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CLOUD COMPUTING: A SUCCESS MODEL FOR SOUTH AFRICAN PRIVATE HOSPITALS

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ABSTRACT

Over the years, hospitals have failed to access important data quickly due to unavailability of kept records leading to either loss of time or reassembling the processes to recapture lost information. The purpose of this paper was to find out about the critical quality factors influencing South African hospitals cloud computing performance. The primary research focus was on private cloud computing (CC) and 72 questionnaires were administered on CC quality by the Chief Information Officers to explore their thoughts on the matter. The findings show that the incorporation of trust into the performance model of information systems should explain the performance of cloud computing in hospitals in an appropriate way. In addition, the quality of information service and device functionality affect cloud satisfaction directly, thus the two are directly affected by trust satisfaction. Trust is the mediator element between the

quality of service and fulfilment. This popular CC model will assist hospitals determine success or failure in South Africa. This study further noted that the findings from surveying CIOs can be different from those of regular users. For better understanding of this subject, this study proposes comparative research to be carried out in the future.

Keywords: Cloud computing, Health care services, Information systems success models.

1. INTRODUCTION

South Africa has delivered universal health insurance to its citizens since 1995 after independence. Over the years this implementation, there has been lack of funds for National Health Insurance; several measures to reduce the funding gap have since been introduced, including groups linked to diagnosis (Ahuja, Mani, & Zambrano, 2012). In 2013, the National Health Insurance (NHI) program's second phase was launched with an extra cover for the premium to tackle the subsidy delinquency. The reduction of running costs has become an imperative priority and a basis of competitive improvement for hospitals of compliance with various national health insurance payment requirements. In order to do this, information Technology (IT) has been used as a vital tool. Hospitals should provide effective health care at a lower cost based on the characteristics of information systems (IS). Such IS healthcare systems include picture archiving and communication system (PACS), Health Information Systems (HIS), and radiological information systems (RIS). Amongst other systems, the IS includes image archiving and communication systems (Freeman & Urbaczewski, 2020).

2. LITERATURE REVIEW

Recently, as the cloud application age evolves, it has become more viable than conventional IT systems to build electronic medical records (EMR) (Gantz & Reinsel, 2012; Hurwitz & Kirsch, 2020; Mekkattuparamban &

Robinson, 2020). Deployment models can be classified into private clouds, public clouds and hybrid clouds according to their applications. The new framework can be used by many hospital-based applications. In recent years, South Africa's cloud infrastructure has become the IT services network for more and more hospitals. Across previous research, however, crucial factors influenced decision undertakings (Patel, Chauhan, & Kapadiya, 2012). On the other hand, there were very few studies to explain the effectiveness of cloud computing in hospitals. Patel et al., (2012) stressed the crucial role of IT capabilities in the success of cloud computing (management, technology and relations). Nevertheless, only IT capacities were considered, certain IS performance factors were not taken into account. Furthermore, their work did not refer to the healthcare industry with other characteristics other than other industries (Chaudhary, Peddoju, & Peddoju, 2020).

This study aims to institute and validate a cloud-based success model for South African health sector particularly in the hospitals to resolve the lack of relevant work. The Hospital Cloud Success model was developed and validated with the survey of the Hospital Chief Information Officers (CIOs) by combining the IS success model with the trust model (Manuel, 2015). Three key contributions to this research have been established. Firstly, the insufficiency of existing literature work is discussed. Secondly, there is a possibility of applying reference to CC use in hospitals in the future. Finally, there is a possibility of applying performance of the cloud-based health systems (Nguyen, Pathirana, Ding, & Seneviratne, 2019).

2.1 Theoretical framework and hypothesis

The IS performance model proposed by DeLone and McLean (2002) is key to the theoretical basis of this analysis. Twenty years on, DeLone and McLean (2002) incorporated various problems and evolutions in the IS world and managed to put forward a revised IS success model and used it in the electronic business environment. This model has been checked with

previous IS researchers (Utomo & Darma, 2020). It points to 3 main factors that influence user expectations and satisfaction which includes the quality of information, device quality and service quality. Furthermore, user intention affects user actions and consequently user satisfaction. It therefore improves consumer expectations and results in a loop of greater user satisfaction. The effectiveness of the IS will eventually lead to benefits and advance the users' willingness to use the information system (Hoxmeier & Lenk, 2020). Figure 1 shows this loop.

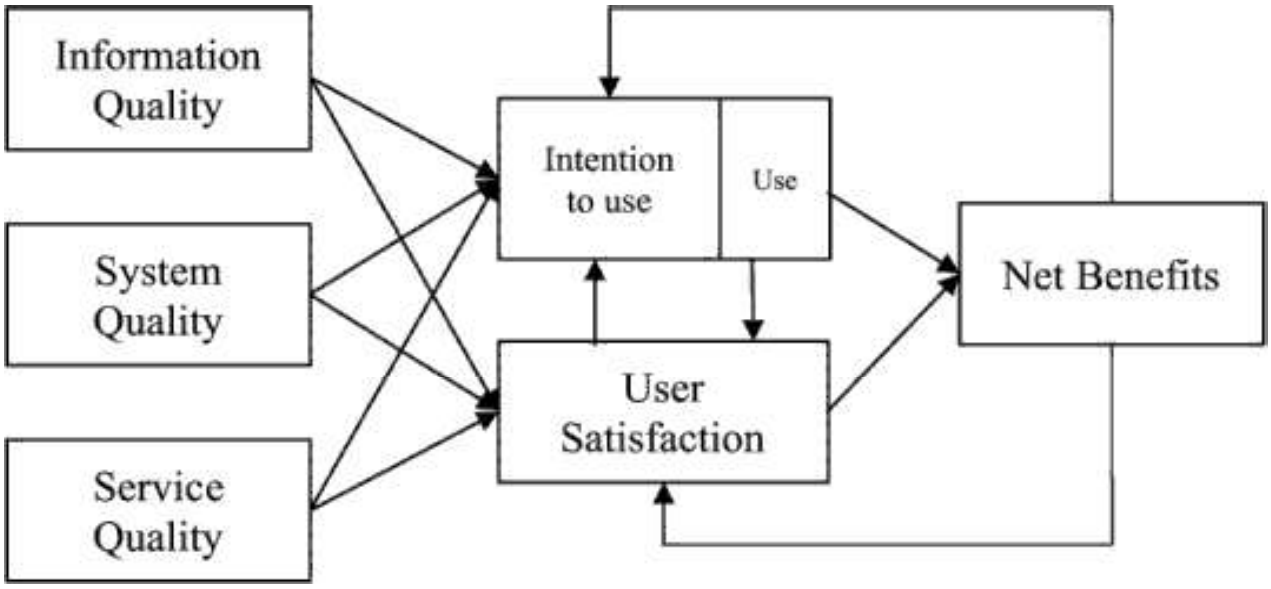

Figure 1: IS success model.

Source: (Adapted from DeLone & McLean, 2002).

In addition to the information system success model, previous studies have shown that CC is also a type of IS subcontracting (Kerr, Troth, & Pickering, 2020). For hospitals, a shift to a cloud computer is a significant change from a conventional IS Platform. Many hospitals would prefer to partner with third-party providers of cloud services. There are no exceptions to that in South Africa. Integrating IS progress and IS externalisation experiences is also important to understand the progress of CC in management of hospitals.

From an Information System subcontracting point of view, literature has suggested that trust is most important for successfully coordination between organisations and service providers (Baker, 2020; Freeman &Urbaczewski, 2020). Moreover, (Hoxmeier & Lenk, 2020) have shown that trust plays a critical role in IS performance. Trust was thus incorporated in the proposed performance style of cloud computing and validated in hospitals with respect to private CC. In the figure 2 below, it can be noted that the proposed model includes 3 quality factors from the model (Hsu & Backhouse, 2020) of the IS performance and incorporates the third, trust factor (Keil & Johnson, 2020). The dependent variable is cloud machine satisfaction, which comes from model (Kumar & Sharma, 2020).

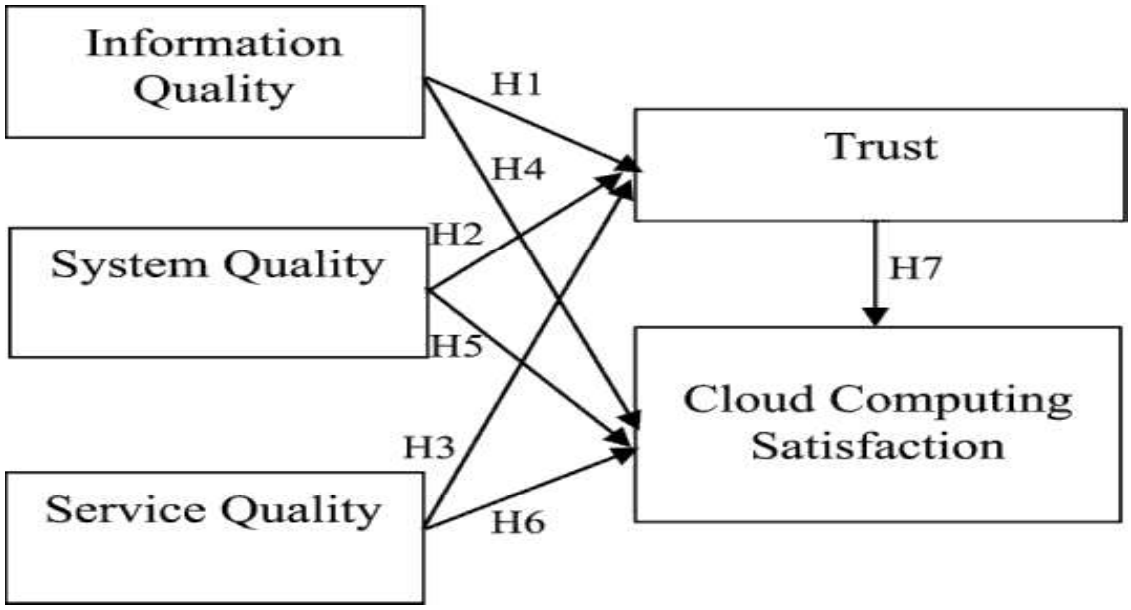

Figure 2: Research model.

Source: Author

Hypothesis 1 (H1): Cloud storage information quality would have a positive effect on the confidence hospitals have in providers for its services.

Hypothesis 2 (H2): The efficiency of the network of cloud computing affects patient trust in service provider information systems positively.

Hypothesis 3 (H3): The CC infrastructure provider's level of service would impact hospitals' trust positively.

Hypothesis 4 (H4): Cloud computing data quality would have a positive effect on the satisfaction of hospitals.

Hypothesis 5 (H5): Cloud computing system consistency would have a positive effect on patient satisfaction.

Hypothesis 6 (H6): Cloud services provider's service quality would have a positive effect on the satisfaction of hospitals.

Hypothesis 7 (H7): Trust in the service providers by hospitals would have a positive effect on their satisfaction.

3. METHODOLOGY

3.1 Methods and Materials

In this analysis, an email-based research was adopted. Parameters in this research have been adapted to the research context from previous studies and updated. Table 1 summarises the descriptions of the work and measures used for each element. As original interventions are not intended for the application of CC in hospitals, the questionnaire has been developed and validated by the following steps. To ensure the authenticity of the questionnaire, three experts were asked to review the questionnaire (2 from the information management and 1 from the hospital manager level), and the contents were then changed. Since the population of this sample is small (only 502 hospitals in South Africa are in this sample), the pilot test used only qualitative methods to authenticate validity and reliability. Finally, the study model used 48 objects to calculate the variables.

Table 1: Variable Definitions and Measurements.

Variable	Operational definition	Item No.	Source
Information quality (Low & Chen, 2012)	The quality of information given to patients by a cloud-based hospital	9	(Low & Chen, 2012)
System quality(Low & Chen, 2012)	Value of the device architecture and accessibility of cloud-based hospital Information Systems	6	(Low & Chen, 2012)
Service quality (Kochan, Nowicki, Sauser, & Randall, 2018)	The cloud service provider's quality of operation	22	(Kochan et al., 2018)
Trust (Esposito, De Santis, Tortora, Chang, & Choo, 2018)	The level of hospital trust in the provider of cloud service	4	(Esposito et al., 2018)
Satisfaction (Albuquerque & Gondim, 2016)	The happiness of the hospital with the cloud-based IS program	7	(Albuquerque & Gondim, 2016)

Note. IS = information systems.

The participants in this study were the hospital's CIOs. The collection of data from 502 hospitals in South Africa took place from December 2019 to February 2020. Turned out of these 257 valid questionnaires were received making a return rate of 51.2%. Of these 171 hospitals, 66.5% were found to be using cloud computing, compared to 86 (33.5%) who were not conversant that cloud computing use.

In comparison, out of 171 private cloud-based hospitals, 67 (39.2%), 50 (29.2%), public cloud, and 52 (30.4 %) hybrid CC respectively were used. This paper concentrates on private CC performance for two key motives, because of the various characteristics and specifications of different forms of cloud computing deployment (Hurwitz & Kirsch, 2020). First, specific implementation models for cloud computing should prevent needless ambiguities. This is because multiple Cloud Computing implementation models have different implementations and purposes. In addition to this, several hospitals have opted to avoid the use of a private cloud because of security concerns (Ahuja et al., 2012; Sultan, 2014). The study has similar

data; the emphasis on such technologies is therefore important. The study also has similar findings.

To test the proposed research model, a sample of 72 was selected. This analysis has four independent variables so that a smallest prerequisite sample size is 40, which is the minimum sample size required (Kotrlik & Higgins, 2001; Sultan, 2014). The minimum size is 10 times more independent variables. This implies that for advanced research, the chosen sample size is adequate. For the following data analysis, SPSS and SmartPLS21 were used.

4. RESULTS AND DISCUSSION

Of the 74 participants, the spread of gender was, 58 men (78.4%) and 11 women (14.9%); 5 absent responses data were removed. The age range was from 30 to 51 years (76%). 61 participants (82.4%) were university graduates or higher. Most had significant experience in information technology of health care (48% had over 10 years of healthcare experience). The interviewees were primarily CIOs and IT department heads. There have been 6 (8%) clinics, 21 (28%) city centres and 47 (64%) national clinics out of all 74 participating respondents from the hospitals. Such a spread is identical to that of the population and therefore represents the set of data. Of the 74 hospitals, 22 have embraced cloud computing (30 percent) over the past two years, while 16 (22 percent) have had two to three years' cloud computing experience. PharmaCloud Framework, EMR and PACS are the 3 most critical applications on the cloud platform. In conclusion, a majority of respondents (88.5%) reported operating on their private cloud computing platform along with a third-part information service partner.

The measurements in this research are evaluated using the following criteria: the compound reliability (CR) > 0.7; average variance extracted (AVE) > 0.5, Alpha value of Cronbach > 0.7 and AVE square roots are greater than the combined coefficients, to guarantee discrimination. To

determine the reliability and validity of the measurements used in this study, Table 2 indicates that all indexes are appropriate. Because of low loading (< 0.5), only 1 out of 9 substances gaging the quality of information was ignored (Albuquerque & Gondim, 2016). So 8 items measured the quality of service. Additional measurements of the original instruments remained unchanged. In terms of discrimination, the Square Roots of AVE have been measured and compared to correlations (Rizo-Patron & Sirohi, 2017). The findings showed that the discriminating validity of each structure is appropriate based on the above criteria. Based on the tests above, we can ensure that advanced analysis can be done using the data collection.

Table 2: Reliability and Validity.

Variables	CR	AVE	Factor loading	R 2	Cronbach's α
Information quality	.95	0.71	0.72-0.90	NA	.94
System quality	.96	0.82	0.75-0.95	NA	.96
Service quality	.99	0.82	0.85-0.91	NA	.99
Trust	.99	0.97	0.98-0.99	.27	.99
Satisfaction	.97	0.84	0.91-0.93	.65	.97

Note. CR = compound reliability; AVE = average variance extracted; NA = not applicable.

4.1 Hypothesis testing

The findings from PLS show that knowledge quality (H4), device quality (H5), and trust (H7) are critical factors in the private cloud satisfaction of hospitals. The levels of R2 is 65.4%. Furthermore, the mediator between the quality of service and satisfaction is trust. Satisfaction means that the standard of service can impact trust directly (H3). Overall, four suggested hypotheses, H3, H4, H5 and H7, are important. Table 3 and Figure 3 sum up the analysis.

Table 3: Final Analysis.

Hypotheses	Path coefficient (β)	t value	Support
H1: Information quality → Trust	.04	0.23	No
H2: System quality → Trust	.25	1.26	No
H3: Service quality → Trust	.37	2.54*	Yes
H4: Information quality → Satisfaction	.34	2.29*	Yes
H5: System quality → Satisfaction	.35	2.04*	Yes
H6: Service quality → Satisfaction	(.14)	1.76	No
H7: Trust → Satisfaction	.37	2.65**	Yes

*P < .05. **P < .01.

Parenthetical value designates negative value.

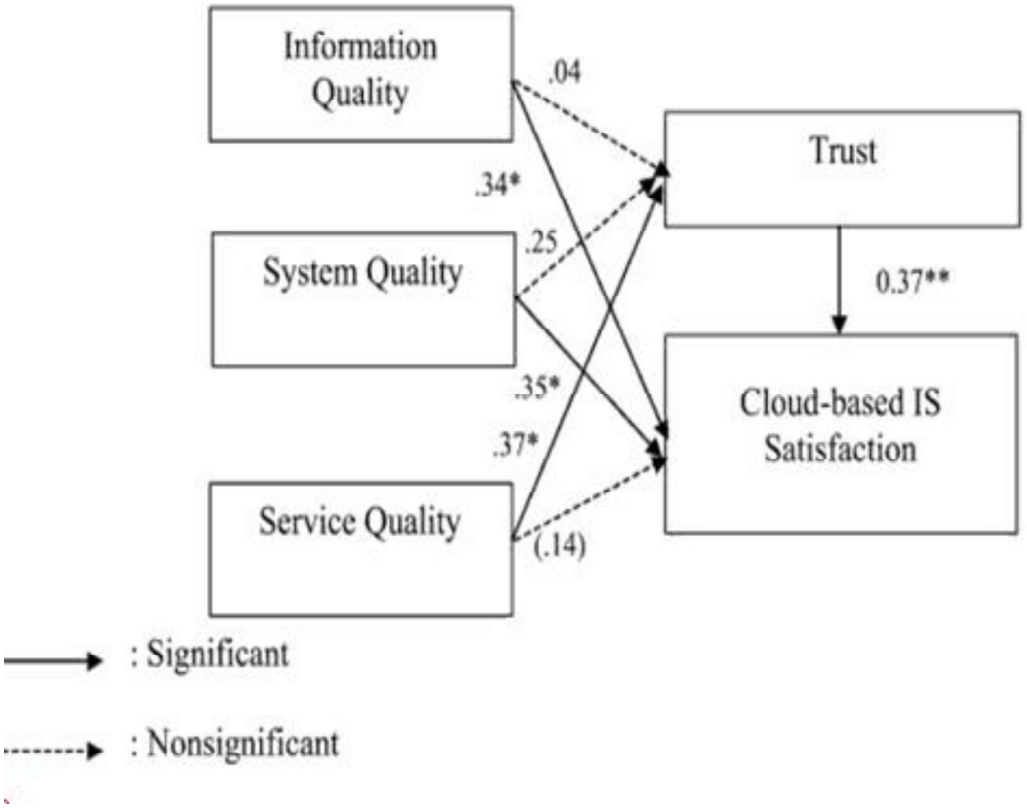

Figure 3: PLS fundamental outcomes.

Note: PLS = partial least square; IS = information systems.

4.2 Discussion

From the information system performance model, this research shows that only the quality of knowledge and consistency of the program affects satisfaction directly. Quality of service will affect the confidence of hospitals in their partners directly (R2 = 27%) and their satisfaction will be affected by confidence. The sum explaining the strength of the cloud computing satisfaction sequential dependent variable is 65 percent. In other words, the incorporation of trust and the IS performance model will enhance awareness of the quality of cloud computing in the sense of private cloud services in South African hospitals. This research concludes that only knowledge quality and device efficiency have a significant consequence on one's gratification from the conventional perspective. However, it is indirect that the quality of service influences satisfaction. This result also supports the opinion provided by (Albuquerque & Gondim, 2016) who noted that the trust to cloud computing does not only impact users' gratification but also aid as a mediation function between the quality of service, in the sense of a commercial CC system, service level contract, and the service quality needs of consumers. Finally, the quality of service is fairly subjective as opposed to information quality and device quality; it therefore does not directly or indirectly affect customer satisfaction. In potential cloud computing research this trend, would be useful.

Cloud systems must provide users with accurate, timely, lightweight, and transparent information for their application in hospitals. In order to ensure there is consistency of the information, it must also satisfy the information requirements of users. With regard to the quality of services, cloud-based applications need to ensure user-friendly operations, particularly for physicians. A user-friendly interface can assist users to perform their duties without any challenging mission. Regarding the cloud service provider, this study found that the best way to ensure customer satisfaction is to increase the quality of services. To simultaneously foster confidence, improved service quality is needed. Only in this way can customer satisfaction be increased. This research indicates that cloud service providers must be open

and not determine in compliance with their own interests. It is essential to discover elucidations that take into account the interests of both parties. Ultimately, both the theoretical and practical implications of this analysis, combined the status of private cloud computing growth and determined the main success factors in South African hospitals. Results can be cited in South Africa and elsewhere, in particular in the African region. In theoretical terms, this research relates to the problems of creating CC environments in hospitals by the use of the conventional IS success model. Furthermore, a success model for cloud computing for hospitals in South Africa was developed and validated. These findings contribute to IS success model research sources and thus enrich the study climate of the information systems success model.

5. CONCLUSIONS AND RECOMMENDATIONS

In this review, there are some confines and possible guidelines for future study. Initially, this research concentrated primarily on private CC in hospitals. CC has various service models and implementation models, based on the concept suggested by the National Institute of Standards and Technology (NIST). This research, however, focused only on private CC in the health sector. Furthermore, South African hospitals are characterised by themselves. Future work can also be carried out through various styles and industries of cloud computing. This research is also a cross-sectional research, and CC, particularly in hospitals, continues to develop (Rizo-Patron & Sirohi, 2017). Longitudinal research is therefore important in this field of study.

Secondly, prospective research should make use of the proposed model to various CC systems and relate their similarities and differences, with a view to making a more important contribution to literature in this field of study. Moreover, the data set includes only South African hospitals; we therefore suggest that data from various countries would allow scientists to contribute more meaningfully. Thirdly, the proposed model contains only 4 independent variables, although the obtained R2 value is appropriate.

Assumption has been made that the performance of cloud computing in hospitals can be understood with more important variables. CIOs are usually responsible for IS production in respect of respondents and may even be end-users. Surveying CIOs is one way to improve the program and should therefore be distinguished from surveying the findings of regular users. The results of users other than CIOs may also be different. For better understanding of this subject, comparative research can be carried out in the future. Eventually, previous studies (Hurwitz & Kirsch, 2020; National Academies of Sciences & Medicine, 2016) had argued for the possible issues of smaller PLS samples; but only 502 hospitals were present at this study and only 74 were private cloud computing approved by legitimate respondents. This leads to a further limit. In order to remove this restriction, future studies could concentrate on end-users.

5.1 Conclusion

This research combines the features of cloud computing through the combination of an information system success model with trust to study the main factors that influence the performance of private CC in hospitals. This study also carried out a questionnaire survey to test the concept and conclusions presented on the basis of this cloud computing performance model. In general, this model's explanatory potential (R2) is 65.4%. Moreover, the findings of the hypothesis test suggest that in hospitals information quality and device quality can have a positive direct impact on cloud satisfaction, which is similar to the finding from previous studies. Service quality therefore influences the satisfaction of consumers indirectly. Trust is the intermediary between satisfaction and quality of service. Conversely, it is important for private cloud computers to provide a good relationship between providers of third-party information and hospitals. In addition, this study found that the adoption of private CC among hospitals in South Africa is a major trend. Pharma Cloud Framework, EMR and PACS are the 3 primary applications on the cloud

platform. Ultimately, 87.5 percent of those interviewed partnered with collaborators from third parties to build a CC system in their hospitals. Ultimately, this suggested success CC model would allow hospital practitioners to measure the performance of private CC services and attain their aim of generating value (Kocabas & Soyata, 2020).

REFERENCES

Ahuja, S. P., Mani, S., & Zambrano, J. (2012). A survey of the state of cloud computing in healthcare. *Network and Communication Technologies, 1*(2), 12.

Albuquerque, S. L., & Gondim, P. R. (2016). Security in cloud-computing-based mobile health. *It Professional, 18*(3), 37-44.

Baker, J. H. (2020). The learning log. *Journal of Information Systems Education, 14*(1), 2.

Chaudhary, A., Peddoju, S. K., & Peddoju, S. K. (2020). Cloud based wireless infrastructure for health monitoring. In *Virtual and Mobile Healthcare: Breakthroughs in Research and Practice* (pp. 34-55): IGI Global.

DeLone, W. H., & McLean, E. R. (2002). *Information systems success revisited.* Paper presented at the Proceedings of the 35th Annual Hawaii International Conference on System Sciences.

Esposito, C., De Santis, A., Tortora, G., Chang, H., & Choo, K.-K. R. (2018). Blockchain: A panacea for healthcare cloud-based data security and privacy? *IEEE Cloud Computing, 5*(1), 31-37.

Freeman, L. A., & Urbaczewski, A. (2020). Using Concept Maps to Assess Students' Understanding of Information Systems. *Journal of Information Systems Education, 12*(1), 1.

Gantz, J., & Reinsel, D. (2012). The digital universe in 2020: Big data, bigger digital shadows, and biggest growth in the far east. *IDC iView: IDC Analyze the future, 2007*(2012), 1-16.

Hoxmeier, J., & Lenk, M. M. (2020). Service-learning in information systems courses: Community projects that make a difference. *Journal of Information Systems Education, 14*(1), 10.

Hsu, C., & Backhouse, J. (2020). Information systems security education: Redressing the balance of theory and practice. *Journal of Information Systems Education, 13*(3), 8.

Hurwitz, J. S., & Kirsch, D. (2020). *Cloud computing for dummies*: John Wiley & Sons.

Keil, M., & Johnson, R. D. (2020). Feedback channels: Using social presence theory to compare voice mail to e-mail. *Journal of Information Systems Education, 13*(4), 4.

Kerr, D., Troth, A., & Pickering, A. (2020). The use of role-playing to help students understand information systems case studies. *Journal of Information Systems Education, 14*(2), 6.

Kocabas, O., & Soyata, T. (2020). Towards privacy-preserving medical cloud computing using homomorphic encryption. In *Virtual and Mobile Healthcare: Breakthroughs in Research and Practice* (pp. 93-125): IGI Global.

Kochan, C. G., Nowicki, D. R., Sauser, B., & Randall, W. S. (2018). Impact of cloud-based information sharing on hospital supply chain performance: A system dynamics framework. *International Journal of Production Economics, 195*, 168-185.

Kotrlik, J., & Higgins, C. (2001). Organizational research: Determining appropriate sample size in survey research appropriate sample size in survey research. *Information technology, learning, and performance journal, 19*(1), 43.

Kumar, M., & Sharma, S. (2020). Dynamic load balancing algorithm to minimize the makespan time and utilize the resources effectively in cloud environment. *International Journal of Computers and Applications, 42*(1), 108-117.

Low, C., & Chen, Y. H. (2012). Criteria for the evaluation of a cloud-based hospital information system outsourcing provider. *Journal of medical systems, 36*(6), 3543-3553.

Manuel, P. (2015). A trust model of cloud computing based on Quality of Service. *Annals of Operations Research, 233*(1), 281-292.

McLean, M., Mizono, M., Von Dehsen, L., Venters, J. D., Kuwatani, T., Kennedy, Z., & Stewart, J. E. (2020). Methods and systems for presenting a camera history. In: Google Patents.

Mekkattuparamban, J. T., & Robinson, M. (2020). Virtual network health checker. In: Google Patents.

National Academies of Sciences, E., & Medicine. (2016). *Future directions for NSF advanced computing infrastructure to support US science and engineering in 2017-2020*: National Academies Press.

Nguyen, D. C., Pathirana, P. N., Ding, M., & Seneviratne, A. (2019). Blockchain for secure EHRs sharing of mobile cloud based e-Health systems. *IEEE access, 7*, 66792-66806.

Patel, S., Chauhan, M., & Kapadiya, K. (2012). 5G: Future mobile technology-vision 2020. *International Journal of Computer Applications, 54*(17).

Rizo-Patron, S., & Sirohi, J. (2017). Operational modal analysis of a helicopter rotor blade using digital image correlation. *Experimental Mechanics, 57*(3), 367-375.

Sultan, N. (2014). Making use of cloud computing for healthcare provision: Opportunities and challenges. *International Journal of Information Management, 34*(2), 177-184.

Utomo, I. G. W., & Darma, G. S. (2020). Measuring optimization of digital military programs: an innovation of information and communication systems in industrial digitalization 4.0. *International research journal of engineering, IT & scientific research, 6*(2), 39-46.