

Cloud computing network adoption in Saudi Arabia

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Abstract

The aim of this paper was to provide a topic-wise review of current status of cloud computing in Saudi Arabia. The review also identified factors promoting and inhibiting its adoption on a large scale. Due to the importance for achieving some goals of Vision 2030, education and healthcare received more attention than other topics. Cost saving and efficiency increase are highly critical to reduce the cost burden of healthcare in the country. The need for more research was indicated with respect to ERP, SCM and CRM of business organisations. Mobile cloud computing is another aspect requiring more research, which is beneficial for both education and healthcare. Research on conceptual models helps to identify factors related to adoption or non-adoption of cloud computing in a particular organisation. Once these are known, decision making models can be used to consider whether cloud computing needs to be adopted.

Keywords: Cloud computing network, adoption, Saudi Arabia

Introduction

The term “Cloud computing” denotes use of internet for data storage, servers, databases, networking and software. In this system, data and files can be saved in a remote database instead of conventional hard drive. Access to the data and software programmes is possible if the computer has access to the web. Cloud computing can be used for cost saving, increased productivity and security. Hence, it is a popular option. However, cloud computing has both advantages and disadvantages.

Saudi Arabian firms have been increasingly adopting cloud computing over the last 15 years. The end-user expenditure of companies was over \$250 billion in 2020 and it is expected to grow by 18% in 2021, driven by covid pandemic for remote working setup. There is also an attempt to introduce 5G networks in the country. Cloud computing is considered as an aid to Saudi Arabia’s rapid economic diversification, as a part of its Vision 2030 (Mohamed, 2021).

Some regulatory frameworks have also been established by Saudi government and its associated organisations. Saudi Arabian Monetary Authority has released a cyber security framework, which, all organisations registered with SAMA must adopt. This framework covers cloud computing also (NNT, 2021).

After a public consultation process in 2016, the telecommunications regulator, the Communications & Information Technology Commission (CITC), issued a cloud computing regulatory framework, the Cloud Framework, which became effective in March 2018. In 2018, the National Cybersecurity Authority (NCA), the government agency responsible for cybersecurity, issued the Essential Cybersecurity Controls (ECC: 2018). In February 2019, the Ministry of Communications and Information Technology of the country published its KSA Cloud First Policy document to demonstrate adoption of cloud services at the government level is very much a concern of the government. The CITC issued amendments to the Cloud Framework in February 2019. Despite all these regulations and amendments, ambiguities on many aspects of cloud computing and its security in Saudi Arabia remain (O’Connell, 2021).

Methods

The impact of cloud computing, including security frameworks and concerns had been the topics of research for some time. In this paper, some selected papers, relevant to Saudi Arabia, are reviewed. The papers for this review have been selected from the results of searching Google Scholar.

Results

Organisations

Huge savings from cloud computing has led to the concept of cloud economy. A few developing countries like India are becoming targets of outsourcing for global corporates facilitated by cloud computing. Saudi Arabia is also progressing fast in this direction. This possibility was investigated by Yamin and Tsaramirsis (2012) using a study of thirty-three public and private organisations in Saudi Arabia. Reasonable to good awareness and knowledge of cloud computing and its economic benefits was observed in various organizations. The technology readiness and attitude towards cloud computing has been positive. These factors are congenial for rapid spread of cloud computing in Saudi Arabia to take advantage of cloud economy.

In a Malaysian review, motivators of cloud computing adoption were identified as measured services, on-demand (self) services, broad network access and rapid elasticity. Inhibitors were security, privacy and trust, compliance, reliability and availability, service pricing, complexity and interoperability and vendor lock-in. The review also tabulated sectors most affected by each factor according to reported results (Amron, Ibrahim, & Chuprat, 2017).

The current status of cloud computing adoption by Saudi public sector organizations was assessed by Al-Ruithe, Benkhelifa, and Hameed (2017). Out of 206 organisations responded, only sixty had adopted cloud computing. Out of 112 organisations, which had not adopted cloud computing, some had not even discussed, a few others were planning to adopt it in the next two years or earlier and the remaining organisations did not want to adopt cloud computing at all. In the case of thirty-four organisations, which said 'don't know,' lack of knowledge of the technology, cloud computing no being a strategy or plan and other reasons were given. Of the organisations, which had already adopted cloud computing, a majority had opted for private cloud, some had it in their premises, some others used public cloud or community cloud. Key issues related to digital transformation for adoption of cloud computing in Saudi public sector were investigated in a related paper by Al-Ruithe, Benkhelifa, and Hameed (2018). Security, privacy and loss of governance and lack of knowledge were identified as the key issues from the results of a survey of 206 public sector organisations. In the government sector, nearly all respondents supported adoption of cloud computing due to its usefulness and perceived quality. But those raised security concerns had a lower level of attitude towards adoption (Alsanea, Barth, & Griffith, 2014).

In the survey studies of Alkhater, Wills, and Walters (2015), sixteen factors were identified as affecting adoption of cloud computing in Saudi Arabia. These factors were availability, reliability, security, privacy, trust, relative advantage, compatibility, trial ability, top management support, organisation size, technological readiness, compliance with regulations, physical location, external support, industry, and culture. This list of factors seems to be comprehensive. Interview results obtained by Al Khater (2017) found that only two out of seventeen factors tested, complexity and competitive pressure, did not affect cloud computing

adoption by Saudi private sector organisations. Results of a survey on 300 IT staff showed that quality of service and trust are the most important factors for cloud adoption and security and privacy concerns were negative factors and location of the organisation significantly and directly affected compliance with regulation and privacy. These effects varied according to size and adopter/non-adopter status of the organisation. Based on interviews with IT professionals, Alanezi (2018) identified security and privacy, government policy, lack of knowledge, and loss of control as the negative impact factors and : reduce expenses, improve IT performance, and promote scalability and flexibility as the positive impact factors for adoption of cloud computing in public or private organizations in Saudi Arabia. Security factors affecting successful adoption of cloud computing in Saudi organisations were identified and a framework was proposed by Alassafi, Alharthi, Alenezi, Walters, and Wills (2016). The framework focused on risks, social and security benefits when implementing security in the cloud services and consisted of three categories of social factors, perceived cloud security risks and perceived cloud security benefits. In a later paper Alassafi M. O. (Alharthi, Walters, & Wills, 2017) added failure of client-side encryption as an additional factor in the framework.

Using diffusion of innovation (DOI) theory and technology-organisation-environment (TOE) framework, Alhammedi, Stanier, and Eardley (2015) examined the factors related to cloud computing adoption in Saudi Arabia. A set of fourteen hypotheses were used for testing. The survey yielded eighty-one valid responses. The results showed that factors of security concerns, organisational readiness, firm status, top management support, government support, compatibility influenced cloud computing adoption. Start-ups were more likely to adopt cloud computing. The validity of these findings is suspect due to the low sample size. Based on the results of a survey of 106 IT managers, IT consultants, and IT professionals of Saudi organisations, Al-Jabri and Alabdulhadi (2016) concluded that top management is positively influence the likelihood of cloud computing adoption.

Using DOI and TOE as the research framework, AlBar and Hoque (2019) investigated on cloud ERP adoption in 136 Saudi organisations. A competitive environment, complexity, ICT infrastructure, observability, relative advantage, regulatory environment, ICT skill and top management support were identified as favourable factors for cloud computing adoption. Compatibility, organisational culture and trialability did not have any effect.

SMEs

It was found by Basahel, Yamin, and Drijan (2016) that concerns of security and privacy and lack of awareness of benefits prevent Saudi SMEs from adopting cloud computing. Based on interviews with managers of SMEs different types of IT industry in Saudi Arabia, Albelaihi and Khan (2020) observed that those SMEs which had adopted cloud computing reported benefits of cost saving, enhancement of innovations, acceleration of decision-making, customer communication and qualitative improvement in performance. But the challenges of low level of knowledge about cloud computing, privacy and security concerns were also revealed.

Education

Cloud computing is the basic environment and platform in the field of education, especially, in the future E-learning. A research done by Al Tayeb, Alghatani, El-Seoud, and El-Sofany (2013) revealed that it is a valuable tool to achieve the course objectives for both students and instructors. Characteristics of academic institutions and benefits and barriers to the adoption of cloud computing in higher educational institutions of developing countries, with special

emphasis on Saudi Arabia, were reviewed by Karim and Rampersad (2017). A survey of adoption of cloud computing by educational institutions by Almajalid (2017) showed that it enables minimal use of resources with high quality service. Students can perform well academically, and administration can perform their business tasks well. More sustainable and efficient teaching and research can take place with cloud computing leading to enhanced quality of teaching and learning. This has led to educational institutions increasingly adopting cloud computing. In a work using TOE model, Tashkandi and Al-Jabri (2015) noted that the factors affecting cloud computing adoption in the case of Saudi educational institutions were relative advantage, data privacy and complexity. Differences in compatibility, complexity, vendor lock-in and peer pressure were found between large and small institutions. Adoption rate was higher among large institutions than smaller ones. Future development of cloud computing in Saudi Arabia depends on improving internet infrastructure and network, affordable costs and addressing privacy and security concerns of non-adopters by service providers. In this research, universities were used as samples and the limited number of universities also limited the sample size to thirty-three. This affects the validity of the findings obtained. Using 451 higher education students, Almarazroi, Kabbar, Naser, and Shen (2019) observed some gender effects on adoption of cloud computing among Saudi university students. It was found that trust in the case of female students and image in the case of male students were the main determinants of behavioural intentions towards adoption of cloud computing. Adoption of mobile cloud computing (MCC) by Saudi university students was influenced by perceived ease of use, perceived usefulness, social influence, accessibility of technology, individual characteristics, perceived privacy, and security as the results of a survey of 163 students by Abdulfattah (2021) revealed. Survey results of 210 participants from different departments in public universities of Saudi Arabia revealed that PEOU, PU, quality of service, relative advantage and trust determined adoption of mobile cloud computing by Saudi academic staff (Almaiah & Al-Khasawneh, 2020). TAM model was used here. Results of a survey of more than 300 participants from 5 Saudi universities by Noor (2016) revealed ubiquitous network access and on demand (self-service) as the two top motivators and availability, reliability, security, compliance, and privacy as the top five inhibitors, in their order of ranking. In a mixed methods study, Karim and Rampersad (2017) investigated on four factors (technological, organisational, environmental, and cultural) as influencers of cloud computing adoption by Saudi university students. An extended TOE consisting of (technology, organisation, and environment and Hofstede cultural dimensions (Hofstede, 2021) were used as the framework. Relative advantage, compatibility, top management support, readiness, competitive pressure, regulatory support, high masculinity and high individualism were found to impact adoption of cloud computing positively. Negative impact was observed in the case of security concerns, high uncertainty avoidance, and high power distance. Complexity, language or religion did not have any impact. Sample sizes for both methods have not been indicated in this paper. The impact of trust on adopting cloud computing by undergraduate students at Saudi Arabian universities was evaluated by Almazroi, Shen, and Mohammed (2018). A modified TAM with trust as an added component was used. Survey responses of 527 undergraduate students of two Saudi universities indicated PEOU, PU and trust as significant predictors of intention to adopt cloud computing by the Saudi university students. Observing that the most important barrier to adoption of cloud computing are perceptual and attitudinal, Alotaibi (2014) explored the factors related to the users' attitudes and intentions to adopt cloud computing among IT professionals and end-users in Saudi Arabia. An extended Technology Acceptance Model (TAM), which integrates Trust (TR), Anxiety (ANX) and Perceived Risk (PR) was used as the research

framework. Results of a survey of 966 participants showed that trust positively influenced Perceived Ease of Use (PEOU) and anxiety and PR affected PEOU and perceived usefulness (PU). Trust, attitude and PU predicted behavioural intention (BI) to adopt cloud computing. In another Saudi work using TAM with added factors of gender, age, education, occupation and nationality, Alharbi (2012) found a high level of acceptance of cloud computing with the use of the standard TAM. Significant effects of age, education, occupation and nationality on attitude towards adoption of cloud computing were also observed. TAM was used by Alresheedi, Lu, Maolood, Fatanid, and Ince (2018) to find that PEOU directly impacted attitude towards cloud computing, PEOU and PU intention to use it and attitude has direct impact on intention to use cloud computing. In addition, technical support has positive impact on PU, PEOU, attitude and intention to use it and PEOU has direct impact on PU. Direct impact of PEOU, PU, technical support, attitude, intention to use on actual use of cloud computing were also observed. The role of cloud computing in teaching learning at 29 Saudi government universities was in line with four principles of social constructivism theory (social interaction, previous experience, activity of learner, and development of mental skills), as was found by Alenezi (2019) through a survey of 84 deans and vice-deans of e-learning in these universities. Although several advantages have been recognised, the difference between adoption of cloud computing in general and cloud-based education as a service (CEaaS) has not been well understood. There is a lack of knowledge about adoption of cloud computing at the organisational level. To address these issues and to understand the factors of adoption of cloud computing at higher education level, Qasem, et al. (2021) developed a theoretical model by integrating four theories: technology-organization-environment framework (TOE), fit viability model (FVM), diffusion of innovations (DOI), and institutional theory (INT). The model may facilitate informed decision making at the management level.

Healthcare

Pointing out that e-health suffers from the problems of high cost, complexity and shortages of IT-skilled staff, Alharbi, Atkins, and Stanier (2015) and Alharbi, Atkins, and Stanier (2017) suggested cloud computing (e-health cloud) as a solution for Saudi Arabia. In this respect, a decision making framework, consisting of Organisation, Technology, Environment, Human and Business was proposed. The framework awaits testing and validation. Using TOE, Information System Strategic Triangle (IS Triangle) and Human-Organisation-Technology model (Hot-fit model), Alharbi, Atkins, and Stanier (2016) showed that, for adoption of cloud computing by healthcare organisations, business perspective was most important, followed by technology, organisational, environmental and human perspectives in the order of decreasing importance. Soft financial analysis, relative advantage, hard financial analysis, attitude toward change and pressure from partners in the business ecosystem were the factors influencing adoption of cloud computing by these organizations. It was also noted that more than one-third of the organisations had already adopted cloud computing; about 30% intended to adopt it within two years; about 22% did not know and about 12% did not intend to adopt it. In a case study of King Fahd Specialist Hospital, using a balanced score card approach, Alharbi, Atkins, Stanier, and Al-Buti (2016) showed that private cloud computing will provide strategic values for all five perspectives of internal process, customer, financial, organisational capability perspectives, with some high expectations for the financial perspective. A cost-centric model was proposed to the organisation. Using TOE and DOI with added decision maker context, Almubarak (2017) identified the factors of cloud computing adoption by Saudi university hospitals using the results of interviews and

survey of 120 participants. Most important factors noted in sequential order, were relative advantage of its use, innovativeness of decision-maker, IT knowledge of decision-maker, compatibility, and top management support. Among the context, decision-maker's context was most significant, followed by technological, organisational and environmental contexts, in that order. These results are useful for hospitals to make decisions about adoption of cloud computing. Noting that utilisation of cloud computing as a health information technology is challenged by security, privacy, reliability, integration and data portability are some leading to its slow adoption in Saudi Arabia and that e-health, security and privacy are very important, Chikhaoui, Sarabdeen, and Parveen (2017) discussed stringent security and privacy regulations on patient records as one of the barriers for its wider adoption.

As cloud computing consumes a lot of power and causes high levels of carbon emissions, sustainability issues are relevant for cloud computing also. Thus, adoption of green cloud computing becomes important. Adoption of green computing with best practices and actors affecting green computing were discussed by Alharbi, Alahrbi, and Alkhamali (2020).

Conceptual and decision-making models

A conceptual model for cloud computing adoption in Saudi Arabia was proposed by Alkhater, Chang, Wills, and Walters (2015) after reviewing the relevant literature. The model integrated all aspects of TOE framework and identified the key factors likely to influence organisations to use cloud services. Only competitive pressure and trading partner pressure were not significant out of all factors in the model. The model is presented in Fig 1.

A decision value model for Saudi public organisations was proposed by Mreea, Munasinghe, and Sharma (2016). The model included business, financial, and technical attributes. The model enables a decision on whether to invest in cloud computing or continue with the current in-house capabilities. The decision model is presented in Fig 2.

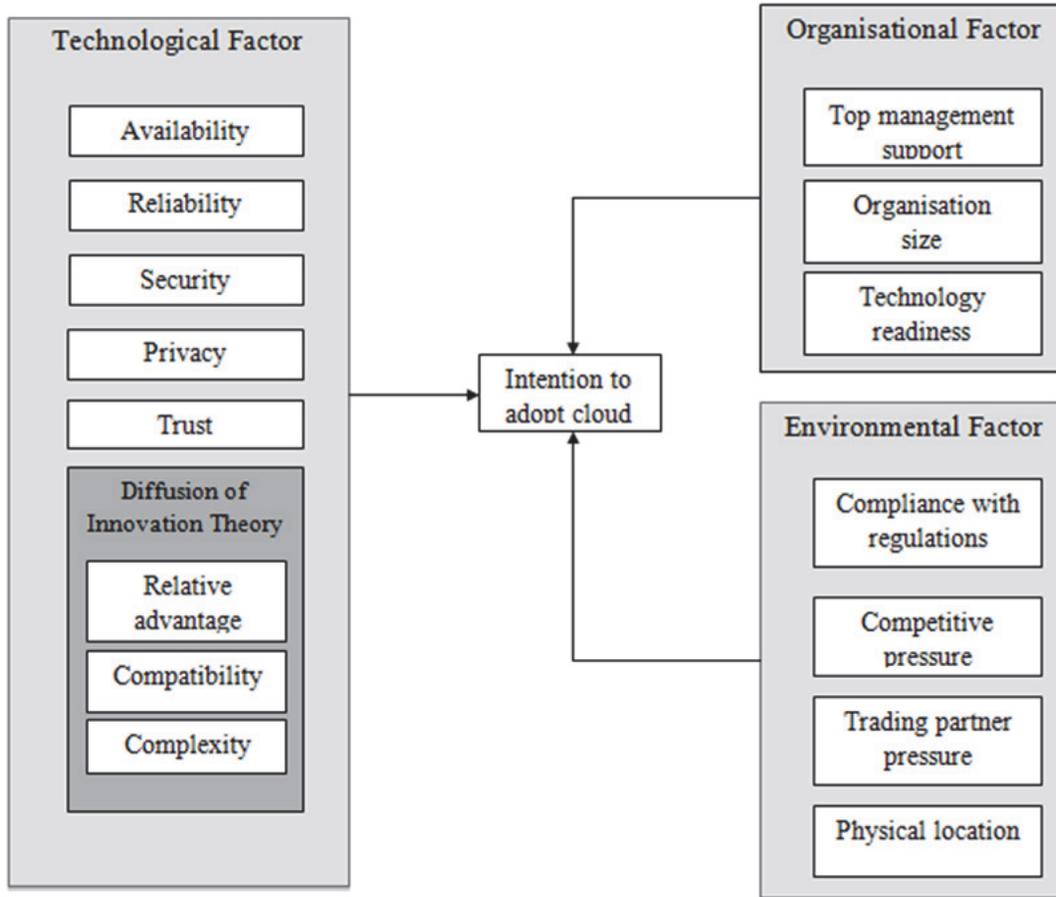


Figure 1 Conceptual model of cloud computing adoption in Saudi Arabia (Alkhatir, Chang, Wills, & Walters, 2015)

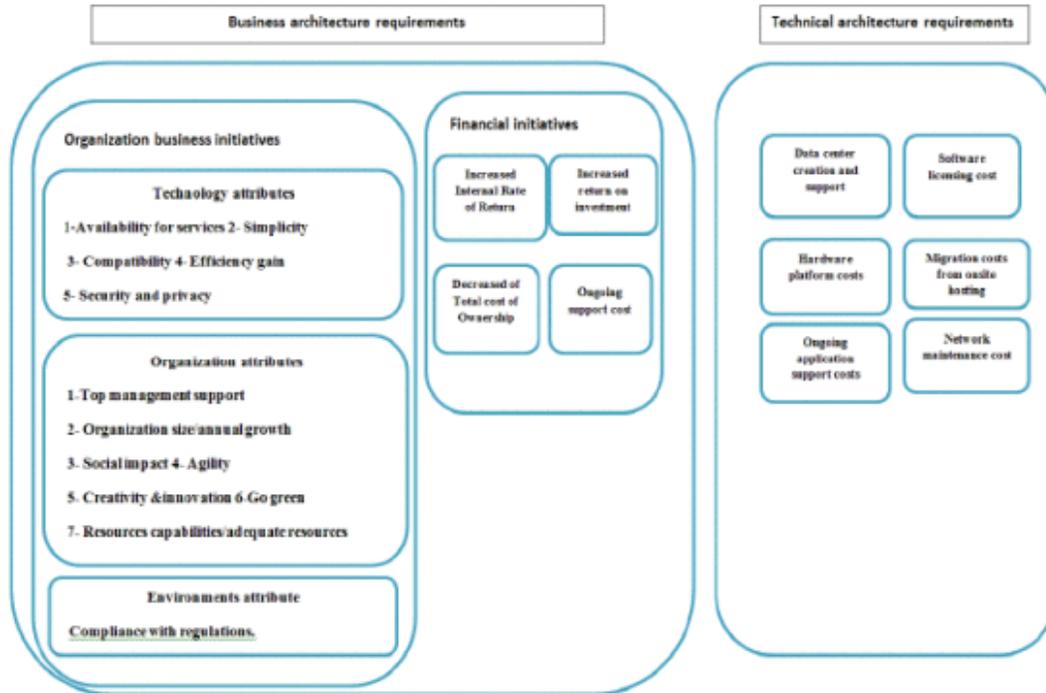


Figure 2 Decision value model for adoption of cloud computing by Saudi public organisations (Mreea, Munasinghe, & Sharma, 2016).

Another decision model for Saudi e-government (G-GOVERNMENT (ACCE-GOV)) for adoption of cloud computing was proposed by Al Mudawi, Beloff, and White (2019). The model was based on factors identified from TOE and DOI frameworks and consisted of technological, environmental, organisational and social contexts.

Discussion

The topic-wise breakup of papers is as given in Table 1.

Table 1. Topic-wise distribution of reviewed papers.

Topic	Number of papers
Organisation	13
SMEs	2
Education	16
Healthcare	7
Conceptual and decision models	3
Total	41

Greater emphasis had been placed education and healthcare. It is understandable since, Saudi Arabia is using education as the tool to enhance the skill levels of its workforce to global levels to minimise dependence on expatriates for services in key sectors, as a goal of Vision 2030.

Increase in prevalence of chronic ailments like diabetes and obesity puts pressure on the cost burden of the country, as it offers free healthcare to its citizens. Cost saving and efficiency increases are two aspects, which determines widespread adoption of cloud computing among educational and healthcare organizations of Saudi Arabia. Only seven papers were available on healthcare. More on use of cloud-based e-health patient self-management of chronic diseases will be highly useful to address the specific challenges faced by the country in this area.

On the other hand, little work exists in topic area of mobile cloud computing especially in education and healthcare. Only two works on this topic area were seen in education. For businesses organisations, enterprise resource planning (ERP), supply chain management (SCM), customer relations management (CRM) are very important. Cloud computing tools can be developed in these aspects also. Only one paper dealing with ERP was seen.

As SMEs form the backbone of any economy and is so in the case of Saudi Arabia, more works need to be done on this sector. SMEs lack the required resources to adopt cloud computing in key areas of their operations. Therefore, it is also necessary that the government support them on financial, technical and management aspects of cloud computing.

Conceptual models facilitate identification of factors promoting and inhibiting adoption of cloud computing by organisations. Therefore, many more works are required in this area to rapidly increase the adoption rate of cloud computing in Saudi Arabia. Similarly, decision-making models help organizations to use definite criteria to decide either to adopt or not to adopt cloud computing. Hence, importance of more research in this area is clear.

Conclusions

This topic-wise review showed helped to understand the current status of adoption of cloud computing in different sectors and factors contributing to their adoption or non-adoption. Much work has been done in education and to some extent in healthcare sectors in line with their importance for achieving some goals of Vision 2030. However, much more work needs to be done in certain other critical areas. It is hoped that more work on these areas will be done in times to come.

This paper was a topic-wise review of current status and factors of adoption of cloud computing in Saudi Arabia. A more detailed and systematic review could have been done. This may be a future paper, although it is doubtful whether any additional useful information can be obtained from such quantitative review at this point of time.

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