Digital Transformation in Healthcare: A Case Study of the University of Ghana Medical Centre with a Particular Focus on SECTRA PACS

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Abstract

The University of Ghana Medical Centre LTD (UGMC) is a state-of-the-art facility that provides world-class quaternary health care, training, and research in Ghana and beyond. Located in Legon, Accra, UGMC epitomizes Ghanaian hospitality with a strong focus on customer service. Since its opening in 2018, UGMC has operated as a fully paperless facility, with all patient records generated, stored, and maintained digitally.

This study aimed to explore digital transformation in healthcare using UGMC as a case study, particularly focusing on advancements made with SECTRA PACS amidst economic, legal, and ethical challenges. A multiple-case study design was used to explore how UGMC has been transformed digitally.

The findings suggest that digital transformation is changing the face of the healthcare sector. This change should drive organizations to operate, grow, and innovate business models in healthcare and outline policies through ascertained digital advances while addressing legal, economic, and ethical considerations for successful healthcare digital transformations.

Keywords: Digital Transformation, SECTRA PACS, Healthcare Innovation, Radiology Information System, UGMC

1. Introduction

The advent of digital imaging in healthcare has irreversibly changed medicine for the better, both in developed and developing countries. In developed nations, most hospitals and healthcare services employ or subscribe to Radiology Information Systems (RIS) and Picture Archiving and Communication Systems (PACS), through which appointments are managed for various services. These systems ensure advanced efficiency in the management of patient referrals, appointment scheduling, and the status of patient reports. Other critical features of PACS, such as voice recognition and the arrangement of folders based on the modality of service, are also present in commercial RIS and PACS systems. All processes are completely digitized, allowing for seamless online transactions.

Digitization of healthcare processes is recognized today as a key global strategy for healthcare delivery. The potential contribution of electronic medical records to healthcare service delivery, especially in terms of patient care, is unprecedented. On a global scale, for both curative and preventive healthcare to be effective and efficient, especially in a developing context, digitizing healthcare processes is crucial. To realize these potential benefits, there is a growing sense of enthusiasm for developing various technological innovations that could guarantee the success of a digitized hospital (C Gjellebæk, et al., 2020).

Certainly, transforming significant healthcare records from a cumbersome manual mode into an electronic, user-friendly system deserves appropriate accolades. It is often a time-consuming process, but once accomplished, it yields valuable advantages. With the success of this transformation, significant benefits include timesaving, cost recovery, service improvement, and workflow enhancement. In current digitized healthcare systems, notable benefits of digitization include access to critical services such as patient registration, clinical care, medication management, laboratory testing, and imaging, among others (Q Wang, et al., 2021).

1.1. Background of the University of Ghana Medical Centre

The University of Ghana Medical Centre Ltd (UGMC) is a medical facility that offers top notch quaternary health services along, with training and research opportunities in Ghana and West Africa as well as other regions. UGMC is recognized as the leading hospital in Ghana. It serves as the quaternary health centre in the country with a capacity of 1,000 beds to meet the healthcare demands of more than 5 million people, in its vicinity. The Centre features the largest ICU in the country and houses the second-largest cardiothoracic unit in the sub-region. It is also the sole state-owned institution that provides assisted reproductive technology services (Wahab, H., & Aka, P. C., 2021).

The original idea of UGMC, which dates to the 1960s was to provide advanced medical research as well as training of healthcare professionals has been sustained over the years. Since its opening, in 2018 and commencement of operations thereafter, the University of Ghana Medical Centre (UGMC) has garnered attention from regions within the country and beyond owing to its state-of-the-art facilities. The medical facility offers an array of services encompassing cardiology, dermatology, critical care, gastroenterology and other medical fields such as neurosurgery, gynecology, oncology, optometry and pediatric care, among others.

The UGMC, like many universities - focuses not only on patient care (primary purpose) but also trains medical and nursing students alongside research, innovation, and development in healthcare. UGMC's Medical Training and Simulation Centre, the first of its kind in the sub-region and among the largest in Africa, is a multidisciplinary academic facility that employs high-quality computer-based simulations to educate both medical and non-medical trainees. These simulations include patient simulation, simulated clinical environments, virtual procedure stations, and the use of standardized patients.

To advance its research capabilities, the UGMC founded the Medical and Scientific Research Centre. This Centre promotes cutting-edge translational research through local and worldwide collaborations, with an emphasis on generating novel therapies, methods, and procedures to improve public health. The UGMC's Clinical and Research Laboratories, equipped with cutting-edge technology, assist the hospital in detecting infectious diseases, performing molecular research, and providing training opportunities.

While UGMC had the aim of improving the health of people in the Ghana and beyond, through continued innovation, excellence and access to healthcare, several digitized components were added and interconnected around the processes in the treatment of patients. One of such components is the Sectra

Picture Archiving Communication System (PACS), which is designed as an enterprise system. This chapter outlines a digital transformation process operated on the Operations Process (Treatment) of the healthcare facility it considers. To understand the boundaries, the understanding of a typical healthcare system within which UGMC is hosted is shown – the operations process is then discussed and contextualized to highlight problematic aspects that demand resolution. The section related to PACS introduces the reader to the system and opens the discussion on how the UGMC went digital and what problems were then mitigated – the challenges facing the system are then explored from the discussion. The results show massive advantages and some disadvantages that are argued in further analysis and conclusions (N Stathonikos, et al., 2021). To make that thread, we have broken the discussion into the title chapters.

1.2. Overview of SECTRA PACS

The Sectra Picture Archiving and Communication System (PACS) initiative is designed to digitally transform the operations of the University of Ghana Medical Centre. As the first data-driven solution for scientifically organized radiology services, it aims to enhance efficiency and save lives through accurate, precise, and user-friendly data. Sectra PACS comprises four key modules: the Radiology Information System (RIS), the PACS Server, the Workstation—allowing radiologists and users to manipulate images for better decision-making—and Teleradiology, which enables remote specialist radiologists to attend to cases when needed (A Salas Castillo, 2024).

With the capacity to store about 75,000 images and audio-visual recordings from various radiology examination modalities, and the power to move terabytes of data within a month at the speed of 2 to 3 GB per second, Sectra PACS was expected to improve the operational efficiency of radiology services. This would enhance operational improvements and supply chain enhancements, which were expected to generate a higher opportunity for capturing and monetizing data collected from the various modalities to improve the operational efficiency of the radiology service as part of UGMC. Furthermore, the expected close to zero wastage of diagnostic assets and equipment was anticipated to bring about a disruptive positive transformation in the healthcare offering business space of customers of UGMC. These customers of UGMC were expected to be joyful in the science-based operation and superior flexibility and control over the quality and quantity of information in diagnostic images, as well as the associated enhancement and preferences for the most certain diagnostic outcomes for patients.

2. Digital Transformation in Healthcare

The vital aspects of healthcare delivery, labour productivity and patient satisfaction & outcomes are important goals in digital transformation. This focused evolution will be achieved by technology enablers (multifunctional AI systems, machine learning, IoT in embedded and integrated medical devices, data science) — that are both instruments like genomics, big data to social innovations including the cloud computing & electronic health records. Digital transition is the future of healthcare, but several impediments can lead to unsuccessful realization. For digital and IT frameworks to matter regarding what they can do for digitally transforming processes, tools need you be: converged, solution-oriented, networked, reliable and governable. Failure to adapt to these technology trends has led to budget overload, operational and productivity paralysis, and slow healthcare improvements. This chapter reflects on the successful transformation of a leading medical Centre, which transitioned from analog to digital in radiology medical imaging within a relatively poor techno-environment (Sabastian Hermes, et al., 2020). This research is built on a six-step digital maturity model. Materials and methods. We utilized a detailed

descriptive case study methodology for an investigation of the transformation process experienced by The Centre with their Radiology Medical Image Archiving & Communication (PACS) system. With that said, results do show a transition from an intelligence to informed digital maturity level with success. This paper considers the particular change processes in operation that may have contributed to this success. The aim is to aid in establishing a consensus which could inform other healthcare organizations on their digital transformation journeys (L. Wessel A. Baiyere, et al., 2021).

Key contributions include a contextual analysis of the case study institution, the implementation of a six-step digital maturity model, and the use of digital transformation master data, big data, and integrated templates to assist a successful transformation. Stakeholder drivers and impediments influenced the digital transformation strategy. The discussion and conclusions provide insights into the implications for practice and academia, as well as potential research avenues (R Duncan, et al., 2022).

2.1. Importance and Benefits

The radiology department is critical to modern healthcare, and its efficiency directly impacts patient outcomes. A well-functioning radiology department promotes prompt diagnosis and treatment, increasing patient satisfaction and overall healthcare quality. Picture Archiving and Communication Systems (PACS) have been developed as an important tool for speeding radiology operations and improving diagnostic accuracy (R. Abbasi et al., 2020).

PACS offers numerous benefits, including cost reduction in the processing and distribution of digital images, efficient storage and retrieval of images, and the potential to facilitate care through telemedicine. By integrating PACS, radiologists can work more efficiently and effectively, reducing the need for manual image handling and interpretation. This leads to quicker turnaround times and improved diagnostic accuracy.

Adaptability is one of PACS's primary capabilities. The system can be tailored to the specific requirements and preferences of various radiology departments. For instance, the PACS interface can be customized to mimic a service map, complete with the department's emblem, to help users feel at ease and acquainted.

The implementation of PACS has a significant impact on radiology departments. Healthcare personnel have reported increased workflow efficiency, diagnostic accuracy, and overall patient care. The system's user-friendly interface, scalability, and ability to handle evolving needs have been identified as critical elements in its success.

Largely, PACS is an effective tool for improving the efficiency and quality of radiological services. Its ability to streamline operations, reduce costs, and enable telemedicine makes it a necessary component of modern healthcare. Investing in PACS allows healthcare organizations to enhance patient outcomes and position themselves for long-term success.

2.2. Challenges and Risks

There is a need to take into account the difficulties and risks associated with the successful implementation of the Sectra PACS system in digitizing medical images. Chief among these is the hefty upfront expenditure required for acquiring hardware—such as servers, storage equipment, and Speech Mikes—and software, including Enterprise Operating System, VMware, Voice Recognition, Uniview, and Sectra IDS7. This large expenditure is further exacerbated by local currency depreciation, which affects foreign exchange rates and necessitates a significant immediate payment.

Another major challenge is ensuring seamless integration with healthcare systems, such as Electronic Health Records, to guarantee adherence to interoperability guidelines like Health Level 17 (HL17) and

Fast Healthcare Interoperability Resources (FHIR). This can be particularly challenging due to differences in data formats and standards. Successful implementation requires expertise in API integration of medical equipment, as well as overcoming issues stemming from the distinct proprietary standards of vendors (Lazarova, et al., 2022).

Capacity planning is another critical aspect. It is important to account for the anticipated growth in imaging volumes driven by the activities of the Radiology Department. Current storage infrastructure, projected growth, and utilization must be carefully considered to manage medical image workloads effectively, as these tasks can be resource-intensive. Additionally, the rapid pace of technological advancement poses the risk of PACS systems becoming obsolete. To mitigate this, staying current with software updates and upgrades is essential.

Security is another pressing concern. According to the **HIPAA Journal** (Steve Alder, 2024), the global average cost of a data breach has increased by 10% from 2023, reaching an average of $4.88 million. This highlights the importance of adhering to security measures like ISO 27001 to protect against unauthorized access, breaches, or data loss. While no system is entirely secure, strict adherence to the triad of security measures—confidentiality, integrity, and availability—is crucial to mitigate risks associated with Sectra PACS.

System outages resulting from hardware failures, software faults, or system problems could significantly impact patient care and workflow. To address this, a fully virtualized landscape with snapshots is essential, ensuring a recovery point objective (RPO) of 60 minutes and a recovery time objective (RTO) as close to zero as possible.

In Ghana, there is also the challenge of complying with legislative instruments such as the **Cybersecurity Act, 2020 (Act 1038)**, the **Data Protection Act, 2012 (Act 843)**, and international standards like ISO 27001, HIPAA, and GDPR. This three-pronged approach ensures local adherence to avoid sanctions, including the potential revocation of a healthcare provider's license, while also maintaining global best practices. Non-adherence to these standards could lead to facility shutdowns, whereas compliance strengthens the reputation for delivering quality healthcare on both local and international fronts.

3. Implementation of SECTRA PACS at UGMC

Established in 2018, the University of Ghana Medical Centre (UGMC) is one of the Africa's finest hospitals with an imaging department in healthcare. The Picture Archiving and Communication System was recommended and implemented as part of a turn-key project to serve as the hospital's imaging storage, retrieval, and transmission system. The system is intended for use by radiologists, radiographers, clinicians, and any other hospital staff with access privileges. Throughout the integration of the system, logistics, contractual, and technical parameters of the project have been administratively managed.

The implementation PACS at UGMC was carried out in seven phases, leading up to installation, mainly as follows: requirements specification, site preparation, system installation, system integration, data migration, training and commissioning. As a healthcare provider dealing in nearly every medical and surgical specialty, the additional modules of the information system were integrated to enhance the smooth service provision of image-enabled care. A preliminary effects study of the system revealed significant improvement in patient care. Proper network extension to other modalities can eliminate latencies and loss of studies and will be a matter of future work. In furtherance to that, integration of the PACS to the hospital's Electronic Health Record has been finalized (DK Afriyie, et al., 2020).

3.1. Planning and Preparation

The University of Ghana Medical Centre (UGMC) envisions being a leader in world-class patient care, training, and research in the Sub-Saharan Africa region. Therefore, implementing a PACS system aligns with this vision by enhancing patient care, education, and medical research, mirroring the model set by Sheba Medical Centre in Israel. The implementation of a PACS required extensive planning and preparation. The complexity of transitioning from the naturally accepted film to digital radiography and the ability to handle large and diverse datasets in the form of images also necessitated that the stakeholders had a clear understanding of what was to be achieved. In line with its technology and digital transformation strategy, the UGMC embarked on a mission to automate the processes in a bid to perform better in Image Archiving and Communication Systems (D. Bediako, 2022).

The purpose of this paper is to describe the planning and implementation of PACS in the University of Ghana Medical Centre. The implementation of PACS will significantly reduce the costs of managing radiological film records and also help the UGMC to accelerate diagnosis and treatment decisions. The implementation of the PACS system began with a careful review of its organizational readiness, ensuring the availability of physical resources and a plan of action with clear objectives. The project implementation was achieved with the deployment of a strong project team, governance, soliciting support from the senior leadership, establishing strong vendor support, and training of the human resources.

3.2. Installation and Training

Installation is the process of putting the system into use by doing the actual work of making the system operational. The work scope includes the physical installation of the system hardware, configuration of the system, software installation, and validation of the installation. Training encompasses the process of pre-exposing users to new information and enhancing their knowledge and skills prior to the actual usage of the system. It enhances the effective utilization of the system through the acquisition and internalization of skills and expertise. Since the system was proposed for clinical use, it was therefore expected to be installed and the potential users properly trained to maximize the utilization of the system (C Sardianos, et al., 2021)

Before the installation, a facility readiness assessment was conducted, which resulted in some of the site preparations, such as the provision and pre-installation of server rack, to be completed ahead the arrival of the systems. Servers, storage severs et al were installed and configured according to scope of the project. It was further virtualized to improved resource utilization, increased flexibility, enhanced disaster recovery and simplify management. The installation was done jointly by local and overseas engineers and was completed successfully without any hitches.

4. Impact and Results

Given the volatile, uncertain, complex, and ambiguous environment of healthcare, it was important for the UGMC to invest in a paperless operation, i.e., a digital healthcare platform with image management. The PACS solution has a modular design and can be easily expanded over time as the need for more functionalities emerges. In addition, it also provided the UGMC with the flexibility to enable integration with other third-party systems. PACS became 'the backbone' of the UGMC ICT infrastructure because all patients and their image analysis reports are stored in the PACS, which becomes an essential tool for visual examination, diagnosis, and patient follow-up during and after the scans. Moreover, medical staff and other authorized professionals were allowed to remotely log into PACS, access, and interpret images online.

It is important to highlight that the UGMC project was unique, introducing partly new technology, e.g., Nuclear Medicine and Brachytherapy that were not in use in Sub-Saharan Africa (J Salifu Yendork, et al., 2020). The principal key results from UGMC digital transformation projects were realized through improved performance, enhanced services, and a better medical staff experience, creating a win-win situation for the patients and the hospital management. Specifically, the key benefits generated could also be attributed to the lessons learned, which emphasized the need to have empathetic commitment from project implementers to engage the clinicians. The UGMC medical staff and top management were engaged right from the beginning of the collaboration and were always encouraged to participate in all processes right from the stage of requirements gathering, which, amongst other things, let the UGMC hospital staff take ownership and leadership in the digitization journey of the hospital. This inclusiveness improved performance and enhanced job satisfaction in the UGMC medical staff members as they are encouraged to identify and implement continuous improvements of operational processes, learner-centered services, and the definition of specific hospital goals.

4.1. Improved Workflow Efficiency

In a hospital, the clinical use of IT solutions should be accompanied by consideration of the impact on the work of healthcare professionals. Especially for clinical information systems, the effect on workflow in clinical care is a key concern of healthcare professionals, such as radiologists or clinicians. Workflow in clinical care is connected with many healthcare professionals in order to ascertain what information is needed to diagnose and treat. Consequently, managing and integrating the information flow for radiology plays an essential role if the modernization of healthcare is to be successful.

In the time of wet film, radiologists were centralized in the radiology department. Due to the implementation of digital X-ray devices, nowadays the radiologists frequently work in decentralized locations e.g., in their own office or at home. This decentralized work is only possible because of the availability of all information about the patient and the X-ray images in digital form (RP Franca, et al., 2022). With the introduction of digital image acquisition and digital screening, massive problems emerged in the field of image management and distribution of images to the image review places and the referring clinicians. The requirement of each potentially involved person to call up any patient image and the need to prevent potential data loss during this call often led to disruptions of the working schedule. The introduction of PACS will smooth the road to streamline the digital workflow by providing each person involved in patient care with the image information they need.

4.2. Enhanced Patient Care

The advantages of Sectra PACS in enhancing patient care cannot be overemphasized. As it promotes a business value-driven change, Sectra PACS introduces many benefits. It has enhanced and provided better patient care. It has improved workflow, which has resulted in faster viewing of patient images, review, and reporting of results. Sectra PACS multi-image scaling allows the comparison of new and prior patient images up to five times faster (JD Pierce, et al., 2022). It exposes more time for reading and diagnosis. It adds more processing power to medical imaging. It has the potential to reduce traffic in a reading area for daytime studies, thereby enabling radiologists to dedicate more time to interpretation and quality reporting. This has resulted in improved interpretation, diagnosis, and treatment of patients.

Some patients need a fast examination of their results in order to process their treatment or management as soon as possible. The introduction of Sectra PACS has made it possible for these patients to receive faster service and, in turn, reduce their discomfort while waiting for the results. There is better information flow between primary care physicians and consulting physicians or referrals or those who are being

transferred to the centre. They can access and view the operational images of their patients for advice. This has an underlying effect of reducing costs and, more importantly, the burden of patients due to faster access to specialist diagnoses. In the case of emergency departments, they receive exams faster and get started on treatment. The rapid imaging results facilitate the decision-making process and allow for better care. There is an improvement in the ability of the hospital to offer non-stop urgent support or trauma services. The subsequent recall for patients who, under ordinary circumstances, would have to return later or get called back to conduct an incomplete or inadequate exam is being reduced. Thus, there is a high-quality level of care due to faster workflow in an emergency. This enhanced patient care is significantly impacting patient satisfaction, patient demand, and eventually financial gains for the hospital. It corresponds directly to the frequency and expectation of patients seeking care.

5. Conclusion and Future Directions
The successful implementation of SECTRA PACS at the University of Ghana Medical Centre (UGMC) demonstrates the transformative potential of digital technology in healthcare. By digitizing radiology services, UGMC has significantly improved workflow efficiency, enhanced patient care, and fostered a more collaborative healthcare environment. SECTRA PACS has significantly improved healthcare at UGMC. It has streamlined radiology processes, leading to faster diagnoses and better patient care. The system has also facilitated collaboration among healthcare professionals and improved access to care for patients in remote areas. However, implementing such technology comes with challenges like initial investment costs and cybersecurity concerns. To ensure successful digital transformation, healthcare organizations must develop a comprehensive strategy that addresses these issues. Future directions include expanding digital integration, leveraging AI, and prioritizing cybersecurity.

Conflict of Interest
The authors declare no conflicts of interest in relation to this study. All aspects of the research, analysis, and manuscript preparation were conducted independently, with no financial or personal relationships that could have influenced the work presented.

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