A CONCEPTUAL FRAMEWORK TO MANAGE THE IMPLEMENTATION OF CLOUD COMPUTING PROJECTS

ABSTRACT: The majority of organisations have the intention to adopt cloud computing (CC) in order to achieve its advantages. Nevertheless, the implementation of cloud computing introduces intricacies and potential hazards to Information Technology (IT) initiatives. The objective of this study is to give empirical research findings pertaining to the efficient management of cloud computing project execution. The validation of a framework for cloud computing project management (CCPM) was conducted through a series of exploratory qualitative semi-interviews involving sixteen (16) IT professionals representing various organisations in South Africa. The primary discoveries indicate that elements related to CC complexity, PM knowledge domains, project methodologies, and change management play a crucial role in the successful implementation of cloud computing projects. A total of fifty-one difficulty variables pertaining to cloud computing were found to be significant throughout the implementation of cloud projects. The elements were classified into eight distinct areas, specifically environmental, organisational, technical, financial, governance, people management, uncertainty, and dynamics. This study revealed that a majority of the PM knowledge areas, specifically risk management, cost management, business cases, resource management, procurement management, stakeholder management, communication management, integration management, and quality management, were deemed significant. The use of the agile methodology is highly recommended for firms seeking to undertake cloud-based initiatives. Moreover, the significance of change management in effectively executing cloud computing initiatives cannot be overstated, as the use of cloud computing necessitates alterations inside an organisation that affect individuals, organisational procedures, and the overall culture, among various other aspects. The study employed intentional sampling as the sampling technique, wherein the sample was deliberately chosen from the population of IT professionals and IT project managers who possess expertise in the execution and supervision of cloud computing projects. The research employed a hybrid thematic analysis approach for data analysis. The researcher conducted an identification, analysis, and reporting of the themes and patterns derived from both the pre-existing template and the interview data. The statistical software package ATLAS.ti was employed for the purpose of data analysis.

Keywords: Cloud computing; IT Project complexity; Cloud computing project complexity; Project management; Knowledge area; Project approach, Change Management

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1. Introduction

Cloud computing (CC) is a prominent technological development that plays a crucial role in facilitating digital transformation within businesses (El-Gazzar, Hustad, & Olsen, 2016). It serves as the fundamental basis for the fourth industrial revolution (Emejom et al., 2019; Roblek, Meško, & Krapež, 2016). Additionally, it offers companies numerous benefits and advantages compared to conventional information technology (El-Gazzar et al., 2016; Ristov, Gusev, & Kostoska, 2012; Rosenthal et al., 2010; Zhang, Cheng, & Boutaba, 2010).

Cloud computing enables organisations to concentrate on their primary business activities, as cloud computing providers assume responsibility for the management and upkeep of the IT infrastructure and applications on their behalf (Buyya, Yeo, & Venugopal, 2008; Subramanian & Jeyaraj, 2018). Due to this rationale, cloud computing exhibits reduced complexity and enhanced ease of implementation, hence facilitating accessibility, deployment, and utilisation. This technology offers enterprises the ability to access and scale solutions as needed, while requiring minimum management (Mell & Grance, 2011). Furthermore, this approach facilitates the utilisation of computing services by organisations through a subscription-based model, enabling them to just pay for the resources they have really consumed (Armbrust et al., 2010). The pay-as-you-use model of cloud computing offers flexibility and cost-effectiveness to organisations by excluding maintenance, support, and licensing expenses from their overall expenditures. The growth of cloud computing services is anticipated to experience significant expansion in the forthcoming years. According to projections, the market size and growth are anticipated to expand at a rate about three times that of the entire IT services sector. Specifically, it is expected to increase from $214.3 million (US dollars) in 2019 to $331.2 million (US dollars) in 2022.

The implementation of cloud computing introduces intricacies to information technology projects (Muka & Marnewick, 2018). It is imperative for organisations to possess a comprehensive understanding of the project complexity associated with the deployment of cloud computing, as complexity is an intrinsic characteristic of any project (Botchkarev & Finnigan, 2015). In addition, the success of a project is influenced by its level of complexity, as evidenced by studies conducted by Bosch-Rekveldt et al. (2011), Murray (2002) and Williamson (2011). Nevertheless, there is still a lack of comprehensive integration of project management best practises to effectively address the unique challenges associated with managing cloud computing projects. This raises the question of whether cloud computing projects should be approached differently from traditional IT projects or not (Conway & Curry, 2012; Wang et al., 2016). The existing body of research on the management of cloud computing deployments is currently minimal (Stendal & Westin, 2018). According to El-Gazzar et al. (2016) and Thobejane and Marnewick (2020), the currently existing body of research on cloud computing project management in the context of IT project management is insufficient.

This article presents a theoretical framework for cloud computing project management (CC-PM) by drawing upon the theoretical frameworks of middle-range theory and complexity theory. The adoption of middle-range theory was motivated by the absence of comprehensive theories that specifically addressed the domain of cloud computing project management research. It has been determined that large theories exhibit a lack of specificity, assertions, and empirical testing (Im, 2018; Swanson et al., 2020). A similar phenomenon was observed within the field of information systems, as several academics in this subject have argued that the process of borrowing and adapting existing theories hinders the development of new and novel theoretical frameworks (Hassan & Lowry, 2015). Furthermore, Hassan and Lowry (2015) advocate for the incorporation of middle-range theory by IT/IS researchers as a means to develop novel theories within their respective fields. This approach facilitates a more precise contextualization and concentration on the particular area of investigation, hence enabling easier falsification and expansion of knowledge. Therefore, we propose the utilisation of middle-range theory in the project management of cloud computing.

The study employed complexity theory as a framework to enhance comprehension of the intricate challenges introduced by cloud computing in the context of IT projects. Complexity theory is concerned with comprehending the interconnections of constituent elements, their mechanisms of sustenance, and the emergence of resultant phenomen (Turner & Baker, 2019).

The primary objective of the study was to provide a conceptual framework for project management in cloud computing, specifically targeting IT professionals in South Africa. The primary aim of this study is to present the research outcomes pertaining to the efficient implementation of cloud computing initiatives. In order to elucidate the conceptual framework, the following questions were asked:

1. What are the project management elements earmarked to address cloud computing project implementations?
2. Which cloud computing project complexity factors are significant for cloud project?
3. How are cloud project complexity factors integrated with current project management elements earmarked to enable effective cloud computing implementation processes?

The paper is structured into five distinct sections. The first section of the paper examines the existing literature pertaining to cloud computing, project management knowledge domains, project methodologies, and the complexity of cloud computing projects. The second section introduces a conceptual framework for project management in the context of cloud computing. In section three, the research technique is presented. The fourth section of the paper provided a comprehensive discussion of the obtained results and their further analysis. The final section of the paper presents the conclusion.

2. Literature Review

Cloud computing

There are different definitions of cloud computing in academia and in the industry. Aceto, Persico, and Pescapé (2020) define cloud computing as *'a paradigm that enables "Utility Computing", i.e. the leasing of computing resources (computational power, storage, and the related networking resources) in real time, with minimal interaction with the provider.'*

Cloud computing is characterised by five key features: on-demand self-service, resource pooling, rapid deployment, a large network, and a pay-as-you-use (Buyya et al., 2008; Mell & Grance, 2011; Rosenthal et al., 2010).

- **On-demand self-service** means that people and organisations have the ability to utilise cloud services on an as-needed basis. Organisations have the option to access these cloud services through several avenues such as web portals, command lines, and Application Programmable Interfaces (APIs).
- **Resources pooling** means that cloud services have the capability to be shared among multiple organisations, with the absence of information on the specific location of these cloud services.
- **Rapid provisioning** means the capability of managing, deploying, and releasing demand for cloud services in an automated manner, without requiring any manual interventions. This solution provides assistance to enterprises who have challenges in accurately forecasting their future demand.
- **Broad network** access refers to the capability of enterprises to utilise cloud services via the internet, employing a range of mechanisms including desktop computers, laptops, mobile devices, and other similar devices.
- **Pay as you use** means that organisations possess the option to subscribe and remunerate solely for the utilisation of cloud service resources (e.g. CPU, data transfers, memory etc.) they have used.

The term "CC service models" pertains to the diverse range of computing services that are provided to organisations through internet-based platforms, allowing for on-demand access. The primary distinction among these service models lies in the allocation of responsibilities for various computing services, encompassing infrastructure (such as compute and storage), operating systems (OS), platforms (such as middleware and programming languages like Java and .Net), software/applications (such as ERP and CRM), and data management. There exist three primary models for cloud services. Table 1 provides a concise overview of the three distinct service models within the realm of cloud computing. These models are specifically referred to as: Infrastructure as a Service (IaaS), Platform as Service (PaaS) and Software as a Service (SaaS) (Leavitt, 2009; Mell & Grance, 2011; Subashini & Kavitha, 2011; Vaquero et al., 2008).

Table 1: Cloud computing service models

Service models	Computing services				
	Infrastructure	OS	Platforms	Software/applications	Data
Infrastructure as a Service	Cloud provider	Organisation	Organisation	Organisation	Organisation
Platform as a Service	Cloud provider	Cloud provider	Organisation	Organisation	Organisation
Software as a Service	Cloud provider	Cloud provider	Cloud provider	Cloud provider	Organisation

Organisations have the option to select from five primary cloud deployment models (Leavitt, 2009; Mell & Grance, 2011; Vaquero et al., 2008). These options include public, private, hybrid, community, and cloud-on-premise (Cloud@ Consumer). Deployment models are classified based on the physical location or installation of the computing infrastructure, the entity responsible for its management, and the extent to which it is shared among other businesses. Table 2 provides a differentiation of the five distinct cloud computing deployment methodologies (Dawoud, Takouna, & Meinel, 2010; Leavitt, 2009; Mell & Grance, 2011; Mueller, 2019; Vaquero et al., 2008).

Table 2: Cloud computing deployment models

Attributes	Private	Public	Hybrid	Community	Cloud @ customer
Location of infrastructure	Organisation data centre	Cloud provider data centre	Both organisation and cloud provider data centres	Cloud provider data centre	Organisation data centre
Who is responsible for infrastructure?	Organisation	Cloud provider	Both Organisation and cloud provider	Cloud provider	Cloud provider
Shared infrastructure?	No	Yes	Organisation (No)/Cloud provider (Yes)	Yes (with selected organisations/community)	No

The next session discusses project management.

3. Project Management

The primary objective of this part is to examine the requisite project management (PM) knowledge and skills necessary for the successful implementation of cloud computing.

Within the realm of project management (PM) standards, there exist ten (10) fundamental knowledge domains that are universally essential for the achievement of project success. The knowledge areas pertaining to project management encompass integration management, scope management, schedule management, resource management, cost management, communication management, quality management, risk management, stakeholder management, and procurement management (Drob & Zichil, 2013; Project Management Institute, 2021; Zandhuis & Stellingwerf, 2013). Furthermore, it should be noted that the Project Management (PM) standards under consideration do not have a distinct knowledge area specifically dedicated to business cases. Instead, the concept of business cases is integrated into many other knowledge areas. An illustration of this can be seen in the PMBOK® Guide published by the Project Management Institute, where the business case is incorporated under the domain of integration management (Project Management Institute, 2017). This study established a distinct knowledge domain for the business case. Due to its crucial significance in IT initiatives, this knowledge area is accorded the same attention as other domains (Einhorn, Marnewick, & Meredith, 2019).

Every knowledge domain consists of a set of procedures, also known as process groups, which are categorised into different project phases. The aforementioned knowledge domains encompass processes that are categorised into process groups (Project Management Institute, 2017; Zandhuis & Stellingwerf, 2013). The process groups encompassed within project management are initiation, planning, execution, monitoring and controlling, and closure. Process groups are iterated at every phase of the project life cycle. The various stages of the project are executed inside the project life cycle as an integral component of the project methodology (Project Management Institute, 2017).

Project approaches

The concept of a project approach refers to a set of rules and standards that outline the appropriate methods for managing a project (Introna & Whitley, 1997). The selection of a project approach holds significance as it aids in the establishment of structure and organisation within the project's execution. The methodologies employed in this study encompass a spectrum of techniques, varying from those that rely heavily on predictive models and assume a comprehensive understanding of the contextual factors, to those that exhibit a greater degree of adaptability, uncertainty, and volatility (Kuruppuarachchi, Mandal, & Smith, 2002). The two predominant methodologies in software development are the waterfall and agile approaches. The Agile approach places a greater emphasis on the ability to adapt and innovate, while the waterfall approach prioritises prediction and control (Highsmith, 2009; Vinekar, Slinkman, & Nerur, 2006).

The selection of a project approach facilitates the determination of the project life cycle that aligns with other project approaches. The project life cycle delineates the procedural steps involved in the delivery of a project. There exist three primary project life cycles (Kuruppuarachchi et al., 2002; Project Management Institute, 2017):

- **Predictive linear (plan driven)**: In the realm of project management, a predictive linear life cycle is employed when the project's needs, costs, and time frame are well-established and can be accurately foreseen. The many stages of this life cycle may exhibit either a sequential or overlapping nature, encompassing the planning, analysis, design, and implementation phases. This process yields the most stable goods and is characterised by enhanced manageability.
- **Iterative/incremental approach**: Similar to the predicted life cycle, the phases have the potential to occur in a consecutive manner. However, the specific needs are not predetermined and lack comprehensive definition. The life cycle of this process involves the repetition of phases in a cyclical manner, wherein each cycle encompasses all project phases, including planning, analysis, design, and execution.
- **Adaptive (change- driven)**: the reason for the existence of many iterations lies in the practise of dividing the time slots into shorter periods, commonly referred to as sprints.

The next section discusses cloud computing project complexity.

Cloud computing project complexity

The role of complexity in projects is of utmost importance, particularly in its contribution to project failures (Bosch-Rekveldt et al., 2011; Murray, 2002; Williamson, 2011). Baccarini (1996) defines project complexity as *'consisting of many varied interrelated parts and can be operationalised in terms of differentiation and interdependency.'* Tatikonda and Rosenthal (2000) *refer to project complexity as the degree of uniqueness and novelty exhibited by a product or service, encompassing its development processes, performance targets, and interconnectedness in relation to its technological advancement and difficulty. In their study,* Lu et al. (2015) *provided a definition of project complexity as "consisting of many varied interrelated parts, and had dynamic and emerging features".*

Acquiring a comprehensive understanding of project difficulties is crucial in preventing and mitigating instances of project failures. The subject of IT project complexity has been extensively studied in the field of project management (Daniels & LaMarsh, 2007; Wallace, Keil, & Rai, 2004; Xia & Lee, 2004). Cloud computing initiatives are subject to the complications often associated with IT projects, as cloud computing is considered a subset of the broader field of information technology (Leavitt, 2009; Mell & Grance, 2011; Vaquero et al., 2008). The complexity categories of cloud computing projects are derived from the complexity categories of IT projects, resulting in comprehensive complexity categories for cloud computing IT projects.

The complexity of CC IT projects can be classified into the following categories (Botchkarev & Finnigan, 2015; Joseph, 2017; Merali, 2006; Poveda-Bautista, Diego-Mas, & Leon-Medina, 2018; Williamson, 2011; Xia & Lee, 2004):

- Organisational project complexity pertains to the various aspects that impact the overall functioning of an organisation, including its constituent pieces, structures, units, and the modifications introduced by associated elements.
- Governance pertains to the challenges faced by companies and cloud providers in situations when there is a lack of clarity on accountabilities, roles, and responsibilities.
- Financial project complexity pertains to the intricate financial aspects that arise for organisations' balance sheets when they transition their IT services to cloud computing.
- Technology project complexity refers to the various factors associated with technology and its related components.
- Environmental IT projects pertain to the circumstances under which these projects are carried out, primarily encompassing elements such as economic, social, and legal concerns.
- Uncertainty relates to the present and future conditions of several project components, wherein forecasting changes can prove challenging.
- Dynamics IT project complexity relates to the management of project changes, encompassing both internal and external modifications that occur inside the project.
- The category of IT project complexity related to people management encompasses all factors associated with individuals that have an impact on the project.

In aggregate, these categories encompass a total of 70 distinct complexity factors. Figure 1 depicts the various categories of difficulty associated with the CC IT project, along with their corresponding components.

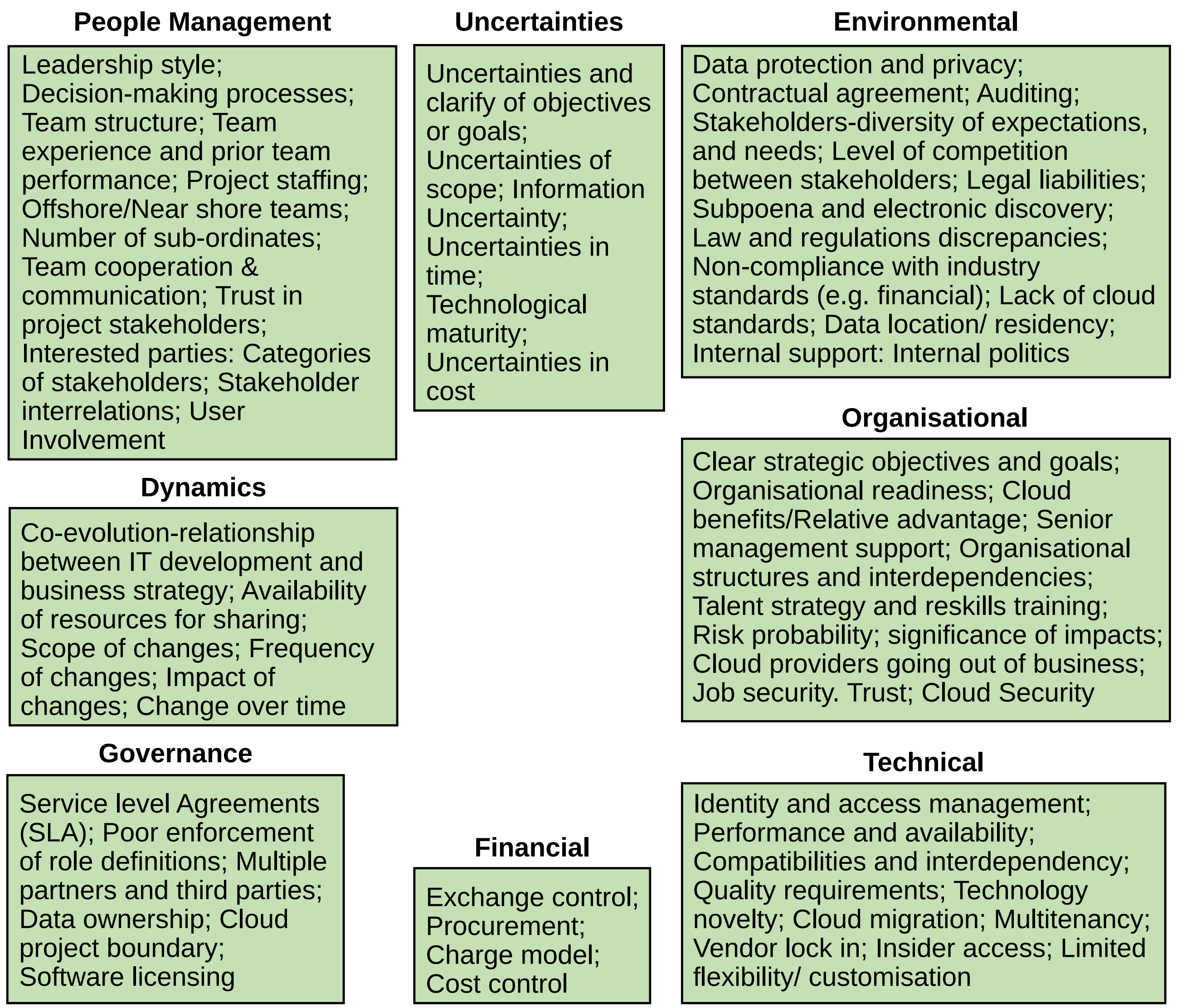

Figure 1: CC-IT factors

In the next cloud computing project management conceptual framework is brief explained.

Cloud Computing Project Management Conceptual Model

This section provides an explanation of the components comprising the conceptual framework for project management in cloud computing. The conceptual framework that has been established is depicted in Figure 2.

The constituents of the conceptual framework were formulated by deductive content analysis. The establishment of the conceptual cloud computing project management framework was supported by a literature assessment conducted by Mayring (2014). In order to ascertain the constituents of the conceptual framework, the subsequent steps were undertaken:

1. The research question and research problem served as guiding factors in the identification of essential concepts during the process of literature review. The identified fundamental principles encompassed project management knowledge areas, project methodologies, the intricacy of IT projects, and the intricacy of cloud computing projects.
2. The process of identifying concepts was afterwards accompanied by the construction of interconnections among these concepts through the utilisation of concept mapping techniques.
3. Finally, the elements of the conceptual framework were established as follows: project knowledge areas, project strategy, and cloud computing project complexity.

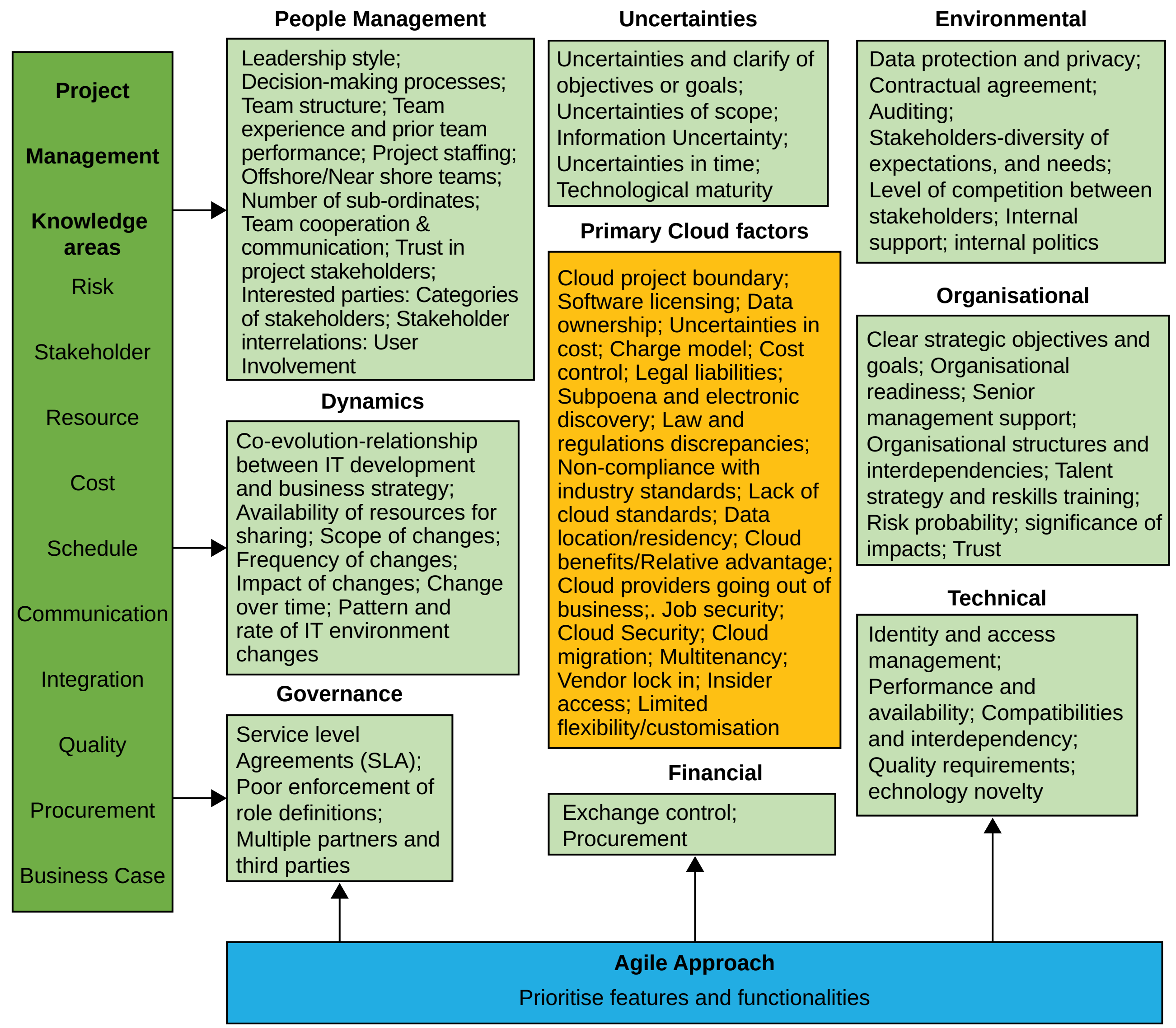

Figure 2: Cloud Computing Project management Conceptual Framework (Thobejane & Marnewick, 2020)

The following part provides a discussion of the four components that have been established within the conceptual framework of Cloud Computing Project management.

Project approach: The agile methodology is commonly favoured in the context of cloud computing due to its ability to enable enterprises to effectively prioritise features and functions, adapt to changes, and achieve speedy outcomes (Calnan & Rozen, 2019; Laanti, Salo, & Abrahamsson, 2011; Špundak, 2014).

Project management knowledge areas: The knowledge areas deemed relevant for cloud computing projects include risk management, resource management, scope management, schedule management, business cases, cost management, stakeholder management, communication management, integration management, procurement management, and quality management. The literature review above elucidates that the knowledge areas encompassed the business case (Project Management Institute, 2017; Zandhuis & Stellingwerf, 2013).

Cloud computing categories: Cloud computing category refers to a collection of interconnected cloud computing elements. The cloud classifications depicted in Figure 2 are visually represented by green blocks. The categorization of clouds encompasses various domains, including technical, environmental, organisational, financial, people management, governance, uncertainty, and dynamics.

Cloud computing factors: In order to ensure the successful implementation of cloud computing projects, it is crucial to evaluate and address the unique aspects that are essential for such projects. These variables, which are of utmost importance, should be carefully identified and highlighted within the designated orange block. When comparing projects in the context of cloud computing, it is crucial to consider several primary factors. These factors include job security, legal liabilities, discrepancies in laws and regulations, non-compliance with standards, data location, cloud migration, limited customization, infrastructure as a code, the possibility of cloud providers going bankrupt, the relative advantage of cloud computing, data ownership, uncertainties in cost estimation, charge models, cost models, and software licencing. Additional secondary variables related to cloud computing should be integrated into projects to complement the basic criteria, as seen in Figure 2.

4. Research Methodology

This study employed an exploratory qualitative methodology as the researcher sought to investigate the perspectives of individuals with prior experience in cloud computing. These participants provided their insights and expertise gained from their involvement in the implementation and management of cloud projects within their respective sectors. Their perspectives contributed to the comprehension of efficient implementation strategies for cloud computing initiatives. The utilisation of semi-structured interviews in this study was motivated by the researcher's desire to elicit the participants' perspectives on cloud computing initiatives, encompassing their own comprehension, encounters, emotions, and related aspects. The researchers conducted virtual semi-structured face-to-face interviews using video conference platforms such as Zoom and Skype. The interviewer has the option to deviate from the predetermined interview questions in a non-sequential manner. Furthermore, the utilisation of semi-structured interviews provided the participants with a conducive environment to express their thoughts and opinions without any inhibitions or constraints.

The efficacy of a semi-structured interview is contingent upon the researcher's proficiency in eliciting and capturing the knowledge and experiences of the interview participants. Furthermore, the extent to which a study's findings can be considered valid is contingent upon the researcher's proficiency in comprehending and accurately interpreting the information conveyed.

The interview guide was designed and employed as a means of safeguarding against the inadvertent omission of crucial information during the interview process. This interview guide was structured into distinct sections, specifically encompassing demographic information, difficulties related to cloud computing, and a subsequent portion dedicated to project management. The last piece specifically delved into knowledge domains and various project techniques. A total of sixteen interviews were conducted and audio-recorded. The audio recordings were transcribed and afterwards subjected to coding. Likewise, comprehensive records were documented during the interview process.

All interviews were meticulously documented, with the audio being meticulously preserved in the form of mp3 files. The transcription of each file was conducted via Transcribe software. Following the completion of each interview, the transcribed files were then transferred and compiled into a Word document. Subsequently, the audio recordings were reviewed once more to verify the accuracy of the transcription software in transcribing the records, while also addressing any misspelt words. The aforementioned procedure followed an iterative approach, whereby each individual audio file underwent many listening sessions to ascertain the accuracy of the transcribed data. Table 4 presents a comprehensive overview of the interviewees' summary details.

Table 4: List of interviewees

Interviewee	Industry	Video	Role
Interviewee 1	Petro chemical	Zoom	DevOps leader
Interviewee 2	Insurance	Zoom	Software developer
Interviewee 3	Petro chemical	Zoom	Business partner/ system analyst
Interviewee 4	Financial	Skype	Cloud engineer
Interviewee 5	Consulting	Skype	Senior developer
Interviewee 6	Higher Education	Skype	Director–business development
Interviewee 7	Higher Education	Skype	IT Project/business manager
Interviewee 8	Consulting	Skype	Senior developer
Interviewee 9	Consulting	Zoom	IT project manager
Interviewee 10	Insurance	Skype	Senior developer
Interviewee 11	Higher Education	Skype	Senior architect
Interviewee 12	Consulting	Zoom	Security manager/ System analyst
Interviewee 13	Financial	Skype	Team leader
Interviewee 14	Consulting	Skype	Consultant manager
Interviewee 15	Consulting	Skype	Project manager
Interviewee 16	Consulting	Skype	Senior software developer

The study employs deliberate sampling as a methodological approach. The sample was derived from a population consisting of IT project managers and IT professionals who possess prior experience in the implementation and management of cloud computing projects.

The data analysis strategy employed in this study was a hybrid approach that combined theme analysis and pattern matching analysis (Braun & Clarke, 2006). Thematic analysis refers to the process through which themes are derived from the collected research material. According to Braun and Clarke (2006), individuals who employ qualitative research methods are capable of acquiring the skills necessary for doing thematic analysis. This course offers fundamental abilities that are essential for various data analytics. Thematic analysis is considered advantageous due to its methodological nature, since it offers flexibility by not being bound to a certain theoretical framework. Instead, it encompasses both inductive and deductive coding approaches (Williams & Moser, 2019). Inductive coding involves the derivation of codes from the interview data, whereas deductive coding entails the pre-coding and development of codes based on existing literature.

The research employed the six-step theme analysis framework developed by Fereday and Muir-Cochrane (2006), which offers explicit instructions on its application. The objective of thematic analysis is to identify and categorise themes within the collected data, which holds significant importance. The researchers recognised various themes and employed them to address the research inquiries. In contrast to content analysis, thematic analysis involves the interpretation and comprehension of themes, rather than merely providing a summary of the data. It is advisable to refrain from formulating study questions that may inadvertently transform into overarching themes. The 6 steps do not need to be followed sequentially.

- First step of the analysis is to use the literature review to systematically construct a priori template through deductive reasoning. A comprehensive set of eight (8) themes or groups were identified, accompanied by a total of 70 codes, as depicted in Figure 1.
- Step 2 involves conducting tests to assess the dependability of the codes. The second researcher conducted a comprehensive examination of the pre-existing template, which included an analysis of the themes and codes. The involvement of many people in the development of the codes enhances their trustworthiness.
- Step 3 entails acquiring knowledge and comprehending the factual data. The researcher diligently transcribed the audio recordings of the interviews and carefully examined the resulting transcripts. The researcher generated a total of eight (8) new codes using an inductive process. These codes are as follows: change, awareness, expectations, training, talent, coordination, development and information-technology operations (DevOps), and infrastructure as a code. The data, once transcribed, was coded using ATLAS.ti 8, a software tool for computer-assisted qualitative data analysis (CAQDAS).
- Step 4 involves importing and loading the pre-existing template into ATLAS.ti 8. This template consists of themes and their corresponding codes as outlined in the codebook. The topics and corresponding codes outlined in the codebook were utilised to analyse the transcript data and identify significant textual segments. The initial patterns outlined the various aspects that impact the difficulties of cloud computing projects, and project management principles were subsequently formulated and refined, drawing upon notions derived from the existing body of literature.
- Step 5 involves a thorough examination of the themes. Ensuring the coherence and empirical validation of the defined topics was of paramount importance. The themes were constructed through the process of integrating and amalgamating the codes derived from the pre-existing template, known as the priori template, with the newly developing codes. This stage encompassed the process of code refinement and topic identification. A total of five (5) newly derived codes, including organisational change, awareness, expectations, talent and training, and coordination, were amalgamated to create a novel thematic category referred to as change management. The integration of DevOps and infrastructure as code practises were implemented across the organisation, with DevOps serving as an organisational code and infrastructure as code serving as a technical code.
- Step 6 and last, do the write up. This entails the interpretation of the obtained results, the subsequent publication of the findings, and engaging in conversations around them.

The next section focuses on the results and analysis of the empirical study.

5. Results and Analysis

This section provides an exposition of the study's findings derived from empirical data. The validation process was conducted for each layer of the conceptual framework, and the subsequent sections provide detailed explanations for each layer.

CC project complexity factors

A total of 51 cloud computing factors, which have been validated and deemed significant, are shown in Table 5 through Table 12. The presented tables illustrate three categories of factors: primary cloud factors, secondary cloud factors, and insignificant cloud factors. Primary cloud factors are specific to cloud computing, while secondary cloud factors are applicable to both cloud projects and traditional IT projects. Insignificant cloud factors, on the other hand, have been determined to lack significance or importance in the context of cloud projects. There are a total of 16 basic components and 35 subsidiary elements that contribute to the formation of clouds. Owing to the interviews, it was observed that a total of 19 complexity characteristics related to cloud computing projects did not demonstrate a substantial influence on the outcome of such projects.

The empirical data revealed that the technical, dynamic, and uncertainty components were not found to be statistically significant when compared to the findings of the literature review. According to the respondents, the incorporation of cloud computing involves the consideration of several organisational and financial considerations that hold major importance.

Organisational considerations encompass various aspects, among which the key factors related to cloud computing include cloud security, job security, and cloud advantages. On job security, Interviewer 4 mentioned that '*I know that system administrators specifically with Azure (IaaS) they did complain about job security that it (cloud) did take lot of jobs'*. On cloud security, one of the interviewees cautioned that *'Overselling (of cloud computing) means they ignore some of the security challenges that come with that (cloud) specific solution*.' The other factors are as shown the Table 5.

Table 5: Validated Organisational factors

Organisational cloud computing factors		
Primary	**Secondary**	**Insignificant**
Cloud security; Jobs security; Cloud benefits / relative advantage; Cloud providers going out of business	DevOps; Organisational readiness; Risk probability, significance of impacts; Trust; Talent strategy and skills training; Organisational structures and interdependencies; Senior management support; Clear strategic objectives and goals	-

From **financial** factors, the charge model and cost model were found to be primary cloud factors. One of the issues is that organisations are adopting charge model without good monitoring in place, interviewee14 mentioned that '*Building (of cloud) is easy, deployment it was seamless, and everybody loved the solution. Downside was month end when invoice is coming; we found that our usage for the month for that instance was around 4 million rands… That was huge shock to the system…That is the down side with cloud. We had to pay that and stop our instance, had to scale down, and remove it.'* On the cost model, Interviewee 2 said this when asked about Capex and Opex, *'I think that there is definitely a huge game. The fact that we do not need to approve millions and millions of rands in infrastructure to be spend all at once is great'*. The other factors are as shown in Table 6.

Table 6: Validated financial factors

Financial cloud computing factors		
Primary	**Secondary**	**Insignificant**
Charge model; Cost model	Exchange controls; procurement	-

The key cloud factors identified in this study include technical factors such as infrastructure as code, cloud migration, data loss, and limited flexibility. Interviewee 2 explained the difference between on-premise and the cloud environment in terms of infrastructure as a code *'On the on-premise world, if you are to do an implementation of anything in the infrastructure world, it is generally not repeatable. Somebody click through the whole thing, and in the cloud world there are concepts of infrastructure as a code.'* Interviewee 1 further mentioned *'The benefit of having the script is that you can repeat it at any time that you want to, and every time you run it will give you the exact (same) result'*. Some interviewees expressed different views when it came to limited customisation of cloud solutions, Interviewee 4 said that '*I find out with some of these solutions, once go cloud is difficult to actually go back. Like to reverse'*. Furthermore, interviewees found some of technical factors are secondary factors and other are no longer significant as shown in Table 7.

Table 7: Validated Technical factors

Technical cloud computing factors		
Primary	**Secondary**	**Insignificant**
Infrastructure as code, Cloud migration; Limited flexibility/ customisation	Quality requirements; Performance and availability; Compatibilities and interdependency; Data loss	Vendor lock-in; Multitenancy; Technology novelty; Insider access; Technological architectures and infrastructure; Identity and access management

The key elements identified in this study include governance factors, data ownership, and software considerations. The interviewees expressed caution over the challenges that organisations should consider, specifically in relation to the feasibility of reusing on-premise licenses in a cloud environment. Interviewee 2 indicated that *'With Microsoft there is an arrangement that you can reuse licences on-premise in the cloud, but that not apply to Amazon (AWS). If you are aligned to Amazon, you need to consider those things that you are going to buy additional licences to go and run on the Amazon Managed Services...And it is quite a big point of contention in the IT world today.'*

Interviewees did not find cloud boundary significant. Interviewee 3 said how they manage shadow IT *'We have relationship managers. They help us to manage those relationships. These are full-time jobs that people should ensure that things are managed effectively.'* The other factors are as shown the Table 8.

Table 8: Validated Governance factors

Governance cloud computing factors		
Primary	**Secondary**	**Insignificant**
Data ownership; Software licensing	Service level agreement (SLA); Joint-venture partners (parties/contractors); Poor enforcement of role definitions	Cloud computing boundary

From **People management** factors, there are no specific primary cloud factors that emerged. Interviewee 2 when asked about experience and prior experience factor, said that *'yes, absolutely, having people who have experience is absolutely key'*. He further said that organisations need to be realistic when searching for cloud skills because there are still limited, *'because it's new to most people. You do not find somebody with 20 years' experience doing cloud, for example. Many people are learning, there is a lot of humidity in the streets. And everyone else is open to the fact that we are all learning.'*

The impact of the number of subordinates on cloud projects was found to be statistically insignificant, as cloud projects tend to use a more agile strategy. Interviewee 10 said that *'People believe that they do not have to be monitored to do their tasks. Thus, why I did explain that we adopted the style of agile, which does not required people to be micro managed and monitored all the time'.*

The other factors are as shown the Table 9.

Table 9: Validated People management factors

People management cloud computing factors		
Primary	**Secondary**	**Insignificant**
-	Team experience and prior team performance; Project staffing; Offshore teams; Trust in project stakeholders; Interested parties: Categories of stakeholders; Stakeholder interrelations; Interests of involved parties; User involvement; Team structure; Leadership style	Number of subordinates; Decision-making processes

Among the several criteria considered, environmental conditions, contractual agreements, and data residency emerged as the key factors. They interviewees mentioned that contract agreement with cloud are mostly one sided, Interviewee 6 expressed that organisations need legal experts unlike before, because '*it was very easy in the past. Now it's getting very complicated to run a (cloud) contract with the SLAs.'*

On data location issues Interviewees mentioned how they mitigate it. Interviewee 2 having said'*…will pick a location that is geopolitically friendly to our nation. For example, Ireland is one such location'.*

The interviewees observed that the standards for cloud computing had reached a level of maturity, hence diminishing their significance in the implementation of cloud projects. Interviewee14 said that *'Three years ago was very different. Google and AWS was one direction; Microsoft was going completely different in terms of standards. However, over time all of them become interoperable…You can move seamless among them.'* The other factors are as shown the Table 10.

Table 10: Validated Environmental factors

Environmental cloud computing factors		
Primary	**Secondary**	**Insignificant**
Legal liabilities, subpoena and electronic discovery; Law and regulations; Data residency; Non-compliance with industry standards	Data protection and privacy; Contractual agreement; Auditing; Level of competition between stakeholders; Issues of internal politics; Internal support	Lack of cloud computing standards

From **uncertainty** factors, cost uncertainties is only one primary factor. Interviewee 15 said that '*…some of the pricing are not clear across cloud platforms. It makes it difficult to project how much you can be paying.'* Interviewee 6 said that '*...we found as a challenge is that we didn't understand the costing of the cloud environment...So, everybody thinking moving away from on-premise to the cloud it's going to be much cheaper, currently I'm experiencing it more expensive'.* The other factors were found to be insignificant as shown the Table 11.

Table 11: Validated Uncertainty factors

Uncertainty cloud computing factors		
Primary	**Secondary**	**Insignificant**
Uncertainties in cost	Uncertainties and clarify of objectives or goals	Information uncertainty; Uncertainties in time; Technological maturity; Uncertainties of scope

There are no primary factors in dynamics factors. The sole major factor observed in both cloud and traditional IT projects is the co-evolutionary relationship between IT development and business strategy. Interviewee 3 mentioned the importance of this relationship when he said that *'[s]o companies need to be very clear what is in the strategy. Why do they want to go cloud? So, understanding the motivation and business outcome is very key.'* The other factors were found to be not significant as shown the Table 12.

Table 12: Validated dynamics cloud computing factors

Dynamics cloud computing factors		
Primary	**Secondary**	**Insignificant**
-	Co-evolution-relationship between IT development and business strategy	Impact of changes; Scope of changes; Frequency of changes; Change over time; Pattern and rate of IT environment changes; Availability of resources for sharing

In the next section, the validated project management knowledge areas are discussed.

Project management Knowledge areas

The interviewees concurred with the existing research, which posits that business cases should be regarded as a distinct knowledge domain due to their pivotal significance in project management. The interview participants had divergent perspectives regarding the motivations and rationales for their organisations' use of cloud computing. During the interview, Interviewee 6 disclosed that their firm had implemented cloud computing technology because they *'see the trend in the application world.*

According to the interviewers, the knowledge domains of project scope and schedule management are deemed insignificant in the context of cloud computing. Cloud projects are often inclined to adopt an agile strategy due to its distinct approach to scope management, which differs from traditional methods. Interviewee 14 commented on how scope is handled and managed on-cloud projects *'Scope has to do with features and functionalities. Features and functionalities we understand, that is why we moved away from waterfall to agile methodology to extreme programming. Because we expect high variability in terms of scope and changes. Therefore, instead of pushing back against changes, we learn to embrace them. How do we embrace them? We put all those changes in the backlog'.*

The other knowledge domains that are deemed significant in the context of cloud computing projects include integration management, cost management, resource management, communication management, risk management, quality management, stakeholder management, and procurement management.

Project approach

The analysis of the interview data revealed that a majority of cloud computing initiatives implemented an agile strategy. The interviewees highlighted the advantages of implementing an agile methodology, as it enables them to effectively manage project modifications and effectively prioritise additions and functions. Furthermore, due to its iterative nature, the agile strategy facilitates quick results.

The majority of the interviewees mentioned that they have used the agile approach. Interviewee 8 said that *'At the moment it's mostly agile with specific milestones… That is what we did. I don't think we really did waterfall'.* In addition, Interviewee 9 explained the reasons why they went for the agile approach '*We can see the end product much quicker, and you can make changes as you go along. It is just better for me. Waterfall I don't like it anymore'.* Interviewee 13 shared some advice when organisations need to adopt the agile approach that '*If you adopt an agile, communication is key. Scrum is an approach / methodology that we have taken. So, communication becomes key'.*

Change management

Based on the findings obtained from the conducted interviews, it was observed that change management emerged as a distinct and crucial component in effectively managing projects related to cloud computing. Moran and Brightman (2001: 111) describes change management as *'the process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers'.* Interviewees emphasised the importance of change management, and Interviewee 13 mentioned that *'If change management is not done properly, then the relationships between the consulting and the clients in most cases are very sour. So as long as change management is done properly and people aware what they are getting into'.* Change management is categorised with the following factors:

Awareness: it is imperative for enterprises to ensure that their personnel are well-informed about cloud computing projects and the potential impact these initiatives may have on their roles and responsibilities. Interviewee 5 added by saying that *'I think many people; they have not yet have comprehended what is actually means to say something is cloud computing.'.*

Manage expectations: cloud computing initiatives have the potential to induce transformative effects within organisations. In turn, it becomes imperative to effectively handle and regulate expectations across various hierarchical levels within these organisations. Interviewee 6 explained that *'[t]he other thing also that we found the challenge in this, the whole management of expectations. Because what people see out there, they don't really worry about how the technology is working.'* Interviewee 13 further said that *'so you flag people to say this is what's going to change and they understand what's going to happen once we go live.'*

Training and skill management: cloud computing is distinguished from conventional information technology (IT) practises, hence warranting enterprises to allocate resources towards educating and reskilling their workforce. Interviewee 13 mentioned that *'Remember change management is going to also drive the way you going to train your end-users. With proper change management, training starts way before you can go live'.*

Organisational change: organisations are required to conduct thorough investigations and have a comprehensive understanding of the various changes that will accompany the implementation of cloud initiatives. Interviewee 2 mentioned approval processes as some of the organisational changes by saying *'…in the on-premise world there are certain approval processes which applies. I think a lot of that need to be looked. For example, lot of things will be regarded as change that need to go the CAB (change advisory board) and so on. However, in the cloud world, you need to leverage the speed that is available'.*

Coordination, communication: cloud computing necessitates that organisations exert effort in managing coordination and communication throughout the entire company. This is crucial in order to ensure that a consistent and uniform message is disseminated regarding the changes brought about by cloud computing. Interviewee

7 mentioned that the *'Challenge that we'd have is that any security application that you would put on an environment, proper change management or change control needs to be applied. Now when we do these deployments, there is no change board that sits. Now the role of communicating everything lies with the IT manager. But the biggest challenge is that IT managers are not change people in most cases. Communicating the message becomes difficult'.*

The next section deals with relationships between the components of the framework.

Relationship between the components

In order to comprehend the correlations between factors in cloud computing and knowledge fields, as well as the integration of cloud factors with knowledge areas to tackle cloud projects, a mapping exercise was conducted to correlate each cloud factor with its relevant knowledge area. For instance, all aspects pertaining to cloud computing hazards were integrated into the framework of project risk management. Based on the validation of cloud factors, empirical evidence indicates a direct correspondence between cloud factors and knowledge fields. Furthermore, all aspects of cloud computing are interconnected with knowledge domains.

Table 13 presents the quantitative data regarding the frequency of cloud variables within each cloud category, as they pertain to the various knowledge domains. This observation indicates that there exist other cloud-related characteristics that are associated with the practise of risk management. The significant prevalence of cloud elements necessitates a strong emphasis on risk management throughout the implementation of cloud computing initiatives by enterprises. The user's text could be rewritten as follows: The user's text could be rephrased to emphasise the examination of hazards associated with environmental, organisational, and technical issues in cloud computing.

Risk management, stakeholder management, resource management, and business cases are crucial knowledge areas in relation to the multitude of factors associated with cloud computing. In the context of stakeholder management, it is imperative for enterprises to prioritise the management of individuals and consider the influence of environmental cloud variables. The prioritisation of resource management should centre on effective management of both organisational and personnel aspects, whilst the emphasis of business cases should be on the evaluation of organisational cloud components. Cost management, integration management, procurement management, communication management, and quality management are considered to have a moderate level of importance, correspondingly.

The significance of organisational, environmental, and people management cloud computing project complexity categories is paramount when considering the complexity of a cloud computing project. This is due to the substantial number of project complexity elements associated with each of these categories. The technical and governance categories are considered to be of significant importance, mostly due to the presence of several project complexity elements. Conversely, the financial, dynamics, and uncertainty categories are deemed to be somewhat important, as they encompass a relatively lower number of project complexity factors.

Table 13: Updated overall CC project complexity counts per knowledge area

Knowledge Area	Organisational	Environmental	People management	Technical	Governance	Financial	Uncertainties	Dynamics	Total
Risk management	5	7	2	5	1	1	-	-	21
Stakeholder management	-	3	4	-	1	-	-	-	8
Resource management	2	-	2	1	1	-	-	-	6
Business case	4	-	-	-	1	-		1	6
Cost management	-	-	-	-	-	2	1	-	3
Integration management	1	-	1	-	-		1	-	3
Procurement management	-	-	-	-	1	1	-	-	2
Communication management	-	-	1	-	-	-	-	-	1
Quality management	-	-	-	1	-	-	-	-	1
Total	12	10	10	7	5	4	2	1	51

(dark grey)	Extremely important-category and knowledge area with 10 or more cloud computing project complexity factors
(medium grey)	Very Important-category or knowledge area with between five(5) and nine(9) cloud computing project complexity factors
(light grey)	Moderately important-category or knowledge area with less than five(5) cloud computing project complexity factors

As shown in Table 13, scope management and schedule management are not important for inclusion in the final framework.

Change management and CC project complexity factors

The introduction and implementation of cloud computing have had a transformative impact, resulting in complications and organisational changes. The application of change management is crucial for effectively managing the complexities and alterations associated with cloud computing initiatives. The empirical investigation demonstrated the applicability of change management to three distinct categories within cloud computing: organisational, people management, and governance. These categories primarily address factors that have an impact on companies and individuals. Change management processes encompass various critical aspects, including but not limited to job security, the establishment of clear roles and responsibilities, effective communication of strategic objectives and goals, talent strategy, and the provision of reskilling training in response to the advent of cloud computing. These elements exert a significant impact on businesses on a broad scale and necessitate attention at the enterprise level.

Awareness: Organisations ought to disseminate information regarding key variables pertaining to organisational cloud adoption, encompassing the clarification of strategic objectives and aims, the advantages associated with cloud computing, as well as the potential risks inherent in cloud-based operations. It is imperative that all relevant stakeholders are informed about the service level agreements (SLAs) that businesses have established with numerous partners within the governance cloud framework. This is necessary to effectively manage expectations and ensure clarity regarding data ownership rights and associated terms.

Managing expectations: It is imperative for organisations to establish clear delineations of involvement, as well as roles and duties, for various stakeholders, including project users. The provided clarifications will aid in effectively managing and addressing the expectations.

Talent strategy and reskills training: The management of training and skills should be conducted at the organisational level rather than at the project level. In order to effectively strategize training programmes inside their respective firms, it is imperative for organisations to possess a comprehensive understanding of the skills gap. The successful implementation of cloud projects may pose challenges in the absence of individuals possessing the requisite skills and expertise..

Organisational changes: Cloud computing has the potential to introduce a range of organisational modifications within entities. These modifications can encompass a variety of aspects, including alterations to business processes and structural elements such as divisions. Examples of such changes include the implementation of DevOps practises, adjustments to procurement processes, and other organisational modifications. The tangible effects of cloud providers, such as their potential closure, are indeed significant. It is imperative for organisations to strategically devise plans to effectively tackle and resolve these aforementioned difficulties. It is imperative for the change management team to effectively address any difficulties that may arise as a result of these changes.

Coordination and communication: It is imperative to ensure active involvement of individuals throughout the entire project within the organisation. Effective communication, collaboration, and coordination are essential elements within project teams. Effective communication plays a vital role in fostering trust and enhancing relationships among various project stakeholders, encompassing not only multiple partners but also third parties.

The subsequent part will go into the correlation between change management and project management.

Change management and project management

The project management standards such as PMI, APM, IPMA, and others mostly focus on change management within the context of individual projects, rather than addressing it comprehensively at the organisational level. According to the Project Management Institute (PMI, 2017), integration management is solely responsible for facilitating the coordination of changes across the many knowledge areas within a project, rather than at an organisational level. Change management is a discipline that focuses on the management of individuals and organisational factors that have an impact on several aspects such as costs, quality, risks, and procurement management. Communication, stakeholder engagement, and resource allocation are integral components of or pertain to, the field of change management.

The subsequent part introduces the ultimate conceptual framework for project management in cloud computing.

Updated conceptual CC PM framework

The verified framework for project management in cloud computing is depicted in Figure 3. The conceptual framework incorporates an additional component known as change management.

The inclusion of change management in the implementation of cloud computing projects is crucial as it facilitates the resolution of human-centric challenges both inside the project itself and throughout the entire company. Organisations should implement awareness programmes, effectively manage stakeholder expectations, facilitate coordination efforts, and cultivate connections with diverse stakeholders from project inception and throughout its duration. Furthermore, the effective management of personnel and the comprehensive training of diverse stakeholders are crucial factors to consider.

Organisations should prioritise the major characteristics of cloud computing when considering cloud projects, as these factors are fundamental components, as evidenced by the final conceptual framework. Furthermore, it is imperative for enterprises to exercise caution regarding secondary cloud variables. The comprehension of environmental, organisational, technical, financial, and governance cloud categories is crucial for enterprises in relation to major cloud variables.

The project management knowledge domains, namely risk management, cost management, business cases, resource management, and procurement management, hold substantial importance in the context of cloud projects due to their direct relevance to key factors associated with cloud computing. The significance of scope management and schedule management in cloud computing projects is limited. The agile method was identified as a significant factor in cloud computing initiatives inside the project approach component.

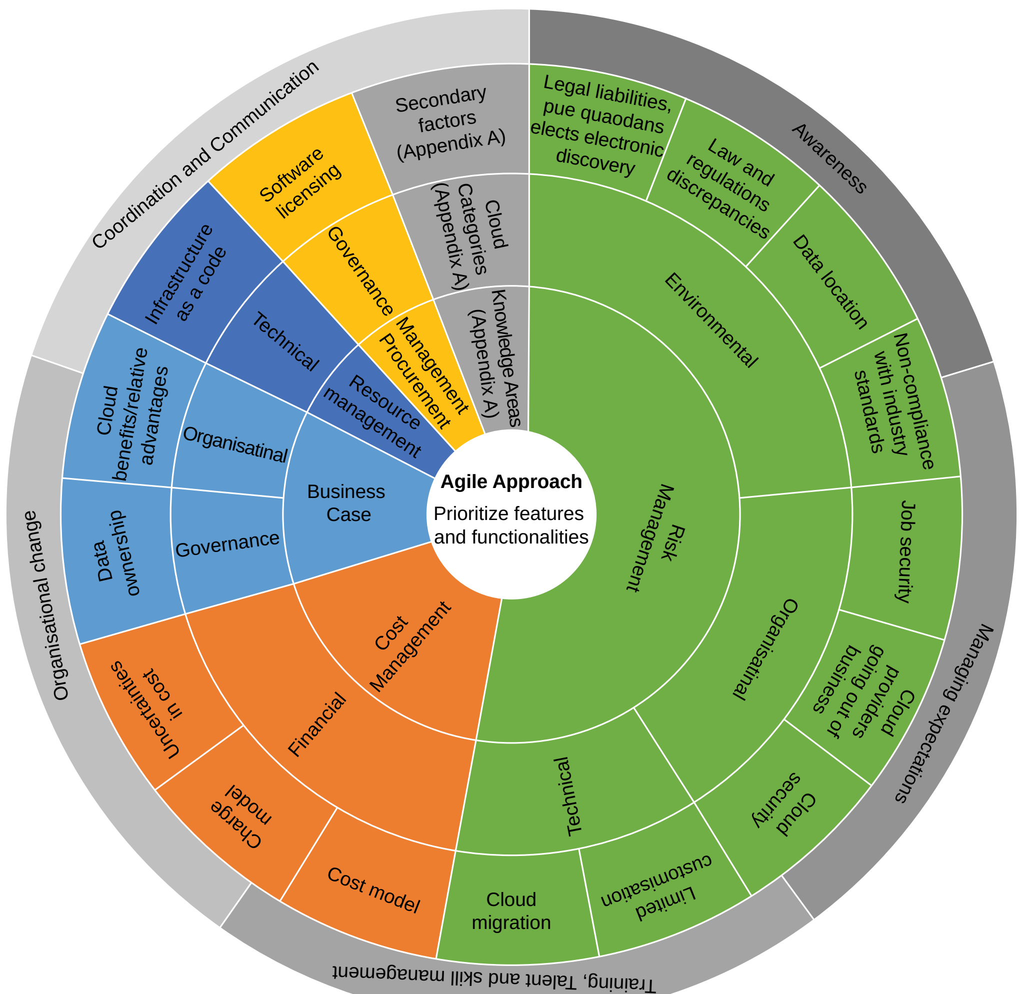

Figure 3: Final conceptual cloud computing project management framework

6. Conclusions

Extensive study has been conducted on the attributes and functionalities, such as services, deployments, benefits, and hazards, associated with cloud computing. However, the scholarly literature remains limited in terms of investigating the implementation and management aspects of cloud computing projects. The undeniable advantages and expansion of cloud computing have generated significant interest among businesses, prompting them to actively pursue the implementation of cloud computing initiatives. The objective of this study endeavour was to investigate the optimal strategies for the successful implementation of cloud projects.

The verified conceptual framework consisted of several key components, specifically change management, project approach, project management knowledge domains, cloud computing aspects, and cloud computing categories. The change management component of cloud computing projects necessitates firms to comprehend and execute several crucial components, including awareness, communication, coordination, skill and training, and organisational transformation. A total of 51 cloud computing parameters were identified as statistically significant. In cloud projects, the significance of scope management and schedule management in the knowledge fields was not taken into consideration. The agile methodology was suggested as a suitable technique for implementing cloud computing.

The conceptual framework that has been established demonstrates its potential utility as a guiding tool for businesses and IT professionals in the management of CC projects. The present study aimed to ascertain the primary project complexity characteristics that exert an influence on the successful execution of CC projects. The results of this study can provide valuable guidance for firms seeking to improve their decision-making processes in this particular area. This study also contributes to the existing body of knowledge in the disciplines of climate change and project management within the academic context. The results of this study can serve as a reliable foundation for researchers to draw upon when undertaking subsequent investigations and implementing novel theories within these respective domains.

7. Limitations of the research

1. The applicability of the research findings across industries might be constrained by the narrow representation of participants from a limited number of sectors.
2. The potential scope of cloud computing complexity concerns might not be entirely addressed due to the participants being predominantly sourced from specific industries.
3. The findings' generalizability to different geographical areas is circumscribed as the study's focus was exclusively confined to South Africa.
4. The research findings are delimited by both temporal and spatial factors, stemming from the fluid nature of technology evolution, particularly within the realm of cloud computing.
5. The researcher's utilization of personal comprehension, experience, and judgment to formulate certain generalizations introduces the possibility of subjectivity and inherent social biases.

8. Suggestions for future research

The following are possible for future research:

1. For comprehensive industry coverage and validation within distinct sectors.
2. To investigate diverse cloud complexities based on service and deployment models.
3. Given the study's confinement to a singular geographic locale, it is imperative to extend the scope to encompass multiple countries. Validation should span various industries and geographical regions.
4. To incorporate participants encompassing a spectrum of roles and positions within the realm of cloud computing.
5. What is the significance of change management in enhancing cloud computing projects?
6. How does the adoption of an agile project approach influence the outcomes of a cloud computing project?

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