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When traditional information technology project managers encounter the cloud: Opportunities and dilemmas in the transition to cloud services

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Abstract

Cloud computing is an evolving technology in the IT industry that has rapidly changed the conventional way information technology (IT) products and services are delivered. This study aims to identify the opportunities and dilemmas IT project managers are encountering in managing cloud projects, and to develop a system dynamics model to capture the complexity of cloud adoption. A questionnaire survey was conducted among IT project managers and data were analyzed via T-Tests, ANOVA, and principal component analysis. The identified opportunities and dilemmas in adopting cloud services formed the elements in the system dynamics model. Findings revealed incorporating cloud services in IT projects could shorten project timeline, optimize project scope, and reduce project cost. However, project managers also expressed concern about data privacy, security, IT governance, and local regulation when moving services to the cloud. Incorporation of proper change management plan and detailed risk management plan are required to identify the privacy and regulatory concerns and the project managers should enhance their social and cultural management skills.

Keywords: Cloud project, IT Project Manager, Opportunities and Dilemmas, System dynamics

Highlights:

- Examination of IT project manager perceptions of cloud computing
- Key opportunities and dilemmas identified and variables used in causal loop diagrams
- More experienced IT project managers see opportunities and dilemmas differently
- Key dilemmas require risk management and interpersonal skills to manage effectively

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1.0 Introduction

Information Technology (IT) project management is a type of project management where IT projects are planned, executed, monitored, and controlled by a project team (Hsu et al., 2014). Compared to other types of projects (e.g., construction and manufacturing projects), IT projects are normally short-term and with greater uncertainty. IT projects also have a higher failure rate due to the unique technological challenges relating to hardware and software misconfiguration, network failure, security risks, or interoperability issues (Weingartner et al., 2015). General project management challenges including deadlines, budget constraints and resource constraint also contribute to the potential failure causes in IT projects. Recently, cloud computing influences how IT is implemented; thus, cloud services are becoming the dominant IT service delivery model in this decade (Zhang et al., 2010) and this has significant impact on how IT projects are managed.

Cloud computing was defined by the National Institute of Standards and Technology (NIST) as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources including networks, servers, storage, applications, and services that could be rapidly provisioned and released with minimal management effort or service provider interaction. Cloud services have altered the definition of products in traditional IT projects, where hardware and software packages are delivered to customers. Instead, the products in cloud services consist only of various services instead of physical hardware and software and this forces a role change for the IT project managers involved. Cloud projects are challenging because of their dynamic nature (Walterbusch et al., 2013). IT project management is complicated as it involves the transitioning of business needs and demanding stakeholders to workable solution. However, while these challenges present dilemmas to the IT project managers, the change to provision of cloud services also affords many new opportunities to organizations and managers (Gupta et al., 2013).

This research is important because the change in technology to cloud projects forces re-consideration of strategy, information systems policy, and organizational requirements (Marston et al., 2011), all of which need to be carefully evaluated by the IT project managers. While the social and cultural determinants of traditional IT project success are well understood, cloud projects have changed the project management method in software development and infrastructure implementation projects. Despite this, many IT project managers have only been equipped with general skills to manage IT projects (Muhic & Johansson, 2014) and may be missing skills vital to manage the transition to cloud projects. Risks in cloud computing projects that the managers

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may need to work with include tool immaturity, unavailability of skills, increased engineering costs, and compliance issues. In addition, the growing volume of cloud services has led Gartner to predict that by 2016, most new IT spending will be on cloud computing (Gartner, 2013). This strong growth and dominance in spend provides further motivation to understand the impact of cloud computing on IT project managers. Therefore, the aim of this research is to identify the opportunities and dilemmas that exist in managing cloud projects, establish how different IT project managers perceive these differently, and to develop a system dynamics model to simulate the complexity of cloud adoption.

The rest of the paper is structured as follows. First, we provide an overview of the project management challenges inherent during the shift towards cloud-based services. We then outline our research questions and aims to determine how these opportunities and dilemmas are perceived and then discuss the survey and modelling methodology that we used to address these. We present the results of the analysis and the developed causal loop diagram (CLD) and model based on the survey data, presenting social and cultural management skills as the key challenges facing IT project managers. We discuss our findings and show agreement with past literature but also highlight key opportunities and factors that experienced IT project managers can leverage as they shift towards the cloud and highlight now emerging IT project managers should augment their skills.

2.0 Related Literature

2.1 IT Project Management Evolving to Cloud

The rapid changes towards cloud computing has changed the roles and responsibilities of IT project managers. Traditionally, the three important elements in IT projects were people, process, and technology; these needed to be defined, balanced and integrated to optimize the project performance (Liu, 2010). However, the trend of moving to cloud services changed the role of IT project managers from technical support to new skills such as proper contracts management, strategic IT investments, ensuring efficient alignment between the legacy application and cloud services, acquiring expertise for IT resource planning, governing new development in data privacy and security, and managing compliance issues (Smith et al., 2011). Project managers play an important role in monitoring and controlling the deployment phases in an IT project life cycle. They must manage and address issues relating to project performance – especially meeting time-based criteria (Agarwal & Rathod, 2006) – and also reduce the social and cultural elements that lead to instability in projects (Liu et al., 2011). Such measures of success may also depend on whether the IT project manager is working with an external client, in which case client satisfaction is crucial (Savolainen et al., 2012). Key measures of success (e.g., cost overruns and adherence to time-based criteria) can be adversely impacted by requirements changes, which are therefore a key risk that must be managed (Fu et al., 2012).

In the IT industry, project managers are classified into two types who manage projects differently: technical project managers and functional project managers. Technical project managers are responsible for technical elements such as assessing technical risks, solving technical problems, and communicating to non-technical audiences. Technical project managers are normally consider as IT professionals. In contrast, a functional project manager is responsible for non-technical elements of the project; e.g., time and cost planning, requirements gathering, and usability testing. The IT project lifecycle includes multiple phases; e.g., initiation, planning, executing, monitoring, controlling, and closure (Pitsis et al., 2014). IT projects are short and have high levels of uncertainty so that managing risk is always a central problem regardless whether the project is outsourced or in-house (Liu & Wang, 2014).

2.2 Traditional Services vs. Cloud Services in IT Projects

Traditional IT services always refer to outright ownership and locally provisioned hardware and software. When the capacity of the server is exceeded, additional hardware must be added to the physical equipment. The traditional server model has been used for decades because it was simple to implement, deploy, and was owned by the customer. However, the traditional approach has limitations in scalability and agility to accommodate the increasing server workloads. Proper knowledge and experience were required for the IT personnel to maintain and operate the servers at certain locations (Weingartner et al., 2015) and new skills and empowerment of staff is related to their ability to deploy the agile methods (Sheffield & Lemétayer, 2013) that are becoming increasingly important to accommodate many and rapid changes. Cloud computing can accommodate a range of payment types including metered service, pay-per-use, remotely provisioned, and tenant-based subscription. Servers run in a virtualized environment with shared resources in a data center managed by the cloud service provider. The customer does not own the servers but rather subscribes to the services and the provisioning of the servers are conducted remotely via the internet. With the subscription of cloud services, the daily operation and maintenance tasks can be offloaded to the cloud service provider. The support and maintenance from the provider is based on the service level agreement (SLA) agreed to during the subscription (Gupta et al., 2013). Cloud computing provides flexibility and scalability to customers. New virtual servers or services can be purchased on a pay-per-use basis and paid for based on the actual usage. The operation and maintenance costs are reduced and offloaded to the service provider; thus, increasingly corporate computing is shifting away from a traditional model to cloud computing model by increasing the abstraction and encapsulation guaranteed by the cloud services (Cioca & Ivascu, 2014).

NIST identified five essential characteristics of cloud computing: on-demand service, broad network access, resource pooling, rapid elasticity, and measured service. There are three common service models for cloud services. First, software as a service (SaaS) - applications are delivered as a service to end users over the Internet. SaaS allowed users to run existing online applications. Examples of SaaS providers are Microsoft Office 365, Salesforce, and Google Apps. Second, platform as a service (PaaS) - application development and deployment platform is delivered as a service. PaaS allowed users to create their own cloud applications using existing tools and script languages. Examples of PaaS providers are Windows Azure, Force.com, and Google App Engine, Apache Stratos. Third, infrastructure as a service (IaaS) - server, storage, and network capacity with associated software are delivered as a service. IaaS allows users to run all types of applications on selected cloud hardware. Examples of IaaS include Amazon EC2, Windows Azure, and Rackspace (Brown, 2011).

2.3 Advantages and Disadvantages of Cloud Services

At the infrastructure level, enterprise administrators were evolving to data center operators and were focusing less on scoping the servers but more on maximizing utilization and agility through tools or single management consoles (Too & Weaver, 2014). Application developers were stepping away from traditional server deployment models and were adapting to horizontally scalable application roles. At the software level, system administrators were moving from hands-on duties to become application service managers with service level agreements (SLA) and vendor management as a primary responsibility. Figure 1 illustrates how the components evolved from traditional IT services to cloud services – cloud computing made a major change to the traditional IT services. There were queries and inherent challenges for the adoption of cloud; e.g., security concern, loss of control over cloud resources, and reliability. On the other hand, many benefits were identified; e.g., scalability and agility (Tsai & Hung, 2014).

<< Insert Figure 1 here >>

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Cloud computing lowers the cost of maintaining the IT infrastructure by offering pay-per-user model to customers. The dynamic provisioning of resources from a centralized management console reduces the hassle of the service provisioning exercise. Cloud computing provides instant access to resources with no upfront capital investments for users, leading to a faster time to market in many businesses. It also encourages the conversion from IT capital expense (CAPEX) to operational expense (OPEX). The upfront costs in corporate computing can be reduced with cloud computing and scalability is achieved in both services and resources. The computing resources are managed to centralize management console to deploy faster. The resources can be scaled up or down depending on the usage via the self-service portal without the interaction from service provider. The service provider promises reliable services through virtualized computer and storage technologies. A guaranteed high availability service level agreement (SLA) provided by the service provider ensures that services are running at all times (Buyya et al, 2009). The increasing availability and low cost of wireless technology has increased the use of mobile devices to communicate over existing physical conduit technologies.

However, the cloud also bring challenges to organizations; e.g., security has become the biggest concern when moving to cloud (Voas & Zhang, 2009). Unlike the traditional IT approach, where the IT department takes the full control on servers and systems in-housed, the performance and reliability on the services provided by cloud are hard to measure. Even if the service provider commits a high availability of their services under the SLA, it is hard to justify the reliability and performance. The standardization of cloud computing was unknown to subscribers. Customers have no physical access to the data center. Another challenge to cloud adoption is the content of local, national, and international regulations and policies. Data ownership, data privacy, audit issues, and data locations are the biggest concerns towards cloud. Cloud computing environments are shared tenancy environments. Data from different subscribers could be hosted on the same physical server in the same data center. The cloud servers therefore become a central point of vulnerability, where attackers could target the shared technology inside cloud computing environments. These factors mean that the IT project manager must place increasing importance on managing stakeholder expectations and their relationships and social and cultural expectations relating to the change. It is these human-focused skills that are regarded as the most important skills for project managers (El-Sabaa, 2001).

2.4 Hypothesis and research question

We hypothesize that the challenges and dilemmas relating to cloud services require more careful management of people and social and cultural elements within the organization – not technical elements. More experienced project managers will be better equipped to manage the transition. Therefore, we hypothesize:

H1: At least one group (of IT project managers) has a different rating for the opportunities and dilemmas in managing cloud projects.

This is closely related to the research question: what are the key opportunities and dilemmas in moving to cloud services in IT and how are these perceived by different groups of IT project managers?

3.0 Research Methods and Procedures

To address the research questions, a two-phase study was undertaken. First, a questionnaire was devised and submitted to IT project managers. Second, the results were analyzed and used to inform the development of models using system dynamics principles, to support managerial decision-making.

The questionnaire design was based on the literature review and expert opinions. The initial questionnaire was checked by the research team and other academic experts to ensure that the questions were comprehensible and easily understood, as this increases the validity of the responses (Salant & Dillman, 1994). The questionnaire was designed using closed-ended questions because the responses can be easily administered and analyzed. The questionnaire has four sections (see Appendix A). Section A was intended to capture the demographic information of the project managers; e.g., years' experience, phases and scale of projects they have been involved with, project constraints, project manager's role, and types of projects managed in the past five years. Section B was designed to determine the project managers' readiness regarding adopting cloud computing. Sections C and D are to identify opportunities and dilemmas in managing cloud projects.

The questionnaire survey required responses from experienced IT project managers. Therefore, we randomly selected 1000 IT project managers from major IT vendors (e.g., Cisco and SAP) and the Project Management Institute. Within this specific population of IT project managers, we applied a set of criteria to establish that respondents met particular criteria and we therefore requested that only respondents who were 'qualified' respond; respondents must meet the following criteria: a) They

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should be willing to participate, b) They should be from an IT background, c) They should be either technical or functional project managers, and d) They must have sufficient experience in managing IT projects. We received 117 returned questionnaires; however, two were incomplete and five respondents reported less than two years' experience and so these seven responses were discarded. This left us with 110 complete responses with sufficient experience that chose to participate and met these criteria from the 1000 questionnaires distributed, giving a responding rate of 11%. As we required the respondents to have extensive professional experience, we believed that this was a reasonable response rate.

Data were organized and processed via T-Tests, ANOVA, and factor analysis. Furthermore, system dynamics models were constructed with the relevant data collected from the questionnaire. The opportunities and dilemmas in adopting cloud services formed part of the elements in the system dynamics model, supported by the questionnaire responses and factors. Project managers' perspectives on the transition to cloud systems were represented in the structure of the dynamic processes in adopting cloud services. The relationship between cause and effect was reflected in the stock and flow and causal loop diagrams to explain the complexity of the dynamic behavior, depicted using CLDs created in Vensim. The interrelationships between multiple factors can be modelled using CLDs, particularly those 'soft' or behavioral factors that are difficult to simulate in stock and flow models. The CLDs allow managers to present a model of the system and understand which factors will provide more leverage in influencing the desired outcome, while accounting for system-wide impact of changes (Wolstenholme, 1990).

Table 1 presents the demographic information of the 110 respondents, including experiences, roles, types of projects, agreement on cloud adoption, and service models adopted in their respective companies. There were 77 technical project managers and 33 functional project managers. There are 32 (29%) respondents who have managed IT projects for less than 5 years, and 59 (54%) for 5 to 10 years and 19 (17%) respondents more than ten years in the IT industry.

<< Insert Table 1 here >>

4.0 Data Interpretation and Analysis

4.1 Inferential Analysis

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Technical and functional project managers provided different views on IT project's constraints. Besides time and cost, technical project managers stressed "business scope" as a major constraint in IT projects, while functional project managers stressed "business drivers". Independent T-Tests were used to analyze the data from Section B in the questionnaire. In total, six questions related to cloud adoption were used to test the respondents' current confidence level in managing cloud projects. The objective of this test was to understand whether project managers' readiness towards cloud projects differed based on their roles. The dependent variable represented the respondents' readiness in managing cloud projects. The independent variable was used to separate the cases into two groups, namely: technical project managers and functional project managers. The p value (2-tailed) at 0.025 in the first test in Table 2 determined the level of confidence indicating that majority of project managers were not ready in managing cloud projects, which was probably because their companies have not yet adopted cloud computing. This was evidenced by the p value (2-tailed) at 0.000 in the second test in Table 2 showing that project managers in those organizations already adopted cloud computing were ready in managing cloud projects. Table 3 ranked opportunities and dilemmas in managing cloud projects.

<< Insert Table 2 here >>

<< Insert Table 3 here >>

One-way analysis of variance (ANOVA) was conducted to determine whether there were significant differences among respondents' rating for opportunities and dilemmas in managing cloud projects according to their work experiences, thus addressing the research question to determine whether different groups of IT project managers perceive the opportunities and dilemmas differently.

We find that three groups of respondents' responses differed significantly on the opportunities coded as OP1, OP2, OP4, OP6, OP8, OP9, and dilemmas coded as D1, D2, D3, D4, D5, D6, D9 and D10 as presented in Table 4; thus, the null hypothesis was rejected. However, it did not show which specific group were different from another, which was indicated by the subsequent Tukey Post Hoc Multiple Comparison Test in Table 5. The overall F-values were significant. Specifically, project managers' views on D1 were significantly different between the groups with less than 5-years' experience and more than 5-years' experience. However, this kind of difference did not appear between the groups with less than and more than 10-years' experience.

<< Insert Table 4 here >>

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<< Insert Table 5 here >>

4.2. Factor Analysis

Factor analysis was used to identify the underlying structure in a data set by reducing the number of factors that explained most of the variances observed in the collected data. Factor analysis assumes that relationships between variables are due to the effects of underlying factors and that correlations are the result of variables sharing common causes. This technique allowed a simpler and clearer interpretation of the relationships among the data. Before conducting factor analysis, the Kaiser-Meyer-Olkin (KMO) test was used to measure the sampling adequacy and Bartlett Test of Sphericity was used to measure the presence of correlations (Table 6). The KMO values vary from 0 to 1. A value at 0 indicates diffusion in the pattern of correlations, which means the following tests would be inappropriate. A KMO value closer to 1 indicates the patterns of correlations were relatively compact and factor analysis could yield distinct and reliable factors. Kaiser (1974) recommended that a value greater than 0.5 is acceptable; values between 0.5 and 0.7 are good; values between 0.7 and 0.8 are great; and values above 0.8 are superb; in our case the KMO value of 0.681 was judged to be sufficient to continue analysis. Bartlett's test observed whether the population correlation matrix resembles an identity matrix, whereby every variable is perfectly correlated with others. Bartlett's test of sphericity, testing the overall significance of correlations in the correlation matrix, was significant (approx. χ^2 (45) = 286.632, p<0.000) indicating that it was appropriate to derive factors for the underlying opportunities and dilemmas in this model.

In Table 6, each component was set according to a series of correlations between different opportunities and dilemmas faced by project managers. The column labeled as "Initial Eigenvalues" relates to Eigen value of the correlation matrix. To carry out the factor analysis, only components with Eigen values greater than 1 were selected. The Eigen values indicate the amount of total variances accounted for.

Table 6: Principal Component Analysis on Total Variance in Analyzing Opportunities and Dilemmas

Opportunities	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
OP1	3.316	33.159	33.159	3.316	33.159	33.159	2.745	27.450	27.450
OP2	1.344	13.443	46.601	1.344	13.443	46.601	1.638	16.377	43.827
OP3	1.213	12.127	58.729	1.213	12.127	58.729	1.490	14.902	58.729
OP4	.937	9.368	68.097						
OP5	.835	8.346	76.442						
OP6	.753	7.534	83.977						
OP7	.561	5.612	89.589						
OP8	.483	4.829	94.418						
OP9	.330	3.304	97.722						
OP10	.228	2.278	100.000						
Dilemmas	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
D1	2.851	28.512	28.512	2.851	28.512	28.512	2.749	27.491	27.491
D2	2.171	21.705	50.217	2.171	21.705	50.217	2.152	21.520	49.011
D3	1.234	12.341	62.558	1.234	12.341	62.558	1.355	13.547	62.558
D4	.936	9.361	71.919						
D5	.844	8.443	80.362						
D6	.569	5.688	86.051						
D7	.437	4.371	90.422						
D8	.376	3.760	94.182						
D9	.319	3.189	97.371						
D10	.263	2.629	100.000						

The initial and rotated Eigen values were used to confirm the variation explained by each extract component. Lower values mean there is a lower contribution to the explanation of the variance in the set of the survey attributes. For example, the initial Eigen value at 3.316 for OP1 indicates that the proportion of the total test variance accounted for by the first factor OP1 was 27.45%. In this study, only three components carried Eigen values bigger than 1 and, as shown in the cumulative % column, these three components (OP1, OP2, OP3) accounted for 58.73% of the whole variance. The initial Eigen value of the first factor in the dilemmas column was 2.851 and the proportion of the total test variance accounted by the first factor was 27.49%. Only three components (D1, D2, D3) carried Eigen values more than 1, which meant that these three components accounted for 62.56% of the total variance. The Scree plot shown in Figure 2 provides a graphical picture of the Eigen value for each component extracted. The slope of the scree was reducing, while moving towards components with Eigen values less than 1. The point of interest was defined between components 3 and 4, where the figure curve connected to the points and started to flatten out horizontally. In Figure 2, the place where a sharp change in angle was considered as the exact point that Eigen values of less than 1 were placed. On the sharp slope of curve, the Eigen values bigger than one were located, while in the flatten part of the curve, the Eigen values smaller than 1 were plotted.

<< Insert Figure 2 here >>

The extraction of rotated component matrix in Table 7 was conducted to identify which opportunities and dilemmas contributed the highest level of influence in managing cloud projects. This factor loading showed the comparative contribution that a variable made to a factor. We interpreted factor loadings with an absolute value greater than 0.4 (ignoring the +ve or –ve sign), which explained around 16% of the variance in the variable. The opportunity factor (OP8; 0.809) had greater influence on component 1 than other components. Whereas, the opportunity factor (OP5; 0.665) had the most influence on component 3. The dilemmas factor (D1; 0.835) had the greatest influence on component 1, and D4 (0.716) had the most influence on component 3. This was used to extract the most effective opportunities factor for each component.

Table 7: Rotated Component Matrix in Analyzing the Opportunities & Dilemmas

	Component			Dilemmas	Component		
Opportunities	1	2	3		1	2	3

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OP8	.809			D1	.835	-.017	-.002
OP6	.697			D2	.772	-.071	.320
OP9	.693		-.309	D3	.634	-.160	.097
OP1	.651	.332	.383	D4	.103	.039	.716
OP4	.593			D5	.716	.131	-.159
OP2	.533	.419	.321	D6	.724	.087	.129
OP3		.799		D7	-.018	.789	.151
OP10		.631		D8	-.050	.892	.039
OP7			.775	D9	.050	.820	-.067
OP5		.353	.665	D10	-.048	-.060	-.812
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 4 iterations							

4.3 System Dynamics in Managing Cloud Projects

System dynamics is an analytical modeling approach that extends beyond conventional systems to simulate a range of comprehensive and dynamic engineering and social problems. System dynamics interacts with various elements of a system and captures the dynamic aspect by incorporating concepts such as stock and flows, feedback, and delays into the dynamic behavior of a system over time. In this study, system dynamics models such as stock and flow diagrams (for a simple illustrative case) and causal loop diagrams were created to simulate the opportunities and dilemmas evaluating from managing traditional IT projects to managing cloud projects. The use of qualitative CLDs was important in this study as the relationships are complex, challenging, to structure and quantify (Wolstenholme, 1990), providing managers with leverage in moving a system towards the desired outcomes (Maani & Cavana, 2000).

4.3.1 Stock and Flow Diagram

Stock and flow diagrams consist of a combination of four different components: stocks, flows, converters, and connectors. The principle of accumulation was used in the diagram. Dynamic behaviors occur when flows accumulate in stocks. The flows influence stocks and vice versa. Stocks could influence flows or converters. The converters could influence flows or other converters. Figure 3 depicts the adoption rate to the cloud projects. Opportunities and dilemmas refer to the several variables in the model. The more opportunities for cloud projects, the higher adoption rate. From a project manager's perspective, opportunities could benefit the organization and could increase the willingness to move to cloud. The state of the system grows exponentially from its initial value when the opportunities are identified. Project managers are willing to adopt cloud services if the solution provide sufficient opportunities; as more projects shift to the cloud and more opportunities are identified, this

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behavior will increase the number of cloud projects. In contrast, dilemmas could decrease the cloud adoption and if there are more dilemmas, this could lead to a substantial decrease in the cloud projects undertaken.

<< Insert Figure 3 here >>

<< Insert Figure 4 here >>

4.3.2 Causal Loop Diagrams (CLD)

Project managers can turn to several tools to understand the impact (on the final outcome) of making changes to particular variables. Force-field analysis during brainstorming can be used to identify key factors that can be used to drive the desired outcomes or which reduce risk (Royer, 2000); as an approach, this fails to accommodate many factors and complexity. Influence diagrams capture more complexity and enable a causal connection between factors to be established (Armstrong, 2011), and information flows can be included (Charoenngam, 1993) and strength parameters can be estimated. This approach is largely linear but enables a user to comprehend how and what should be changed to influence the desired outcomes. Causal loop diagrams, an integral component of system dynamics analysis, are a third method. CLDs accommodate the complexity of relationships that can be presented in influence diagrams, but also go beyond the constraints of a linear relationship by explicitly acknowledging the importance of feedback in the relationship (e.g., both reinforcing and balancing effects); this can be particularly relevant in projects where social and inter-personal factors can be amplified and impact on project success (Liu et al., 2011.). The use of CLDs enables managers to better understand key inter-dependencies and behavioral connections between variables, enabling managers to make targeted improvements (Eden et al., 2000), by understanding how to implement control for the key variables while considering the system-wide impacts (Wolstenholme, 1990).

Causal loop diagrams (CLD) are a graphical method to show the interrelated factors and causal relationships between system elements. CLDs consist of factors and dynamic links connecting the factors; they are often used to provide insight into the mechanisms that contribute to problems in projects and allow a more holistic perspective on the problem (Love et al., 2010). The influence could be positive or negative. As shown in Figure 5, positive sign indicates that higher cause leads to higher effects or a lower cause leads to lower effects. In contrast, negative sign indicates that higher cause leads to lower effect or lower cause leads to higher effects.

<< Insert Figure 5 here >>

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When several arrows in the causal diagram return to one factor, it creates a loop. Since the relationship is dynamic, it provides feedback to the original factor forming a feedback loop. There are two kinds of feedback loops: positive feedback loops (reinforcing loops) and negative feedback loops (balancing loops). A positive feedback loop or reinforcing loop indicates a rapid growth at an ever-increasing rate. This is also referred to the exponential growth. A negative feedback loop or balancing loop indicates that the change will counteract the impact of the cause, creating a 'balancing' influence on the original cause and limiting the long-term change potential for that loop. If the current level of the interest variable of is above the goal, the loop structure will push its value down, while if the current level was below the goal, the loop structure pushed its value up. Figure 6 illustrates the relationships among the opportunities in managing cloud projects. In this diagram, the short descriptive phrases represent the elements that made up the factors and the arrows representing the causal influences. For instance, the opportunity "Shorten project timeline" was directly influenced by "Optimize project scope" and influences "Reduce project cost", creating a loop where changes to these variables encourage positive changes in the other variables. A positive feedback loop or reinforcing loop occurred among these opportunities in managing cloud projects.

<< Insert Figure 6 here >>

CLD present many complex relationships that are difficult to describe verbally, because normal language presents interrelations in linear cause-and-effect chains while the actual systems in CLD are circular cause-and-effect chains. Considering "Reduce project cost" as the opportunity, IT cost "Switching from CAPEX to OPEX" (i.e., from capital expenses to operational expenses) and "On demand resources" from cloud could influence the overall project costs. The relationship among these opportunities was shown to be significant. By leveraging the latest technology and best practices from cloud solutions, this could reduce project cost and optimize project scope. "Self-service portal" provided a centralized location for managing the services by reducing service provisioning hassle and thus optimizing project scope. In this scenario, a reinforcing loop was created. The nature and importance of this reinforcing loop indicates that managers should carefully work to shift organizational culture, as this has also been highlighted as important in adopting new approaches (Sheffield & Lemétayer, 2013).

A chain relationship was created where the self-service portal could simplify the system for cloud solutions and ultimately optimize the project scope. Cloud solutions can provide high availability service level agreements (SLA) by leveraging the

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latest technology and best practices with low risk. The causal loop also dictated that the lower the technology risk, the better system integration in the IT systems. A positive feedback loop occurred in the quality of the execution of the cloud solutions. No procurement process and pay-per-use model for cloud technology could ultimately shorten project timeline and reduce project cost. In contrast, as shown in Figure 7, project managers were in dilemma when dealing with the transition from managing traditional IT projects and managing cloud projects. These dilemmas are also aligned with existing research, which indicates the relative of importance of social and cultural barriers to implementation, rather than technical barriers (Sheffield & Lemétayer, 2013).

<< Insert Figure 7 here >>

While these loops are all reinforcing, essentially amplifying and increasing the motivation to move towards cloud services, there are a number of dilemmas that were identified in the questionnaire responses and these can be modelled in a similar manner. The top 3 dilemmas in managing cloud projects were “Forces of change”, “Transparency”, and “IT related gap”. These dilemmas created a causal loop relationship. Cloud computing requires significant changes in “System and application management”, “Change project delivery model”, “People skills and competencies”. “Transparency”, “Vision and strategy”, “Top management support”, “Job insecurity”, and “People skills and competencies” are the dilemmas that traditional project managers are going to encounter. The “IT related gap” proved the decrease in the adoption rate among IT project managers. A balancing loop appears in this relationship, indicating that even where these factors are changed, the relationships will act to limit the overall impact on the system. Limitations in the transparency of cloud infrastructure (e.g., system integrity, data locality, confidentiality and privacy, governance and security) leads to business concerns among project managers. IT project managers seeking to influence and modify their ability to successfully move to cloud services, should seek to influence the vision and strategy in the organization, and use this to influence top management support. Both these factors will change how the IT related gap is perceived, leading to a stronger motivation and force for change in the workplace. Meanwhile, the vision and strategy can also have a balancing impact on the job insecurity felt by staff; managed correctly, a carefully articulated vision for the change should not threaten staff job security and will therefore lead to improved outcomes and more willingness of staff to increase their skills to align themselves with the change. Working closely with a range of stakeholders to influence

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these factors and may be more easily accomplished by experienced IT project managers; the experience requirements to manage such social challenges may explain the difference in perception between the groups with different levels of experience.

5.0 Discussion on Findings

The questionnaire survey in this study revealed that the technical project managers ranked time, scope, and cost as the top three projects constraints, supported by Kutsch and Hall (2005). Nevertheless, Wateridge (1995) argued that functional project managers found that business drivers are more significant than the scope was supported by how the non-technical factors (e.g., managerial, organizational business drivers and cultural issues) played a crucial role in determining the success of a project.

Recently, the opportunities and dilemmas in adopting cloud computing became a major concern among IT project managers. Cloud computing offered a competitive advantage to an organization to save cost and time in making the IT services ready to cater the business needs. Moving to cloud could shorten the project implementation timeline, eliminate service provisioning hassle, simplify system and application management, reduce deployment cost, optimize project scope, and lower technology risk. The emerging cloud solutions could fulfilled most of the common requirements of IT projects such as agility and cost saving as stated by Dukaric and Juric (2013). However, there are related challenges. As argued by Avram (2014), implementing new technology should start from evaluating the economical processes of the organization. IT as an enabler in business processes should help improve the business efficiency and effectiveness but the increased technical complexity, difficulties in security, virtual team, and organizational instability could be the biggest challenges to the IT project management as supported by Sultan (2011). These also highlight the role that interpersonal conflict can have on project performance instability (Liu et al. 2011), part of which is captured in Figure 7.

In the transition moving to cloud, bridging the gap between process, people and technology is essential. The shifts from IT products to IT services have changed the nature of IT projects as supported by Sauer and Reich (2009). Our study supports findings from Vouk (2008) that cloud computing could change the way traditional IT services are invented, developed, deployed, scaled, and maintained with the pay-per-use model. While the contexts differ, we find that the managerial capability relating to managing people and social elements is important in effecting the desired change, similar to how the move to agile systems examined by Sheffield and Lemétayer (2013) requires a strong people-oriented skill-set. This suggests that more experienced IT project managers and those with robust inter-personal skills will be best-positioned to lead and manage the transition to cloud computing. In this way, managers can reduce the overall instability in projects that can be related to social and cultural elements as identified by Liu et al. (2011), with reference to the relationships depicted in the CLDs (Figures 6 and 7), as a guide towards understanding how to manage these dilemmas. However, even within the relationships identified in this research, we have not addressed the importance of various performance criteria, whether they are time-based (identified as crucial by Agarwal and Rathod (2006)) or whether this is related to work with external clients (c.f., Savolainen et al. (2012)).

For new and emerging IT project managers, these results suggest that their personal and social skills be carefully evaluated. While a strong technical background is still required, the survey results and the CLDs make a case that social and cultural management are perceived by experienced managers as being vital. In addition to developing these skills over time and with more experience, junior IT project managers may benefit from targeted training to enhance their capabilities in these areas, allowing them to more effectively move towards cloud IT project management.

6.0 Conclusions

The rapid evolution of technology in the IT industry and the rise of cloud computing applications is altering how IT products and services are delivered and managed. IT project managers encounter both opportunities and dilemmas to adopt cloud technologies. This study found that to incorporate cloud services in IT projects could shorten project timeline, optimize project scope, and reduce project cost. However, project managers are also concerned about data privacy, security, IT governance, and local regulation when moving to cloud. Bridging the gap is not easy. Moving to the cloud requires project managers to prioritize the services and to develop a transition plan with strategies in managing the co-existence period and backup plans in the event that system goes down or data is lost during the transfer process. To alter the dilemmas to opportunities in adopting cloud computing, incorporation of proper change management plan and detailed risk management plan are required to identify the privacy and regulatory concerns as well as those issues related to data locality, protection and replication. An adequate governance process to assess security of cloud technologies should be created to handle cloud related concerns. IT project managers should enhance their social management skills to influence key variables relating to top managers and the vision and strategies. Further studies should look into the return on investment (ROI) for cloud computing, with a particular focus on the measurement and monitoring of ROI, and also seek to understand the impact of time-based criteria for project success.

A key limitation of this study is the low response rate, possibly caused by the requirement that all respondents have extensive work experience. Future studies should focus on improving the response rate. Another limitation is that the companies that we sampled from tend to be the larger multi-national firms; respondents from smaller firms may have different perspectives, driven by different social, cultural, and organizational realities that they work within.

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Appendix A. SURVEY INSTRUMENT

Opportunities and dilemmas in managing cloud projects

Section A – General Information *required field

1. How many years have you worked in managing IT projects?*

○ Less than 5 years
○ 5 to 10 years
○ More than 10 years

2. A project has multiple phases (e.g. Initiation, Planning, Executing, Monitoring / Controlling and Closure). How many phases have you managed before?*

○ 1
○ 2
○ 3
○ 4
○ 5

3. What has been the time-scale of the longest running project that you have managed?*

○ Less than 3 months
○ 4 to 6 months
○ More than 6 months

4. What was the major source of constraints on your project?*

○ Time
○ Resources
○ Business drivers
○ Scope
○ Cost

5. Would you consider yourself more of a technical or functional project manager?*

○ Technical project manager
○ Functional project manager

6. What kind of projects that you have managed in the past five years?*

○ Business application development projects
○ Infrastructure deployment projects
○ Maintenance and Operations projects

Section B – Adoption of Cloud Computing *required field

1. Is your organization adopting cloud computing?*

○ Yes

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○ No

2. Which types of cloud offering is your organization currently using? (You may select more than one services)*

☐ Software as a Service; e.g. Microsoft Office 365, Salesforce, Google Apps, etc
☐ Platform as a Service; e.g. Windows Azure, Force.com, Google App Engine, Apache Stratos, etc
☐ Infrastructure as a Service; e.g. Amazon EC2, Windows Azure, Rackspace, etc
☐ None

3. Have you managed cloud computing related projects before?*

○ Yes
○ No

4. If yes (from question 3), how many cloud projects have you involved?

○ Less than 5
○ More than 5

5. How much confidence do you currently have in your knowledge of the cloud?

○ I am very familiar
○ I am familiar
○ I am just a beginner for cloud services
○ I am not familiar

6. If no (from question 3), are you interested in managing cloud project?

○ Yes
○ No

Section C – What are the opportunities in managing cloud projects?

*required field

(Please select Yes to agree to the statement and No to disagree to the statement)

1. Shorten project implementation timeline.*

○ Yes
○ No

2. Self-service portal can eliminate service provisioning hassle.*

○ Yes
○ No

3. No procurement process required.*
○ Yes
○ No

4. Simplify system and application management.*
○ Yes
○ No

5. Leverage the latest technology and best practices in the service offering.*
○ Yes
○ No

6. Cloud projects can reduce cost of deployment.*
○ Yes
○ No

7. Cloud offering can help organization subscribe to the required services.*
○ Yes
○ No

8. Cloud project can optimize project scope by performing standard off the shelf deployment.*
○ Yes
○ No

9. Lower technology risk with the certified configurations and less customization.*
○ Yes
○ No

10. High availability service level agreement.*
○ Yes
○ No

Section D – What are the dilemmas in managing cloud projects?

*required field

(Please select Yes to agree to the statement and No to disagree to the statement)

1. There is difference in managing traditional IT project and cloud project.*
○ Yes
○ No

2. The project delivery process for cloud project is simple and less complicated.*
○ Yes
○ No

3. Self-service and remote provisioning for cloud resources has changed the deployment steps for IT projects.*

○ Yes
○ No

4. Retraining and other skill enhancement initiatives are required for project managers and team members.*
○ Yes
○ No

5. Project manager to align the cloud project's vision and strategy.*
○ Yes
○ No

6. Project manager should be aware on the value of cloud computing.*
○ Yes
○ No

7. Loss of control rights to the data and resources storing on cloud server always the dilemma.*
○ Yes
○ No

8. Security and data privacy are the main concern for the project team.*
○ Yes
○ No

9. Change of governance and security policy could risk the project.*
○ Yes
○ No

10. When moving to cloud, will you afraid of losing job?*
○ Yes
○ No

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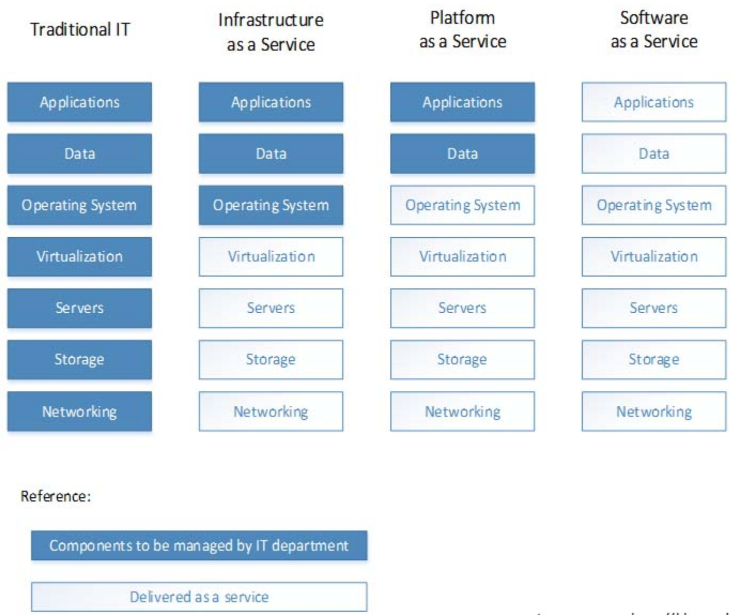

Figure 1: components evolved from traditional IT services to cloud services

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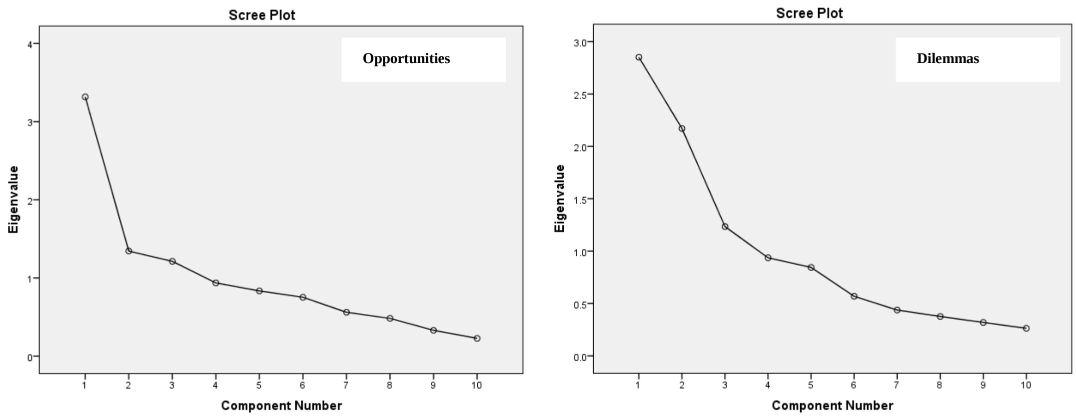

Figure 2: Scree Plot of Opportunities & Dilemmas in Managing Cloud Projects

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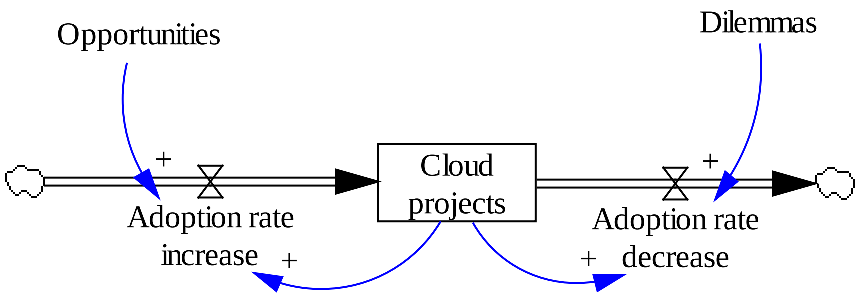

Figure 3: Stock and Flow Diagram

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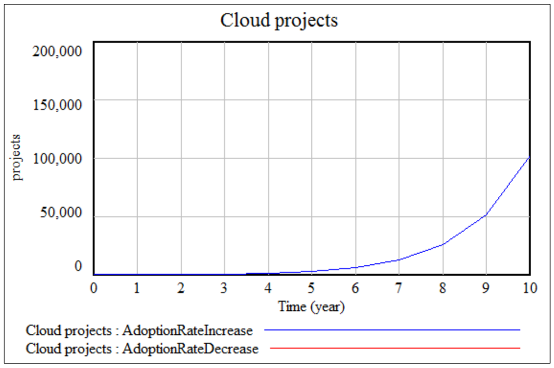

Figure 4: Cloud Adoption Rate

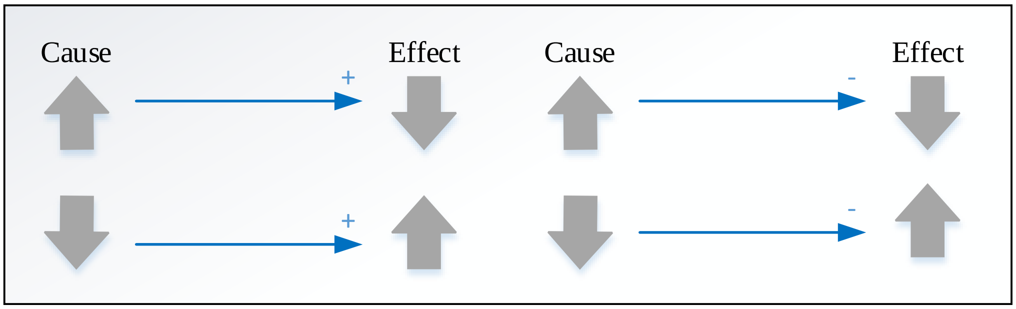

Figure 5: Sign of Arrow Head in CLD

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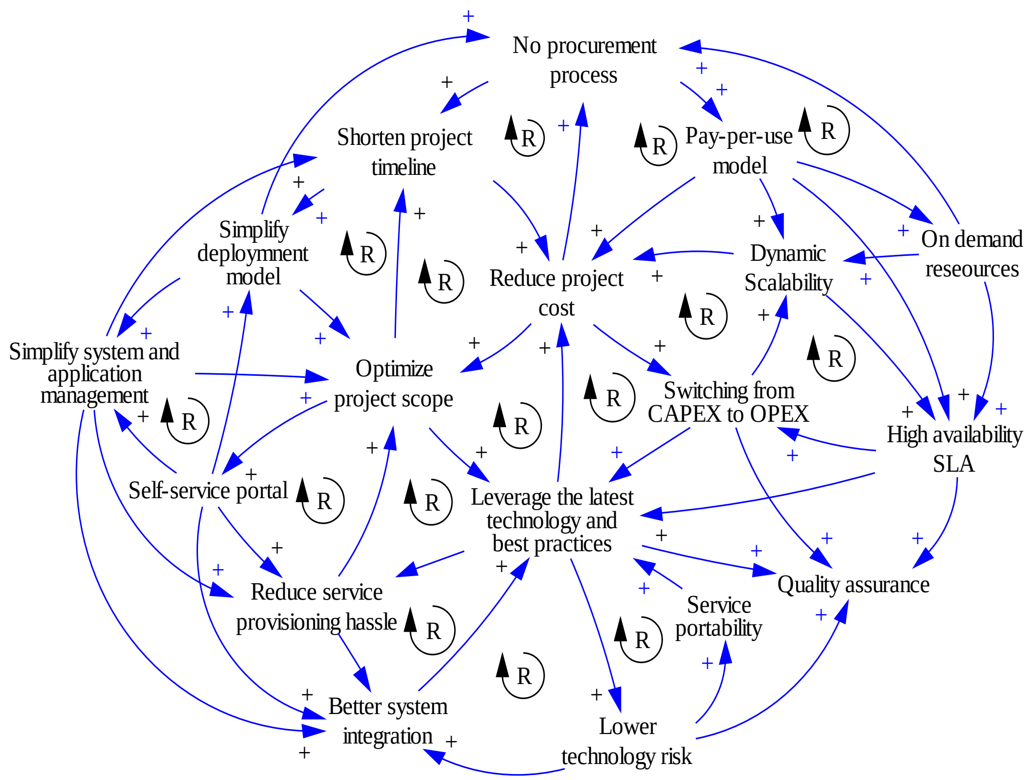

Figure 6: Causal Loop Diagram for Opportunities in Managing Cloud Projects

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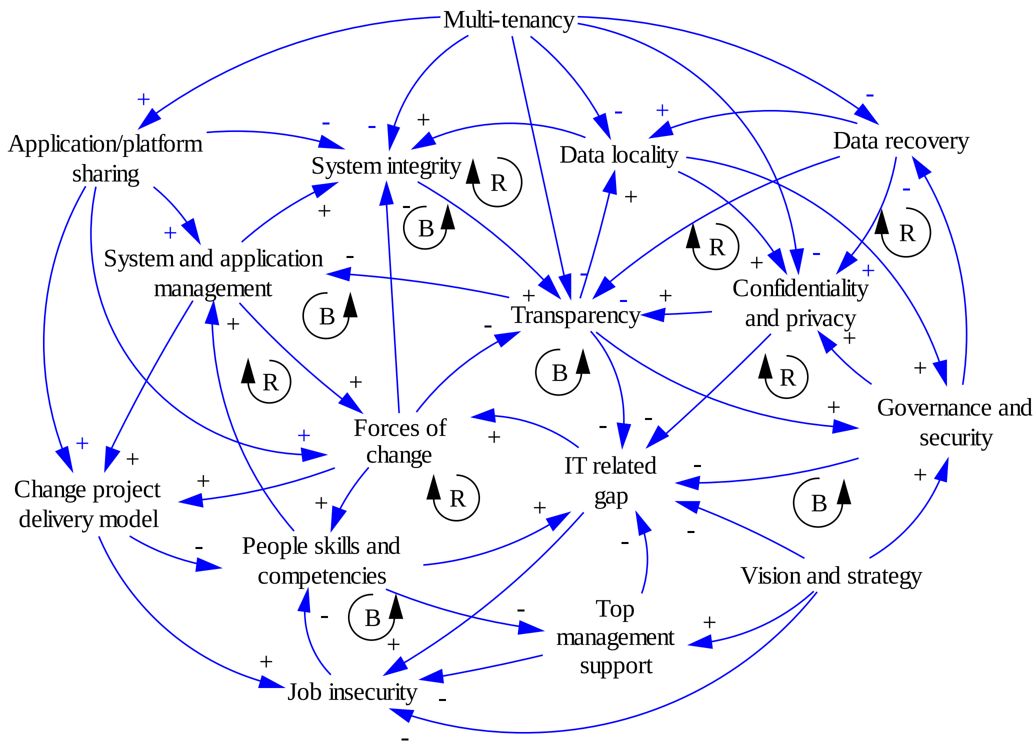

Figure 7: Causal Loop Diagram for Dilemmas in Managing Cloud Projects

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Table 1: Demographic Profile of Respondents

Variable	Categories	Number of Respondents	Frequency (%)
Years of Experience	Less than 5 years	32	29
	5-10 years	59	54
	More than 10 years	19	17
Role of Project Manager	Technical	77	70
	Functional	33	30
Type of Projects Managed	Business application development	34	31
	Infrastructure deployment	46	42
	Maintenance and operations	30	27
Cloud Adoption	Yes – Had managed cloud project	59	54
	No – Not ready for cloud	51	46
Cloud Service Model	Platform as a Service (PaaS)	7	6
	Infrastructure as a Service (IaaS)	4	3
	Software as a Service (SaaS)	74	62
	None	34	3

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Table 2: Independent Samples Test on Readiness in Managing Cloud Projects

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Would you consider yourself more of a technical or functional project manager?	Equal variances assumed	4.935	.028	2.277	108	.025	.271	.119	.035	.508
	Equal variances not assumed			2.042	20.499	.054	.271	.133	-.005	.548
Is your organization adopting cloud computing?	Equal variances assumed	.045	.832	-4.516	108	.000	-.517	.115	-.744	-.290
	Equal variances not assumed			-4.492	22.151	.000	-.517	.115	-.756	-.279

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Table 3: Opportunities & Dilemmas in Managing Cloud Projects

Opportunities	Ref	Mean	SD	**Dilemmas**	Ref	Mean	SD
Cloud offering can help organization subscribe to the required services	OP7	1.98	.134	Security and data privacy are the main concern for the project team	D8	1.94	.245
High availability service level agreement	OP10	1.98	.134	Change of governance and security policy could risk the project	D9	1.93	.261
No procurement of hardware and software required	OP3	1.95	.209	Loss of control rights to the data and resources storing on cloud server always the dilemma	D7	1.92	.275
Leverage the latest technology and best practices in the service offering	OP5	1.94	.245	Retraining and other skill enhancement initiatives are required for project managers and team members	D4	1.89	.313
Self-service portal can eliminate service provisioning hassle	OP2	1.87	.335	Self-service and remote provisioning for cloud resources has changed the deployment steps for IT projects	D3	1.86	.345
Cloud projects can reduce cost of deployment	OP6	1.86	.345	Project manager should be aware on the value of cloud computing	D6	1.85	.354
Simplify system and application management	OP4	1.82	.387	The project delivery process for cloud project is simple and less complicated	D2	1.80	.402
Shorten project implementation timeline	OP1	1.81	.395	There is difference in managing traditional IT project and cloud project	D1	1.75	.432
Lower technology risk with the certified configurations and less customization	OP9	1.70	.460	Project manager to align the cloud project's vision and strategy	D5	1.64	.483
Cloud project can optimize project scope by performing standard off the shelf deployment	OP8	1.67	.471	Job Insecurity	D10	1.06	.245

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Table 4: ANOVA on Opportunities & Dilemmas in Managing Cloud Projects

Opportunities		Sum of Squares	df	Mean Square	F	Sig.	**Dilemmas**		Sum of Squares	df	Mean Square	F	Sig.
OP1	Between Groups	4.315	2	2.157	18.210	.000	D1	Between Groups	6.618	2	3.309	25.739	.000
	Within Groups	12.676	107	.118				Within Groups	13.755	107	.129		
	Total	16.991	109					Total	20.373	109			
OP2	Between Groups	2.120	2	1.060	11.231	.000	D2	Between Groups	3.376	2	1.688	12.699	.000
	Within Groups	10.098	107	.094				Within Groups	14.224	107	.133		
	Total	12.218	109					Total	17.600	109			
OP3	Between Groups	.082	2	.041	.939	.394	D3	Between Groups	.954	2	.477	4.254	.017
	Within Groups	4.690	107	.044				Within Groups	12.000	107	.112		
	Total	4.773	109					Total	12.955	109			
OP4	Between Groups	3.115	2	1.557	12.578	.000	D4	Between Groups	1.153	2	.577	6.470	.002
	Within Groups	13.249	107	.124				Within Groups	9.537	107	.089		
	Total	16.364	109					Total	10.691	109			
OP5	Between Groups	.207	2	.104	1.745	.179	D5	Between Groups	5.209	2	2.605	13.766	.000
	Within Groups	6.347	107	.059				Within Groups	20.245	107	.189		
	Total	6.555	109					Total	25.455	109			
OP6	Between Groups	3.305	2	1.653	18.327	.000	D6	Between Groups	2.663	2	1.332	12.943	.000
	Within Groups	9.649	107	.090				Within Groups	11.009	107	.103		
	Total	12.955	109					Total	13.673	109			
OP7	Between Groups	.012	2	.006	.324	.724	D7	Between Groups	.408	2	.204	2.780	.067
	Within Groups	1.952	107	.018				Within Groups	7.855	107	.073		
	Total	1.964	109					Total	8.264	109			
OP8	Between Groups	7.939	2	3.969	26.089	.000	D8	Between Groups	.212	2	.106	1.788	.172
	Within Groups	16.280	107	.152				Within Groups	6.343	107	.059		
	Total	24.218	109					Total	6.555	109			
OP9	Between Groups	5.098	2	2.549	15.152	.000	D9	Between Groups	.531	2	.266	4.129	.019
	Within Groups	18.002	107	.168				Within Groups	6.887	107	.064		
	Total	23.100	109					Total	7.418	109			
OP10	Between Groups	.033	2	.017	.921	.401	D10	Between Groups	.404	2	.202	3.510	.033
	Within Groups	1.930	107	.018				Within Groups	6.151	107	.057		
	Total	1.964	109					Total	6.555	109			

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Table 5: Tukey Post Hoc Multiple Comparison on Opportunities & Dilemmas in Managing Cloud Projects

OP1				OP6				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1	2	
Less than 5 years	32	1.5		Less than 5 years	32	1.59		
5 to 10 years	59		1.93	More than 10 years	19		1.95	
More than 10 years	19		1.95	5 to 10 years	59		1.98	
Sig.		1	0.984	Sig.		1	0.891	
OP2				OP7				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1		
Less than 5 years	32	1.66		Less than 5 years	32	1.97		
More than 10 years	19		1.95	5 to 10 years	59	1.98		
5 to 10 years	59		1.97	More than 10 years	19	2		
Sig.		1	0.97	Sig.		0.646		
OP3				OP8				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1				1	2	3
More than 10 years	19	1.89		Less than 5 years	32	1.28		
5 to 10 years	59	1.97		More than 10 years	19		1.63	
Less than 5 years	32	1.97		5 to 10 years	59			1.9
Sig.		0.364		Sig.		1	1	1
OP4				OP9				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1	2	
Less than 5 years	32	1.56		Less than 5 years	32	1.44		
More than 10 years	19		1.84	More than 10 years	19	1.53		
5 to 10 years	59		1.95	5 to 10 years	59		1.9	
Sig.		1	0.472	Sig.		0.68	1	
OP5				OP10				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1				1		
Less than 5 years	32	1.88		More than 10 years	19	1.95		
5 to 10 years	59	1.95		5 to 10 years	59	1.98		
More than 10 years	19	2		Less than 5 years	32	2		
Sig.		0.122		Sig.		0.29		
D1				D6				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1	2	
Less than 5 years	32	1.38		Less than 5 years	32	1.63		
More than 10 years	19		1.84	More than 10 years	19		1.84	
5 to 10 years	59		1.93	5 to 10 years	59		1.98	
Sig.		1	0.598	Sig.		1	0.212	
D2				D7				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1	2	
Less than 5 years	32	1.53		More than 10 years	19	1.79		
More than 10 years	19		1.84	5 to 10 years	59	1.93	1.93	
5 to 10 years	59		1.93	Less than 5 years	32		1.97	
Sig.		1	0.608	Sig.		0.11	0.862	
D3				D8				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1		
More than 10 years	19	1.74		More than 10 years	19	1.84		
Less than 5 years	32	1.78	1.78	5 to 10 years	59	1.95		
5 to 10 years	59		1.95	Less than 5 years	32	1.97		
Sig.		0.866	0.134	Sig.		0.116		
D4				D9				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1	2	
More than 10 years	19	1.68		More than 10 years	19	1.79		
Less than 5 years	32		1.88	5 to 10 years	59	1.93	1.93	
5 to 10 years	59		1.97	Less than 5 years	32		2	
Sig.		1	0.469	Sig.		0.081	0.559	
D5				D10				
Work experience	N	Subset for alpha = 0.05		Work experience	N	Subset for alpha = 0.05		
		1	2			1	2	
Less than 5 years	32	1.31		More than 10 years	19	1		
More than 10 years	19		1.63	5 to 10 years	59	1.03	1.03	
5 to 10 years	59		1.81	Less than 5 years	32		1.16	
Sig.		1	0.244	Sig.		0.849	0.125	