Design and Implementation of Government Cloud Computing Requirements:TOGAF

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Abstract—Digital technologies, such as cloud computing, have transformed business activities, particularly in the public domain. In the corporate sector, where cloud computing technology has long been implemented, some organisations have succeeded, while others have been less successful. Saudi Arabia has enthusiastically supported the move to cloud computing technology; however, from a business perspective, its implementation of government cloud technology is still relatively nascent and has faced numerous challenges. The existing literature suggests that the government cloud migration depends not only on project drivers, but also on considerable barriers, which often delay successful implementation. Furthermore, many current barriers and drivers clearly involve the roles of cloud vendors, meaning that cloud vendors must be fully engaged in order to develop comprehensive solutions. Addressing this phenomenon from the lens of enterprise architecture (EA) may support the development of appropriate deployment requirements for optimal government cloud implementation. Thus, this paper is a research in progress that analyses the major barriers and drivers affecting cloud implementation in public organisations, taking into consideration the perspectives of cloud consumers and vendors. This paper also introduces a mapping conceptual model throughout The Open Group Architecture Framework (TOGAF) that supports a novel framework for tackling these barriers and their influences and enhancing drivers via a set of requirements.

Keywords—cloud computing, enterprise architecture, TOGAF, implementation.

I. INTRODUCTION

This In the area of digital government, cloud computing technology has become a top priority for information technology (IT) leaders. Cloud computing technology offers several potential benefits, such as cost savings, agility, efficiency, resource integration, business opportunities, and the reduction of complex work processes [1] . The utilization of cloud computing in the government field is commonly termed the government cloud (g-cloud), an initiative that has been implemented and widely adopted by the government of the United Kingdom[2, 3].

Since emerging in the last few years, the g-cloud concept has gained global recognition for optimising public cloud-based services and increasing IT efficiency. It supplements IT organisations with new technology features, such as infrastructure scalability, virtualisation, and shared resources [4]. However, interconnections across cloud computing technologies, including, particularly, the g-cloud and enterprise architecture (EA), have not yet been fully discussed [3, 5-7]. EA's mission with respect to cloud computing technology has been to establish robust business strategies and widespread conceptual models [6]. For example, business, information systems (IS), and technology architectures are central components of EA, and Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are the main platforms for cloud technologies. Both EA and cloud platforms seek to achieve certain business goals. Thus, the growth of EA principles among decision makers has helped enterprises develop more sustainable business cases that are successfully aligned with new technologies, such as cloud computing [3, 8-10]. Combining EA elements can support optimal communication and functionality within an enterprise and with external stakeholders, covering different types of cloud computing technology [11].

Saudi Arabia has made some progress in implementing cloud technology in the public organisations [12]. However, in addition to the complexity of cloud technology, Saudi public organisations are characterized by a context that may hinder the successful development of cloud computing technologies. This context comprises several characteristics, including uncertainties regarding new technologies, bureaucratic structures, the influence of internal cultural practices, and decision makers' mindsets [13-16].

This paper, which is part of a larger research project, contributes by proposes a mapping model designed to support a future novel g-cloud implementation framework utilizing The Open Group Architecture Framework (TOGAF), to successfully develop and examine enterprise requirements based on various discovered barriers and drivers and support

efforts capable of tackling these barriers and their influences and enhancing drivers.

The rest of this paper is structured as follows. Section 2 presents a broad review of the major drivers and barriers of cloud computing adoption in corporate sectors. Section 3 presents the lineage between enterprise architecture and government cloud computing. Section 4 shows the mapping conceptual model of g-cloud implementation along with novel objectives and potential requirements. Finally, conclusions are drawn, and future work as well as scope are discussed in section 4.

II. LITERATURE REVIEW

A. Major Drivers of G-cloud Implementation

The main driver of g-cloud computing adoption is the organisational value creation sparked by the full virtualization of IT resources. In the Norwegian government context, cloud computing brought significant business value at both the strategic and the technical levels by promoting greater IT efficiency in service delivery [2]. This enabling feature was elaborated by Busch, Smith [3], who stated that the implementation of cloud computing within the Australian government context tangibly increased both business value and economic value. Alsanea [13] Investigated the implementation of cloud computing in government sectors in Saudi Arabia from both theoretical and practical perspectives and confirmed that cloud technology increases business productivity.

Cloud solutions are based on a pay-per-use model. This new payment approach has led public organisations to migrate toward cloud technologies to reduce costs and ensure excellent service delivery [17]. Alsanea [13] elaborated that cost reduction is an enabler in the cloud adoption in Saudi Arabian public organisations. Another cloud computing driver is the technical advantage of flexible and scalable systems, which allow organisations to focus more on their core businesses [18, 19]. A study by [20] of the Australian government context argued that the technical advantages of g-cloud adoption, such as flexibility and scalability, are positively associated with organisations' cloud adoption. Similarly, Alsanea [13] found that system availability was the main driver of Saudi Arabian cloud adoption. Cloud elasticity and scalability also support greater system flexibility and ensure business continuity in the Jordanian e-government context [21]. Janssen and Joha [17] found that the main supportive factors of cloud implementation were innovation and the use of up-to-date software. Jones [22] confirmed that g-cloud adoption increased resilience and agility in the context of the government of the United Kingdom. Finally, Alkhlewi, Walters [23] explored the internal and external factors affecting the adoption of private cloud computing by Saudi Arabian government agencies and showed that disaster recovery is a critical technical enabler. However, most extant studies have failed to consider the wider scope of cloud providers' enablers that will included in the present study.

B. Major Barriers to g-cloud Implementation

Data sensitivity, data security and privacy are critical components of the global e-government system. Data security

and privacy are primary barriers to g-cloud implementation because government regulations in most countries prevent the storing of important data outside of the country or specific government organisations [2]. In particular, cloud vendors lack the capabilities to address network security, data accessibility, and data confidentiality, which poses ongoing and serious challenges [24]. Alsanea [13] noted that Saudi Arabia is particularly hindered by security and privacy matters with respect to g-cloud computing. The country also suffers a lack of trust in cloud vendors [25, 26] and even cloud technology [13], both of which hinder g-cloud implementation. Certain cultural traditions might also pose barriers to g-cloud implementation [27]. Mukhametzhanova, Harvey [28] argued that culture is a critical barrier that negatively influences g-cloud system access. El-Gazzar, Hustad [2] demonstrated that culture is an obstacle to g-cloud implementation and found that its effect is most dramatic when top management has the power to resist people's attempts to utilize cloud technology and develop their work. For these reasons, investigating g-cloud implementations in different societies and cultures has significant implications, as do studies of the variations in organisational contexts, attitude, and stakeholders that can significantly impact the success of g-cloud implementation projects [29, 30]. Rigid organisational strategies present another obstacle that might lead to disagreements between cloud vendors and cloud consumers. This barrier might create additional barriers, such as conflicts in service-level agreement cooperation and agreement strategies between cloud vendors and cloud consumers, particularly in the case of private clouds [2]. The absence or complexity of government regulations, compliance, and other national standardisations can also prevent the success of g-cloud implementation in some government contexts [31]. Haag and Eckhardt [18] claimed that non-compliance with applied government regulations and privacy laws inhibits g-cloud adoption. In the Saudi Arabian government context, the absence of legislation and standards act as a hindering factor [23]. Furthermore, in cloud technologies, data sovereignty is a key barrier to the storage of sensitive data for global governments [26]. Irion [32] argued that data sovereignty is a barrier on the cloud vendor side, since cloud vendors may take control of physical storage data centres or may hire third parties to store their data. However, as of yet, there have been no empirical investigations addressing the question of data sovereignty within the g-cloud context. Cloud performance issues might be a barrier when applications are inaccessible due to low speed connectivity or system failures, both of which typically breach cloud vendors' promises [1, 33]. In Turkey, cloud system performance is a primary obstacle that negatively influences service quality and availability [34]. Alsanea [13] confirmed that g-cloud service performance is negatively affected by the current lack of IT infrastructure within government agencies. Interoperability and integration issues related to the g-cloud stem from a lack of consent standards, a lack of compatibility among services, and inconsistent cloud vendor platforms [28]. According to Chang, Walters [1] interoperability is a major technical concern that negatively affects the successful implementation of g-cloud technologies, largely due to differences in vendor-side cloud platforms. However, previous studies have investigated multiple cloud deployment models solely from a technical

point of view prior to actual implementation and have not empirically addressed the success stage of g-cloud implementation. Service-level agreements (SLAs) and contracts between cloud vendors and customers are reported as barriers to g-cloud implementation [18, 32]. According to Tweneboah-Koduah, Endicott-Popovsky [26], in the g-cloud context, both SLAs and contracting processes should be clarified in organisations' cloud strategies prior to any migration. El-Gazzar, Hustad [2] identified SLAs as being among the top 18 challenges facing cloud adoption across three case studies in the Norwegian government context.

Thus, the present paper aims to develop a novel G-cloud implementation conceptual model utilising The Open Group Architecture Framework (TOGAF) in order to empirically develop and examine enterprise requirements, based on various, discovered barriers and drivers in the context of Saudi Arabia.

III. ENTERPRISE ARCHITECTURAL REQUIREMENTS FOR G-CLOUD IMPLEMENTATION

In the past few years, EA has had an extensive impact on all enterprises. The Open Group [11] defined EA as involving an understanding and optimisation of all enterprise information, technology services, processes, and infrastructure elements; the effort to find out how those elements interrelate; and the pursuit of a balance between IT efficiency and business innovation within current and future business scopes and strategies. This paper will use the definition proposed by the Open Group.

The TOGAF is a requirements-centric framework with the main purpose of practically delivering a standard method for EA design involving all appropriate enterprise resources and processes. The TOGAF plays a crucial role in regulating and minimising risk during the architecture development process. It empowers organisations to add value and construct practical and economic solutions in alignment with current and future business needs based on an iterative process model and best-practice framework. The TOGAF also relates to the government context, where it has been widely implemented and has exhibited several strengths, such as a developed process, strong documentation, and a robust modelling language (ArchiMate) [35]. Within the TOGAF, the Architecture Development Method (ADM) is a core method that comprises several steps involving establishing and developing architecture solutions content and then transforming and governing the recognition architectures [11, 36, 37]. Thus, this study adopted TOGAF to address the requirements for g-cloud implementation within the context of Saudi Arabia.

Developing architecture requirements is one of the main step towards success in processing and establishing organisational cloud-based services. The development of requirements must involve interrelated cloud vendors, IT practitioners, and cloud computing experts, who can help understand, classify, and deploy the g-cloud implementation project. Furthermore, the requirements must meet both organisational needs and the needs of any desired cloud

services. These issues can be addressed through the analysis and requirements shaping processes Wang, He [38]. Likewise, organisational cloud-based services projects demand requirements crafted from an enterprise architecture point of view, which is used to identify the type and characteristics of cloud solution and then to align these with the project's overall objectives [7, 39]. Cloud-based service projects must involve different types of requirements such as network capacity and specify scalability and system availability [7, 40]. Thus, developing success requirements for g-cloud implementation requires the clear recognition of business goals and requirements, stakeholder rules, IT capabilities, and understanding of existing barriers and drivers which have been considered in this research project [38, 39, 41].

IV. THEORETICAL MODEL

The proposed g-cloud implementation mapping model tracks two main views in which include g-cloud vendors and clients. Also, tracks various barriers to g-cloud implementation and uses them to support efforts to overcome these barriers and comprehensively identify any potential requirements.

To identify success requirements, TOGAF ADM first identifies key elements that describe new objectives, capabilities and opportunities to successfully meet the government's goals [42]. In this paper the main contribution exist by developing objectives that have been developed in alignment with g-cloud overall goals in the context of Saudi Arabia as well as considering the exposed barriers and drivers. In addition, from a wider perspective, it delivers new capabilities to meet the developed requirements that would address the major barriers identified in business, IS, and technology architectures. The developed objectives have been aligned with potential requirements. It recognises and classifies the necessary requirements for success and the scope in accordance with the strategic alignment model introduced by Henderson and Venkatraman [43] and the TOGAF ADM best-business-scenario matrices [6, 11, 36, 39]. See Table 1 and Figure 1.

TABLE I. G-CLOUD IMPLEMENTATION MODEL OBJECTIVES AND POTENTIAL DEVELOPED REQUIREMENTS BASED ON LITERATURE REVIEW .

<i>N</i>	<i>Objectives</i>	<i>Potential Requirements</i>	<i>Scope</i>
<i>1</i>	Improve effective G-cloud strategies	Establish open strategic plan. Strategies to develop relationships between g-cloud vendors and customers.	Strategic
<i>2</i>	Improve G-cloud vendor trust	Host data centre and treat sensitive data on premises to avoid data lock-in. Assess cloud vendor reputation and credibility.	Strategic
<i>3</i>	Improve compliance during G-cloud implementation	Consider and quote government regulations. Clarify and apply compliance	Strategic

		features.	
4	Improve data sovereignty of the G-cloud project	Host and locate the data centres in same geographical location where the government exist. Host and treat physical data storage in Saudi Arabia with strict rules.	Strategic
5	Develop an effective organisational culture	Refine organisational culture. Increase readiness and awareness of individuals to avoid resistance to change.	Strategic
6	Improve cost calculation methods	Develop a comprehensive policy for cost calculation for g-cloud project. List operation requirements to comply with cost include information security activities. Reduce impact of economic crises and financial issues.	Strategic
7	Enhance organisation value	Support business/ economic and return on investment (ROI) value. Reduce cost of IT expenses. Develop employee / organisation innovation.	Strategic
8	Improve Service Level Agreements (SLAs) implementation	Develop comprehensive SLA criteria. Approve mandatory SLA requirements in alliance with cloud vendor. Identify cloud vendor responsibilities.	Operational
9	Improve data security and privacy	Develop solid security policy. Utilize updated network security products. Apply strict rules for data access, control and confidentiality.	Operational
10	Optimise service flexibility and availability	Reduce complexity of customisation for better services functionality. Monitor systems incidents for better connectivity. Establish data disaster recovery to avoid data centre/system breakdown.	Operational
11	Improve interoperability and integration	Adopt open and consent standards among applications. Detach legacy systems.	Operational
12	Increase G-cloud elasticity	Increase agility. Facilitate mobile services.	Operational

Fig.1. Targeted g-cloud implementation reference model according to TOGAF ADM.

To accomplish these steps in accordance with TOGAF ADM procedures, and based on an review of the existing barriers and drivers identified in the literature, mentioned objectives and potential requirements developed for future measurement and analyzed in the context of g-cloud implementation in Saudi Arabia. Since the present study utilized the TOGAF ADM to develop success requirements for G-cloud implementation, it is necessary to understand the developed reference model presented above.

This g-cloud implementation reference model was developed according to the content, rules, and structure of the TOGAF ADM in order to provide comprehensive structures for g-cloud implementation and the business landscape. Specifically, the reference model focuses on the stage of formulating requirements for g-cloud implementation from the lens of exposed barriers and drivers. Also, it include both the cloud vendor and consumers roles in order to suit the context of the Saudi Arabian g-cloud. Following the TOGAF ADM framework, the reference model comprises six main components.

First, the model identifies the major g-cloud barriers and drivers, which are then grouped and defined to suit the scope of the present study. Second, it aggregates and maps these barriers and drivers onto the ADM phase's business, information system, and technology components, and develops initial requirements. Third, the potential requirements are moved to the main stage, where they are developed according to the TOGAF ADM's requirement management process. This involves the identification of any key principles, descriptions, propositions, and constraints, all of which will be presented in the next paper. Next, the process maps the potential developed requirements (capabilities) onto the TOGAF ADM. Fourth, at the stage of g-cloud realization and implementation, the study provides detailed descriptions of the requirements' drivers. At

this stage, all of the project's goals, objectives, and developed requirements interact together to achieve implementation governance in the alignment with Saudi Arabian g-cloud goals and strategies.

The g-cloud vendor becomes a major influencer here and can be considered a fifth-component external stakeholder. Furthermore, the g-cloud vendor engages with the development and implementation of both requirements and principles and significantly contributes to the achievement of the developed requirements. Sixth, the reference model shows all of the actions, structures, and outcomes of the g-cloud reference model mapped in accordance with the TOGAF ADM content. The double-headed arrows indicate interrelationships that may be iterative processes. For instance, the relationship between g-cloud implementation and g-cloud requirements is identified as an outcome and desired solution; however, due its dependence on other requirements, this relationship might not be achieved during the first project iteration, meaning that further iterations may be required implementation requirements.

V. CONCLUSION, FUTURE SCOPE, AND ANTICIPATED RESULTS

This paper has given an account of and the reasons for the widespread use of cloud computing technology in public organisations. The literature review offers a detailed explanation of identifies major barriers and drivers influencing governmental organisations, taking into consideration the perspectives of g-cloud vendor and consumer. Then, the paper also identifies a novel link between cloud computing in government organisations and EA information systems. Based on existing g-cloud barriers and drivers, this paper presented novel g-cloud implementation mapping model illustrating objectives and potential requirements for the conceptualization process, thus suggesting ways to tackle this process appropriately. EA standards have specific properties that bring value to the government organization which easily understood to interpret by g-cloud stakeholders, sufficiently robust to support decisions toward cloud technology. As mentioned in the introduction, the present research is part of a larger research project comprising two main segments that aims to facilitate the comprehensive success of g-cloud implementation requirements for multiple case studies qualitatively in Saudi Arabian context. To achieve this objective, future stages of this research will address the first segment: assessing the developed objectives and potential requirements, and formulating final g-cloud requirements covering g-cloud vender perceptions. This is a work-in-progress, with results forthcoming. The second segment of the study will interview g-cloud consumers' managers and practitioners and will seek to gather information about the utility and usability of the successfully developed g-cloud The results of this second segment will be incorporated with and discussed interchangeably with those of the previous segment to support a final successful g-cloud implementation requirements matrix, which will enhance g-cloud implementation within the selected context and potentially offer certain features that can be generalized on a global scale.

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