building the technical capacity of a work force through quality engineering education programmes” (Clinton & Jones, 2010, p. 313). There are calls for African engineering education to prepare an engineer that will take advantage of opportunities of globalisation (A-UK partnership & RAE, 2012; World Bank, 2014). Globalisation of engineering education is said to be even more imperative for African countries now because of the urgent needs to build local engineering capacity in order to match its aspirations of industrialisation, and the need to move their economies forward (Mhilu et al., 2008). The benefits in developing global skills for Africa are many, but the following are those that may have the most impact.

One benefit is that, global engineers will enable Africa to take advantage of the global working environment that exist in most African countries. In most Sub-Saharan African countries there is a competitive local market that includes international organisations, projects and opportunities as industries and services move from North to South. Economic globalisation is driving investments to Africa and therefore there is a need to prepare the local engineering capacity (Mohamedbhai, 2015) that is prepared for the global work environment. Other countries in the Global South, for instance countries in South Asia like India and Pakistan (Domal, 2010; Dossani & Kenney, 2007; Raju, 2001), are already taking advantage of the opportunities to work locally or remotely in multinational projects, with people from different cultures and countries from their own, through outsourcing. Outsourcing is not common in Africa, but there are other ways that job markets are opening up there, including opportunities in projects that promote sustainable development or humanitarian projects that seek solutions, which may require engineering expertise.

The most important benefit of globalisation of African engineers is its potential to build local capacity to solve local problems such as shortage of water, insufficient infrastructures, pollution and power shortages (A-UK partnership & RAE, 2012). There are opportunities to participate in large public projects for instance in the constructions and expansions of public utilities and infrastructure such as water, transport and electricity, that have resulted from growing populations and improvement of lifestyle (UNESCO, 2010). There are also more investment projects currently, particularly in mining, oil and gas, and expansion in infrastructure which includes investments and aid that are going into those expansions. There are also investments directed into solutions to poverty including pyramid markets, entrepreneurship, opportunities in application of computing, energy and bio-science technologies, which add opportunities for African engineers with global skills.

'Globalisation of engineers' is beneficial for sustainable development of Africa. Development of engineers has been often linked to developing skills for sustainable development. UNESCO (2010) and authors like Bourn (2018) particularly advocate global skills to be allied to sustainable development and claims that it has not been done enough. According to UNESCO Director-General:

> An estimated 2.5 million new engineers and technicians are required in Sub-Saharan Africa to achieve the Millennium Development Goals of improved access to clean water and sanitation. (Irina Bokova, UNESCO Director-General, Africa Engineering week 2015, in http://www.unesco.org)

Africa needs to improve its engineering capacity. Most importantly developing countries such as those in Africa, need engineers with global competencies or skills for the purpose of driving sustainable development in their countries by solving local problems and improving local problems (Mhilu et al., 2008).

But there is a big problem of engineering capacity in Africa and the problem is of quality as well as quantity as reported in A-UK partnership and RAE (2012). The low capacity of engineering is reported to be the cause of Africa's low industrialisation status (Mhilu et al., 2008), and therefore the need for globalisation.

Another benefit is that, the increased opportunity for mobility of African engineers within Africa and the world makes globalisation of engineers valuable for Africa. Engineering is a global profession with well-developed standards that are universally understood for instance ability to design a system, component or a process, as well as other technical skills specific to certain engineering disciplines (Bourn, 2018). The dropping numbers of engineers in other parts of the world such as the UK and the US due to low enrolments (RAE, 2007), means that there are opportunities for mobility of African graduate engineers to work outside borders in various countries in Africa and beyond. Although mobility is not an aspiration of African states as they are already struggling with brain drain (Kumar, Ochieng, & Onyango, 2004), it is an opportunity for individual engineers who want to explore markets outside their local realm.

1.2 The Problem and purpose

The main problem addressed by this research is in the existing discourse on 'globalisation of engineers' which focused on responding to the needs of the 21st century. That, *the existing discourse on globalisation of engineers originates from the Global North perspective and it may not be suitable for Africa*. Literature on engineering education for the 21st century (Allan & Chisholm, 2009; Altbach & Knight, 2007; G. Augusti, 2007a; Patil & Codner, 2007; Spinks, Silburn, & Birchall, 2007) have assessed the increasing opportunities, challenges and strategies for globalisation and have emphasized the necessity for transformation in engineering education in order to cope with the demands of the 21st century. The discussions (Chan & Fishbein, 2009; Hunter et al., 2006; King, 2008; Lohmann et al., 2006; RAE, 2007) have identified and evaluated generic competencies for global engineer or engineers of the 21st century (listed in section 1.1.1) that need to be developed by Higher Education and proposed how those competencies are to be developed and assessed.

The support for global competencies or competencies for the 21st century is evident from the literature on national and international accreditation for engineering education (G. Augusti, 2007b; Patil & Codner, 2007; Patil, Nair, & Codner, 2008). Further the global competencies have also been incorporated in accreditation standards of most developed nations for example USA (ASCE, 2010) and Australia (Engineers Australia, 2016). The competencies were used in accreditation to guide curriculum development process as an outcome-based education system. Some literature associated a global engineer to someone with competencies stipulated by accreditation, for instance the popular ABET criteria from the US was promoted as global (Lucena, Downey, Jesiek, & Elber, 2008). At some point standards stipulated by international accreditation systems such as the Washington Accord mutual agreement, were discussed as approaches to developing global competencies (Patil & Codner, 2007; Patil et al., 2008). Researchers in engineering education looked to accreditation and equivalence in order to develop what and engineering degree was worth in the global market.

The discussions that linked global accreditation and engineering competencies clearly show the domination of the USA's ABET criteria in the global scene of engineering education. At some point it was claimed that European educators and industrialist were in consensus that the competencies stipulated by ABET if achieved will result to global engineers (Hedberg, 2001). There was also a notion that, to be a global engineer, one may have to be a product of internationally recognised engineering education such as those that were accredited by Washington accord or ABET (Patil & Codner, 2007). Such proposals seem to make assumptions of the accreditation system in the Global North context especially in the USA, which until now is not spread in Africa as discussed in Chapter 2, Section 2.3.

From reviewing global engineer debate, it is clear that most of the literature going back to the mid-1990s, say pre ABET 2000 up to the recent times that has shifted more to humanitarian engineering, linking to the UN sustainable development Goals (Bourn, 2018), comes out of North America, and some from Europe, Australia and Canada, and other countries that represent the economic Global North region. You can see not only from what they say but from the approaches and programs that resulted from it, for instance Humanitarian Engineering program at Colorado School of Mines which comprises of courses such as Cultures in the Developing World particularly Africa and Asia, Latin America (Gosink, Lucena, & Moskal, 2003). Similarly, those programs that are linked to Engineers Without Borders (EWB) projects, reported in different articles (Amadei & Sandekian, 2010; Andrea & Brent, 2017), that it is all about the global North going to the Global South. Bourn (2018) confirmed to this Global North perspective or narrative of the global engineer concept. If this is what the existing knowledge is about then - how much attention should the Global South in particular Africa be paying to this and why? And what would be the consequences of following it or not following it?

Recent debates in engineering education have been about developing a proper definition of objectives and outcomes (competencies) (Jesiek et al., 2014; Johri & Olds, 2014; Walther & Radcliffe, 2007) and has been about observing practice and trying to fill the gap between engineering education and practice (Trevelyan, 2010a; Walther & Radcliffe, 2007). The researchers on developing engineering competence have highlighted the importance of a theoretically based and empirically grounded research in defining competence (Jesiek et al., 2014; Johri & Olds, 2014; Walther & Radcliffe, 2007). They have also raised the importance of considering the context in which the competencies are developed (or the learning environment) in relation to the context that they are applied (or practice), and therefore emphasised on the importance of studying practice or the engineering workplace (Johri, 2010; Johri & Olds, 2014; Trevelyan, 2010b). This conforms to the notion that argue that engineering education is a complex social learning space and it may take more than the traditional higher engineering education structure to achieve the expected goals of developing required competencies for practice (Litzinger, Lattuca, Hadgraft, & Newstetter, 2011; Sheppard et al., 2009; Walther & Radcliffe, 2007).

Whilst the available literature offers potentials in relevant approaches to developing global engineers, there is a noticeable lack of contribution of an African voice in those discussions. Literature also portrays a sense that collaboration between Global North and Global South is necessary for global transformation of engineering education. The concerns of lack of participation from the African and other Global South in important discussions on globalisation have been raised before (Ibrahim & Cockrum, 1993). Further, authors of larger international studies that focus on globalisation have sometimes admitted to not including Africa and other similar contexts (Ibrahim & Cockrum, 1993; Lucena et al., 2008). The concept of global engineer was criticized by Johnston (2001) for being controlled by the Global North narrative, and argued that the concept needed to be developed with more inclusivity of other contexts. Even when they have included an African perspective for instance in Patil and Gray (2009), the perspective was represented by South Africa, which exhibit a different context to most of the Sub-Saharan Africa due to its level of economy.

The few discussions available about African engineering education for 21st century or for globalisation, also show imposition of the Global North discourse to Africa. Most have settled on development of competence required for global engineers that will be used to guide curriculum design and development as well as accreditation systems (Mohamedbhai, 2015; UNESCO, 2010) the approach that is currently used in the Global North. The scattered discussions, mostly from studies that are motivated and funded by organisation such as World Bank, RAE, UNESCO and EHEA have often proposed approaches such as Tuning Africa (https://tuningafrica.org) CDIO Initiative for Africa (Mbanguta, 2004), which are replicated programs or procedures from the Global North, Tuning and CDIO (Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014; OECD, 2011). The initiatives although accessible world-wide and make efforts to be inclusive to all regions including Africa (Hahn & Teferra, 2013; Sackey et al., 2014), are assuming certain conditions of the Global North. This may be a problem similar to what was raised by others:

> Despite much talk about global interconnectivity and interdependence,
> international contact remains within globally differentiated cultural

> communities—the west versus the rest. (Rizvi & Lingard, 2010, p. 175)

> All too often these exchanges and experiences reproduce dominant notions of cultural superiority, and Intercultural dialogue becomes not true dialogue but a form of reproduction of cultural domination. (Bourn, 2018, p. 211)

So, whilst the approaches to globalisation proposed may seem promising and may have been successful in the Global North, there is still a need for a closer look into the practical implications of applying the discourse for developing global engineers from an African native point of view.

The purpose of this thesis is to explore the relevance of the concept of globalisation and the proposed methods/models to developing global engineers in Global South context, in particular the African context. Exploring this concept of development of global engineer from an African point of view will determine what the concept of globalisation means from that perspective.

1.3 Research Questions

The main research question of this thesis is:

What is the applicability and relevance of the concept of globalisation of engineers to African engineering education?

The research sub-questions are:

1. What is the history and significance of the global engineer concept from an African perspective?
2. How influential are existing local and international engineering education and accreditation systems in developing engineers in Africa that meet global standards?
3. In what ways is current engineering education environment supportive or inhibitive to the development of African global engineers?
4. What are the implications of the findings of sub-questions 1, 2 and 3 for the future of global engineering education in Africa?

In order to answer the above questions, the research examines the activities of main stakeholders of engineering education with the aim of analysing local context issues of developing global engineers in the Africa engineering education and recommend approaches/strategies of globalisation that are relevant to Africa. Since the research questions required a deeper understanding of the context in which stakeholders operate, a qualitative research approach was followed (Creswell & Poth, 2018; Denzin & Lincoln, 2008) applying case study methodology.

Qualitative research requires application of theory to explain the data (Borrego, Douglas, & Amelink, 2009; Koro ljungberg & Douglas, 2008). A theoretical framework based on Bourdieu's theory of practice (Bourdieu, 1977) is employed to analyse qualitative data collected in form of interview, focus groups and documents. Bourdieu's social theory that is focused on three main notions of field (social area of practice), capital (field's currency) and habitus (learnt behaviours), was selected because of its ability to analyse practices within the social world such as the engineering education practice in question. In this thesis it was used to explore the difference in practice between the African context and the Global North context of engineering education; and also between engineering education and industry in Africa. Bourdieu's theory of practice is explained in details in chapter 3.

1.4 Contribution of the thesis to knowledge

This thesis is making a theoretically and empirically based contribution on the situation of African engineering education from an African point of view, to the existing discussion of development of global engineers; where this perspective is not well represented. Through Bourdieu's theory which will be explained in detail in chapter 3, the research will provide a different way of looking at the global engineering education arena as a social area of practice (field) or a space of constant competition, where actors with different powers (capital) interact. This view of engineering education as a field, will expose how it is influenced by various external powers - economic, political, social, and so on - that manifest themselves through different influences with the strongest ones coming from Industry and Higher Education. The research will explore the contextual differences between the Global North and Global South, proving that when the engineering education field is viewed from different contexts, it offers different views for its players in terms of the capital that they can possess as well as the strategies that are available to them on the capital that - it is never a level playing field.

The assessment of the situation of African engineering education in the research will consequently contribute to two other areas. One of them is contributing an African concept to the developing discussion on developing engineers with competencies for the changing world – which often lacked inclusion of the global South and especially non-industrialised nations in the Global South. The contribution also adds to the discussions on engineering education in Africa that focus on issues like curriculum, accreditation and teaching and learning methods of which there is currently little represented in literature. Another area is the research on engineering competencies that looks at what engineers do in practice for instance work by Trevelyan (2010b), who collects view from industry on competencies that are required for practice. Like engineering education practice, industry practice is viewed using the theoretical lens of Bourdieu as field in its own rights and using the notions of capital, rules and habitus the gaps are explained.

1.5 Researcher's position

> All researchers bring value to the study, but qualitative researchers make their value known. (Creswell & Poth, 2018, p. 21)

As a qualitative researcher it is important that my philosophical position is known well in advance (Creswell & Poth, 2018). I put forth the discussion on my position as a researcher, so that my subjectivity is taken into consideration, as part of credibility (internal validity) and reflexivity. The discussion of my researcher's position here is also to account for reliability of the research– explaining that operations can be repeated (Yin, 2009) – although with certain conditions. Reliability of the findings will depend on whether the researcher has similar experience.

1.5.1 An African researching Africa

The research presented here originates from the area where I practice and used to practice, as Clough and Nutbrown (2012, p. 11) states "The need to research particular issues grows from the contexts in which the researcher operates". In that grain, I would like to declare my position as an African academic with experience working in an institution in Africa, now undertaking my research in an Australian institution. In my case my experience in curriculum reviews within my department and my quest to understand the process more in order to be able to contribute to the best outcomes from the training process led me to this journey of researching African engineering education. My experience and understanding of the context in question means that I can interpret the views of participants well (Creswell & Poth, 2018).

Relatively, in the article about *Reliability and validity in qualitative research within education in Africa,* Brock-Utne (1996) talks about the importance of African researchers to investigate African issues of education. This is because most education literature that researchers look into, has a ‘Western-centric’ feel, and therefore researchers are not able to get the views from Africa. The article adds that the feeling and experiences of the researcher should also be analysed if they themselves are African. That is why it is important to explain and describe myself as an African researching the Africa context, and also show that my position as an African influence the research, that I also have a lived experience.

Being an African, I have an advantage of being a local with local experience, which puts me in a good position as a researcher, for example when it comes to sourcing for participants and locating documentary information. I also speak the local or national language in Tanzania, Kiswahili and therefore it is easy for me to get around and also translate to English when required to, although this was not an issue since all the participants were also articulate in English language, since it is a common medium of communication especially in education and industry domains. I believe that being local made it easy for me to be acquainted with participants enough for them to open up to me, as I was perceived to be of similar position to them – no power imbalance.

1.5.2 My African Experience

I am a Tanzanian native born, raised and educated in Tanzania from primary to tertiary level. I am female academic, with 5 years’ experience working as an assistant lecturer at a highly ranked public University. I also had short experience of working in the Tanzania local industry in the capacity of an engineer, so I have some understanding of how the Tanzanian industry operates from my own experience to an extent that I can relate to the participants or to the procedures – so I can fill in the gaps in knowledge when required. Being from a developing country, I have lived experience of the work situations of a third world country, such as issues of economy and limited budget towards education and also therefore high dependency on external funding to run even the most critical activities. There is also the issue of lack of qualified human resources that is crucial to the economy. Like any other developing country, political and economic influences highly affect engineering education and Higher Education in general.

My own African perspective may be one that is tainted due to my experiences. The education system I obtained which follows the British system with English being the medium of instructions and using books and teaching materials that are written in English language. The questions, examples and demonstrations will mostly be from scenarios in the Global North. This is because there is no pure culture (isolated) especially when it comes to Africans due to our history of colonisation– as explained through Homi Bhabha's *Third Space and African identity* (Kalua, 2009).

> […] attempts at achieving an authentic African identity in terms of plenitude, regarding culture as pure and unalloyed, seem untenable […]. But the fact that Africa's identity is not fixed allows for a liminal view of the whole continent whose identities keep shifting in and out of ontological focus, intra- and internationally. (Kalua, 2009, pp. 29-30)

I wish to also acknowledge the influence that studying and teaching outside Africa, in Australian education system, may have altered my own African perspective. (Brock-Utne, 1996)talks about the need to acknowledge that even if I am one of them, my years of being away and maybe undertaking my research and engaging in academic activities in an Australian university, may have altered my perceptions of things. I may have a different view influenced by a Global North view of things from a different position. Being away for about 7 years, I have no doubt that my thoughts are very much influenced by what I call the Global North ideal of education, and maybe at times I myself may exhibit what I call a *Global North perspective* in my arguments. In terms of Bourdieu's theories, I can say that my habitus is partly influenced by the Global North ideals.

1.5.3 My Epistemological position

I began this research with the aim of creating my understanding of curriculum processes to see if there is a possibility of preparing a curriculum that can develop engineers who are able to practice in the global environment. I adopted a qualitative research approach which is contrary to my previous training of quantitative using modelling and laboratory experiments, and that with qualitative research I would need a theory or a lens to look into my data. Along the way I realised that the nature of my research questions required more than a focus on curriculum but on engineering practice, an area which is influenced by socio- economic, historical, and political factors, so I had to turn to the social theories of Bourdieu, which I found to be more suitable in explaining my analysis.

This new research direction which is more about social interactions, required a constructivist (interpretivist) approach (Creswell & Poth, 2018; Koro ljungberg & Douglas, 2008) to building understanding. I have gained experiences and training in qualitative research and Bourdieu's theory from workshops, consultation with experts and through doing, while working on this study as well as other qualitative studies in teaching and learning during the time of my PhD. Therefore I am now almost completely displaced from my previous positivist (Creswell & Poth, 2018; Crotty, 1998) thinking of research.

1.5.4 My subjective experience of engineering education practice

Trained and then lecturing in Tanzania at the same public university means my experience may be biased to the practices of one institution, the institution which is also the first and largest public university in Tanzania where most of the locally trained engineers are produced. Also, my experience with the university as a student and beyond to also being a female junior academic there means that I have a lived understanding of the *rules*.

As a junior lecturer in my department, I had an opportunity to attend Departmental curriculum review meetings and I recall not really understanding how the process worked which made it difficult for me to contribute. There was never any prior training or time to be acquainted to the process. In the meetings were discussions on the subjects or topics (content) that are important for a particular course usually lead by a more experienced academic like the head of department. For example, when discussing civil engineering course or program which was going from being specific to more general – the discussion was focused on what courses should be added or removed from the curriculum, and what I could see is academics (colleagues) arguing for the importance of their subjects to remain in the program. The major constrain was the maximum number of hours that students could take to complete the program. For example, when there was a need for a course called Ethics and Professionalism for Engineers was argued and the same for entrepreneurship course. These were added to final year as it was believed they were necessary for practicing in the industry.

My own confusion is what pushed me to this research to bring some changes and insights to the existing system or at least to bring understanding to someone who was at my position, hence the beginning of this research. Since then the research has developed into looking at curriculum for ‘globalisation of engineers’, as my position in an Australian institution allowed for a bigger prospect to look at and make a meaningful contribution.

1.6 Thesis arrangement

The thesis follows the set argument bringing an African perspective in globalisation, showing that the context from which African engineering education is structured, and the way it operates is different from that of the recommended globalisation discourse, the Global North perspective, and therefore how the discourse may be suitable or unsuitable for Africa. The thesis has nine chapter including this one (chapter one).

Chapter two explores the available literature to conceptualise the situation of engineering education in Africa, explaining the diversity of the African higher engineering education context and also the discrepancies that it has to the context of engineering education where globalisation concepts originate.

Chapter three unpacks the theoretical framework of Bourdieu that is used to analyse engineering practices reported in the data. The framework comes from Bourdieu's basic concepts of *field*, *capital* and *habitus* which are described and illustrated with examples from different areas of social practice.

Chapter four is an ethnographic chapter where I am taking the theory from chapter 3 to explain how it applies to engineering education in relation to my particular subject – 'globalisation of engineers'. It constructs engineering education as a field explaining through examples capital rules and habitus and how they relate, then sets up a stage for detail analysis of African contexts.

Chapter five describes how I have arrived at a Methodology; including selection of a case, methods of data collections and reasons. The chapter contains a pilot study that influenced the direction of the research. It explains how the data was analysed including the coding process. It also gives account ethical considerations made and how quality measures of transferability, reliability, credibility and reflexivity were considered in the research.

Chapter six is a results chapter where I present my findings in terms of Bourdieu's notions of field, capital and habitus. The findings show the analysis that resulted in establishing the position of African context in the global engineering education field constructed in chapter six which illustrate the difference in the global North and the Global South contexts. Using Tanzanian as a case, the findings also conceptualise the position of African engineering graduates in relation to industry.

Chapter seven presents the discussion of findings in relation to the particular topic of 'globalisation of engineers'. It brings together research questions (from chapter 1), and the theoretical questions (from chapter 4), where research question was addressed using the theoretical explanations.

Chapter eight, the Conclusion chapter, states the original contribution of the research to existing knowledge. It summarises the results of the research including answers to the research questions. It supports the results and point out the limitations of the research.

Chapter nine is a recommendations chapter where I give suggestions that have stemmed from my research. In this chapter I also suggest areas or avenues for further research, opening a discussion into different domains.

2.0 Contextualising engineering education in Africa

This chapter presents a literature review that was conducted in order to introduce engineering education in the African context. Part of the initial results of the review were published in a journal paper *Internationalization of Professional Engineers: A review of Globalisation of Engineering Education and Accreditation- Challenges from an African Perspective* (Matemba & Lloyd, 2017), in the International Journal of Engineering Education (IJEE). Since the publication, additional literature on African engineering education and Higher Education was reviewed and the arguments have evolved as will be seen in this chapter. The focus has changed to reflect the focus of this research which is 'globalisation' of engineers and not 'internationalisation' of engineers. In higher education, the two terms, globalisation and internationalisation, although related and both impact engineering education, differ in meaning (Altbach, 2015) as was explained in 1.1.1. This chapter therefore builds from the review (especially section 3 and 4) to bring an updated understanding of the state of engineering education in Africa, with permission from the chief editor (Appendix A).

2.1 The African context: Colonisation and diversity on education

The African continent is made up of 54 countries that makes it difficult to comprehend similar characteristics in the whole region. The 54 countries are usually categorised in several ways such as one being used by United Nations (https://unstats.un.org) that is into five regions: Eastern Africa, Western Africa, Central Africa, Northern Africa and Southern Africa (United Nations, 2020). Another common way, is dividing the continent into two regions, countries in the southern part of the Saharan Desert named Sub-Saharan Africa, and countries in the northern part of the Saharan desert named Saharan Africa. In addition to Regional categories or Sub-Saharan/Saharan, there is another common way that countries in the African continent are categorised, which is according to the languages that were leftover by their colonialists: Francophone, Arabophone, Lusophone and Anglophone Africa. The African context is therefore diverse with the continent presenting a broad variety of cultural, political, social, and economic situations, as well as Higher Education systems (Teferra & Knight, 2008), that impact engineering education practice.

Historically, Africa was colonised by different European nations and the residues of that colonial era is still visible in many areas including their education system. Although there are reports of original African education before colonisation, the existing education system in most countries -from primary to tertiary level- was set up by the colonialists (Teferra & Altbachl, 2004). These countries although later on took over their education systems when they gained independence, have not changed it much. The colonial influence on education is still ongoing with most countries still holding strong ties with their previous colonizers in terms of aid and funding in their education system (Teferra, 2008) when they gained independence. The influence is evident in the similarities that exist in the Higher Education systems for instance the Francophone African countries have similar education system to France, while most of the Anglophone African countries follow a British system, with some later changing to an American or a Canadian system (Case, Fraser, Kumar, & Itika, 2016; Teferra & Altbachl, 2004). The colonial histories of the countries, have resulted in a variety of education systems in Africa.

There is also diversity in local languages in African countries totals up to 2000 languages (Heine & Nurse, 2000), but this diversity in languages have not had a big influence in Higher Education (HE) because the languages that was used for instruction was the language of their colonisers which was adopted with the education systems (Teferra & Altbachl, 2004), for instance the East African countries that were colonised by the British used English while the West African countries used the French system.

2.2 The Sub-Saharan African region

For the purpose of this research, the discussion of the African context, will be narrowed down to the Sub-Saharan region or Southern Saharan Africa (SSA) – which includes 48 countries, divided into West African region, Central African region, East African region and South African region.

This research has focused on Sub-Saharan Africa because most of the countries in this region are in the low-income economies category (gross national income (GNI) per capita of USD 1,025 or less in 2018) according to data from the World Bank (The World Bank, 2020b). These countries are also in similar political as well as social positions, and therefore have similar issues in their Higher Education systems. Countries in the Northern part of the Sahara or the Northern Africa region (Algeria, Tunisia Egypt, Libya, Algeria, Sudan and Morocco) present a different landscape and different problems due to their different social political status, that usually exclude them from the generalisation for African contexts of higher education as seen in the literature (Materu, 2007; Teferra & Knight, 2008). According to (Teferra & Altbachl, 2004), most of the SSA countries with a few exceptions share similar history of colonialization, gaining independence around the year 1960s onward with Namibia being the last one to gain its independence in 1990. Only two countries, Ethiopia and Liberia, are known to have not been colonized although at times Liberia is said to have been colonised by the USA.

Apart from South Africa, Namibia, Botswana and Mauritius, the SSA countries are low-economy countries also known as developing countries, and therefore they are often dependent on external funding to subsidise most of the sectors, including education as further discussed, and referenced in section 2.2.1. Contrary, Northern African countries are mostly in the lower-middle-income and upper-middle-income economy categories, according to the World Bank (The World Bank, 2020b) with countries such as Morocco, Libya, Tunisia and Algeria are more aligned to the Middle Eastern countries and are sometimes included in discussions with Middle East and together called the MENA (Middle East and North Africa) region as seen in Abdulwahed, Hasna, and Froyd (2016). MENA countries share same situations in Higher Education such as rapid growth of institutions, and in particular institutions offering engineering in the past decade, due to growth in oil and gas industry (Abdulwahed et al., 2016).

The education systems in the Northern African countries are usually either aligned to Europe or the Middle East, for example Egypt which in 2015 was reported to have been preparing to match its system with Bologna process and adopt the European Union Standards (Schomaker, 2015). For instance, there is evidence of the European Union supporting the Northern African countries, Egypt, Libya, Tunisia and Algeria through the Tempus Programme that aims to modernise the countries Higher Education in areas such as quality control, relevance, and increasing capacity of Higher Education institutions, according to the European Commission (www.eacea.ec.europa.eu). This programme tries to develop voluntary harmonisation of participating countries with the Bologna process (Knight, 2014). So, the Northern Saharan countries although sharing the history of colonisation with the rest of Africa, present a completely different landscape and experience different challenges when it comes to Higher Education, this is due to their histories, economic, political and social-cultural environments, being different from the common history of most Sub-Saharan countries.

Due to that great diversity between the Northern African countries with the rest, this research focuses on countries in the Southern part of Sahara, Sub-Saharan region, specifically the developing or the lower income countries whose context is very different from the context from which the literature on globalisation originates; and whose difference is crucial to this research. The countries include Egypt, Libya, Morocco, Algeria, Tunisia and Sudan.

2.2.1 Common characteristics of Higher Education in Sub-Saharan Africa

SSA countries share a number of characteristics in Higher Education systems, especially because they have similar economic situations, most being low-income economies (The World Bank, 2020b). For instance due to most of them being low-income economies, there is limited resources directed to funding Higher Education (Mohamedbhai, 2015; Teferra, 2008). The economic situation is combined with their history of colonialism, where their Higher Education system is inherited from colonialists, mainly France and British (Teferra & Altbachl, 2004). As a result the education systems are mostly grouped according to the two colonial influences- Francophone and Anglophone, although some countries may have grown from their coloniser education to adopting other systems, although also from the Global North. So, colonial legacy and the influence of economic situation are the baseline of many similar situations as explained here.

i. Language of instruction

Language of instruction in Higher Education is the language of the colonizers, and since the main colonisers by the time of independence were Britain and France, the main languages inherited are French and English. (Teferra & Knight, 2008). But there are also a few countries that adopted Portuguese as their official language including Angola and Mozambique. The three languages have divided the region and are said to be Anglophone, Francophone and Lusophone; and this diversity in languages have been one of the main obstacles when it comes to regionalisation efforts in African Higher Education (Woldegiorgis, Jonck, & Goujon, 2015). Overall, there is predominance of English language in the region as claimed by Teferra and Altbachl (2004), and also evident through associations formed, such as the African Association of Universities and also in the disseminations of knowledge.

ii. Economy and insufficient local funding

In most countries in SSA, there is insufficient local financial and human resources for supporting Higher Education systems which are mainly dependent on government support (Kumar et al., 2004). Although African governments are reported to be trying to commit a considerable amount of funding to Higher Education from their limited budget, there is still a great dependence upon foreign resources to fund Higher Education, especially for research and human capacity development (Teferra, 2013). Foreign funding can be unpredictable and unreliable due to shifting priorities, priorities that may not be in alignment with the African local market needs (Altbach, Reisberg, & Rumbley, 2019; Teferra, 2013). There is also a common problem of shortage of human resources facing most Higher Education institutions in Africa which has been mostly worsened by the brain drain, where academics go to study abroad and never return (Altbach & Knight, 2007; Teferra & Altbachl, 2004). The brain drain trend is mostly contributed by the economic situation of the countries and the academics are seeking better life for themselves and their families. The economic situation has been the decider of practice in Higher Education. It has continued to influence practice such as quality assurance and accreditation (Materu & Rigetti, 2010).

The insufficiency in financial and human resources is a result of their economic situations, hence, those countries whose economic situations are different (e.g. South Africa, Botswana, Namibia, Mauritius) may less experience these problems.

iii. Dependence on donor funding and the impact

The prevailing problems of funding have continued to affect various practices in Higher Education in Africa including curriculum process, teaching, Quality Assurance and accreditation, because of the regions dependency of unreliable donor funding, different from Global North who apply their own funding. This donor influence in Higher Education funding is still very much visible on the poorest economies whose education was greatly dependent on external funding. For example we will see later on in section 2.3.4, that initiatives to improve engineering education system in Africa are initiated and supported by external organisations who have also been providing funding to other areas in Africa such as World Bank, UNESCO. This indicate that that donors have a lot of power over the African countries and they get to dictate what goes on in the continent. They can decide to set their own priorities on which areas to support, even if it is not on the interest of Africa. Those priorities could change at any time and affect the efforts in Africa.

The impact of donor funding largely influenced Higher Education in Sub-Saharan African countries in the late 20th century, as it led to African Higher Education lagging behind the rest of the world in knowledge economy (Teferra & Altbachl, 2004). It is reported that during the 1980s and the 1990s, Higher Education in Africa was almost neglected by policies of external donors and their governments in the efforts to improve access to primary and secondary education, because Higher Education was deemed to be a luxury during the time (Ishengoma, 2013; Provini, 2019; Teferra, 2013). The donor funding policies, for instance from the World Bank, influenced government policies in some African countries to focus on primary and secondary education, in bid for long-term investment (Provini, 2019; Teferra, 2013). For instance in Tanzania there was a policy for education for all', that focused on making sure everyone gets education, the policy did not include Higher Education (Ishengoma, 2013). This means that during the period of major transformations in Higher Education in the Global North (the 1990s), resulting from industrialisation and advancement in technology (section 1.2.2), the Higher Education sector in African countries was struggling with decline in funding affecting its resources.

According to Teferra (2008), the donor policies that were neglecting Higher Education came to an end around the 2000s after realising that Higher Education was an important aspect of economic development of African nation, the shift he called "emancipation and revitalisation" (p. 9). However, by this time the African Higher Education which then depended entirely on government funding and external funding from donors such as World Bank, had already significantly lagged behind the rest of the world.

iv. Private vs public institution

Despite the funding situation, there is increased demand for access to universities therefore increased enrolments, which resulted in growth of private institutions. In effort to rescue the funding situation against the increased demand for access, some countries introduced cost sharing policies from the late 1990s, for instance Tanzania introduced the 1999 National Higher Education policy, which among other things encouraged privately funded institutions and privately funded students in public institution (Ishengoma, 2007). The private Higher Education institutions did not gain traction at the beginning but have done so phenomenally in the last decade or so, with countries showing significant growth, for instance Ethiopia going from zero to sixty institutions (Teferra, 2008).

The existing private institutions although growing in numbers and significance, they are reported to be generally unstable, unwarranted and resource challenged, with those run by religious groups proving to be more promising (Ishengoma, 2007). According to Teferra (2008, p. 9), "these institutions are generally smaller in size, limited to programs of popular demand, market oriented, and fee and tuition dependent", and therefore low enrolments compared to public institutions. They have also raised the question of quality especially since they do not pursue research and they often rely largely on part-time staff from major public institutions.

Despite a significant growth in privately funded institutions as well as cost sharing in individual student funding seen in the past decade or so, Higher Education in most African countries is still very much a 'public affair' (Teferra, 2008, p. 10) and public institutions are the majority. The public universities in Africa have continued to be highly dependent on government and external donors and landers, who may come with their own agenda, which in turn influences educational policies and practices in those countries (Ishengoma, 2013). This implies that economically African Higher Education is weak against the powers of Global North, who are usually the donors.

v. Regional collaborations in Higher Education[3]

Most SSA countries are involved in some kind of sub-regional, regional and international integration in Higher Education, however these integrations are problematic because of lack of funding to financially support them, and diversity of education systems and policies, among member countries. Previous work from this research discussed African regional and sub-regional collaborations as follows (Matemba & Lloyd, 2017, p. 2091):

[3] This sub-section incorporates paragraphs from the article Internationalisation of Professional Engineers: A Review of Globalisation of Engineering Education and Accreditation—Challenges from an African Perspective (Matemba & Lloyd, 2017, p. 2091). The material is incorporated with permission obtained from the Chief Editor of the International Journal of Engineering Education Journal, the journal that owns the copyright, attached in Appendix A.

Regionally, the African Union (AU), through its African Union Commission (AUC) and the African Association of Universities (AAU), is leading the efforts to harmonise Higher Education in the African continent, with the aim of promoting quality in Higher Education, facilitating mobility of graduates within the continent and creating stronger ties between countries. In 2007, AU, through its African AUC, developed a strategic document on harmonisation of Higher Education, the Higher Education Protocol (AU-HEP) and in 2009 appointed AAU to be the key implementer. Although AU-HEP has not gained much momentum, it has been a catalyst to some collaboration in African sub-regional or sub-continental levels. AU-HEP, based on the successful European regionalisation system, the Bologna process, raises questions on whether the system is applicable to the African context (Woldegiorgis et al., 2015).

In Africa, harmonisation of Higher Education and accreditation is more substantial and observable at sub-regional or sub-continental level than at regional level (Knight, 2014). For example, the activities of accreditation of Higher Education that were established among Francophone African countries, Conseil African et Malgache pour l'Enseignement Superieur (CAMES) back in 1968. Although CAMES experienced a major decline in the 1970s and 1980s, they later re-emerged in some countries in the 1990s and is still active (Materu & Rigetti, 2010). Apart from CAMES (Francophone Africa), there are other prevailing sub-regional initiatives in Higher Education and quality assurance.

There is Higher Education Quality Management Initiative for Southern Africa (HEQMISA) by the Southern African Development Community (SADC). In the Eastern African region, the East Africa Higher Education community has regional collaboration in the form of Inter University Council of Eastern Africa (IUCEA) that is focussed on harmonization of Higher Education and a strategic plan to enhance development and management of Higher Education in East Africa (Ogachi, 2009). The Economic Community of West African States (ECOWAS) has also signed a protocol of cooperation and a convention to allow mutual recognition of accredited certificates from member countries (Knight, 2014).

Additional to the discussed about collaborations in Matemba and Lloyd (2017), there are also reports of international collaboration that usually exist between African Higher Education institutions and international institutions and organisations. SSA are involved in international collaborations in Higher Education, famously known as 'Partnerships' (Teferra, 2013, p. 38), which have been significant in supporting Higher Education in Africa and in particular research area. However, the relationships are usually of donor- receiver where the party from the North is the donor and Africa the receiver (Teferra, 2013). African parties being on the receiving end often find themselves in a powerless negotiating position, where it is difficult to argue for their interests to be considers in the relationships (Ishengoma, 2016). Further, there is a notion that the Global North perspective is superior to the South, so unconsciously they feel compelled to accept ideas from their North partners. Therefore the collaborations may potentially cause reproduction of inequalities between the North and the South (Bourn, 2018; Rizvi & Lingard, 2010).

In summary, common characteristics of Higher Education in Sub-Saharan Africa include among others: colonialism history and their impact to education; inherited language of instruction: limited funding and human resources; introduction of private institution against public institutions; and regional and international collaborations. These characteristics form baseline factors that influence engineering education practice in Sub-Saharan Africa, and therefore need to be considered in this research.

2.2.2 Exceptional countries in Higher Education in Sub-Saharan Africa

Most countries in the Sub-Saharan Africa project common situations, except for a few that have shown to be exceptional from the context, those that do not share the characteristics mentioned before in section 2.2.1, and therefore worth taking note. These are mainly African countries that are in the Upper- Middle-economy group (Teferra & Altbachl, 2004) which according to World Bank country and lending groups classification include: South Africa, Mauritius, Namibia, Angola and Botswana (The World Bank, 2020b). When referring to the SSA context, these countries are excluded because they have shown a different scenario when it comes to economic, political and education scenes. These countries may at times appear in the SSA discussions because of having some geographical, cultural parallels to the context.

South Africa (SA) which was considered a leader in engineering education in Africa after the apartheid regime was dismantled in the 1990s, is usually exempted from the SSA context because of having characteristics of a developed country (Massaquoi & Luti, 1997). For instance SA has program accreditation for their engineering education, and has been a member of the Washington Accord since 1999 according to the International Engineering Alliance (www.ieagreements.org). In their Higher Education they have very different or rather very advanced procedures and policies that can be easily compared to the developed countries of the global North. This has manifested in the difference in policies and procedures that influence engineering education – for instance when it comes to curriculum review their autonomy is greater that other African countries (Case et al., 2016).

South African engineering education developed significantly especially because of the country's wealth in minerals and they had well developed courses such as their mineral and processing engineering programs (Kumar et al., 2004). Economic wise, SA is in the upper-middle-income category and therefore may not face the same economic challenges faced by other SSA countries. Despite that, South Africa has its own challenges that are the result of apartheid that are very visible in their engineering education research (Kumar et al., 2004). For instance, the issues of black students from underprivileged background that were previously not given an opportunity in some of the universities (Case, 2006; Massaquoi & Luti, 1997). The existence of hierarchies or obvious classes as a result which pose different situations of engineering education and Higher Education depending on their class, for example the previously black universities, coloured and white Universities (Naidoo, 2004). These are some of the reasons that SA is exempted from the SSA context in discussion.

Other countries which are excluded from the discussion of SSA context are Mauritius and Botswana. These are in the upper-middle-income category (The World Bank, 2020b), and therefore present different issues when it comes to engineering education, for instance they do not report any financial issues, but discuss problems of lack of staff and issues related to the faculty attitude (Teferra, 2013). Mauritius has program accreditation for engineering programs by the Engineers Institution (https://www.iemauritius.com). Further Mauritius seems to be pursuing alignment with the Washington accord, the efforts that are evident from the 2016 pilot project on Building capacity through Accreditation of Engineering Education (Royal Academy of Engineering, 2020). The project was supported by the Global challenges research Fund (GCRF) African catalyst Program of the Royal Academy of engineering (RAE) (https://www.raeng.org.uk). Like Mauritius, Botswana is seen working to gain the Washington Accord accreditation as one of its universities –University Botswana for their engineering programs with through South Africa (Uziak, Oladiran, & Moalosi, 2010; Uziak, Oladiran, Walczak, & Gizejowski, 2014). Other countries that could be excluded in this context Namibia, and sometimes Angola although not much information was found about engineering education but it was excluded because of its current economic status – upper-middle income by 2018.

Therefore, any mention of the Sub-Saharan Africa context or simply African context going forward in this research will be referring to Sub-Saharan countries with an exception of South Africa, Mauritius, Botswana, Namibia and Angola. This description of context is also important for consideration in the transferability of the research which will be explained later in the Methodology and Findings (Chapter 5, Section 5.7, chapter 6, section 6.3).

2.3 Engineering Higher Education in Sub-Saharan Africa

2.3.1 The review of African engineering education situation – areas of discrepancy[4]

The earlier review of the African context of engineering education and accreditation by (Matemba & Lloyd, 2017), explained the distinctive situation of African engineering education and highlighted several areas where the practices are different from those that are prevalent in the Global North context, the difference that this research is interested in. Drawing from that discussion, I have divided the discrepancies into four categories, what I have called four 'areas of discrepancies': engineering education, accreditation, professional bodies' involvement and collaborations. The four areas or discrepancies will also later make the foundation for data collection (in Chapter 5).

i. Engineering Education

Engineering Education in Africa offered in Higher Education institutions is characterised by emphasis on information transmittal via lectures, limited problem-oriented or project based learning, lack of research, overcrowded facilities and lack of industry input (Materu, 2007). This is typical of what is known as a traditional method or teacher-centred method that does not align with the current global developments towards a more student focussed teaching delivery (Felder, Brent, & Prince, 2011). Student focussed methods of teaching, such as the Conceive Design

[4] This sub-section incorporates copyright materials in form of paragraphs and a table from Section 3 of the article Internationalisation of Professional Engineers: A Review of Globalisation of Engineering Education and Accreditation—Challenges from an African Perspective (Matemba & Lloyd, 2017, pp. 2088-2092). The material is incorporated with permission obtained from the Chief Editor of the International Journal of Engineering Education Journal, the journal that owns the copyright. The permission is attached in Appendix A.

Implement Operate philosophy, Flipped Classrooms, Problem Based Learning, Project Based Learning, and other student-centred learning approaches grounded in constructivist learning theories are relatively rare in the African educational context (Felder et al., 2011). Traditional teaching methods are often focussed on syllabus or content, rather than articulating student attributes or learning outcomes. This is in contrast to the trend towards outcomes-based education and accreditation.

University-Industry partnership weakness is one of the major challenges facing engineering education in Africa compounding the difficulties faced due to limited funding, inadequate human resources, poor infrastructure and lack of political will (Beanland et al., 2013; Oanda, 2014). Engineering industry in Africa tends to move fast in efforts of internationalisation whilst leaving the education programs behind. There are many companies in Africa that conduct international activities and these employ locally educated engineers, however the engineering curricula does not prepare graduates for this reality resulting in the need for industry-based training (Kumar et al., 2004). Despite this, industry is not strongly involved in developing engineering curriculum in order to integrate issues that are important in the job market (Beanland et al., 2013), hence curriculum in most African universities does not reflect the developments in the industry.

ii. Accreditation

The accreditation in SSA is said to be Institutional Accreditation as opposed to Program Accreditation that matches the globalisation discourse. Institutional accreditation refers to the recognition and endorsement of the university or Higher Education provider and their systems, which according to (Materu & Rigetti, 2010) "focus on the institution as a whole as the primary focus of the assessment process" (Materu & Rigetti, 2010, p. 15). On the other hand program accreditation is the course specific approval where the primary focus is professional degrees or programs. Materu and Rigetti (2010) found, in their assessment of quality assurance in a number of countries in Africa, that most countries focus on institutional accreditation rather than program accreditation mainly because program accreditations are labour intensive and costly. There are countries like South Africa, Nigeria, Mauritius that were reported to be undertaking program accreditation in Sub-Saharan Africa, which at that time their levels of development were beyond the financial and human capacity of most SSA countries. Table 2.1 shows the state of accreditation with engineering program accreditation only confirmed in four countries, and not in ten other, while for some their state is unknown (in column 7).

Accreditation of Higher Education in Africa is said to still be new and weak, with accreditation agencies in most countries like Cameroon, Ghana, Tanzania and Mauritius being established only between the 1990s and the 2000s. These accreditation agencies' activities were limited "to accreditation of private universities, with actual accreditation of public universities starting after 2000" (Materu & Rigetti, 2010, p. 6). For instance, Cameroon initiated institutional accreditation of private universities as late as 1991 under the auspices of the National Commission on Private Higher Education (NCPHE) (Hayward, 2006). Further, more than half of the countries in Africa do not have a fully functional Higher Education quality assurance mechanism in place (Woldegiorgis et al., 2015). By 2010, only 30% (16 out of 55) of African countries had Accreditation agencies that were operational, which included the earliest one established by Francophone Africa in 1968, Conseil African et Malgache pour l'Enseignement Superieur (CAMES), to the latest one established in 2006 in Zimbabwe (Materu & Rigetti, 2010; Okebukola, 2014).

Table 2.1State of Engineering education accreditation in Africa

Region	Sub-continental Regions	Sub-Regional Accreditation or QA System	Member Countries	Language Affiliation	Higher Education Accreditation or QA Agency	Engineering Program Accreditation
Sub-Saharan	Southern Africa	SADC/ HEQMISA	South Africa	Anglophone	HEQC -2001	✓
			Botswana	Anglophone	BTEC **-1999**	✓
			Zimbabwe	Anglophone	ZIMCHE-2006	×
			Mauritius	Francophone	MTEC-1997	✓
			Namibia	Anglophone	NQA-1996	-
			Mozambique	Lusophone	NCHE-2007	×
	Western Africa	ECOWAS	Ghana	Anglophone	NAB 1993	×
			Nigeria	Anglophone	NUC 1990-1991	✓
		CAMES	Mali	Francophone	-	-
	Central Africa	CAMES	Congo	Francophone	-	×
			Cameroun	Francophone	NCPHE 1991	×
	Eastern Africa	IUCEA/EAQF	Tanzania	Anglophone	HEAC-1995 TCU-**2005**	×
			Kenya	Anglophone	CHE 1985	×
			Uganda	Anglophone	NCHE 2005	×
			Rwanda	Francophone	-	×
			Burundi	Anglophone	-	×
Saharan	Northern Africa	ANQAHE	Egypt	Arabophone	NAQAAE-2007	×
			Sudan	Arabophone	EVAC- 2003	×
			Tunisia	Arabophone	-	-

Note. Adopted (and updated) from “Internationalization of Professional Engineers: A review of globalisation of engineering and accreditation- challenges from an African perspective” by E. Matemba and N Lloyd, 2017, *International Journal of Engineering Education*, 33(6), p. 2089. Copyright 2011 TEMPUS Publications.

Table 2.1 summarises the state of accreditation in some countries in Sub-Saharan Africa by 2017, capturing those 19 African countries, borrowed from Matemba and Lloyd (2017). The accreditation agencies responsible for accreditation of Higher Education (in Table 2.1) are linked to the government, usually as government bodies. There is some literature that suggests that the idea of non-governmental accreditation is still perceived to be very important in many countries (Hayward, 2006), but may be difficult to implement. These national agencies also performed a number of other functions apart from accreditation as stated by Materu and Righetti (Materu & Rigetti, 2010, p. 7) "QA [Quality Assurance] agencies at this early stage in Africa are responsible for multiple functions beyond those performed by a typical agency in more developed HE [Higher Education] systems". Functions may include determining access into universities for future students. This multitasking may require significant resources not afforded to these agencies.

Although some form of national and international recognition is considered vital for institutions (Uziak et al., 2010), most African institutions seek recognition through international ranking of their university, rather than through program accreditation means as they do in the global North, whereas ranking may have completely different objectives from those of producing professional graduates with required competencies for the global market (Altbach, Reisberg, & Rumbley, 2009; Materu & Rigetti, 2010). There is also a tendency for some universities in African countries of individually seeking accreditation from international accreditation systems like the Washington accord (WA) (Materu, 2007), which shows that it is the importance of international accreditation for African institutions. An example is the University of Botswana (UB) working to acquire accreditation of its engineering programs with the Engineers Council of South Africa (ECSA) in order to be a member of WA (Oladiran, Pezzotta, Uziak, & Gizejowski, 2013). Recently, it was reported that Mauritius is striving to become member of the Washington Accord (RAE, 2020b).

International accreditation procedures are sophisticated and very involving, a task that may be very challenging to the already multifunctioning governmental quality assurance or accreditation agencies in Africa. Their lack of financial and human resources hinder them from application of accreditation processes rigorously or consistently (Materu, 2007). The existing international and accreditation systems follow a competence based programme accreditation (G. Augusti, 2012), which may restrict the African accreditation agencies which are mostly national agencies performing institutional accreditation. As discussed earlier, the existing accreditation agencies in Africa therefore already laden with responsibilities, that providing accreditation service to institutions is one of the few responsibilities. Further, the tendency to seek accreditation from international accreditation systems seem to involve the SSA countries that are in the exceptional group, e.g. Botswana and Mauritius, which may be because their economic position allow them to do so. Hence the reason that they are left out of the context, despite displaying some similar characteristics, such as not having outcome-based education and accreditation.

iii. Professional Bodies Involvement

In most African countries, professional bodies are not the authorities that set the requirements for accreditation. Professional bodies in Africa have a legal mandate for registration of graduates despite not having any input into improvement of the curricula. However, it is evident that professional bodies in Africa, such as the Engineers Registration Board (ERB) in Tanzania, show concern in the lack of professional skills in graduate engineers. They address this concern by funding programs for Continued Professional Development (CPD) to develop those skills after graduation (Mukama, 2005). Kumar et al. (2004) contends that this may imply that professional bodies in Africa may not realize the contribution of engineering curriculum in developing professional skills in Engineers and in turn improving engineering profession. Although it is said that professional bodies are represented in the accreditation panels in most African countries, research is yet to establish the link between the standards used by professional bodies and those used by education accreditation or quality assurance systems (Materu & Rigetti, 2010).

iv. International recognition

When it comes to international recognition, regional and international collaboration become important factor, for instance the European countries collaboration in harmonisation of Higher Education through the bologna process was an important agent in the collaboration in engineering education accreditation through the EURopean ACcredited Engineer (EUR-ACE) (G. Augusti, 2005; G Augusti, Borri, & Guberti, 2007). Also the Washington accord is a product of the international Engineers Alliances (IEA), an alliance of engineers who have sign agreements that govern engineering education and engineering profession (www.ieagreements.org). For Sub-Saharan African countries, collaborations in engineering education are mostly through the collaborations that exist in Higher Education discussed in 2.2.1. v. As discussed before these collaborations often fail because member countries fail to support them financially due to their economic constraints.

Regional initiatives in Higher Education, for instance in accreditation and quality assurance, whilst important in internationalisation and recognition, have often failed to progress in Africa due to lack of funding (Oanda, 2014). Due to the economic situation of member countries any, initiatives for regional collaboration between African countries depends on funding from donors such as the World Bank (Materu & Rigetti, 2010; Mhilu et al., 2008; Woldegiorgis et al., 2015). Apart from funding, regional initiatives in harmonisation of Higher Education and accreditation are also faced with the issue of disparities in existing education and accreditation systems as they are all colonially inherited. The effort by AU to harmonise Higher Education at a regional level, including establishment of a regional wide Accreditation Agency for Higher Education in 2012, have failed to show significant development. This is also partly because, due to the historical context that shaped African Higher Education, the existing national and sub-regional systems do not have similar priorities or standards for harmonisation in every SSA nation (Alemu, 2014).

African institutions and engineering education departments have been involved in international initiatives in engineering education that aim in enhancing education and accreditation. The most prominent one being Tuning Africa Project, the project on African Higher Education Harmonisation and Tuning. The Tuning Africa Project uses the tuning methodology, which has been very successful in Europe, to bring harmonisation of standards in Higher Education in general (Hahn & Teferra, 2013; Knight, 2014; Sackey et al., 2014). According to (Onana et al., 2014), sixty Higher Education institutions in Africa successfully defined generic and specific competencies for global engineers in Africa that take into account local requirements in five programs in its pilot round (between 2010 and 2014). The five programs included civil and mechanical engineering, medicine, teacher education and agriculture.

The Tuning project seems ideal for Africa, and its incorporation in curriculum reforms has been endorsed (Ishengoma, 2017; Onana et al., 2014), however there are two issues to consider. One, the 'Tuning' methodology is grounded on competence based- education (Knight, 2014), which puts emphasis on graduate competencies by identifying generic and specific competencies, hence raises the question of applicability to content-focused Africa education explained above

(2.3.1.i). Two, although the Tuning project is a collaborative initiative between the European Union and African union (EU-AU), it is funded by the European Commission (Onana et al., 2014) and hence the issue of sustainability is still questionable.

Similar collaboration is the ongoing Royal academy of engineering (REA) initiatives in Sub-Saharan Africa. (A-UK partnership & RAE, 2012). The Royal Academy of Engineering established the Higher Education Partnerships in Sub-Saharan Africa Programme (HEP-SSA) in 2016. According to RAE (www.raeng.org.uk):

> This programme [HEP-SSA] aims to ensure that the higher education system in sub-Saharan Africa produces engineers with the skills and knowledge required to meet the needs of industry and tackle local challenges. It also aims to address the engineering skills shortage, and showcase engineering's role in driving economic development in the region. (RAE, 2020a, p. para.2)

The programme aim to achieve this by forming and strengthening relationships between academia and industry. The initiative which is supported by the Anglo American Group Foundation and the UK Government through the Global Challenges Research Fund followed the pilot project called Enriching Engineering Education Programme between 2013 and 2015 (RAE, 2020b). Like the tuning project, HEP-SSA show emphasis on skills or competencies and external funding, hence the same concerns of applicability and sustainability.

At some point there seemed to be an initiatives called CDIO Africa reported in Mbanguta (2004), which was based on applying the Conceive Design Implement Operate (CDIO) initiative (http://www.cdio.org) for enhancing Engineering Education in Africa. The Conceive Design Implement Operate (CDIO) framework is an accessible, open-access community of practice, with detailed procedures on designing learning outcomes, the institutional and academic processes, the learning environment and constructive alignment of assessment (Crawley et al., 2014). This explicit framework would be beneficial for guiding African universities for designing curriculum and pedagogy. There was no current information found on CDIO Africa, however, there is evidence that CDIO framework has been adopted in Africa, in the Ubora Project for medical sciences (http://ubora-biomedical.org). The CDIO framework has yet to be adopted widely by institutions in Sub-Saharan Africa, apart from South Africa, as seen in the CDIO website (http://www.cdio.org).

Other initiatives reported are African Network for Scientific and Technological Institutions (ANSTI), UNESCO Engineering Initiative (UEI) African Engineering Education Association (AEEA) Africa Engineers Forum (AEF) (Mohamedbhai, 2015) These initiatives and those described above have similar characteristics; that they are fairly new, externally funded and attached to organisations such as RAE, UNESCO, and therefore lacking own initiative. Ishengoma (2016) has described these kinds of are partnerships as North- South partnerships in Higher Education (2.2.1 v). The articles main argument is that:

> … while partnerships in African public universities are critical strategies for the internationalization of Higher Education, they have not significantly contributed to the strengthening of Higher Education capacity because of their inherent structural imbalances and shortcomings. (Ishengoma, 2016, p. 2)

Regional and sub-regional collaborations are weak and sometimes depend on donor funding, and they lack own initiative. Some of the existing regional and sub-regional initiatives are in collaboration with partners from the Global North, however since they are externally funded and externally motivated, they leave African partners in a dominated position against the Global North partners. As explained previously in Sections 1.2 and 2.2.1, there is a good chance that they perpetuate the dominance of the Global North Rizvi & Lingard (2011) and Bourn (2011). The dominance of the North over the South or of Europe over Africa is a problem because it perpetuates the inequality. There may be opportunity here is for Africa to take advantage of the initiative by setting their own priorities to create programs that are self-sustaining in the future, this however will not be an easy mission.

In summary, the review has highlighted areas that engineering education in the African context presented differently from the context that is assumed by the globalisation discourse, the difference that is of interest to this research. Understanding how these areas may affect 'globalisation of engineers' is important for this research. The four areas of discrepancies; engineering education, accreditation, professional body involvement and international recognition; are to be investigated in order to bring to light what is contributing to this difference. The areas therefore make a foundation for research design, particularly the pilot study (chapter 5, section 5.3).

2.3.2 Previous studies on improvement of African engineering education

There is little published information around engineering education in Africa especially the Sub-Saharan African region as found by the author and others (A-UK partnership & RAE, 2012; Matemba & Lloyd, 2017). This review found limited journal articles that on similar studies engineering education practice in Africa. Most similar work was in reports from organisations such as RAE, UNESCO, World Bank and others, who apart from having their own focus or agenda, may have been originating from the Global North perspective, therefore caution was exercised in using the information. Despite the scarceness, the existing studies and initiatives on engineering education in Africa are vital in this research, because they contain evidence widely gathered from the region and are therefore useful.

i. Early initiatives in engineering education

In 1993, there was a report that Assessing Engineering education in Sub-Saharan Africa edited by Manuel Zymelman, who was then in the World Bank's Technical Department of the Africa Region as a senior advisor in the Human Resources Division (Zymelman, 1993). The report that was published as a World Bank technical paper number 197, to communicate work done by the Africa Technical Department. In the foreword, the director of the Technical department Africa Region acknowledges the importance of engineering education to the economic development of Africa Stating:

> Economic development depends on the ability of Africa societies to introduce and maintain technological change […]. Engineering education is one of the most important vehicles for developing the capacity. (Zymelman, 1993, p. vii)

Note that the above paper was published in the 1990s, an era of technological development in the world and especially in the Global North as discussed in chapter 1.1.2. It calls for improvement in engineering education parallel to those in the North (Ibrahim & Cockrum, 1993). But, the report also talked about the bad economic situation that African countries were in at that time (1990s), and the impact this had on manufacturing industry.

> Most of the African region is now burdened with disabling economic stagnation. The situation has led to an alarming decline of established manufacturing industries, particularly those dependent on imported raw

> materials and spare parts. Restrictions on long-term lending by financial institutions are stifling expansion of small scale industries, and production levels of certain ore and mineral extracting industries have dropped as world demand for them shrink. (Zymelman, 1993, p. 46)

The economic stagnation that the quote reveals was also later confirmed by others in Higher Education literature (Ishengoma, 2004; Teferra & Altbachl, 2004), when they talked about the effect that the situation had on Higher Education funding. This quote therefore highlights a different scenario that African industry was going through, compared to that of rapid industrial development in the Global North scenario, a scenario of failing manufacturing industries. Therefore it is evident that during the time African engineering education as well as its industry were not on the same page with the Global North.

Also in the late 1990s, Massaquoi and Luti (1997) reported an interesting meeting of engineering deans from African universities, aimed at exploring appropriate methods of Quality Assurance for Africa and also the relevance of engineering education to the African industry, as they were looking at the need for engineers to solve social economic problems within the region. What was noticeable from this report was that, unlike such discussions in the Global North during this time (late 1990s), the discussion focussed on different methods of improving engineering education, for instance there was no mention of competence –based education or program accreditation in the discussions. The suggestions were considerate of the African context of engineering including challenges of resources – financial, physical and human resources. The report (Massaquoi & Luti, 1997) was coordinated by UNESCO under the Auspices of ANSTI. While explaining the region, it clearly excluded South Africa (SA), citing that SA exhibits similar features to those of developed economy, congruent to section 2.2.2.

The two earlier studies start to show that there is a difference between engineering education in Africa and the Global North has been in existence. It also show the different factors that underlying especially issues that are related to their low economy.

ii. Later initiatives in improving engineering education - for industrial capacity building

A report titled *Preliminary study: Engineering Education evaluation* (Mhilu et al., 2008) explores the status of engineering education, and develops a framework for Assessing engineering education training and capacities within Southern African Development Community (SADC) universities. The report discussed the urgency to improve the regions engineering capacity through revitalisation of engineering education institutions. It urges Higher Education institutions (universities and technical colleges) to be the leaders in developing continental engineering programs that will enable Africa to build engineering capacity in order to create an industrial transformation and hence economic change. Mhilu et al. (2008) developed a framework for evaluation of engineering education that a holistic evaluation and analysis of existing programs to better understand challenges faced and be able to mitigate the challenges. It emphasizes the need to first assess the current situation of engineering education to determine areas of improvement, therefore, has considers the context of education.

In the same lines of capacity building, is the 2010 UNESCO report (UNESCO, 2010). As mentioned earlier the UNESCO report on *Engineering: issues, challenges and opportunities for development* (UNESCO, 2010), which has been cited widely in engineering education, contains an immense amount of information about engineering education in Africa The report for instance contains a sub-section (7.2.3) on *Capacity Building for Sustainability in Africa* (UNESCO, 2010, pp. 315-319) explaining the issues of sustainable development in Africa and propose way forward which include reforms in engineering education curriculum (basically adopting an outcome based system) and international accreditation of engineering programs.

Recently, Mohamedbhai (2015) conducted a desk study *Improving engineering education in sub-Saharan Africa* that aimed to evaluate the state of engineering education and training in Africa, survey regional initiatives for improving, and accreditation of engineering education program in Africa. The study reviewed, analysed and reported on the situation of engineering education in the Sub-Saharan and it was conducted as part of yet another World Bank initiative called Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) that started in 2013. Mohamedbhai (2015) explained the state of engineering education using two reports one from the Royal Academy of Engineers' *Engineers for Africa: identifying engineering capacity needs in Sub-Saharan Africa* and the other is the 2010 UNESCO report, *Engineering: issues challenges and opportunities for development*. In an earlier report on the project to the World Bank, (Mohamedbhai, 2014, p. 8) summarised the situation of engineering education in SSA to be as follows:

- Shortage of engineers, yet unemployment of engineering graduates.

- Lack of funds to procure laboratory equipment and other facilities.
- Out of date curricula and old methods of teaching
- Lack of academic staff with industrial experience; difficulty in recruiting and retaining staff because of poor salaries and employment conditions.
- Weak university-industry partnership
- Lack of opportunities for industrial experience for engineering students.

Mohamedbhai (2015) reviewed the studies on skills need and discussed the skills in terms of the human resources required. Apart from engineering professions he also reported that there is a great shortage of engineering technicians in Africa for instance he mentioned the need for technicians, or people with technical skills, and recommended promoting vocational training. The lack of technical skills and the need for vocational training is a critical issue, however I will not go into details about it here, because my focus is on training of professional engineers. With regards to training professionals the study did not focus on training and not the skills that the professional engineers needed, hence the disconnected with industry.

Mohamedbhai (2015) highlighted several partnership collaborative initiatives in improving engineering education in SS Africa including those discussed in 2.3.1.iv, e.g. Tuning Africa. Other regional initiatives discussed were African Network for Scientific and Technological Institutions (ANSTI), African Engineering Education Association (AEEA), UNESCO Engineering Initiative (UEI), Africa Engineers Forum (AEF), Federation of African Engineering Organisations (FAEO) and Africa-UK Engineering for development Partnership. By 2015, all these initiatives were actively running various programmes in Africa mostly with African Higher Education institutions although current publications were not obtained. This is problem with most studies in Africa such as (Mohamedbhai, 2015), the lack of continuity; they usually run for the course of the funded project and have failed to continue once the project is finished. Some have not even made it past the pilot phase. For instance for Preliminary study: Engineering Education evaluation (Mhilu et al., 2008), I have failed to locate any other work connected to this pilot study report, by the authors or the organisations, which seems to be a common trend with these types of initiatives, they are separate and often there is no continuation. But their existence show the current progress and also the willingness to collaborations in improving engineering education.

These literature discussed here, although offering insights on African context, their perspective and proposals seem to lean on a Global North ideal of engineering education, for instance the proposals such as international accreditation and outcome-based education are the ways to improving engineering education and sometimes ways to globalisation of engineering education. Although the literature make the connection between engineering education and national economy, the studies and frameworks proposed, focused on engineering education, while not considering understanding industry – the context where engineers practice. Sometimes it seems like these proposals are surface dressing the issues and have not taken in consideration of the practical application in the African context. Also looking at the methodologies in some of these studies, this research considers that the problem may be similar to that raised by (Walther & Radcliffe, 2007) and later (Jesiek et al., 2014) that the studies are lacking grounding in theoretical and empirical research.

2.3.3 Way forward for this research

The state of engineering education is discussed from available literature, showing several realities of practice resulting from contextual issues of funding, colonial history as well as its trajectory. The need for improvement of engineering education is also connected to the demand to build human capacity for sustainable development. These can be combined with the issues in Higher Education above. Whilst there are potential problems in the previous studies, there is also a lot of valuable information in this body of knowledge about curriculum processes, teaching and learning methods, accreditation and quality assurance and even graduate competencies needed by the industry in Africa. This research examines engineering education from an African perspective while including the previous reported studies, acknowledging their particular interest and watch out for bias. The research involves a more analytical look at the challenges using empirical data and an appropriate theoretical framework is required, in additional to consideration of the context in which training and practice occurs – the SSA context of engineering education and industry.

2.4 Tanzania as a case of the Sub-Saharan African context

In order to study the context in detail, I will be concentrating on one country, Tanzania, which is categorised among the Sub-Saharan African countries, and sometimes also making references to the rest of the Sub-Saharan. Tanzania makes a typical case of Sub-Saharan African context because it portrays characteristics of the context (sub-section 2.2.1). Using published information, I give an overview of the Tanzanian background in terms of economic, historical, political, and social as well as language that may influence engineering education practice in Tanzania. I then briefly outline the Tanzanian Higher Education system that is linked to the engineering education practice being investigated.

2.4.1 Economy

Economically, Tanzania is a developing country in the lower- income economies category in the World Bank Country and Lending Groups (The World Bank, 2020b). The Eastern African country has a reported population of about 56 Million, with GDP of 57.437 Billion US$ in 2018 and GNI per capital 1,020 US$ (The World Bank, 2020a). The World Bank data also show that Tanzania has sustained an economic growth with average GDP increases of 6–7% a year in the past decade. The GDP is mainly contributed by first the service sector and then agriculture and industry, according to the Tanzania Economic Outlook report in the Africa Economic output (ADBG, 2019, p. 180). The report also shows the existence of large public investments such as the Standard gauge railways, investments that would likely require adequate pool of resources, including most importantly human resources.

In the early 1990s, Tanzania experienced an economic crisis which impacted early industrialisation efforts. During that time all production industries were under the government after being nationalised following Tanzania adopting Socialism in the 1967. The industry were therefore struggling due to lack of foreign exchange to purchase important raw materials among other problems. To address this problem, the government implemented some reform measures in the mid-1990s that included "privatization of publicly owned industries; liberalization of the economy to embrace the market driven system and review of tax regimes and regulation systems to stimulate industry activities." (Keynote by Hon. Charles J. Mwijage, Tanzanian Minister of Industry, Trade and Investment, at the Annual Engineers Day (AED), 2016 p. 3). By then Tanzania had already moved from Socialism to Neo-liberalism in the 1980s, the process that also affected other areas like education (Provini, 2019). This is the foundation of the Tanzanian Industry.

Since 2000, Tanzania has been aspiring to move its economy from lower income to middle income, which is stated clearly its 25 year vision, the Tanzanian Development Vison 2025 (TDV 2025):

> In other words, it is envisioned that Tanzanians will have graduated from a least developed country to a middle income country by the year 2025 with a high level of human development. (Planning Commission, 2000, p. 5)

The vision articulates 3 main targets that are expected to be achieved by 2025, with one that closely linked to engineering industry and engineering education, *A Strong and Competitive Economy*, which is cluster 3.3 of the targets. Others in item 3 are High quality Livelihood (3.1) and Good Governance and the Rule of Law (3.2). The goals in the *Strong and Competitive Economy* are highlighted in the in Tanzania Development Vision 2025 (Planning Commission, 2000, p. 10) as shown in Table:

Table 2.2 TDV 2025 Strong and Competitive Economy target

The economy is expected to have the following characteristics:

- A diversified and semi-industrialized economy with a substantial industrial sector comparable to typical middle-income countries.
- Macroeconomic stability manifested by a low inflation economy and basic macroeconomic balances.
- A growth rate of 8% per annum or more.
- An adequate level of physical infrastructure needed to cope with the requirements of the Vision in all sectors.
- An active and competitive player in the regional and world markets, with the capacity to articulate and promote national interests and to adjust quickly to regional and global market shifts.

It is also envisaged that fast growth will be pursued while effectively reversing current adverse trends in the loss and degradation of environmental resources (such as forests, fisheries, fresh water, climate, soils, biodiversity) and in the accumulation of hazardous substance.

Note. Adapted from “Tanzania Development Vision 2025” by Planning Commission, 2000, p. 10. (Distributed by the Tanzanian Ministry of Finance)

For the economic aspirations above have raises concern if Tanzania has adequate human capital, including engineering human capital, in both quantity and quality to achieve this vision (Luhanga, 2015). In his assessment of Fifteen years of Implementation of the vision Luhanga

(2015) highlighted the problems of the vision which was mainly its vagueness especially on the issue of human capacity development targets in the first decade of its implementation 2000-2010, then indicated efforts there were effort to provide more specific strategies including that would aid proper planning for building the human capacity required. This research supports that the realisation of TVD 2025 will highly depend on human capital- including engineering human capital.

2.4.2 Socio- political background

i. Colonial history

Historically, Tanzania was first colonised by Germany until 1919 when Britain took over the colony after Germany was defeated in World War 1. Britain colonised Tanzania until 1961 when it gained its Independence, at that time it was known as Tanganyika. Tanganyika then joined with Zanzibar in 1965, and the union attained the name Tanzania. After independence in 1961, the education system from primary through to tertiary was inherited from the British system of education although there have been some changes in tertiary education through some Higher Education reforms, for instance some major reforms in Faculty of Engineering structure in the 1988/1989 (Luhanga, 2003). Despite a few reforms, the Tanzanian system of Higher Education has not changed in the same pace as the British system, but it still hold ties with the previous colonisers.

ii. Politics

Tanzanian political environment has gone through its own trajectory that may that similar to some SSA countries, while also different from others. Six years after independence Tanzania adopted the Arusha declaration in 1967, and adopted a notion of Socialism. The socialism failed in 1980 and Tanzania went into neo-liberalism which it maintains currently. Tanzania is a Republic with executive president, in multiparty democratic system where presidents can stay in power for a maximum of two terms of five years each, according to its Constitution (Tanzania, 1977). This is similar to most Sub –Saharan African countries. It is common for Politics to influence economy/industry hence the intention for revealing Tanzanian political structure especially through different policies. Provini (2019) described Tanzania as a peaceful African countries that was favoured by foreign investors, but recently, Tanzanian political environment including national policies have continually affected activities in engineering industry. For instance in recent years, with a change in governments, changes in investment policies and mining have resulted in less investment with investors who are mostly from outside the country crediting this low investment to uncertainty in the future policies (ADBG, 2019). For a country that is dependent on foreign investment, such events would affect its industry, including engineering projects as well as the engineering job market for engineers.

iii. Languages

In terms of languages used in Tanzania, Kiswahili is the country's official speaking language and it is the language of instruction in primary level education, especially in public schools. In secondary and tertiary level education, English is the language of instruction, is now increasingly popular in private primary schools- famously known as English medium schools. The use of English language in academia and industry is due to the impact of colonial history with Britain, putting Tanzanian in the Anglophone Africa group. All professionals including engineers in Tanzania can communicate well in English and Kiswahili. English is also the language used in the industry documents, emails and other formal communications, however in the workplaces and with the rest of the people for instance labourers and artisans working in engineering projects, using Kiswahili is more appropriate. The wide use of English language including being the language in government documents such as policies, set up the potential to aid data collection, processing and interpretation.

2.4.3 Engineering Higher Education Institutions

Tanzania had no university education offered locally at the time of its independence from Britain in 1961. Rather there was a University college of Dar es salaam was established in 1961 as a college of the University of London in order to train civil servants. The University college of Dar es salaam later became the consistent college of the University of East Africa in 1963 and then in 1970 it was established as the University of Dar es salaam(UDSM), an independent university (Luhanga, 2003). The first main public Higher Education institution, University of Dar es salaam, was the first to offer engineering degrees under the Faculty of Engineering (FoE) since 1973. In 2005, the faculty became a campus college of the University of Dar es salaam, and was called the College of Engineering and Technology (CoET), the name that is held to date (www.udsm.ac.tz). In a presentation at the 2018 Annual Engineers Day (AED), Masika (2018) reported that, there were 11 Tertiary Institutions that were training engineers in Tanzania by 2017, two of which were private institutions, as shown in Table 2.3.

Table 2.3 Institutions that offer Engineering programs in Tanzania and their estimated output

	Institution	Public/private	Graduate output 1997 -2017
1	College of Engineering and Technology COET	Public	42.5%
2	Sokoine University of Agriculture (SUA)	Public	3.6%
3	Ardhi University (ARU)	Public	3.5%
4	University of Dodoma () UDOM	Public	4.8%
5	Mbeya University of Science and Technology (MUST)	Public	6.4%
6	Dar es salaam Institute of Technology (DIT)	Public	23.5%
7	National Institute of Technology (NIT)	Public	0.2%
8	Arusha Technical College (ATC)	Public	0.5%
9	Water Resources management Institute (WRMI)	Public	0.3%
10	St Joseph University of Technology (SJUIT) check	Private	13.7%
11	Saint Augustine University of Technology (SAUT)	Private	0.7

Note. Adopted from "Capacity Development of Engineers," by R. J. Masika, 2018, Slides presented at the Annual Engineers Day, Dar es salaam, Tanzania. Retrieved from https://www.erb.go.tz/index.php/testmenu/category/11-presentations-aed2018

According to Table 2.3 , the total output from the 11 institutions between 1997 and 2017 was 9,522 graduate engineers, the output that he claims to be very low compared to the fast growing Tanzania population (now at 56 Million). Generally, the number of graduates produced by institutions in Tanzania is said to be much lower even compared to its neighbouring Kenya and Uganda. (Ishengoma, 2007; Provini, 2019). With aspirations in building capacity for industrialisation, this is not a good indication. With the growing population as well as globalisation and the activities that are associated with it, and the country already lagging behind in number of engineers per population (UNESCO, 2010), engineering education in Tanzania will need to increase its enrolments and therefore outputs.

2.4.4 Higher Education funding issues affecting engineering education

Higher Education in Tanzania was funded entirely by the Government and the external donor until 1992 when cost sharing policy was introduced in Tanzania (Ishengoma, 2004). Like other countries in the Sub-Saharan, Tanzania faces numerous challenges when it comes to funding Higher Education (Mgaiwa, 2018). The main challenges were contributed by funding policies in the 1980s and1990s, as well as financial crisis that confronted the country around the same time that was facing many SSA countries discussed in (2.2.1 iii). During this time education funding focus (internal and external) was shifted to primary and secondary education and Higher Education was considered a luxury, hence less funding. The financial crisis in the 1990s did not only affect the industrial sector, but also was hard felt in other sectors including the education sector funding especially in Higher Education. Around the time there was increase in demand for access to university, demanding for increased budget to the already struggling Higher Education system. This mismatch between demand for access and budgetary allocations led to the Tanzanian government in 1992 to introduce some reforms in the National Higher Education Policy that included Cost-sharing policies in order to bring non-governmental income to public institutions and increase access to university (Ishengoma, 2004, 2013).

The Cost-sharing policies introduced fee paying students in public university, which up to that time (1992), the University of Dar es salaam was the only public fully fledged university in Tanzania, later joined by other public institutions as they were introduced. The number of privately funded students in public institutions however, is very low compared to total enrolments and the income they bring is therefore small, which means the purpose of increased access is was not significantly achieved (Provini, 2019). The cost-sharing policies also led the way to introduction of private institutions, although these were only officially permitted to operate in 1997. The number of private Higher Education institutions increased fast to 11 by 2003 (Ishengoma, 2004), 21 by 2007 (Ishengoma, 2007) and currently there are 27 registered and approved private universities and colleges operating in Tanzanian, according to TCU (http://www.tcu.go.tz). Despite the surge in number of private institutions to more than 60%, their contribution of enrolments remain low, at about 24% of total, (Ishengoma, 2007), usually because they are smaller in size.

Compared to its neighbouring countries, Kenya and Uganda, Tanzania's Higher Education system is remains largely dependent on public funds despite its effort to implementation some liberal policies such as cost-sharing (Provini, 2019). This situation in Tanzania is very different for instance to the highly commercialized and privatized Higher Education system in Kenya, a country sharing its border. Provini (2019) attributed the Tanzanian Higher education funding situation to the Socialism culture that affects Tanzanian political structure and ideologies, remaining from the time between 1967 and 1985 when Tanzania practiced Socialism which encouraged nationalisation of organisations, while Kenya and Uganda adopted a free market which encouraged privatisation. This means that Tanzania is in a different position from its neighbours when it comes to Higher Education funding and enrolments, due to its somewhat different post-colonialism trajectory.

The discussion above has specifically introduced the setting of engineering education practice in Tanzania, the practice that is being investigated in this research. Since this research acknowledges that engineering education practice in any country is highly influenced by history, economics, politics and language, education, it is therefore important that these factors are known upfront for the case of Tanzania.

2.5 Chapter Summary

In this Chapter, I have demonstrated the African context of engineering education through analysis of literature before going into empirical study. The review of literature on the situation of engineering education in the Sub-Saharan Africa show a context that is different from the context where discussions in globalisation originates. The current situation of engineering education in Africa in relation to the world presented contextual issues (challenges and the opportunities) that are related to globalisation of African engineers that raise concern on applicability of the Global North discourse to Africa. Essentially, through this review highlighted the areas of difference between the largely traditional African educational system, and the outcome-based Global North system that is assumed in the existing discourse. Identified four Areas of discrepancies: These areas set the direction of the research, namely: Engineering education, Accreditation, Professional body involvement, International recognition; which will be further investigated through an empirical enquiry.

This chapter strengthen the main argument of this research that the proposed discourse is developed from a Global North context of engineering education, and may not necessarily be applicable to non- Global North context, in particular the Sub-Saharan African context. The initiatives to improve engineering education can be seen as just moving towards a Global North model, which did not bear fruits in the context as informed. Further the international many existing international initiatives do not seem to take African circumstances into account (2.3.2). This research established the need for the initiatives to change to accommodate the African context. This would require a deeper look into the meanings of the situations in engineering education in Africa by collecting data from lived experiences looking at what the stakeholders are doing, through interviews and focus groups as explained in Chapter 5. A theoretical framework that would take into consideration the socio-cultural as well the political and economic differences of practices between contexts is also important for analysing that data. Therefore, Bourdieu's theory of practice was found to be appropriate, because of the ability to expose the social-cultural structures that make up practice, as explained in the next chapter.

3.0 Theory

This chapter discusses key concepts of Bourdieu theory that forms the theoretical framework for this research. The theory is selected because of its ability to analyse social practices such as engineering education, a practice that is influenced by other factors such as economy and Higher Education policies. Bourdieu's theory of practice provides for this research the tools to examine the different ways globalisation is understood, valued and acted upon by different sets of actors. The chapter starts by introducing the theory, and then explain the basic concepts of *field*, *capital* and *habitus* including the ways that the interdependent concepts function and relate to each other. The chapter concludes by explaining the theoretical research approach, laying out the main questions that set up a theoretical framework for the research.

3.1 Bourdieu's Theory of Practice

Pierre Bourdieu has come from a long tradition in the social sciences, particularly the French tradition. His concepts originate from other social theorists like Max Weber, Emile Durkheim, Norbert Elias and Marcel Mauss (Harker, Mahar, & Wilkes, 1990; Webb, Schirato, & Danaher, 2002). Bourdieu has often, in his work, acknowledged those earlier theorists for providing the landmarks that have structured his ideas, and has made efforts to explain where he departed from their theories (Bourdieu, 1984, 1998; Bourdieu & Wacquant, 1992). One of the difference between him and other sociologists is said to be his reliance on philosophical approaches when trying to make sense of a social group (Frank, 1980). Bourdieu has also drawn theories from and across other fields such as anthropology, the history of science, linguistic, phenomenology, philosophy and even psychology, to inform his work. The most influential school of thought for Bourdieu is Marxism, but he has since also diverged a lot from the theory, which sees all social relations as primarily economic. In his theories, Bourdieu has borrowed and reworked concepts such as capital and class but made them to be different from Marx's capital and class (Bourdieu, 1977). Bourdieu has often criticised Marxist 'crude economism and structuralism' in his early works, which is eloquently explained in (Harker et al., 1990, p. 109); a discussion which is beyond the scope of this theory chapter.

Bourdieu is mentioned among the 'most influential' 'French thinkers' whose work has gone beyond 'structuralism' (Webb et al., 2002, p. 1). He has become famous for his attempt to bring together objectivism (structuralism) and subjectivism (Frank, 1980; Grenfell, 2008). In the preface of his book *Practical reason*, Bourdieu explains his philosophy of action to be a two-way relationship:

> This philosophy is condensed in a small number of fundamental concepts – habitus, field, capital- and its cornerstone is the two-way relationship between objective structures (those of social fields) and incorporated structures (those of the habitus).' (Bourdieu, 1998, p. vii)

By this, he means social life is an interrelationship of pre-existing social structure and agency in that each creates the other, and they cannot be looked at separately. The social structures do not have reality without the people moving in them and that the people moving in them cannot move freely, they have to take some account of the structure. Bourdieu has thus successfully brought to understanding the relationship between social *fields* such as institutions, discourses, fields, ideologies (objective structures) and what people do in those social fields, and why they do what they do (habitus) (Webb et al., 2002). The philosophy of action, referred here as the *theory of practice* fundamentally concentrates on three main elements, *field*, *capital*, and *habitus to* explain individual and group behaviour in a social context.

Together with the three fundamental concepts, Bourdieu uses the concept of conflict or *competition* to identify what matters to people, which explains struggles by individuals in the social context (Bourdieu, 1998). This concept is becoming relevant in the current times of increased push for globalisation agenda in Higher Education as a result of and advanced technological developments (Marginson, 2008). The research will use this concept of competition to examine the workings of the field of engineering education with respect to increased calls for globalisation of curriculum, with particular interest on how competition is influenced by global considerations. Researchers in Higher Education for example are using the notion of *competition* to analyse and explain individual actions and interactions in different educational contexts including classroom, institutional, national and global (Kloot, 2011; Naidoo, 2004). *Competition* is a useful concept for this research in analysing how individuals in engineering education are behaving with respect to globalisation.

3.2 *Field* and *Capital*

According to Bourdieu, in a social world, social practice is understood to take place in variety of *fields* which are interconnected to each other (Crossley, 2001). People move between different social *fields* all the time and at a given time they are expected to behave according to the rules of the *field* they are in (Bourdieu, 1998). Looking at everyday life as a simple illustration, each person encounters different *fields* as they go through their day, such as family, work, and school, which requires them to change their behaviour accordingly. For example rules on verbal communication varies from the *field* of family to the *field* of work.

3.2.1 Field

Bourdieu often uses the analogy of sport *field*, and in particular football, to illustrate how *fields* are constituted and how they differ from each other (Bourdieu & Wacquant, 1992; Grenfell, 2008). In the analogy, he explains the field to have specific rules which are known by its players just like in a football game, the rules which distinguish it from other sport fields. That in football, "What players can do, and where they can go during the game, depends on their field position" (Grenfell, 2008, p. 68). To expand on this, the football *field* has its own objectives, say to get the ball into the goal. It has certain rules such as – a ball must be kicked by foot and not touched by hands; also it values anything that contributes to scoring a goal- say physical attributes of a player or their technique. By contrast, a cricket *field* has different goals and different set of rules to football – for instance a ball is thrown by hand and hit by a bat, and there is no kicking. In short, the *field* of cricket requires you to act differently from the *field* of football, and what distinguishes the two is the invisible structures that are made up of the things of values and the rules of interaction that are typical to each field. Bourdieu has labelled these things of value as *capital*, a term he takes from Karl Marx's *Das Kapital* (Marx, 2001). *Capital* will be explained further in 4.1.1.

Fields overlap with other *fields* and therefore are partially influenced by other fields (Harker et al., 1990). They overlap where they share the things that are of value (*capital*), so unlike a football *field*, where capital from other *fields* (such as cricket) cannot be imported into it, a social *field* can have *capital* that it shares with other social *fields.* And a *field* can have more than one type of *capital*, some of which may be shared with another *field*. Nonetheless a social *field*, just like a football *field*, must be able to present rules and *capital* that are specific to it - distinct capital and rules (Grenfell, 2008). In order to depict a social area of action as a *field*, we must illustrate that the social area has its own typical *capital* and rules that agents are playing for and by, as this research will do when defining engineering education as a field in chapter 4. But first, we need to understand *capital*.

3.2.2 Capital

Capital is something that is of value, and also something that is competed for in the *field*. Using the previous example of family as a *field*, there are things that are considered to be of value in the family. For example, the payoffs that children get if they help around the house with chores; say several hours to watch television. The television time that a child acquires from the family *field* may not be used when the child enters another *field* say school *field*. Similarly, if parents are given respect in the family, because of being an elder; when they enter work, they cannot use that respect *capital* from the family field in order to earn more money or get a promotion in the work field. The two types of *capital*, television hours and respect, can be only be used for exchange within the same *field* so they are specific or distinct to family *field*. As mentioned previously, distinct *capital* is important for a social space to be identified as a *field;* meaning that a field is defined by its *capital*.

> Anything may count as capital that is afforded, however tacitly, an exchange value in a given field, and thereby serves both as a resource for action and as a "good" to be sought after and accumulated. The implication of this is that forms of capital are multiple; each field defines its own species of capital. (Crossley, 2001, p. 87)

Crossley (2001) here points out that there are certain kind of things that are of value (*capital*) and are described by the particular *field* that they are in. He also asserts that *capital* is the currency of the *field* since it bears exchange value as in Bourdieu (1998). For example, in one family, being of a certain age may be considered valuable together with being able to provide for the family; so a family member who provides for the family, may also be the person who gets the most respect and that respect may earn them a decision making right in the family. Another family member, say the eldest family member (with the most age capital), may use their age to earn respect and that respect may also give them a decision making right. Crossley (2001) also asserts that *capital* may take different forms, can be transferable in the *field* such like ability to provide for family, age respect and decision making right, in the family *field*.

Crossley (2001) also adds that some forms of *capital* are interdependent and can be converted within and across fields, into economic capital (capital associated with money), that being the most transformable, and the most fundamental capital in most *fields*. This can be explained in terms of academic standings in the university. A professor for instance can get more funding by trading on their position as a professor because the title of Professor in grant has capital. They (professors) can also use that grant money they acquire to improve their standing with respect to other professors in the University for example, to get promoted to leadership positions. So, the position /capital professor can be traded for economic benefits and vice versa which means a senior lecturer who can acquire grant funding, can also use the economic benefits of the funding to apply for professor position. One thing to note is that, agents in the *field* can also play to increase or to conserve their capital, in conformity with the implicit rules of the *field*.

In regards to forms of capital, Bourdieu has identified four primary forms of capital Economic, Cultural, Social and Symbolic as explained in Webb et al. (2002). This distinction between the forms of capital (i.e. economic, cultural, social and symbolic) is of less significance in this research and the term *capital* will be used to identify, in any form, anything that constitutes value and is exchangeable in a *field*, which is specific for each field (Bourdieu & Wacquant, 1992). The notion of forms of *capital* in this research therefore allows us to ask the questions: What is the specific capital of the field in question? The answers to this question according to the theory will help define that field, in this incidence the field of engineering education later in chapter 6.

3.2.3 Structure of the *field*

Bourdieu explained structure of the *field* as the objective positions that are imposed by the distribution of *capital* and the rules for distribution of that *capital* (Bourdieu, 1993a). This means that *capital* is what outlines the structure of any *field*. That, *field* is made of objective hierarchical positions that agents and institutions can take up according to the amount and type of capital they possess (Naidoo, 2004; Webb et al., 2002). Think about a hierarchical system, such as the university that recognises some objective positions such as tutor assistant, assistant lecturer, lecturer, senior lecturer, and professor. The objective positions are characterised by *capital* such as certain levels of education, number of publications, teaching and other academic credits. The university system rewards those positions in different ways and people in that field strategize to get into those positions by obeying rules of the game. Although all universities may have same described positions, those positions however, are not all equal; if you are a professor at a small regional institution it is not the same as professor at a large state university. This means that the objectives positions are objective but also relative (Bourdieu & Wacquant, 1992).

The objective positions depend on different kinds of *capital* that are active and recognised by the *field* (Grenfell, 2008). For example in the university *field*, some people may have teaching positions where they get recognised for teaching skills and expertise; others may have research positions and get recognised for their research outputs. So people identify what the possibilities are in the *field* and pursue those possibilities. Also in the university field, especially in professional education such as engineering, there are emerging positions forged for people with social elements such as community liaising and humanitarian engineering. These people are engineering academics but they also set up projects in the community, run internships and the like. These academics would typically have previous experience and contacts in the industry or in the NGOs, which they bring in and make available to their faculty, and the faculty in turn can say it is providing real world engineering training. This fairly new position that these academics have created, and added to its significance in the *field*, brings *capital* that the *field* can exploit-community capital.

> In analytic terms, a field may be defined as a network, or a configuration, of objective relations between positions. And these positions are objectively defined, in their existence and in the determinations they impose upon their occupants, agents or institutions, by their present and potential situation *(situs)* in the structure of the distribution of species of power (or capital) whose possession commands access to that specific profits that are at stake in the field, as well as by their objective relation to other positions (domination, subordination, homology, etc.). (Bourdieu & Wacquant, 1992, p. 97)

A network of objective relations between positions, means the comparison between the positions is the one that is significant. These positions are defined by what individuals need to have (capital) and what they need to do to get into those positions, also what tenants in those positions are expected to do to maintain them (Matemba & Lloyd, 2019). For example in Higher Education *field*, institutions can take up different positions and therefore offer different objective positions to occupants. A professor position in one university say large state university is not the same as a professor position in a smaller regional university because the state university have more of the typical capital that the field supports, knowledge creation capital, and has hence taken a higher position.

The example above elaborates the notion of relativity of positions with respect to the field, that in Higher Education field, the professorship positions depend on the positions taken by their institutions, which also depend on the typical capital of the field – in this case knowledge creation. Bourdieu and Wacquant (1992) explain this relativity of positions by explaining that the field is structured such that some positions dominate other positions, some are subordinate to other position and some are similar (homologous) to other positions. It is important to note here that, positions can be also structurally similar, homologous, even when they may have been attained through the use of different capital or different amount of capital.

The significance of these positions in the social field is in the function of the field:

> The principle of the dynamics of a field lies in the form of its structure and, in particular, in the distance, the gaps, the asymmetries between the various specific forces that confront one another. The forces that are active in the field – and thus selected by the analyst as pertinent because they produce the most relevant differences- are those which define the specific capital. (Bourdieu & Wacquant, 1992, p. 101)

The forces can be things like funding policies and practices. Therefore motor causes of function and transformation of a field are in its structure- objective positions. Strategies (position taking) depend on the position of the agent and what that position would entail and allow. (Bourdieu & Wacquant, 1992)

> … the field as a structure of objective relations between positions of force undergirds and guides the strategies whereby the occupants of these positions seek, individually or collectively to safeguard or improve their position and to impose the principle of hierarchization most favourable to their own products. The strategies of agents depend on their position in the field, that is, in the distribution of the specific capital, and on the perception that they have of the field depending on the point of view they take on the field as they view taken from a point in the field. (Bourdieu & Wacquant, 1992, p. 101)

Now since these objective positions are ordered by the specific capital of the field and the rules of distribution of that capital, then for the structure (shape) of the field to change the rules of the field have to change and capital will have to change. What happens when change is introduced to, for example, by defining new type of capital such as globalisation in engineering education as in the case of this research? When agents try to change capital of the field it causes competition or conflict as existing players seek to maintain their positions.

> The field of power (which should not be confused with the political field) is not

> a field like any others. It is a space of relations of force between the different kinds of capital or, more precisely, between the agents who possess a sufficient amount of one of the different kinds of capital to be in a position to dominate the corresponding field, whose struggles intensify whenever the relative value of the different kinds of capital is questioned […] (Bourdieu, 1998, p. 34)

In any field there are dominant and dominated positions and these positions are determined by the amount of the field specific capital an agent holds (Grenfell, 2008). A person can have power or be in a dominant position; if they have more of the capital that is specific to the field and is supported by the field; also if they bring into the field capital that has a high exchange value in the field (Bourdieu, 1998).

This means that, to occupy a dominant position in a particular field one needs to have sufficient quantity of specific capital. The person with more power is therefore in a dominant position in the field, and as Webb et al. (2002) asserts when you are in position of power, you have the advantage to designate what constitutes capital in a field. This means that you can also set the rules for competition in such a way that you protect your own position. An individual, or group of people, may have a power advantage over others in a field and therefore they would set the rules and define what is of value in that field. The domination in the field however is not that straight forward that you can see the set of agents (dominant) enforcing it (Bourdieu, 1998), but it is engrained within practice and can be observed as a product of actions of those agents.

3.2.4 Autonomous and heteronomous poles (polar structure) of the field

In this research, understanding the distribution of power in the *field* will be an important step in analysing a *field*, because it will help establish the power that different objective positions can have in the *field*. Objective positions can be further elaborated using the polar structure notion of *field*; its *autonomous* and *heteronomous* poles (Albright, 2017).

In any *field*, there are at least two poles (Albright, 2017), just like the N and S poles of a magnet called *autonomous* pole and *heteronomous* pole. All the action in the *field* will always gravitate around those poles like the magnetic field around the poles of a bar magnet. An autonomous pole is "that part of the field that tends to operate according to principles derived from the *field* itself and which tends to be isolated and removed from the rest of the society" (Webb et al., 2002, p. ix). It is the pole that follows the rules defined by the *field* itself and centres on *capital* that is not shared or does not overlap with any other *field*, its distinctive *capital*. As mentioned before, in order for a social context to be a *field*, it must have its distinct capital or autonomous *capital*, meaning that it must have an autonomous pole. For example if we look at family as a *field*, those rules and *capital* that are only applicable in that particular family unit, such as - the person who completes chores will gain television time - will form an autonomous pole of the family *field*.

The other pole is the *heteronomous* pole which is "that part of the *field* bound up in relations with other fields and expressing their values" (Webb et al., 2002, p. xiii), meaning its *capital* is shared with other fields. This pole is easy to establish because most fields are influenced by other fields. If a family supports *capital* that is shared by other field for example children that are doing well and earning awards at school, can earn extra points at home and therefore school awards will make up for heteronomous pole of the family field. The more visible heteronomous poles in the family field as well as in most fields, is economic or money pole, because money creates an overlap with many fields such as work or business in the example of family. So a family member, say the breadwinner, dedicates their time in the work *field* in order to get paid money that they can use to provide for the family, which in turn allows them to maintain their breadwinner position at home.

Autonomous and *heteronomous* poles are significant in establishing in more detail the structure of the *field* by determining agents' positions according to the type and amount of *capital* they possess. The polar structure can clearly show the different potential positions that actors can take up according to the distribution of *capital* around the two poles. How close people are to the two poles, depends on the amount and type of *capital* they possess. For instance, the *field* of Higher Education is known to be made up of two main poles, the *autonomous* knowledge creation pole and the *heteronomous* economic pole (Maton, 2005). An academic who is doing ground-breaking research will be closer to the knowledge creation pole, while another academic who is excellent at winning research grants will be closer to the economic pole. Although they have different types of *capital*, both academics have important positions in the *field* because they are closer to the two poles (Bourdieu, 1993a); they fulfil those poles' needs. This means that the further away one is from those two poles, for example someone lacking those two skillsets; the lesser their position is in the *field*.

For instance, Naidoo (2004) and later Marginson (2008) have used the polar structure to position agents in the *field* of global Higher Education in their studies. Marginson (2008), shows the autonomous and heteronomous poles of the Higher Education field; knowledge pole being *autonomous* and economic pole being *heteronomous*. He positions agents, who are universities that value different *capital*, closer or further to the respective pole according to what they value. In his established field the global elite universities such as Yale, Harvard and Stanford, Oxford and the like (the Global Super League), which have global dominance in knowledge capital, take position closer to the autonomous pole. Then, the economic /business focused global universities including for profit and some non for profit vocational universities in UK, US and Australia, that provide educational internationally and capitalise in revenues and market shares, occupy positions near the heteronomous pole of the field. In the global Higher Education *field* both positions are important; meaning that universities that are short of the two types of *capital*, will have much lower/lesser positions.

Naidoo (2004) also demonstrated poles when they constructed the South African *field* of university education in order to analyse how social political forces within it translate themselves in the development of new admission policies in South Africa. They applied Bourdieu's theoretical concepts to explain the relationship between South African universities during the period of political change in 1985-1990, that included lifting of the racial segregation legislations in universities set in 1959 the apartheid laws. Naidoo explains the structure of the South African Higher Education *field* by positioning contrasting Black and White universities. (Naidoo, 2004) positioned a white English-medium university in a more *autonomous* sector because of being less influenced by external factors; and positioned a Black university in a more *heteronomous* sector because being largely influenced by political forces, the democratic movement in particular. She then showed how the positions came to play in admission policies for the white universities that are almost completely autonomous and for the Black universities that are very much heteronomous, influenced by the political forces. (Naidoo, 2004) then explains how particular historical developments that occurred in South Africa have shaped the internal structure its university education *field* which has in turn translated the social political forces in admission policies.

This will be useful in determining positions of actors in engineering education field once specific capital is defined. It is therefore useful for this to identified the two poles and the relevant *capital* that makes those poles when establishing engineering education as a *field*, in order to explain objective positions, as well as the rules of playing in those positions, and hence a more distinct structure of the field.

3.2.5 *Competition* or struggle in the *field*

The important discussion in Bourdieu's theory of interest to this research, is competition or the struggle for *capital* in the *field*. Bourdieu and Wacquant (1992) referred to a *field* as a space of conflict or a space of *competition* where participants try to establish domination over the types of *capital* effective in the *field*. The struggles that are being discussed here are the everyday undertakings that people use to get to what they want.

> "But a field is also constituted by, or out of, the conflict which is involved when groups or individuals attempt to determine what constitutes capital within that field, and how that capital is to be distributed."(Webb et al., 2002, p. 22)

This quote shows that the conception of conflict or *competition* is important in explaining that individuals determine what will count as *capital* within a *field* and this has to be agreed upon by other individuals in the field, and getting that agreement necessitates *competition*. Agents can argue (compete) about what should count as capital and how that *capital* should be distributed in that field. The simple struggles to negotiate what is capital can result in change of rules on distribution of capital, which means transformation of the structure of the *field*. When the struggles do not result in any changes to what is capital, but changes to who can possess it, this means the structure of the *field* will remain as it is.

From the discussion of configuration of *field*, we know that *capital* is what pre-determines the structure of the *field* or the objective positions that agents can take in the *field*. Also when entering the field agents may either conform to the pre-determined objective positions or may struggle to define new positions in the field. To emphasise the notion of competition, let's look at the field as a field of power, a space where agents are in constant struggle for capital. Part of what causes *competition* is the actors' *habitus* that they bring to the *field* that causes them to act in a particular way in that *field (Grenfell, 2008).* Therefore while *capital* governs the structure of the *field*, *habitus* is responsible for the dynamics of the *field*. This implies that capital determines the options that agents get in the *field*, but the choices that those agents make in taking their positions in the field come from their *habitus* (Naidoo, 2004). We can say that *habitus* is an important notion because it is what causes the dynamics of the field. *Habitus* is explained in section 3.3

3.3 *Habitus*

Habitus is an actor's patterns of behaviour that build up over the lifetime. These learned patterns of behaviour are influenced by values and beliefs for instance ones gender, race, religion, experiences, and education. So habitus is very historically and culturally influenced, as Webb et al. (2002) explains it "as values and dispositions gained from our cultural history that generally stay with us across contexts (they are durable and transportable)." (pp. 36-37). Since *habitus* is connected to individuals' or actors' history, to understand it will require us to identify the individual histories of the actors. Example a child's behaviour in the family field will depend on what the values and beliefs they have acquired during the course of their growth, which includes things like religious practices, gender roles, cultural norms, education and behaviours.

> An agent's habitus is an active residue or sediment of his past that functions within his present, shaping his perception, thought, and action and thereby moulding social practice in a regular way. (Crossley, 2001, p. 83)

This means that *habitus* is not only made of past history, but interplay of past and present; and it is acquired over a lifetime; and is what formulates the social activities in the field. For instance in the *field* of Higher Education, academics enter the *field* with their learned patterns of behaviour with regards to teaching from their past experiences and education, which may guide their own teaching styles. Upon entering the Higher Education *field* they will have to learn the rules of the *field* and their behaviour will be shaped in relation to the rules of the *field*. It might be that the field recognises the *habitus* that these academics bring or they might have to develop new patterns of behaviours to match what is required by the *field*. It is important to note here that the academics will teach in a certain way only in the university *field*, which means *habitus* is only significant when perceived in the *field* (Bourdieu & Wacquant, 1992), hence the relationship between habitus and field.

3.3.1 Habitus and field

Reay (2004) explains how *habitus* acts in response to the *field*, and therefore it is dependent of the field that it is in; meaning it acts in accordance to its environment:

> "Habituses are permeable and responsive to what is going on around them. Current circumstances are not just there to be acted upon, but are internalized and become yet another layer to add to those from earlier socializations: …

> Thus, while habitus reflects the social position in which it was constructed, it also carries within it the genesis of new creative responses that are capable of transcending the social conditions in which it was produced. (Reay, 2004, pp. 434-435)

Further she claims that habitus can also change beyond the original conditions that it was created. *Habitus* is constituted in instants of practice and is also completely arbitrary, and operates at a level that is partly unconscious (Webb et al., 2002). Referring back to the example of the university *field*, academics who enter the university will partly unconsciously act in reaction to the norms they encounter in that *field*. Those academics that respond positively to the norms of the university may become successful; while those who do not respond positively to the norms of the university may find difficulties. This combination of their past and their encounter in the *field* is what shapes their actions in the field. Hence, *habitus* determine how individuals act in the *field*.

> A field consists of a set of objective positions, historical relations between positions anchors in certain forms of power (or capital), while habitus consists of a set of historical relations "deposited" within individual bodies in the forms of mental and corporal schemata of perception, appreciation, and actions. (Bourdieu & Wacquant, 1992, p. 16)

So according to (Bourdieu & Wacquant, 1992), field is linked to structure or 'objectivity', while habitus relates to 'subjectivity'. The two notions of field and habitus therefore play an important part of Bourdieu's theory of practice in reconciling the two ideals.

Habitus is related to *field* in a logic that they function in reliance of one another: such that the field helps in taming habitus, while *habitus* on the other side creates an important realm through practice. Crossley calls this "a circular relationship", and explains that, "Involvement in a field shapes the *habitus* that in turn shapes the actions that reproduce the field." (Crossley, 2001, p. 87). The *fields* in which people practice can 'produce' or 'transform' their attitudes and practices (Webb et al., 2002). For example in a family context, how one's habitus is expected to change when one grows- taking on more responsibility for instance- and what benefit they get from making those changes.

> The relation between habitus and field operates in two ways. On one side, it is a relation of *conditioning:* the field structures the habitus, which is the product of

the embodiment of the immanent necessity of a field …On the other side, it is a relation of knowledge or *cognitive construction*. (Bourdieu & Wacquant, 1992, p. 127)

Further, Bourdieu and Wacquant say that a person's habitus determines whether or not they think it is worth playing the game in a particular field.

Habitus contributes to constituting the field as a meaningful world, a world endowed with sense and value, in which it is worth investing one's energy. (Bourdieu & Wacquant, 1992, p. 127)

There are patterns of behaviour that a certain field will generally reward, and these will be referred to as dominant habitus and the agents with these behaviours will usually produce in the field. The field of engineering programs for example tends to attract people that have certain habitus related to abstract thinking. This is because the field rewards behaviours that are associated with abstract thinking, people who are good in mathematics and physics and so on – so these are dominant behaviours.

3.3.2 Habitus and strategy (position taking)

The concept of strategy has developed along the idea of struggle or competition and it is an important concept that is said to break with both objectivity and subjectivity, in that *strategy* is dependent on the objective structure and their *habitus* (Harker et al., 1990). Bourdieu has used the notion of strategy to explain actions occurring in Higher Education (Webb et al., 2001), for instance in showing that "agents and institutions individually or collectively implement strategies in order to improve or defend their positions in relation to other occupants" (Naidoo, 2004, p. 459). In the concept of *field*, Bourdieu brings together the concepts of *competition* and *strategy* in the field in three ideas:

1. The idea that the struggle for recognition is a fundamental dimension of social life. Struggles over accumulation of capital. Therefore there must be a specific logic of accumulation of symbolic capital, such as the capital which is founded on knowledge and recognition; 2. The idea of strategy, like the orientation of practice is not conscious nor calculated nor is it mechanically determined. It is the intuitive product of 'knowing the rules of the game 3: the idea that there is logic of practice – the details of which depend on specific time and place, or may of course depend on sequence of events over time. (Bourdieu,

Fr. ed. 1987:33 Cited in Harker et al., 1990, pp. 17-18).

Bourdieu's *strategy* is understood to be specific orientation of practice; however unlike strategy used in language, it is not based on conscious calculations, but is the result of individual's unconscious response to the field as they encounter the rules of the field. So, strategy is position taking, and habitus on one hand can explain how an individual has developed certain attitudes and strategy on one hand and on the other it can explain how they practice (Webb et al., 2002). This research will use this notion of *habitus* to analyse individual behaviour in engineering education *field*, by drawing out the existing *strategies* from observed practices of agents in the *field*.

3.4 Theoretical Approach

The three elements *field*, *capital* and *habitus* are interdependent and can only be defined within the theoretical system that they institute and not separately. In that sense therefore a field is defined as a social area of action with specific *capital* (values) that determine the structure of the field (objective positions) to be pursued by different agents (individuals and institutions), with different *habitus* (patterns of behaviours) that those agents brings in the *field* and therefore explain action in the *field* (Bourdieu, 1977; Bourdieu & Wacquant, 1992). Therefore studying practices or what people do in the field with their *habitus* may lead to predicting what lay in people's histories and explain why they do what they do.

So in addition to the research question and sub questions considering Bourdieu's theoretical framework raised the following questions:

1. What forms of capital are actors in in engineering education *field* pursuing and how is that capital distributed (the rules)?
2. What are the different *habitus* that actors (individual and institutions) bring to the *field* of engineering education?
3. What are the *competitions* that exist in the *field* of engineering education with regards to 'globalisation of engineers' (in Africa)?
4. What are the *Strategies* that African engineering education actors in Africa can employ in order to globalise their engineers?

Identifying *capital* and more specifically the distinct capital in engineering education will help in establishing it as a *field* and therefore applying Bourdieu's theories in designing the methodology including collecting and analysing data, for example when recruiting participants I sought voices of those with and without capital in the Tanzanian context. Assuming that engineering education is a field, knowing the capital in engineering education field will inform the rewards that actors are looking for, also the rules that they have to follow to possess that capital. The different forms of capital and their distribution explains the structure of the engineering education *field* by identifying the objective positions, the possibilities that exist for agents in the *field*, according to the capital they possess (Webb et al., 2002). Understanding positions will determine the how and why actors in the *field* of engineering education position themselves, hence explain how the *field* of engineering education is structured – objective positions. *Autonomous* and *heteronomous* pole will be used here to get more accurate objective positions.

Understanding *habitus* of actors, in this case mainly African actors, means that we are able to look at how agents choose to act in relation to the rules of engineering education *field*. This can help explain the ways that engineering education's discourses such as globalisation discourse is responsive or resistant to the African stakeholders' *habitus* and their context and therefore digs deeper into the underlying issues for adaption of such discourses (Devine, 2012). Identifying and describing the struggles or conflicts in the engineering education field will shed light on the important issues of globalisation of engineering education from an African perspective (Matemba & Lloyd, 2017). This will then help us to understand ways that engineering education field is affecting the development of African global engineers.

The observed data on interactions of agents in the *field* (engineering education practice) (interviews and focused groups), reflect interaction between *capital* and *habitus* in the *field* of engineering education. The analysis of these data can establish, if there exists, possible strategies that African actors are applying in order to improve their position in the *field* of engineering education or provide a prospect for this research to suggest other strategies that actors can apply in order to improve their positions in the *field*.

3.5 Chapter Summary

In this chapter, I have established how Bourdieu's concepts of *field* allows us to analyse practices such as engineering education practices being researched by examining what people are doing in the field. From the observations, we can determine the rules of interaction of the field and what is valued by that *field* or what they are competing for (*capital*). *Capital* is fundamental to that analysis because it helps us to establish the positions that agents can take in the *field* and hence the analysis of structure, and *habitus* is important because it will explain why people behave the way they behave, according to their positions and leant behaviour.

In the next chapter (Chapter 4), I demonstrate how I applied this theory to construct engineering education as a field, in order to allow me to analyse the globalisation discourse.

4.0 **Engineering Education as a *Field*[5]**

To analyse issues of engineering education practice such as the issues of globalising engineering education in this research, it is useful to view the space of practice (engineering education) as a distinctive area of study, which Bourdieu's conceptualisation makes possible through the concept of field (Maton, 2005). In this chapter I demonstrate that engineering education is a comprehensive field that can be analysed using Bourdieu's theory, and to show in general how this field works, before I go on to consider the particular case of 'globalisation of engineers' that I am interested in. A different version of this chapter was presented as a paper titled: *Constructing the Bourdieusian field of engineering education: Engineering education transformation as a field phenomenon*, at the Research in Engineering Education Symposium in July 2019 in Cape Town (Matemba & Lloyd, 2019).

4.1 **The Engineering Education field**

4.1.1 The structure

This chapter pays particular attention to Bourdieu's demonstration of the composition of the field (the structure of the field) which is defined by objective positions that agents (actors, participants) can take in the field (Bourdieu, 1993b) and what those positions may allow. The structure of the field is defined by organisation of specific capital and the way people go about obtaining that capital, the rules or specific logic of the field. Further, for any field, it is its structure that will guide its function (Grenfell, 2008) therefore it is important to construct engineering education as a field in order to expose the objective positions that agents playing in the field can take according to the type and amount of capital they possess. Knowing agents' positions (structure of the field) will enable the analysis of practice to apprehend the different positions, and hence the different viewpoints in the field.

As mentioned in chapter 4, Bourdieu is known for his success on reconciliation of objectivism (structure) and subjectivism (coming from habitus) through bringing together field, capital, and

[5] This chapter incorporates concepts and materials that were previously presented in an article Matemba, E., & Lloyd, N. (2019). Constructing the Bourdieusian field of engineering education: Engineering education transformation as a field phenomena. Paper presented at the Eighth Research in Engineering Education Symposium, 10-12 July, Cape Town. The copyrights of the paper were retained by the authors, therefore there was no need to obtain permission from the conference.

habitus. That practice is constituted not only by the structure of the field (agent's positions) but also habitus that agents bring into the field. What agents do (disposition/position taking/strategy) in the field, depend on a combination of their habitus and their position in the field, which agent occupy according to the capital they possess (Bourdieu, 2010). This research is interested in exposing the intersection of what the field of engineering education will allow (the structure) and the habitus (learned behaviour) that people bring with them, and how the interaction plays out, in their actions or practices.

4.1.2 The field in discussion

The area of engineering education under inspection is the one that holds together as a coherent set of actions (or field of behaviour) is the one that focuses on developing engineers or developing engineering skills through Higher Education (Siller, Rosales, Haines, & Benally, 2009; Spinks et al., 2007). This is the area of practice where people (individuals or institutions) such as academia, industry and professional community, are involved because of their interest in developing engineering competence (knowledge, skills and attributes) that will allow smooth entry and navigation into the engineering profession (Sheppard, Colby, Macatangay, & Sullivan, 2006). These people, who in Bourdieu's terms may be defined as agents, have debated for years about what should be taught, who should be taught and how it should be taught (Froyd, Wankat, & Smith, 2012; Seely, 1999). They have also had to play by certain implicit rules that the field is made up of, for example, adhering to accreditation, transforming to outcomes-based education and engaging in engineering education research (EER), which they have sometimes argue over. These agents also bring to the field their own sets of behaviour habitus that contributes to their actions.

The area of engineering education in discussion, is different from engineering education research area which is suggested to be an emerging 'field of inquiry'(Borrego & Bernhard, 2011), where people are interested in inquiry into engineering education (Jesiek, Newswander, & Borrego, 2009). In engineering education research, people argue about things like theories of learning, dissemination of quality research, research methodologies to use, and other issues which are related to improving rigor in engineering education (Borrego et al., 2009; Kellam & Cirell, 2018; Streveler & Smith, 2006). Rather, the *field* of engineering education corresponds to the engineering education that is said to be aimed at preparing graduates for employment or the engineering profession (Crawley et al., 2014; King, 2008; Sheppard et al., 2009), albeit this field is influenced by Engineering Education Research. Constructing the field of engineering education therefore allows demonstration of how people who are vested in undergraduate training of engineers are positioned, and the implications that these positions on their actions for instance when it comes to 'globalisation of engineers'.

4.2 Field of Engineering Education in Literature

A brief review of previous studies in engineering education that have applied Bourdieu's theory was conducted in order to apprehend what other researchers are discussing concerning field, capital, and habitus, that is connected to the agents they are observing (summarised in Table 4.1). Establishing engineering education as a distinctive *field* seems to be problematic and the reviewed studies have mostly either applied Higher Education *field* (Ahmed, Kloot, & Collier-Reed, 2015; Case et al., 2016; Kloot & Rouvrais, 2017; Naidoo, 2004) or classroom field (Devine, 2012). The main problem with discussing engineering education as a field has been the difficulty to isolate its specific capital due to its strong links to other areas such as industry, disciplinary sciences, and university (Higher Education) policies; whilst according to Bourdieu and Wacquant (1992) specific capital is what describes an area as a field.

4.2.1 Capital and positions in the field

Two of the studies in Table 4.1, both PhD theses, Kloot (2011) and Jolly (2016), have constructed *fields* of engineering education for their analysis; each with their own approach but neither of them have clearly separated the capital that is specific to engineering education. These studies are all following different research questions, and the space they defined was sufficient to address those research questions; but what is notable about this body of work is the way they have identified capital depending on the space of engineering education they were defining, for instance cultural capital for field of classroom or intellectual and academic capital for a field of engineering education operating under university rules. Further in some work the different types of positions for agents to pursue in engineering education have been explicitly and implicitly expressed.

Table 4.1 Bourdieu's theory in engineering education literature: *field*, *capital* and *agents*

Reference	**Field (Space of action)**	**Capital (What is valued)**	**Agents**
Kloot, Bruce 2011 A Bourdieuian analysis of foundation programmes within the field of engineering education: Two South African case studies.	Engineering education (within the structure of university field with special connection to industry)	Intellectual and Academic development	Academia Industrial players
Jolly, Hannah 2016 Understanding Pedagogical Content Knowledge for Engineering Education: The effect of field and habitus.	Engineering education field (containing four nodes: industrial, Higher Education, regulatory, and engineering education)	Industry practice (Industrial) Research (Higher ed.)- –graduate competencies (Regulatory and accreditation) - theories of education and learning and about optimising educative process (EE research)	Teachers (Academia)
Ahmed et al 2015 Why students leave engineering and built environment programmes when they are academically eligible to continue.	Higher Education field	Cultural capital	Students
Case el al 2016 The significance of context for curriculum development in engineering education: a case study across three African countries.	Higher Education (University field) - containing capital that is shared by industry	Funding, accreditation industry university policies	University departments (curriculum developers)
Devine, Jo 2016 An analysis of socio-cultural congruence and its impact on diverse student cohorts in an engineering context.	Classroom	Cultural capital	Students

Jolly (2016) describes engineering education as a field made up of four main nodes, which are points where engineering education intersects with other fields namely; engineering industry, Higher Education, regulatory bodies, and engineering education research, and which respectively describes four main capital of engineering constituted by each of the node. They discuss capital of *industry practice* at industrial node, *research capital* at Higher Education node, and *graduate competencies* capital at regulatory node. Then at the engineering education research node they include capital on the *theories of education and learning*, and about optimising educative process focus (Jolly, 2016, pp. 51-60). By accounting for the availability of four different types of capital, Jolly (2016) offers an insight on the type of situations and opportunities that agents encounter in engineering education field, as a result of influences of other aspects of society to the engineering education field For instance, showing that there are different positions around the four nodes that academics (teachers) can take depending on the type of capital they have and the capital they are pursuing.

In *A Bourdieuian analysis of foundation programmes within the field of engineering education*, Kloot (2011)describes the field of engineering education that is operating within the university field, the rules of the university field affect how different academics are pursuing different capital. He argues that engineering education is a *field* that operates within the structures of University *field* and therefore uses forms of capital that originate from the university field that Kloot (2011) draws from Bourdieu's work *Homo Academicus*, intellectual capital and academic capital. From interviews of experienced engineering academics in South Africa, he found that pure academicians valued capital that has its origins in the university field – intellectual capital. The intellectual capital has been commonly identified as a dominant capital for Higher Education by Naidoo (2004), and also in Bourdieu's work in Higher Education (Bourdieu, 1988). So the academics that possess this capital may take a more dominant position in the field.

Kloot (2011) also identified another group of academics that valued capital that supports teaching and learning, which he referred to as academic capital. Academic capital is the capital that has emerged in Higher Education arena since the 1960s, and favoured by academics that engage directly with curriculum and students (Clegg, 2009). Kloot (2015) in his recent work present the academic capital as capital that is positioned in the opposite pole of the intellectual capital the polar structure of university field, resulting in opposing forces in the field. He found that in engineering this capital was also favoured by a group of academics that are more industry based, or those with links to Industry.

With regard to capital in engineering education field, the references show some congruence on the existence of different types of capital that agents can pursue in engineering education field, and although they gave them different terms, there is some overlap. The field describe in Jolly (2016) seems to relate to a kind of teacher's field, where the four types of capital (industry practice, research, graduate competencies, theory of education and learning) are in play to constrain or support to improve engineering teachers position taking or their choices in teaching. The field of engineering education that Kloot (2011) constructs leans more on the university field definition with a focus on academics' actions and their reasons for the choices they have made in their academic path and that is why it is learning on the university rules. My view of engineering education falls on similar space of developing engineers that includes teaching, but, also considers the wider influences of other fields and participants including industry. Its capital may be closer to the capital that were identified previously, meaning industry practice and graduate competencies Jolly (2016), and also the academic capital in Kloot (2011).

Jolly (2016) and Kloot (2011) arguments, although differing in view on capital and field, provide an important base for constructing the engineering education field for this research. The two are also the most useful studies for my purposes because they pose scenarios and discussions that will be very important for illustration of how people in the field of engineering education operate. We will see in some contexts that agents in the field of engineering education have been able to manipulate what is considered capital in the field and therefore differentiate it from the university or Higher Education field. For instance they (agents) have argued for academic roles that are more dedicated to people who are more inclined to industry requirements, and they have significant links to industry and care about producing graduates that can be competent in their engineering roles. Building from what they have said, I will try to explain my argument that engineering education is a distinctive field.

4.2.2 Agents and habitus in engineering education field

The agents in the engineering education field identified in previous studies (Table 4.1) are universities, academia and students (Devine, 2016; Jolly, 2016; Kloot, 2011). Apart from the traditional agents (universities, academia and students), it is now common to find non-traditional agents playing in the engineering education field, such as engineering firms, professional and regulatory bodies and international engineering and Higher Education associations. This is because of the capital that operates in it – the competencies capital, as will developed later on in

4.3. In this research, I have focused on four categories of agents that are: Higher Education agents (universities and academia), Industry agents (employers), regulatory agents (accreditation and professional body) and junior engineers (graduates or alumni). Observing what the agents are doing in the field will inform about the field's capital, habitus and strategy.

Agents for various reasons enter and play in the field of engineering education because of their interest in pursuing the field's capital – mainly competencies and scientific knowledge capital. According to Bourdieu and Wacquant (1992), they (people) can enter the field because they also bring into the field certain forms of capital that are transferable to the capital of the field of engineering education. The agents are also assumed to know the rules of the field and to try to play by them as they pursue capital, at times they will also try to influence the rules of the field. For instance Academia or university agents pursue different types of capital in their field of engineering education as previously suggested (Jolly, 2016; Kloot, 2011), that some pursue research which is related to Higher Education capital and others pursue practice which is related to industry. All academia are usually bounded by the rules of Higher Education.

Student agents are mainly interested in the cultural capital of engineering education field which as Kloot (2011) identified may be that of Higher Education field – intellectual capital. This is because the engineering education field is influenced by Higher Education field. There are also emerging motivations for students who pursue competence which is the industry type of capital, especially with development of the global job market. However, the success in this seems to depend on what the context of their university structure (rules) would allow or value and what their habitus will guide them to do in the given environment. The agents playing in the field are the bearers of capital and their activities in the field rely on the position in the field (their viewpoint) as well as the habitus they bring in the field. This is explained by Bourdieu and Wacquant as follows:

> *… social agents are not "particles"* that are mechanically pushed and pulled about by external forces. They are, rather, bearers of capitals and, depending on their trajectory and on the position they occupy in the field by virtue of their endowment (volume and structure) in capital, and they have a propensity to orient themselves actively either toward the preservation of the distribution of capital or toward the subversion of this distribution. (Bourdieu & Wacquant, 1992, pp. 108-109)

For instance, when in engineering education field, engineering firms are interested in the development of professional competencies of graduates. They also bring into the field values like employment for graduates and placements for engineering students that universities are interested in, and therefore have a say in the field. Universities will try and align to the required competencies because they are pursuing secured employment for their engineering graduates, which in turn improved their position with regards to employability, while in the Higher Education field universities may be pursuing knowledge creation or intellectual capital that brings academic recognition for their institution. Universities also get ranked on graduate employability outcomes and firms also use the placement as recruitment screening for those skills. In some countries, especially countries in the Global North, engineering professional bodies will inform graduate competencies through accreditation which in turn tend to set the tone for curriculum. This is not happening in all areas of Higher Education hence another thing that engineering education is distinct from the Higher Education field.

Those agents in engineering education bring to the *field* their *habitus* which determines guides what they do *(practice)* or the choices they make in the *field.* Bourdieu and Wacquant (1992, p. 18) states that "Habitus is the structuring mechanism that operates from within agents, though it is neither strictly individual or in itself fully determinative of conduct." In *Distinction (Bourdieu, 2010),* also explain that "The habitus is not only a structuring structure, which organizes practices and the perception of practices, but also a structured structure:" (p. 166)

Bourdieu's field could be perceived to be a radical contextualisation because it also takes into consideration the agents' trajectories. He claims the field:

> ... takes into consideration not only works themselves, seen rationally within the space of available possibilities and within the historical development of such possibilities, but also producers of works in terms of their strategies and trajectories, based on their individual and class habitus as well as their objective position within the field. (Bourdieu, 1993a, p. 9)

For example (Kloot, 2009) explained issues of structure and the struggles within the South African Higher Education field using interviews of elite academics and their career trajectories. He indicates that those academics that were supporting foundation programmes are for academic capital and have developed their ideals (habitus) though their engagement with other areas outside research including administrative roles and industry. Kloot (2009), also expounds that those who are more focused on the research capital find foundation programs to be difficult to get involved in, especially if one really wants to focus on research, which implies that those who are for intellectual capital insist that their universities are research-lead and therefore they should concentrate on research. These people have typically also achieved their positions in the field (e.g. promotion) through rules of pursuit of research so feel threatened by the introduction of new rules. Their ideals (habitus) is also developed in their research trajectory.

4.2.3 Influence of industry and Higher Education on the structure of the field

The *capital* discussion from studies in Table 4.1 show that the field of engineering education like any other social field, is embedded within other fields (Grenfell, 2008) that influence not only its capital but in a significant way its specific logic (rules). The strong influence that external forces have on engineering education, especially those from the fields of industry and Higher Education, is an important discussion for this research, influencing the *capital* and rules that make up the structure of the field where engineering education agents operate.

Kloot (2011) suggests here that the technical field of engineering education basically functions within the rules of University field, but also acknowledges that there is an interest in the competencies of engineers that is held by its links to industry, and this is what makes engineering education field distinct from being just part of the University field. Kloot (2011) states that:

> It is important to note that the field of engineering education… should not be thought of as part of the university field as an engineering faculty is part of an institution… Instead, the field of engineering education should be thought of as a field in its own right, largely operating according to the basic principles of the university field but with a special connection to industry that values the skills and expertise of the engineer. (Kloot, 2011, pp. 42-43)

Kloot (2011) defining engineering education 'as a field in its own right' but also implying that it operates according to the principles of the university. Also the fact that engineering education field is also maintaining the forms of capital that had their origins in the university (or Higher Education) field (academic and intellectual capital), is interpreted by this research having low autonomy because of lacking own capital. This research agrees with Kloot on 'special connection to industry, but also extend the argument that industry has a significant influence on the way the field functions – its structure- especially with engineering education aspirations to be relevant to practice as will be explained later on (4.3). Kloot (2011) in a way also indicates the dilemma in engineering education between theory and practice, an important discussion that is also experienced by other professional Higher Education with connection to industry such as medical, architecture, teaching and nursing education (Sheppard et al., 2009).

Jolly (2016) shows that teachers face a barrier from the dominant forms of capital that favoured research capital, which is imposed by the field of Higher Education node. That Higher Education field rewards research and does not sufficiently reward teaching, which is an important dimension of teachers' work. On the other hand, she explains a contrasting capital in the engineering industry node, imposed by the industry field, which privileges connection to engineering practice and leans more on teaching than research. The industry node favours teaching activities that represent engineering practices such as students building a prototype bridge. So like, (Jolly, 2016) brings across the point of having opposing power (capital) operating in the field of engineering education which cause tension, for instance tension that has consequences on practice. This is according to the capital and rules (structure) of the engineering education field as well as the behaviours (habitus) that the field would allow.

Case et al. (2016)have also addressed the influence of external forces, despite not asserting that engineering education is a field. They suggested that the industry influence has resulted in engineering education to take a position in heteronomous pole of the university field- to indicate the part of the field whose capital is influenced by external forces. They thus positioned engineering education opposite to autonomous pole of the university field which hosts high levels of the intellectual capital. In their findings Case et al. (2016) describe industry to be one of the three areas that highly influence the curriculum process in engineering education because of its position to provide employment to graduates and work placement to student engineers. Other areas were the State through funding and accreditation, and the institution policies/rules.

Kloot (2011) also explains that different forces related to academic development had "[carved] out a space 'within the field [of engineering education] for things to be done differently" (p. 177), when he was explaining the position of foundation programs (ASPECT) in the SA engineering education field. What we take from this is that, new positions can be created within engineering education field and allow for change in the structure of the field, hence industry influence has power to change the structure of engineering education. Observing current developments in engineering education around the world, such as proposal for courses that imitate industry practice and those that have a full involvement of industry partners such as the Bachelor of Engineering Practice offered at Swinburne (Cook, Mann, & Daniel, 2017), it is easy to see a new position carved out by industry, and its significance to engineering education space, to a point where the field of is beginning to recognise it and reward it. Just like in Kloot's argument, these kinds of developments have not come easy, but through competition (contestation) put forth by a group of academics and other agents. The position signifies the emerging structure of engineering education field.

To add to the argument of industry influence, this current research supports that industry has been significant in shaping engineering education, not just in determining the skills and the expertise of an engineer to fit in an industrial job, but has also imposed the values and beliefs in engineering education. Looking at the history of engineering education next in section 4.3 will show the bottom-line connection of industry that has been very influential in all transformations in engineering education to its current state. The extent to which the industry and its allies are willing to pursue competencies, reveals existence of a certain capital, related to developing competencies of engineers that makes up for the uniqueness of engineering education – the competencies capital. The competencies capital, which I will expand on in the following section, is of interest to this research because it is the specific capital distinguishes engineering education field.

Next, I expand on the argument that shows that the status of the field is distinctive with its own capital and rules using literature on engineering education trajectory, in addition to the discussion in this chapter, to construct the basis of analysis for this research.

4.3 Constructing the field of engineering education for this research

As discussed in the beginning of this chapter, this research will capitalise on the notion of field and in particular its structure (objective positions), in order to expose engineering education as a social area of practice, field, whose structure is defined by its specific capital and the rules around obtaining that capital. According to Grenfell (2008), information about the structure of the field (i.e. its capital and rules) can be understood by observing occurrences in the field, that is, what the main actors within it are doing, and how they are doing what they do. These occurrences can be obtained from studying the field's trajectory which, for engineering education practice, has been well documented in the wealth of publications that report on major transformations and trends in engineering education (Matemba & Lloyd, 2019). This provides an opportunity for a framework to analyse engineering practice more rationally, and from a social theoretical view point of Bourdieu's theory, the issues of 'globalisation of engineers'.

This research takes advantage of the abundant literature on engineering transformation, because those transformations have contributed significantly in shaping the practice of engineering up to what it is now. The transformations that have also contributed to the concept of globalisation, have allowed for the development of a form of capital that focuses more on graduate competencies, also referred to as graduate skills, in relation to industry practice, as explained previously in chapter 2.

In order to construct the field of engineering education, published literature on the transformation, history, evolution, or development of engineering education and accreditation, was explored as explained previously in earlier work by the author and their supervisor (Matemba & Lloyd, 2019). The literature explored, about 35 references, was mainly from the Global North especially from North America and Europe, which explains the characteristics of the field that is constructed here. The references reported on developments beginning with the major transformations that happened in the 1990s, such as those in the US (ASEE, 1994) and in Australia (Engineers Australia, 1996) as a result of various industrial developments in the1980s. The method of gathering, selecting the literature is explained in details in (Matemba & Lloyd, 2019, p. 381). From those transformations' occurrences, capital of the field, and rules of obtaining that capital was drawn. Some habitus that is conventional in the engineering education practice was also observed in agents. Therefore, using the trajectory literature, in addition to the discussion in 6.1 and 6.2, this section expands on the argument that shows that the status of the field is distinctive with its own capital and rules to construct the basis of analysis for this research.

4.3.1 The structure of engineering education field

The influence of Higher Education on engineering education is the main source of the dilemma between what universities think industry practice is, and what industry is expecting(Trevelyan, 2010a; Walther & Radcliffe, 2007). It comes from history where engineering education and other professional education were incorporated into research universities and had to comply with the rules, changing its focus to scientific knowledge in the 1960s (Froyd, Wankat, & Smith, 2012; Seely, 1999). Engineering as a discipline did not have a long deep-rooted history academically compared to other Higher Education, it was a practice-based training where engineers learned on the job. However recent history, from the 1990s, has seen an upsurge in the industry practice interest especially in connection to globalisation as evident in the developments in engineering education reported in literature introduced in chapter 2.

The 1990s trend seemed to be reversing the earlier process described in Seely (1999) by downplaying the science and maths and emphasizing practical non-technical skills in order to relate more to the engineering practice. These trends are what this research has observed to be the point where engineering education started distinguishing itself from Higher Education field. Because of this history, there has since been tension between engineering practice and theory (Sheppard et al., 2008) which has led engineering education to always occupy an equivocal place in the academy area. Hence the significance of discussing the trajectory of engineering education from the 1990s in relation to how the field took its shape (structure) – its capital and its rules.

i. Specific capital- relevant to industry competencies

Engineering education agents (educators, institutions, professional bodies and student) value being and remaining relevant to industry –this has been showing up several times in the literature, where engineering education advocates have tried to define what the relevance to industry practice is, in terms of competencies that graduate engineers can demonstrate. Industry practice has been changing and therefore the definition of what is a relevant capital has also transformed over the years. The major trends in engineering education in the 1990s such as those reforms to outcome based education and competence based accreditation in the US (ASEE, 1994) and in Australia (Engineers Australia, 1996) and other countries in the Global North have allowed for the development of a form of capital that focuses more on competencies, such as those introduced in chapter 1, section 1.2 also referred to as industry practice capital.

Up until 1980s, the demand was more for of technical competencies and engineering education was emphasising on scientific knowledge behind engineering –the engineering sciences which seemed to be relevant enough for the industry during that time. By the 1990s the demand changed to be about non-technical competencies or soft skills on top of the technical skills previously required for graduates, due to the changes in the industry in reaction to the pressures of technological innovation, globalisation and the changing markets (Ibrahim & Cockrum, 1993; Mackenzie, 1999). The pattern was observed from US, UK and Australia, with other Global North countries also followed shortly after. As pointed out previously (section 2.1), the issue of developing generic skills for engineers raised in the similar economies of the Global North wanting to remain relevant in the period of the global markets which was prevailing in the industry then. In the UK, the issue of lack of the so called ‘generic skills’ (or generic competencies) in engineering graduates, was raised earlier on by the famous 1980 Finniston Report (Brown, 1998), and became more prevalent in the 1990s (Dodrige, 1999) due to the impact of the increasing globalisation on industry.

> These influences are leading to a more dynamic and agile manufacturing sector in the UK which, in turn, is placing increasing demands on the education system for the skilled people it needs to compete in global markets in the 21st century. (Mackenzie, 1999, p. 270)

According to Mackenzie (1999), UK Higher Education institutions were facing increasing appeals to produce graduates with skills that could enable UK to remain competitive in the times of global markets. Dodrige (1999) asserts this pressure led to a focus on generic competence that later on led to the changes to outcome-based approach (from learning objectives to learning outcomes) in engineering education in the UK in the late 1990s. Similarly, in the US, motivated by global markets resulting from the requirement to produce globally competent engineers:

> In the United States, reform activities relevant to our analysis started in the 1980s with initiatives to increase the flow of students through the engineering pipeline, shifted in the 1990s to attempts to create flexible engineers for a global economy, and then coalesced in the late 1990s with the establishment of new accreditation criteria for engineering programs. (Lucena et al., 2008, p. 434)

By new accreditation criteria, (Lucena et al., 2008) was referring to the American Board of Engineering and Technology (ABET) criteria 2000. Since the introduction of the ABET criteria at the end of the 20th century, competencies or skills have continued to be a central topic of discussion among engineering education stakeholders, and they have at different stages discussed the meaning of the skills and how to they can be developed in students (Shauman, Besterfield-Sacre, & McGourty, 2005; Spinks et al., 2007). Also in terms of acquiring capital, ABET gained a lot of power and influence in the engineering education arena, it became a leader in outcome based accreditation with countries referring to its criteria as the best methods or as a definition of generic competencies. Up until then ABET had been a primary regulator of engineering education in the 1980s only provided accreditation that was input-focused (based on resources and curriculum credits) (Lucena et al., 2008), and not outcome-focused (based on graduate competencies).

There were more demands for engineers with skills for global or 21st century working environments (Hedberg, 2001), and there were also initiatives to try and meet the demands. To develop the ABET skills (Felder, 2003; Shauman et al., 2005)This time the demands were more explicit and specific and detailed for example there was emphasis of intercultural skills as a requirement for graduate engineers to be able to work with or among people from other cultures (Downey et al., 2006; Lucena et al., 2008). Engineering education advocates were asking questions like – what do global engineers really do, or what are the competencies required by engineers and so on, in order to define competencies that are relevant to the role that was facing them in the industry. This shows relevance to practice capital at play through and the recent calls for globalisation are developments of those initiatives.

The initiatives resulted in the replication of the 1990 trends in engineering education and accreditation, although not with the same magnitude. There were reviews of engineering education that led to redefinition of competencies by the same actors ABET in the US, ENAEE in Europe, and EA in Australia (Sally A Male, Bush, & Chapman, 2010; Sally Amanda Male, Bush, & Chapman, 2011; RAE, 2007). Meanwhile there was still a competence dilemma in engineering education between what engineers were describing as graduate attributes and traits that industry require, which in Bourdieu's terms can be described as competition or conflict about the capital of the field.

The efforts to defining and developing competencies such through outcome based education was found to be insufficient (Allan & Chisholm, 2009; Walther & Radcliffe, 2007), because engineering graduates need to demonstrate how they can apply those skills in the actual practice, which is mostly difficult to demonstrate in the normal HE education system.

Engineering education literature at that time, proposed more attention on relevance to engineering practice:

> If engineering students are to be prepared to meet the challenges of today and tomorrow, the [centre] of their education should be professional practice, integrating technical knowledge and skills of practice through a consistent focus on developing the identity and commitment of the professional engineer. Teaching for professional practice should be the touchstone for future choices about both curriculum content and pedagogical strategies in undergraduate engineering education.(Sheppard et al., 2009, p. 7)

Sheppard et al. (2009) and others (Litzinger et al., 2011; Walther, Kellam, Sochacka, & Radcliffe, 2011) during this time were arguing for engineering education to focus on developing practice competencies and there was more inquiry that focuses on the role of engineers in the industry (Trevelyan, 2010b, 2014). Researchers were trying to move from simply defining the graduate competencies into addressing the gap between the defined graduate competencies and professional attributes, in order to ease the transition from graduate to professional engineer. For example it was found that a lot of what engineers do in their practice is interacting with other people; which requires non-technical skills (Trevelyan, 2010a). There were therefore calls to develop experiences that can help students develop and apply those professional skills – technical as well as professional.

Recently, there were more initiatives to conceptualise competencies of engineers from engineering practice (Johri & Olds, 2014; Sally Amanda Male et al., 2011; Trevelyan, 2010b) as well as rethinking the goals of engineer education to "provide the learning required by students to become successful engineers" (Crawley et al., 2014, p. 1). This goes hand in hand with an increased discussion about global competencies or 21st century competencies as others prefer to label them, those competencies that will enable engineers to work with people from different cultures, who define problems differently and sometimes in different contexts from ones they were trained in (Bourn & Neal, 2008; Jesiek et al., 2014). We are now seeing more and more the incorporation of society in engineering sometimes in a form of Sustainable Development Goals (SDG) (Bourn, 2018; Guerra, Ulseth, Jonhson, & Kolmos, 2017), where global skills are promoted for solving global challenges.

There have been many developments in the past decade towards humanitarian engineering with activities in engineering education that is associated with this type of capital such as engineering courses that conduct the Engineers Without Borders (EWB) challenge courses, explained in Kusano and Johri (2015), these involve students to provide simple solutions to problems in developing communities. We can also see the impact of the humanitarian or social perspective in the competencies stipulated in different countries, in the USA's ABET criteria the (ABET, 2017; Parkinson, 2009), UK's Engineering Council Output Standards (Engineering Council, 2014), and in Canada's CEAB graduate attributes (Chan & Fishbein, 2009). This is not necessarily because these societies defines global competence based on humanitarian impulses, but because industry is opening up new markets in areas that may not be familiar to graduates. Therefore they see the need to build skills that will enable graduates to work in those environment, and also to empower those in the situations (Bourn & Neal, 2008). The competencies capital in engineering education has evolved to relate to the engineering industry in ways that other Higher Education fields do not, and this level of inclusion of industry is what distinguished engineering education from Higher Education.

The transformations or changes in engineering education that happened through the years are a bid to be relevant to industry. They are efforts to respond to the particular demands to produce engineers that are suitable to work in the specific engineering industry era, and for the 21st century, this means engineers that can work effectively in global working environments (Jones, 2003; King, 2008; Nguyen, 1998; Parkinson, 2009; RAE, 2007). Figure 4.1 illustrates the development in engineering education focus as observed in the literature. The developments were responding to the demands facing the profession at different times.

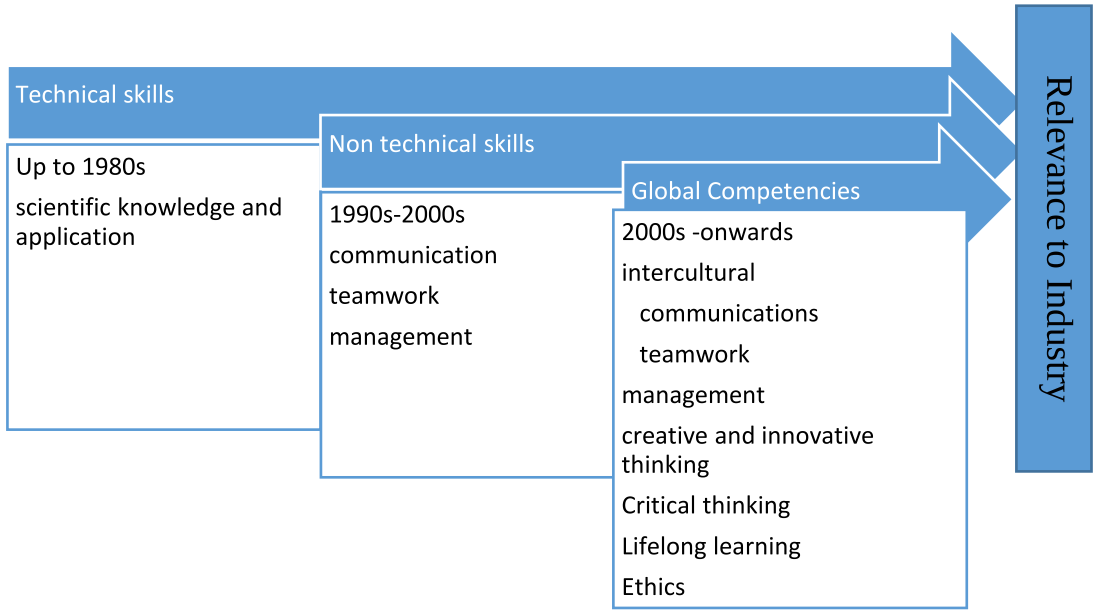

Figure 4.1 Re-defining of Competencies in response to the changes in the industry

According to the above discussion, I do not only agree with earlier studies (Jolly, 2016; Kloot, 2011) that engineering education is strongly influenced by rules of Higher Education (university) field, but I also wish to extend their argument about engineering education field being different from Higher Education per se by having capital that is being defined by industry and imposed by regulatory and accrediting authorities – the competencies capital. This is due to the fact stated before that engineering training was not originally in Higher Education Also institutions that train engineers have continued with efforts to demonstrate that they can develop industry relevant competencies, in a bid to better their position in the field by acquiring competencies capital.

Connecting the trajectory argument to the previous discussions from literature on field of engineering education (in section 4.2), it seems that there is a common point, the fact that engineering education has a very strong impetus towards industry; it is highly influenced by the industry. Although that doesn't make it unique from other Higher Education disciplines for example social work that is also highly influence by external forces (social and political), what is particular about this field is that its industrial concerns that are influencing the way things are done. For example, industry concerns about management skills (acquiring jobs or projects for a firm, getting them done within a minimum time and under budget), and now their concerns about being able to compete in the global market. These industry concerns have contributed a lot to the transformations in engineering education through the centuries, for instance inclusion of project management, entrepreneurship, and humanitarian engineering contents in the curriculum. So, the industry has created an avenue for agents to pursue in the field –a space to make changes.

The relevance to industry practice capital is continuously motivated by the situation in industry, which has recently been the global job markets. Definition of what entails relevance to industry is context specific since different context pose different industry especially depending on different economy. It is currently being defined by the Global North context/perspective of engineering education –with US leading and spreading the agenda from their country to global through ABET certification- hence its dominance in the field (Anwar & Richards, 2013). Redefinition of competencies discussions is also based on context, in the case presented here is that of countries in the Global North who are mostly High Economy countries, and therefore hold power to dictate capital. As established by (Lucena et al., 2008) that redefinition of competencies usually starts from the local and then goes to international for the United States and Europe but not for Latin America.

Lucena et al. (2008) explains how the US has taken its discourse on engineering competencies from country to global which has resulted in it being considered a global discourse. Their local context is what is considered global, so they have acquired a dominant position in this ideal engineering education field. Therefore at least since developing the ABET criteria in 1996, the US has been able to dictate what is valued in the field or what relevance to industry means. They have also been able to make rules of how to obtain that capital, for instance through competence-based curriculum and accreditation as explained later in 2.1.2. Also, from the quote it clearly shows the position of Latin America. Different approach to redefining competencies observed, shows a Latin America's dominated position in the field. Also, Europe taking their time starting with regionalisation show that they value regionalisation. This is consistent with what Bourdieu says that the person with high capital of the field dictates what capital is and also the rules to acquire or demonstrate that capital and in this case US and Europe.

ii. Conflicting Capital - Scientific Knowledge capital

Despite demonstrating its own capital, Engineering Education is constrained by Higher Education. This is more apparent from its academic agents (individual and institutions) who also operate in university space of Higher Education field.

> … although engineering schools aim to prepare students for the profession, they are heavily influenced by academic traditions that do not always support the profession's needs.(Sheppard et al., 2009, p. 4)

What they are saying here is that engineering schools are interested in training students for the profession but because the schools are set up within Higher Education field as settled before (Kloot, 2011), they are constrained by the Higher Education rules. Operating within the university settings that may not share the goal of training students for the profession this is because Higher Education is interested in knowledge capital which another capital that is active in engineering education. In engineering this capital is scientific knowledge capital related to the Higher Education field, and acts as an opposing capital to skills capital in engineering education. This capital was not in engineering education at the beginning, but was introduced to engineering (Froyd et al., 2012; Seely, 1999) when engineering training was finding its place in the Higher Education.

It should be noted that engineering education had shifted from 'hands on' and practical emphasis to engineering science and analytical emphasis in 1935-1965 in the US (Froyd et al., 2012)– Scientific Knowledge Capital. This is because after World War II engineers were seen inferior to scientists to because of their lack the scientific and mathematics knowledge underlying their practice. During this time engineering education shifted to the focus in knowledge creation or the focus of creating knowledge for knowledge sake, where the scientific knowledge capital of engineering education is directed. But "the changing emphasis from applications to fundamentals in engineering schools did not reflect a similar pattern in the practice of engineering" (Wankat, et al., 2005, p. 218), and the tensions between theory and practice in the profession persisted, and continue to be debated globally today. This tension remains ingrained in the structure of engineering education hence affect the positions of agents; for instance, it results in positions that are more attuned to industry relevant rules and others that are more attuned to the Higher Education rules.

In Bourdieu's terms, the tension can be explained as conflict over what constitutes capital in the field, which is also seen in the wider field of Higher Education at individual and institutional level (Marginson, 2008; Naidoo, 2004). How this conflict plays out in the rules of the field, which is to be discussed later, is a relevant point with regard to globalisation.

iii. The rules/specific logic of the field of engineering education

Rules of the field are influenced by the influencing capital. For example, Higher Education rules about obtaining knowledge capital often affect rules as seen in (Kloot, 2011), therefore in engineering education field it is important for students to achieve a certain grade in written exam in theory or knowledge. Engineering education field is therefore influenced by certain rules of Higher Education field. Because of the influencing structure of Higher Education there is a focus on scientific knowledge capital in the universities offering, where concentration is on the theory and practice for instance laboratories are just an additional to theory (Sheppard et al., 2009). These rules contribute to the structure of engineering education field. But in the structure there is also influence coming from the capital emerging from the industry (4.3.1. i), and debates with rules to support this capital have grown in the past two decades, with the quest for education to be more relevant to engineering.

Observing the occurrences in engineering education, there is for instance a specific logic with regards to attaining competencies capital. We see that there have always been debates on producing engineers that are able to practice which have instigated major changes in the field, for instance change to outcome-based curriculum and accreditation or shift in methods of delivery to more active learning methods (Felder, 2003). For instance, in Australia, there was a realisation that the emphasis on engineering sciences, that was enacted previously, was resulting in graduates with high technical skills, but lower their ability to be competent in practice. Due to that, the Institution of Engineers Australia commissioned a review that was reported as *Changing the Culture: engineering education into the future* (Engineers Australia, 1996). The

Changing the Culture report would later become instrumental to engineering education trajectory in Australia, leading to transformation to outcome-based accreditation and curriculum (King, 2008). The report recommended that schools follow a clear set of goals and recommended a list of ten graduate attributes that to a certain degree their students have to acquire, which was the basis of changes in Accreditation processes in Australia in the late 1990s as reported by King (2008):

> Engineers Australia published a new accreditation policy in 1997 based on the ten graduate attributes listed above, thereby directly reflecting the change imperatives recommended in the Changing the Culture report. The policy called upon the accreditation process to focus increasingly on graduate outcomes, …
> (King, 2008, p. 19)

This means that by the early 2000 the US, UK and Australia some most other countries of similar economies were at the same position where outcome-based education and /or accreditation had just been introduced and several changes were going on in engineering education accreditation and curriculum.

There has also been a certain way that people have gone about making those changes relevant for instance by instigating forums, conferences and then try and get other actors involved national regionally or globally to discuss the topic (Lucena et al., 2008), for instance during introduction of ABET 2000 (Yeargan, Aldridge, Jacobson, & White, 1995; Yeargan & Hernaut, 2001). The transformation activities in engineering education from the 1990s informs a certain pattern to which agents were going about in making transformations or in pursuing capital that include significant involvement of professional bodies in debating and developing standards for accreditation, which include lists of graduate attributes or outcomes-based competencies. This way of doing things, that is high involvement of professional bodies, is typical to the field of engineering education (and maybe some other professional education) and therefore it is a specific logic of engineering education field.

From 2000, there were more initiatives around the world to transform engineering education and accreditation with efforts to identify and stipulate required competencies by various engineering and engineering education. There was an increase in forums and studies around the world that were discussing how to describe the generic skills for graduates (Dodrige, 1999), and also how to teach them. Engineering education research area also developed a lot from getting involved in researching the transforming field – engineering education. These efforts were related to the capital of the field which was responding to relevance to industry. Therefore, Outcome-based education and accreditation, student centred learning, involvement of professional bodies as well as international collaborations are basically the steps that people take in pursuit for capital – specific logic or rules of the field of engineering education.

4.3.2 Mapping the Structure of the Global Field of engineering education

From the discussion, I draw that engineering education field is a field that is influenced by two fields: *the field of Higher Education* and *the field of industry*. Specific capital of the field is *competency capital* that is related to industry influences, and *scientific knowledge* capital that is related to Higher Education influences. The two opposite capitals create conflict or competition in the field, named *theory vs practice*. The field of engineering education operates by the rules or specific logic represented in the existing discourse which can be demonstrated as: *Outcome-based engineering curriculum and accreditation*, regulated by *Competence-based program Accreditation* offered by a *professional body*, with strong national, regional and *international collaborations* in engineering and the general Higher Education. We know also from (Bourdieu, 1998) that the rules do not make sense outside the field, so they are specific to engineering education field, and related to the field's capital. Figure 4.2 demonstrates this definition of engineering education field

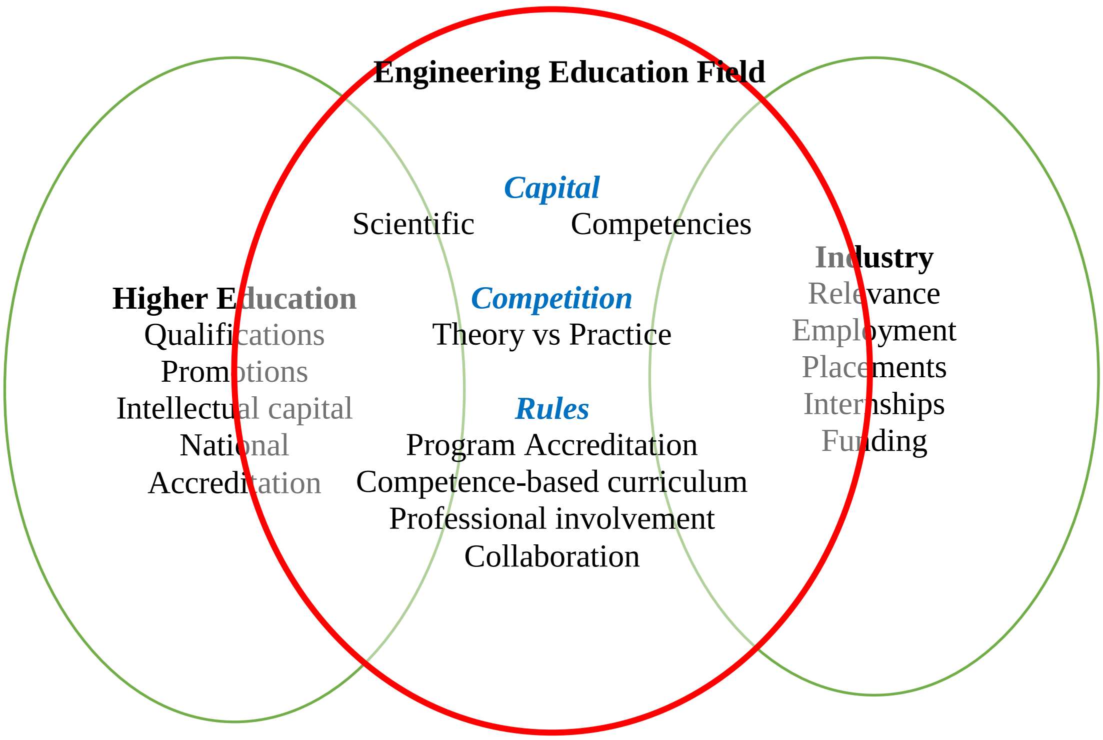

Figure 4.2 Engineering education field- the Industry and higher education influence

Figure 4.2 summarises the reality of engineering education field with details of available capital rule and the conflicts that exist. It also illustrates the influence and overlaps of the fields of Higher Education and industry and their in response to the capital that they affect. It is however difficult to use the demonstration (Figure 4.2) to show positions of engineering education agents. This is because the figure (4.2) does not explain the exact differences between the volumes of capital (forces) that are active in the field, and therefore cannot inform on the exact objective positions of agents and how they relate to one another. Positions of agents in the field can be better illustrated using the notion of the *field of power*, a matrix that Bourdieu himself has used to illustrate positions in some of his works (Bourdieu, 1998, 2010). This power field which uses the polar structure described in Section 3.2.4, shows power positions according to the amount of capital required by those positions, where Scientific Knowledge Capital and Competencies capital create the polar opposites as illustrated in Figure 4.3.

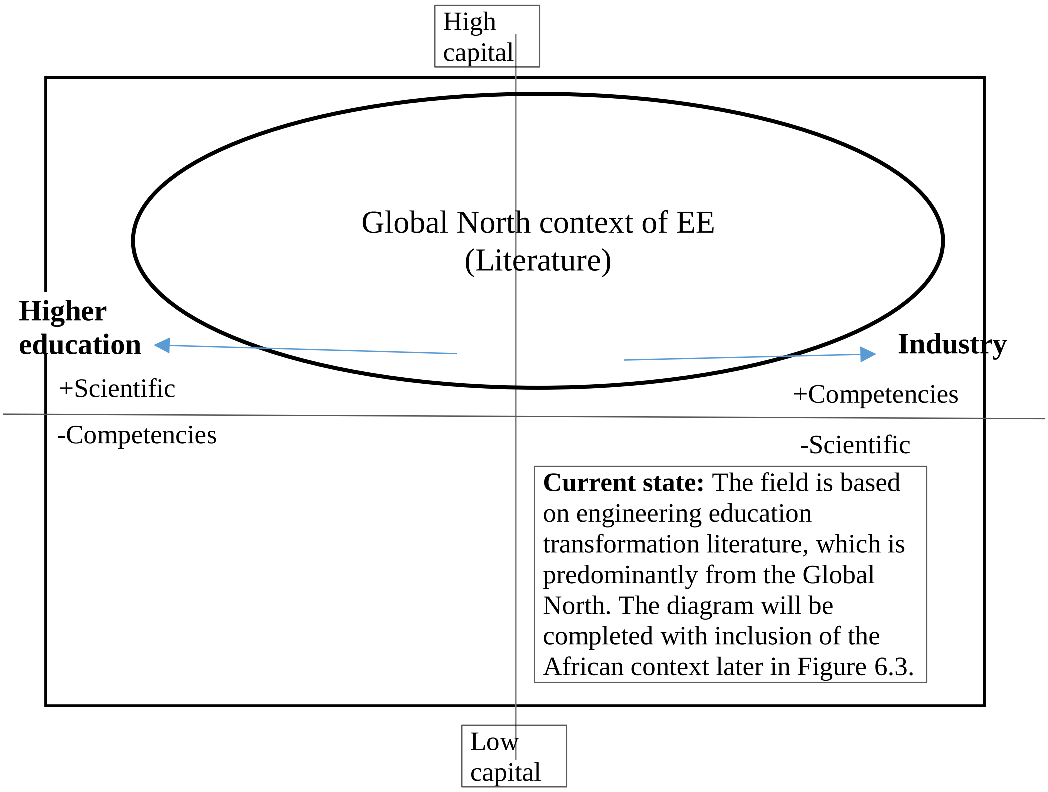

Figure 4.3 Polar structure of engineering education field to show position of the Global North

The engineering education *field of power* (Figure 4.3) presents the objective positions in engineering education take when they enter the field according to capital (type and volume). The horizontal axis represents the type of capital and the vertical axis represents the amount of volume of that capital. The top left quadrant – high scientific capital or Higher Education capital, Top right quadrant high competencies capital. Bottom left is lower to lack of scientific capital, while the bottom right are lower. The bottom represents lower to no capital while the top of the horizontal line is high to highest capital. These are positions that agents can take in the field.

The objective positions of Global North agents (Global North context) are mapped out at the top quadrants (left and right), showing High volume of capital in both Higher Education and Industry, and therefore their dominant position. The plotting has considering the discussion above, which clearly shows Global North having more capital and being well within the described field. The agents in the Global North are able to occupy higher positions in the engineering education field illustrated, because their habitus also matches the rules of the field- ‘like a fish in water’ (Bourdieu & Wacquant, 1992, p. 127). This concludes this chapter.

4.4 Chapter Summary

The question of whether engineering education is a field and whether it has enough distinctive capital to establish itself as a *field* remains open for criticism. What I am able to establish in this chapter is that it is a different field compared to Higher Education, and has a different focus to the emerging field of engineering education research, which is to develop engineers for practice. Its comparative position, I believe is sufficient to allow it to be looked at as a field and be able to apply Bourdieu's concepts, which will allow for a deeper understanding of the specific issues of engineering education practice such as those discussed in chapters 2 and 3. Viewed as a field, engineering education theoretically exposes the underlying structures, showing positions and different powers that are working to conserve or transform the field, and how that may have impact on the research phenomena – 'globalisation of engineers'.

In this chapter I have argued that engineering education is a field and show that it is a distinct field with its own capital competencies and rules (that are different from Higher Education). I have identified the engineering education area in examination (aligned with developing engineers for practice), then went on to look at other engineering education work that uses Bourdieu and lastly construct the engineering education field for this research. The literature on transformations of the engineering education was used to show the shift in the meaning of the field's capital - what is considered to be competencies for graduate engineers - from technical skills to professional skills and to current global competencies. This can explain the dependence of engineering education on engineering industry, despite operating within Higher Education rules. Through the transformation in engineering education and according to needs that emerged from the industry, I have shown how the field has defined and re-defined its specific capital.

The discussions expose the domination of the Global North in the field including how they have gained their capital and how they have used it. Bourdieu's notion of field has been used here to expose this domination, and this is illustrated through a quadrant showing the structure of engineering education field - the ideal global field as it is represented in the discussions in engineering education literature. The global engineering education field in a way seems to be responding to (or be supportive of) the Global North way of doing things, and it has been evident here that the Global North rules are dominating the scene and let its players dictate what happens in the global field at least since the late1990s. I have also shown that the field has put value on the definition of graduate competencies, especially in the global competencies.

The existing discussions in engineering education, which have resulted in the field constructed here (Figure 4.3), have represented the concept from a Global North perspective of engineering education, hence lacking perspective of the African context. The position of the African context in the general field need to be recognised first so that the issues of globalisation of African engineers can then be contextualised within the system of engineering education, and not in isolation. This system is the result of structure and behaviour that exist in African engineering education due to its position to the rest of the world. But, there is very limited literature available to represent the African perspective of what' ‘globalisation of engineers’ looks like, hence the need to acquire more information of an African context through empirical data, and in this research has selected Tanzania as a representation of the African context (section 2.4) to do that. In the next chapter, I will explain how the data was collected and analysed – the methodology of the research.

5.0 Methodology

This chapter describes the methodology of this research, including the selection of methods for data collection, sampling and data analysis. It includes the details of a pilot study that was conducted in order to confirm the case study and review the data collection tool. Using the results of the pilot study, I have confirmed (with reasons) my decision of using Bourdieu's notions of field, capital and habitus as a lens to look into the data. To collect information that is required to address the research questions (in Section 1.3) in the detail that is required by this research, qualitative research methods: interviews, focus groups and documentary are applied.

5.1 Qualitative research

I have adopted a qualitative research approach (Denzin & Lincoln, 2008) to capitalize on its potential to analyse issues in a greater depth, required for this research. Qualitative methods are preferred for the general educational research when human behaviour and interaction is involved (Lichtman, 2013). Qualitative research is also useful in explaining the context in which practice or interactions occur (Creswell & Poth, 2018), which in this research is the engineering education area of practice (field). "We cannot always separate what people say from the place where they say it – whether this context is their home, family or work." (Creswell & Poth, 2018, p. 46) In this research what actors in engineering education do or how they interact is dependent on the field or their context. And as has been discussed previously, the African context may differ from the Global North context of engineering education where most of the globalisation discourse originates. Qualitative research therefore allows for the African contexts to be explored.

Qualitative methods (interviews, focus groups and document analysis) were applied to collect data because they allow the use of the accessible rich, descriptive information, useful for this inquiry. Interviews and focus groups for instance were selected as primary methods to collect that information because they allow for direct engagement with the stakeholders (who in this research are agents) and therefore offer more reliable information on the subject (Kvale, 2007). The interviews and focus groups were supported by documentary data because of the wide availability of information around engineering competencies, as well as extensive literature on engineering accreditation systems existing in the world available in form of texts. The source of such information was accessed from published literature (journal papers, conference proceedings, books and reports and so on), and official websites of governments, NGOs and engineering associations.

Qualitative research methodologies have been well supported in discussions in engineering education research in recent years to be applied for understanding issues of engineering education, an area of Higher Education that has recently been more inclined to social and economic influences (Case & Light, 2011). Koro ljungberg and Douglas (2008) urge engineering education researcher to increase the use of qualitative methods in order to expand in the areas such student learning in different settings. Case and Light (2011) advocate qualitative research methodologies can better address challenges in engineering education like innovative pedagogies, "diversity and the changing requirements for engineering graduates in the twenty-first century" p.186, as it is the case in this research, where globalisation discourse has emerged as a result of 21st century aspirations.

Understanding that qualitative research comes with its own challenges, one being the dangers of oversimplification, the research adheres to the recommendations for proper use of qualitative research methods by providing theoretical justification for selection of methods (Case & Light, 2011) and acknowledging the role of theory in research (Borrego et al., 2009; Koro ljungberg & Douglas, 2008). Furthermore being considerate of the importance of rigor in qualitative research, this chapter gives an account of procedures that ensure reliability, validity transferability and reflexivity of the research.

5.2 Methodological framework

5.2.1 Research paradigm

My research leans more on the 'interpretivist' research paradigm (Koro ljungberg & Douglas, 2008, p. 165), which looks for understanding of people and situations or their context in such a way that a way that subjectivity would be involved (Hall, 2008). In this circumstance, information is best sought from people who have lived experiences, hence the selection of interviews and focus groups for this research. This paradigm aligns with my research on engineering education practice, because like any other educational research, involve human behaviour and social interactions; and uses various approaches and strategies to solve problems in educational settings (Cohen, 2017). Because of its involvement with human behaviour and social interactions and their settings or context the research may incorporate theories from other disciplines such as anthropology, sociology, behaviour, and history (Koul, 2008; Lichtman, 2013). This explains the selection of the social theories of Bourdieu for this research.

5.2.2 Case study

Case study methodology using a single case (Yin, 2009) was selected for this research because of various reasons that made it the most promising, one of the reasons being its ability to explore context in great depth (Case & Light, 2011) required for this research. In order to explore relevance of the discourse on 'globalisation of engineers' to Africa (1.3), I needed to explore deeper issues that are related to the African context of engineering education, that were not covered by literature. I needed a methodology to address how and why (Yin, 2009) the situation of engineering education is the way that it is presented in literature (2.3.1): traditional and content-focused education, institution accreditation by national agency, low involvement of professional bodies, and having weak, unsustainable, and sometimes unequal collaboration for international recognition. In order to address the research questions (1.3), this research first seeks an understanding of the engineering education practice in Africa, for instance 'how' engineering education programs are designed and delivered and 'why' they are designed and delivered that way.

Other reasons case study method was selected includes this methodology being the best to use when you have different types of data like the case here where I have three different sources, because it is able to work with multiple data (Case & Light, 2011; Yin, 2009). The information or data for this research is available in various forms and therefore a study of the case study brings together different types of data that is important for getting a well-rounded view of the situation, using different methods to collect such as documentary evidence, archival evidence, interviews and focus groups. Lastly case study is compatible with Bourdieu's theories as explained by Grenfell and James (1998), and have been applied widely with Bourdieu's theories in engineering and Higher Education studies such as (Jolly, 2016; Kloot, 2011; Naidoo, 2004).

5.2.3 Tanzania as a case study of Sub-Saharan Africa

Tanzania is selected as a case study of Sub-Saharan Africa in order to allow for an in-depth examination of the issues of African engineering education that were established in literature (Chapter 2), in order to comprehend causes of those different procedures and what it implies to the efforts for developing globally competent engineers in African countries. The case is selected because of both its interest and convenience (Yin, 2009). With regards to interest, Tanzania present a typical case of engineering and Higher Education situations in Sub- Saharan Africa that is described in the literature in chapter 2. The Tanzania context is explained in relation to the targeted African context in section 2.4. Conveniently, it is home to the researcher who has also worked as an academic in the main pubic University, the University of Dar es Salaam, hence familiar with the context. This familiarity can also come with its own challenges in terms of research, however all precautionary measures have been taken and explained in this thesis (section 5.5).

In addition to the reasons above, there is a wealth of available information on Tanzanian engineering education and Higher Education from previous studies. This is because Tanzania has been used as one of the cases of Africa several times in different studies in engineering education and the general Higher Education (Case et al., 2016; Materu & Rigetti, 2010; Mhilu et al., 2008). For instance the University of Dar es Salaam (UDSM) was involved as one of the of Africa contexts in a comparison study that looked at the significance of context for curriculum development which involved two other African countries: Kenya and South Africa (Case et al., 2016). The available information is used as secondary data for this research to explore engineering education practice in the context before conducting qualitative study.

5.2.4 Unit of analysis of the case

The unit of analysis is the engineering education practice focusing on curriculum and accreditation and sometimes the teaching and learning (pedagogy), the phenomena that the literature on global engineering discourse and transformation is focusing on. From the literature, I have established the African context of engineering education practice differs from that of the Global North, which is dominating the current global context or perspective of engineering practice. But the literature does not explain the underlying reasons why the African context of engineering education is different. I have then employed Bourdieu's theory to expose the existing engineering education structure as a field (chapter 4), and an area of enquiry, which can be explored using the notions of field, capital, and habitus. This structure will help to explain the differences in practice between the African context and the Global North context of engineering education, described previously in Chapter 4, and their causes.

5.2.5 Research project phases

This research project was conducted in 4 main phases with each phase informing the next as shown in Figure 5.1.

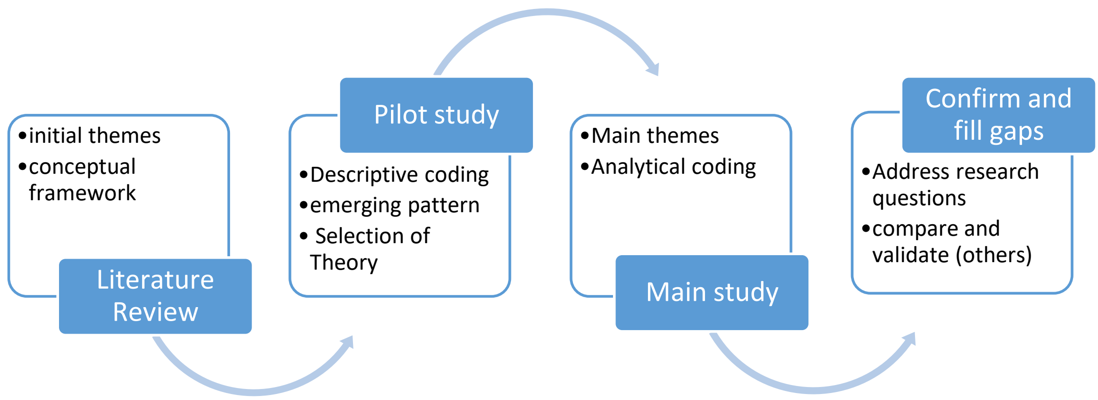

Figure 5.1 Four main stages of the research

i. Phase 1: Literature review

In this phase, published issues of internationalization and accreditation in Higher Education in Africa were assessed to establish the current situation of globalisation of engineering education together with the challenges and opportunities for Africa. The existing systems of international education and accreditation, including international mutual agreements are critically reviewed in terms of their global applicability, hence their repercussions to the African context. Reported concerns for internationalization such as accessibility, costs, transparency, discrepancies were discussed. From the critical review of Internationalization of Engineers with an 'African perspective', initial themes that guided data collection and analysis of the pilot study, were generated. The review has also resulted in a paper *Internationalization of Engineers: a challenge for Engineering Educators from an African perspective* (Matemba & Lloyd, 2017) that was published in the international journal of engineering education.

ii. Phase 2: Pilot study

The pilot study involves initial data collection and analysis that informed the evolving methodology and the direction for the research. The pilot study, which included three interviews of expert engineers from academia, industry and professional body, was done in Tanzania during January 2015 for the purpose of testing the data collection tool. The pilot study produced a list of implications that further shaped the data collection tools. The phase also resulted into confirming Bourdieu's theory and themes as explained in the next section (5.3). The outcome of this pilot study informed phase 3, the main study.

iii. Phase 3: Main Study

The main study contained collection and analysis of data around the issues of African local context, using the case study of Tanzania and a few other African cases. This stage of data collection expanded from an outcome of the pilot. It involved 15 interviews of experts, and 2 focus groups of alumni, recordings and transcripts and documentary evidence. The analysis of data collected was analytic and provided main results and discussion of the study.

iv. Phase 4: Confirm and fill the gaps

This phase includes using literature to fill the gaps, compare and validate results and Addressing the research questions. This phase includes results of from the two countries outside Tanzania to confirm the sampling domain for transferability of the study.

5.3 The Pilot Study

A pilot study of three interviews of experts from the industry, professional body and academia together with one focus group of 5 engineering alumni from Tanzania, was conducted to obtain initial data to refine the content of the research plan as well as the procedures used to collect and analyse data (Yin, 2009). In this section, I present how I collected and interpreted pilot study data that helped to shape my research. This includes confirmation of initially established themes and new themes; discussion on issues of data collection tool, and the synergy of Bourdieu theory and its appropriateness in analysing the themes.

All of the data was gathered for the selected case study, Tanzania, in January 2015. The participants recruited were either people who were known to the author or new contacts who were obtained through the author's contacts. This a technique of recruiting participants through existing participants is called 'snowball sampling' (Lichtman, 2013, p. 192). Further there was little to no financial expenses used to obtain the data as the participants willingly provided the venues which were mainly their offices including the focus group venue which was provided by one of the participants..

5.3.1 Pilot data, participants and methods

Three semi-structured interviews were conducted, strategically aimed to gather well-rounded understanding of engineering education and its connection to engineering practice. In particular, I used purposeful sampling (Guba & Lincoln, 1994) sought three experts to represent three main stakeholders; a consulting engineer who also owns a consulting firm and has experience working in international projects to get an industry view, an official from the Engineers Registration board of Tanzania to get a regulatory body view, and a senior academic who was involved in review of curriculum to get a view from academia or Higher Education.

The three interviews although conducted from the same guiding topics from the interview guide prepared during the initial research design (Table 5.1), each had a different focus. The interview for industry participant included views on the competence of graduates they employ, as well as their training. The interviews from professional body participant focused on views relating to the professional body involvement in curriculum and accreditation of engineering education, and the general development of engineers. And, lastly the interviews for engineering educators or the academia participant focused on curriculum and accreditation of engineering program, as well as program delivery. The focus is summarised in Table 5.3.

Table 5.1 Pilot Interview guiding questions

Interview Guide

Introduction – tell me about yourself and your position in engineering education

The interviewer will explore your perspectives on:

- Globalisation of engineering understanding
- Required competencies of engineers- how they are developed, demonstrated or assessed
- Engineering accreditation situation –system, importance in shaping engineering education
- The learning environments and experiences of engineers
- The role of higher institutions, professional bodies and industry in developing engineers
- These topics were expanded from the information sheet sent to participants.

In addition to the interviews, one focus group was conducted, from engineering alumni of a Tanzanian University, to gain their views on how the education they received relates to their roles as the practicing engineers and their views on global competitiveness. The focus group was moderated by the author using the guiding questions in Table 5.2. Information about the interviews and focus group's foci is also summarised in Table 5.3.

Table 5.2 Pilot Focus group guiding topics for preliminary study

Focus group guide What is your view on the learning experience of the undergraduate engineering training in Tanzania in relation to your role as an engineer Prompts: • Role of engineers • Skills – current and global • The engineering education /training relevance to your role/s • Skills that were gained or competence • Areas in the training that you think need improvement • Skill development- how did you develop skills to be a professional engineer • Learning experience (tertiary or pre-tertiary)

The pilot focus group included five participants who were alumni of the same university – University of Dar es salaam one of them was a female engineer. All participants were civil engineers; four of them were the class of 2007 and one from the class of 2008. Two of the engineers were self-employed contractors engineers, one working in a family business and the other one who had just started his own contactor business after working in a government organisation for about seven (7) years. One was an academic (assistant lecturer) in a government institution and two were private employees in an international consulting firm. Some are registered engineers. All were graduate from the same University, hence similar experience. The participants' profiles are summarised in the last column of **Error! Reference source not found.**.

Note that, in this focus group discussion, as a researcher, I was also a moderator who at the same time was also an alumnus of the same University as the participants. At the time of the focus group, I had five years' experience as an academic at the same institution (UDSM). I have sometimes considered myself as a participant because of my involvement and contribution to the data and due to my ability to relate to participants and relive the experience and add to the conversation. This involvement may have influenced the dynamics of the discussions and create possibilities for bias as pointed out earlier in section 1.5.3. For instance it was easy for participants to open up as they felt comfortable knowing the moderator understood the situation they were meaning to describe. To some point in qualitative research the moderator is expected to construct information with the participants but also care must be taken to avoid biasness in perspective. To overcome this bias and aim for more well-versed responses for the main study, sampling will intentionally seek diversity in terms of the university they come from, their year of completion, gender, and type of industry they practice.

Table 5.3 Pilot study participant's profiles

	Interview 1 Industry	Interview 2 Professional body	Interview 3 Academia	Focus Group (5 participants) Alumni
Profile	Independent Consulting Engineer late career with United Nations and Donors/Government development projects and programmes, an Arbitrator and Adjudicator. Fellow and a PE of American Society of Civil Engineers (ASCE), a Chartered Engineer Fellow of Institute of Engineers UK. Part time academic, researcher and an external examiner.	High official, Engineering registration board (ERB) A consulting engineer A university professor and senior lecturer and has held various Departmental and college administrative positions.	Senior lecturer at University of Dar es salaam. Lead tracer studies for all Tanzanian institutions as well as parts of East Africa\involved in the Inter-University Council of East Africa	2007 to 2008 graduation From the same University All civil engineers Some are Registered engineers One is an academic One female 2 are self employed At least 2 government employees 2 are private employees
Years of Expertise	30 + years in the Industry	30 + years in academia and industry	30 + years in academia	6-7 years' experience
Interview focus	Accreditation and internationalisation Industry needs	Professional body involvement Accreditation and internationalisation	Curriculum Internationalisat-ion	Learning experience in relation to engineering roles

5.3.2 Coding pilot data

Recordings of interviews and focus group were transcribed by external transcriber (proposed by the supervisor) and uploaded onto NVivo10 program by the researcher. The data was coded starting with concept-driven coding, where data was coded into pre-defined categories (Richards, 2009), and then moved to data-driven coding. To set up pre-defined categories for coding, four nodes were established corresponding to the four initial themes generated from the critical review of literature. The four initial themes that guided this pilot study data collection and analysis produced the following level one nodes: 1. Engineering education, 2. Accreditation, 3. Professional bodies and 4. International recognition. These were level one nodes which are described in Table 5.4.

For the purpose of the pilot study, I conducted a thematic analysis (Bazeley & Jackson, 2013) where I applied two levels of coding, to find out what the participants were saying about the engineering education practice in their country. In the first level I placed big chunks of relevant data under each of the four pre-defined nodes (Richards, 2009), a method that Bazeley and Jackson (2013) named broad brush coding. For the second level coding I went into each of the seven main nodes, read the data and started coding to develop sub-themes (second level nodes) as seen in Figure 5.2. The coding continued iteratively until the nodes and sub nodes were satisfied and there was no new information appearing. The sub-themes given to nodes represented categories in that theme and they were descriptive at this point, meaning they represented the participants' direct words or meaning are used. A more analytical investigation of data is done during the main study as explained in section 5.4.3 and interpretation later in Chapter 6 when there is enough data. The pilot data will be combined with the main data for data analysis.

I also allowed for two new themes to develop from the data, when there was interesting information that did not fit the four categories, while keeping all my data to avoid losing important information in this stage. As I read through the transcripts, I also noted issues that did not qualify as themes but were pertinent to the data collection process or participants in the study. Those issues are for example questions or topics that I felt were either ineffective, invasive or leading and out of topic questions. Also noted were problems with the way some questions were asked, unclear questions and also any particular interest the participants had in the research and so on. So, I created an extra node called 'Tools and other issues' hence the seven level-one nodes seen in Figure 5.2.

Table 5.4 Level one nodes from literature review

Node	Corresponding initial theme	Node name and description
***Education* System**	Engineering Education in Africa is traditional and content- based	*Education system*: This node contains views on engineering education system in Tanzania as a case of Sub-Saharan Africa. It includes issues of curriculum or content of the programs offered at the university, their graduates, relevance to industry, content, learning experiences, and curriculum.
Accreditation	Accreditation system in African is institutional, conducted by national agencies. Not yet part of the international Accreditation systems	*Accreditation*: This node includes views on African Accreditation system its history and strength. It also contains views of whether it is Institutional accreditation or program accreditation. Investigation on the existing initiatives for internationalisation –such as regionalisation, as well as issues of access to Existing Accreditation system.
***Professional bodies*:**	There is very low involvement of Engineering Professional bodies in undergraduate engineering education in African specifically in curriculum and accreditation matters	*Professional body*: This node contains views from interview and focus groups on the level of the engineering professional body in engineering education in Tanzania. It also looks at the other areas of development of engineers that they are or should be involved in. The information in this theme has been divided into the different sub themes which are: accreditation; tertiary education curriculum; post tertiary training; and registration and practicing stage.
International recognition	International recognitions is met with weak, unsustainable regional and sub regional collaborations, that lack own initiative. International collaborations are unequal.	*International recognition:* This node which was letter on changed to *international collaboration* initiatives and contains views on initiatives to form collaboration outside the country. The collaborations can be sub-regional (meaning within East Africa) and regional meaning (within the African region) or even outside the African region. They can also be at any level- individual, departmental institutional and so on.

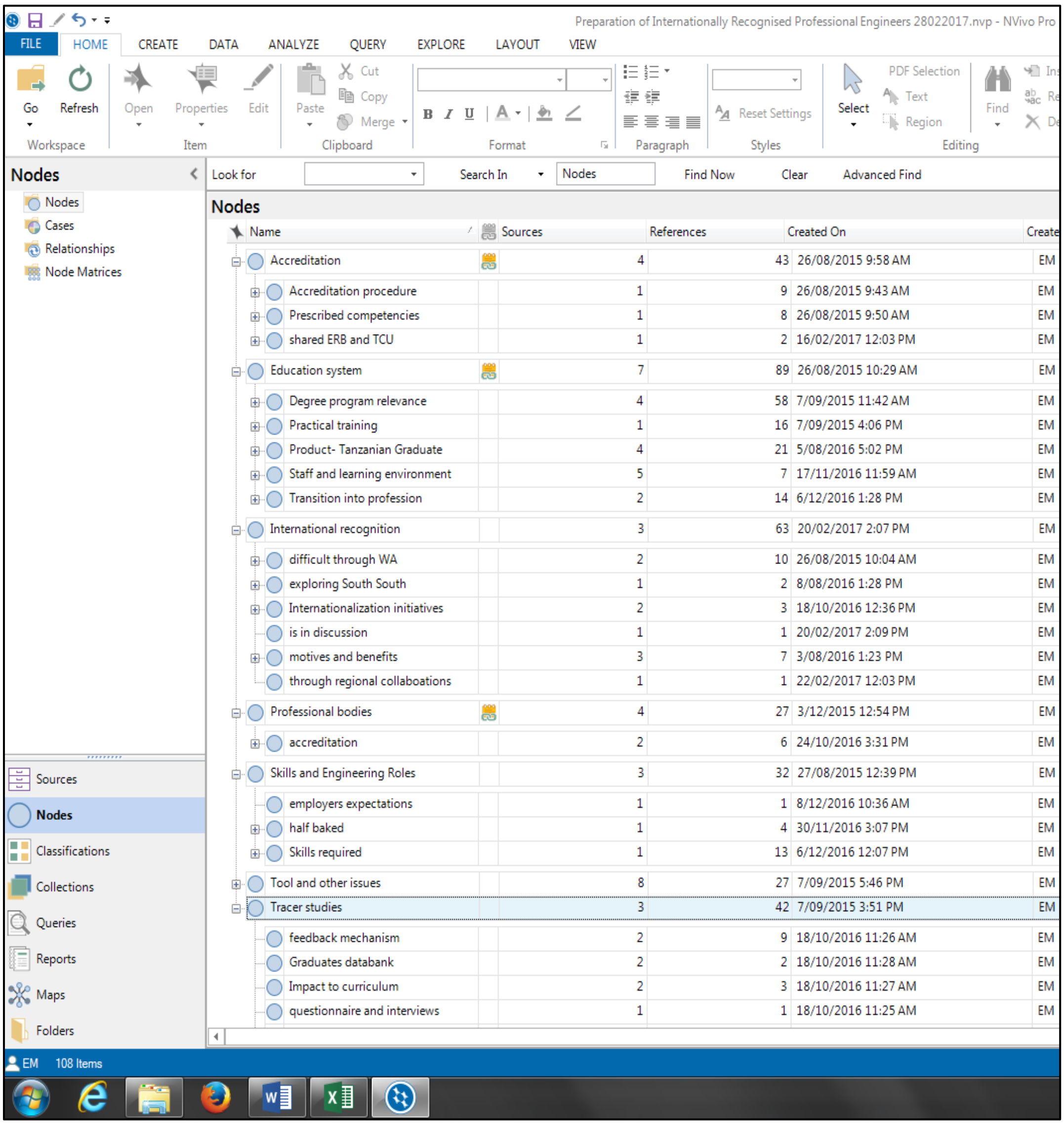

Figure 5.2 Level one coding (Main themes) and level two coding (sub-themes) of pilot study data. Screenshot from this research's data analysis project in Nvivo

5.3.3 Pilot study findings and discussion

The descriptive analysis of the data show coherence to the themes representing the areas of discrepancies in African engineering education established previously in literature review: engineering education system, accreditation, professional bodies' involvement and international collaboration initiatives also reported in the previous work (Matemba & Lloyd, 2017). There are also some new main themes and also new sub- themes were allowed to emerge such as the 'Skills and engineering roles' and 'Tracer Studies' during level 1 coding, which I thought were commonly appearing in the data but did not quite fit the pre-described codes, therefore I created as new nodes for them (Figure 5.2).

i. *Engineering Education System in Tanzania*

Pilot study results show that Alumni recalled their undergraduate education being loaded with content, general and not having enough practical context– claims that make indications of a typical traditional 'chalk and talk' education system. They have painted it to be time-poor or "crowded" to the point that "… it doesn't give you time to go to the lab and solve practical problems." (Pilot FG, 2015). Alumni recall the education system they went through as being loaded with many things that were sometimes unnecessary, and as a result it hindered creativity and promoted cramming and 'copy and pasting', as there was no time left to apply what one has learnt. In their own words:

> *The education system that we have promotes cramming and then we have copy paste, lots of copy paste. (Pilot focus group, 2015)*

The suggestion that the education system denies time for students to figure things out by themselves, they seem to imply that there is lack of active learning or student centred learning approaches that usually give students time to think and also credited to support creativity (Felder et al., 2011). The traditional chalk and talk delivery was also reported in literature (2.3.1).

The pilot study data suggested that engineering education being traditional, content laden, and general education system hinders creativity, and made them "the jack of all trade and a master of none". However there were no direct suggestions of whether or not it was content-based, which implicated further investigation. The results were mainly from the views of alumni engineers, who were recalling what they experienced or what was delivered to them. The curriculum or content and its process which can give more accurate information on this issue was not investigated. Therefore a look into the engineering education content through the program outlines and observing the curriculum processes though people who are responsible for curriculum development to find out if it is indeed not outcome- based and why it is that way became a goal of the main study. This is important in explaining issues of context in connection to globalisation initiatives that put an emphasis on outcome-based education and student-centred teaching styles.

ii. Accreditation system

Pilot study results suggest the accreditation system is through a national quality assurance agency called Tanzania Commission of Universities (TCU). Unlike the Global North context where professional bodies are in charge of accreditation, the engineering professional body in Tanzania, Engineers Registration Board (ERB), does not. This is despite the fact that it has the authority to do so as informed by professional body official:

> *The Engineers Registration Board has a legal mandate to accredit engineering undergraduate programs. But this is a mandate that is also shared with another institution, the Tanzania Commission for Universities, TCU. (Pilot Interview 1, 2015)*

It was raised in literature (chapter 3), that national quality assurance agencies in Africa regulate not only engineering programs but all Higher Education programs in institutions in the entire country while also handling other tasks such as university admissions (Matemba & Lloyd, 2017). National accreditation institutions have capacity to accredit institutions and not specifically programs. The concerns are on the agency's capacity to accredit each and every program offered by all the Higher Education institution to the level of detail that is sufficient for each and every profession. There is a need therefore to find out from the accreditation agency how accreditation of a specific programs such as engineering programs is done in order to address this concern in the research.

The Global North context described in Chapter 2 have program accreditation done by professional communities in different professional education programs such as engineering, law and medicine, in addition to having national accreditation systems to deal with institutional accreditation such as Australian Qualification Framework in Australian (King, Howard, Brodie, Male, & Hoffmann, 2015). The Program accreditation by the professional community is also evidently practiced by existing international systems of such as ABET and EUR-ACE in implementing program accreditation, therefore this draws attention on a significant gap that exists between the Tanzanian system and the existing accreditation systems prevailing in the international scene. It became important then for this research to investigate the accreditation procedure by looking at the standards used by the agency, to determine if they are indeed program specific.

iii. Professional body involvement

The pilot study findings indicate a situation similar to what was reported in the literature, that the level of involvement of professional body in undergraduate engineering education is low, especially in accreditation and curriculum, compared to similar bodies' involvement in Higher Education in the Global North. However there is evidence of significant involvement in post-graduation professional development, registration and regulation, suggesting that professional bodies are concerned with development of engineers.

In accreditation, the professional body in Tanzania, Engineering Registration Board (ERB), although holds 'a legal mandate to accredit engineering undergraduate programs'(Pilot Interview 1, 2015), it does not accredit engineering education– with the main reason given being to avoiding conflict with national accrediting agency. The accreditation mandate as the participant claimed "is also shared with another institution" which is a national accreditation agency, Tanzania Council of University (TCU), discussed under the accreditation theme (in ii) above (Pilot Interview 1, 2015). The admission that the professional body leaves the accreditation role to the national accreditation agency may indicate also that their influence in what the engineers are being taught may be low. The participant also claimed that:

> *…we do not want the ERB to be seen as the national authority for accrediting engineering programs. We still want this to be done by TCU. (Pilot Interview 1, 2015)*

Then Interview participant 1, gives the reason as to why the accreditation is left to TCU, one reason being to avoid "conflicts" which he implies had happened in Kenya, a country neighbouring Tanzania, where the accreditation agency and the professional body "who are going each [their] own way in the process - there was a lot of problems. I think there are court cases lately." (Pilot Interview 1, 2015). This contradicted what he said earlier about the professional body's mandate to accredit engineering education and therefore prompted the need to follow it up for clarification. A repeat interview with the member was proposed for the main study. It became important to also find out briefly about the system and activities of accreditation in Kenya, to see if it portrays similar characteristics as Tanzania with regards to professional bodies.

The participant also discounted the insinuation (from literature) that the professional bodies have low input in curriculum design and accreditation, claim that the professional body participant discounted saying that in the case of Tanzania “for any engineering program to be accepted by TCU, ERB has to give their consent.” (Pilot Interview 1, 2015). And when he was asked about the professional body’s participation in the curriculum processes for example at one of the Universities, the professional body participant could not “specifically say how [ERB was] involved”, instead supposing that it “must have been involved a stakeholder” (Pilot Interview 1, 2015). The participant insisted that the curriculum process at the University of Dar es salaam involves professional bodies.

The pilot study response on involvement in curriculum reviews and development in universities being that of having a stakeholder/representative instead of being the body in charge of specifying requirements for the training programs as is seen in the Global North, sparked more interest for this research to pursue inquiry into the whole process of curriculum review, the people involved and their contribution. Also the standards used and who sets them and how they are incorporated into the curriculum. This prompted a need to find out more about the role of this professional body stakeholder in the process, and if there are defined tasks. I will also need to get views from the academia and TCU officials as well as collect documentary information of how curriculums are designed and developed. Furthermore the answers to the level of involvement questions, suggest the need to ask more specific questions during the main data collection cycle.

There is another implication that professional bodies are not involved in the curriculum process because they do not directly prescribe standards for engineers used in curriculum development. Although this not explicitly stated, it was obvious through the interview (Pilot Interview 1, 2015). For instance when questioned about graduate competencies, the participant (Pilot Interview 1, 2015) instead mentioned the list of competencies required for engineering professionals in Tanzania; analytical skills, professional/management, practical competencies and general professional competencies including communication; and also said that these competencies are obtained through workshop training and fieldwork. It indicates the need to find out if in any way the mentioned professional engineering competencies or any other are incorporated into the curriculum by developers. If they are, then find out how they are and if at all they are assessed in accreditation.

Although the response imply that their involvement in engineering education is low, both the interviews and focus group findings suggested that there is a significant professional body involvement after graduation through a Continuous Professional Development (CPD) program for graduate engineers called Structured Engineer Apprenticeship Program (SEAP) (www.erb.go.tz). According to the professional body interview, the program that is run by the engineers registration board (ERB) involves an industry attachment, government funding, mentoring and monitoring with continuous feedback (students required to submit reports every 3 months). Professional body participant informed that when graduates join SEAP, they are attached to work places (companies and organisations) where they "supervise projects" and "manage projects". They even "participate in general office management, general managing of activities in offices." (Pilot Interview 1, 2015). This is also to be followed up in the main study.

Pilot focus group participants expressed praises to the SEAP program for its significant role in developing practicing competence after graduating, but also suggested that ERB could do more in engineering education. For instance they could also assist in securing mandatory placements (or practical training places) in national and international projects in areas that they want to pursue, because they believe the professional body is in a good position with the industry to do so. This implicates the need to follow through with ERB and find out whether they are involved in securing internships and placements for students.

iv. International recognition (collaboration)

International recognition of engineering education is considered by African participants, however it seems to be difficult to achieve, due to the difficulty in accessing existing international systems, such as the difficulties established previously in the literature (2.3). The professional body participant expressed views on the difficulty to join the Washington Accord mutual agreement which confirms what the literature says about the accessibility of existing international accreditation systems. In the interview, the professional body simply put it that they (Washington Accord) appeared like the 'big boys club' (Pilot Interview 1, 2015) compared to the Tanzanian Professional body, when explaining the difficulty to access. This was in line with the criticism on the global applicability/accessibility of the international accreditation systems in previous article on this research (Matemba & Lloyd, 2017). The article identified problems such as cost of joining, non-transparency, outcome based education suitability; and hence explain the difficulty for African countries with their weak, underfunded education system, to join.

According to pilot interview 1 participant, they were instead trying to access international recognition through join the South-South Corporation which felt more accessible:

> *Discussions are now ongoing to be able to form some kind of another recognition mechanism that would enable the mobility of engineers at least within countries that are similar in nature and economy. (Pilot Interview 1, 2015)*

According to the participant, the collaboration that has been going on, starts with regional African then Asia (South-South), where there are countries such as Singapore and Malaysia that are already ahead in the international recognition:

> *But also as a nucleus for cooperating with the eastern, southern and south Asian countries block for which there is already something [...]*
>
> *I know of the initiative that we are undertaking with the south Asian countries, East Asian countries. This has been undertaken actually under the auspices of UNESCO. So that is something that is also international. That is also something that is recognised through the official UN body. (Pilot Interview 1, 2015)*

This informed on existing internationalisation or globalisation efforts that are of interest to this research. The efforts are to be followed up by a second interview and an investigation of UNESCO website for this initiative. This led to investigate if there are any other regional and sub-regional collaboration initiatives that Tanzania is part of. For instance regional and sub-regional collaborations such as African Association of Universities (AAU) and Inter-University Council of East Africa (IUCEA) exist at institutional levels (Higher Education and not program) as literature established (2. Also seek proof of what literature says about most regional collaborations being still young and unstable, mostly donor dependent, which were not confirmed during the pilot study.

v. Skills and Industry roles or Relevance to Industry (New theme 1)

A number issues developed that did not fit the pre-defined nodes but were of interest to the research. These issues made up a new node called Skills and Industry (and later on changed to Relevance to Industry) to represent theme that about African engineering degree program's relevant to the industry. They include the following:

In terms of graduate competence, three out of the five pilot focus group participants mentioned that one needs at least two years and up to four years to gain confidence in their engineering role.

That the education they get does not prepare them to go straight into their roles for example one of them quoted here:

> *So you would need at least another two three years before you actually became competent enough to do something on your own without close supervision.*
> *(Pilot Focus group, 2015)*

This may indicate that engineering graduates in Tanzania are not job ready and they need time to develop practice competence. However this is normal elsewhere too, for instance in Australia.

On engineering competitiveness of Tanzanian engineering education, the industry participant who has experience in teaching in the engineering education system on a part time basis, thinks that the education is as good as any other. As he claims:

> *What I can say, our engineers here, and our training engineers, training institution here, they just produce very good engineers, I have no doubt about it, I have worked with them, I have been part of the teaching staff on part-time basis, (Pilot Interview 2, 2015)*

Interview 2 participant suggest that the graduates are competitive, but goes on to scrutinise the education system for not being tested against the global benchmark which he recommends it should.

> *[…] but what I can say we need now, what is the fear, let us test ourselves on the global benchmark. (Pilot Interview 2, 2015)*

Further interview 2 informs that most of the academicians in Tanzanian universities have networks abroad and international education (in the world) – hence globalised.

> *I know that academia is working hard to network and our professors and lecturers are all studying in various universities in the world and they have done well. (Pilot Interview 2, 2015)*

This implies that there is capacity to globalise engineering education because academia have experience and networks abroad. So, Tanzania academia get engineering education recognised internationally which is like saying making engineering education relevant to the current global industry and therefore give their engineers more opportunities in the global market.

There was also a view that the education received to some extent helps "develops some soft skills like teamwork, communication and entrepreneurship" which they often referred to as practical skills or just practical. The mentioned skills are also skills that are considered important in global working (1.1.1). Participants reported for instance that entrepreneurship was taught in the program but it is too focused in the engineering profession, and that industry required more entrepreneurship training than what was being offered by their engineering education.

> *So the entrepreneur that we learn outside the university goes beyond the profession. Because when you look at the projects we all get ourselves involved in, we have all these aspects of engineering, they go beyond civil engineering. (Pilot Focus group, 2015)*

Despite pointing out the insufficiency, this evidence shows that there is entrepreneurship learning within the engineering education. Pilot focus group participants advised on the need for "more time for practicals" in order to develop practice or the mentioned competencies, claiming that "the times for practicals are too short." (Pilot Focus group, 2015)

The participants also expressed awareness of some global skills when they raised the importance of being able to work with other people from different disciplines/professions and different levels of education from them such as technicians and foremen. They explain that multidisciplinary teams are common working circumstances in engineering projects.

> *[…] apart from the knowledge and the books, how to relate to other field and aspects of engineering, how to seek and make the most of other professionals. (Pilot Focus group, 2015)*

> *[…] because when you look at us, say we go to construction sites […], we have to relate to technicians and foremen. Those are people lower than us. They have diplomas, they have certificates, but when we make use of the experience and expertise, they really add a lot. (Pilot Focus group, 2015)*

This suggests that the alumni experience in practice has led to realisation that engineers need to relate with people from other disciplines (multidisciplinary) and other levels (multilevel) in practice. In a way they also included that engineering work requires integration of other aspects and therefore the need to have a cross-disciplinary aspect. This interdisciplinary skills and cross-disciplinary aspects are considered global skills or competencies by others in the literature (Allan & Chisholm, 2008; Chan & Fishbein, 2009).

The pilot study findings indicate that there is some industry demand for global competencies in engineers, with students reporting a work environment require skills like: entrepreneurship, interdisciplinary, teamwork and communication. The implications of this for the research include following up on the importance of these skills for global working environment. Moreover to avoid the vagueness about global skills, I include a list of the 21st century skills defined through literature in section 1.1.1 in data collection, so that I can explore the consensus or diversity of skills considered to be global.

Findings pointed out the importance of post graduate or post – tertiary internship program, Structured Engineering Apprenticeship Program (SEAP) in developing practicing skills. The SEAP has been praised by alumni engineers (focus group participants) for its part in developing engineers, post- graduation, and therefore potential for developing global skills. However, students also proposed that the same involvement is needed pre-graduation during the practical training, industry placement, which students have to do at the end of every year of their degrees. This implicates the need to follow through with this post-graduation intervention (SEAP) to find out if it consists of development of competencies, and whether it is similar or different to engineering education. Examine the possibilities of applying it at the university level.

vi. Tracer studies (New theme2)

A new theme developed since there was a lot of information coming up about the studies done prior to curriculum reviews. This theme separated views regarding tracer studies. Pilot Interview 3 participant, a Tanzanian academic who was involved with curriculum reviews at the University of Dar es salaam and other Universities in East Africa, explained that tracer studies were rigorous process of skills needs evaluations that considers the engineering job market and stakeholders, done before any curriculum development or review. The evaluations included collecting information through surveys from former graduates and employers mostly in firms that have received graduates or students for attachment from a particular university, in order "to modify our programs to suit the requirements of the labour market." (Pilot Interview 3, 2015). According to Pilot Interview 3 participant, the tracer studies have been used since 1989 to collect feedback from industry experts and former graduates before every curriculum review.

This was an interesting finding that was not raised in the literature, it also refuted the claim by focus group participant that the curriculum is outdated, *"the curriculum we are operating with I think is the one of the 1970s (Pilot Focus group, 2015).* The focus group participants were graduates of 2007 and 2008, while the tracer study tradition had been implemented for more than a decade before they even started their degree in 2003. This prompted the research to address this contradiction on curriculum, there is a need to seek information of tracer studies and how they are incorporated into the curriculum and how effective people think they are. The implication for main study include collecting previous tracer studies and find out their purpose, feedback collected and the methods. For the feedback, the main study needs to acquire different views of the curriculum review process and how feedback from tracer studies is incorporated.

The themes (i-vi) are related to the rules of the field, which make up for the structure of the engineering education field in Tanzania context. The structure allows the Tanzanian context of engineering education to be compared to engineering education field constructed in 4.3 with prevailing rules of: outcome-based education and accreditation, student centred learning, involvement of professional bodies and international collaborations (see Section 4.3.1 iii).

5.3.4 Limitations of the pilot study

The pilot study data from 3 interviews and 1 focus group of 5 participants provided very insightful findings for the research, but it was not sufficient to make any conclusions or any meaningful theoretical discussions at this stage. It made implications that became vital to the direction of the study. At the pilot stage, data was analysed at descriptive level, meaning that at most times it was presented from the participants own words with very little interpretation. Nonetheless, the pilot study and its findings provided a guide to data collection during the main study. The pilot data was analysed again more analytically together with the data from the main study in Chapter 6, to provide a more meaningful discussion and conclusion for this research.

5.3.5 Summary of implications for main study

The result of the pilot study provided confirmation of the case study through themes established in the literature review (Chapter 3). This meant that Tanzania is a suitable case of the Sub-Saharan African context under research. The pilot study provided feedback on the data collection tool in terms of the questions asked, and tested the effectiveness of data collection method for obtaining the required information. The outcome of the study was used to create a research plan with more informed themes from more focused methodology to guide the main study, which is a valid approach as described by Yin (2009). The pilot study resulted in several implications for the main summarised here:

i. Confirming the case

Thematic analysis of pilot study data confirmed the four main themes that were established in the literature: *Engineering system, accreditation*, *professional body* and *international recognition* (renamed as *collaboration)*. This validated the existence in Tanzania of characteristics or issues of African engineering education discussed in Chapter 3 and elsewhere (Matemba & Lloyd, 2017). This confirmation indicates that the selected case – Tanzania present the characteristics of an African context in terms of engineering education, that was described in the literature, hence a typical case study for this research.

Apart from the many challenges the pilot study raises some opportunities such as Tracer studies use, that could be potential for considering industry feedback into the curriculum, and also practical training, which was hailed by alumni to have helped in acquiring industry skills. These opportunities were worth pursuing. The study therefore allowed two new themes to emerge, which resulted in a nodes and sub nodes: *Skills for engineering roles* (later renamed *relevance to industry*) and *Tracer studies* respectively, resulting to a total of six themes. The six themes, which are centred on curriculum, teaching and learning, and accreditation practices became areas of focus in African engineering education, when looking at and the issues of 'globalisation of engineers' in the African context. These themes were now: *Engineering system, Accreditation, Professional body*, *Collaboration, Relevance to Industry* and *Tracer studies* respectively.

ii. Implications for sampling and recruitment

From the three interviews of different stakeholders, pilot study findings confirm the need for the diversity of views, not just to group them in the three groups but also to consider diversity within those groups. To ensure diversity of interviews participants in the main study, an approach called 'Sampling frames' from Handwerker (2001) was adopted. According to (Handwerker, 2001), informants or participants are cultural experts because "everyone is an expert in what he or she knows" p. 91. In this research, the participants (academia, engineers, professional body) are the cultural experts in their particular areas, as related to engineering education. Also since among every group of experts for instance academia, you can have different views according their different life experiences (cultural variations), so, in sampling it is important to pay attention to these differences and seek out their sources. These could be their age, years of experience, their type of industry, their gender and so on.

Handwerker (2001, p. 93) proposes designing 'sampling frames' for cultural data in ways that the different "situated life experiences that may influence the patterns of social interaction through which people construct cultural phenomena" are taken care of. Table 5.5 presents a sampling frame designed for main study as adopted from Handwerker (2001, p. 96). The frames considered the participants' employers (whether they are government employee, private employee or self-employee), their years of expertise, in addition to their different sectors (academia, Industry and Regulatory).

Table 5.5 Sampling frames for main study

Stakeholder	Industry				Academia				Regulatory
Employer	Private/self		Government		Private/self		Public		All
Years of expertise	0-10	>10	0-10	>10	0-10	>10	0-10	>10	NA
Number of interviews	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6

Note. Adapted and modified from "Quick Ethnography," W. P. Handwerker, 2001, Walnut Creek, CA: AltaMira Press. p. 96.

For focus groups, diverse participant recruitment methods were identified to be deployed in the main study via social media and the Engineering Registration Board database. In order to source the right participants, a request for expression of interest, asking for their universities, their degree, gender, industry of practice, position, and other demographics, was required to allow for a selection of diverse group of participants. The researcher then made a purposive selection to ensure the diversity of participants in terms of years of experience

Allow additional time for recruiting interviews participants since they are expert in their areas, and wanted to be prepared for the questions. Make sure you also make considerations for elite interviewees advised by Kvale (2007), such as confirming the transcripts with them as well as sending them feedback after the interviews.

iii. Implications for data collection

The pilot study results have implications for the main data collection structure including the design of questions and sub-questions for the interviews and focus groups as seen in the Case Study Protocol in Appendix B. The implications for data collection were the following:

- To avoid ambiguity, set up some probing questions for the main study using information from the subthemes that developed from the main themes at level two coding.
- To better understand the curriculum process, the interviewer can ask questions like: Who are the key people involved? What is the feedback mechanism- if Tracer studies are conducted - ask how are they conducted? How is feedback integrated into curriculum?
- For the investigation to focus more on the people involved in curriculum process for instance, Heads of departments.
- There is a need to look at the engineering education curriculum to confirm if it is indeed content based and find out whether or not competence-based education is adopted.
- There is need to find out from the academia and TCU officials how accreditation of engineering programs is done and also collect documentary information such as standards, guidelines for curriculums design and development. Check if they are program specific and competencies are stipulated.
- Follow up on professional engineering competencies mentioned by Professional body participant to see if they are formally incorporated into the curriculum by developers.
- For the main study try to ask more specific questions, for example competencies that graduates entering the industry should possess, not practicing professional engineers.
- Prepare a list of skills so that I can ask in the interviews, for example communication intercultural skills and so on, to avoid vagueness.
- Seek information of tracer studies and how they are applied to the curriculum and how effective people think they are. Get different views of the curriculum development/review process including how the feedback from tracer studies is incorporated in the curriculum. Collect and analyse previous tracer studies and find out their purpose, feedback collected, the methods and so on.
- Investigate on post-graduation skills development and see if it relates to skill development in engineering education.

- Incorporate documentary analysis method in order to collect and analyse documentary data such as TCU standards, local publications, conference proceedings and unpublished work.

iv. Theory selection

The pilot study results indicate that there are discrepancies in how engineering education operates between the African context and the context that is represented in most of the Global North engineering education in literature. The different ways of operating reported, seems to be an outcome of underlying structure of engineering education practice – how it has come to being -which include its social cultural constructs. Bourdieu theory of practice explained in chapter 3 provides an avenue to investigate engineering education practice through the relationship between positions (structure) and powers (capital) of people practicing in engineering education and how they behave (habitus) (Grenfell, 2008). Further Bourdieu's notion of *field* (Grenfell, 2008, pp. 67-81) was proposed in order to set engineering education practice as an area of study that was necessary for analysis of the phenomena. Bourdieu's *field* has been used to explain issues underlying a certain practice such as a professional education practice like medical education (Brosnan, 2010) and MBA education (Vaara & Faÿ, 2011). This would enable exploration of issues of developing global engineers from an African position and its implications.

5.4 Main study design

Based on the results of the pilot study, the same approach proceeded in the main study with improvements based on considerations proposed in the pilot study 5.3.5. The improved research design is discussed here.

5.4.1 Data collection, sampling and recruiting candidates

Data was therefore collected through interviews and focus groups, and additionally, documentary evidence was collected to subsidise the data. The data collection for main study followed the Case Study Protocol in Appendix B, and the data collection methods and sources are summarised in Table 5.6.

Table 5.6 Data collection methods and sources used in the research

Dates of collection	Activity	Method and participants
January- February 2015	Pilot Study	Semi- structured Interview of experts (N=3) (professional body=1, academia =1 and industry=1) One Alumni focus group (N=5)
January – December 2016	Main Study	Semi- structured Interviews of experts (N=16) Two Alumni focus groups (N=15)
January 2016 to date	Documentary data	N=30 plus documents that include: 2 tracer studies 2 curriculums 4 accreditation documents 2 participant authored papers Other (e.g. webpages, government documents)

i. *Semi Structured Interviews*

> A semi-structured life world interview attempts to understand themes of the lived daily world from the subjects own perspectives. (Kvale, 2007, p. 10)
>
> It seeks to obtain descriptions of the interviewees lived world with respect to interpretation of the meaning of the described phenomena. (Kvale, 2007, p. 11)

Semi-structured interviews were used to collect experts' opinions of their lived experience on the issues connected to developing global engineers and engineers in general. By experts I mean people with long and broad experience in their field who (Kvale, 2007) referred to as Elites.

The interviews took a form of guided informal conversations, in a friendly tone, rather than structured formal queries (Denzin & Lincoln, 2008; Kvale, 2007). It included a set of questions developed from literature and then tested in the pilot study, the questions that were flexible rather than rigid. Although I took an approach of a friendly conversation, I also tried to keep the interview focus on the topic of subject matter (Kvale, 2007) by following the set of question but at times I could not avoid to sway out of line. I also tried to avoid being biased by sticking to the same line of enquiry and the protocol (Appendix B) for all the participants as suggested by (Yin, 2009). The set of questions included probing questions (Silverman, 2013) that were asked in order to explore some of the subjects or seek more clarifications, when it was necessary. The interviews were recorded with the interviewee's permission. The participants were provided with an information sheet attached as Appendix C, and a consent form also attached as Appendix D, which they had to sign to consent to the interview prior to the interview. Notes were taken during the interviews that later helped inform the data analysis process.

Interview participants were selected through purposive sampling technique employed according to Lincoln and Guba (1985), where interview participants were chosen with the aim of providing their experience and perspective about the engineering education practice in Tanzania, and sometimes in relation to the to the topic of 'globalisation of engineers'. The particular samples was selected because of their position in the field, unique experiences or individual situations to provide important insights about engineering education in Africa (Koro ljungberg & Douglas, 2008). The research focuses on small samples in order to examine the contexts in great detail and to describe the situations in enough depth.

To get the whole picture of engineering education in Tanzania there was a need to capture the views from the different stakeholders as was observed in the pilot study that there was a different view or perspective from the industry, professional bodies, academia and also alumni who represent the product of the engineering education system. There was also a different focus depending on what the participant is more involved in for instance pilot interview 3 was more focused on the Tracer studies and the sub region collaborations. However, despite the various perspective/views there is still needs to be enough data from each view, therefore the data sample had to be distributes between the three sectors in the study. As discussed in 5.3.5 (ii), this was done using 'sampling frames' as explained in (Handwerker, 2001). A similar strategy is explained as 'stratified sampling' in (Robinson, 2014, pp. 32-33). Table 5.7 presents the sampling frame for interview participants in the main study.

According to the sampling frame in Table 5.7, the anticipated total number of participants was a minimum of 27 and a maximum of 54. 30 participants were contacted, of which 24 had confirmed or agreed to be interviewed, but only 14 were available to be interviewed during the main study. In addition, two (2) interviews of participants from Malawi and Botswana were conducted while attending an African Engineering Education conference, increasing the number to 16. The 3 interviews from pilot study were also added to make a total of 19 interviews from Tanzanian experts. Brief profiles of interviewees (unidentifiable) deduced from their published Bios and interviews are attached as Appendix E, with care to protect their anonymity. The response to interviews was unexpectedly low due to several reasons on the researcher's side (time, travel and budget constraints) as well as the participants' side which are reported later on in the limitations of the research (section 8.2). The interview data was however well subsidised with the documentary data.

Table 5.7 Interview Sample – using Sampling frames

Stakeholder	**Industry**				**Academia**				**Regulatory**	**Total**
Employer	Private/self		Government		Private/self		Public		All	
Years of expertise in current field	0-10	>10	0-10	>10	0-10	>10	0-10	>10	NA	
Number of interviews Projected	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	**27-54**
Number of people who confirmed	4	3	2	1	1	1	3	6	3	**24**
Actual main interviews	**3**	**3**	**0**	**1**	**1**	**0**	**3**	**3**	**2**	**16**
Pilot study Interviews	0	1	0	0	0	0	0	1	1	**3**
Total interviewed	**3**	**4**	**0**	**1**	**1**	**0**	**3**	**4**	**3**	**19**

Note. Adapted and modified from "Quick Ethnography," W. P. Handwerker, 2001, Walnut Creek, CA: AltaMira Press. p. 96.

ii. Focus groups

Two focus groups aiming for 6 to 10 people who as suggested by Barbour (2007), were used to obtain an overview and perspectives of the system of education from the people who know it best, the previous students (referred here as alumni). The alumni selected were those had experience working in different sectors in the engineering industry as well as academia, I selected a focus group method to obtain information from the alumni participants because a discussion environment will work well with them rather than interviews (Kvale, 2007). The alumni for the focus groups were recruited because of they had shared characteristic (Barbour, 2007). Their shared experiences (Denzin & Lincoln, 2008) training in Tanzania meant that there was potential to get information from them as a group. With this group of people, more could be gained by insinuating discussions since they will assist each other through reliving their time of their training.

Focus groups encourage informal group discussions which are usually focused around a particular topic (Denzin & Lincoln, 2008), so in this study, graduates and early career engineers were led into discussions around 'how education had prepared them for their roles as global engineers'. This topic was prompted by the moderator from the beginning of each focus group discussion, such as:

> *Good evening, everyone. This is a focus group to contribute to the PhD on […]. Part of the study is to find out the experience from alumni of different universities in Tanzania on their curriculum, all the training they went through in relation to their roles [in the industry]. (Moderator, FG2. 2016)*

As the above quote explains, participants were asked to reflect on the engineering education they received, and how it has helped them in their roles as engineers from the time they graduated.

The focus group participants were provided with a one page questionnaire, to record a few demographics (e.g. gender, discipline, year of graduation), with a section that required them to rank a list of ten global competencies in order of their importance with the first being most important and tenth being the least important (attached as Appendix F). The questionnaire part was used as a stimuli for the conversation (Barbour, 2007) as proposed in the pilot study (5.3.5). The sheet also worked as an icebreaker to start up conversations. In addition, a set of semi-structured questions (from protocol in Appendix B) was used in order to allow any new views that may raise form the discussions in order to gain a better understanding of the local perspective. As a moderator, I was there to encourage discussions including getting involved by sharing my own experience, rather ask each person a particular questions, and this in my opinion worked out successfully in getting participants to open up. The focus groups followed a longitudinal design to inform topics under discussion (Kvale, 2007), where the Pilot focus group was used to structure the two main focus groups.

In recruiting focus group participants, I took advantage of my position as an engineer alumni from Tanzania (Section 1.5.2), and its potential for finding other engineering alumni. I found that it is easy to source them through their social networking groups, since it is common in Tanzania for early to mid-career engineers, to still be in communication with their university colleagues through networking groups on social media such as WhatsApp, Facebook and the like. The invitations to focus groups for the main study were sent through emails, messages and WhatsApp messages to contacts who shared them with their social and work groups, asking them to send an email to express interest (see Appendix G), and by a word of mouth at the

Annual Engineers Day (AED). The WhatsApp messages were successful as it is a tendency in Tanzania for alumni to form a group for instance a group of civil engineers, class of 2007 and so on. There are also WhatsApp groups that brought together staff members for instance who work at the university, this made WhatsApp an efficient method to reach people. So, being in part of an alumni group myself, on WhatsApp, helped me spread the invitation faster through the social channels.

The response to the invitation was good with about 30 expressions of interest received within a week, and through purposeful sampling 20 were selected for focus group,. The selections were carefully done to ensure diversity in gender, universities, disciplines, years of experience as well as employers categories. The 20 selected were each sent an invitation email that asked them to confirm attendance, while these who were not selected were also sent an email or a message (depending on the method they used when expressing interest) to thank them for expressing interest. Although 20 alumni, had confirmed that they will be attending, only 15 attended and participated in the two focus groups: Focus group 1 (Table 5.4) and Focus group 2 (Table 5.5). Among the five that did not turn up only one sent an apology on the day stating personal emergency as a reason for not attending, which seemed reasonable considering it was at the end of a work day. There were only four expression of interest received from female engineers and they were all selected and confirmed by email, still two of them were among the absentees. This means that only two female participated in the focus groups, among the four that were recruited, and one was in each.

Incentives were used which included meal and a drink which was part of the conference package at the venue hired, as well as token of appreciation in form of transport money as the participants had to get to the venue by their own means. Providing food and refunding participants expenses is culturally appropriate and expected in Tanzania (Africa) for events such as in seminars, workshops and meetings. Note that the two focus group were conducted at a conference venue that was hired and that all the costs were properly reported and included in the research budget by the researcher. For the pilot study focus group there were no incentives because the participant were known to the researcher and were willing to help. These expenses posed potential funding limitations because focus groups required to hire a venue and provide refreshments and reimbursement of transportation money, therefore only two focus groups were conducted according to the research budget.

In naming the data, the first letter M used to identify male participant and F used to identify female participant, and FG1 stands for Focus group 1 and FG2 stands for FG2. For instance F1-FG1 means first female in focus group one. (See naming in Table 5.8 and Table 5.9)

Table 5.8 Focus group 1 participant's profile

Alumni	Discipline	Years after graduation (in 2016)	University of graduation	Government employed	Private employed	Self-employed/ entrepreneur
M1-FG1	Civil	9	UDSM			✓
M2- FG1	Textile engineering	1	-		✓	
F1- FG1	Chemical	4	UDSM	✓		✓
M3-FG1	Software	1	UDSM		✓	
M4-FG1	Municipal Industrial services	2	ARDHI		✓	
M5-FG1	Environmental engineering	2	ARDHI	✓		
M6-FG1	Chemical and Process	1	-			
M7-FG1	Civil Engineering	2	UDSM			
M8-FG1	Industrial and Management	3	UDSM	✓		
M9-FG1	Civil	10	UDSM	✓		
		Average 3.5				

Table 5.8 presents information Focus group one (FG1) which was composed of 10 engineering alumni; where 6 were from UDSM,2 were from ARU, and 2 who did not specify their Institutions. Among them 8 had less than 5 years of experience after graduation or in the industry. In the group there were some participants who stood out and who I wish to highlight. For instance an entrepreneur participant (M1-FG1) who was often dominating the conversation, and who did not hold back in sharing his experience as an entrepreneur. There was female participant (F1- FG1), who seem to have experience with international company as well as experience studying abroad, where she did her masters. There were also two participants who were Ardhi University (ARU) alumni, I would identify them as M4-FG1and M5-FG1, who despite their few years of experience, were very outspoken than their peers. There was one junior academic

participant (M9-FG) who although often quiet was confirming some of the situation of engineering training raised.

Table 5.9 Focus group 2 participants

Alumni	Discipline	Years after graduation	University of Graduation	Government employed	Private employed
F1-FG2	Computer Engineering	3	SJUIT	✓	
M1-FG2	Mechanical	12	UDSM		✓
M2- FG2	Environmental engineering	2	ARU	✓	
M3-FG2	Mechanical	13	UDSM		✓
M4-FG2	Civil	10	UDSM	✓	
		Average 8			

Table 5.9 presents information on focus group 2 (FG2) which was composed of 5 participants; 1 female, and 4 male participants, who are alumni from 3 different institutions- St Joseph University in Tanzania (SJUIT), Ardhi University (ARU) and University of Das es salaam (UDSM). The four different engineering disciplines represented by the participants: Computer Engineering, Mechanical Engineering. Environmental Engineering and Civil Engineering. 3 government employed and two private employed with none of them self- employed or an entrepreneur. In this group every member contributed almost equally to the discussion although M1-FG2, who has been in the industry for 12 years, was often leading the discussion. With only 2 participants having less than 5 years of experience and the remaining three engineers with ten or more years of experience after graduation, the dynamics in this group's discussions were different from group 1. For instance the more experienced engineers (M1-FG2, M4-FG2 and M5-FG2), analysed the topic of 'globalisation of engineers' further and contributed their suggestions rather than just critiquing the education system. Their discussion focused more and what the problem is in engineering training.

iii. Documentary analysis

In order to obtain the specific objectives in section 1.6 this research will take advantage of the fact that there is rich information available in document form which will be regarded as data. Documentary evidence method will be the best method to supplement the interviews and focus group methods especially since the area of research, engineering education, contain valuable information (Bell, 1999; Yin, 2009) such as reports, guidelines and standards. The documents, offer a lot of insight about the engineering education practices such as curriculum and accreditation for this research, although they were produced for purposes different from that of the research. Documentary method was useful when access to subjects is difficult (Bell, 1999) for instance in this case due to time and funding assigned to collect data, I could not interview all the participants intended and therefore documentary data provided information on practices and procedures. The steps on how to (deal with) locate, categorize, select and analyze documentary evidence in (Bell, 1999; Silverman, 2010) were observed.

The search for documentary evidence (Yin, 2009) started prior to the interviews and focus groups and continued even after the data collection wherever the information was available including from institutions, government organizations as well as publicly accessible websites. Some of the participants also provided documentary evidence that included organizational reports, curriculums as well as journal papers that they had authored or presented in local conferences and journals. Care was taken to record the location where they are stored and how long they were stored for and a critical analysis was done to it. For resources that are confidential access was inquired. The kind of documents that have appeared during the search include pdf documents, websites and slides and printed sources.

Yin (2009) supports documentary evidence for being useful but also warns that they can be biased. Understanding that documentary sources are usually made for a particular purpose (Silverman, 2010; Yin, 2009)which is not this research, they should therefore be approached for what they are and not what they are used to accomplish. Further Documents are social facts, they are not transparent representation of an organization (Silverman, 2010). This means that they will not be treated as firm evidence however official they may be. Caution was practiced when collecting and analysing documentary data, keeping in mind the importance of understanding how the documents were produced, circulated, read, stored and used; also what they can and cannot be used for.

5.4.2 Data analysis

iv. Data processing

The interviews and focus group discussions were recorded using a Philips digital voice tracer. The audio files were then transcribed by an outsourced professional transcriber, and the transcripts uploaded into Nvivo 10 (QSR, Pty) and saved together with their audio files for coding by the researcher. The transcripts were reviewed against their audios to check for errors and to complete the incomplete parts. This is very important because if errors are left the data could give a different meaning later on in the analysis.

I made use of Memos feature in NVivo software (Richards, 2009) to explain themes and also interest points and the thought process, as they formed during the whole process of coding to ensure reliability of data interpretation process. A memo was created for each of the first-level nodes for both pilot study and main study. In Nvivo project file, codes were initially categorised separately to represent the different views for example all codes from focus groups were brought together under the main node called *Alumni views*. The interviews nodes were categorised into three nodes *Academic*, *Industry* and Industry and *Regulatory bodies*, these however were not considered to be first level nodes. There were no attributes used to categorise the data during the pilot phase, but attributes explained in (Richards, 2009) were set up in the main data phase in order to provide a more detailed analysis for instance age group, experience gender and some unique characteristics that were useful in the discussion.

v. Descriptive Coding

My approach to data analysis was the same as that of the pilot study, to start with broad coding then move to more detailed coding (Bazeley & Jackson, 2013). For the first level coding, all data was broadly coded into the six main themes or nodes of analysis that were established in and emerged from the pilot study (5.3.3): Education System, Accreditation, Professional bodies, International recognition, Relevance to Industry, Tracer studies. So selected chunks of data were dropped into the relevant categories, the approach names bucket coding. Bazeley and Jackson (2013) has called this broad-brush or bucket coding was an initial sorting mechanism using established themes.

For the second level of coding, I revisited the broad topics/themes and coded the already coded data again to break down allowing for subthemes to emerge from the data. The sub themes were not necessarily all coded in the level one node that the data was originally found, but were allowed to emerge in any of the other nodes or even as new level one nodes (Bazeley & Jackson, 2013). The coding was data driven coding (Richards, 2009) so there were no pre-established level two nodes, however notes taken during a particular interview or focus group were also used to guide the process. Again new themes were allowed to arise ad-hoc during the analysis and all second level nodes were revisited and an iterative process of coding continued where new codes developed, some codes were merged as well as some coding names changed to suit the content within the nodes. Also moving of some nodes were moved to different parent nodes. The final nodes and sub-nodes were grouped into two main categories as follows:

- Engineering education structure
    - Education
    - Teaching and learning
    - accreditation
    - professional body
    - collaboration
- Relevance to industry
    - Engineering industry field
    - Engineering education field
    - Practice gap
    - How they close the gap

The two coding levels (first and second) are also explained in the pilot study. Third and fourth coding levels included nodes that represented meanings – analytical interpretation level explained next (iii), and these are not included in the pilot study because the initial stage was only descriptive.

vi. Analytical interpretation

In this level, I draw out meanings of the emerging themes and concepts first from the story that the participants are telling me (people's understanding of what is happening) then explain the reason behind those themes (Bazeley, 2009), the process known as thick description (Borrego et al., 2009). After having the themes presented then I have to ask of the data- why those themes have come up (reason). Why do people have that understanding? Then use the theory to make an explanation out of it. The analytical interpretation (level 3 and 4) included expanding on the meanings assigned to each node or the reasons behind the themes that were occurring, sometimes the meaning were in theoretical terms.

For example, consider the findings that engineering education in Tanzania does not follow Outcome-Based Education'. I tried to find out from the data why they are 'not following OBE' (explained in detailed later in section 6.1.1), which is the way that the engineering education field operates (specific logic) to achieve competencies relevant to industry in the Global North discourse, and there is no doubt about that with evidence in chapter 4. I would ask questions like "Do they not feel the pressure to be relevant to industry? Does this mean that in their context, industry influence is not strong enough to make them want to achieve the required competencies?" and try to find out from the data. The questions will stay close to the theoretical framework. Level 3 and 4 are illustrated in Table 5.10, with complete and detailed analysis in Table 6.1, in Section 6.1.6.

Table 5.10 An example of analytical level code for theme curriculum is not content based

Theme	Reason (level 3)	Position (level 4)
Curriculum process is not content based, borrowed from the global North	Low industry influence HE structure	***low industry capital, HE capital*** ***Dominated***

Note. An excerpt from Table 6.1

For documentary analysis, this research has selected the problem oriented approach (Bell, 1999) whereby the focus of the study had been established from the secondary literature before going to the Primary data. The interpretation/analysis mostly followed the researcher's theoretical perspective which is that of interpretivist. The data was mostly used to fill the gaps of information required in the analysis of interviews and focus groups, although a few times it stood alone, for instance in explaining the procedures such as curriculum and accreditation.

5.5 Ethical considerations

All procedures regarding human research ethics were followed as outlined and approved by the Human Research Ethics Committee (HREC) at Curtin University (HREC approval number ENG-40-14). The participants gave their informed consent as explained by (Kvale, 2007) before the interviews and focus groups. Each participant was well informed about the research and their participation through an information sheet and clarification from the researcher (Appendix C), and were asked to sign consent forms (Appendix D) before participation. They were also asked if they agreed to be recorded before the recorder was switched on, which all of them agreed. For one organisation, special permissions to obtain data was sought from organisation before conducting an interview with one of its staff because that is the procedure for that organisation.

All participants for interviews and focus groups were volunteers. As described in 5.4, recruitment varied between pilot and main study, although overall, all participants took part voluntarily. For instance interview participants were individually invited by an individual email which included information sheet and consent form attached, while focus groups participants were invited through public advertisements. Participants had to express interest to participate after which they were sent an official invitation which they would have to confirm. Also, incentives were used in Focus groups as a token of appreciation to participants in a form of for transport and meals as explained in 5.4.1, while in interviews incentives were not required.

Confidentiality was maintained throughout the research from data collection to publishing (Kvale, 2007) to ensure that I avoid reporting data that would identify the participants. Since I collected data myself, I personally ensured that the participants were de-identified and not re-identifiable, especially in reporting and publications. Data was anonymised for storage into the research drive, for instance the interview data was saved with individual identifiers such as EMPhD-Interview-1-20160908 to maintain anonymity (Handwerker, 2001). For instance attached as Appendix E is in the participant's profiles Table participants' names attached here were changed to protect their identities. I kept a list of the identified data and the corresponding names given. This is despite the fact that interview participant had no problem with their names being published but I had. Care was also taken when using participant's statements as quotes in the thesis to protect their privacy (Kvale, 2007).

5.6 Research Quality: reliability, credibility, transferability, reflexivity

In qualitative research, it is important to give account on how I ensure the research observes quality standards of qualitative research. Therefore it is important to explain how the research design and methods used have ensured the thoroughness to the research – quality testing. For interpretivist theoretical perspectives (paradigms) that drives this research (Koro ljungberg & Douglas, 2008), this quality testing includes guaranteeing reliability, credibility (internal validity), transferability (external validity), authenticity and reflexivity (dependability) when required (Guba & Lincoln, 1994; Yin, 2009). The Quality assurances for this research have are spread in different phases of the research process and also reported in different sections of the thesis, but a summary of explanations on how they were addressed throughout the document is provided in Table 5.11.

Table 5.11 Summary of measures taken to ensure quality of the research

Quality tests	How they were addressed
Credibility –internal validity Internal validity or credibility as referred to in qualitative research ensures that what we measure reflect what we expected to measure (Creswell & Poth, 2018; Flick et al., 2007). In Quantitative this means is there truth to what you found, but there is no single truth in qualitative research hence credibility is a more appropriate term (Borrego et al., 2009) or as Yin (2009) suggests, construct validity to explain instead of not internal validity.	By giving an account of how I am doing my work throughout the chapters
	Using sampling frames to ensure that I have considered views of different cultural experts (Handwerker, 2001)
	discussed my researcher's position including my philosophical perspectives early on in the thesis and have declared my bias in Chapter 1, section 1.6 (Creswell & Poth, 2018)
	Triangulation: Using multiple sources, multiple methods to back up is suggested to address validity (Yin, 2009). This is addressed first in the sources of data selected: documentary, interviews, secondary data etc. Using different kind of approaches to get same information from the same group. See triangulation and its criticism in (Seale, 1999)
	Credibility was ensured by seeking respondent validation. This was especially important for the elite interviewees
Transferability to other settings – (external validity/ generalisability) That the results can be transferred to similar settings(Borrego et al., 2009). Generalise explanations- eg if I find similar things in the setting they too will find similar things (Yin, 2009).	In this research involving a single case of Tanzania, transferability is insured by defining the domain for transferability (Yin, 2009). By describing the context being studied in Section 2.1 (what it is and what it is not), then explaining the Tanzania setting as typical of a whole Sub-Saharan African country in Section 2.4, I have identified elements of Tanzanian situation that can be transferred to other contexts as well countries in similar situations (Borrego et al., 2009). The setting with its exceptions is presented in the transferability domain in Figure 5.3 below. Empirical transferability- is ensured by providing well-grounded evidence –not just snippets: Transferability was enhanced by providing a "thick description of a specific context, allowing the reader to make connections between the study and his or her own situation" (Borrego et al., 2009, p. 57). See the chapter 6, section 6.4.

Table 5.11Continues…

Quality tests	How they were addressed
Dependability –reliability and trackable data Demonstrating that operations can be repeated to give the same results in order to minimize errors and biases in the study (Yin, 2009). As Yin noted, there is no need to replicate results to another case study, but to show that the results can be achieved if going over the same case again – most of my pilot study results from the same case study were replicated.	Reliability is ensured by documenting procedure in the research process. Case study protocol (see Appendix B) is used to ensure reliability during data collection (Yin, 2009). In this research the protocol was tested during the preliminary study and updated for the main study. Data was collected according to the instructions in the protocol. To ensure dependability in coding, I developed nodes journals, diaries or memos and kept some consistency in this. Example ensure the code was done the same way at each level, ie level one, two and three. The coding journals helped me to explain how I have arrived to my codes and finally research findings. How ideas and themes have developed and changed.
	The skills of the Researchers in methodology, data collection methods and analysis software are declared (mentioned in section 1.6 and section 5.6)
	For reliability of findings all participants were sent the interview narratives through email to check that they are not misrepresented in any way.
Reflexivity –objectivity This is when "researchers examine their own biases and make them known" (Borrego et al., 2009, p. 60).	Defining my position as a researcher (Creswell & Poth, 2018) in Section 1.6 and also my relationship with the participants in the pilot study, and also by often expressing my view on the topic in the thesis. Explaining the lesson learned from conducting a pilot study (Section 5.3) and how that has impacted the direction of the research.

5.6.1 The domain for the research transferability

The domain for transferability of this research is presented in Figure 5.3. The concept is adopted from the ‘sample universe, inclusion/exclusion criteria’ in (Robinson, 2014, p. 27). The Figure shows that the sample universe (the domain) is Sub-Saharan African engineering education, and the specific sample investigated is mostly from Tanzania. Figure 5.3 also show the diversity of perspectives sought within the sample – Academia, Industry regulatory bodies and early career engineers that are alumni from African Higher Education institutions. The Figure describes the domains inclusion criteria for that transferability of the research- developing countries in Sub-Saharan Africa, and also the exclusion criteria.

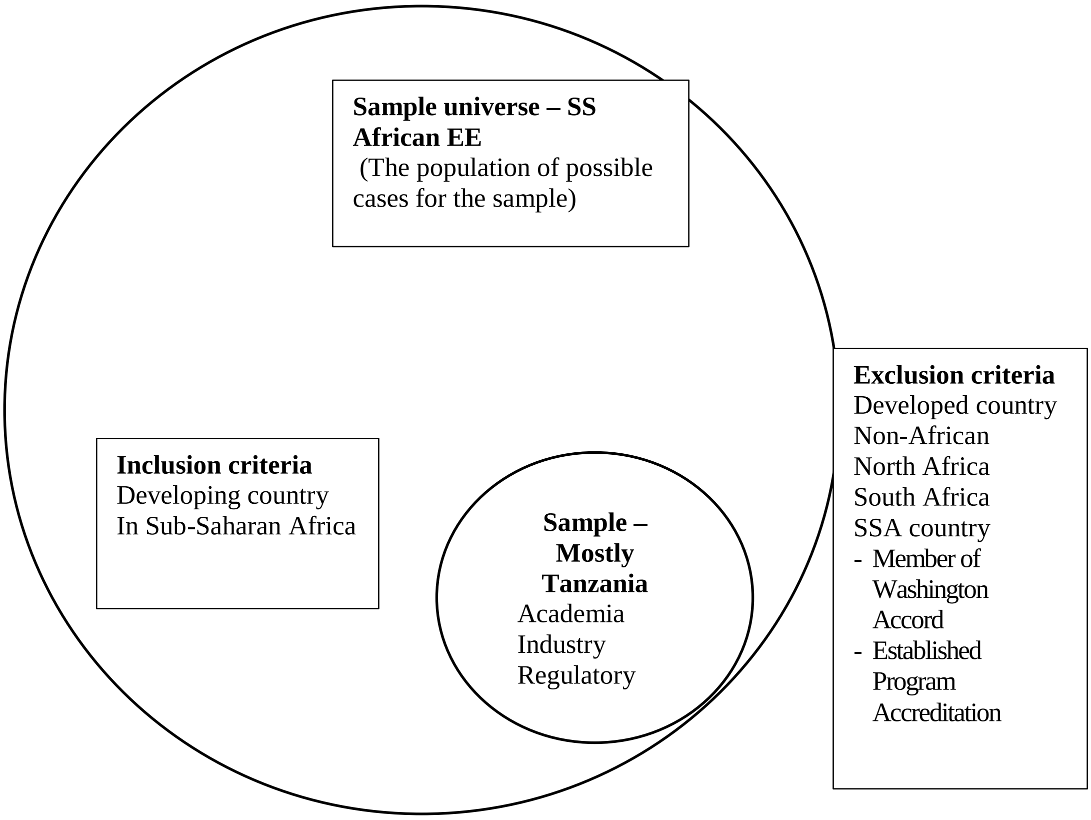

Figure 5.3 Transferability domain for the Research. Adopted from “Sampling in Interview-Based Qualitative Research: A Theoretical and Practical Guide,” O. C. Robinson, 2014, Qualitative Research in Psychology, 11(1), p. 27. doi:10.1080/14780887.2013.801543

5.7 Chapter Summary

In this chapter I have laid out the Methodology of the research including the pilot study that was conducted earlier in order to validate the themes and guide the direction of the research. I have explained the research's methodological framework including the main phases of the research process: literature review, pilot study, main study, and confirmation phases. I have explained in details how empirical data was collected including sampling and recruiting participants. I have also revealed how data was processed and interpreted to produce the results. I have notified of the ethical issues and considerations taken to mitigate the issues. At the end I have elaborated in a summary table (Table 11) how quality was ensured throughout the research process, using relevant checks for qualitative research. Further, I have explained the domain of transferability of the research more clearly using a diagram (Figure 5.3).

In the next chapter, using data collected, I position African agents in the engineering education field constructed in Chapter 4 (Figure 4.3), and establish how other powers are organised against them in the field, therefore analyse their action (position taking), according to their position or their viewpoint in the field, and in turn explain how the field functions within its different contexts. Placing African agents in the field will help map the African context of engineering education against the general contexts will lead to understand the differences in structure (logic of the field), show that the positions available for agents in the African context of engineering education can be different when observed within the global or the general field. This is because the values in the context of the field and rules of interaction that agents have to adhere to, as well as their habitus, are also different from the Global North engineering education scene.

6.0 Findings

This chapter presents results of the analysis of the African context of engineering education practice in two parts: one showing the contexts practice in comparison to the engineering education field constructed in Chapter 4, and also in comparison to the field of industry practice. The first (Section 6.1) illustrates the gap between the African context and the Global North context while the second (Section 6.2) brings attention to the existing proficiency gap between the African engineering education and engineering Industry.

In 6.1, I will show how Bourdieu's notions of capital, rules and habitus play out within the field in Tanzania compared to the field explained in Chapter 4. The engineering education field that was constructed in Section 4.3 to depict a global scene of engineering education, shows the domination of the Global North perspective of engineering education and how that has come about (how the Global North has gained its capital) in the fields trajectory from the available literature. With regards to discussions in Chapter 2 and the pilot study results in Chapter 5 (in Section 5.3), the African context offers a different setting of engineering education to that of the Global North, with some of the areas of significant discrepancies highlighted. I provide evidence-based understanding of the contextual discrepancies of engineering education practice in the Africa and their underlying causes in terms of capital and rules and a few times habitus. The discrepancies are analysed in more depth here and some representative direct quotes are used as evidence to the analysis from the lived experiences of its stakeholders drawn from the data collected.

In 6.2, I presents the analysis developed from the Relevance to Practice node, which developed as a new node in the pilot study (5.3) and became a category in the main study. The node was analysed separately due to its importance as it contains information that sheds light on the situation of engineering education in Tanzania with respect to its industry, crucial for this research. Once more using Bourdieu's concepts, I analyse engineering education and industry as two separate social areas of practices – training field and practicing or workplace field respectively. So on graduation student agents (graduates) are transitioning from their training field (engineering education) to their workplace field (industry). The practice gap between the two fields in the African context is presented and its link to globalisation established. Literature, for example Walther et al. (2011); (Walther & Radcliffe, 2007), Trevelyan (2010b) and Johri (2010) found that the best way to define engineer is by studying the industry which engineers are going to practice. In order to determine competencies are relevant to the African context, it is important to study the engineering practice or the industry.

I am now going to lay out how applying the theory to the Tanzania case helps us demonstrate the gulf that exists between the Global North and Africa, as well as the relevance of African engineering education to its industry.

6.1 Conflict in Structure: rules and capital

The general engineering education field constructed in Chapter 4 has certain implicit rules that agents follow when pursuing capital of the field, in order to improve or reserve their positions in the field. The rules that are related to demonstrating competencies include an outcome-based education, student centred learning, program accreditation by a professional body and collaboration between stakeholders. In *Practical Reason*, Bourdieu (1998) explained that there is a logic to the rules (the specific logic), and that agents operating in the field, know the rules of the field and how to behave. Observing through data, the activities in engineering education in Tanzania such as curriculum development, teaching and learning and so on, compared to the one describing the field in Chapter 4, I found that agents in Tanzania operate differently, against the logic of the general engineering education field. Playing against the rules by African agents may pose some problems.

6.1.1 Curriculum

Findings confirmed that engineering education curriculum in Tanzania is not following Outcome-Based Education (OBE) system, despite documentary data on the curriculum and curriculum development process implicating that the education system is content focused. Curriculum emphasis seems to be on the courses and contents, which are represented by the number of hours that students take each week. The hours are known as units in the unit outline (course outline). The curriculum, as reported by participants, ensures the degree program contains the "minimum number of units that [the student] has to acquire" to complete a course (Interview 4, 2016) and not about the learning outcomes. This is despite the fact that the terms 'learning outcomes' and 'objectives' usually appear in the course outlines, as was observed in the *UDSM 2011 Civil Engineering Curriculum: Detailed course content,* in Figure 6.1.

Course Title: SC 122: Dynamics of Solids (1 unit) (Semester 2)

Prerequisites: SC 121

Objectives:

1. To analyse forces and solve simple problems of particles and bodies in motion.
2. To derive and apply equations for bodies in linear, rotational and oscillatory motion.

Learning Outcomes:

Knowledge of basic dynamic problems will be obtained

Course Content:

Dynamics of particles Kinematics of particles –rectilinear and curvilinear motion; normal, tangential, rectangular and polar coordinates.
Dynamics of rigid bodies Plane kinetics of rigid bodies- Force, mass and acceleration of rigid bodies; work; potential and kinetic energy

Delivery Mode: 1 hour lecture + 2 hour tutorials per week

Assessment Mode: Coursework 40% + University Examination 60%

References:
Meriam, J. L. *Engineering Mechanics, Vol. 2, Dynamics*, John Wiley and Sons, New York, 1980

Figure 6.1 An excerpt showing a Course Outline. From Documentary data "Civil Engineering Curriculum: Detailed course content," UDSM, 2011.

The results show that Tanzanian education is not like the Outcome-Based system described in the Global North where the learning outcomes are derived from generic competencies which are prescribed by professional bodies. In Tanzania, the professional body (Engineers Registration Board) does not prescribe course competencies. Curriculum process follows rules stipulated by the national accrediting body, Tanzania Commission of Universities (TCU). Despite TCU stipulating "Well formulated Expected Learning Outcomes" in item v of the in the *Procedures for Program Accreditation* found on TCU website (http://www.tcu.go.tz), it is vague on how this is done, and there are no generic competencies stipulated in the standards provided. This vagueness means the task of coming up with objectives and outcomes for the curriculum is left to the universities, specifically to the curriculum developers, who now have a lot of academic independence.

This academic independence left to university in curriculum process may be the same elsewhere including in the Global North, but the difference here is the in the lack of prescribed competencies, which in the Global North define capital of the field. Lack of prescribed competencies and vagueness of the accreditation standards puts a great responsibility on curriculum developers which may include them redefining capital for their institutions. Further inquiry of the data was then conducted on: How do curriculum developers come up with these without having the competencies that guide their decisions? and what are the implications of doing so? Looking at the practices in the Tanzanian context of the field, raises the following issues of practice: OBE Policy vs practice gap, reliance on Global North perspective, Problems in incorporation of industry, as discussed here.

i. OBE Policy vs practice gap

The research found evidence of OBE instructions to Higher Education curriculum process which were not implicated in practice. There are several mentions of the terms 'Outcome Based Education (OBE)', 'competence-based curriculum', or the elements of them appearing in TCU documents obtained from the TCU website (www.tcu.go.tz), although the practice on the ground is different. For instance the TCU has instructions about competence-based curriculum process in its stipulated guidelines such *as Quality Assurance General Guidelines and Minimum Standards for Provision of University Education in Tanzania*, *Revised Curriculum Framework* and *Procedures for Program Accreditation* in their website (http://www.tcu.go.tz). In some of those TCU instructions (e.g. in *Revised Curriculum Framework*), there is a requirement for provision of course 'learning outcomes', the instruction has also been pointed out by interview 8 participant when asked about plans to move to outcome –based education. He mentioned that:

> *[…] nowadays the Tanzania Commission for Universities, in a way it has a certain framework which forces universities now to draw their curriculum using outcome-based, but it is only done partially because they are insisting on changing the learning outcomes, you have to write the learning outcomes, but which does not relate to the course content. As long as you're satisfy that they approve. (Interview 8, 2016)*

In this quote, Interview 8 participant implies that the procedure is not done authentically, because learning outcomes are thought of or developed once the courses or content has been decided, not the other way round where learning outcomes are developed first. Because of the persistence in learning outcomes, sometimes the learning outcomes do not match the course content.

Interview 8 participant, who has a good understanding of the institutions procedures (rules), further criticised engineering education in Tanzania for not being outcome-based, saying:

> *[…] procedure [where] we have to pass through maybe what we call the expected learning outcomes, enabling outcomes before coming down to the course content […] is never there in East African universities. That, you can be assured. (Interview 8, 2016)*

Interview 8 participant explains that a proper procedure for curriculum include defining the "learning outcomes from industry feedback" on skills/ competencies, which he informs, is not the case in Tanzanian engineering education. He emphasizes on the need to "earmark the abilities needed by the industries" which he feels is lacking in their curriculum process, where the curriculum is "just change[d]". (Interview 8, 2016) Interview 8 participant has occupied various capacities at his current University including quality assurance (according to his publicly available profile and the interview), and is familiar with what outcome-based education entails.

This contradiction between instructions and actual procedure in curriculum review process is similar to what Chisholm and Leyendecker (2008) referred to as the gap between practice and policy the about having a policy but not implementing in practice,. According to Chisholm and Leyendecker (2008), OBE has been introduced in South Africa but it has not taken root yet in classroom levels, academics have not adopted it widely. But looking at this trend we can see that the gap may be caused the fact that curriculum process is a social practice and therefore there is bound to be contradictions between guidelines (instructions), that are externally imposed and practice that is proceeded by academics, as explained by (Annala & Mäkinen, 2017). In Bourdieu's terms practice depends on the agents' position (capital and rules) and their habitus. The amount capital they own in their position and their habitus determines their decision or action. If these are not in line with the Outcome based practice then they will resort to what is possible for them. The contradictory narratives between what's in the instructions and what is in the actual practice are also expressed by Annala and Mäkinen (2017) as:

> This is due to the fact that, despite the curriculum being refined as an institutional document, its creation is inevitably preceded by negotiations of meaning within the local academic communities. These negotiations of

> meaning often bring to light competing internal and external tensions regarding curricular missions, visions and individual scholars' prior beliefs. (Annala & Mäkinen, 2017, p. 1)

Therefore, in order to understand the situation of engineering education practice, it is more accurate to investigate what the academics are doing on the ground rather than what the policy is saying, which represent the institutional interests. So, in Bourdieu's terms the policy vs practice can be explained in terms of competition of capital: institutional capital vs academia capital.

Data indicated that the practice or decisions depended on the capital and habitus that curriculum developers bring to the field, and that different agents may go about doing differently because of their own experiences and beliefs. For instance, those who are connected to industry may argue that the curriculum should contain things that are more related to industry practice, while the more research and knowledge focused or mainstream academics, may argue about having more technical or scientific components in the curriculum. This is a problem of academic lack of prescribed competencies.

There are contradicting findings in a very small scale, which report of the existence of a competence-based system in engineering training in Tanzania worth reporting. This was reported in an interview with Interview 13 participant who was an academic from a Marine institution, Dar es salaam Maritime Institute, DMI (See Appendix I).

> *Our system is a competence-based system. I think you know, UDSM they use knowledge-based system. [...]. We are teaching competence-based for seafarers. So, we teach from lowest level – we call it Ratings, up to the highest level – Chief Engineers or Master Mariners. (Interview 13, 2016)*

This highest level rating that participant 13 was talking about, is a Bachelor Degree level, rated as NTA Level 7/8, in their institution's website. DMI offers other qualifications such as certificate, diploma and advanced diploma. This evidence of OBE is considered to be of small scale because the institution has only about 300 students a year, and students taking the engineering Bachelor Degree are a part of the total intake. This number is very small compared to other engineering education providers in the country, for instance the institution enrolment of 84 students in the year 2017-2018 compared to ARU's enrolment 1125 students and UDSM's enrolment of 9068 students in the same enrolment period, according to TCU's *Higher*

Education Institutions Students Admission, Enrolment and Graduation Statistics (http://www.tcu.go.tz). These statistics are for total numbers of students enrolled in the institutions, where students enrolling in engineering degree programs are only a portion of.

Results also noted that the institution only train engineers for marine work which is not part of the traditional engineering professions, and therefore they may not share the same job market. According to participant 13 (Interview 13, 2016) and on the website (https://www.dmi.ac.tz), the course has acquired international standards from STCW Convention of the International Maritime Organisation, equivalent to professional accreditation (contradicting the results in 6.1.3). This is also evidence that the course if influence by the Marine Industry including the international marine professional community, so high in industry capital. This research also found that the institution was not yet in the TCU's List of Approved University Institutions in Tanzania as of 31st January 2020 on the TCU website (http://www.tcu.go.tz), despite participant 13 informing then (2016) that, the institution was on its way to acquire registration.

This scenario was therefore different from what was observed from the engineering programmes in the institutions reported by other participants (such as interview 1, 4 and 8). However, the fact that this shows evidence of the existence of OBE in engineering education in Africa, specifically that a different context may exist, is worth reporting for future considerations (see Chapter 9).

ii. Reliance on the Global North perspective

The lack of prescribed general engineering competencies or attributes in Tanzania, has seen those involved in curriculum trying to build some objectives or criteria by drawing from Universities in other countries, mainly the Global North. For instance, according to Interview 8 participant, instead of designing the Learning outcomes, the curriculum developers will come up with courses (content), by modifying other people's curriculums.

> *This time around I think we need people on oil and gas and actually scoping syllabuses from Norway as well as other countries who are in a way engaged in oil and gas teaching, just modify a bit to end up with some management courses as well as engineering courses and after that, there you are, you have the syllabus. (Interview 8, 2016)*

Two other participants that were in charge of curriculum development activities in their departments, also spoke about looking at other people's curriculums for reference. They do this by literature search or looking at other universities which they believe to be best practicing, and those universities that practitioners referred to were in the Global North and also in South Africa.

> *We normally do a search in Google, then if we see something, sometimes we communicate with the university. We one-time communicated with XXXXXX University because we saw there was some courses there that they were offering and we had to ask them what their curriculum that they'd written. (Interview 4, 2016)*

Participants also reported to use already established relationships with Global North institutions at the department and individual levels. All in all, this means that African academics willingly borrow and adopt systems from the Global North, showing their dominated position in the field of engineering education. Global North institutional agents, such as the Universities where the curriculums are borrowed from, seem to be able to demonstrate large amounts of the field's capital – competencies, and also Higher Education capital- scientific knowledge. Capital "allows its possessors to wield a power, and influence, and thus to exist, in the field under considerations instead of being considered a negligible quantity." (Bourdieu & Wacquant, 1992, p. 98) Therefore, Global North institutions' possess power in the field of engineering education.

Interview 4 participant mentioned that they communicated with a University which is in South Africa, implicating that South African Universities have got high capital in the international engineering and Higher Education scenes. This evidence reinforces the reasons for excluding South Africa from the African context described in the section 2.2.2, that it resembles the Global North context. A study by Case et al. (2016) also reports on the difference that exists between South Africa, a middle economy country according to The World Bank (www.worldbank.org), and two East African low economy countries of Tanzania and Kenya. It shows how curricula reform activities the autonomy of engineering departments in the countries may be significantly influenced by their local contexts. Case et al. (2016) argue that in Tanzania, activities were based on institutional policies which is highly influenced by the state, while in SA, the engineering department had more autonomy from their Higher Education and state.

Further to the domination of the Global North in the field, participant 4 also spoke of using materials from the University in USA where he completed his PhD and where he used to teach. When asked a question if he has "a list of objectives or outcomes of what you want the students to become in the end?" He replied:

Yes, I have one for transportation engineer courses and I've been using it over and over. But actually, that one I borrowed from where I was teaching in USA. But as the college, no it doesn't have any. (Interview 4, 2016)

Note that, interview participant 4, having experience teaching in the USA, has habitus that is influenced by the Global North system of Higher Education. This practice of drawing from the Global North informed by the data is a case which is likely to be prevalent within African academics. This is because most the academics have attained their post graduate education abroad (Kumar et al., 2004), with some having experienced teaching depending on their exposure to the systems there. Interview 4 participant's decisions when it comes to curriculum development is dependent on his habitus that was shaped by his personal trajectory of teaching abroad. He also mentioned that there were no objectives given by the college, which means the institutional structure allowed for this space where agents can choose their own objectives.

iii. Problems in incorporation of industry feedback

Findings confirm that industry feedback is collected by Universities through tracer studies before every curriculum review or development process, usually every 3 - 4 years, depending on the institutions, using surveys and interviews of graduates and employers (Pilot interview 3, 2015, Interview 1, 2016, Interview 2, 2016 and Interview 8, 2016, Interview 10, 2016). These tracer studies are market research tools used by institutions to evaluate competence of graduate against the job market requirements as explained in 5.3.3vi. They are equivalent to Graduate Destination Surveys in Australia, USA and SA.

First, before coming up with the curriculum, normally what we do is carry out tracer studies for our graduates who have graduated 10 years to give us the experience […] (Interview 8, 2016)

We normally conduct the tracer study of our graduates. We identify their needs within the market. And also, we do the market survey to see the potential areas for graduates. (Interview 10, 2016)

The tracer studies seem to have potential for engineering curricula especially in relation to relevance to industry however, the uncertainties in the way that the feedback is incorporated into the curriculum, raised interest for this research. This is because despite their mentioning of skills or competencies required by the industry, it appeared that feedback is usually incorporated with a focus on content and not competencies, and also it is selective depending on the curricular developers' decisions. This indicates a low influence of industry in engineering education.

Therefore, there is feedback collected from graduates in the industry, who participants have often referred to as stakeholders, through tracer studies to inform curriculum review. Interview participant 10, who was at the administrative level, where tracer studies seem to be instigated from, confirms that the feedback from the tracer studies is used to inform curriculum process.

> *So once we have done the tracer study, identified their needs, then we discuss at the college level, we have what we call the management - college management committee, which is composed of all heads of departments and their coordinators of different activities. And once we agree the direction, then we forward the information to the departments where the curriculums are developed. (Interview 10, 2016)*

It is clear that the feedback is at least used to alert the need for a new curriculum or revision but there was a need to question how this feedback on required capabilities is incorporated in the curriculum, if it is used as competencies informing learning outcomes like in the OBE practice. There was a common response on how the feedback from tracer studies was incorporated back in the curriculum which confirmed the content-based nature of the curriculum process. For instance, interviewer 8 describing that after the tracer studies are conducted "the curriculums are just developed, just developed by changing the course contents." This focus on content in responding to feedback was also implicitly expressed in the other interviews, for instance when talking about feedback from graduates working in the industry that the students were overloaded.

> *And of course we had also to report that the previous curriculum, actually students were overloaded. So we had to reduce the number of units, which means that the load to the students. […] For example, we had courses which used to stand as a single course, for example ethics and professional practice, I think, which now has been merged into a one course […]. So the contents had to be reduced in terms of the load, […]. We had courses which we had to amend, for example, timber structures, which used to be a separate course, and masonry structures. Now it's a single course: masonry timber structures and masonry. (Interview 10, 2016)*

Likewise, when responding to the question about incorporating feedback into the curriculum, interviewee 4 referred to changing of courses, and not to learning outcomes.

> *Okay, like addition of other courses, optional courses. At the beginning we didn't have courses like hazardous waste. […] We didn't have, […] Transportation economics, we didn't have that course. We didn't have irrigation engineering. But it happened that a couple of [graduates] who were assigned in a project somewhere where they were dealing with dams and whatever and we get the feedback like they don't know anything about this. So we decided, when we were reviewing the curriculum, we should do those courses. (Interview 4, 2016)*

The two tracer studies reports collected from the College of Engineering and Technology (CoET); Tracer study results 2011 and Tracer study results 2011 show that engineering educators collect valuable feedback from industry through surveys of graduates and employers. The two studies however, each collected industry opinions with different purposes, the two were not parallel and therefore it was difficult to find common themes. The 2011 was tracing the competitiveness of graduates that have gone to industry from the college of engineering, more like assessing the performance of their undergraduate programmes. The 2016 study had less interest to this research because it was assessing the need for new postgraduate programmes - more like a needs assessment for the proposed programmes, as stated in the introduction:

> *The College of Engineering and Technology (CoET) is in the process of carrying out curricula reviews of its postgraduate programmes in order to ensure that they are in line with the technological changes, address the needs of the society and respond to the market demand. (CoET 2016 Tracer Study Results Report)*

The data collected from the 2011 study included opinions of graduates and industry on engineering training components including courses included, practical training, practical workshops as well as final year projects. There was also data about post-graduation progression including issues of employability, employment criteria, graduate roles and graduate competitiveness in the industry. The data was quantitatively analysed and results were presented in form of summaries of the percentages. The reports also collected views included opinions and suggestions for improvements of the programmes as well as attributes required to be relevance to industry. The reports have not offered clear and particular recommendations on how the improvements are to be implemented back into curriculum and training.

The results in 6.1.1, present the issue of capital and rules, in a sense that most of the engineering education context in Tanzania does not correspond to outcome-based education rules. Also university agents (academics) do not play by the rules – follow Outcome based curriculum process, despite this being in the policies. It is obvious that according to the prevalent Higher Education rules, there are currently no rewards, apart from self, for academics to pursue industry demands. Therefore, while responding to industry demands has been the main driver of the activities in the engineering education field or the field's capital in the Global North (Sheppard et al., 2009), in Tanzania this does not seem to be the case at least at the graduate level and especially with the local practitioners. We have seen in Chapter 4 that the structure of the field in the Global North has been influenced by industry, and this has some implications on globalisation.

6.1.2 Teaching and learning

Perspectives on the engineering education's teaching and learning methods from different participants including students, show that, in Tanzania, Student-Centred Learning (SCL) is not common. Despite there been some evidence of it being used sparingly by a few institutions or individual academics, still traditional teaching and learning style is prevalent. One academic participant in a large public institution (Interview 8, 2016), confirmed that the system at his institution is traditional 'chalk and talk'. Interview 8 participant believes that the teaching and learning approaches need to change so that "we can improve skills and knowledge for graduates by changing the syllabus, by changing the teaching method" (Interview 8, 2016). But the participant also believes that the changing need changing the "mindsets of top management" (Interview 8, 2016). By management he means senior University Management, say Vice Chancellery level.

These findings are in line with claims made by focus group participants that the training they received was general, very loaded, which made them "the jack of all trade and a master of none". (Pilot FG, 2015))

At the same time, there seem to be enough evidence that shows that there is another public institution that has presented a teaching a learning approach that seems like Project-Based

Learning (PjBL) (Barron et al., 1998; Kolmos & de Graaff, 2014), as confirmed by participants (Interview 12 and Interview 4). According to Interview 12 participant:

> *A: This is something that we've discussed, for example, at Ardhi University [ARU] and we introduced at the university, which is teaching by doing. For example like I was explaining to you, when we teach them about water supply then we give them a project in water supply.*
>
> *Q: Like a project based -*
>
> *A: Project based teaching, and that is what we train at [ARU].*
>
> *(Interview 12, 2016)*

Note that, the institution (ARU), is an Architectural institution which only trains a small cohort of engineers compared to the institution that Interview 8 participant is reporting about.

Analytical exploration of the data under this theme suggests that adoption of Student-centred learning depends on two main reasons: institutional structure (rules and capital) and academia experience (habitus).

i. Traditional with a few Traces of Student-centred TL

The results show that the choice of approach such as traditional teaching and learning reported, is the product of institutional structure. For instance there seems to be appreciation of the SCL in ARU because the institutional rules allow it while it seems to be difficult to make changes to student-centred learning at UDSM, until the change of structure is imposed by the administration or actors that have capital. As Interview participant 8 has said that in order to change the management need to be convinced not just the staff that teach but most importantly the administration. He adds:

> *I think we need to demonstrate that and it has to be done by surveys or practical kind of remarks or getting experts from outside through workshops […] like the way we've been conducting these workshops […]. And depending on the findings actually most of them will fully appreciate and when it comes to changing our kind of teaching and learning, maybe it will be easier for them to accommodate that. (Interview 8, 2016)*

The fact that changing will require that much effort to convince the top management that student centred approaches to teaching and learning can be beneficial seems to be an issue of institutional structures which is to do with capital and rules. Top management have the power (high capital) in the institution, therefore they can decide on the capital and rules that are valued by the institution. In order to influence changes in the structure that has operated in a certain way by for a long time there needs to be a stronger power (someone with high capital). Note that Participant 8's university enjoys the status of the oldest and most prestigious university in Tanzania and its structures are not easily altered.

With regards to the Project-based approach to teaching at ARU, Interview 4 participant refer to it as a "style of teaching" that was "borrowed from the architectural department where each semester student had to do a class project". The participant elaborated that students were given projects that were specific to their course as well as year of study:

> *For instance, if a student, civil engineering student in second year, for instance, they have to do a project in transportation. In second semester they have to do a project in water. So when they go to third year, the same. The third year they have to do structural and second year they have to do management and fourth year it's all about entrepreneur. (Interview 4, 2016)*

Interview 4 participant added that every semester students have to do one project in a group of four: "A very extensive project, from the beginning all the way to the end of the project and it has four units." (Interview 4, 2016)

Further, ARU academia found this approach to be beneficial in terms of being relevant to professional practice and it has worked well in helping students when they go out to industry. They report that the model includes mentoring from industry volunteers that meet the students weekly.

> *It really helps them a lot. It really helps them a lot because that's where they have an opportunity of sitting with the professionals. Because we normally invite people from outside. So if they're doing a project in transportation, maybe we have road way design, traffic, parking, auto design and whatever, part of infrastructure, then each week we have to meet for discussion. (Interview 4, 2016)*

Interview 4 participants explains how the mentoring occurs, saying:

They have a total of eight hours a week. So there are two sessions a week, of four hours each. [...], they present what they've done, where they are, what problems do they have and then the next session we call the professional of that area, they sit with them, now they explain that problem, the situation that is challenging them, we give them the way forward, things like that. (Interview 4, 2016)

From the quote, it shows that the project-based approach also includes presentations that sets the students up for practice. As Interview 4 (2016) suggests that the approach has also helped them "to model especially what they're learning in the class" into practice.

Participants (interview 4 and interview 12) believe the approach is successful based on the good feedback they are receiving from industry since the engineering programme started, which is in 2013 according to ARU website (http://www.aru.ac.tz).

It's successful. We have a system at Ardhi [ARU] where we try to track down our students and report to their employers and try to seek feedback to see what they think, and I think most of them are very happy with the students. I mean this is just the third lot that's going into the job market [...]. The first, the second are already in the job market and the reception has been really good. We've been told they're really, really good engineers. They're better prepared than perhaps the other institutions. (Interview 12, 2016)

The quote shows the appreciation by the education practitioners, of the method of delivering the Civil Engineering degree program, which operates according to the methods of teaching and learning of the Architectural institution, where students undertake a project in every semester. There was also an interesting finding about the architectural courses being offered within the civil engineering department in UDSM, have also adopted the seemingly student centred project-based model explained above. According to Interview 10 participant, the architectural courses have their way of delivery that requires a certain types of rooms – facilities.

Overall the results indicate that there are different ways of delivering engineering programs between institutions in Tanzanian context, which is an issue of existence of different institutional structures (capital and rules). This may include the difference in student numbers and sizes of cohorts against facilities, volunteers and staff numbers. For instance Interview 4 participant was explaining that the number or students enrolled for the civil engineering course to be dropped from 80 students to 30 the previous year (2015) in order to match the number of staff they had. These findings have highlighted the very small size of the cohort at ARU compared to others.

Documentary data have also shown that the number of engineering students that enrol in the civil engineering program at ARU is much lower than that in the University of Dar es salaam (TCU's List of Approved University Institutions in Tanzania as of 31st January 2020 on http://www.tcu.go.tz). Also, that ARU's Civil engineering course produces very low number of engineers (3.5% of the total number of engineers produced in 2017) compared for instance to UDSM (who produces 45%), according to Masika (2018) presentation at the Annual Engineer Day (See also Table 2.3 in Chapter 2, Section 2.4.3). The fact that the engineering cohort is very small could be the reason why this method works, since there are less constraints when it comes to resources including staff, volunteers and facilities within the context. The lower numbers going to industry may also mean that their impact is in the industry is also small in scale, that is why it is referred here as traces of PBL.

Unlike engineering education, architectural education field is highly influenced by the Architectural profession or its industry and therefore values capital that is favoured by industry. So, the overlap between architectural education and engineering education at ARU has allowed for positions in engineering education for a more student-centred approach that values relevance to Industry, different from the University of Dar es salaam. Therefore when it comes to teaching and learning, the structure of engineering education in Tanzania, allows for positions of doing things different from the prevailing Higher Education institutional structures, and these positions are a result of influence from other parts of Higher Education. This kind of finding, that shows the difference in institutional structure between institutions, was parallel to (Kloot, 2011), who found where there were big differences in structure between UCT and Stellenbosch, where UCT allowed for new positions to develop, while in Stellenbosch did not. Structure has an effect on how agents operate, despite their habitus.

ii. Staff attitude on Teaching and learning

The data informed that there was low adoption of student-centred learning due to the fact that the staff are not proficient in the system especially the senior and those in administration, since for most, their education background was also purely traditional. Data seems to suggest that the change to student-centred learning methods and outcome-based education may be desirable but will take time and will require a lot of training for staff. As Interview 8 participant puts it:

It will change but slowly. It has to be slowly because our kind of staff now, most of them actually are used for this knowledge-based chalk and talk, to change them into problem-based or using developing curriculum – these kind of – it needs training actually. It needs training and also a change of mindset. (Interview 8, 2016)

The issue of people's mindsets and experiences is related to people's habitus, that changing to SCL methods will require a change in habitus of academics.

There is more evidence that indicate that academic's habitus plays a part in whether SCL is accepted or not. Being a graduate from UDSM (2007), interview participant 12 attests that this was not the approach used in her education, when asked if they thought the training at ARU was different, compare to their own training, she said:

Yeah, it's very different. I mean coming from University of Dar es Salaam [UDSM]and teaching these students, sometimes I feel a little jealous. Seriously, I feel jealous and sometimes I feel like well, I wasn't taught this when I'm being asked to teach them this because I had to learn it on my own, but then also that begs the question of how many of us actually have the ability to learn it on our own. I was lucky I had that ability to learn it on my own, but then there may be people that do not have that ability, so it is a good thing that we're able to teach them, but honestly I get a little jealous sometimes. (Interview 12, 2016)

Habitus obtained from her training is different from the habitus developed on her own, which seems to match the teaching approaches that are accepted at ARU. Note that Interview 12 participant went into academia after working in the industry for 6 years (see Appendix E) after graduating. It seems that through her 6 years' experience in the industry working with international organisation raising up to a level consulting engineer, she has come to be receptive of this way of teaching, and is actually very positive about it. This is a case where structure influences ones habitus (see section 3.3.1), the habitus developed by the industry structure and the institutional structure. Participant 13 situation can be explained using Bourdieu's concepts as Grenfell (2008) explains:

The notion of degrees of what I have called here field-habitus match or clash is not only crucial to the processes outlined above but also to how these processes are normally rendered invisible to the social agents involved. As "fish in the

> water", social agents are typically unaware of the supporting, life- affirming water, the match between their habitus and the fields in which they flourish or feel at ease, and how they come to be in those contexts. (Grenfell, 2008, p. 58)

This explains the reason why participants that advocate for student centred learning systems, for instance Interview 13, Interview 4 and even Interview 8, have come across similar experiences for instance through experience working in the industry, studying abroad or participating in international projects that constantly advocate for such ways of practices.

This notion can also be used to discuss the reason why the PBL methods and even outcome-based education have not been widely adopted despite being introduced and sometimes promoted by institutions. This is because the habitus of the African (general) educators/academia community has not yet changed.

> …. though the habitus is shaped by ongoing contexts, this is slow and unconscious – our dispositions are not blown around easily on the tides of change in the social worlds we inhabit. One can thus have situations where the field changes more rapidly than, or in different directions to, the habitus of its members. The practices of social agents can them seem anachronistic, stubbornly resistant or ill-informed. (Grenfell, 2008, p. 58)

Although this research did not focus on the ordinary lecturer and selected mostly prominent members, it has confirmed what was previously found (Chisholm & Leyendecker, 2009) that the advocated ways in competence based education have not taken much root in Africa.

As learned from previous works discussed in chapter 6, academic agents in their form of engineering education *field* are pursuing various types of capital for instance some pursue research which is Higher Education capital, and some competencies which is industry capital. The academics also bring to the field different *habituses*, some can have *habitus* that is more inclined to Higher Education while others can be more inclined to Industry, as is in the case of participant 12 here who has entered academia after several years of working in the industry, with international company. This means that even within the same structures, their practices or decisions may differ because of their different *habituses*.

In the focus groups, ARU students had similar positive reaction about the education they received, they seem to appreciate its contribution to their professional role. They are part of the few batches that had gone into industry from the degree course since it started 2010 (Interview

4, 2016) and they represented a certain perspective or habitus with their appraisal of the method. This acknowledgement is parallel with academia (interview participants) boasting about the good feedback they have received from the industry. This shows that the ARU methods may be relevant to industry practice or competence capital explained in 4.3.1. The SCL approach at ARU and its relevance to industry will be further explored in the next session (6.2).

Therefore, when it comes to teaching and learning practices the prevalent approach is traditional chalk and talk with traces of PBL. These are result of influencing institutional structures as well as agents' habitus. That the positions that engineering academic take within an institution and the position of an institution, affects how the engineering course is delivered.

6.1.3 Accreditation

Findings confirm the descriptive pilot findings (section 5.3.3 ii), which indicates that, Tanzanian Accreditation is done by a national agency- and not by the professional body. Professional body official confirmed in Interview 3, (2016) that, although accreditation mandate is shared between a national accreditation body, called Tanzania Council of Universities (TCU) and the professional body (ERB), the professional body does not accredit engineering education, it leaves the task to TCU. This is the same body that instructs curriculum process as seen before in section 6.1. So, unlike the Global North where professional bodies are leading in accreditation of engineering education programs, as the ruled show in Chapter 6, in Tanzania, the professional body does not accredit engineering education. This issue of involvement is discussed further in the next section, 7.1.4.

Engineering education in Tanzania is accredited only by the TCU, a body that also accredits all other Higher Education programs in the country. According to all academic interview participants, the only accreditation system that they know that operates in Tanzania is the one through the national accreditation body – TCU. For instance when I asked if they had any system that was accrediting their programs, Interview 10 participant was quick to answer saying and that "[a]part from the Tanzania Commission for Universities [TCU], we don't have." (Interview No 10) There were similar responses captured from the two who are involved in curriculum development within their departments for instance participant 4 stating that:

> *Actually we normally submit to TCU. […]. For accreditation, for our case, what we know is TCU is the one which is controlling all the issues […]. Because, the one that is checking us, is reviewing our curriculum and say this*

NTS level, this is degree level. (Interview 4, 2016)

Interviewee 4 is referring to the 10 levels in the National Qualification Framework (NQF) (see Appendix H), that are stipulated in the TCU's University Qualification Framework the Higher Education rules in TCU (https://www.tcu.go.tz). From the NFQ, TCU has developed a University Qualification framework which only includes post-secondary level (from NFQ level 6 to 10), where level 6 is Diploma, level 7 is Higher diploma, level 8 is Bachelor degree, Level 9 is Master Degree and level 10 is Doctorate Degree. NQF is analogous to Australian Qualifications Framework AQF (TEQSA, 2017), while TCU is the equivalent of the Tertiary Education Quality Standards Agency (TEQSA) in Australia, as seen in website of TEQSA (https://www.teqsa.gov.au).

Data provided information to address concerns raised by the pilot study results regarding the capacity of the accrediting agency to accredit each program to 'the level of detail that is sufficient' for the profession (in this case engineering profession. TCU is a national accreditation body that accredits all university programs from all institutions in Tanzania (https://www.tcu.go.tz) and also determines if an institution is capable of being a University of offering certain courses (institutional accreditation). TCU has other functions apart from accrediting all Higher Education programs, which has been stated on its website (https://www.tcu.go.tz).

Looking at the agency's (https://www.tcu.go.tz) functions it shows consistence with literature discussing the issue of capacity of National accreditation agencies as a challenge of Quality Assurance in African Higher Education (Materu & Rigetti, 2010). According to TCU (https://www.tcu.go.tz), apart from its core functions of regulating Higher Education which includes accreditation of all programs, the National accrediting body, TCU has two other functions. One of acting as an advisory body to the government "on matters related to Higher Education in Tanzania as well as international issues pertaining to Higher Education, including advice in program and policy formulation and other best practices". The other one is playing a "Supportive" role to universities to ensure orderly conduct in operations such as "coordinating of admission[s] of students, offering training and other sensitisation interventions in key areas like quality assurance, university leadership and management, fund raising and resources mobilisation, entrepreneurial skills and gender mainstreaming". The capacity of TCU to undertake all the other function and be able to conduct program accreditation, remains questionable. In the following, I will continue with analysis of findings about accreditation practice as it is conducted by TCU.

i. Accreditation process by National accrediting body- Higher Education rules

With regards to TCU's accreditation procedure in Tanzania, there are two levels, institutional level and program level:

> *[…] they are two different procedures. We accredit the Institution separate, and then program work accreditation is accredited separately. So, firstly there must be accreditation of the Institution. (Interview 6, 2016)*

According to TCU (https://www.tcu.go.tz) the institutional accreditation level, is where they recognize, approve, register and accredit Universities operating in Tanzania, and the program accreditation level involves evaluating all curriculums offered by registered higher institutions in Tanzania. The program accreditation process was analysed closely as detailed in this section to determine if it is outcome-based, as raised in the pilot study. This process was found to be different from the competence-focused program accreditation process, where the curriculum is accredited by a professional accrediting body such as ABET in the US, or ECSA in South Africa. This accreditation is done when the courses (curriculums) are being developed and approved or every after 5 years. It resembles institutional accreditation such as that stipulated by the TEQSA in Australia.

The results show that TCU sets the rules of accreditation in Tanzania. The program accreditation is done during the process of curriculum review and TCU sets requirements for curriculum review and development in Tanzania. Interviews and documentary evidence prove that TCU sets the *rules* of accreditation. Interview participant 1 reported that that: "Firstly there is a clear format that has been recommended by Tanzanian Commission for Universities so you have to observe that." (Interview 1, 2016). Consistent with interview 1, TCU have provided a four page document that show the step by step process of accreditation titled "Procedures for Programme accreditation" in their website Tanzania Commissions for Universities (https://www.tcu.go.tz). In the document there is a curriculum development process for institutions to follow. The document stipulates stages or steps that curriculum developers must follow for their "curricula to be accredited". The first four steps explain the process before submission for accreditation and these are consistent with the curriculum process reported by Interviews 1, 4 and 8.

> *Step 1, the proposed curricular submitted to the Department /Faculty Board, who at Step 2 will initially endorse proposed curriculum. Step 3: The curriculum is submitted to the University Senate for approval and if the senate approves the Step 4 follows here the University submits the curriculum to TCU through Programme Management System (PMS). (TCU, Procedure for Program Accreditation. Retrieved from http://www.tcu.go.tz)*

Similar procedure (Step 1 to Step 4) was reported by academia interview 1 and Interview 10 participants at UDSM, as well as Interview 4 participant at ARU, although not with the elaboration of stages as given above. For instance Interview 1 participant, explained the activities at the Department level as a head of Department where he was responsible of forming a team which develops of review a proposed curriculum then discuss in Department level before going to the College and if approved it is submitted to the University level (senate), which coincide with step 1 and Step 2. He also added that:

> *The team [curriculum committee] will have to present to the department to make sure that all issues are taken on board, they are considered appropriately, and to get also views from other members of the department who are probably not involved in the actual review. And then you continue to present now the curriculum in the various fora in the university, at the college level, College of Management, College Board, and, of course, eventually the curriculum will be presented at the university level. I [Head of Department] have a role to play from the beginning to the end of the curriculum review, all similar for development, curriculum development if it is a new program that you're developing. (Interview 1, 2016)*

Participant 10 who is at the College level elaborated the 'back and forth' activities between department, College level and Institutional (University) levels before the curriculum is ready for submission to TCU (step 4). The highest level to approve is the university through the Senate as informed by interview participants:

> *And once they have the draft, then they have to submit it to the college so that we can harmonise the curriculum before we forward them to the university*

organs, normally the senate, for approval. And approved by senate, then it has to be submitted to the Tanzania Commission for Universities for final approval. (Interview 10, 2016)

So the university level now, there would be the Senate committees which look into that and people view their comments and then you have to work on their comments and then send it back again. (Interview 1, 2016)

So, from the senate the curriculum "then goes to TCU" who will also review it and either approve it or reject it and propose corrections, or provide reasons for rejecting it (Interview 4, 2016).

According to the academia participants, the process before submission to TCU is fairly iterative in every level from department to the senate. Here is a quote from Interview 1 explaining the iterative review process involved:

That means also before it goes to TCU, there are various stages in the university which you have to pass and where you get also always feedback. You cannot imagine maybe that when you are doing that development, sometimes the curriculum can go to and fro, back and forth. You send it to committee, they bring it back with comments and sometimes you only see rejection and they're saying maybe this area, maybe the university doesn't want it to go into this area and there's no need or whatever so that will be views. […] and you have to work on the feedback which you get and then you resubmit. (Interview 1, 2016)

The process is also what entails the curriculum development process. After those processes in the institution, the curriculum is submitted to TCU, as stated in "Stage 4" of the Procedures for Program Accreditation (http://www.tcu.go.tz). The curriculum goes through the remaining steps (Step 5 to Step 8), and this is where accreditation procedure is evident as follows:

When TCU receive it Step 5: TCU Secretariat verify the minimum requirements for programme accreditation and requirement for adherence to the standards of quality assurance aspect in the design of the curricula for programme. Step 6: If does not meet the requirement, is returned to University, if meets the requirements it, is forwarded to the peer reviewers and professional bodies where applicable. In Step 7 TCU The peer reviewers' recommendations are sent to the university institution for inclusion into the curriculum. The institution *resubmits the curriculum in the PMS [online submission portal] after inclusion of the curriculum reviewers' recommendations. The reviewers verify the Institution's implementation status and recommends for accreditation or otherwise put more suggestions. Step 8: Finally the revised curriculum together with reviewers report are presented at the Accreditation Committee meeting which recommends to the Commission for decision. (TCU, Procedures for Program Accreditation. Retrieved from http://www.tcu.go.tz)*

The same process was also confirmed by Interview 6 participant the accreditation agency official.

This means that TCU has to approve all curricula after institutions have made all the revisions as explained above. The findings therefore show evidence of existence of a strong and established national accreditation system for engineering education and the whole Higher Education system that is well understood by the users (agents). This is an issue of structure (capital and rules). The rules in the Tanzanian context with regards to curriculum and accreditation are set by the Higher Education, and that agents in their local context are conversant with those rules as seen in the consistent evidence.

However, despite TCU calling the process program accreditation and often mention outcome based or competence based in their documents, the analysis of process found that it is not competence based type of programme accreditation as it is practiced in engineering education accreditation in the Global North. This is further explained next (section 6.1.3 ii).

ii. Not competence-based – Low influence of industry capital

Observing the content in the procedure for accreditation of the curriculum, we can see what the accreditation participant means when they refer to program accreditation, because every curriculum has to undergo assessment before it is approved or accreditation, however the procedure is not outcome-based as it is in the Global North, which shows countries taking on a competence-based accreditation of engineering education from the end of the 20th century (King, 2008).

The accreditation and curriculum documents on the TCU website seem to refer to the accreditation as program accreditation, however data on the practice proves that is an institutional accreditation. Interview 5 who is from regulatory body referred to accreditation as

‘Program accreditation’ (interview 5, 2016). Also looking at the standards provided and also the procedures and guidelines provided in the documentary data, there are several areas where terms like ‘competence-based’, and ‘even outcome-based program accreditation’ are used. For instance when explaining the program or curriculum accreditation process:

> *Curriculum accreditation is a form of quality assurance which is carried out for the purposes of accountability and improvement of programmes offered by University Institutions in Tanzania. The Commissions agenda is to oversee quality assurance systems in Universities including designing curriculum which are competence based and convey our National Philosophy. (Section 1.1, TCU, Procedures for Program Accreditation. Retrieved from http://www.tcu.go.tz)*

The TCU definition is a bit vague and the standards for accreditation do not explicitly list specific professional requirements. The quote however present the rules that forms the structure for universities in Tanzania to adhere to.

But for engineering education in Tanzania, there are no pre-defined competencies (skills) for curriculum. TCU does not provide competencies, although according to TCU guidelines the curriculum developers have to come up with learning outcomes.

> ***Q:** And do they have requirements of skills? Or how are their requirements set by the TCU, how do they look like?*
>
> *A: No, TCU, they won’t have the skills, but for us, what we do when we develop the curriculum, we have to come up with the learning outcomes. So we - as the college - all the departments, we identify the skills which are required and the competencies, and then we develop. So we develop our learning outcomes. (Interview 10, 2016)*
>
> *A: For TCU, what they do is to look whether - to review, to see if the contents - because developed, they actually enable their students to get, to achieve their - or to attain their learning outcomes which are specified (Interview 10, 2016)*

When asked if they specify skills (competencies) or attribute that students need to achieve for instance for engineering programmes, the participant from TCU responded:

> *Oh, those ones now comes to their Board. That’s why we say the first thing they have to do, they have to get registered to the professional Board. That’s*

left to the professional Board who are now in control of the students within the country. (Interview 6, 2016)

That curriculums need to obtain accreditation/approval from their professional bodies first before they get approval of TCU.

[…] They have to be approved at their professional Board, then they will come to us. Then for us, we can approve, pending on their professional Board requirement. Because now they are not as specific skills in their field right now. Then they specify their contents, then from there we can proceed with the other requirement. (Interview 6, 2016)

But it was established earlier that engineering professional body in Tanzania does not define competencies for accreditation, showing that the Tanzanian context of engineering education operates against the competence-based accreditation rules discussed in chapter 4 (section 4.3.1).

The Higher Education accreditation rules in Tanzania, although not provide specific list of competencies seem to also allow or propose a competence-based accreditation by the professional bodies. This means that there is this position available within the Higher Education structure for engineering education agents, especially professional bodies to pursue a competence based accreditation. This position for competence-based accreditation has been confirmed by the findings that show that there are existing program accreditations conducted by other professional bodies in Tanzania, such as Architecture presented in the data, but not engineering education. For instance it was reported in interview 10 that within the department of Structural Engineering there was an architectural program has to undergo accreditation by the architectural professional body:

No, of course for that one, actually, is a different case because when we develop, we have to submit it to the Tanzania Commission for Universities, and also to the Architects and Quantity Surveying Board. That is a must. (Interview 10, 2016).

Which means that accreditation system is not the same throughout are there may be professional Higher Education that require program accreditation. The architectural program also reported be seeking for international accreditation through the Commonwealth:

So now the board actually is the one which is facilitating to see that the *program is accredited by the Commonwealth Association of Architects. (Interview 10, 2016).*

The architectural education operates within the Higher Education system and also adheres to TCU rules, because at the institution level, ARU is accredited by TCU. From the data it seems that, what the national accrediting body in Tanzania is accrediting is different from what was supposed to be accredited by the professional body. This is also the case in Australia where the national higher accreditation system, TEQSA (https://www.teqsa.gov.au) exists, with different functions to a professional body like Engineers Australia (EA). The professional body was supposed to accredited specific requirements of the profession focusing on the competencies that engineers need to demonstrate at the end of their program, like the Engineers Australia's Stage one competencies (Engineers Australia, 2016). But does not seem to be the case in Tanzania according to the findings.

So, competence-based Program accreditation by professional body exists in the Higher Education field in Tanzania, and it co-exists with the institutional and program accreditation by a National agency explained above (6.1.3 i). The competence based is more related to the profession of the industry, while the national agency accreditation is more related to Higher Education. For engineering academia what is important (capital) is getting approval from TCU, while for architecture, program accreditation by the professional body is as important, so competencies are important too. So engineering education in Tanzania is likely to be position towards the Higher Education.

iii. International accreditation is difficult to achieve

For instance joining international accreditation systems is considered important for recognition. Participants think that accreditation especially international is important for international Recognition, facilitate transfers (mobility)

> *Yes, I think that is very important because once you are accredited, basically you can have the possibility of transferring. Students can transfer to other universities because we have something in common. And of course not only that, even the mobility of the graduates to be employed because they would be recognised by other countries. (Interview 10, 2016)*

The research findings show that participants agree that International accreditation is considered a strategy to acquire international recognition and therefore improve position in the field, however it was found that International systems of accreditation are difficulty to access. For instance, professional body participant described attempts to join:

> *We [Engineers Registration Body] have been, for a long time, trying to access this recognition through various avenues. Through maybe recognition first by a member of Washington Accord and, therefore, from there we can be recognised internationally as well […] But it has not been possible so far. I think that our view, or my view, is that those members of Washington Accord are more or less -- I think it is more or less an exclusive club. (Pilot Interview 1, 2015)*

The quote shows the participant was familiar with the existing international systems of accreditation in particular Washington accord, but claimed that WA was difficulty to access and feel like the 'big boys club' (Pilot Interview 1, 2015). Here the participant pointed out the fact that the Washington Accord was not inclusive. The participant explained how their long efforts to accredit engineering education through the Washington Accord member have failed:

> *However, international recognition of our degree program or degree programs offered in Tanzania is something that has been discussed for a long time. […] But definitely the efforts that have been made so far have not borne any fruits and they have not been encouraged by looking at what others have achieved either. (Pilot Interview 1, 2015)*

This confirms what the literature established about accessibility of existing international accreditation systems.

Interview participants further criticize the Washington Accord for not been successful in being an international recognition system because of not acquiring many new members. They add on the issue that:

> *[…], but the Washington Accord membership, even now, is very limited. There have not been so many new members over the last, say, five or ten years. What I know is definitely Washington Accord is something that has, in my opinion, not been able to bear the full extent of fruits that I expected in international recognition of engineering qualifications. (Pilot Interview 1, 2015)*

What this means for Africa is that, when it comes to accreditation, the capital and rules or operation within those systems is not something that is achievable by African agents like the professional body.

The findings show that in Tanzanian engineering education actors are therefore considering other alternatives to international recognition through the South –South cooperation. Note that collaboration with the Washington Accord is considered a North-South cooperation.

> *We are trying to see how we can share engineering knowledge in, if you like, maybe developing countries or middle income countries at most. So what we are exploring now is to look at how we can work together, not necessarily with the Washington Accord club members, but rather within the -- if you like, if I may use a rather old term -- south cooperation to see how we can form our own recognition system by working with countries in Asia such as Malaysia, such as Singapore, such as, if you like, the Southeast Asian countries. (Pilot Interview 1, 2015)*

There is confirmation about efforts of the South-South collaboration from the main data, for instance this statement from Interview 3:

> *And the third initiative is we are working with several leading countries in the South, Malaysia specifically, to try and harmonise engineering training, but also to have some kind of uniformity in the accreditation procedures of engineering qualifications. (Interview 3, 2016)*

From the findings it is clear that there are effort made by engineering education and the professional community to gain international recognition through accreditation. So International accreditation or international association seems to be a rule of demonstrating international competency in engineering - industry capital internationally. But it seems that collaboration with the existing international systems and alliances have not been successful, and the Tanzanian agents are taking an alternative way to form alliances with the other countries in the Global South. This therefore may be a strategy to gain social and economic capital of forces, through collaboration. Collaboration will be discussed further in section 6.1.5.

6.1.4 Professional bodies

Tanzania has two main professional engineers' bodies – Engineers Registration Board (ERB), which is a government body whose mandatory membership is required in order to practice in Tanzania, and Institute of Engineers Tanzania (IET), which is a non-profit organisation registered in 1975 and whose membership is voluntary according to IET (https://iet.or.tz/). The Engineers Registration Board (ERB) is a statutory body established by an Act of Parliament, Tanzania Engineers Registration Act No. 15 of 1997 found in ERB website (http://www.erb.go.tz). ERB is the body that holds the authority of regulating engineering profession in Tanzania from the Tanzanian government, which includes the obligation to accredit engineering programs and register engineers into different levels (http://www.erb.go.tz). Analysis of data show that the level of involvement of the professional body in engineering education curriculum and accreditation is much lower compared to that assumed in the engineering education discussed in section 4.3.

In accreditation, data confirmed that the engineering professional body, despite having legal mandate in development of engineers in Tanzania, does not accredit engineering education, and as discussed in the previous section (6.1.3) that accreditation is done by a national accrediting body, TCU. According to the participant from the professional body, ERB:

> *ERB has a legal mandate to accredit engineering programs or undergraduate training programs in Tanzania. But this mandate is also given to TCU, Tanzania Commission of Universities. And therefore there is a duplication of roles. So what we've agreed and put in our regulations is that we work together with TCU to accredit engineering programs in Tanzania. (Interview 1, 2016)*

The participant defends that ERB also works closely and in collaboration with TCU in accrediting engineering programs and that they give consent for any engineering program to be approved. According to Interview 3 participant, professional body also accepts and registers graduates that come from TCU approved engineering programs to work in the industry. There is also evidence showing significant involvement of the professional body right after engineers graduate through their apprenticeship programme.

The findings show that the engineering professional body in Tanzania, ERB has authority to accredit contradicts with what was said in the literature, that in Africa, 'engineering professional bodies have no authority in setting requirements for accreditation' (section 2.3.1). This means engineering professional bodies have the authority, but what is interesting is that despite having legal authority to accredit, they are not directly accrediting engineering education but leave it to a national quality assurance agent with whom they share accreditation authority Further professional body does not prescribe competencies or standards for curriculum design as it is in the global North, the task is left to the curriculum developers (also discussed in section 6.1.1). This means that professional bodies in Africa may have authority to regulate engineering education but they are not currently fully exercising it.

Further analysis of data using theoretical framework to explore the reasons why accreditation is left to TCU and why is ERB not more involved and what the implications are when it comes to African engineering education situation. The following is the analysis focusing on: not directly accrediting engineering programs, not defining competencies for curriculum, and significant involvement post-graduation.

i. Not directly accrediting engineering education

Main data confirmed results from pilot study data (Section 5.3.3 iii) that the professional body does not directly accredit engineering programs to avoid conflict with the national accrediting body. Interview 3 participant explained:

> *As a board we are governed first by the law, the regulations, and the by-laws. The main law says we should accredit. The regulations say that we work with TCU to ensure that we don't clash, because there is that potential that we may clash, and that is what we intend to consolidate, to continue forging closer working relationship with TCU in order not to reach a point where we are stepping onto each other's toes.* (Interview 3, 2016)

According to the quote the reason behind this practice is grounded within the rules of the professional body, its regulations. Descriptive pilot findings also suggested that conflict between the two bodies is something that participant claimed to have occurred in another Kenya, which is also a SSA country in East Africa (Section 5.3.3).

In a brief investigation of the Kenyan system, I could not confirm that such conflict exists, but I found evidence that, the professional body in Kenya is more involved in the accreditation of engineering education than Tanzania. According to the website of Engineers Board of Kenya (EBK) (https://ebk.or.ke), the functions of the professional body in Kenya includes specifying criteria for curriculum design and assessing engineering programmes for credibility. This means that they have accreditation instructions (rules) that are specific to engineering programs. Looking at the criteria in their website however, it does not reflect a competence-based accreditation or outcome-based accreditation system as such explicitly defined in the Global North, where the board specifies some competencies. Like Tanzania, they have not defined competencies for curriculum development but in terms of involvement, they are more involved than the Professional body in Tanzania. The Kenyan situation with regards to professional body involvement is varying from Tanzania although both are part of the SSA sample being researched and this raises interest. The details of the Kenyans accreditation are out of the scope of this study but may be worth pursuing in the future research.

Accreditation procedure stipulated by TCU shows very little if any involvement of professional body in Step 6 in the Curriculum process, which states that "if meets the requirements it, is forwarded to the peer reviewers and professional bodies where applicable." (TCU, *Procedures for Program Accreditation*, in http://www.tcu.go.tz). This means confirms that although ERB does not accredit the curriculum, they have a member (stakeholders) in the review process. This confirms that the board does not itself accredit engineering curriculums, but is only involved through TCU and its involvement is explained by TCU to be through as reviewers. .Interview 6 participants also informed about this explaining that when the curriculum is received, it is first sent to selected team of peer reviewers, who are individuals from another university, or a professional body if the curriculum has one.

> *And if the curriculum involves professional bodies like engineers or nursing or medical. First of all, we assist the Institution to start to follow the procedure of accreditation of the program in the professional body. So, they have to go to Engineers, get registered with the Engineers, who also have that requirement. So, when they're submitting to us, then we have to get the approval from their professional body. And also, for us in the review process, we are to obtain somebody from their Engineering Board, will be included in the peer review team. (Interview 6, 2016)*

Interview 6 participant adds that the peer reviewers will send their comments, which will be sent to the institutions seeking accreditation for implementation. The revised curriculum is then submitted back to TCU for accreditation. This confirms that although ERB does not accredit the curriculum, they have a member involved in the process.

Interview 10 participant also spoke about this process and noted the current indirect position of the professional board, given its mandate to regulate engineering education.

But we note that there is also the Engineers Registration Board, which is also supposed to regulate the engineering education. And now what used to be the practice normally if it is an engineering curriculum, the Tanzania Commission for Universities will give their documents to the board or select some individuals to review the curriculum. But we think that is not enough, adequate. (Interview 10, 2016)

In the above quote, Interview 10 participant expresses his dissatisfaction on how the professional body is involved through individuals (peer reviewers) that TCU select.

Yeah, there is a need of government of the board [ERB] as a board, not at the individuals. So that we submit it to the board, so that the board can look into it, identify the experts to go through it. And also maybe through their board meetings, they can comment. And what do you think is important is that the board should identify the minimum requirements for all engineering courses, so that when we develop the curriculum then we know what are the basics which we have to meet. (Interview 10, 2016)

The academic participant seems to support the need for the professional body to be the one prescribing requirements for curriculum development and accreditation. This expresses academic agents view or preference when it comes to having standards for curriculum development.

But, the research also found that the professional body in Tanzania is not prescribing specific competencies for engineering curriculum. The pilot study findings did not confirm whether or not professional body defined competencies for engineering curriculum, which raised interest in following up during the main study. A repeat interview was done with this participant in the main study (Interview 3, 2016) to try and break down this involvement in more depth and its reasons. When Interview participant was asked if they as a professional body have specific attributes that [curriculums] need to meet, he answered:

***A:** Essentially at the end of the day it is all about TCU, but what we do is we agree with TCU that the program should have certain characteristics, certain features. It must have some basic science training, it has to have some* *analytical training, it has to have some practical aspects, and the extent to which these are part of the curriculum is more or less, I wouldn't say fixed, but there is guidance into it. For example, how much should be the practical content of it within the university and outside the university. (Interview 3, 2016)*

Again the answer was general that the curriculum needs to have science training analytical training and practical aspects, but not specific when it comes to competencies that can be translated to learning outcomes. Therefore the professional body does not define capital of the field of engineering education in Tanzania, nor does it set the rules, but the national accreditation body does through prescribing curriculum design and accreditation of Higher Education including engineering education.

It was also found that industry and professional bodies are involved as stakeholders in curriculum development departmental meetings. When asked about the role of Industry and professional body being present as stakeholders at the committee in influencing the curriculum participant 8 had this to say:

Of course, stakeholders are invited, they know nothing about curriculum, they are not well versed with the curriculum. At the end of the day, the Department actually dictates what should go into the contents depending on the availability of staff. (Interview 8, 2016)

Interview 8 participant, referring to the curriculum process at their institution, indicate that the involvement of professional body in curriculum as a stakeholder does not give them much power (capital) especially since they are not conversant with the curriculum. The professional body has low capital in engineering curriculum.

The findings on the involvement of professional bodies in undergraduate engineering accreditation and curriculum process seems to confirm the low influence of engineering profession (industry structure) in engineering education. In Bourdieu's terms this relates to low industry capital and domination of Higher Education rules. The Tanzanian professional body (agent) involvement differs from how Global North regulatory agents operate in the engineering education field in section 4.3, for example how Engineers Australia go about making changes or defining the capital of the field or influencing the structure of the field. In Australia, Engineers Australia sets the required competencies (capital) and standards (rules) on how institutions can demonstrate that their programs can develop students with those competencies (King, 2008).

Tanzanian case does not match the structure that assumes a system where engineering professional body (government or non-government) of a country influences the rules of engineering programs in that country.

ii. High involvement after graduation – influencing industry structure

Despite the questionably low involvement of professional body during undergraduate training, findings confirm that it is well involved in training engineers post-graduation through a professional development program known as Structured Engineers Apprenticeship Programme (SEAP). As indicated in the pilot study (section 5.3.3 iii) the registration board, ERB, runs a government funded apprenticeship program that is involves an industry attachments, mentoring and monitoring with continuous feedback where students are required to submit reports every 3 months. The SEAP program is definition on the professional body's website as follows:

> *Structured Engineers Apprenticeship Programme (SEAP) is a government funded programme which was launched by the Minister of works […] on 13 January, 2003 and is supervised by the Board. ERB (http://www.erb.go.tz)*

The definition confirms that the apprenticeships are government funded and supported. The SEAP program is also discussed in review paper and is explained in details by Mukama (2005) who provides the following definition:

> The Structured Engineers Apprenticeship Programme (SEAP) or the Initial Professional Development (IPD) is a three-year training programme. It has been instituted in order to enable fresh graduate engineers to acquire professional competence and skills in a structured and systematic manner and thereafter register as professional engineers thus enabling the engineers to enter the job market fully equipped to practice the profession with confidence and effectiveness. (Mukama, 2005, p. 7)

According to (Mukama, 2005) SEAP was designed to address lack of professional competencies which were causing unemployment to graduate engineers.

> Experience has shown that quite a good number of young graduate engineers do not secure employment due to lack of professional exposure/experience/competence. (Mukama, 2005, p. 1)

This lack of employment was causing graduate engineers to also not get experience needed for employment, and as a result get trapped in a vicious cycle of "no experience-no employment-no experience" which may result in quitting the profession (Mukama, 2005). The program was meant to stop this cycle by providing initial experience and also speed up development of skills in practicing engineers from graduate level to professional engineer level.

> *[SEAP] aims at enabling Tanzanian graduate engineers wishing to practise engineering to qualify for registration as professional engineers in the shorted possible time. ERB (http://www.erb.go.tz)*

The quote suggests that the program is aiming at developing a professional competence required to be registered professional engineer, which is analogous to Australian Engineering Competency Standards Stage 2, stipulated by the Australian professional body, Engineers Australia (EA) (www.engineersaustralia.org.au). This shows that SEAP was designed to curb the problem or the concern on lack of competencies in Engineering. More analysis tries to understand the reason this lack of competencies is not addressed earlier by incorporating the competencies into engineering education. One of the reasons could be because of the belief that skills are gained in practice, that the HE system does not provide the environment to gain practicing skills – professional skills. This is explored further in section 6.2 when analysing the issues of relevance to industry.

There is a great significance put on the internship program by the professional bodies as can be observed in the way the program is structured (SEAP rules and regulations found in http://www.erb.go.tz). For instance the professional body provides placement for graduate engineers. But according to SEAP rules and regulation obtained from their website, this is actually what the professional body does. Regulation no 2.0 titles Selection of SEAP Places, states that:

> *ERB provides sufficiently suitable places for SEAP. However, Trainees are allowed to propose additional places of their choice. Training places proposed by trainees will be considered if proposals are made before the selection process. All places proposed by trainees must be approved by ERB. (ERB, SEAP rules and regulation. Retrieved from http://www.erb.go.tz)*

On the issue of providing placement, the pilot study focus group participants suggested that ERB should take the responsibility for placing graduates into different projects relevant to what they are aiming for, instead of letting students look for internships on their own as is the case currently. Hence insinuated that ERB was not providing places for SEAP. However the above quote confirms that professional body in Tanzania is obliged to assigns places for SEAP, unless students want to nominate their own.

Also, data shows that in the program, there is mentoring provided by the industry, and supervision by someone from ERB at least once a year. Industry is not obliged to pay for their training but just provide places for training, since are fully paid by the government, which means industry tend to want to take students as they can benefit from the free human resources in exchange for providing training.

Further SEAP is endorsed as an important feature in the context of Tanzanian engineering education field, and there is evidence in the data to support this. For instance participants in Pilot focus group as well as Focus group 2 also inform about SEAP as important from obtaining practicing skills including global skills (see details later in 6.2.4).

In theoretical terms, when it comes to engineering education field, the engineering professional body in Tanzania has low capital and therefore does not influence the rules, unlike Global North engineering bodies like ABET. However, in the industry the professional bodies have a lot of capital and they set the rules of the field, including rules in development of graduate engineers through SEAP. From the participants views it seems that professional bodies are very much involved in the two later stages of development of engineers which are training post tertiary and regulating engineering profession in Tanzania for practicing engineers. On the other hand, the professional body seem to possess very high capital in the industry field and dictate the rules of that field. That due to their control of internship and registration of entry into the industry by deciding who can practice and who cannot and so on, as well as what is counted as capital in the field. In that field and being a government body their actions are highly influenced by the state and what is going on.

There was an observation of lack of collaboration among main stakeholders in engineering education. Data showed disconnect between professional body and engineering education institution, and between professional body and accreditation agency. Professional body does not even mention engineering education accreditation in its website, despite professional body participant claiming that there is a collaboration in accreditation. Further, the observation of the Annual Engineers Day (AED) activities by the author noticed that lack of attention on engineering education, the focus was more on the industry and activities of engineers post degree. This is completely opposite to many Global North countries, including Australia, where there is collaboration of Higher Education, Professional body and Engineering education community (King, Howard, Male, & Hoffmann, 2015). The issue of conflict between professional body and national accreditation could be restored through proper collaboration between the two institutions, where the separate roles in accreditation are understood.

What I also noticed from the Annual Engineering Day (AED) forum I attended, and by looking into the documentary data from previous forums, is that engineering professional community did not seem to give much significance to the engineering education at least in their activities. The closest they got to engineering education was acknowledging graduates who did well in their degrees with an award and prize money, which may be a way of encouraging students to do well in their degree. Hence the emphasis on the high academic performance or good marks, which is Higher Education capital. They talk about local companies and significant projects coming up without thinking much on the human capacity. It seems to me that they are not connecting this with the importance of engineering education although a few times there have been presentations that have informed so (ERB, 2016 Annual Engineers Day Proceedings, retrieved from http://www.erb.go.tz). Engineering education, in my opinion, should be a component of the initiatives towards middle income by engineering professional community.

6.1.5 Collaborations

Pilot study findings on international recognition implicate a further investigation on regional and sub-regional collaboration initiatives that Tanzania is involved in, to determine the existing collaboration efforts and their effects in recognition. There is evidence confirming that Tanzania through its agents (individual and institutions), is part of various sub-regional, regional and international initiatives and alliances in engineering education and the general Higher Education. Some of the collaborations are at institutional level (Higher Education) and some are at the departmental level while others are at the level of regulatory authorities. The findings are discussed as follows:

i. Sub-regional East Africa collaborations in HE and Professional bodies

There is evidence that shows established collaboration in Higher Education as well as engineering profession within the East African region. These collaboration are supported by the political collaboration between the countries – the East African Community (EAC). The EAC was originally founded by three countries Kenya Uganda and Tanzania who were later joined by Burundi and Rwanda in 2007. There were also indications that South Sudan was in the process of joining the EAC, but this has not yet being confirmed. As Interview 3 informs:

> *There are several initiatives. I would say three main initiatives. One is we are working within the East-African community to bring together five, possibly six now, including South Sudan, countries to harmonise engineering training and engineering professional division, that is one. (Interview 3, 2016)*

The professional body participant implies that there is Higher Education collaboration as well as professional body. Analysis of the findings established that the two collaborations commence separately, but both have implications to engineering education.

The collaboration in Higher Education involves cooperation between the universities within East African region through an institution called the Inter-University Council of East Africa (IUCEA). IUCEA is an institution of the East African Community (EAC) that was established in 1980, declined in 1992 due to financial problems that also led to the collapse of EAC. The institution was revitalised in 2000 starting with Kenya, Uganda, and the United Republic of Tanzania, after the three original partner countries of the East African Community (EAC) signed a new EAC treaty in 1999 as it is explained in the IUCEA website:

> *Upon its re-establishment, EAC recognized IUCEA as one of the surviving institutions of the former Community. Therefore, it was agreed to establish IUCEA as an institution of the new EAC. In that process in 2000 IUCEA underwent revitalization […] in 2002 the Ministers responsible for Higher Education of Kenya, Tanzania and Uganda signed the IUCEA Protocol as an instrument that made IUCEA a legal body corporate of EAC. IUCEA (https://iucea.org)*

It is also reported that, later in 2007 when Burundi and Rwanda joined the EAC, they were also included in IUCEA, bringing the number of partners to five.

Interview data informs that there are efforts to come up with a common Higher Education qualification system in the East African region through the EAC but there are challenges of different systems of education participants as participant 8 explains:

> *We have regional cooperation. There's no problem with that because that's*

> *why we have the inter-university institution, organisation, which tends to oversee the quality of different universities in East Africa actually. And, at the moment, it is trying to come up with the National Qualifications System at the regional level so that different countries could tap that into their national qualification framework. But for East Africa, we're having a problem when it comes to undergraduates because, for our case, admission to the university is after Form 6. Kenya admissions for universities is after just Form 4. Uganda is a mix and Burundi, also, I think, is a mix. (Interview 8, 2016)*

Separately, there are collaboration initiatives between East African Professional bodies. Tanzania, through its professional body, ERB, was a signatory of Mutual Recognition Agreement (MRA) for Engineers in East African Community (EAC) in 2014. The MRA was signed on 7th December 2012 by three parties: Engineers Board of Kenya, EBK, The Engineers Registration Board (ERB) Tanzania and Engineers Registration Board (ERB) Uganda; in Arusha Tanzania, according to the presentation by James Okiror at the Engineers Annual Event 2014 on Mutual Recognition Agreement for Engineers in EAC in documentary data.

2. MRA for EAC Engineers

The Parties to the MRA

	The Engineers Board of Kenya (EBK) *established under The Engineer's Act 2011*
	The Engineers Registration Board (ERB)Tanzania *established under the Engineers Reg. Act, No. 15 of 1997*
	The Engineers Registration Board (ERB) - Uganda *established under the Engineers Reg. Act, Cap 271.*

By the time of signing the MRA, The Republic of Burundi and the Republic of Rwanda were still in the process of establishing the necessary legal and institutional framework for the engineering profession, and will append the MRA at a later date.

Figure 6.2 Parties to the MRA for East African Community Engineers. Expert from "Mutual Recognition Agreement for Engineers in EAC," Presentation slides by James Okiror, 2014, *Engineers Annual Event*. Retrieved from https://ebk.or.ke.

Interview 8 participant also informs of this MRA when asked about existing collaborations:

> *So what we are doing -- at East African general level, what we have is recognition across members of East African community. Right now, we have [...] recognition agreements, MRAs that has been signed by member countries. So all the East African countries are in the process of recognising each other's academic as well as professional competencies. Therefore, that will enable mobility of engineers, at least within East African countries, as a springboard towards maybe expanded regional cooperation, including SADC countries. . (Interview 8, 2016)*

Documentary data also confirm this, for instance in a presentation retrieved from:

> *An MRA for engineering professionals in the EAC is an agreement for mutual recognition of professionals. It enables a professional in one state in the region*

> *to be recognized as a professional in all the states. Similarly, a registration certificate or practicing licence issued in one state becomes honoured in the other states, leads to a free flow of engineering services across the region, [and] facilitates free movement of professionals across the EAC. (James Okiror, 2014, Mutual Recognition Agreement for Engineers in EAC, Engineers Annual Event, Arusha).*

Existence of the professional body collaborations at sub-regional level, and also Higher Education collaborations may be potential for engineering education in the future, although the collaboration did not focus on accreditation.

A little bit was mention to indicate that there were also efforts to harmonise engineering education within the Southern Africa Development Communities (SADC) countries by participant 8 and participant 10, but there was not much information given about it.

ii. Regional Africa collaborations at higher levels

The data reported existence of a regional initiative to harmonise Higher Education in Africa called the Tuning Africa Project. A participant at one of the institutions when asked if there was any initiative to harmonise Higher Education, replied:

> *Yes. We have the one there - what you call the Tuning Project, which is the European Union working with African Union to harmonise education in Africa. So in that project, civil engineering is involved. Mechanical also is involved from the engineering side because the others, I think, used to be medicine, agriculture and teacher education. So now it has been extended, I think, to have economics and education. (Interview 10, 2016)*

Although these initiatives were at the general Higher Education level, they focused on courses including two engineering courses, Civil engineering and Mechanical engineering, among others. But as the participant informed, the project – Tuning is from Europe and European Union is involved and in such collaborations it is clear who is providing the funding. Therefore these efforts seem to be not only externally funded but also externally motivated, despite having the African Union involved.

Data also informed on the challenges of harmonising engineering education in Africa which is having two different education systems Anglophone and the Francophone within the context, as explained by Interview 10 participant.

> *Yeah, because now for Anglophone, we have the four-year system, where we offer the Bachelor of Science. But for the Francophone, they have the five-year system where it is a Masters. So they study for three years, and then two continuous. That is five. So they have a Masters. So now it's hard to harmonise, of course, at what level? Not at the undergraduate. Maybe it will – after postgrad. (Interview 10, 2016)*

These are the issues of diversity of Education in the African context resulting from colonialism, explained in chapter 2, section 2.1.

Further there were claims from the pilot study that African collaborations in engineering education and the general Higher Education are donor dependent, hence they are unstable. These claims were confirmed by Interview 8 participant:

> ***Q:*** *So you mean most of these collaborations are donor-funded?*
>
> ***A:*** *Exactly. I tell you, they're all donor funded, yeah.* (Interview 8, 2016)

If collaborations are funded, it means that African have low capital in these collaborations and therefore cannot decide on what is of interest. This finding resonate with the discussion of African collaborations in Section 2.3.1 iv that is discussing the Africa wide initiatives such as "Enriching Engineering education in Africa" by RAE, Tuning Africa and others that externally motivated and funded. For instance the Tuning Africa Project is based on the EUR-ACE and supported by European Commission hence concerns of local originality and sustainability. African partners have no capital and therefore they cannot demand what is of interest to them or how the initiatives should be conducted in these partnerships.

There is institutional collaboration at Higher Education level known as African Association of Universities as

> *We have an organisation called AAU [African Association of Universities], whatever, which also oversees different universities from different regions. […] But that's too far for us to feel it. Maybe that can be only felt by inter-universities for East Africa as well as maybe Tanzania Commission for*

Universities and the Kenya Commission for Universities. But, for a normal person like me, you don't feel it. (Interview 8, 2016)

What Interview 8 participant is insinuating is that, the regional collaborations such as AAU, are at such a high level that the ordinary academic cannot experience them or benefit from their work. It can only be reached by the levels of the University commissions. This mean individual agents have no capital in them, not involved.

iii. International collaborations are unequal

International collaborations have been considered to be important part of engineering and Higher Education. The pilot discussed the existing difficulties in joining such associations for instance through international accreditation. The efforts to join Washington Accord are seem impossible as the current position as discussed in 6.1.3iii. The data shows the impossibilities faced by African countries who try to join international accreditation systems, which led them to turn to collaborations within the African region and with other countries in the Global South. The professional body participant (Interview 3, 2016) for instance citing difficulty of accessibility of the system and the alliances not being inclusive. The research tries to analyse the reasons for turning to the South, whether they feel left out or too far from the North-North collaboration.

Findings also indicated another problem linked to pursuing international recognition through accreditation; this was the difference in accreditation practices between Tanzania and the practices prevailing in the Global North systems or alliances. The Global North systems involve engineering professional bodies as accreditation agents and conducting program accreditation of their engineering education programs, while in Tanzania the professional body does not do this. Instead accreditation of engineering education follows instructions provided by a National Accrediting Body as was reported in section 6.1.3 and 6.3.4. The professional bodies are also usually signatories to international accreditation systems representing their countries for instance ABET in the Washington Accord. Therefore the rules do not match and therefore it will be difficult for Tanzania professional body to join the accreditation system at the status that it is in. Therefore a conflict in structure.

The problem with having separate initiatives to harmonise was expressed by professional body participants, who proposes having a global body.

[…], but what I see is that there are so many initiatives to harmonise

engineering programs, and we don't as yet have a global body that has the mandate to do that, and it would have been good for UNESCO to take lead in that, as far as I'm concerned. (*Interview 3, 2016)*

The participant here proposes that UNESCO take the authority of controlling engineering education programs. But it seems like UNESCO organisation has been in the frontline according with its report Engineering Issues in the 2010. It has also continued to prioritise engineering education, and has also being inclusive of the African context and the rest of the Global South, in its publications. Further the South-South cooperation in engineering education is under the organisations Auspices. (UNESCO, 2017). It is not clear how this has helped Africa, and the suggestion to bring all initiatives together is a good one, in fact UNESCO is already at a good position to do that.

Data show that Tanzanian Universities have established international collaborations through partnerships with universities abroad, usually in the Global North. According to participants (especially interviews 1, 8 and 12), these collaborations indicate that these collaborations are for comparing programs, getting advice for their programs, receiving help in establishing courses and sometimes even help with equipment.

In recent times we've also been developing links with the various universities even in having a Memorandum of Understanding (MoU) with the different universities and comparing notes. Some of them we have shared the curriculum, what we have and what they have also, and some people have visited us and they have looked at our programs and they've given their views. We have been to other places here like in Norway University of Science and Technology and in other places talking to these people and looking at their programs and studying how they're conducting their programs so as we can improve our own. (Interview 1, 2016)

With outside universities, not specifically civil engineering, but because we are in the school of construction economics and management at Ardhi [ARU] university, they have a longstanding collaboration with the universities like KTH in Sweden. (Interview 12, 2016)

From the data, these partnerships seem to be unequal or one way, with one side (usually the institution from the North) being a giver of information or donation and the other side being a receiver. This form of North-South relationship is prevalent in Tanzanian institutions as also reported by Ishengoma (2016) who has discussed the issues of North-South partnerships (discussed in Section 2.2.1v). In theoretical terms, the giver, who is usually considered the best practice institution, would automatically have capital in the relationship in form of social capital, monetary capital as well as knowledge capital, and therefore hold a dominant position. With low to no capital in the relationship and hence being in a dominated, Tanzanian Institutions cannot determine the operations or what pitch their priorities.

There were also regional OBE like initiatives or some emerging push for competence-based education, which some of the academics in Tanzania are involved in, although this impetus seemed to be externally originated by organisations. Interview10 participant was involved in the Tuning Africa project (Tuning Africa, 2014) in his position as a senior in College of Engineering, which he explained as "what you call the Tuning Project, which is the European Union working with African Union to harmonise education in Africa." The Tuning Africa project is about defining common competencies for Higher Education graduate in the African region different disciplines including engineering, in order to facilitate harmonisation (Hahn & Teferra, 2013). Interview 8 participant also informed that he was involved in project on "Enriching Engineering Education in Sub-Saharan Africa [EEEP]", which is an initiative by the UK's Royal Academy of Engineers (RAE) (RAE, 2020b), which is reported by Mohamedbhai (2015). However, both initiatives are externally motivated and funded by the Global North and therefore does not show original influence from the Tanzanian context.

6.1.6 Summary on structure and positioning the African Engineering Education in the general Engineering Education field

The findings above (6.1.1 - 6.1.5) seem to imply that the operations in engineering education practice in Tanzania are going against the rules of the perceived global engineering education field constructed in Chapter 4 (Figure 4.2 in Section 4.3). The global engineering education field is responding to rules of the Global North engineering education. This analysis therefore through the case study of Tanzania, makes the following summary of the African engineering education context in Table 6.1.

Table 6.1 represents the results of level 3 and level four analysis (as was introduced before in the Chapter 5, Section 5.4.2 iii). The last column in Table 6.1 is used to map out the various positions of African context against the general engineering education field. The positions are assigned by the researcher alongside the Global North context as demonstrated in Figure 6.3. This diagram (Figure 6.3), is a visualisation tool to interpret the results of this research. It demonstrates the position of African context of engineering education in relation to the global engineering education field and therefore in relation to the globalisation discourse. It is not meant to be an accurate measure of amounts of capital and positions, but a visual demonstration to show the extent of the difference.

Table 6.1 Summary of analysis of the African Engineering Education - position in the general Engineering Education field

Theme	Reason	Implications in EE
Curriculum		
Policy vs practice– Curriculum practice is not Outcome-based Contradicting results – evidence of outcome-based education	*Little to no industry influence* *HE structure* *Some influence from industry*	***Low industry capital*** ***HE rules*** ***Some industry capital (not significant)***
Content borrowed from Global North	*Global North domination*	***Low HE and industry capital***
The feedback is not competence based	*Low industry influence*	***Towards HE***
Teaching and learning (TL)		
TL is mostly traditional, lacks practical There are some incidences of SCL such as PBL.	*HE influence - theory* *Institutional structure*	***HE capital*** ***Low to Moderate industry capital***
Staff attitude	*HE influence habitus*	***Towards HE***
Accreditation		
Accreditation by National Agency for HE Quality assurance. Not competence-base accreditation - Generic standards stipulated by the agency.	*HE influence – policies* *Low influence of professional community*	***Towards HE node*** ***Low industry capital***
International systems of accreditation are difficult for African agents to access	*Africa is excluded – practice does not match the field's capital and rules*	***Marginalized*** ***Low industry capital***
Professional bodies		
Low involvement in engineering education- curriculum and accreditation	*EE follows Higher Education structure (rules)*	***Higher Education capital and rules***
High involvement after graduation	*High influence of industry structure (rules)*	***No industry impact in EE capital***
Collaborations		
East Africa collaborations in Higher Education and engineering profession	*Separate initiatives in Industry and Higher Education*	***Potential HE and Industry capital***
Regional Africa initiatives Most regional collaborations exist at institutional levels and are still young and unstable, mostly donor dependent	*Initiatives not localised or contextualised to practice* *Global North agenda dominant*	***Low capital in HE and industry*** ***Low positions***
International collaborations are unequal	*Dominated position*	***Low HE and Industry capital***

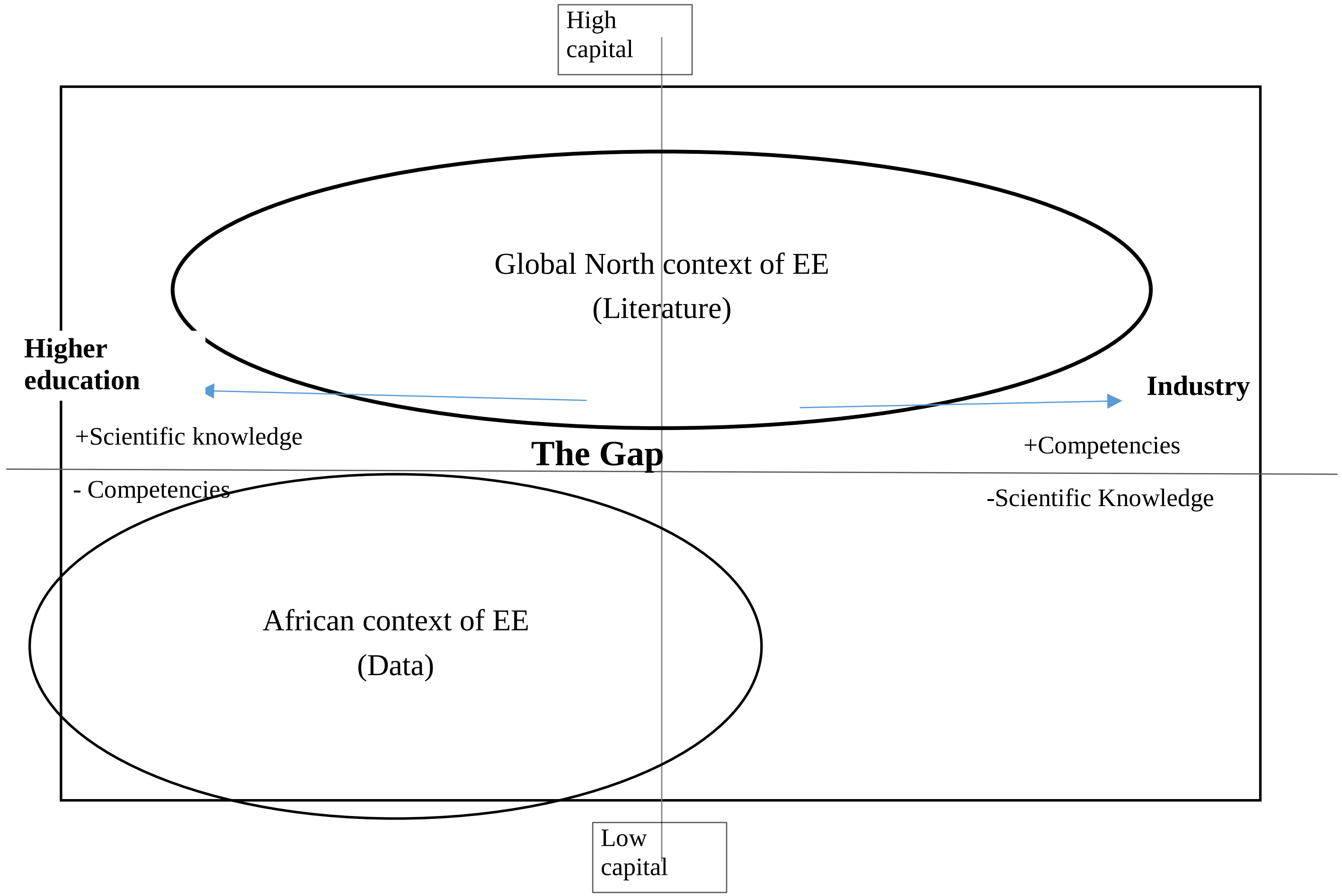

Figure 6.3 Positioning African context in the Engineering education field based on existing discourse

In Figure 6.3, the horizontal positions represent positions according to the type of capital that is valued. There are positions available between two nodes in engineering education, Industry on the right which includes high competencies capital and Higher Education on the left, which is for high scientific knowledge capital. According to the results, Tanzanian context of engineering education is positioned closer to the Higher Education node because the context agrees with Higher Education capital and rules, and away from industry node because of being in conflict with capital and rules of industry nodes. Vertical alignment represent the amount or volume of capital, the Tanzanian context occupies the lower parts of the quadrant because of having low capital in Industry as well as Higher Education. This ranges from having no capita to having some capital and shown in the table and therefore the structure. The results from the case study of Tanzania position the African context at the lower left quadrant as presented in Figure 6.3.

This quadrant (Figure 6.3), which exposes the inequality in positions between Africa and Global North is an original contribution to existing knowledge, and forms the basis for supporting my argument. This position of the African context poses challenges for its agents who need to navigate the existing engineering field where the Global North oriented rules dominate. The research therefore extend previous arguments on the dominance of the Global North perspectives.

> But as for some other professions, there is less evidence from the material identified of understanding globalisation and particularly power relations and the dominance of Global North perspectives. (Bourn 2018, 214-215)

Figure 6.3 shows positions according to amount of capital and therefore the dominant and dominated power positions of the two contexts. The Figure (6.3) also present a range of possible positions in the African context and their difference from the positions in the Global North context, which shows that Engineering education activities are different in depending on context or country. This notion is true even within any context and was also noted by (Ibrahim & Cockrum, 1993) when they studied engineering educations in six countries; France, Germany, Japan, Russia UK and USA, that:

> Regardless of the country examines, there was always an intricate relationship between engineering education, the national education hierarchy, economy, level of development, history, social make up, and international alliances. (Ibrahim & Cockrum, 1993, p. 291)

This reference is useful in explaining how contextual issues such as economy, education policies, colonial backgrounds, educators' trajectories and existing regional and international alliances discussed in Chapter 2, have affected how engineering education is practiced in African countries. For example, the low economic position of Tanzania, position it at the dominated side in the global economic power. This position is reproduced when it comes to collaborations as we have seen that in North-South collaborations, the Global North perspective dominates. Another example is the effect of the British colonialism that is evident in Tanzanian Higher Education, in terms of education system and language. Social, cultural and political inequalities create power differences between the Global North and the Global South which is replicated in engineering education field – hence the danger of the field's reproduction of inequality (Swartz, 1997).

The section (6.1) has explored the context specific issues of applying the proposed globalisation discourse to the African context of engineering education, and establish the position of Sub-Saharan African countries in the global engineering education debate. This means that, transferability (5.6.1) of the research to contexts beyond the case study of Tanzania will have to first confirm that it is indeed the same as explained here. Section 6.2 presents the analysis of engineering education's relevance to Tanzanian industry.

6.2 The relevance of Engineering Education to Industry Practice

Data on the relevance of Tanzanian engineering education to its industry is analysed in this section, through the theoretical lens of Bourdieu, where engineering education and industry are viewed as two distinct areas of practice – *fields*. Engineering education was viewed as *engineers training field* and industry as *engineers practicing field* respectively, drawing from data the evidence of *capital*, rules and *habitus*. The research established the qualities required to practice in African industries compared to qualities that engineering education focuses on. Findings show a great disconnect, that the two fields are very different in terms of their focus, what they consider to be important. The differences between the two fields were analysed in terms of capital, and habitus that is valued in the two field as explained in 6.2.1 and 6.2.2.

Since the focus here is on the education of engineers and its relevance to industry, alumni focus groups which consisted on graduates and early career engineers provided the most data especially with their concentration on participants' experience of engineering practice in the workplace. The three focus group transcripts (one pilot focus group and the two main focus groups), which provided views from early career engineers, were each analysed separately to identify themes. The pilot focus group's descriptive results and implications reported in Chapter 5 (Section 5.3) were used to provide direction for the two focus groups. Here, all three focus groups data is brought together to identify patterns, create categories and sub categories as well as meanings. Apart from focus groups, Industry interviews also provided data about the Tanzanian industry and the requirements for graduate engineers.

6.2.1 Engineering industry field in Tanzania

The focus group data from Tanzania indicated a gap in practice between engineering education and engineering industry that was experienced by graduates as they transition into work. The extent of that gap is illustrated by the evidence of the time it takes for graduates to develop competence to practice confidently in their roles. The competences required are often relevant to global competencies listed in section 1.1.1. Participants in their own words claimed:

> *I came to realise that I had an appropriate knowledge from the university as a civil engineer. But the skill I didn't acquire enough skill to make me immediately get into the industry and be compatible in the industry. (Pilot FG, 2015)*
>
> *So four years, maybe three years study, one year for internship maybe, from there we can have the engineers who have confidence. (Pilot FG, 2015)*
>
> *[…] it needs one to three years to get the necessary skills in the industry. Depending on the exposure you get when you get into the industry. (Pilot FG, 2015)*
>
> *Basically the knowledge I acquired is quite good, but some of the practical things which we are required to be given long time, so that to be competent and confident with the environment. (Pilot FG, 2015)*
>
> *[…] I feel like when things which we have been taught yes they are applicable, but in the university there is not enough research or practical, in-the-field practicals of course. […] but after doing such work for a certain period of time, maybe two to three years, maybe can be confident. (Pilot FG, 2015)*

The quotes expressed that early career engineers felt that, when they entered the industry they had sufficient knowledge but not enough skills and confidence to practice in the industry. They indicated that practice competence was acquired after exposure to the industry and that this would need time of exposure to industry, two to four years, depending on the type of exposure. Also according to the quotes, the types of exposure to industry varies. This prompted the need for the main study to investigate further on the experience of graduate engineers as they enter the industry and the results were analysed. Also the issue of developing confidence is the matter of structure developing habitus, that industry field transforms engineer's behaviour from student behaviour to professional behaviour. There is to say that engineers in Tanzania develop practicing (professional) competencies in the industry.

During the main study, each participant in the two focus groups was provided with a stimuli that contained a list of global competencies derived from globalisation literature in section 1.1.1 (see Appendix F). This list was used as a discussion starter and also to obtain engineer's perspectives on particular competencies required to practice successfully in Tanzanian industry. Before the start of the focus group discussion, every participant was given the list and was told to think about ranking them in order of importance, then they were asked to explain the reasons for their rankings. The ranks were not important for the research but the list worked as a conversation starter, as I meant to find out if the global skills are relevant to them and their current role and also most important was to find out why they were relevant. Analysis of the discussions provides further understanding the circumstances of Tanzanian engineering industry and the requirements.

i. Local vs international working environment

According to the findings, there seems to be existence of two contexts within the Tanzanian engineering industry– the local and the international or global (Industry). It is seen from the alumni point of view that after graduation they are sometimes met with different demands –for instance from international field who are expecting to recruit graduates with some teamwork skills. This is evident from the different views from participants when talking about industry needs between international and local companies/employers.

The Tanzanian industry include a considerable amount of multinational companies and international projects which provide international working opportunities. As of September 2019, there were 184 local firms and 62 foreign firms registered to work in Tanzania, according to Engineers Registration Board list of registered engineers available on their website (www.erb.go.tz). That shows local firms roughly make up 75% of all engineering firms in

Tanzania, the majority of the job market. Foreign firms making about 25 % of all the engineering firms currently operating in Tanzania (www.erb.go.tz), also means the opportunities for Tanzanian engineers to engage in these foreign firms including as employees, partners or sub-contractors, are significant. Focus group participants confirm the increasing opportunities for global working with a reference to existence of opportunities to work in multinational companies.

> *[…] mean now there's lots of mobility and there are lots of international companies working in Tanzania, so today you may be working in the Tanzanian office, the next day you are working in the South African office and maybe even the Australian office. (Pilot FG, 2015)*

The focus groups data indicated that companies operating in Tanzania value professional skills especially international firms who explicitly make skills such as teamwork a requirement for recruitment.

> *To add on that, I've got the teamwork here, I've been passing through a lot of interviews after my graduation and the same thing was interviewed when I was going to these international oil companies. So what they will do, they give people the interview but at the end of the day they give the teamwork that you should do in groups, and they will also test, see your creativeness in solving the problems for the company, they can just give you papers or spaghetti and they tell you, "Maybe you should now produce maybe a building from this spaghetti, a building from this paper," but you do it in groups. So if the student was not that much good in teamworking during his studies, of course he will face some difficulties at the end of this. If he was looking for the job, then he's going to miss that job because he doesn't have any experience in the teamwork. (F1-FG1, 2016)*

The quote describes a scenario where the lack of skills may have hindered opportunities for employment with international firms. This hence describes the impact that disconnect between engineering education and industry may have, which is to reduce graduates opportunities to access the global job market. The quote mentioning teamwork in connection to the international firm indicate that international firms in the Tanzanian industry may prefer practice related competencies such as teamwork, which is an important competence for global engineers, as an entry requirements.

The local firms seem to choose ones academic performance and not competencies, when recruiting at entry point or graduate level. When asked about what they look for when employing graduates, three industry participants, who are also local employers (Interview 2, Interview 5 and interview 7), replied that they look for someone who has performed well in his degree or someone with a high GPA (good marks). Interview 2 participant, who is a consultant, said:

> *Consultancy is the design, consultancy is all about making use of what you have been trained at university, and consultancy is all about designing, analysis, analysing and design. And this is not just someone who the brain is not up to standard. So really for consulting firm, we need the graduate engineers who have the great thinking capacity, and most of them are those who have performed well. There's a lot of challenges, and as a consultant engineer, we need somebody to stand alone and not be assisted all the time. And this quality, you can just get from the one who has performed well from the school. (Interview 2, 2016)*

According to another industry participants (Interview 7, 2016), a graduate who has high marks is one who can easily be trained, as they sometimes considered them to be self-learners or fast-learners. From the responses is evidence that the local firms in Tanzania which makes up the majority of the industry (75%) value scientific knowledge capital which is capital in Higher Education. So a graduate with high marks is considered to have high capital and will likely succeed in acquiring job with the local firms. This mean that graduates need good marks as capital to enter the industry or to succeed in entry to the field however according to focus groups (Pilot FG, FG1 and FG2), progress or success in the industry field (including local firms) needs to develop practicing competencies.

Participants who had experienced international companies indicated that there is a requirement for professional competencies such as teamwork. The competencies are tested or considered at the entry level, including in acquiring places for doing internships after graduation. But this was not the case with local firms which make about 75% of the industry, who value students' academic performance more than professional or practicing competencies when recruiting at entry level. This means that graduate engineers are not disadvantaged in employability, since they can use scientific knowledge capital (Higher Education capital) to enter the local industry through local firms, but competencies capital opens up more opportunities for them to explore the entire job market.

Graduate and early career engineers in the pilot focus group, expressed their frustrations of not being able to practice confidently in their roles regardless of where they were practicing in the industry (local or intentional firms). They felt that they lacked some professional practicing competencies such as teamwork, communication, entrepreneurship and others, valuable to their roles, and that it has taken some of them up to four years to develop them. Those professional competencies they mentioned as important competencies for global engineers – global competencies. Main study findings confirmed that global competencies are valuable in getting employment with the international firms, which makes the other 25% of the industry, and also succeeding in their engineering roles. So although lack of competencies is not a concern to the local firms, it is to Tanzania graduate engineers who have to rely on their abilities to traverse the industry, sometimes deterring them from exploring the global opportunities available within their own industry.

In the following sections 6.2.1 (ii –vi), the Tanzanian engineering industry is further explored in relation to the competencies that are required to practice and their justification according to views from industry interview and focus groups.

ii. Solving (real) problems in the changing environment

While discussing the different competencies that engineers need to be able to succeed in practice, using the stimuli (in Appendix G), there seemed to be a common implication among the participants of focus groups and interviews that, engineering is a practice related to *solving problems* and an engineer is a *problem solver*. This response was particularly common with industry interviews (2, 5, 7, 9 and 11) and the two main study focus groups (FG1 and FG2). For instance, interview 11 participant said this about problem solving skills:

> *That is the foundation. And the engineer should be able to solve a problem. Engineers are problem-solvers. We are creators. […]. They create, they maintain, they sustain engineering infrastructure and products. (Interview 11, 2016)*

Participants from both focus groups were therefore consistent with prioritising analytical and problem solving skills as the most important skills. They often mentioned solving problems when referring to engineering work.

> *If engineers are here to solve problems, they must have the problem solving skills. […], they must have a problem statement, they must analyse the problem, must know how to solve this. In solving a problem it requires an analysis. You can't just solve a problem without analysis. You have a number of problems, you analyse, approach them methodologically, everything. I've put that as the most important for the engineers who are graduate engineers. (M1- FG2, 2016)*

The quote imply that engineers were problem solvers, and illustrates why analytical and problem solving skills were important in engineering practice. This was consistent with the explanations from industry interview participants, when responding to the question about important skills that graduate engineers need to have. Almost all of the industry participants prioritised analytical and problem solving skills. Here are some of their reasons:

> *I'm ranking higher the issue of having an analytical and problem solving skills and generally my perception is that this is the education that we get in engineering. […], you have to know how to apply that education in analysing problems and also in solving problems. (Interview 9, 2016)*

> *Without having really an analytical and problem-solving skills, you won't create an entity or a product or a service which will meet the customer or the society demand and function. […] Everything we do – need to build a road, need to build a factory, a water project – you must start by analysing the demand, the need, the skills available, and what you intend to deliver. (Interview 11, 2016)*

> *I would really like a graduate to be very good in analysing the problems. […], really important, because challenges are always there in our work, that is part of our work, so – not all the time that you find the challenges that you have met in previous – they are different, so someone who can really analyse a problem and find the solution to it, that's really big for us. (Interview 5, 2016)*

There were other skills that were connected to the problem solving role of engineers, and sometimes considered important in solving current engineering problems, and these included: critical thinking, creative thinking and teamwork, and even communication. As focus group participants stated, "After understanding the problem, you should think critically on how you can solve it by maybe reducing the costs, the costs shouldn't be high." (F1- FG 2, 2016) Interview results also agree:

> *[…] you need to have somebody who is actually creative and who is having innovative thinking. The playing field has changed a lot over the past few years. We used to be more on the hardware. We have already moved so much into software. We need somebody to have this analytical kind of outlook and, of course, the programs are there, they can know the programs, they know the problem, they will know easily how to solve it. What you need is now creativity, somebody who can see the problem, use the programs to actually have the best solution to the problem. (Interview 9, 2016)*

> *[…] creative and innovative thinking coupled with critical thinking which really get out of the box what if – what is going to happen – and then followed by clear communication strategy, both oral and written. The problem is that we engineers [formally] […] just work with the problem that has been solved by software, QED (Interview11, 2016)*

Such statements indicate that engineering requires solving real problems that are ill-defined therefore require more than just formula or a software to solve a problem. They require critical thinking and creativity, which may not have been required formally in the practice.

According to the data, the dynamic and changing nature of engineering industry means that one needs research skills to understand the situation they are dealing with at a particular instance. Research was supported in the focus group discussions to be a valuable skill in the industry, by at least four people, two from each focus group. Participants from FG 1 claimed that research skills were important in order to provide a solution because "you need to understand the situation" (M1, FG1), "you should do some research to see what's going on in the world and all that stuff." (F1-FG1, 2016). In focus group 2, a female participant explained:

> *[…] as for me, the most important skill I can rank is research skills. An engineer should understand the environment and all the business, maybe the pros and*

cons before starting any business or before doing any activity since the key goal of the engineer is to solve the problem. (F1- FG 2, 2016).

After doing the research, through these research skills you can know all the problems and help the community to solve their problems and you do the part of the engineer. […] Without research, you cannot understand. (M1-FG2, 2016)

Note that, participants have linked engineering work to solving problems, and then linked research skills to solving problems. The second quote for instance shows the importance of research skills in understand the problem the society is facing in order to ensuring that engineers are delivering human centred design. Research skills are important in engineering work, and therefore capital in engineering industry.

Another skills that has been associated with problem solving is lifelong learning. Interview participant 2 is concerned with the changing role of engineers mentioned that "the engineer's role is becoming broader in those changes." (Pilot Interview 2, 2015)

You see, there is one thing about lifelong learning. A lot of things are changing. Design standards are changing. There are a lot of issues coming in new materials, new construction methods. And a lot of disciplines now coming into multi-facet approach in any project you are getting. So you need to learn many things which are coming. For example, right now, you might see that my time when I was reading construction management in 1973-74, the best project was time, quality and cost. But now we are looking at sustainability. We are looking at the lifecycle analysis. We are looking - when you are thinking about designing this building, what happens when the life ends? If I'm going to be commission this project, where am I going to throw this material? Is it a waste? (Interview 11, 2016)

Interview 11 participant further explained the requirements of engineering work have changed over time, that for instance materials and energy one chooses to use requires them to be conscious of not just cost but also environmental suitability. This therefore justifies the need for lifelong learning because engineers will need to evolve with their evolving industry.

Further, due to the current and future developments in technology, engineers are also required to be up to date with technology or as a participant in the focus group term it being "tech savvy" (Pilot FG, 2015) and lifelong learning is required for that.

And like today and 20 years back it's different. There is the new technology that has come around us, and there is different method that is being discovered as we go, and graduates as engineers have to go through them. […]So if we just sit down and rely on what we have, then you'll be left behind. […] And this life-long learning, it increases the efficiency. The speed of completing a task become smaller. It's like now, now we use software to design. Should we rely on the manual? Can you imagine someone designing 40-storey building?. (Interview 2, 2016)

The understanding and importance of lifelong learning skills is also explained in relation to engineering work- as a capital in the engineering industry.

The findings have confirmed that Problem solving skills, and other skills that were associated with solving engineering problems, like critical thinking, creative thinking, research, lifelong learning, and communication, are required for engineering practice. These are similar to global competencies in Section 1.1.1, and discussed as valuable to global engineering education field constructed in section 4.3, therefore global competencies are important in the Tanzanian industry. Note that these findings have represented the views of experienced local engineers, who are employers of engineers (local firms) and the graduate engineers themselves. Missing are views from foreign engineers working in Tanzania. Moreover, the findings show that there is value or capital in having global skills in the Tanzanian engineering industry.

iii. Multi-discipline and Multilevel working environments

Pilot focus group findings indicated that Focus group participants explained their engineering practicing environment as multidisciplinary, therefore requiring them to be able to effectively interact with people from other disciplines. The pilot focus group participants also express that engineering practice is multilevel – that people from different levels of education or status from their own. This includes for instance projects where one needs to know how to work with technicians and foremen. Findings from main study also confirm that the industry practice includes multidisciplinary and multilevel working environments, and further explained the importance of being able to work well in those environments. They suggested that engineers need interdisciplinary teamwork and communication skills in order to succeed.

Another aspect looking at that, is engineers are supposed to come up with a *solution to solve society's problems. Now, some other societies have got their cultures of which as an engineer you cannot establish the culture of the society unless you have a sociologist. Therefore, you have to come up with solutions that will solve the problem of the people, but considering the cultural aspects. Now, if you don't integrate, then you cannot solve the problem. You may think that you have solved the problem, but your solution cannot work because the people cannot adopt it, cannot adopt the solution. Therefore it is very important to have some kind of multidisciplinary approach to problem solving. (FG1, 2016)*

Here focus group 1 participants suggested that, in relation to their task of solving problems, engineers require interdisciplinary teamwork in problem solving involving other disciplines. They have also pointed out that the real engineering problems such as problems facing a certain society require interdisciplinary intervention.

A focus group 1 participant, a contractor, emphasizes on the value of interdisciplinary teamwork in the industry. He says:

I think teamwork [interdisciplinary] is important according my aspect of my job. I have made several decision-making which need co-operation of different disciplines, so you can assume that you are confident in something, but at the end of the day you come up with realizing the decision, it wasn't right, because just have some mistakes, due to lack of some technical advice from other disciplines. (M1- FG1, 2016)

According to him interdisciplinary teamworking skills are important in decision making.

They also mentioned multidisciplinary communication because projects include different professions and disciplines, for instance there was an interesting contribution in Focus group 1 discussions:

I can contribute for the case of the communications. So for the way you interlinking the professional careers, like mechanical, chemical at the same time, with accountant and procurement at the same time. The way you communicate, it means the way you prepare for the project, the way you prepare the report. In means in terms of formulation of graphical, I think for all careers, they can understand what you want to do, what you wanting to take on *the field, especially for the industry. (FG1, 2016)*

"[One needs to] know how [to] communicate, what kind of the society you are faced with for the purpose of what thing you want to talk to them."(FG1, 2016)

One of the FG 1 participants gave an example of himself as a chemical engineer who wanted to introduce their product to the society, people who are not in chemical engineering. They explained that it would not be appropriate to use the chemical engineering language to explain the "means of the formulation" of the product. Participant added "whether I put the calcium carbonate, or I put the sodium hydroxide, it's not so simple for them to understand me". That they would need to communicate in ways that is "better for them to understand" (FG1). This means that they would need skills to translate their technical language to general language for a bigger audience. Being able to communicate to different audiences is part of working well with others.

Participants in the Pilot focus group discussed the importance of inter-level working skills and one participant said:

Those are people lower than us. They have diplomas, they have certificates, but when we make use of the experience and expertise, they really add a lot. But if say someone we have an issue as engineers, because it's a difficult, one of the most complex areas, so it can also feed us with a negativity. Maybe he got authoritative kind of approach, which does not really build a positive environment when designing or when relating to others when seeking for opportunities. (Pilot FG, 2015)

Pilot focus group participants talked about the wealth of information that one can get from those that are in a lower level.

Teamwork is important because there is no single engineer who is an expert in everything. And sometimes I have found that you can be a good engineer if you can form a team and you can use the skills of others even if they are not as learned as you are. One time we were constructing a road and I took some soil from a bridge. After excavating the bridge, the soil seemed had eroded because of the overburden. I used it to backfill my cavity approach but one old guy said, "No, this soil is not good because this is clay." And he is not learned that, you have to take what he's saying and consider it. (Interview 7, 2016)

The scenario where getting advice from an experienced person, who was from a lower level of education from them, became valuable in deciding the type of soil that was good for backfilling a cavity in the road, shows the importance of inter-level communication and teamworking skills. This scenario and others above suggests that the alumni experience in practice has led to realisation that engineers need to relate with people from other disciplines (multidisciplinary) and other levels (multilevel) in practice. In a way they also included that engineering work requires integration of other aspects and therefore the need to have a cross-disciplinary aspect. This interdisciplinary skills and cross-disciplinary aspects are considered global skills or competencies by others in the literature.

Findings therefore show that interdisciplinary and inter-level communications and teamwork skills are capital in engineering industry in Tanzania, because of their ability to facilitate engineers to consider the contribution of people from other disciplines and other levels in the success of their work- work well with others. But, being able to work well with others is also dependent on one's behaviour, one's habitus, so the engineering industry also requires interdisciplinary and inter-level type of habitus. This means that practicing successfully in the multidisciplinary and multilevel environment in the Tanzanian industry requires one to have interdisciplinary and inter-level capital and habitus.

iv. Business nature require competence in Entrepreneurship

Pilot study indicated that entrepreneurship was important for engineers which prompted further investigation. From the main study, there were suggestions that Engineering is a business therefore it requires economic and entrepreneurship understanding and skills.

> *I thought entrepreneurship was supposed to be number one, because most of us when we're at school, we are just thinking of being employed. And the truth is, if you are just thinking of being employed, then you are not thinking of other things, apart from engineering, you won't go anywhere. So most of the time when we complete, you might find out we are all focussing on getting jobs, and not maybe being,[…] an entrepreneur, or start your own business. (M5- FG1, 2016)*

> *So the skills like teamwork and entrepreneurship, they have to be emphasised on the next generation of engineers, so when they complete they can stand on*

their own. (M4-FG1, 2016)

Participant was implying that there are opportunities in entrepreneurship in the Tanzanian industry that graduates need to tap into, which seems to be confirmed by two participants who are in the focus group (M1-FG1 and M3-FG1). This means the culture of entrepreneurship exists in the industry in Tanzania. The participants also suggested that it is very important that education imparts the business side of engineering to the students.

> *It's not intentional of the country, neither the university, to see a business or its graduate fail so those are the areas. In the curriculum, I would prefer that there's more segments on business management. (M3-FG2, 2016)*

> *I mean if you are not incorporating business in engineering, you are going nowhere. (M4-FG1, 2016)*

The support for incorporation of business in engineering education, as an important competence for engineers, is also seen in literature in developing global engineers, with some supporting business skills and business awareness to be important for the future of engineering practice (Chan & Fishbein, 2009; Spinks et al., 2007).

Interview 5 participant explains that entrepreneurship knowledge and skills are important in decision making:

> *Entrepreneurship is very important. Because any decision one's make, has to have entrepreneurial impact. So it is very important that engineers understand this, because decision-making process now has to also consider the cost implications, apart from the technicalities. (Interview 5, 2016)*

Further Interview 5 participant explained that entrepreneurship was not only important for those who are planning to own their own firms but also important to those who are employed, because, even when employed, engineers are often in a position where they have to make decision for their employers.

> *Even when they're employed, because the companies – or if they're employed in the government, or whatever, the idea is to provide a solution with the most cost-effective solution. So if they have those entrepreneurial ideas in their minds, then it will aid them making those decisions. And that will be very important, because if they make the wrong decision, which means they will*

incur – the employee or employer will incur some costs, which is not good. (Interview 5, 2016)

The participant also suggested that business part of engineering needs to be part and parcel of the engineering training. This means that business aspects and entrepreneurship skill are valuable for engineering practice, and therefore capital in the industry field in Tanzania.

v. Communication in a foreign language is valued by the industry

Parallel to the international working environment in Tanzanian industry, there was evidence that showed there is an advantage in being able to communicate in foreign language. According to focus group participants, foreign language for Tanzania "includes English, of course" (M1-FG2, 2016y). Industry participant also confirm on the importance of English language in engineering industry by saying:

> *We have projects internally in the country, we have projects that we are working with foreign consultants and so we have to communicate definitely in using English. As you know, most of our projects and contracts are written in English so that is almost a must to know that language. We also work outside the country so definitely we need English as a communication media. (Interview 9, 2016)*

According to the quote, English is the language of the engineering industry in Tanzania, used in project documents and contracts, as was also noted in Chapter 2, Section 2.5.1.iv. English is also considered a foreign language to Tanzania, whose national language is Kiswahili. So, when discussing foreign language participants were also including English. Further, data show that there are huge disadvantages when graduate engineers are not being able to communicate efficiently in English language, especially in getting employment in international organisations or projects.

> *[…] in Tanzania, most of the engineers, they are failing in international employment because of this foreign language, they don't explain themselves [well] when it comes to interviews et cetera. (M4- FG1, 2016)*

Here they were referring to English, the language that is commonly used in the industry as explained above, hence the language used in interviews.

Being able to communicate in a foreign language, other than English, was also considered as an advantage, although not very important. This is because a foreign language can open one to more opportunities especially as the country is moving towards industrialisation and the engineering industry is becoming more global.

> *You can group it all together with the communication in foreign languages whenever they apply because foreign language in Tanzania is only English that is why it's used, but a person with a French knowledge could have an added advantage with a certain type of project. For instance, projects may be financed by the Agency Francais Development, something like that, the project frame of the French Embassy. (M1-FG2, 2016)*

> *I have a few boys, two boys, who also can communicate in Chinese and you'll be surprise by thinking is Chinese also important where we are going so, yes. […]. Is also important at least in the business sense for the time being. (Interview 9, 2016)*

Languages mentioned include Chinese, French, and Turkish language. One participant informed that there was an engineer employed in a housing project somewhere in Tanzania "because he knows Turkish" (M4- FG1, 2016). According to the participant, the contractor company undertaking the project was from Turkey and the owner only spoke Turkish, and could not communicate in any other language, "and they employed him because they can communicate with him" (M4- FG1, 2016). This implies that, communicating in Turkish here, created an opportunities for the engineer, and therefore capital in the industry.

There is some data which indicated that, the value in being able to communicate in a foreign language may extend beyond job opportunities into enabling partnerships and mobility in the times of globalisation of economies. Participant who is an entrepreneur, uses his own example when he travelled to china for business:

> *And now we are opening up the world, we need at least an engineer to be able to speak at least in more than two or three languages. I find it important, for example, to speak Chinese, but I know Chinese is very difficult. But now we are trading with Chinese, the African [countries are] trading with Chinese, the whole of Europe is going to China. I went to China the other day, it was very difficult there. I spent the whole day sitting in my hotel not knowing, even those*

hostel waitresses could not help, because they cannot even speak English. (M1-FG1, 2016)

Therefore speaking other languages opens up more opportunities for work and collaboration:

> *So knowing the language is important because we need to trade more international, and an engineer should be able to communicate with different people from different cultures, different languages. Because that also explains their level of competency. […] Because if someone doesn't speak your language but you can speak his language, then definitely you will have a lot of opportunity working with him. (M1- FG1, 2016)*

The quote has highlighted on being able to communicate with people from different culture, which is related to having global competence. That there are opportunities for Tanzanian with global competencies. This also show that global competence is valued by graduate and early career engineers to improve their job opportunities and collaboration. Interestingly, the results also show that English and other foreign languages are considered capital in Tanzanian industry, while their own language (Kiswahili) seem to have little value in engineering work, when it comes to job opportunities and their engineering industry. This exposes a dominated position of African engineers, in relation to languages in their own context.

vi. Ethical and professional behaviour

Research findings have raised the importance of graduate engineers to have ethical and professional behaviour in their engineering work because their work affects the society. Evidence show the importance of ethics in decision making because engineering industry is influenced by different powers including corruption, political leaders, and other agendas, typical of low-income countries like Tanzania. Interview 2 participant explains the importance of ethics in the construction industry, saying:

> *So when I talk about the ethics for graduate engineers, you see with third world [lower- income] countries like Tanzania and other African, there is the politics, they become overruling the professionalism. And if you don't have the policy [ethics], if the graduate engineer, they don't have the policy [ethics], then they can be misled and they cannot stand on their decisions, on their professional decisions. There is a lot of intrusions, a lot of hiccups in the undertakings in the*

construction industry because of these politicians, because of the client, because of what not and so on. The ethics makes the engineer to stand on their professional decisions, and this is very, very important. (Interview 2, 2016)

Ethical and professional behaviours are important in guiding engineers in decision making position, so they can stand above political influences and different powers which are prevalent in African engineering industry.

We have seen that the professional misconducts caused by the politicians, and it is not that the engineer, they were not aware; it's because they were trying to serve their positions. [...]. From the school they have to know where they have to stand. From the school they have to know what is important for them to do and what is not important for them to do. So this is very, very important. (Interview 2, 2016)

But decision making is practice and in Bourdieu's notion, practice will depend on habitus and structure, in this case the structure which is the industry, as the quote explains, may be lack ethics in its structure, so it is up to the engineers habitus to influence practice. Therefore sometimes graduate engineers in Tanzania need to have strong ethical and professional habitus to make decisions.

vii. Summarising engineering industry in Tanzania – capital and habitus

Tanzania industry field has two contexts within its local industry: the local firm context and the international firm or project context. It all boils down to the different capitals that the engineering firms or projects in the two contexts value, that the local context value scientific knowledge or capital that is valued by Higher Education, while international context value global competencies, capita that is favoured in the global engineering education scene (Chapter 4, Section 4.3.2). The fact that some firms, especially the international firms, are focusing on global competencies such as teamwork, communication shows that. The local Industry on the other hand put value on good marks, because they seem to be expecting the graduates to gain their professional competencies (which are similar to global skills) on the job, and does not seem to value such competencies so much at entry point. The Tanzanian engineering industry field in Section 6.2.1 (i-vi) is summarised in Table 6.2.

Table 6.2 Tanzanian Industry Field

Tanzania Industry	**Local context**	**International context**
Context	Local firms Local projects including big public infrastructure projects	International firms International projects Opportunities to work in other countries
Capital for graduate employability	Scientific knowledge (Good Marks)	Global competencies
Capital for practice *What practicing competencies do they care about?*	Technical skills – understanding/interpreting design drawings Demonstrate global competencies: Solving Problems capital Analytical and problem solving, Creativity, Critical thinking , teamwork, research and communication skills Interdisciplinary and inter-level -Teamwork skills -Communication skills Business understanding capital -Entrepreneurship skills Communication in English and other foreign Language -intercultural	
Habitus *What are the accepted behaviours?*	Interdisciplinary and inter-level habitus Lifelong learning -Readiness to learn -updated technology (tech savvy) Ethical and Professional behaviour -confidence to practice – professional demeanour	

The graduates and early career engineers themselves, believe that their actual role (in the industry) is a lot more complicated than what their education had prepared them for. They realise that they needed more than just 'good marks' to get ahead when they entered practice. They felt that engineering education could have done more to make them more relevant to practice and they fail to connect the education environment to that of industry. They have many times expressed the gap in terms of global competencies required to succeed in the industry, which does not seem to be an issue to the local industry firms and academia.

Habitus in engineering industry can be a bit difficult to identify, but according to findings it has to be the behaviour around making certain decisions and working well with others, this may therefore include behaviour around acquiring or demonstrating other skills like critical thinking, teamwork, communication and other. The industry interviews have specified a few habitus such as ethics, professional behaviour, lifelong learning, interdisciplinary working and inter-level working. Habitus may also be related to have *confidence* to practice notion that was common with the pilot focus group participants. For global competitiveness pilot focus group participants suggest the need to develop *confidence* as if it was also a competency. Their argument suggested that most graduates lack confidence when it comes to practice, which this may be parallel with professional demeanour which is also a matter of one's habitus.

6.2.2 Engineering Education field in Tanzania

The previous section (6.2.1), has analysed the views on Tanzanian engineering Industry and established in terms of capital and habitus requirements for graduate engineers to enter and successfully practice. This section, analyses views on engineering education in Tanzania to establish its relevance to the industry, particularly in relation to industry capital and habitus. The analysis focuses on views on graduate readiness, curriculum, learning environment, relevance to industry. The engineering education practice, as was found in 6.1, is highly controlled by the structures of Higher Education field, so the engineering education values scientific knowledge capital which is expressed in form of marks that students obtain, where high marks are linked to good performance or success in the field. Since the local industry value marks for entry, engineering education field is relevant, however there are gaps when it comes to industry practice, that result from engineering education practice being in contrast to the engineering industry practice.

i. Relevant for entry into industry – scientific knowledge capital

There is evidence that engineering education in Tanzania is relevant to industry because of the reported high employability of graduate engineers. According to academic participants, Interview 10 (from UDSM) and Interview 4 (from ARU), graduates from their institutions get absorbed quickly by the industry.

> *That's why we find our students, they get employed - I could say immediate on graduation. (Interview 10, 2016)*

The first, the second are already in the job market and the reception has been really good. We've been told they're really, really good engineers. (Interview 4, 2016)

This high employability of graduates from the participants from two institutions indicate that the engineering education field in Tanzania enable graduates to acquire capital that can get them access into the industry field.

In addition to that evidence, Industry participants who were also employers, expressed satisfaction with graduate from Tanzanian institutions. For instance Interview 11 participant, who particularly referred to graduates from UDSM, had this to say:

[…] well, to the best of my understanding, many people are very happy with the graduates from the University of Dar es Salaam [UDSM], to be honest. I've been speaking with the foreign engineers. I've been in contact with them. They are very happy with the students from University of Dar es Salaam. (Interview 11, 2016)

The majority of focus participants were also alumni of UDSM, the oldest public University in Tanzania that started training engineers since 1977. The university produces the most graduates to the industry, 42.5% out of all eleven universities offering engineering, reported previously in Table 2.3 (section 2.5.2).

The focus group participants on the other hand have expressed their frustration of their education not preparing them to practice in their roles. Graduates believe that their scientific knowledge is very good, but admitted they were lacking in practical skills to practice in the industry. They have even compared themselves to graduates from other universities and admitted that other graduates may be better in practical work than them.

Yeah there's two things here, we better in theory more than them, but practically some of them are better than us, but like 60% to 40%. (Pilot FG, 2015)

The focus group participants were referring to competence for their engineering role, which suggested that they were already employed. But results also show that graduates and early career engineers felt that their engineering training did not prepare them to be ready for their industry roles, that it lacked practical industry experience. The lack practice competence therefore was not affecting their employability (their entry to the field), but their success in their practice (their ability to navigate the field).

Tanzanian engineering education is to a good extent relevant to its local industry, because it develops graduates that have capital required for entry into the industry field (getting employed). Engineering education in Tanzania therefore focuses on scientific knowledge capital, while global competencies not deemed as important. This is opposite what is often expressed in engineering education discussions in the Global North (see Section 4.3.1). Having scientific knowledge may mean having capital which is valued by Higher Education, the opposing capital of the industry field. Marks can measure scientific knowledge but cannot measure or guarantee practical competence, which seems to be valuable in the long run. Participants often used the term practice to explain the practical competence which involves technical competencies and global competencies. Practice is therefore the industry capital.

ii. Gap in graduates work readiness

Despite engineering education producing capital that allows entry to industry, findings show concerns about the lack of technical practical skills, important in engineering role, referring to failure to apply of scientific knowledge to real life practice – for instance in reading drawings and designing structures. For example, one participant explained that the university did not prepare one for the realities of designing complex structures or infrastructure:

> *[…] for example I am practising in the water sector, what goes into designing a dam say, what goes into designing a treatment plant, what goes into designing a water network. So you don't come out of university knowing these things; you may know a few formulas here and there and you may have a rough idea, but actually doing it, you have so much [work to do]. (Pilot Focus group, 2015)*

There are implications here, that there is a gap to be filled to move from a graduate to being able to design the actual structures.

Academia acknowledged this gap in practice and seemed to have an expectation that when industry receive students, they were going to train them especially since there is an apprenticeship program.

> *For example at [ARU] where I'm teaching I believe what we are imparting onto the students is actually sufficient for them to go into the market, but it is not enough. Once they get into the market, can the employers who have received them then further train them? I think the key issue here is apprenticeship and*

that is why apprenticeship is also part of the training program. (Interview 12, 2016)

Also, from industry interviews it was clear that there is some form of training and mentorship available to graduates as they enter industry, which is usually through a structured apprenticeship program – SEAP (discussed in Section 6.1.4 ii). There are also efforts by individual firms. As Interview 2 participant explains:

> *When we get fresh graduates from the university, then they have to undergo three month probation, and this is to see if they really cope with the company policies, also with the cases of the consulting. The cases of consulting is fast thinking, proper visualisation, so in three months this is the probation and training. And even after that, when we confirm him, then we'll have to go alone with him and he's assigned with a civil engineer to go with him until when we know that he can now stand alone and can be assigned something alone. (Interview 2, 2016)*

Data show a sense of responsibility and commitment to train from the industry and the level of expectation of competence from graduates.

Still, industry interviews and focus groups participants were reporting that graduate engineers were lacking in practical technical skills such as interpreting drawings and designing. They informed that there was a problem with regards to putting what they learnt into practice. For instance an industry participant (Interview 7, 2016) expressed his disappointment on a graduate he had come across in one of the projects that he was supervising, saying:

> *Yeah, yeah, a great number. I remember one of the students, was given a drawing, a plan, for a bridge and the bridge had got a pile foundation. She was asked, "Can you see the pile there?" She said, "No, I cannot see it." […] she could not see it in the drawing and now she's doing administration within the Tanzania National Roads Agency [TANROADS]. She's supposed to know. (Interview 7, 2016)*

The senior engineer blames the engineering curriculum for the practical incompetency, referring to application of scientific knowledge to their industry practice. He claims that due to such incompetency, some graduate engineer end up in administrative work.

> *And some of them, of course, they end in administrative work and sometimes*

they escape from the practical aspect. (Interview 7, 2016)

Interview participant 5 had similar problems with students not being able to design a structure. But there are many discussions that show that graduates sometimes cannot read and interpret drawings, which is a very basic and important part of most engineering work. Then another one supported

And all of them have GPAs of 4.9, but they can't even read engineering drawings. (Pilot FG)

This means there is a possibility that graduates have high marks but are lacking in basic practical competencies. So, relying on marks for technical practice competence can be a potential problem when marks are related to quality of graduates.

There were also debates that indicate that there may be different qualities from different universities, when it comes to marks, for instance they were talking about weaknesses when it comes to some universities which award high marks to students while their competence in practice is questionable.

Yeah I think and talking about the quality of the students that comes out of the universities [...], there has to be a method of seeing that the education that is being given out at these universities is standardised, because like XXXX *said, you get somebody from some university with a GPA of 4.2 who can read a drawing and somebody from another university with a GPA of 2.7 who is very competent. (Pilot FG, 2015)*

This situation may be a problem for those valuing marks for employment, keeping in mind that local firms believe that high achieving students are competent and also fast learners (in section 6.2.1 ii).

Pilot study participants have also raised the issues of education focussing on marks coupled with their loaded undergraduate engineering curriculum.

So from my experience when I was studying my bachelor degree, we were being bombarded with a lot of things, a lot of modules. I remember we used to learn like eight, nine modules a semester. So a person is not really, does not really get time to concentrate on a single or a few things, but rather just touching here and there, just for the sake of passing and move on to the next level. Next year, *not trying to be discontinued from the university. (Pilot FG, 2015)*

This means that, according to the constrains of loaded curriculum and requirement for marks, the student is left with no choice but to try and get through as much content as they can for the sake of passing exams – getting marks capital. At times this means that the students have to cram materials, therefore not learn them as they further explained:

> *It doesn't give a student time to, once you give a student the basics, then you should let the student use the basics to figure out some things by himself or by herself. But our system does not do that, it doesn't give even the time to; the materials are too many, you're just cramming just to answer the question on the exams and then pass. So it doesn't give you time to go to the lab and solve practical problems. (Pilot FG, 2015)*

The quote explains the effects that the impulse to strive for marks can have on students development of competence. The quote has also specifically pointed out lack of time for lab and solving practical problems, problems which are associated to reasons for graduates' lack of technical practice skills. There is no time in the curriculum to practice what they have learnt.

Apart from being associated with curriculum, this issue of lack of technical practical skills has also been attributed to the learning environment in engineering education not matching the practicing environment in the industry. For instance a Pilot focus group participant explained:

> *I would say in the university you learn say the importance of moisture in compaction of granular material, you learn and you know it is important and you need this much of moisture content. In the lab you can do it, but when you get into the field, mixing huge amount of material, trying to acquire that moisture, that you cannot measure, you need to see and do some visual tests and you need some experience to know if this material behaves this means it has acquired this amount of moisture content. So such a skill you will need to get into the field and currently in the training that is offered does not offer that level of skill to trainees. (Pilot FG, 2015)*

The pilot focus groups participant has raised the issue of differences between the education environment (the training field) and industry environment (the practicing field), in terms of the magnitude and nature of the work involved in the real field. This means that at most times engineering education field cannot develop some of the practical technical skills that can be readily applied to industry. To develop some practicing skills, one would need to be in the industry field. Also there was a view that learning environments in Tanzanian institutions pose immense challenges to "becoming a very good engineer.' (Pilot FG, 2015)

This confirm that graduate and early career engineers believe that the learning environment in Tanzania lacks important ingredients such as equipment and practical activities required for industry competence to develop. Participants suggested changes:

> *So we can say that if the environment will be improved, like facilities, laboratories and the field the practicals to be given more time, maybe we will be confident. (Pilot FG, 2015)*

The focus group participant is insinuating the need to change the learning environment to include more practical components, show they are proposing that engineering education need to be more relevant to industry. Their suggestion requires a change in institutional structure, which is not easy as it depends on the capital that is valued in the institution. There needs to be people who will argue/debate for it, and the people need to be in a good position in the field of engineering education for instance the administration who have capital in the University or institution. All in all real engineering practice was viewed to be difficult to learn in the university setting unless the setting is made as close to real setting as possible. This may be possible through interventions that reflect authentic learning environments, like Project Based Learning (PBL) (Kolmos & de Graaff, 2014) and through Work Integrated Learning (WIL) (Smith, Ferns, & Russell, 2014).

iii. Gap in industry practice skills – competencies capital

Findings also reported on the problem of graduates lacking global skills. For example, here was an admission that engineers are known to be poor in communication.

> *Engineers, we all know, they are very poor in communications which, to me, I tend to think is one of the very social skills that an engineer should be able to do it. (M3-FG2, 2016)*

According to the quote, engineers have low industry capital, since communication was among the skills that were said to be important for Industry practice (in section 6.2.1). Participants in Focus group 2 discussed about the contribution of their tertiary education training to the poor communication skills reported, they linked the problem to academic-focused nature of education in Tanzania.

Trying to be a critical thinker here, it could be the nature of education, the nature of the system of education that we get. For us who grew up here in Tanzania it's like go to school, achieve your A's and so on and so on and then get a job but as we grow out of school, we tend to realise the 'go to school thing' doesn't apply that much, you need also to have social skills like your communicating and so on and so on that we need in the engineering field. (M1-FG2, 2016)

According to the quote, the focus of high academic achievement relating to marks is what prevents student engineers from developing global skills that are useful in the industry. In other words, the gaps in developing global competencies in the engineering institutions are a result of socio-cultural circumstances of engineering education practice in Tanzania. The participant also raised an implication that the structure which supports marks capital is not just at tertiary education level, but it goes even further back – pre-tertiary education and upbringing. It is therefore ingrained in engineering students' habitus.

The focus on marks seem to also be influenced by the local industry, as industry participants have indicated that with regards to employment at graduate level, they (local firms) valued high marks instead, and the lack of practice competencies was not raised as a problem. Importantly, this is because within the Tanzania industry structure they have traineeships or apprenticeship for graduate engineers that are well structured and supported by the government through engineering professional body, as discusses in 6.1.4 ii.

There was some evidence from focus groups and curriculum documents that the engineering education in Tanzania tries to include non-technical skills such as teamwork through group work settings, and also communications through presentations and technical report writing. These efforts however, seem to have been constrained by situations within the education system related to the structure of the training field and also habitus and the student engineers.

Especially if you concentrate too much on the design and academics and so and so, you tend to be – or myself, I don't know, it's like so many things that you are worried yourself [about] speaking out or you find it so difficult to communicate what you know in a very simple terms for the audience to understand so sometimes they [engineers] tend to be maybe quiet verbally. (M1-FG2, 2016)

In terms of communication, maybe written communication, we [graduates] tend *to […], sometimes we miss the [variety] of communication, […]. The only form of written communication that the engineering education portrays to the students is design report. "In the business of today, there is how to win your customer." (M1-FG2, 2016)*

Here, the participant referred to written communication as a means to win customers. There was more discussion especially among focus group participants (all groups) on the importance of the global skills like teamwork, creative thinking, entrepreneurship, communication, interdisciplinary and inter-level skills as well as intercultural communication in engineering work in section 6.2.1. The blamed their education system/structure (curriculum and pedagogy), for not allowing development of those skills.

For instance as pilot focus findings indicated, and main study confirmed, the engineering curriculum was loaded, general and outdated, not matching the current job situations that they are facing.

The courses, the curriculum to prepare us for the kind of life that we live in today. When you look at the knowledge, the books, it's a lot really. When you look at us, we went through water resources, structures and the road aspect of civil engineering, (Pilot FG, 2016)

As discussed in pilot findings (5.3.3 i) the students were bombarded with modules, which developed a habit of 'copy & paste' as a result hindering a chance to develop creativity.

Yeah on the same issue of creativity and the training, I find the training at the university, our university does not cater for creativity. (Pilot FG, 2015)

This shows that the engineering education field does not put value on creativity, which is a skill required by industry especially global – hence industry capital.

An academia participant (Interview 12, 2016) defends the issue of a loaded curriculum when they explained the lack of space and time in engineering curriculum to include development of global skills. Adding that:

Well, the training is not enough per se but, as somebody who is in the education system as well, I do not think that you could design a program that is all encompassing. (Interview 12, 2016)

Also there was a mentioned on engineering education being outdated – for instance in technology:

> *I think we are left – we are left behind. Quite a bit. Our training has been kind of – the curriculum is kind of outdated, not moving at the pace of technological changes. So we find it's difficult to adapt once we meet with foreigners, or whatever. Because the technological advancement, the skills – some things are basic, but the most important thing is to understand how the world is working, is moving now, we are still lagging behind. (Interview 5, 2016)*

There was also a discussion of lack of global competence in a form of lack of global working habitus such as ethical behaviour in graduate engineers

> *When you get graduates, again, there are a few things that you may feel that maybe they lack. In our context we chose, we have the privilege to scrutinise them well and so you choose them but sometimes you find them, even the basic ethical behaviour is missing because you took them [by] looking at their faces but now when it comes to real life, you find that you have still to fill some gaps. (Interview 9, 2016)*

Industry participants seem to expect that engineering education should at least be able to instil some professional behaviour in engineers.

> *Sometimes [it is] the upbringing but when you go to the educational institutions as well with the things they do, is actually to adjust you to behave like a professional. We are not asking too much but at least somebody must know how to be a professional. (Interview 9, 2016)*

However according to the engineering education focus, this research cannot see how this is possible. There seem to be no incentives for engineering education practitioners to focus on professional behaviour.

Interview 7 participant mentioned the problem with some student not having a ready to learn attitude, when they spoke about the students that they received for Workplace internships (Practical Training)

> *The first program I am finding, many students have got a problem in their mindset. They think that after graduating from the university, they are going to*

just make some money but they find that they don't have the skills, the necessary skills and some of them are not ready to learn, that's the problem. […] there is a problem in attitudes. (Interview 7, 2016)

According to the participant, the students have a 'not ready to learn' attitude, which is counter what is expected in industry, and this is an issue of habitus. Therefore there is an expectation that the students at least bring to the industry a ready to learn habitus.

Structurally, as we have seen in the previous section that engineering education in Tanzania is highly influenced by its Higher Education field which focuses of marks (units system) and the number of hours that a student needs to complete in the program (6.1.1). Therefore the existing education structure may be a factor impedes development of global engineers. This is again (as in 6.2.1ii), is the problem of engineering education field and its structure related to allowing or inhibiting developing of industry capital and habitus.

iv. Elements of engineering education showing relevance to practice

In contrast to the views of learning environment discussed above, findings suggest that there is a model used by Ardhi University (ARU) to train engineers, which is very relevant to industry. Alumni from ARU believe that the model is helpful in relating to the industry. As discussed previously in 6.1.2 I, ARU uses a project-based model that involves industry mentoring. One of the focus group participants from ARU said:

So for [ARU] now for experience, I think is the best and you can take it for your modification for your PhD, the format of [ARU] in teaching, or teaching methodology, is very good, because each semester or each semester we have some project. This project is fulfilment of lectures. When we have some, maybe you come up with the water supply, after theory of water supply, there is a project of that, you form a group, and you do that project from questionnaire, designing, and you find a problem and engineering solution. That is actually working. (M4-FG1, 2016)

It's very relevant, […], as my Bachelor of Municipal and Industrial Service Engineering, it means you treat those, you treated the same as they treated municipal, so water with water, whatever. So you use that team working and the type of teaching from your school, they use it in daily life. (M4-FG1, 2016)

The ARU alumni in FG 1 implied that the PBL model developed global skills such as problem solving and teamwork because it portrayed a working environment close to that of industry and therefore real problems. They explained that the problem solving and teamwork strategies that they use in their training, is what they also use in engineering practice to easily adopt to industry.

> *Each semester, yeah, each semester you do that thing. It means each semester you come across with the different people, with different stakeholders, with the different people. So this type of teaching, it is good, it can be interpreted to other universities. I can graduate from ARU and I can go directly to be entrepreneur, or to do my own company or whatever, because I have already worked as teamworker in each semester. (M5-FG1, 2016)*

An academia interview participant from ARU (Interview 4, 2016) also reported that the ARU graduate are "better prepared than perhaps the other institutions." Also according to the ARU participants, their institution seem to have a system that helps set up the student habitus for industry. These contrasting views from different universities represent part of engineering education that have a different structure from the majority in Tanzania – hence allow different positions. However as already mentioned in section 6.1.2, ARU's engineering training is a small scale when it comes to engineering graduates it produces and therefore may not have a large impact. However, the engineering programs offered within an Architectural University shows the different position that universities can have– how this can affect capital and rules –structure of engineering within the context.

Another element engineering education in Tanzania that was relevance to industry practice was Practical training. Practical training (PT) is a form of Work integrated learning (WIL) included in engineering curriculum across all institutions researched (see Appendix I) , where students take eight (8) weeks placements every year for the first three years of their four year undergraduate program, in the industry where they do engineering work (Interview 4, interview 13, interview 12). For instance in the Civil engineering curriculum collected as documentary data, it is listed as a special courses, whose unit is compulsory. See Figure 6.4.

Table 3.7 Special Courses

Code No.	Course Name	Units
MG 445	Entrepreneurship for Engineers	3.0
SD/TR/WR 498	Final Project I	2.0
SD/TR/WR 499	Final Project II	4.0
PT1	Practical Training I	2.0
PT2	Practical Training II	2.0
PT3	Practical Training III	2.0
Total		15.0

Figure 6.4 Excerpt of curriculum showing Special Courses. From "Curriculum for the Proposed Bachelor of Science in Civil Engineering: Detail of the Course Contents," UDSM, 2011, p. 5.

The excerpt from the curriculum (Figure 6.4) indicate that this Practical training component seems mandatory and therefore an implicit rule forming the structure of Tanzanian engineering education context. Findings report that, graduates acknowledged that PT was significant for helping in developing skills for industry practice industry capital.

> *Just to add on that, so I can say where maybe by Bachelor degree prepared me a bit, but not completely. I took the advantage of practical training. From there is where you go and see some physical stuff. "Oh, so this is the centrifugal metre. Oh, this is this." But when you do in the class and you just say, "Okay, to find the volumetric flow here, you just do some formulas and do it," but when you go to the practical training, that is where you get the real test of what you do. (FG1)*

According to the focus pilot focus group participants, the WIL component needed more time for Placements, proper preparation and supervision as well as plan and structure. Focus group participants had similar responses in pilot study (5.3.3), and also in the main study:

> *Yeah, even six months just in your final year, just spend even six months doing whatever, if it is a project or your practical training in a real field. (FG1, 2016)*

Focus group participants suggested for the component to run for six months to one year, instead of the eight weeks each of the first three years, as suggested by a. Interview12 also thought that 8 weeks was not enough time:

> *Every end of academic year I think we have about eight weeks of internship which is not really enough but it is something. (Interview 12, 2016)*

Focus groups also advised that the PT's would be efficient is they are properly prepared including making sure students are assigned to places where they are learning and are getting supervision or mentoring. But this is not yet achieved in the current training.

> *First, those companies that are receiving practical training students, most of the time those officials there, those officials there, don't receive those students as a fellow coming to learn, […], so the students are left to do whatever they want not bothering to follow up whatever they're doing to take them through a test, to talk to them, to give them the A, B, C of the place. A few practical training centres do bother. They may assign a supervisor, an officer to take the student through to make sure that their day-to-day activities is more in touch with what the students are doing, they follow-up their work in time, working hours, they do exactly what is being done in that office. (M7-FG2, 2016)*

> *In case of practical training, I think this is part which most of us would say maybe our curriculum didn't prepare us well to jump into the industry. Just because the structure for practical training, I think we have, for[UDSM] we have just eight weeks every year for practical training, which to my side I say is not enough, you see. Maybe for our colleagues from [ARU], I think they have a year. (M8-FG 1, 2016)*

> *Very, very important. It needs to be better structured. (M1-FG 1, 2016)*

Further, according to the quotes, a well-structured practical training program has potential to develop practicing skills technical and global.

The focus group participants (Pilot FG, FG1 and FG2) also suggested that, the placements provide potential for exposure to other aspects and contexts of engineering industry outside the technical work, and therefore potential in incorporating global skills. They even proposed that students should spend time in another countries during the course of their studies to gain more confidence and international competence- to build cultural competence and habitus.

6.2.3 Summary: The practice gap between Engineering Education and Industry in Tanzania

To summarise, engineering education in Tanzania is mostly constrained by the Higher Education field that has focus on scientific knowledge or theory demonstrated by good marks, which marks it difficult to develop the required practice capital. From the findings above, it reveals that engineering education field in the African context has not yet separated itself as a different context from Higher Education and therefore the capital that is prevalent is scientific capital. According to section 6.2.1, the local context industry may accept scientific knowledge capital in form of marks at entry point but for success in practice or further gaining position in the international context, one would eventually be required to develop the global competencies. Therefore, there are gaps in competencies for industry practice, the gaps are currently being filled by the industry through graduate apprenticeships organised by the engineering professional body and fully supported from the government. Table 6.3 summarises the two fields engineering education and engineering industry side by side.

According to Table 6.3, the industry participants value academic performance relating someone who performs well to someone who is trainable. This means that a university that can produce high performing graduates, and that students that can strategize well in the engineering training field and acquire capital - high marks, are in good position to acquire jobs in the industry. For instance the participant from one of the institution expressing his satisfaction with the number of their students getting absorbed by the industry, means that they have no issue regarding employability with their graduates. Employability in the sense of acquiring a job has not been as an issue expressed, the only issue seems to be being competent in the job especially in international companies and also being confident in practice. This means there is a problem of engineering education not meeting industry demand, which is improved will lead to graduate engineers taking full advantage of their engineering industry.

The problem of education not meeting industry demands in competencies is not new, has been expressed in the Global North since 1990 (Nguyen, 1998) and several steps have been taken including transforming engineering education and accreditation to a more competence based, however all these efforts seem to be in vain since up until recently the complaint is still the same (Allan & Chisholm, 2009; Lohmann et al., 2006; Walther et al., 2011; Walther & Radcliffe, 2007).

Table 6.3 Contrasting Engineering Education Field in Tanzania and the Industry field

	Engineering education (training) field	**Industry (practicing) field**
Main capital	**Capital**: good performance in form of Marks – Higher Education capital Content focused	**Local capital**: Marks (on entry), transferrable competencies for success **International capital:** practice competencies, global competencies
Nature of practice and requirements	**Constrained by Higher Education capital** -Value academic performance– marks - More theory - Scientific Knowledge - Minimum exposure to practice - Include some soft skills development but -Constrained by time (units system) -Influenced by social culture - General, outdated and loaded Curriculum -No time for creativity -single answer question -cramming **Gap in practice – technical** - e.g. reading drawings and designing **Gap in global competencies** - e.g. teamwork, communication and ethical **Elements supported for relevance to industry** - ARU – project based - PT component helps but needs -More time -Proper prep and supervision -Plan and structure	**Solving (real) problems** -problem solving skills -critical thinking and creativity **Engineering is a business** -Business understanding - entrepreneurship **Multidiscipline and multilevel** -Interdisciplinary teamwork - inter-level working skills **Multicultural and international working opportunities** -Intercultural teamwork and communication -Communication in Foreign language – English and others **Dynamic/changing** - Research skills - Lifelong learning -updated technology **Politically influences and social impact** -ethical and professional behaviour

So, it is obvious that the issue is not resolved and some researchers in engineering education have argued that the previous did not bear fruits because of lack of consideration of the contribution of the context in which competencies are developed and used (Trevelyan, 2010a, 2010b), and also the approaches used lacking theoretical grounding (Jesiek et al., 2014; Trevelyan, 2014; Walther & Radcliffe, 2007). The findings here show that in Tanzania the problem seems to be the engineering education field not being able to achieve fully what industry requires due to the structure of engineering education being quite different from engineering practice, and the expectations of development of skills post-graduation.

For engineering education to be relevant to practice, it will require a change in structure (capital and rules) and a change in its agents' habitus both of which are not easy. As it was proposed, some of the things will be difficult to change for instance the competencies that can only be developed through practice – however some aspects of practice can be simulated by education for instance using project based learning and work integrated learning. Also some issues such as academics not having the industry habitus is also difficult to change, the reason why the initiative to be relevant to practice may seems to be in vain. But, there is a common capital between industry and education in Tanzania, which is 'good marks', it would need both fields to be engaged and agreeable in order for change to take place.

6.2.4 How Tanzanian engineers develop practice – Strategies

The topic of the complexities of how students develop into engineering professionals is covered in elsewhere in the literature (Litzinger et al., 2011; Stevens, O'Connor, Garrison, Jocuns, & Amos, 2008; Trevelyan, 2014; Walther et al., 2011; Walther & Radcliffe, 2007). Here, I explore briefly how participants in Tanzania have developed from graduate engineers into the engineers they currently are now at their different stages with some having attained professional engineering status. I am looking at what has contributed to their development – specifically the global competence formation in their education or afterwards that is worth paying attention to. Therefore establish the strategies that are available in African context of engineering education field or other fields (industry). It was established from the data that most of the practicing skills or professional skills develop in the industry, a little through the practical training and mostly later on after graduation through apprenticeship or training in the firms.

i. Post-graduation training - internship

According to graduate and early career engineers, there are opportunities for Continuing Professional Development (CPD) after graduation.

> *So there are so many opportunities outside after the four years, but I think what prepares best is the process does not end after the four years, actually it's the beginning. Because when you look at the projects we all get ourselves involved*

in, we have all these aspects of engineering, they go beyond civil engineering. So I think it's the personal development that is also required, apart from the knowledge and the books, how to relate to other field and aspects of engineering, how to seek and make the most of other professionals. (Pilot FG, 2015)

This means that graduates had to develop themselves and learn practice skills along the way after graduating. By personal development, the participant means personal professional development and this means developing ones habitus. This habitus is necessary in developing global competencies.

The main opportunity that graduate take to develop their practice is the SEAP program.

After graduating, yes, I just applied for an internship somewhere and then I started to learn, yeah. (F1- FG 2, 2016)

SEAP program is a good strategy to develop practicing skills – industry capital (supporting lit). This is learning that happened post qualification. If they thought it was better to develop these skills before qualification or after?

I think the best thing is just to learn before, because learning before you become confident and then it's easier for you to get maybe in any job or any job you can apply for since you have the knowledge enough to do the work. But since you are empty, then you can't have confidence to maybe ask for a certain tender or whatever. (F1- FG 2, 2016)

The focus group participant suggested that it was important that some global competencies are developed during their undergraduate training, so that they would enter the industry with some confidence to practice- industry capital and habitus.

ii. Lifelong learning attitude

The graduates explained that since there was a lot of learning that is required after graduation and therefore lifelong learning skills were important.

Yeah. After graduating, I thought I was ready for the industry but after coming into the industry, I need to go back and learn more. Since you find some stuff you haven't practised them during my studies which are just done in the office, *so you find that you don't have soft skills (FG 2, 2016)*

Soft skills can be equated to Global competence - important for industry.

Lifelong learning is important for updating oneself with technology.

> *Because you talk of technology, we understand technology is transition and four years to learn entire technology for the next 20 years may not be enough, so the skill, the creativity skill and the skill that every day is an opportunity to learn something new including technology, is something that has to be fostered, has to be instilled among the students. Because when we hear from those who are very senior that they started with computers that would fill two rooms you understand, they had cards, the program cards and it would take three weeks to create a program card. Today the same people are using Microsoft Project, Windows yeah so the skills that they had from back then is every day is an opportunity to learn. (Pilot FG, 2015)*

The graduates seem to refer to having an attitude to learn or lifelong learning attitude – habitus for Industry.

iii. Learning from mistakes/failure (habitus)

According to the entrepreneur participants navigating the industry can be a difficult process. An interview with the industry participant who is also was an entrepreneur relates to his story of learning through failure:

> *But failure's part of growth one should realise. Failure is part of growth. And in the field, in the practice, in the streets, there are so many failures and we fail on a daily basis. We design, things fail, it doesn't work, you amend and the thing goes on. It's that experience that we learn from the mistakes. (M3-FG 2, 2016)*

This explains the importance of having humility to fail and learn from it and try again as a habitus for developing practicing competencies. This habitus can be also linked to lifelong learning. The transition to industry strategy or potential for developing into practicing professional depends on this habitus.

6.3 Chapter Summary

In this chapter, I have analysed the discrepancies of engineering education between Africa and the Global North using Bourdieu's theories of practice, and found that the African context of engineering education has been operating according to the rules that are in conflict to the rules of the Global North which are dominant in the global engineering field, and this has resulted to Africa's dominated position in engineering education field.

The chapter has also analysed through the theoretical lens of Bourdieu, the relevance of engineering education in Tanzania to its engineering industry. Engineering education and industry are viewed as two distinct but interacting areas of practice – fields - the engineering education as engineers training field and industry as engineers practicing field respectively. The analysis found that, like in the Global North, there is a competence gap between engineering education and engineering industry in Tanzania. The competence gap is explained in terms of capital, and habitus. Findings show that the two fields are very different in terms of the capital as well as the habitus required to succeed in each that the two fields were valuing different kinds of capital. But, except they shared common capital, Scientific Knowledge, when it comes entry into the industry, with an expectation that industry capital will be acquired in the industry. Despite that expectation of acquiring industry capital in the industry, findings have established that graduates and early career engineers believe they should have been more equipped with global competencies, which would have made them integrate easier into the practice of the current industry.

The next chapter discusses the implications that the resulting position of engineering education will have on efforts to globalise engineers, and eventually answer the research questions.

7.0 Discussion

In the previous chapter, I have presented findings on the practice of developing engineers (engineering education) in the African context (described in Chapter 2), with evidence from Tanzania, analysed through Bourdieu's concepts of capital, rules and habitus. The contextual issues of engineering education underlying its structure were uncovered and the dominated position of the African context was presented against the global context. Findings show that African engineering education has a dominated position in the global engineering education field (Figure 6.3) because its operations are going against the rules of the global field (Section 6.1). Additionally, engineering education in Africa contrasts with its industry because of the different capitals and habitus, resulting in a gap in practice that graduate engineers have to close to be successful in the local and global engineering industry (Section 6.2).

In this chapter, I discuss the implications of the findings on the topic of 'globalisation of engineers' in Africa and the wider sphere, settling the reasons for my argument that, *the existing discourse on globalisation of engineers originates from the Global North perspective and it may not be suitable for Africa* (Section 1.2). The discourse may need to be revised in other Global South contexts. The discussion focuses on the position that the existing structure of engineering education leaves African graduate engineers, the main agents in this research, and also, what this means for engineering education aspiring to produce engineers with global competencies. Based on that, I will conclude with how the research has answered the research sub-questions and addressed the main question. I will also discuss the contribution of this research to existing knowledge.

7.1 The implications of the findings on 'globalisation of engineers'

With regards to 'globalisation of engineers' in Africa, there are two sides to the argument presented here. The first side: Globalisation discourse is responding to industry demands and the training traditions in the Global North, but it is not taking into account the African context (Section 6.1), should Africa still adopt this method? How can they become successful in the field? Can they influence the rules? The second side: If African training regimes are not addressing industry demands (Section 6.2), is this a problem for African engineers when it comes to the global job market? Does it limit their possibilities of getting employment with large multinational companies or projects, or are they actually well placed because they have local knowledge, considering where the jobs are moving – to the Global South.

7.1.1 1st side of argument: Failure of the globalisation discourse

This research argues that globalisation discourse has failed to be applicable to African context because of its Global North perspective and marginalisation of the African perspective. Globalisation resulted in a push for reforms in engineering education and other professional education towards outcome based education, competence based accreditation, student-centred pedagogy and international collaborations – the rules of practice prevalent in Global North. Even in Africa, this pressure for transformation is experienced, and several initiatives to reform engineering education are established. But the initiatives are failing to make significant impact because the rules that they are advocating are also those of the Global North, which are in conflict with the practice in Africa. For instance the Tuning Africa movement supporting competence-based education (Section 2.3.4), for developing competencies – industry relevant capital, valued by the global field of engineering education. Therefore the regular behaviour or practice in African engineering education is mostly in conflict with the Global North rules of operation in the global engineering education field.

In Africa, the initiatives are mostly experienced at managerial levels of the universities such as by faculty level (e.g. deans council) and college level and university level, where the people involved (deans, principals, curriculum officers) participate in international initiatives, conferences and forums and projects as findings show (section 6.1). However, practically, the transformation initiatives have not gained much traction at the lower levels in the classrooms. This is because of contrasting structures between the African context and the global engineering education field. African context reward Higher Education capital while the global field reward industry capital (Section 6.1). In this case, Institutions may care about demonstrating industry relevance for recognition and employability, but for the teachers 'on the ground' they are pursuing scientific knowledge as they try to adhere to the rules of Higher Education, where they operate. Note that Tanzania inherited the British Higher education system (2.4.2), which ended up being more theoretical than practical (Gardelle, Cardona Gil, Benguerna, Bolat, & Naran, 2017). Adopting these methods will be impractical if the capital that guide the teachers on the ground are not changed. The

The dominated position of their engineering education, has seen African agents passively accepting whatever has been proposed by the Global North, for instance academia borrowing curriculum and objectives from Universities in the Global North (6.1.1). Meanwhile, Global North engineering agents who are in dominant positions, argue for capital and rules of the field that respond to their context to protect their position. They unconsciously dictate for instance what this research depicts as an 'ideal global engineering competency' (see section 4.3.2). Bourdieu theory explains how the existing structure of engineering education facilitate reproduction power inequality between the North and the South. This is parallel to what Swartz (1997) says is the purpose of Bourdieu's work, to show how 'stratified social systems of hierarchy and domination persist and reproduce intergenerationally without powerful resistance and without the conscious recognition of their members.' (p. 6)

The structure of global engineering education field (in Figure 6.3) explains the extent of dominance of the Global North perspectives in the globalisation discourse, with respect to the dominated position of African engineering education, and its implications, concerns raised previously (Bourn & Neal, 2008; Johnston, 2001). If this structure is left to prevail in globalisation discussions, the dominated power positions of African agents, would hinder them from negotiating the capital and the rules of the field, resulting in marginalisation of the African perspective. This can be seen in most globalisation initiatives in Africa, where the inequality between North and South that takes place despite the very best intentions of aid/donor agencies for example European Union and UNESCO. Unless the effects of unequal power dynamics are resolved or at reduced, success of the African actors including their efforts for globalisation, will continue to be affected in the wider engineering field. In such initiatives it is therefore important that actors ensure that African partners' interests are catered for by encouraging them to negotiate capital and rules.

When it comes to 'globalisation of engineers', African actors may want to pursue the same capital as the Global North – 'global engineering competency' which is valuable in the African global industry (international firms, projects and so on) (section 6.2.1). However, their engineering education context does not depict the same capital and rules as the Global North. When Global North actors talk about pursuing the globalisation of the engineering curriculum, not only are they going to be pursuing something different from what the African universities will be pursuing because their field offers different capital, but they are also going to proceed in a different way due to divergent rules and their agents' habitus. The article by (Chisholm &

Leyendecker, 2008) has explained how Sub Saharan African educators were receptive of learner-centeredness, outcomes- and competency-based education and national qualifications frameworks, however there was failure in implementing. The failure was due to the difference in education practice made up of agency and the local field.

For Africa to adopt the concept of 'globalisation of engineers', their perspective of it needs to be included. This will require changing the current rules to accommodate their engineering education context and sometimes their industry context, all in all this will require change in structure. But, at their dominated position, it is difficult for African actors to influence the rules, but with support of the Global North actors through international communities of practice, this can be endorsed. This may be the reason why for instance there are initiatives to join with South-South cooperation or to join with other African countries. The issue of marginalisation of other perspectives especially those from the Global South in globalisation discourse has been pointed out a few times earlier, (Bourn, 2018; Ibrahim & Cockrum, 1993; Johnston, 2001). Bourn (2018) urged the international engineering education communities of practice to ensure that systems that are considered international/global have included a wider international perspective. Using Bourdieu's theory this research has addressed the power differences that constitute the global engineering education practice, therefore provide an approach to challenge the 'dominant neo-liberal notions of the linkages between globalisation and education'(Bourn, 2018, p. 559).

7.1.2 2nd side of the Argument: The position of African graduate engineers

Graduate and early career engineers in Tanzania value capital that is relevant to global industry. The Tanzanian case shows that African engineering industry or projects are now multinational, multidisciplinary and multilevel, an environment experienced by graduate engineers elsewhere, the Global North alike. Engineers are required to have problem solving, critical thinking, creative thinking, intercultural and inter-level teamwork and communication skills, business or entrepreneurship skills, an ability to communicate in a foreign language, combined with ethical and professional behaviour (6.2.1). This means Industry in Africa has become global and therefore graduate engineers need global competencies – capital of global engineering education field, to be relevant to their industry. For African engineers, being globally competent means being able to work with international companies and also being experts in their local contexts (section 6.2.1). But, the current engineering education in Africa is not adequately addressing global industry demands (6.2.3), which means problems to African graduate engineers when it comes to global job market that has now well trickled into their context.

African engineers are disadvantaged because of their dominated and marginalised position held by their engineering education context in the global field, in addition to the problems of their educational trajectory not developing in them capital and habitus to succeed in the global market not being industry ready. At the moment with the engineering education moving towards more relevance to industry capital as they embrace globalisation, most African engineers in their context of engineering education (explained in 6.2) will feel marginalised or even displaced especially at graduate level, as they enter the industry. Although majority of their industry – the local (about 75%) would accept them in because they can present capital for entry, when it comes to traversing the industry they find themselves lacking the right capital – including global competencies (6.2.3). Global competencies are valued at entry by the global industry, which makes the other 25% of their industry. As a result, the African graduate engineers in the global engineering field, will be starting at a double disadvantaged position compared to that of engineers from the Global North.

From experiences of graduate and early career engineers, it seems like the improvement of African graduate engineers' positions in the industry field depends on the structure of the field that they find themselves practicing in, the local or international, and also their development of the habitus that is required for success in the field (e.g. the ability to work with people from different disciplines or different cultures). For the few that integrate with the international scene of global industry (e.g. international firms or projects), they have the opportunity to slowly gain the global competence (industry capital) and improve their positions, during this time their habitus would also have changed – develop 'confidence to practice' as they labelled it. A strong apprenticeship program means they can improve their position as established from focus group discussion about their transition to industry (6.2.4). Therefore, SEAP and other strong graduate development programs are essential. Also, companies that are receiving graduates for apprenticeship need to work with the universities to address the gaps they are observing.

With economic globalisation developments, we have seen engineering industries (job markets) increasingly moving from the North to the South, and therefore job opportunities are opening up in the Global South including in Africa. For African engineers, being locals in Africa can be an advantage, since they know how to navigate what others perceive to be complex working environments (developing countries). So when it comes to globalisation, the local context poses many advantages for African engineers. While others, coming from the Global North, are learning to work in what they perceived as complex environments, African graduate engineers can be already acquainted. Hence, locally trained engineers are at an advantage position, if they understand their local industry. Engineering education in Africa need to transform in order to develop graduates with at least a minimum amount of relevant skills that will enable them to adapt to industry (sooner than 3-5 years), in other words some capital that will start them off at a better position.

In addition, some African countries, like Tanzania have started implementing policies that favour local firms and individuals in public projects, this include policies that require foreign firms to form partnerships with local firms in order them to attain work in the country. There are more opportunities for engineers to collaborate with multinational companies, but the position of local graduates' competitiveness raises concerns of their capacity to do so. This is an opportunity for engineering education to look at ways they can develop local engineers that can confidently form meaningful partnerships with international partners. The local industry and professional bodies must be involved earlier to ensure that the right competencies are developed in the Universities, which means that the value should be on practicing skills at early stages instead of waiting until after graduation.

Findings show that, African graduate engineers have used opportunities available in their engineering education field to develop capital and habitus expected in the industry for global working, despite the challenges of their position. In education, this can be achieved by creating supportive environments for developing capital and habitus. Drawing from the results of this research, the following actions need to be considered in order to create and strengthen supportive environments for to develop capital and habitus. First, strengthening Work Integrated Learning (WIL) components of the engineering education, practical training, so that students can gain the optimum benefits of an authentic engineering practice. Second, explore applicability of existing Project- based teaching models to wider engineering institutions. Finally, capitalise on the government funded apprenticeship program, SEAP, for developing skills after graduation.

In concluding the argument, I believe that the African perspective here can significantly benefit the 'globalisation of engineers' discussion and efforts. This research therefore recommends that in looking for solutions especially in relation to developing global engineers, it is worth observing the context of engineering industry for requirements, and particularly vital is to include the Global South contexts such as the African context, since new markets are being opened there.

Understanding the requirements of working in the local industry in the Global South may help better prepare engineers, including those of the Global North, for taking advantage of the opportunities that the markets will offer.

7.2 Addressing Research Questions

This research draws from the findings and the main argument on failure of the global discourse and problems of engineering education regimes not addressing global competence development (7.1), to address research question and sub-questions above. First the research sub-questions are addressed as follows:

7.2.1 What is the history and significance of the global engineer concept from an African perspective?

The research confirmed that the global engineer concept in Africa has a short history, it only started appearing in most local discussions in the last decade or so (Section 1.1.2), therefore lagging about two decades behind the Global North (where the concept developed in the 1990 after industrial revolutions in the 1980s). The concept although discussed in literature and seem important for industry, it does not seem to be given value (seen as capital) in the African engineering education structure yet. However, the current and prospective developments in Africa make it valuable for African engineering education to incorporate the concept in order to build capacity for sustainable development (Section 1.1.3) especially current times when most African nations have visions to move to middle income economy. In order to do that, Africa need to develop engineers who can take advantage of the global industry through:

- International companies that offer opportunities for engineers with global skills
- Mobility opportunities for graduate engineers to take advantage of the global markets
- Projects addressing social local problems that require global competencies to solve
- Opportunities to solve problems captured in UN Sustainable Goals, with most being found in Africa.

Despite the concepts prospects for providing Africa with means to address its socio-economic development needs, this research has confirmed that the existing globalisation discourse is taking account of the Global North industry demands and training, and often marginalising Africa (7.1). Therefore, African engineering education needs its own definition of the global engineer that is representative of their industry and approaches for developing that global engineers that are appropriate for their engineering education (Chapter 2).

7.2.2 How influential are existing local and international engineering education and accreditation procedures in developing engineers in Africa that meet global standards?

The influence of existing engineering education and accreditation procedures in developing global engineers is the matter of the impacting rules that form engineering education field.

The international procedures (rules) often make certain assumptions of the Global North engineering education (7.1.1). The construction of the global field of engineering education (Section 4.3), revealed how the existing structure (capital and rules) had come to being, which is the result of the Global North narrative dictating capital and rules including those relating to globalisation. For instance in accreditation there is an assumption that there is competence-based program accreditation conducted by a professional accreditation body. We cannot make this assumption in Africa, but this assumption is part of the rules of obtaining capital in the global field of engineering education (Chapter 4, Section 4.3). This research has explained how in pursuing an argument on developing global competencies, people have taken these sets of pre-existing rules, and have used them to introduce these new rules (7.1), for example, how they have redefined the accreditation criterion to match global standards. Since African engineering education is in conflict to those rules (6.1), it will be difficult for them to obtain globalisation – develop engineers that meet those global standards.

While the global engineering education structure (capital and rules) is currently responding to global industry, the local structure of engineering education and accreditation in Africa is corresponding to the Higher Education field structure (6.1). Higher Education field structure supports scientific knowledge capital, opposite to industry field structure where global competence capital is appreciated (see Figure 6.3). There were a few practices identified that could be related to developing industry capital including global competencies, such as the Project based Learning model used by one institution. But these were appearing in very small scale compared of the entire local engineering education, and therefore made a very low impact. Also having compulsory internships (industry placements) component within the curriculum, but these internships are currently not focused on competencies as capital. This means that at most the existing local procedures do not at all support development of engineers with global standards, in fact they are mostly detached from industry capital.

7.2.3 In what ways is the engineering education situation supportive or inhibitive to the development of African global engineers?

The current situation of African engineering education (introduced in Section 2.4 and confirmed by the findings in Chapter 6) implicates its dominated and marginalised position explained in Section 7.1. This position of African engineering education is inhibitive to development of global engineers because:

- Its focus on Higher Education capital and rules results in producing graduate engineers that may have scientific knowledge capital but lack industry capital, which is important for global engineers.
- Lack of practical aspects, meaning not developing practical competencies related to global working.
- Learning experiences including habitus of most academia in the African context do not match that of the general field's rules.

The research has also shown that to a small scale the engineering education situation (position) has potential to be supportive to the development of global engineers:

- Through local strategies for developing practice capital such as apprenticeships rules, Project-based Learning initiatives appearing in a small scale, and existing collaborations potential for the local engineering education graduates to integrate into the industry. But the Higher Education focus of engineering education, will make these strategies inefficient. The strategies are however not yet recognised in the global field.

The current position of engineering education, means it is difficult for them (engineering educators) to demonstrate industry capital based on the current rules. This includes for instance changing to Student-Centred Learning, despite findings showing some achievement in the context.

7.2.4 What are the implications of the findings of sub questions 1, 2 and 3, for the future of global engineering education in Africa?

From the answers to research sub-questions 1, 2 and 3, and the argument made in section 7.1, this research has provided a case study of Tanzania to bring this perspective to light as follows:

- The global engineer concept has recently become of significance to the African context because of its prospects to contribute to sustainable socio-economic development, especially during the time when most African countries are aspiring to move their economies from the lower income into the middle income economy.
- That the international procedures of engineering education such as accreditation should not be referred to as criteria for global engineer competencies for Africa to avoid marginalisation of African context.
- Furthermore, the disadvantage position African engineering education, against the global engineering education, and against its industry, limits African engineer education from developing global engineers.
- However, the research also shows, there are opportunities to influence structures through some avenues or areas of influence that already existing in Africa.

The future of African engineering education will depend on the ability of African engineering educators to take advantage of the existing local structures in developing engineers who are competent in the global market. It will also depend on the persistence of African engineering education leaders and actors to contribute their perspective in international agenda, especially during this time when the attention is on the UN Sustainable Development Goals (SDGs), so as to influence the field into more inclusivity. This can include debating about the inclusion of other narratives such as this one from Africa and the Global South in the current discourse so that the structure reflects a more equal playing field. For instance, propose that the global engineering arena endorse placements and apprenticeships as acceptable rules for development of global competencies. These can be used as avenues and possibilities or opportunities to influence the global structure, and also provide for narrative that is more inclusive of Africa.

7.3 My contribution to knowledge: theory and context

7.3.1 Engineering education practice

The thesis makes a contribution to the existing discussion of globalisation from an African perspective; where the African perspective is not well represented. In addition to providing an African perspective, the research also contributes empirically and theoretically to the research on developing competencies for the 21st century in two ways. Theoretically, the research suggests a way of looking at engineering education as a social area of practice (field) distinct from Higher Education, with many influences in and out of Higher Education. Empirically, the research employs a qualitative approach to enquiry that allows for deeper understanding of people and their context, including engineering education and industry contexts. Hence the contribution of the thesis to existing knowledge.

The thesis contributes to previous work on 'globalisation of engineers', which has been criticised for lacking theoretical grounding in defining and developing global competencies; not considering context, and having little relevance to the role of engineer in the workplace (Bourn, 2018; Jesiek et al., 2014; Walther et al., 2011). Bourdieu's theory is used to show the influences on engineering education that may affect development of competence for global engineering. This view exposed engineering education field as a space that is highly influenced by Industry and Higher Education fields, which are manifested through economic, political, social and administrative powers. The research emphasises the contextual differences and proves that when the engineering education space is viewed from different contexts – global, regional, country or institutional, it offers different views for its players in terms of the power (capital) that their positions can afford them as well as the strategies that are available to them in those positions.

The research contributes to the knowledge on *development of practice competence* (Litzinger et al., 2011; Walther et al., 2011) using evidence to explain the gap that exists between engineering education and industry practice in Africa. Like engineering education practice, industry practice is viewed using the lens of Bourdieu as a field and using the notions of capital, rules and habitus the gaps are explained. This is in line with the research on engineering that tries to investigate what engineers do (Trevelyan, 2010b), in order to design training that aligns to industry. The existing research in engineering practice is said to lack contributions from the Global South and especially non-industrialised nations (Domal, 2010). The approach for assessing the situation of African engineering industry in order to establish competence gaps in this research, provides a framework for studying competence formation in engineering education that focuses on observing engineering industry, an approach that aligns with others (Jesiek et al., 2014; Johri, 2010; Trevelyan, 2010b; Walther et al., 2011; Walther & Radcliffe, 2007). This study prospects may form a base for future research in engineering practice.

7.3.2 The bigger picture discussion

The topic of this research 'globalisation of engineers' resides in the general discussion on development of practice competencies rather than on how engineering Higher Education structure develops global competencies. This allows for consideration of areas of engineering development that are beyond the Higher Education structure including post-graduation education, apprenticeships, and so on, in order to envisage approaches to facilitate the transition into practice.

The issue of context becomes very important in studies of globalisation because the factors that affect engineering education practice are context dependent. The North American and the Australian Cases as representatives of the Global North show engineering education trajectories experienced in the 1990s similar to what most African countries are experiencing in this time of globalisation. During the time (1990s), the Global North countries were pressured by the need to build their engineering capacity due to the industrial and economic developments, political, social and structural factors that required them to stay relevant in the global job market. Those factors are context specific, but now globalisation has led engineering to be a global practice and hence opened up global job opportunities for engineers with global skills irrespective of context. This has resulted in convergence of capital, making industry relevant competencies to be capital of the broader field. That is why we see engineering education stakeholders working to achieve this capital through the efforts to define and re-define competencies, in order to respond to industry demands.

The opportunities available in the current industry due to development of global job markets especially those situated in developing countries, including most African countries, has made it beneficial for African engineers with global skills to maximise their job opportunities, and also to increase industry capacity in their countries. This is because African agents find themselves in demand to play in the global context even within their own countries while they still have to adhere to the rules in their local context (that can be quite different). This is also a case in other Global South context such as South Asia where work has been outsourced to and opportunities for engineers to work in multinational organisation while in their own countries presents (Domal, 2010; Raju, 2001).

In order to succeed in the global arena of engineering education one is expected to play by the rules, but the rules that dominate are those proposed by the Global North: outcome/competence based education, program accreditation which then favour the Global North engineer. It is evident in African context of engineering education there appears to be a push for the same rules of the field in the Global South. When it comes to engineering education, African agents are coming from different viewpoints from Global North agents in the field, and due to that their position taking is expected to be different. So explains the failure of the discourse – not considering the African context of engineering education.

Bourdieu's theory is appropriate in re-defining competence for global working or practice by allowing identifying and illustrating capital and habitus that are at stake in the global job market. According to Bourdieu, field is an area in which we act according to the specific rules in pursuit of specific capital, its boundary are found where the field's influence cease. (Bourdieu & Wacquant, 1992). We have seen that the effects of the global job market capital extends to contexts of the Global South and does not only affect the global North. And also in globalisation of education, the job market or the industry is the capital to engineering education, since institutions are aspiring to be relevant to industry or sensitive to employers in order to sell their graduates to the global job market. Findings show that capital related to the global industry can be obtained through various rules not necessarily those that pertain to the Global North (6.2), but the dominant specified rules supported by the existing discourse make it difficult for others to demonstrate capital.

This research maintains that the problem of the 'globalisation of engineers' discourse is not in the defining, developing and accessing of competencies as suggested by the existing discourse, but is in the defining capital, rules and habitus in engineering education. This is because the meaning of those parameters is associated with the context in which the engineering education practice occurs. And this is not a problem of Africa or the Global South alone, as the requirement to be relevant to industry increases, we are seeing that Global North nations, are reporting not achieving the engineers with the competencies to practice (Litzinger et al., 2011; Walther et al., 2011; Walther & Radcliffe, 2007). Therefore, in order to adopt approaches relevant to any engineering practice, there is a need to consider those context specific parameters.

What is important to this research and future research, is understanding that the two fields engineering education and industry are different, and finding that middle ground is very useful in smoothening the transition. For the African context, this is where the approaches like Work Integrated Learning (WIL) and Problem based learning (PBL) may become useful, as the context seem to already accommodate them.

8.0 Conclusion

This thesis has made a theoretical grounded and empirical based contribution to the existing discussion of development of global engineers, from an African perspective of engineering education practice. It has exposed, through Bourdieu's theory of practice, the fact that the existing discourse is not relevant to African context of engineering education. This is because of the different contextual influences that affect African context, that go against the perceived Global North perceptions of engineering education, and therefore difference in structural constructs. These different structural constructs eventually puts Africa in a dominated position in the global engineering education arena. But through the data, we have learnt that there are different strategies available for developing global skills in engineers compared to the ones discussed in the literature.

8.1 Significant and Original Contribution to Knowledge

This main contribution has been applying Bourdieu's theory to show the various influences facing engineering education practice, through an African perspective. This contribution has consequently added to two areas: application of theory in engineering education research and developing professional engineering competence, and more specifically in developing global engineer.

This works' suggestions of viewing engineering education as a social area practice, exposes its true nature composed of many influences (its underlying structures) that affect practice, therefore providing a better understanding of the issues of the practice. There are many potentials in the area of developing competence or competence formation, for the approach that applies an appropriate theory, a theory that allows consideration of contexts, in this case the education and the practice contexts, and therefore the approach needs to be pursued in more depth and breadth in other contexts. This contribution to the developing studies that focus on formation of practice competence where they analyse engineering practice, the theory is useful because engineering practice is also a social affair – as it involves social interactions communication, empathy conflict resolution (Bourn, 2018; Trevelyan, 2014), hence a social theory will be fitting.

As established in Chapter 1, the main aim of this research is to address the research question: *What is the applicability and relevance of the concept of globalisation of engineers to African* *engineering education?* In order to address the main research question, 4 sub questions were created:

1. What is the history and significance of the global engineer concept from an African perspective?
2. How influential are existing local and international engineering education and accreditation procedures in developing engineers in Africa that meet global standards?
3. In what ways is the engineering education situation supportive or inhibitive to the development of African global engineers?
4. What are the implications of the findings of sub questions 1, 2 and 3 for the future of global engineering education in Africa?

Chapter 1, also shows that the current debate originates from the Global North system of engineering education and may therefore be difficult to apply to Global South contexts such as the African context. It also draws attention to the noticeable low contribution of African perspective in the globalisation debate. In order to understand globalisation phenomenon in the African context, a review of literature was conducted on African Engineering education in order to contextualise African engineering education (Chapter 2). The review identifies and analyses some main issues of local context that may potentially make it difficult to apply the existing discourse in globalisation engineers to the African context. These local issues form areas of discrepancies between the African context and the Global North context of engineering education where globalisation discourse originates – in curriculum, teaching and learning, accreditation, professional bodies involvement as well as collaborations.

A research methodology was designed to closely analyse the contextual issues of curriculum and accreditation for developing global engineers in African and recommend approaches/strategies of globalisation that are relevant to Africa. The areas of discrepancies provided a basis for research design. Qualitative methodology was applied, and Tanzania was used as a case of Africa because of having the characteristics and also for its convenience. The research involved two stages of data collection and analysis; pilot study and main study (Chapter 5). A pilot study was conducted in Tanzania which confirmed case to be suitable, shaped the research plan and also lead to decisions to apply a social theoretical framework of Bourdieu (explained in Chapter 4) as a lens to analyse the main data.

Bourdieu's theory provide a way of looking at engineering education practice as a social arena (field) and expose its structure (Chapter 4), which exposes the global context with its capital and rules. It also shows the dominating of the Global North perspective and agents in the field. This was the basis for analysing data. By looking at the African agents are doing (their practice) and positioning the African context against the general field, and also the position of African engineering education in relation to its own engineering industry (in chapter 6), understanding what is possible for African actors when it comes to the development of African global engineers compared to other actors (Chapter 7). This exposure then allowed me to first validate using evidence (in Section 7.1) the main argument of the thesis that: *The existing discourse on globalisation of engineers originates from the Global North perspective and it may not be suitable for Africa*.

In line with that argument, I have presented the influences from the people in the Global North who are speaking about globalisation and the influences on the field in the Global South on the people who are being spoken about (Section 7.1). This is where we can see that the pressures are different for these two groups of people that they might be using the same word globalisation but they are in such a different place in the field that it cannot mean the same thing, it cannot be worth the same amount of capital. That explains why the concept is difficult to implement in the African context. Bourdieu's theory provides a principled and structured way of explain this situation.

My significant and original contribution to knowledge therefore, is the theoretical grounded and empirically proven approach (explained in 7.2) that addresses the gulf between Global North and Global South practices, particularly the Sub-Saharan African context. The approach is also considerate of context, showing the unequal positions that the two contexts take in the perceived global engineering education arena (Chapter 6, Figure 6.3). The implications of the positions explain the failure of the discourse on 'globalisation of engineers' in Africa and the opportunities that African position in the field present for the future of the field (Chapter 7, Section 7.1). From this argument, I was able to address the research question, by addressing the sub-questions in Section 7.2, in summary:

1. The concept of globalisation is new in Africa but is significant for its social economic development prospects
2. The existing local and international engineering education procedures form the specific rules that engineering education has to follow to obtain capital, and therefore affect

3. The position of African engineering education due to its position against in the global engineering field as well as its position against its own industry is inhibitive of developing global engineers because of the difficulty in demonstrating industry capital. In a very small scale there are emerging situations that have potential to be supportive, if capitalised on – for instance internships, apprenticeship and existing PBL models.
4. The implications of the findings to future of globalisation of engineering education are: to define from an African perspective, an African global engineer - capital and rules required; to negotiate the inclusion of African context in the international discussion of 'globalisation of engineers'; and to take advantage of local strategies with potential to develop global skills, that are already contextualised for development of industry capital -internships, apprenticeship and existing PBL models.

Therefore the research answers the main research question as follows:

> ***What is the applicability and relevance of the concept of globalisation of engineers to African engineering education?***

By addressing the sub-questions, the research has therefore managed to explain from an African perspective the position of Africa in engineering education based on Bourdieu's theory of practice, the position that has considered its education contexts and requirements for industry practice. According to Bourdieu, the relationship between structure and habitus is important (section 3.3) – what people do with respect to the strategies they can utilise according to their position and the rules of the game in their context, and different contexts of the same field may offer different rules such as the African and the Global Northern contexts of engineering education. African engineering education need to implement strategies that are accessible within their engineering education position. In order to do that, these strategies need to be defined and included in their global engineering narrative. From this perspective, it is clear that Africa needs to define 'globalisation of engineers' from an African perspective since the existing discourse does not provide that, so the research proposes a study of the African industry that offers more reality.

In the current development in engineering education around the world, African engineers, while well placed geographically when it comes to the global job markets, are disadvantaged by the existing structure (their position), by not demonstrating upon graduation the capital (e.g. globally recognised/accredited education) as well as the habitus, that matches that of industry. Although at the moment, due to existence of jobs there seems to be high demand for engineers, and therefore employment may not be an issue. But, with the prospects of increasing the demand for engineers in Africa due to infrastructural and industrial developments, and the increased mobility between countries, there will be more competition for employment as it is the case elsewhere. Therefore, African graduates need global competencies – capital and habitus, hence the relevance of the concept.

In conclusion, globalisation has been driving transformations in engineering education in the Global North so the agenda serves the demands of the Global North. The answer to who a global engineer is will be different depending on where you are positioned in the globe (Global North or Global South). As the literature shows, there are differences in the way a global engineer was discussed. A lot of the movement about globalising the curriculum is focused around competencies that can be transplanted in the Global North in order to practice in the Global South. The Global North narrative does not fit Africa, hence the current discourse is not applicable to Africa. But the concept itself was settled to be very important for Africa especially with current industry. So this research concludes, there is a need to appropriately define 'Global engineer' from an African Perspective. This research forms a basis for achieving that meaning of global engineer, and find suitable approaches that are applicable in African engineering education to develop global engineers.

8.2 Contribution of the position as a researcher

I wish to also point out that my position in this research (section 1.5) has had a considerable effect to the contribution to development of knowledge. First of all my position as an academic in Africa has allowed me to defend why I pre-established the propositions and write my questions, since some of the issues that are relevant in Africa may not have appeared in the literature. For instance, the scarcity of literature on engineering education meant that there was the need to capture the reality according to Africa starting from little literature available into the lived experiences of the participants, unpublished materials, as well as my own experience. My position as a lecturer in Africa meant that I could relate to the local teaching and learning practice and therefore I could contribute to the fact that the competence-based system does not exist in Africa, and therefore defining competencies and as a way to demonstrate capital, had no relevance. The position as a lecturer affiliated with in engineering institution and as an alumni from Tanzania facilitated the recruitment of interview and focus group participants (as discussed in 5.4.1).

My position of teaching and studying in Australia (in the Global North) allowed me to understand the extent to which the context was different from the African context. Further my interaction in engineering education research community in Australia, lets me continue to engage with the topic of developing engineers with an understanding that the gap especially when it comes to the practice on the ground is still a challenge, even in the Global North.

9.0 Recommendations and Future Research

9.1 Key Recommendations

9.1.1 International Community of Practice

This research recommends that the international engineering education community of practice that is engaged in developing the 'globalisation of engineers' discourse, needs to extend outside the existing rules that are connected to specific practices such as competence-based accreditation and outcome-based education, which are marginalising the African context of engineering education practice. The current discourse, apart from marginalising other contexts, have not been very successful in developing engineers who are well aligned to the global industry, even within the Global North. There are benefits in including an African and others in the Global South in the discourse, especially keeping in mind that the job market is moving there or opening in those contexts, and they may have more expertise about navigating those contexts that may otherwise be difficult. The community of practice should therefore focus on the industry capital required, which is similar, and rethink the ways of obtaining and demonstrating capital that are inclusive of diverse contexts in the world.

This research recognises that the current rules of the field have been remarkable in improving the structure and quality of engineering education, especially in the Global North, and they have potential to do so in the Global South, however, they may not be the solution to development of global engineers. That is why this research recommends that procedures such as international accreditation should remain as a method of quality assurance and not a measure of globalisation. Parallel with others (Altbach & Knight, 2007; Jefferies & Evetts, 2000), the research endorses the criterion for accreditation should always be updated to reflect industry expectations and practice, but when it is used to identify global engineers, it creates marginalisation as it is internationalisation and not globalisation.

9.1.2 African engineering education actors

This research recommends that African engineering Higher Education actors especially educators to use opportunities in international platforms to debate for inclusion of definitions of capital and rules that are relevant to the African context to be valued in engineering education. In order to do this, they will have to first define what this capital is, and these rules are, and this can be done through collaboration with industry and professional bodies – to define the requirements of industry. These arguments can be presented in places such as the Annual Engineers Day (AED) forums, and other spaces where engineers from different sectors meet.

The research recommends that engineering educators in Africa take advantage of the local opportunities that are available within the context to develop industry capital and in turn ease the transition, e.g. projects and internships global competencies. Also use lessons from other professional education that are in the same situation, such as Architectural education, who have succeeded to develop industry relevant capital using PBL, within the Higher Education structures. Further the research recommends a project driven curriculum as a way forward in supporting transitioning into industry.

9.1.3 Professional body and Industry

This research recommends more involvement of professional bodies in engineering education. Being responsible of development of engineering, it is important that professional bodies step up into this task as engineering education is an important part of development of engineers, it is the entry point to engineering profession. Refer to results in Section 6.1.4. The Professional bodies can also emphasize global competencies to be considered capital in engineering education on behalf of early career engineers, who on entry, struggle for three to five years to navigate the industry.

We have seen through the Tanzanian case that the professional bodies in Africa have potential to be more involved because they hold a legal mandate to accredit engineering education. In order to ensure that institutions offer education that is relevant to the industry, it will be an advantage that the professional body is more involved in program accreditation of engineering because. Since they are responsible for regulating the profession or the engineering industry, they have more understanding of the requirements there, so their accreditation could focus more on the professional requirements such as competencies, this being the practice in international accreditation.

9.2 Future research

9.2.1 Contexts

Further research should consider inclusion of other context will provide a different insight to the discourse of developing global engineers. The two contexts, Global North and the Sub-Saharan African, are the only ones that are explored here and these may be at the extreme opposites to each other but there may be other contexts that are in-between that may exert a different context from the two extremes, and these are will be worth taking into consideration in future studies when it comes to developing engineers. For instance African contexts with middle income economies such as South Africa, Namibia and Mauritius or those countries in the Northern Sahara (Saharan countries) identified in section 2.1, that were left out in this Sub-Saharan context sample population in Figure 5.3 (in Section 5.7). For instance Botswana showing some structures different from the Global North context. Also the Northern African context which although aligns with some of the Global North ways, its different geographical, political and economic position may exert different influences to those of the Global North.

Also, future research should focus on the rest of the Global North countries that were not well represented by the body of knowledge that was explored in this research. The Global North perspective of the globalisation was established from literature available in English language, hence left out part of Global North context where English is not a language of instruction and dissemination. Future research should look at exploring this context to get a well-rounded perspective of engineering education in the Global North. Hence, the need to consider these and all other contexts that may in any way present a different context

9.2.2 Theoretically based approach

Incorporating Bourdieu's notion of field to analyse engineering education and engineering practice as the social areas of practice that they already are. Global engineer's agenda calls for more involvement of engineers in the society issues, and the issue in the society since the late 20th century has been related to global issues and peace engineering in engineering education forums and conferences (1.1.2 and 4.3.1). Bourdieu's field can be used to analytically construct those relationships between engineering education and society in a way that provides a setting for analysis. For the field of engineering education, actors including those from Africa, pursue global engineering to gain different types of capital, therefore observing what people do the pursuit for global engineering curriculum in the field will provide a theoretical understanding of the field – how people position themselves according to the rules of the field.

Positions are determined by the allocation of specific capital to actors who are thus allocated in the field. When habitus encounters the field in the position attained, it will interact with field to produce action or decision (Harker et al., 1990). Sometimes this action will portray in a way of struggle or conflict, for instance when the habitus does not match the field. Observing actions in the field will enable researchers to understand the position and habitus producing them.

9.2.3 Contextual solutions with a focus on engineering practice

The assessment of views from industry through employers and expert engineers as well as graduates and early career provided a lot of insights on the engineering practice and what is required in terms of practicing competencies – including global competencies. Deeper, more structured assessment of the industry practice in Tanzania is required to find the specific areas of development application of competencies, for instance entrepreneurship. Interpretations of industry practice from academia are also vital for future research, in order to bring a holistic view of the gap that exist between these two practices, and contemplate appropriate solutions for help narrowing that gap.

The discussion shows that there is a noticeable need for the local context knowledge and expertise, which may be taken for granted by local engineers. Local engineers would have an advantage of helping foreign companies adapt to working in Tanzania and Africa if they are equipped with this competency. This may be their bargaining chip for employment in international companies operating in Tanzania, especially since more work is moving to the Global South. This research therefore recommends that further studies explore the issue of local context further especially finding out if there are rules in the local context that are important, which international engineers may not understand.

Because of the diversity in engineering practices resulting from different institutional structures between the few institutions observed, suggest a more diverse and large scale samples of university and industry participants is required. For instance this research found an outlier case of the Maritime University – with the strong collaboration with Maritime profession and the existence of outcome-based education (6.1.1 iv), which hinted the need for diverse and larger scale Future studies in the area can make an effort to include all institutions that train engineers in Tanzania in order to get a well-rounded representation of engineering education in Tanzania.

Further and future research needs to explore contextual strategies such as Work integrated training and PBL model at ARU, for their applicability in African engineering education situation, and their potential to be used widely to develop industry capital.

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Appendices

The appendices follow the order in which they appear in the document

A: Permission to use copyright material: Review paper

B: Information forms

C: Consent forms

D: Invitation to focus group

E: Interview participants' bios

F: Participants Questionnaire- Skills ranking

G: Invitation to focus groups

H: Tanzania National Qualification Framework

I: Profiles of Higher Education Institutions Involved in the Research Study

Appendix A: Review paper Request and Permission to use copyright material

Request for permission to use Copyright materials

Esther Matemba <e.matemba@postgrad.curtin.edu.au>
Mon 9/12/2019 1:41 PM

To: ijee.editor@gmail.com <ijee.editor@gmail.com>
Cc: Natalie Lloyd <Natalie.Lloyd@uts.edu.au>

1 attachments (12 KB)

HDR_copyrights_Approval Slip.docx;

Dear **Ahmad Ibrahim (Chief Editor-IJEE)**

It is my understanding that your Journal (International Journal of Engineering education) are the copyright holder for the following journal article that I published in your journal during my PhD study:

Matemba, E., & Lloyd, N. (2017) Internationalization of Professional Engineers: A review of globalisation of engineering and accreditation- challenges from an African perspective. (In the *International Journal of Engineering Education (IJEE)*, volume33 issue 6 part B, of 2017)

I would like to reproduce, with adequate citation, parts of this work in the literature chapters of a doctoral thesis which I am currently undertaking at Curtin University in Perth, Western Australia. The subject of my research is Globalisation of Engineers: African Professional Engineering Education Perspectives. I am carrying out this research in my own right and have no association with any commercial organisation or sponsor.

The materials that I would like to use for the purposes of the thesis is parts of section 2, section 3 and section 4 and including table 2 and parts of table 3.

Once completed, the thesis will be made available in online form via Curtin University's Institutional Repository espace (http://espace.curtin.edu.au). The material will be provided strictly for educational purposes and on a non-commercial basis.

I would be most grateful for your consent to the copying and communication of the work as proposed. If you are willing to grant this consent, please complete and sign an approval slip such as an example attached and return it to me at the email address shown. Full acknowledgement of the ownership of the copyright and the source of the material will be provided with the material.

I look forward to hearing from you and thank you in advance for your consideration of my request.

Yours sincerely,

Esther Matemba
PhD Student - Civil Engineering
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PERMISSION TO USE COPYRIGHT MATERIAL AS SPECIFIED BELOW:

Parts of section 2, section 3 and section 4 and including table 2 and parts of table 3.

I hereby give permission for **Esther Matemba** to include the abovementioned material(s) in his/her higher degree thesis for Curtin University, and to communicate this material via the espace institutional repository. This permission is granted on a non-exclusive basis and for an indefinite period.

I confirm that I represent the copyright owner of the specified material.

Signed: Ahmad

Name: Ibrahim

Position: Editor-in-Chief, IJEE

Date: 2019_12_09

Please return signed form to **Esther Matemba at** **e.matemba@postgrad.curtin.edu.au**

Appendix B: Case Study Protocol

CASE STUDY PROTOCAL

TITLE: GLOBALISATION OF ENGINEERS: AFRICAN PROFESSIONAL ENGINEERING EDUCATION PERSPECTIVES

INVESTIGATOR: **Esther Elly Matemba email:** e.matemba@student.curtin.au

1.0 Case Study Protocol: Main Study

The case study research questions were based on the six themes as follows:

Theme 1: Engineering education

	Case Study Questions	**Sources of Data**	**Comments**
Quality of Input (Student)			
1	*Entry Points or criteria to tertiary education subjects?* Min grades? Type of training?	Documentary	Accreditation Institutional documents
2	Educational and social economic backgrounds? Type of education? Does it prepare them for the degree?	Focus groups	Alumni
Engineering curriculum			
1	*What are the requirements for curriculum (learning objectives)?* What are they based on? Requirements from industry/ professional bodies or University? How are they established? Why?	Documentary Interviews	Curriculum guidelines Academia and regulatory
2	*How is the curriculum developed/ established?* Who is responsible for curriculum development? How often it get reviewed? How current do you think the engineering curriculum in Tanzania is? Current or outdated? Explain…	Interviews Documentary Interviews	Academia Curriculum guidelines
3	*What is the role if any that accreditation plays in shaping and designing curriculum in your institution?* Local or international?		Academia

4	*What are the issues that affect curriculum development/ design?* What do you see as the impact of the local environment on curriculum design and renewal: economic, political, environmental, and cultural influences affecting institutions and their students?	Documentary Interviews	Academia
5	*How does the curriculum instil international skills?* Methods, content, delivery etc.?	Interviews Focus groups	Academia Alumni
Learning environments			
1.	*How are the learning and teaching environments impacting development of global skills?* Access to facilities? Staff-student ratio? Quality of Staff?	Interviews Focus groups	Academia Alumni
Assessment of competency			
1	*How are student assessed for competencies at your institution?* How is competence demonstrated?	Interviews	Academia industry
2	*How competent are Tanzanian graduate engineers?* What is considered competent? How is it assessed?	Interviews Focus groups	Academia Alumni industry
3	*How do institution ensure quality of their graduates?*	Interviews	Academia
Staff			
1	*What competencies are important for engineers in the 21st century or global engineers?* Identify, rank, explain Can you rank then in order of importance? (if the questionnaire is used) Why did you rank them that way? Explain in your understanding or scenarios.	Interviews Focus group	Academia Alumni industry

2	*Is there Staff development or training at your institution* In teaching and learning (pedagogy), in curriculum development, others.	Interviews	Academia
3	What are the dominant and most preferred teaching practices and why? Traditional chalk and talk? SCL?	Interviews	Academia
Link with the Industry			
1	*What is your view of the industry involvement in Engineering Education? Is it enough? Or could they do more?* Attachments? Apprenticeship? How does learning through industry occur? How valuable is it to engineering education?	Interviews	Academia Industry

Theme 2: Local and International Accreditation systems

	Case Study Questions	**Sources of Data**	**Comments**
Local Accreditation			
1	*What are the existing systems of accreditation?* What are their aims and significance to engineering education accreditation?	Literature Documentary Interviews	Regulatory Academia
2	*Who is in charge of accreditation?* Where do they operate?	Literature Documentary	Regulatory Academia
3	*How important (or otherwise) is accreditation to engineering education?*	Interviews	Regulatory Academia
4	*How is it related to development of international engineers?* Global competencies described?	Documentary evidence	Regulatory Academia
International Accreditation- Applicability/ Accessibility/ appropriateness			

1.	*What are the existing international Accreditation systems that you are aware of?* Countries that are participating	Interview Documentary	Regulatory Academia
2.	*In your opinion, How relevant are the existing International systems to the existing systems of accreditation in Tanzania?* How successful have they been? Regionally? Globally? In the African context (Tanzania)?	Interview	Regulatory Academia
3	*How accessible are they by other countries?* Cost, Procedures, ways of access	Interviews	Regulatory Academia

Theme 3: Professional body involvement

	Case Study Questions	Sources of Data	Comments
Accreditation and Quality of education			
1.	*What is the involvement of engineering professional body/bodies in accreditation of engineering education?* Who accredit? What is the procedure?	Interview Documentary	Regulatory Academia
Curriculum and Learning			
2.	*What is the involvement of engineering professional body/bodies in engineering education?* Curriculum development, Pedagogy.	Interview Documentary	Regulatory Academia

Theme 4: Collaboration

	Case Study Questions	Sources of Data	Comments
Sub regional			
1	*What sub-regional collaboration is Tanzania part of?*	Documentary Interviews	Academia Regulatory Websites

	In engineering education? In higher education? Institutional or departmental collaborations? Professional?		
Regional			
1	*What regional collaboration in engineering education is Tanzania part of?* In engineering education? In higher education? Institutional or departmental collaborations? Professional?	Documentary Interviews	Academia Regulatory Websites
International			
1	*What international collaboration in engineering education is Tanzania part of?* In engineering education? In higher education? Institutional or departmental collaborations? Professional?	Documentary Interviews	Academia Regulatory

Theme 5: Relevance to Industry

	Case Study Questions	Sources of Data	Comments
Competencies for graduate engineers			
1	*What are the most important competencies for the African Engineer?* What are the current local and international professional skills and attributes required to work in the current industry? Rank them? Mention them and why?	Mini Survey Focus groups Interviews	Professional bodies Alumni Industry experts
2	*What are the particular requirements for engineering company?* (industry requirements- labour market)	Documentary Archival Interviews	Websites Literature, Company policies, records Industry
Skills demonstration			
1.	*How do you know that an engineer possess required professional skills?* How does one demonstrate local or global competence?	Interviews	Industry Academia

2.	*What type of engineers are you looking for?* When you employ people? What are the criteria for selecting a suitable engineer?	Interviews	Industry experts
Skills development			
1	*How do student engineers learn international skills?* Formal? Informal?	Interviews Focus groups	Academia Alumni
2	*Where do they learn international skills or gain international competencies?* At university? Outside university? Time?	Interviews Focus groups	Academia Alumni
3	*Why should Global skills be embedded (or enhanced) in curriculum and delivery?? How can Global skills be embedded*	Interviews	Academia Industry
Skill Assessment			
1	How competent do you perceive engineering students are today to work in the global market and why do you perceive this?	Interviews	Academia Industry

Theme 6: Tracer Studies

	Case Study Questions	Sources of Data	Comments
Tracer Studies			
1	*What are Tracer Studies? (if they apply to you)* What are they used for? When are they used? Who conducts them? What information do they collect?	Documentary Interviews	Tracer study reports Academia and regulatory
2	*Apart from tracer studies, are there any other method you use to collect feedback from the industry/employers?*	Interviews	Academia
Feedback into curriculum			
1	*How is the feedback from Tracer Studies or another method incorporated into the curriculum?* Competence-based? Content-based? What is the procedure?	Documentary evidence: Interviews	Tracer study reports Academia and regulatory

Appendix C: Participant information sheet

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16 June 2014

Research topic: Preparation of Internationally Recognised Professional Engineers

Participant Information Sheet

The research aims to develop a procedure for designing an engineering program to produce a graduate who can demonstrate competencies for a global industry. It is envisaged that the procedure could be used in any other region in the world to design a program appropriate for that region.

Why is this study Important? Globalization has created a great demand for engineers who can work beyond their country borders. This study will put together graduate engineer competencies that are internationally recognised and a procedure for training those competencies to students from different backgrounds and learning environments in the world.

How will this study be done? This study will be done through analysis of documentary evidence and interviews. Your participation will be in the interviews. The interviewer will explore your perspectives on:

i) competencies of engineers and how they can be demonstrated,
ii) engineering accreditation in shaping engineering education
iii) the learning environments and experiences of engineers around the world
iv) the role of higher institutions, professional bodies and industry in developing engineers

Are there any risks and inconveniences involved? There will be no risks or hazards associated with this study and the only inconveniences are volunteering your time for the interview.

Is your anonymity protected and can you withdraw from the study? All data are anonymous and therefore you will not be identified either during the research or after publications. You are free at any time to withdraw consent to further participation without prejudice in any way.

What happens to the data? You will hold the permission for the data to be used in the study and you can withdraw the data within at least four weeks of the interview. The results will be presented in the thesis and other publications related to this study. A summary of the results will be sent to you. With your permission some extracts of your interview may be quoted in the thesis and any subsequent publication.

This study has been approved under Curtin University's process for lower-risk Studies (Approval Number **ENG-40-14**). This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21).
For further information on this study contact the researchers named above or the Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au

If you would like to find out more about this project or have any concerns, please do not hesitate to contact the researcher through her email address e.matemba@student.curtin.edu.au or mobile number +61 422055725.

Kind Regards

Esther Matemba

Appendix D: Consent Form

Curtin University

Consent to Participate

Research topic: Preparation of Internationally Recognised Professional Engineers

The aim and nature of the study has been explained to me through information sheet and I understand that:

1. I am participating voluntarily
2. I give my permission to be interviewed with the knowledge that I do not have to give answers to each and every question.
3. I am also aware that I can withdraw from the study at any time without giving explanation
4. I also understand that I hold the permission for the data to be used in the study and I can withdraw the data within at least four weeks of the interview and the data will be deleted
5. I understand that some extracts of my interview may be quoted in the thesis and any subsequent publication with my permission. (Please tick one box below)
   - ☐ I agree to quoting extracts from my interview
   - ☐ I do not agree to quoting extracts from my interview

By Signing this concept form I certify that I __________________________________, agree that I will be willing to participate in this study.

______________________ _________________

Signature Date

Appendix E: Interview Participants Profiles at the time of interviews (2016)

Participant	Type	Position descriptions relevant to the research
Interview 1	Academia	A Senior lecturer and the Head of an engineering Department at one of the oldest public institutions. Has worked collaboratively with other academics from Africa (Kenya and South Africa) and together they have co-authored some work on engineering education.
Interview 2	Industry	A registered as a Consultant Engineer and founder of a consulting company, which he established in 2008 (8 years by the time of the interview-2016). He has 19 years' experience involved in various construction industry's activities, ranging from consultants in terms of design; analysis, design, and construction supervision, up to the construction in terms of construction and the measurement, the skills. He claims that his company started with only three engineers, and at the time of interview (2016) there were about nine engineers (seven fully in the design office, and two supervising engineer on the construction site as a resident engineer).
Interview 3	Regulatory	High position in Engineering Registration Board (ERB) who has authored more than 30 technical papers. The participant is also a professor who lecturers Project Management courses at one of the large public institutions, where they have held various Departmental and college administrative positions.
Interview 4	Academia	Senior lecturer, Acting head of Department, Civil Engineering Department at a public institution in Dar es salaam. Interview 4 participant did not enter academia right away but got into teaching after attaining his PhD in Sweden (academic industry habitus). Before pursuing his PhD, he worked in the industry and currently he is also a consulting engineer and a founding member of a consulting company called CPI international. He has about 10 years' experience after graduation, with less than 5 years working as an academia in Tanzania.
Interview 5	Industry	Registered Professional Engineer (Civil), an Entrepreneur, and a Co-founder/Owner and Managing Director of a construction company. He is graduated from the one of the major public institutions in Tanzania in 2007 (9 years at the time of interview), and has never been employed. He started dreaming and planning of having his own company since he was in third year of his degree,

		in 2006, and realized his dream (started the company) in 2007 (after he graduated). His young company employs graduate engineers, who he claims to train himself.
Interview 6	Regulatory	An accreditation officer at the Tanzania Commission of Universities (TCU) where he coordinates review of curriculum process for the purposes of validation and approval of the curriculum from all University Institutions in Tanzania.
Interview 7	Industry	A Structural engineer, and a registered Consulting engineer with 25 years of experience in the industry at different capacities in the public sector including head of Materials and Research and chief engineer for the Central Materials Factory and highway design engineer for Tanzania National Roads Agency (TANROADS) and others. He also lectures part-time at one of the oldest private institution as well as one public institution. He is also an author of some books in highway (transportation) engineering and also a book explaining the reason behind technological backwardness in Africa. He is an advocates for technical education.
Interview 8	Academia	Associate Professor at Department of Mechanical and Industrial Engineering at a public institution in Dar es salaam. Interview 8 participant is involved with the National Council for Technical Education as technical expert, evaluating different tertiary institutions, and as a chairperson for the same unit. He is has interest in engineering education and is involved in some regional initiatives in improving engineering education. While he understands that at the Tanzanian university education has kept its feet on the knowledge-based education, he is keen to find the advantages of competence-based here against knowledge-based and why do we have a good number of graduates which did not have skills which are responsive to the market. He has also written and presented some papers with a focus on university-industry relationships in local conferences.
Interview 9	Industry	An experienced Consulting Engineer and a part owner of the consulting company, with MSc. in Engineering Management from a local university. 30 years' wide industry experience as an engineer in various areas including research engineer, oil industry, designing and management. Within that experience he worked as a private contractor for about 10 years and now a consultant for 15 years. Prior to his degree in engineering, he already had 10 years' experience as a technician. He is also a part-time lecturer at a local public institution for 6 years –in a course about Professionalism and Ethics.
Interview 10	Academia	Associate Professor and holding a high administrative positioning an engineering college at a public institution, at the time of interview 2016, hence in position to explain engineering training from an administrative view. He is currently retired from University of Dar es salaam (since 2018).

Interview 11	Industry	A PhD holder and an independent Consulting Engineer running his own practice in Tanzania in the areas of Construction Management notably in Training and serving as an Arbitrator and Adjudicator for International Federation of Consulting Engineers (FIDIC). A Fellow and a Professional Engineer of American Society of Civil Engineers (ASCE), and a Chartered Engineer on Fellow of Institute of Engineers UK and a country representative for the Institute of Civil Engineers. Involved in academia as researcher, teaching part time, and as an external examiner at two public institutions. Among the first batch of graduates of engineering at the University of Dar es salaam in 1977 (over 40 years of practice in engineering).
Interview 12	Academia	A female assistant lecturer at a public institution, who was also pursuing a PhD in water resources engineering during the time of interview (2016) At 9 years' experience since graduating her engineering degree, Interview 12 participant, a civil engineer by profession, is also a Registered Consulting Engineer, who has worked in the industry for a large international company based in the UK, before embarking in a career in academic for about a year prior to in 2016. She has also had an opportunity to work with local companies.
Interview 13	Academia	Female early career academic – Assistant Lecturer – with less than 10 years' experience teaching, supervising, dissertations, and also marking examinations – setting and marking, and also invigilation of examination in a small public university situated in Dar es salaam..
Interview 14	Academia	A Professor with 16 years' experience in academia at one of the oldest public Universities in Botswana. He lecturing in bachelor degrees in civil engineering and construction management. Interview 14 participant has been involved in the curriculum development, for revision, mainly, and development, and was also involved in revisions of the Bachelors of Civil Engineering, and also Construction Engineering, with a view of seeking accreditation.
Interview 15	Academia	Associate Professor (female), and Dean of an engineering faculty in one of the oldest public Universities in Malawi. An academic experience of 18 years, among which she was a dean of engineering for 2 terms. She is involved in the education circles as a dean, is in development of programs including restructuring programs She has links with industry including holding a position in the engineering professional body.

The descriptions are mostly derived from participants own account in the interviews and confirming with their available/published Bios

Appendix F: Participants Questionnaire- Skills ranking

Questionnaire (to be filled by participants)

Participant information (anonymous)

Years of experience _____________

Type of engineering (Circle)

- Mechanical
- Civil
- Electrical
- Other(Specify) __________________

Employer:

- Government
- Private
- Self-employed

Professional Skills Ranking:

How will you rank these 10 professional skills in order of importance for Tanzanian graduate engineers? (1-10)

Skill	Rank
Analytical and problem solving skills	
Research Skills	
Creative and innovative thinking	
Lifelong learning	
Critical thinking	
Ethics	
Teamwork	
Communications (oral, written, graphical, strategy, negotiation conflict resolution)	
Communication in foreign languages	
Entrepreneurship	

Other ________________________________

Appendix G: Invitation to focus groups

Invitation to Focus Group on Engineering Training Experience in relation to your engineering role

Are you an Engineer who has obtained their first degree in Tanzania? Would you like to be involved in discussions on engineering degree experience? If your answers are yes to the above question, this invitation may be of interest to you:

I am conducting 2 focus groups on the 27th September 2016 to explore learning experience during your tertiary training and after graduation in relation to your current role as an engineer. The focus groups are part of my PhD research on "**Appropriate preparation of Internationally Recognised Professional Engineers**", which *aims to develop a procedure for designing an engineering program that will produce a graduate who can demonstrate competencies for a global industry.*

Focus group 1	Focus group 2
Date: Wednesday, 27th September 2016	**Date: Wednesday, 27th September 2016**
Time: 5:30 pm - 7.00pm	**Time: 7pm - 8.30pm**
Venue: Tamari hotel, Mwenge.	**Venue: Tamari hotel, Mwenge.**

These sessions will take approximately one hour each, and may contain up to 9 other participants (10 in total). As I really value your commitment and your input in this study, refreshments and 30,000Tshs fuel token will be provided to each participant as 'a thank you' for your time and contribution.

If you are interested, please register your interest through my email: e.matemba@student.curtin.edu.au by 25th September 2016 or text 0717 672 572 with your name, Graduation Year, Name of University graduated, government or private employer, current position.

I thank you in advance for your willingness and effort to participate.

Kind Regards,

Esther Elly Matemba

PhD student, Curtin University, Perth

Appendix H: Tanzania National Qualification Framework

TABLE 3: EDUCATION CLUSTERS

Basic Education and Training Levels				Advanced Education and Training Level	Higher Education and Training Levels				
NQF Level 1	NQF Level 2	NQF Level 3	NQF Level 4	NQF Level 5	NQF Level 6	NQF Level 7	NQF Level 8	NQF Level 9	NQF Level 10
Certificate of Primary Education	National Vocational Certificate I	National Vocational Certificate II	Certificate of Secondary Education, Basic Technician Certificate (NTA Level 4), National Vocational Certificate III, Professional Technician Level I Certificate	Advanced Certificate of Secondary Education, Technician Certificate (NTA Level 5) Professional Technician Level II Certificate, Post NQF Level 4 Certificate	Ordinary Diploma (NTA Level 6), Academic Ordinary Diploma, Academic Post NQF Level 5 Certificate, Professional Level I Certificate	Higher Diploma, Higher Certificate or Professional Level II Certificate	Academic Bachelor Degree, or Bachelor Degree in (Specified Area of Technical Education or Profession), Professional Level III Certificate	Academic Masters Degree, Academic Postgraduate Diploma, Academic Postgraduate Certificate or Master Degree in (Specified Area of Technical Education or Profession), Postgraduate Diploma in (Specified Area of Technical Education or Profession) and Professional Level IV Certificate	Academic Doctorate Degree or Doctorate Degree in (Specified Area of Technical Education or Profession)

Appendix I: Profiles of Higher Education Institutions Involved in the Research Study

Table A1 Profiles of Higher Education Institutions Involved in the Research Study

	Institution, acronym and description	Fully Registered by TCU	Public/private (started engineering bachelor degree)	Institution Enrolment per year 2017/2018	Engineering graduate output 1997 -2017
1	**The University of Dar es Salaam (UDSM)** UDSM started in 1961 as a College of the University of London. In 1963 it became a Constituent College of the University of East Africa, then in August 1970, established as a National University, through the University of Dar es Salaam. The University started offering engineering programs through its Faculty of Engineering (FoE) established in 1973, later the College of Engineering and Technology (CoET) in 2005. Source: UDSM (https://www.udsm.ac.tz)	Yes	Public (1973)	9068	42.5%
2	**Ardhi University (ARU)** ARU is an architectural university originated from a University of Dar es salaam (UDSM) Affiliated college, the University College of Lands and Architectural Studies (UCLAS) established in 1996. ARU was Established as a university in march 2007.	Yes	Public (2013)	1125	3.5%

	ARU that started offering a Civil Engineering bachelor degree since 2013, - Bachelor of Science in Civil Engineering (B.Sc. CE) although they had been offering environmental engineering prior to that (Interview 4, 2016). Source: ARU (http://www.aru.ac.tz))				
3	**St. Joseph University in Tanzania (SJUIT)** St. Joseph University in Tanzania (SJUIT) is a Private University owned and run by the Daughters of Mary Immaculate (DMI) founded in 1984 in a remote village in India, by the current university Founder/Chairman and Chancellor Rev. Fr. Dr. J. E. Arul Raj. SJUIT offers engineering education through one of its three campus colleges called St. Joseph College of engineering education. All three are in Dar es salaam. Source: SJUIT (https://www.sjuit.ac.tz/)	Yes	Private (2011)	Not informed (But 1600s in 2016)	13.7%
4	**Dar es Salaam Institute of Technology (DIT)** DIT was established by an Act of Parliament No.6 of 1997 as a high technical training institution in Tanzania. Historically, DIT was established in 1997 to replace the Dar es Salaam Technical College, and started offering engineering bachelor degrees right away. Source: DIT (https://www.dit.ac.tz)	Yes	Public (1997)	641	23.5%)

5	**Dar es Salaam Maritime institute (DMI)** DMI is a higher learning institution under the supervision of the Ministry responsible for maritime affairs in the United Republic of Tanzania. DMI was formed by cabinet Resolution on 3rd July 1978 and started as a Project under the supervision of the Norwegian Agency for Development Cooperation (NORAD) for the purpose of training employees of the National Shipping Company (TACOSHILI). At that time it was operating under the name Dar es Salaam Maritime Training Unit (DMTU). DMTU acquired the name DMI after its establishment by the Act of Parliament No. 22 of 1991 to cater for greater needs of shipping industry. In 2003, DMI started to offer seafarers education and training in accordance with acceptable international standards -STCW Convention of the International Maritime Organisation (The so called IMO White List). DMI started to offer seafarers education and training at the level of Chief Engineer/Second Engineer and Master/Chief Mate officer's Courses in 2007. Source: DMI (https://www.dmi.ac.tz)	No	Public (2007)	28	Not reported

Other sources: TCU (2020) *List of Approved University Institutions in Tanzania as of 31st January, 2020* and TCU (2018) *Higher Education Institutions Students Admission, Enrolment and Graduation Statistics, both* available in TCU website http://www.tcu.go.tz