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Development and evaluation of a Cloud Computing Adoption Framework (CCAFF) for retail banks in Bahrain

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ABSTRACT

The Information Technology era supports the adoption of Cloud Computing (CC) on a large scale in many business fields, at which the Financial Institutions (i.e., Banking sector) is not an exception. Several gaps were found during an attempted literature reviewing. While several CC methods, strategies, or frameworks have been proposed or utilized for CC adoption in many economic sectors including the Financial institutes (FI)- Banking, it is still a relatively new initiative in many other countries including Bahrain. While Enterprise Architecture (EA) is claimed to be a leading information and business management discipline to develop an architecture that guides the transformation to CC adoption of an enterprise from a baseline state to a target state. However, there is an evident lack of scholarly articles on the development of CC adoption frameworks from EA perspective. Also, it was found that scholarly articles in the evaluation of CC adoption framework are scarce. To address those gaps, this paper aims at developing and evaluating a CCAFF for the CC adoption in Bahraini Banks by adapting a tailored version of the Open Group Architecture Framework (TOGAF) and embedding a tailored version of an enterprise cloud adoption strategy (ECAS) and then evaluating the CCAFF based on several criterions. A six phased Design Science Research Methodology (DSRM) is employed to design the research report, guide, and develop the CCAFF, while the exploratory nature of the research necessitates the employment of a holistic single Case Study strategy for an FI-01 bank, based on semi structured interviews and document analysis data collection techniques. Alongside, the data was analyzed using pattern matching technique. For the CCAFF evaluation, Delphi technique was employed at which seven experts in two rounded panels contribute to the evaluation findings based on six criterions. The evaluation findings demonstrated promising results in terms of ease of use (86.4%), usefulness (84.6%), decision making support (86.6%), comprehensiveness (85.8%), time efficiency (84.8%), and usage intention (84.8%).

1. Introduction

From one side, CC has created a new horizon in many economic sectors, at which it provides on-demand computing services with a dynamic performance capability, low entry costs, ubiquitous access, availability, flexibility, and scalability [1,2], and it has rapidly grown, so it would enforce institutions to adopt [3].

According to [4], the national institute of standards and technology (NIST) defines Cloud Computing (CC) as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

From the other side, Enterprise Architecture (EA) is a discipline that gained a remarkable attention from the academia and the practitioner's communities [5] as it resembles blueprints of the organization's actors, processes, and IT [6]. Number of The Enterprise Architecture Framework (EAF) have emerged in production sectors, defence, health, governmental, private, or even general-purpose domains, one amongst which is the Open Group Architecture Framework (TOGAF) [8]. The Business Architecture (BA) of EA based TOGAF addresses the concerns of the users related to people, process, function, business information, usability, and performance [8]. The BA views include business function, business services, business process, business locations, organization chart, business strategy and objectives, etc., while the Information systems architecture (ISA) views include data, applications, and technology architecture views including technology hardware, operating systems, networks, networking communication devices, etc. [8].

Consequently, integrating EA with CC provides enterprises an opportunity more scalability, high storage capacity and availability, continuity, and security parsing [9,10]. However, the survey conducted by [11] indicates that enterprises face several challenges when performing a successful implementation of cloud solutions such as the transformation of legacy IS apps and associated maintenance. Alternatively, [12] indicate other challenges which affect the comprehensiveness of the cloud strategy.

Subsequently, [13] see that after the cloud transformation, CC needs to be tailored and complemented with the EA as the relationship and integration between EA and CC according to [14] never been discussed in academia so, it is essential to build a link between CC and EA [15]. To address this gap, this paper aims to develop and evaluate an FI based framework for CC adoption strategy (CCAFF) in banks, from the lens of Enterprise Architecture, at which the developed framework is meant to be holistic by addressing the entire IT- CC adoption strategy for FI in the Kingdom of Bahrain and to be evaluated on a single case study (FI-01), specifically by applying a tailored version of EA development methodology (TOGAF).

Thus, for successful development of the (CCAFF), this study follows a six phased Design Science Research Methodology (DSRM), at which a holistic mixed mode single Case Study is employed as a research strategy for the development, with variant validity and reliability measures, while a Delphi technique is applied to evaluate the CCAFF based on six criterions, two panels, and six experts' feedbacks.

2. Literature Review

A. CC Adoption in the FI- Banking sector

Throughout literature review, it was evident that each enterprise has a unique framework to control the flow of tasks. However, currently, the current frameworks development appears mismatching the frequency rate of innovation. The paradigm shift is the adoption of cloud computing. There is a gap between the academic CC adoption initiatives and actual CC adoption utilization. Also, the decision of adaption in financial enterprise which handles sensitive data has many restrictions including, bureaucracy due to its value [37]. [21] debate among adoption consideration in term of benefit and risk for SME. lots of internal and external factors from the enterprise itself effect the cloud adoption, mainly: firm size, environmental, regulation [38], these factors should be considered before CCA.

In the financial institutions, [39] considers the public cloud as a CC environment at which cloud solutions are located publicly outside the banks, thus, having no control; however, control functions are provided to the company using publicly hosted cloud services by subscription. In contrary, the private cloud solutions are located inside the banks having all control so, computing resources (Physical on-site data centre/s ("on-premises")) are used by a third-party provider ("hosted private cloud"), while hybrid cloud solutions integrate the private and public clouds within the same bank to perform specific functions, which suggests a perfect adoption type to all financial institutions.

Researchers have studied the effect of CC adoption in FI banking sectors and argued that CC adoption is highly important for banking in terms of CC technology benefit in this sector.

A comparative analysis to current studies is carried to demonstrate the similarities and the differences. Noticeably, the research works are categorized based on their geographical location employment and the frameworks, methods, models, or strategies applied in the CC adoption. For example, five studies were found in the middle east region and Africa (MENA), such as Egypt, Iran, Ethiopia, and Kenya, while seven studies were found in Asia including four in India and one in Malaysia. Two studies were found in Europe, one of which is in Romania, while one study was found in USA.

There appears many models/ methods/ frameworks to choose from, however most studies don't provide holistic frameworks towards CCA for FI. Also, most proposed solutions are not evaluated and tested in reality. Moreover, some studies consider specific concerns such as, security of the cloud, importance of CC, and many other areas of CC, but the CC adoption. There are other cases that view the enterprise from different aspect not from EA view or use other frameworks development tools which give different results, other than that there is some comparison between traditional process with advance technology in banking without measuring the effort of the suggested/ proposed framework. Finally, most of these studies are utilized outside of the GCC region.

Speaking about the CC adoption in Bahraini FIs, [18] advocates that according to the CC strategic plan of the kingdom of Bahrain government 2030 vision, governmental and non- governmental institutions are obliged to adopt CC in their businesses. [18,40,41] advocate that the GCC countries show interest in CC adoption specially in KSA. However, the CC adoption is not including the FI. This is due to data collecting limitation, sensitivity and confidentiality of data that abide the restricted rules and regulations. Moreover, each section/department of the FI needs authority or permission to get information. Most institutions prefer using local resources instead to cloud oriented ones. Therefore, CC adoption strategies are rare in the FI sector in comparison to other sectors.

By introducing Amazon cloud services recently in Bahrain, variant institution opportunities for cloud computing adoption have emerged. Information and government authority (IGA) of the kingdom of Bahrain view e-Government first in cloud transformation.

3. The Conceptual Models

Meeting the objective of this study, a CCAFF is developed by 1) utilizing a tailored version of TOGAF and 2) aligning TOGAF with a tailored version of enterprise cloud adoption strategy (ECAS) by [42].

From one hand, [43] advocate that TOGAF acts as general-purpose framework for enterprise architecture development that is developed to meet different stakeholder's requirements at which it embraces a set of EA views. This architectural representation articulates the baseline/future business states and explains how architecture is represented and what it is composed of [8]. On the other hand,

ECAS as proposed by [42] is needed by enterprises to plan for governing cloud adoption strategy as it ensures appropriate development with proper controls for progression with business continuity, and upon execution governs implementations so that cloud projects are in alignment with enterprise strategy.

Consequently, the integration between TOGAF and ECAS in a proposed CCASF framework is meant to be develop a comprehensive framework for CC adoption of the Bahraini FI sector.

A. The Baseline and Target Architecture states

According to [8], eight TOGAF phases outline the current state "AS-IS" of the enterprise, including the Preliminary phase, Architecture Vision phase, Business Architecture (BA) phase, Information Systems Architecture (ISA) phase, and Technology Architecture (TA) phase. However, the remaining phases outline the target state "TO-BE" of the enterprise, including Opportunities and Solutions, Migration Planning, Implementation Governance, and Architecture Change Management.

The Preliminary (Phase 0) is the preparation stage that defines the initial actions required to understand the enterprise model in order to help develop the new architecture, by answering standards enterprise question. The preliminary phase is important and necessary to start developing EA. The questions asked collects related information regarding the existing workflow and daily operations, policies, and procedures, understands the business strategy, moreover, identifies the profile of the institution.

The Architecture Vision (Phase A) begins with the existing EA to understand the evolution development cycle and capabilities, while the business principles, goals, strategy, and other factors are considered. Also, ensure that components of the BA are defined and identified clearly, stakeholders and objectives are addressed. In addition, the main business constraints are articulated. Lastly, a formal approve is obtained to proceed with the EA project.

The Business Architecture (Phase B) shows the way that enterprise executes business. The views comprise different business aspects such as: Business Strategic Objective (BSO), Organization Structure, Business units (BU), Business Actor and Role (B A/R), Business Services (BS), Business Function (BF), and Business Processes (BP). In order to reach this view, a set of data collection which comprised of the BSO ID, BSO Name, and BSO Description. Furthermore, the organization structure which contain BU and A/R views, going into details about describing each business units and related roles or actors whether internally or externally. The view of Business Service (BS) describes the end services that each business unit provide which keeps in line with both the BF and BP, in order to achieve this view, the collected data contain BS ID, BS Name and BS Description. Next, the view of Business Function (BF) describes the business units that carry out the business services to meet the BSO, all business functions must be justified, in order to achieve this view, the collected data contain BF ID, BF Name, BU ID, and BS ID. Finally, the view of Business Process (BP) describes the business processes needs to deliver the functions, while set of function deliver the end services, in order to achieve this view, the collected data contain BP ID, BP Name, BP Description, BF ID, and BS ID.

The Information Systems Architecture (Phase C) represents the data and application systems that support the BA of the enterprise. The main application systems should be defined that support the business and the data that interact between these application. In fact, that the applications capabilities are referred to the used technology (the infrastructure). By listing all the used application these collected data includes information about the applications such as: Application ID, Application Name, Application Description, Application Vendor, and Application Origin. Second, the BA

connects the ICT applications and data layer by matching the Bus, A/Rs, BFs, BSs, and BPs with the used application. The collected data contain Application ID, BU ID, A/R ID, BS ID, BF ID, and BP ID. Thus, key data helps in view the Application Process (AP) which deliver the identified services in term of view application priority.

The Technology Architecture (Phase D) shows the enterprise used technology (infrastructure) that should be aligned with the data and application component and should support the vision and mission of the enterprise business. The Technology Architecture TA is comprising of hardware, software, and network. The collected data contain of Tech ID, Tech name, App ID, and App Name.

The Opportunities and Solutions (Phase E) is the initial stage for the creation which leads to implementation and migration plan which is stated in phase F later on. At this phase an overview of the future opportunities are identified taking into consider the benefits and the degree of impact to the enterprise. Opportunities are identified from the gaps in phases B, C, and D based on the enterprise capabilities and business objectives. Opportunities can be formed in many terms such as new technology, new stakeholder, new investment, new applications, new model, or improvements to current situation. Therefore, by identifying new opportunities new solution is designed. the opportunities and solutions phase view a clear vision for the future update to the existing architecture. Much more Proper planning helps in developing a better strategy for migration and implementation plan.

The Migration Planning (Phase F) is the final phase before actual implementation to the architecture. the proposed strategy by [42] is Enterprise Cloud Adoption Strategy (ECAS) matches this phase to provide the migration plan for the CCA. Based on [42] adoption strategy, the strategy of cloud adoption lifecycle is composed of six phases.

The implementation Governance (Phase G) presents the actual architecture implementation, which is adapted according to situation, more details addressed in this phase will gain the actual architecture implementation. The most important part in this phase is to keep monitor the implementation effectiveness, and ensure proper controls are applied to minimize the risks at lower level. The benefit of these monitoring actions are to create learnt list, which can be used in post implementation as a primary data for future development and improvements.

The Architecture Change Management (Phase H) provides feedback for the migration and implementation phase and describes the cloud services actual delivery, this ensure that the EA achieves its business objectives, and also EA is adapting with the latest development in cloud technologies. Further, this phase identifies whether the changes has intended to create new capabilities or enhance currents situation. The expected outcomes are organized and standards are updated to maintain proper risks assessment to EA changes. Moreover, risks associated with the new changes are analyzed.

B. The Enterprise Cloud Adoption Strategy (ECAS)

Integrative with Phase A until Phase F, the insights of [42] as represented by ECAS is tailored and complemented herin in order to provide a holistic migration plan for the enterprise cloud adoption (CCAFF). The strategy is composed of six phases of cloud adoption lifecycle.

C. TOGAF-ECAS alignment and CCAFF

This section demonstrates the conceptual proposed model CCAFF. Figure 1 summarize the previous discussion of the conceptual model.

Figure 1. The conceptual model CCAFF

4. Research Methodology

This section explains in detail the research methodology, in addition to that, a details description for the applied model and analysis technique will be discussed. Starting with the main research strategy the Design since research methodology (DSRM) which is usually used to develop and perform an artifact design in practices that could be implemented in reality according to current enterprise situation. DSRM is a scientific study that is used by people to solve practical problem or perform an improvement. The artefact has many faceted could be either a model, algorithm, IT system, or a new technology, these examples has main common denominator that is tangible, new, original, novel. As mentioned earlier the DSRM has five stages starting with first stage that explicate the problem which could be either practical problem or knowledge problem, next stage is the second stage that define the requirement which probably be either feature/functions or generic qualities, third stage is design and develop the artifacts CCAFF that describe the component of the proposed framework and solution designed, fourth stage is demonstrate the created artefact CCAFF by implementing and testing the case in reality. Finally, last fifth stage evaluates the artefact through ex ante evaluation or ex post evaluation, these stages help gaining improvement (development) or solving a problem. As prefer mentioned DSRM process has flexibility option not to go through all stages activity according to the case, so it could skip the first stage process and begin from the second stage, in addition to that flexibility DSRM process could also skip the first two stages and start performing from stage three. Table I describes the DSRM steps in details.

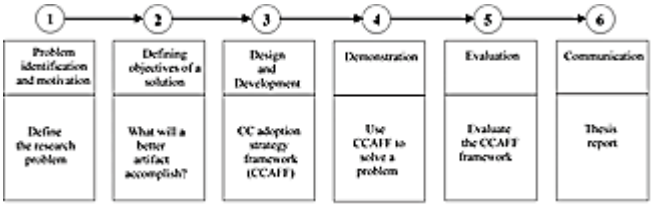

Figure 2. The DSRM Steps Description

Because of the design nature of this paper, this study uses DSRM as a suitable and relevant methodology.

The existence of a specific definition for DSRM is not clear. The term DSRM mean the ability to design and analyse a new unique artifact that solves a particular problem [44]. DSRM has played a vital role in shaping the theoretical framework of enterprises, which can be used to develop products and services that meet the needs of the real world. This framework was also used to identify the various design artifacts that can be used to resolve proposed problems

In addition, [44] advocate that DSRM align the theoretical background of enterprises with the real-world outcome, DSRM has a precise process to design an artifact which resolve a problem, DSRM uses IS interacting with new technology and enterprises for actual scenario solutions.

5. Evaluation

The CCAFF framework is evaluated using the Delphi technique, which was utilized by IS researchers in various subjects [50]. According to [51], Delphi technique enables evaluators to deal with a complex problem to find the most reliable consensus among experts of a given field, by conducting multiple interviews and getting opinion feedback. Consecutively, the current survey questionnaire was carried out carried out using an online questionnaire that is designed by Microsoft Forms, at which the link to the survey was sent to the experts via email. Moreover, the questionnaire consisted of four sections that explain the main concepts of the framework. The first introduces the questionnaire, while the second introduce the demographic profile elements of the experts and organizations. However, the third section provides various Likert-type scales assessment questions from strongly agree (5) to strongly disagree (1). Each criterion has three to five measurement items, while the fourth section consists of open-ended question regarding the views on the proposed framework.

A. Assessment criterion

The data collection was conducted in two phases. All experts were contacted through email to set up the tasks of the survey. During the survey, experts were asked to respond within one week. emails were sent to remind them that they should submit their feedback. The first round of the survey was held in the first week of November 2021.

The experts were asked to answer the survey. The results were returned on time by all panel members. Alternatively, the second round of the Delphi survey started on the second week of November 2021. The experts were asked to answer the questions related to the Delphi survey following the first-round procedure

B. Analytical findings

The results of round-1 were included as feedback to all panel experts in round-2. All experts' panel returned the answers on time. Microsoft Excel is used as a statistical tool to analyze and interpret the data in both rounds to create and analyze the statistical data of each assessment criterion are measured, at which the Standard Deviation (SD) and the Mean Difference (MD) are used to evaluate the proposed CCAFF framework.

Ease of use measurement "Ease of use" measures the extent at which the panel experts believe that using the CCAFF is relatively effortless, while Usefulness measurement "Usefulness" measures the extent at which the panel experts believe that using the CCAFF would enhance job performance.

Decision-making support measurement "Decision making support" measures the extent at which the panel experts believe that using the CCAFF would support the implementation of CC decision-making, while Comprehensiveness measures the extent at which the panel experts believe that using the CCAFF is comprehensive and is composed of all required phases to adopt and migrate to CC.

Required time measurement "Required time" measures the extent at which the panel experts believe that using the CCAFF is not time consuming, while Intention to use measurement "Intention to use" measures the extent at which the panel experts believe they are willing to using and conducting the CCAFF.

C. Empirical results

Overall, the evaluation process produced positive results in both rounds, the experts also stated that the CCAFF is easily understood. Also, they noted that the CCAFF framework is a useful for improving the way they perform their tasks in an organization. They also stated that it is well-equipped to support the sufficient implementation of CC in FI-01 departments. Besides that, the experts panel also noted that the CCAFF should be completed in a time-efficient manner. They also expressed their intention to use it in their respective FIs. Figure 2 shows the evaluation results.

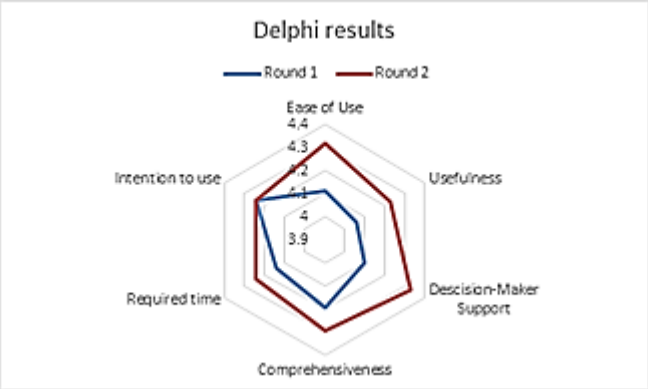

Figure 3. The Delphi technique evaluation result

6. Discussion and Findings

This study focused on developing and evaluating a strategy (framework) that would enable a bank as an FI in Bahrain to CCA from an EA-based perspective. This thesis was following the steps of the DSRM project by [44]. The framework was successfully developed using the TOGAF-ECAS approach targeting FI-01 to create an artifact as a real case study. The CCAFF framework was evaluated using the Delphi technique. This procedure involved a panel of experts to thoroughly review the framework's reliability and accuracy. The findings reveal that CCAFF framework is highly comprehensive (85.8%) and provides the sufficient support for the establishment of CC in the FI industry (86.4%). Moreover, the findings of the survey revealed that (84.6%) of experts agreed that the framework is useful and helpful, in addition (86.6%) of them also agreed that the framework was eased to use by decision-makers for improving the perform of tasks in CCA. However, most of the panel experts agreed that the framework required time to finish (84.8%). In addition, the majority of them (84.8%) also believe that the framework should be used in their FIs. As a result, the artifact has provided a useful guidance for implementing CC in the context of the retail banking industry, plus It can be modified to fit specific requirements.

7. Conclusion

This paper is aimed to explain the proposed conceptual model of CCAFF in details dictating the TOGAF phases along ECAS stages. Beginning with developing the framework using a tailored version of TOGAF which was proven to be the best matching framework for this purpose. The next stage was describing the AS-IS and TO-BE phases. In addition to the application of a tailored version of ECAS strategy for the adoption, a comparison was performed between multiple models and selection of the suitable one was achieved by aligning the ECAS with TOGAF to develop the CCAFF framework. This paper also describes on details the research methodology that is applied in this study which is the DSRM. This paper follows a mixed mode (qualitative &quantitative) approach by applying case study to explore the FI-01 as a holistic single case strategy at which structured

interviews were employed to conduct the data collection strategy. Finally, this paper presented the carried-out process of evaluation to the proposed CCAFF framework using a Delphi technique. The evaluation process assessed the framework and obtained feedback on the utility of the framework based on six specific criterions.

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