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Exploring the Adoption of Cloud Computing for Health Care Delivery in Ghana

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Abstract: Cloud computing is the most recent Information Technology (IT) service available, allowing for universal and convenient network access to a shared pool of configurable computing resources on-demand. It is a rapidly expanding solution that addresses almost all cost-cutting, rapid processing, easy access to information, scalability, and timeliness concerns. Many experts believe it has the potential to improve healthcare services, advance healthcare research, and alter the landscape of health information technology. However, as with any new technology, cloud computing should be tested extensively before widespread adoption. This study investigates the concept of cloud computing and its current adoption in healthcare, evaluating the opportunities and challenges of this computing model through four lenses (management, technology, security, and legal). The study goes on to discuss the strategic planning model that a health organization could use to determine its direction, strategy, and resource allocation when deciding to migrate from traditional to cloud-based health services. As an example, Korle-Bu Teaching Hospital (KBTH) is used. The KBTH is Ghana's largest tertiary hospital, located in Accra. An evaluation survey was conducted to gather knowledge and information from healthcare practitioners as well as IT professionals with extensive knowledge of cloud computing. Finally, experienced project management practitioners were contacted to draw on their knowledge of designing and managing projects in a changing environment. Based on the findings, a five-stage strategic planning model for adopting and implementing cloud computing in the KBTH is recommended: identification, planning, pre-implementation, change management and training, and finally implementation; this model includes guidelines to increase the likelihood of a successful rollout.

Keywords: Cloud Computing, Healthcare, Information Technology, Traditional

1. Introduction

According to Lippeveld et al [1], the introduction and implementation of a health-specific information system for the collection, processing, and reporting of health services at the national and district levels are critical to improving healthcare management. Despite the fact that a large amount of patient data is routinely collected in Ghanaian public health facilities, experience has shown that very little of this data is properly processed and stored to allow easy access to information for onward use by health practitioners for the effective delivery of health care. With the implementation of the National Health Insurance Scheme (NHIS) in 2009, a large amount of data was collected, but it is only used to bill the government for services rendered by health care institutions to NHIS beneficiaries. With the rapid evolution of technology and the nearly equal evolution of society, it has become necessary to use a more efficient and effective method of accessing patient health information by introducing a system that will ensure patient information is readily available when health practitioners require it.

When it presented its health policy plan in 2005, Ghana's government recognized the need to incorporate information and computing technology (ICT) into the delivery of health care. The government of Ghana emphasized the need to introduce ICT as a tool to ensure effective health delivery in

the Ghana e-Health Strategy documentation; the document proposed to introduce a centralized computer-based health management information system that will integrate all aspects of public health service to ensure easy access to health information. While the idea of incorporating IT into healthcare delivery in Ghana is admirable, the proposed model has some inherent challenges. The health policy plan's proposed system would rely on the traditional software and hardware acquisition, installation, and maintenance model. This would necessitate a significant investment in information system support (ISS).

Given the aforementioned requirements, it is not surprising that enthusiasm for an ISS solution is dwindling as technology evolves. As a result, there is a need to shift toward a more sustainable, cost-effective, and simple-to-implement solution, such as cloud computing. Data is collected, processed, and stored in the cloud, regardless of location or time, and is easily accessible to all interested parties (patient, doctor, nurse, etc.). This timely access to information is expected to improve the quality of health care provided to a patient at any point in time. The purpose of this paper is to discuss the use of cloud computing for the effective delivery of health care in Ghana's public health sector, using the Korle-Bu Teaching Hospital as a case study.

2. Related Works

Justice is important in health systems, and one major popular expectation from sovereign governments is to move toward equity, which, according to World Health Organization (WHO), means closing the gap in access to resources, opportunities, and facilities between socially, economically, demographically, or geographically categorized groups. In the context of healthcare, equity is frequently defined as equal access to health and hygiene resources as well as the fairness of health determinants [2]. According to some studies, investments in ICT in the health domain may reduce disparities in the care process [3]. Others, on the other hand, believe that while ICT has the potential to improve health care quality, safety, and equity, it also has the potential to unintentionally increase disparities in the health and health care [4]. As we all know, the majority of ICT services in health are provided as E-health services. E-health is modern technology's response to health inequity, but when poorly implemented, it has the potential to widen the access gap between wealthy people with easy access to computers and networks, or people who can use these technologies effectively, and others who fall into neither of these categories. This means that one of the most difficult challenges for E-health is to bridge the digital divide between gender, social, geographical, and age groups and reach out to those who require the most E-health services [5]. Meanwhile, e-health solutions can alleviate the growing demand for up-to-date healthcare services, which is primarily due to increased health awareness among populations, as well as the often-unsuccessful struggle of regional and national administrations to meet this level of demand. However, the lack of infrastructure required for such solutions limits their short and medium-term potential [6].

Because of the rapid evolution of technology, organizations are moving toward a more robust, cost-effective, and efficient system of providing services to their customers. Organizations used other computing technologies as a means of communication prior to the advent of cloud computing. These computing technologies pave the way for cloud computing adoption. Virtualization, grid computing, autonomic computing, and utility computing are examples of common technologies. Cloud computing is a novel approach to efficiently delivering IT services. Existing literature suggests that cloud technology can improve the quality of services in a variety of industries, including the healthcare [7]. When compared to traditional computing, cloud computing is changing the way businesses do business. Companies are capitalizing on the advantages of this technology to increase revenue.

Recent research has proposed the use of cloud computing in the health care sector to provide efficient and cost-effective health information systems [8, 9]. Rolim et al [10] proposed a solution for collecting vital information from patients via a network of sensors connected to legacy medical devices and delivering the data to a medical centre via cloud computing. Guo et al [11] investigated the shortcomings of traditional hospital management systems and proposed a model for a new intelligent hospital management system provided by cloud computing.

This system will connect various departments within a health institution as well as coordinate activities among health institutions. This is intended to improve the use of medical resources as well as the flow of patients in any health care facility. Nkosi & Mekuria [12], and Shi [13] conceptualize a cloud-based management system that offers multimedia sensor signal processing and security as a service to mobile devices. They proposed a framework based on cloud computing that will use mobile devices to execute complex security and multimedia algorithms, with a focus on rural communities. Still, in the field of rural health care development, Rao et al [14] created a cloud-based healthcare application called 'dhatri.' This application is aimed at remote rural areas and provides universal health care. Organizations that have already adopted cloud computing are expressing how beneficial it has been to them. In order to streamline business operations, American Occupational Network (AON) implemented a cloud-based solution to digitize patient health information. AON has seen an 80% reduction in medical transcription costs since implementing the new solution. Furthermore, the organization now has a faster and more accurate billing process, which has reduced the time it takes to create a bill from 7 days to less than 24 hours [15].

The evolution of ICTs is profoundly transforming all human activities, with a significant impact on the healthcare sector. Aceto et al [16] argue that HC4.0's technological capabilities and innovative mindset are reshaping the vision of the future of healthcare, transforming it into the ubiquitous and continuous availability of personalized medical services.

Cloud computing has established itself as a viable option. It is the direction forward for any organization that must

adapt to technological advancement. It provides numerous economic benefits while avoiding strategic institutional constraints. Consumer demand for easy and timely access to information is also increasing, regardless of where they live. The use of cloud computing in the health sector is a hot topic right now, and more stakeholders are inclined to support this new tool for providing computing services as well as resources.

3. Research Methodology

Due to the fundamental nature of gathering primary data for the research, an exploratory survey approach was used as the methodology. Survey questionnaires were distributed both electronically and on paper. There were two groups of respondents: the first group consisted of selected IT experts (IT professionals in management positions and IT service providers), and the second group consisted of health practitioners (i.e., Doctors, Nurses, Pharmacists, etc.) in order to sample their opinions on the importance of adopting a health information system that will be easily accessible to them.

Korle-Bu Teaching Hospital is Ghana's largest government tertiary health facility in Accra. The hospital has approximately 2000 beds and 17 clinical and diagnostic departments, with a daily average of 1500 patients and approximately 250 admissions [17]. Questionnaires were distributed both online and on paper. Google forms (an electronic survey questionnaire generator) were used to create online questionnaires, which were then sent to targeted respondents as links. Paper-based questionnaires were also distributed at random to health practitioners at Korle-Bu Teaching Hospital. Both questionnaires included a cover letter outlining the purpose of the study as well as a set of questions.

A sample size of 250 was chosen from among IT professionals with extensive knowledge of the subject and health practitioners who will be directly impacted by the technology. Because of the nature of the research, participants were chosen using a purposive sampling technique. Closed-ended questionnaires were used as the primary source of data collection from IT professionals and health practitioners in this study. The researchers used triangulation to validate the data obtained through follow-up interviews. Secondary data was compiled using secondhand information gathered by previous researchers. The secondary data was intended to supplement the primary data.

Descriptive statistics were used in this study. Data was transferred from a Google spreadsheet created with Google forms into Microsoft Excel 2007, and then into the Statistical Package for Social Sciences (SPSS version 18) for coding and analysis. The data was then imported into Microsoft Excel 2007 and used to generate frequency tables and graphs. The slow response rate from questionnaires distributed to health practitioners hampered the research's progress. By administering the majority of the questionnaire during off-peak hours, a strategic approach was taken to continue soliciting the opinions of these groups of people.

4. Results and Analysis

This section presents an analysis and discussion of the survey data collected.

4.1. Characteristics of the Survey

The survey had 171 respondents, with the majority of them being IT professionals (from the health and telecommunications sectors) and health practitioners from the KBTH. The first group of respondents, all of whom were IT professionals, were contacted via email and informed about the purpose of the survey. They were also asked to indicate their willingness to participate by answering an initial question with a 'Yes' or a 'No'. By selecting 'Yes,' they were taken to the rest of the online survey questionnaire. The questionnaire's initial stages dealt with demographic information. Those that met the researchers' requirements were kept during the analysis. Out of 150 emails sent through Google forms, 98 responded and met the criteria for the study.

The second group of respondents included health professionals from the Korle-Bu Teaching Hospital. The questionnaires were distributed by hand to 100 health practitioners at the hospital; the cover letter on the questionnaire indicated the purpose of the research, and respondents had to tick a specific question to indicate their willingness to participate. This was done to ensure that participants were not coerced into participating. Those who indicated a willingness to participate completed the remainder of the questionnaire. 73 questionnaires were received and valid for analysis out of the total number of questionnaires distributed.

4.2. Analysis of the Survey

The online survey consisted of 33 closed-ended questions designed to elicit the opinions of IT professionals working in the health and telecommunications sectors. The paper-based questionnaire consisted of 39 closed-ended questions that were designed to make it simple for participants to respond. Some of these inquiries will be used to provide answers to the research questions. The demographic statistics of the respondents are shown in the tables below.

Table 1. *Years of Service of IT Professionals.*

Years of Service					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	11 – 15 Years	15	15.3	15.3	15.3
	6 – 10 Years	66	67.3	67.3	82.7
	1 – 5 Years	17	17.3	17.3	100
	Total	98	100	100	

According to Table 1, 67.3% of respondents have worked in the IT industry for 6 to 10 years. This number of years provides encouragement to make sound decisions regarding any new IT innovation.

Table 2. *Age Distribution of Practitioners.*

Age					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Above 50	4	5.5	5.5	5.5
	41 – 50	17	23.3	23.3	28.8
	31 – 40	25	34.2	34.2	63
	21 – 30	27	37.0	37.0	100
	Total	73	100	100	

Table 2 shows that the majority of the health practitioners who participated in the survey are between the ages of 21 and 40. This refers to the junior to the middle-level staff at Korle-Bu Teaching Hospital who work on a daily basis and have regular contact with patients.

Table 3. *Years of Service of Health Practitioners.*

Years of Service					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Above 15 Years	7	9.6	9.6	9.6
	11 – 15 Years	20	27.4	27.4	37.0
	6 – 10 Years	29	39.7	39.7	76.7
	1 – 5 Years	17	23.3	23.3	100
	Total	73	100	100	

The majority of health practitioners who participated in the survey had worked between 6 and 15 years, which is not surprising given that nurses make up the majority of health practitioners.

Table 4. *Job Description of Health Practitioners.*

Job Description?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Health Administrator	3	4.1	4.1	4.1
	Pharmacists	6	8.2	8.2	12.3
	Dentist	4	5.5	5.5	17.8
	Radiologist	3	4.1	4.1	21.9
	Laboratory Assistant	2	2.7	2.7	24.7
	Nurse (Staff)	33	45.2	45.2	69.9
	Nurse (Sister)	8	11.0	11.0	80.8
	Nurse (Matron)	7	9.6	9.6	90.4
	Doctor (Specialist)	3	4.1	4.1	94.5
	Doctor (Practitioner)	4	5.5	5.5	100
	Total	73	100	100	

Staff nurses make up 45.2% of those who took part in the survey, making up the majority. Given that Korle-Bu is a teaching hospital with a nursing training college within its walls, it is obvious that this group will comprise the majority.

4.3. Results and Analysis of Research Interest I

The first research topic of interest was the current state and adoption of cloud computing in healthcare. The state of cloud computing adoption in Ghana's healthcare sector is negligible, but there is great potential for its adoption. The study looked into respondents' knowledge of how to use technology. According to the survey, 94.5% of health practitioners at KBTH can use computers and the internet, which is the primary protocol on which cloud computing is based. Tables 5 and 6 show the results of computer knowledge and experience levels among KBTH health practitioners.

Table 5. *Familiarity with the use of Computers.*

Q10. Are you familiar with the use of a computer?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	4	5.5	5.5	5.5
	Yes	69	94.5	94.5	100
	Total	73	100	100	

Table 6. *Self-assessment on the use of Computers.*

Q11. If you answered 'Yes' to Q10, what is your self-assessment about the use of computers?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Low experience	7	9.6	9.6	9.6
	Moderate experience	49	67.1	67.1	96.7
	High experience	17	23.3	23.3	100
	Total	73	100	100	

Tables 7 and 8 show the results of health practitioners' internet knowledge and level of experience at KBTH.

Table 7. *Familiarity with the use of the Internet.*

Q12. Are you familiar with the use of the internet?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	4	5.5	5.5	5.5
	Yes	69	94.5	94.5	100
	Total	73	100	100	

Table 8. *Self-assessment of internet usage.*

Q11. If you answered 'Yes' to Q10, what is your self-assessment about the use of computers?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Low experience	6	8.2	8.3	8.3
	Moderate experience	52	71.2	72.2	80.6
	High experience	14	19.2	19.4	100
	Total	72	98.6	100	
	Missing	1	1.4		
	Total	73	100		

According to the literature on cloud computing, one of the characteristics of cloud computing such as broad network access makes it easy to access computing services with devices such as tablets, mobile phones, workstations, and laptops once the internet is available. This is not a problem in Ghana, where research shows that internet penetration increased from 28% in 2017 to 50% in 2021 [18], a 22% increase in four years. This pattern is likely to continue. According to the National Communication Authority (NCA), 98% of the population, or nearly 25 million people, have subscribed to a mobile service provider in order to access information on the internet.

4.4. Results and Analysis of Research Interest II

The second research interest is concerned with the benefits and drawbacks of cloud computing in healthcare. The perceived benefits and drawbacks of cloud computing can be viewed from a managerial, security, legal, and technological standpoint. Adoption of cloud computing would result in benefits such as cost savings, rapid elasticity when demand incapacity is required, and, finally, easy access to computing services from a management standpoint. Management, on the other hand, may face challenges such as organizational inertia. A security analysis reveals the area's dual nature: it could be viewed as an opportunity, especially when the risk associated with data management is transferred to the service provider; however, security is viewed as a challenge when data is stored in a multi-tenancy environment, as customers fear that working in the cloud may give access to unknown users due to the multi-tenancy nature of cloud computing. From a legal standpoint, opportunities are identified as the best practices and policies implemented by many service providers. Acts that protect information handling are also examples of opportunities. The legal aspects of cloud computing face a number of challenges, including data jurisdiction, property rights, and privacy. From a technological standpoint, opportunities associated with cloud computing include flexibility, scalability, and infrastructure cost-effectiveness, while challenges include over-commitment by service providers in order to win the contract, interoperability issues, and bandwidth limitation. The data collected in the field, as shown in the following figures, are specific to the Korle-Bu Teaching Hospital's case. The results of questions 17-22 of the questionnaire designed for IT professionals are presented below.

Some of the major challenges that must be addressed are performance issues, security and privacy, a lack of government support, integration with the existing system, a lack of equipment, and data jurisdiction. From an IT standpoint, Figure 1 shows that 81.6% of IT professionals strongly agree that a lack of government support could thwart cloud computing adoption in the public health sector. 71.4% strongly agree that security and privacy are critical issues that must be addressed, and 66.3% strongly agree that a lack of equipment, such as computers, could be a barrier to cloud computing adoption. The findings suggest that security and privacy, a lack of government support, and a lack of equipment are major challenges that should be addressed before embarking on any cloud computing migration at Korle-Bu Teaching Hospital.

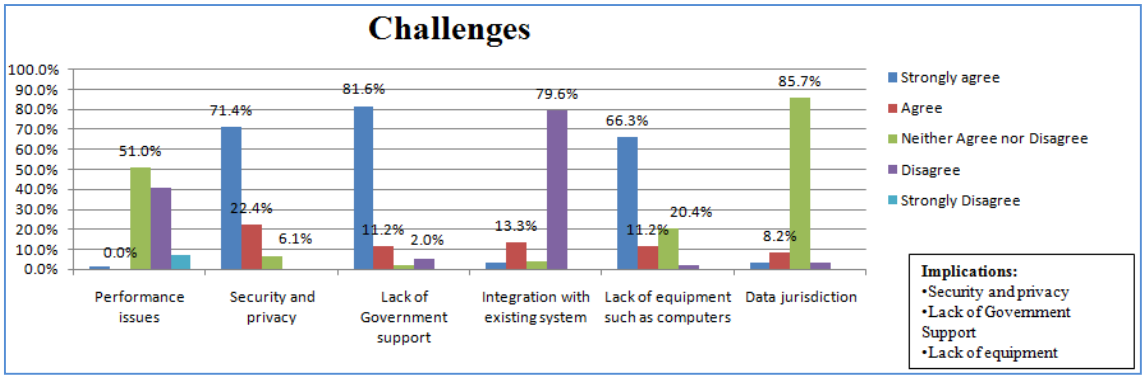

Figure 1. *Challenges from IT Professional's perspective.*

The survey also looked at the opportunities for cloud computing in the public health sector from the perspective of an IT professional. Questions 11-16 of the IT professional questionnaire show the possibilities for implementing cloud computing at Korle-Bu Teaching Hospital.

According to Figure 2, 91.8% of IT professionals strongly agree that adopting cloud computing will result in hardware cost savings. 86.7% strongly agree that cloud computing will reduce IT personnel as we reduce the initial capital expenditure on infrastructure, and 83.7% strongly agree that cloud computing will allow for easy access to patient records. The general implication of the figure is that cost savings on hardware, reduced IT personnel, timely service delivery, initial capital expenditure on infrastructure, and facilitation of information exchange within and between health centres are significant opportunities that should prompt the government to consider cloud computing in the public health sector.

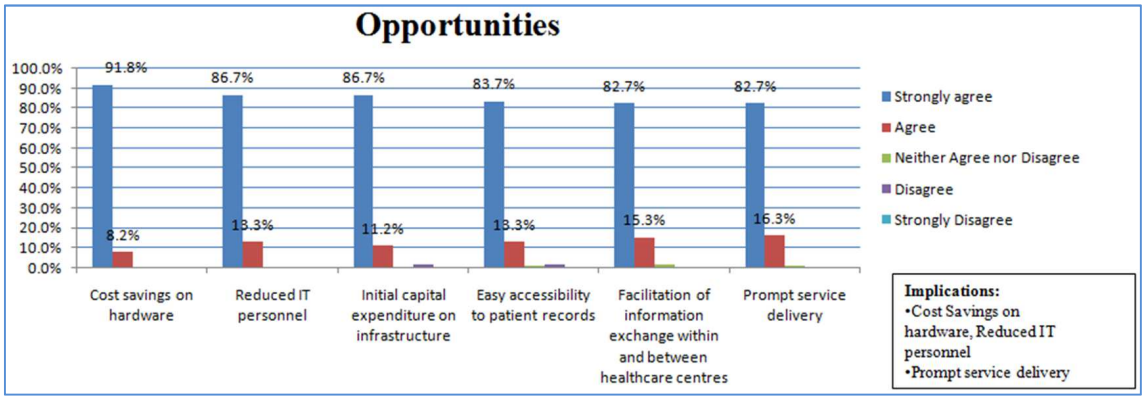

Figure 2. *Opportunities from IT Professional's perspective.*

The challenges for the health practitioners who will be the service's beneficiaries are based on questions 29–35. The following graph examines this.

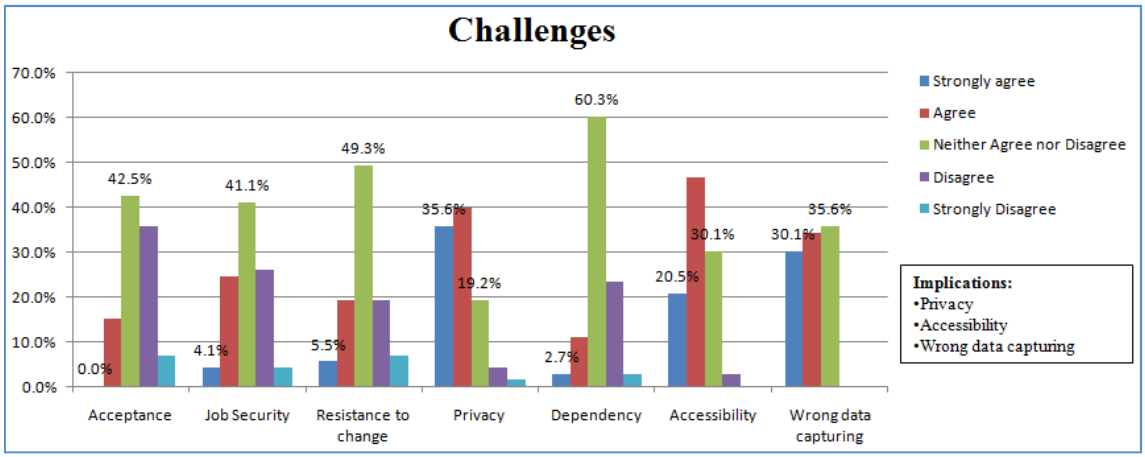

Figure 3. *Challenges from the Health Professional's perspective.*

According to Figure 3, 35.6% of health professionals strongly agree that the privacy of patient information will be jeopardized if it is stored in the cloud. Another 30.1% strongly agree that if the system is down, incorrect data for a patient may be captured, and data must be manually captured and updated later when the system is back up. 20.5% strongly agree that accessing health records when the system is down will be a significant challenge. The analysis's general implication is that privacy, accessibility, and incorrect data capture are the three major challenges that must be seriously considered when planning any cloud computing adoption at Korle-Bu Teaching Hospital.

Figure 4 depicts opportunities from the perspective of health practitioners, which are based on responses to questions 20–25 of the health practitioners' questionnaire. According to Figure 4, 49.3% of health professionals strongly believe that cloud computing will increase productivity. Another 47.9% strongly agree that it will make patient records more accessible. 39.7% believe that cloud computing will boost productivity.

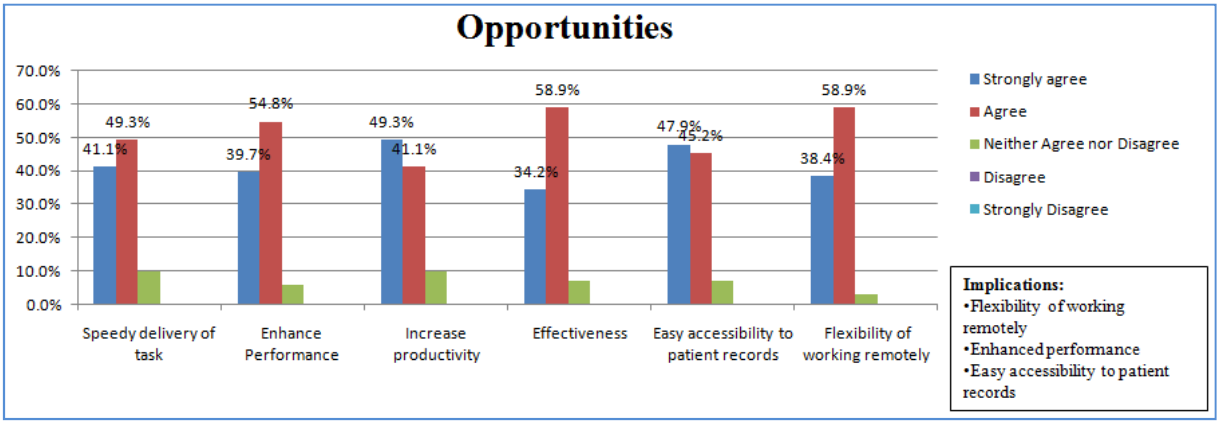

Figure 4. *Opportunities from the Health Professional's perspective.*

Most IT professionals believe that the government will slow the adoption of cloud computing in the public health sector, particularly at Korle-Bu Teaching Hospital. This belief is supported by a statement made by Dr. B. Kunbuoh, then Minister of Health, in the foreword to the Ghana e-Health Strategy document: "The development of our health infrastructure has lagged behind as a result of continued poor investments in the health sector." He went on to say that the government's inability to invest in the health sector was due to the global recession. From the standpoint of the user, the majority of health practitioners believe that the privacy of information in the cloud will be a more pressing issue. Because health information is sensitive, appropriate safeguards must be put in place to ensure that data is not tampered with or that access to this data is not restricted.

Most of the issues raised by both IT professionals and health practitioners are similar to those raised by traditional health information management systems, and as such, they can be addressed with proper planning and good service level agreements (SLA) that are binding on both the cloud service provider and the client.

4.5. Results and Analysis of Research Interest III

The third area of study focuses on the roadmap for deploying cloud computing in the public health sector, with a particular emphasis on Korle-Bu Teaching Hospital (KBTH). Several questions were posed in order to determine the need for a strategic planning model, estimated timelines, required technological infrastructure, and expected government commitment. A final question presented two models to determine the best fit for KBTH. The survey responses are shown in Table 9 below.

Table 9. *Developing or Adopting Strategic Planning Model.*

Q28. Do you think developing or adopting a strategic plan will be appropriate for the migration of healthcare service to the cloud?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Yes	92	93.9	100	100
Missing	System	6	6.1		
Total		98	100		

Based on the responses of both IT professionals and health practitioners at KBTH, it is clear that both groups see the development of a strategic planning model as necessary. Table 9 shows that 77.6% believe it is appropriate to develop a strategic planning model, while 6.1% did not respond because they did not understand or were uninterested in the development of a strategic planning model. Based on these responses, it is clear that there is a need for a strategic planning model to be in place as a roadmap to guide how the cloud migration should be carried out; this would be accompanied by guidelines that emphasized areas to consider seriously.

According to Figure 5, the majority of IT professionals (72.4%) estimate that a project to migrate KBTH's current system to a cloud-based solution will take between 25 and 36 months. From a technical standpoint, this is acceptable, especially if all necessary materials are present. However, given

the complexities involved in dealing with the government, the researchers believe that such a project could take more than 36 months to complete. Considering that this timeline is influenced by factors such as the type of data to migrate, it is also necessary to determine the type of data that should be moved to the cloud.

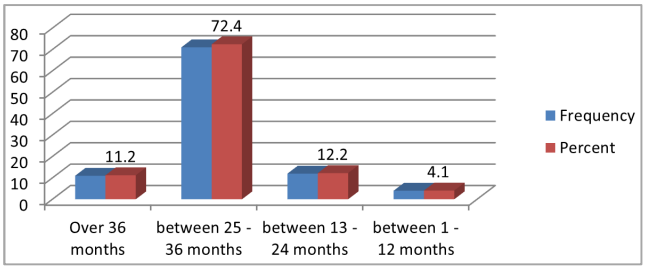

Figure 5. *Estimated Project Duration.*

According to the survey, 45.9% of IT professionals believe that all types of health data should be moved to the cloud, as illustrated in Figure 6. Moving all data to the cloud will reduce IT maintenance and management costs such as daily backups of data and regular server upgrades. Although this may appear to be a good idea, it is best to migrate gradually, running both manual and electronic-based cloud health records concurrently for some time before phasing out the manual system.

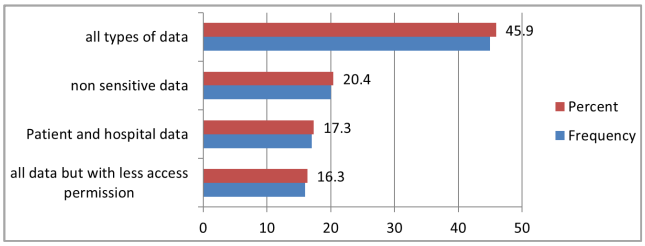

Figure 6. *Type of data to be stored in the cloud.*

The researchers' estimate of a possible timeline of more than 36 months is also bolstered by responses to Questions 24 and 26, which deal with the types of deployment and service models to be used, both of which are related to infrastructure. According to Figure 7, 83.7% believe that a private cloud is more appropriate for hosting KBTH data, while 60.2% believe that the Software as a Service model (SaaS) should be the service model for health information in the cloud. There are three service models and four deployment models to choose from. Each of these models has advantages and disadvantages. A thorough needs assessment will be required before deciding on the best model to use.

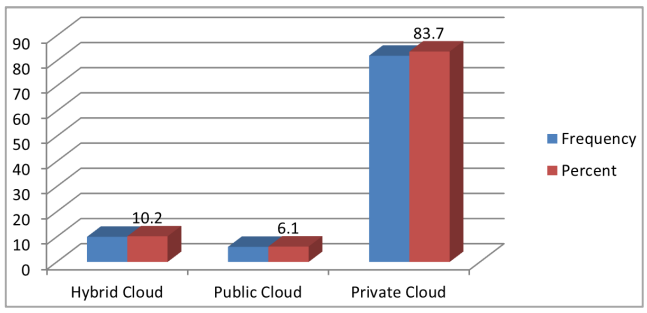

Figure 7. *Cloud computing model appropriate for the health sector.*

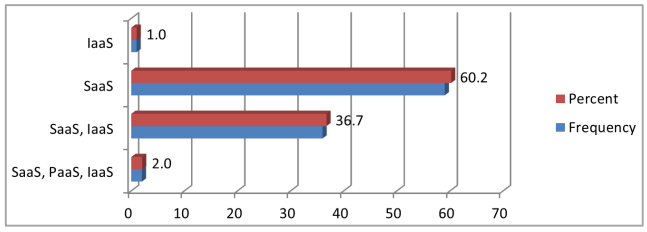

Figure 8. *Cloud computing service model.*

The results of a comparison of two strategic planning models, one developed by the Project Management Institute (PMI) and the other developed by Alex Hui Kuo called the Hospital Cloud Computing Strategic Planning, also known as the HC2SP, are shown in Figure 9. The HC2SP received the most approval, with 39.8%, followed by the PMI, with 37.8%. Respondents who did not agree with any of the models received 16.3%, while those who did not respond received 6.1%. The percentages of approval for either model (PMI or Kuo) are too close to choose one as the one to be adopted and modified for KBTH. As a result, the best solution will be to examine both and devise a strategy that will work best for both.

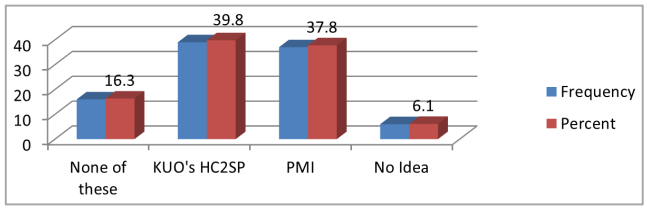

Figure 9. *Best fit Strategic Planning Model.*

Based on the foregoing discussion, we propose a strategic planning model that is best suited to KBTH's situation. The proposed strategic planning model is depicted in Figure 10.

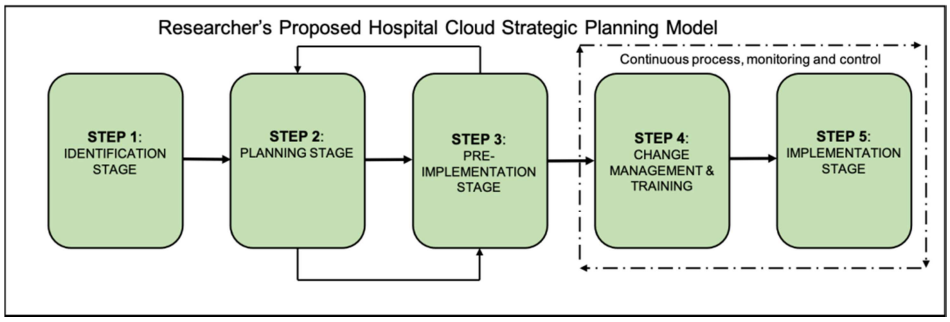

Figure 10. *Proposed Strategic Planning Model.*

The proposed plan does not go into resource allocation or costing and is voluntarily limited to steps identified by this research finding. Budgetary concerns, on the other hand, are concerns that are strategically addressed by the Government (as a public institution), and options can range from a wholly Government-led project to a privately led project and even a partnership led project (i.e., public funds only, donor funding, public-private partnerships, etc.). Whatever the funding formula, the general steps are planning, execution, and dynamic monitoring and control activities, which are as follows for KBTH:

STEP 1: The first step is the IDENTIFICATION STAGE. This necessitates goals that are clear, concise, focused, and realistic. Some key answers on scoping, timelines, and project team are required at this stage (KBTH service situational analysis, SWOT analysis, performance indicators identification, etc.). The goal is also to prioritize and select relevant steps with the best activity sequencing possible. Cloud computing as a possible solution would require KBTH management (or project leaders) to consult with key internal and external stakeholders. These are primarily IT managers, legal advisors, institutional heads, and so on.

STEP 2: PLANNING STAGE: This is the most important stage of the project, and it involves the creation of various plans that will be required for the project, such as an implementation plan, a risk plan, vendor evaluation and selection, the creation and acceptance of service level agreements (SLA), the selection of a deployment and service model, cost estimation, the identification and selection of the right internet service provider, and the identification and prioritization of data to be stored and accessed from the cloud.

STEP 3: PRE-IMPLEMENTATION STAGE: After KBTH's management has chosen a cloud provider and determined which applications will be first moved to the cloud, they begin a test on a small amount of data. Data storage on the server should be done with small increases in size and number of data, while system performance should be monitored as frequently as possible. Attention must be paid in particular to testing the server's storage capacity limits in order to foresee an analysis of a scalability scenario. This is required in order to envision a firm adoption of cloud computing not only for Korle-Bu Teaching Hospital but also for bringing on other public health facilities until the entire country is covered. At the end of the pilot program, KBTH management would need to reassess the cloud's performance, using indicators such as data availability, security, and privacy, for example. A successful trial should result in a firm decision to embrace cloud computing on a larger scale.

STEP 4: CHANGE MANAGEMENT AND TRAINING: One of the most difficult aspects of any project is managing change. The project communications team must maintain proper and continuous communication with all stakeholders, from administrative staff to health care practitioners, from senior staff to end-users; this communication must be educational, focusing on organizational goals and expected benefits to both the organization and individuals. The communication team will also be available to address any job-related concerns. Interactive media, such as forums and/or training sessions, should be used in these communications.

STEP 5: IMPLEMENTATION STAGE: The project's actual implementation begins with the installation of computers in stages (by department). It is best to start with the outpatient department (OPD). Data is continuously captured and accessed by medical practitioners via cloud applications. Paper is gradually being phased out.

The respondents to this questionnaire made a strong point based on the results and analysis: cloud computing for health practitioners could be a solution to improving healthcare services if concerns about data privacy and security are carefully addressed; cloud computing for IT professionals is definitely a solution if the government shows a strong commitment (funding, facilitating, etc.). In the following session, a summary of the observations and necessary recommendations will be presented.

5. Conclusion and Recommendations

After carefully comparing the responses of both IT professionals and health practitioners at KBTH, it is possible to conclude that access to patient information in the cloud will improve healthcare delivery at KBTH. Because of Ghana's current internet penetration rate and lower internet bandwidth costs, implementing a cloud-based system in KBTH will not be a problem. One significant impact of cloud computing in the public health sector will be a reduction in the time it takes to deliver healthcare, particularly in emergency situations. It will also allow medical practitioners to provide care from remote locations without having to be physically present in the hospital.

The study's findings identify challenges and opportunities from the perspectives of IT professionals and health practitioners. The three major challenges for IT professionals are security and privacy, a lack of government support, and a lack of equipment such as computers. Opportunities identified, on the other hand, include cost savings on hardware, flexibility, and improved performance. From the standpoint of health practitioners, the privacy of health information in a cloud-based environment could be jeopardized, cloud accessibility is an issue, especially if the necessary infrastructure is not in place, and incorrect data capturing is an issue if measures to ensure data integrity are not put in place. Health practitioners, on the other hand, believe that cloud computing will provide opportunities such as remote work flexibility and easy access to patient records, leading to improved performance in healthcare delivery. Because cloud computing is a new technology, there is always the possibility of unexpected challenges during the early stages of adoption, but in general, the benefits of adopting a cloud-based environment in the health sector outweigh the challenges. These issues could be addressed with careful planning and a good SLA. As part of the security measures to protect health records in the cloud, data could also be encrypted.

According to the findings, 93.9% of respondents recommend using a strategic planning model to ensure a successful cloud migration. From the perspective of an IT professional, Kuo's HC2SP may be the appropriate strategic planning model based on the frequency of responses, but given the difference in percentage, drawing a conclusion from this sample of respondents exposes the plan to an unacceptable margin of error. As a result, it is preferable to reduce the risk of error by developing a plan based on both the HC2SP and the PMI models specifically for Korle-Bu Teaching Hospital.

With regard to timelines in moving data to the cloud, IT professionals, from a purely technical perspective suggest that all health information should be moved to the cloud. However, health practitioners believe in a slow migration, running manual systems alongside the new cloud-based system until the manual system is eventually phased out. This could be attributed to the earlier privacy concerns of the health practitioners. In terms of the deployment and service model to use, it was gathered from the survey that a private cloud was more suitable. This could be because of the sensitive nature of health records. The service model suggested by many is the Software as a Service (SaaS) model. Based on all these responses, we propose a strategic planning model with guidelines that must be followed carefully when KBTH wants to migrate to the cloud.

Based on the study's findings and analysis, we recommend that Korle-Bu Teaching Hospital consider cloud computing to reduce IT infrastructure costs and improve access to patient health records. Furthermore, whenever KBTH decides to adopt cloud computing, the previously discussed strategic planning model should be considered along with the following guidelines:

1) Sensitization: Because cloud computing is new, the first step would be to raise awareness and obtain full and strong buy-in from those who are most interested in this alternative method of data storage. Because most people are still unaware of its capabilities and have concerns about data security, they are naturally hesitant to store their data in the cloud. Furthermore, people working in health care have a general lack of computer knowledge. As a result, before beginning to adopt cloud computing, the vendor must provide adequate training to improve staff knowledge level regarding cloud computing; the vendor must also continuously seek to ensure that the cloud is reliable and safe so that the customer (KBTH) would trust the service.
2) Service Level Agreement (SLA): Expectations and responsibilities must be established from the start. This is due to the fact that SLAs are critical elements that govern the contract or agreement. Data security is guaranteed, as is 99.99% uptime (constant availability of internet service), constant backup is guaranteed, long-term data availability, health information encryption, and a service restore plan are guaranteed.
3) Datacenter location: Health data is extremely sensitive, and as a government hospital, KBTH should have its own private cloud. In this scenario, only KBTH has access to the cloud's information and may in the future host other health care facilities on their cloud (multi-tenancy as such KBTH is therefore behaving as a cloud service provider and this will be an additional revenue stream for the hospital).
4) Vendor selection: This critical step must be completed prior to implementing cloud computing. Prospective vendors must be subjected to due diligence (financial, reputation, technical ability, experience, etc.).
5) Deployment model selection: Each deployment model has its own set of advantages and disadvantages. The researchers examined various viewpoints expressed by other researchers and experts and concluded that the private cloud is the best deployment model for storing patient and health data, particularly in the long term. This solution, however, is significantly more expensive than the public cloud. The researchers at KBTH advise the public for the pilot project and the private cloud for the actual project.

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