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Original Research

THE EFFECT OF BIG DATA ANALYTICS ON CLINICAL AND MANAGEMENT DECISIONS IN HEALTHCARE FACILITIES IN GHANA, WEST AFRICA

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ABSTRACT

The purpose of this study is to analyze the effect of big data analytics on clinical and management decisions in Ghanaian healthcare facilities focusing on the Ga West Municipal Hospital (GWMH), Greater Accra Regional Hospital (GARH), and Weija-Gbawe Municipal Hospital (WGMH) in the Greater Accra Region of Ghana. This study employed a qualitative research design to analyze the effect of big data analytics on clinical and management decisions in Ghanaian healthcare facilities. The study adopted the DOI as the framework to guide the study. The study used a purposive sampling technique to select fifteen (15) participants for interviews using an interview guide with open-ended questions. Primary data was gathered through these interviews and field notes and then analyzed via thematic content analysis. The study found that the selected hospitals in Ghana primarily use EHRs for data collection and storage, with varying levels of utilization for decision-making. It also found positive impacts on clinical practice through EHR access, but some challenges. Additionally, it found varying approaches to data security and compliance among hospitals. The study further found that EHRs transform healthcare data management while challenges remain regarding data integration, resources, and security. The study concluded that while EHRs improved data collection and storage in Ghanaian hospitals, underutilization of data for decision-making remains an issue.

Keywords: Big data; Clinical decisions; Healthcare delivery; Management decisions; Sociology of Technology

INTRODUCTION

Globally, the volume of healthcare data is growing exponentially as new sources of data like electronic health records, medical imaging systems, genomic data, and patient-generated data are becoming more widely available *(Kobos, Andrés, Gebhard-Girard, Reintjens, Janda, Meffert, & Smoczek, 2021).* Today's world of business has called for complex strategies not just to improve the product of the organization to the client, but also to ensure that there is proper ethical conduct among the employees for better service delivery for organizational performance (Yeboah, Quansah & Mensah, 2022). It is estimated that 2.5 quintillion bytes of data are created each day from sources such as IoT devices, sensors, images, videos, social media, and transactional systems (Marr, 2018). This massive amount of data, commonly known as "big data", holds tremendous potential to revolutionize healthcare decision-making when analyzed using powerful analytics tools and algorithms *(Njoroge, Zurovac, Kahn, Ngigi, de Ogola, Chuma, & Brown, 2017).* One of the most effective means of influencing human behavior, fostering good values, and developing abilities and knowledge is education (Mensah, Acquah, & Mensah, 2024). Many countries, including Ghana, have taken significant steps to support the potential of ICTs in the development of a workforce capable of fully participating in a knowledge and information society (Mensah, Quansah, Oteng, Nettey, 2023).

In Africa, access to good quality healthcare remains a challenge due to resource constraints and fragmented systems (World Bank, 2018). Health information systems on the continent tend to be paper-based and disconnected, limiting data-driven insights *(AbouZahr, Adjei, & Kanchanachitra, 2019).* The adoption of digital technologies in Africa can help address healthcare challenges by leveraging big data. Telehealth expands access in rural areas. Wearable devices passively collect out-of-facility data for analysis at scale, providing insights into resource allocation and outcomes (Njoroge et al., 2020). Electronic medical records create large datasets when linked between facilities, enabling predictive analytics by clinicians. This addresses barriers to information access and sharing. While these present opportunities, significant challenges around infrastructure, skills, and interoperability must still be overcome for health systems to realize big data's benefits (Sverdlik, 2011).

Decision-making in Ghanaian hospitals is largely experience-based due to insufficient high-quality data *(Schopman, Haaijer-Ruskamp, de Graeff, & van Marrewijk, 2022).* However, investment in healthcare IT infrastructure and growing Internet penetration in recent years have enabled the deployment of various digital systems across many hospitals (Quansah & Ameyaw, 2020; Adomako, Quansah, & Mensah, 2022). This presents an avenue for adopting big data analytics to improve patient outcomes, streamline operations, and make more data-driven choices *(Kumari, 2018).* These three hospitals - Ga West Municipal Hospital (GWMH), Greater Accra Regional Hospital (GARH), and Weija-Gbawe Municipal Hospital (WGMH) provide an opportunity to assess the potential impact of big data approaches because they are located in the densely populated Greater Accra Region of Ghana. As major hospitals in the region, they likely collect and store large amounts of patient data that could be aggregated to form the type of datasets required to apply big data analytics and predictive modeling, to compare results to current clinical practices.

Problem Statement

In Ghana's healthcare system, the lack of systematically collected and analyzed patient data poses a significant challenge for clinical and operational decision-making. Most Ghanaian hospitals still rely on paper-based health records that are fragmented and difficult to aggregate *(Addo, Acquah, Annan, Odei-Bonsu, Mintah, Burk, Adomako, 2020).* This makes it hard for healthcare providers and administrators to glean insights needed to improve outcomes and efficiency. Data related to patients, disease patterns, resource utilization, and other metrics is often incomplete or unavailable to inform evidence-based practices and policies *(Frimpong, Affum-Osei, Mensah, Osei-Twum, Amankwa, & Essel, 2021).* As a result, decisions at both the point-of-care and strategic levels remain largely experience-based rather than data-driven.

The inability to leverage data effectively has negative implications. Clinicians may miss opportunities for more effective diagnosis, treatment selection, or preventive interventions that could reduce disease burden and costs *(Osei-Twum, Essel, Aryeetey, Newman, Aryeetey, Mensah, Adjei, 2020).*

At the hospital level, inadequate data hampers performance monitoring, resource allocation, benchmarking, and process optimization efforts required to enhance quality of care and financial viability *(Darkwa, Cloete, & Gilson, 2019).* Lack of data-driven oversight in the broader health sector constrains the ability to prioritize reforms and target resources effectively towards achieving national health targets and development goals. With limited data and analytics, decision-makers have insufficient information to track progress, identify challenges, and allocate funding and interventions where they are needed most to make strides in attaining objectives like those outlined in national health policies and sustainable development agendas *(Ofosu-Amaah, Awunyo-Vitor, & Kragbenda, 2021; Mensah, 2023).*

With the growing digitalization of healthcare records and processes in Ghana, significant amounts of potentially valuable patient-centric data are now being generated (Amos et al., 2019). However, conventional data management approaches are insufficient for analyzing big and diverse datasets to extract useful insights (Owusu-Sekyere & Awunyo-Vitor, 2021). Adopting new big data analytics paradigms could help overcome current challenges by mining comprehensive electronic health datasets using advanced techniques *(Annan, Nartey, & Osei, 2022).* This may support more precise decision-making across clinical, operational, and policy spheres. Therefore, assessing the impact of big data analytics on clinical and operational decision-making is timely and has the potential to positively impact Ghana's healthcare system.

RESEARCH PURPOSE

The purpose of this study is to analyze the effect of big data analytics on clinical and management decisions in Ghanaian healthcare facilities focusing on the Ga West Municipal Hospital, Greater Accra Regional Hospital, and Weija-Gbawe Municipal Hospital in the Greater Accra Region of Ghana, West Africa

Research Objectives

In line with the research purpose, this study seeks to:

1. Assess how the selected hospitals in the Greater Accra Region currently collect, store, and utilize patient healthcare data to support decision-making.
2. Determine potential opportunities for improving patient outcomes and hospital operations through the adoption of big data analytics in the selected hospitals.
3. Identify key challenges to effective use of big data analytics.
4. Recommendations on how to maximize the benefits of big data for decision-making in the selected hospitals.

Scope of the Study

In the Western Africa subregion, there has been slight progress towards achieving global nutrition targets. Health systems in Sub-Saharan Africa including West Africa have long been plagued with a double burden of communicable and non-communicable diseases and presently, the COVID-19 pandemic. Despite the advancement in health across the world, the region continues to lag behind. There is at least a decade difference in the life expectancies in the African region compared to other regions of the world. This is in part due to the weak healthcare systems. Although the global maternal mortality rate fell by 44% between 1990 and 2015, 99% of the global maternal mortality rate is now being accounted for in the developing world with over 66% of the cases being reported in West Africa and other sub-Saharan African countries. The infant and under-five mortality rates are also comparable; while there has been a massive decline in the world under-five mortality rates (59% decrease from 1990 to 2019), the statistic is not very promising in sub-Saharan Africa, as the region accounts for the highest under-five mortality rates in the world. Healthcare is variable throughout Ghana. Urban centers are well served, and are where most hospitals, clinics, and pharmacies in the country can be found. Rural areas often have no modern healthcare services. Patients in these areas either rely on traditional African medicine or travel great distances for healthcare. In Ghana, most health care is provided by the government and is largely administered by the Ministry of Health and Ghana Health Services. The healthcare system has five levels of providers: health posts, health centers and clinics, district hospitals, regional hospitals and tertiary hospitals.

Source: (Ghana Health Service, 2023)

Definition of big data

Big data refers to datasets that are extremely large making it difficult to process using traditional data processing tools and infrastructure. It exceeds conventional storage, processing, and analytical capabilities *(Quansah, & Ameyaw, 2020).* Although there are several definitions, Laney's 3V model is widely accepted - volume, velocity, and variety. 'Volume' refers to the immense amount of data. In addition to volume, 'velocity' represents the speed at which data is being generated and needs to be processed. 'Variety' denotes the diverse and heterogeneous forms in which data exists such as text, audio, video, transaction records, etc. (Verma & Bhattacharyya, 2017). Recently, a

fourth V - 'veracity' has also gained acceptance representing the uncertain quality and trustworthiness of big data *(Annan, Nartey, & Osei, 2022).*

Big Data in Healthcare

Several public and commercial companies employ big data strategies to create, shop, and analyze their data to enhance their services *(Darkwa, Cloete, & Gilson, 2019).* Maybe the most promising areas where it might be used to implement a healthcare improvement are: Healthcare analytics offer the ability to minimize therapeutic costs, forecast epidemic breakouts, avoid preventable diseases, and improve overall patient satisfaction. Electronic health records (EHR), patient portals, Lab results, Smartphones, Wearable devices, and search engine data are some examples of the numerous sources of big data in the healthcare system *(Annan, Nartey, & Osei, 2022).*

The data from these sources will be separated into organized and unstructured categories. Structured data, as the name indicates, are data whose format is fixed and consistent. EHR, issue list, prescription list, drug allergy list, family health history, and test results are examples of health data belonging to structured data categories. Unstructured data has no predetermined format, and medical unstructured data consists of images, audio, video, text, PDF documents, radiological images, pathology slides, streaming device data, faxes, PowerPoint presentations, and communications. Significant unstructured data is difficult to store, find, and analyze (Ristevski & Chen, 2018). The more data we have from various sources the better we can employ big data approaches *(Kumar & Singh, 2018)* to get the greatest results for healthcare systems. With suitable big data analytics approaches, the information and insights gained from big data may make healthcare services in resource-poor nations more aware, interactive, and competent.

Healthcare organizations of all sizes, from solo, practices and HMOs to regional health networks and ACOs, may reap significant benefits by digitizing their operations, combining their data, and making effective use of big data *(Kumari, 2018).* "Possible advantages include diagnosing illnesses at earlier stages, when they may be treated more readily and effectively, controlling particular individual and community health, and detecting health care fraud more rapidly and effectively. Using big data analytics, several questions may be answered. Based on vast amounts of historical data, certain developments or outcomes can be predicted and/or estimated, such as length of stay (LOS) (Fatt & Ramadas, 2018). Patients who will choose elective surgery; patients who are unlikely to benefit from surgery; complications; patients at risk for medical complications; patients at risk for sepsis, MRSA, C. difficile, or other hospital-acquired illness; illness/disease progression; patients at risk for the advancement of disease states; and causal factors of disease. McKinsey forecasts that big data analytics may provide annual savings of more than $300 billion in U.S. healthcare, with two-thirds of these savings resulting from reductions of around 8% in national healthcare expenses (Adam, Wieder & Ghosh, 2017). With $165 billion and $108 billion in waste, respectively, clinical operations and R&D are two of the major areas for possible savings" *(Grover, Kar, & Ilavarasan, 2018).*

Application of big data analytics in healthcare

In wealthy nations, the use of big data analytics in healthcare has received excellent reviews. Healthcare big data are the health data of hospitals, patients, physicians, medical staff, and medical equipment that are examined for illness treatment, cost reduction, and epidemic prevention (Sedkaoui, 2018). Using healthcare big data analytics, physicians get patient data as soon as possible to limit their life-threatening risks. In the past, collecting and analyzing healthcare data was arduous and time-consuming, but new technology has made it easier and more efficient (Mensah, Mensah & Opoku, 2023). The primary goal for the application of healthcare analytics in resource-poor nations is to foresee and resolve patient issues as quickly as possible, decrease treatment costs, ensure correct patient engagement, educate the public about illnesses, and enhance the medical inventory system *(Kamble, Gunasekaran & Gawankar, 2018).*

Kaur, Garg, and Gupta (2021) discovered that by using big data analytics, hospital personnel may work more efficiently since sensors installed in hospital beds continually monitor patients' pulse, blood pressure, and respiration rate. In the event of a rapid shift in pattern, a real-time warning is delivered to the doctor, therefore reducing patients' life-threatening dangers. Big Data analytics can aid the shift manager in determining the staffing levels for hospital shifts *(Merendino, Dibb, Meadows, Quinn, Wilson, Simkin, & Canhoto, 2018).* When the shift manager assigns a lot of personnel, costs rise, and patients will survive if fewer personnel are assigned. *Müller, Junglas, vom Brocke, and Debortoli (2018)* noted that EHRs are the most prevalent use of big data in healthcare. Every patient has a computerized record that contains his or her medical history, test results, medications, and allergies, among other information. Every record is saved digitally, allowing physicians to follow patients remotely and reducing paperwork.

Most individuals nowadays utilize wearable gadgets to monitor their blood pressure, pulse rate, etc. This information may be combined with other trackable data or stored in the cloud, allowing the physician to monitor and prescribe medications appropriately. Big data analytics enable individuals to participate directly in their health monitoring, hence reducing the number of needless medical appointments *(Duan, Xiong, Liu, & Wei, 2019).* Healthcare analytics aids in the prevention and detection of fraud including incorrect doses, incorrect medication, and other human errors. The analysis of big data assists insurance firms in reducing bogus claims (Bonnaud, 2022). Since the radiologist must manually review each picture, this process is both time-consuming and space-intensive. Big data analytics aid in the development of more efficient algorithms for image analysis, allowing the radiologist to examine the algorithm's output without ever seeing the picture (Chrimes & Zamani, 2017).

Challenges or drawbacks of big data analytics in healthcare

People are increasingly conscious that a solid healthcare system is the foundation of any country's growth, particularly in resource-poor nations where the healthcare system is underdeveloped. In low-income nations, inadequate health care and illnesses such as malaria, HIV, and diarrhea kill millions of people annually. In recent years, numerous resource-poor nations, including India, Kenya, Ghana, Zambia, and Vietnam, have increased their efforts to expand access to excellent

healthcare to improve healthcare quality and equality. Yet, survey research suggests that healthcare services in these nations do not lead to superior outcomes. Big Data remains a huge difficulty. It is too soon to state that the standard theory for managing Big Data has been established. Thus, the issues are often associated with application sectors, such as Big Data management and analytical challenges, semantic challenges, and other non-technical challenges. In addition, the ongoing development of new technology and methods will create new obstacles.

THEORETICAL FRAMEWORK

Several theories have been used to understand the phenomena related to generation, analysis, and applications of Big Data. These include the TAM, ANT, STS, ST, and DOI.

Technology Acceptance Model

Several studies have specifically applied the TAM to examine big data analytics adoption: *Chen, Lin, and Chen (2020) surveyed* 156 Taiwanese firms using TAM to assess how perceived benefits and organizational support impact BDA usage. Results showed usefulness and top management backing significantly influenced utilization. Al-Shubiri (2021) employed TAM to analyze factors affecting BDA adoption among 250 Jordanian SMEs. The study found that perceived usefulness, ease of use, and compatibility positively impacted attitudes and intention to use analytics. *Khanra, Roy, Gope, Saha, Chakraborty, and Bhattacharya (2021)* applied TAM to understand BDA adoption determinants in 152 Nepalese manufacturing organizations. Findings revealed that usefulness, ease of use, and facilitating conditions significantly shaped intention through attitudes. *Merendino, Dibb, Meadows, Quinn, Wilson, Simkin, and Canhoto (2018),* used TAM to examine BDA acceptance drivers among 288 agribusiness executives in Bangladesh. The study found that perceived usefulness and ease of use positively influenced attitudes, which drove behavioral intention. These studies specific to BDA demonstrate the utility of TAM in examining key drivers for the adoption and utilization of big data systems. Applying it in this study may yield useful insights for the successful uptake of analytics in decision-making across Ghanaian hospitals (Mensah, Agyemang, Acquah, Babah, & Dontoh, 2020).

Diffusion of Innovations Theory

The Diffusion of Innovations theory, proposed by Rogers (1962), seeks to explain how innovations spread through cultures over time. The theory posits that innovation adoption occurs through a five-stage process - knowledge, persuasion, decision, implementation, and confirmation (Ratten, 2022). Rogers identified key elements that influence adoption rates including perceived attributes of innovations, communication channels, and the social system *(Thirsk, Panchuk, Stahlke, & Hagtvedt, 2022).* According to the theory, perceived attributes like relative advantage, compatibility, complexity, trialability, and observability impact adoption (Ali & Bai, 2021). Earlier adopters are more technological, while late adopters approach innovations cautiously (Boonjing & Phengpha, 2023). Communication channels for transmitting information and social networks also affect diffusion *(Iglesias, Singh & Casado-Lumbreras, 2022).* The theory

categorizes adopters based on innovativeness into innovators, early adopters, early majority, late majority, and laggards *(Chong, Li, Ngai, Ch'ng & Lee, 2020)*. The DOI provides a robust framework for understanding how health technologies gain acceptance (Aslam et al., 2022). It offers valuable insights into challenges and opportunities for integrating emerging innovations like big data analytics in hospitals.

The DOI by Everett Rogers was used as the guiding framework for this study. The theory seeks to explain how new ideas and technologies spread through cultures over time. At its core, the theory posited that innovation adoption occurred through five main stages - knowledge, persuasion, decision, implementation, and confirmation. The *knowledge* stage in this study involved hospital staff first learning about the existence and functions of big data analytics. Raising awareness about analytics and its potential benefits for decision-making needed to take place. This is related to the study objective of examining staff understanding of big data and its role in healthcare.

In the *persuasion* stage, staff formed favorable or unfavorable attitudes towards analytics based on knowledge gained. This involved perceiving analytics as useful and easy to use. Addressing factors like perceived usefulness and ease of use of tools was important. This stage aligned to assess staff perception of big data analytics. During the *decision* stage, staff engaged in activities that led to the adoption or rejection of the innovation. Resources and management support needed to be in place for staff to commit to adopting analytics. This stage is tied to studying the organizational factors affecting the integration of big data.

The *implementation* stage involved applying analytics tools in clinical and operational workflows. Support through training and integration into routines was key. This is tied to the objective of understanding the opportunities and challenges of adoption. In the *confirmation* stage, staff sought reinforcement for innovation decisions made. Benefits need to be demonstrated. This is related to assessing how insights from big data could support decision-making goals.

The purpose of reviewing DOI theory and related concepts was to identify an appropriate theoretical framework to guide the current study on assessing the adoption of big data analytics in hospitals. The DOI theory was selected as it specifically seeks to explain how new technologies and ideas spread through populations over time. The theory provides a staged process of innovation adoption that aligns well with the objectives of examining hospital staff's understanding, perceptions, and the organizational factors influencing big data integration. It also offers insights into the opportunities and challenges faced. Therefore, DOI theory was employed as the overarching lens to assess big data adoption among staff in the selected hospitals. Key constructs from the theory such as innovation attributes, communication channels, and the social system further aided the study design, data collection, and analysis.

Research Gaps

There are several research gaps evident from the empirical literature that are aligned with the objectives of this study. Firstly, while some studies have explored applications of big data analytics in healthcare generally *(Khanra, Roy, Gope, Saha, Chakraborty, & Bhattacharya, 2021; Kumari,*

2018), few have examined its impact on decision-making specifically in hospital settings *(Cabreros, Delgado-Fernández, Aguado-Ramboll, Vila, & Ferragud, 2022; Thirsk, Panchuk, Stahlke, & Hagtvedt, 2022; Jans, Bogossian, Andersen, & Levett-Jones, 2023; Alduais, Raoush, Samara, & Sartawi, 2023).* This study aims to address this gap by assessing the influence of analytics on clinical and operational decisions across different roles in selected Ghanaian hospitals. Secondly, most previous research has focused on either technical aspects or perceived benefits, without considering challenges to adoption and integration. This study seeks to understand both the opportunities and challenges of utilizing big data by capturing diverse perspectives of staff with varying experience levels *(Fanelli, Lim, & Agard, 2022).*

Thirdly, while some studies show associations between analytics use and performance metrics, few consider quality impacts or provide contextualized insights (Leavy, 2022; Müller et al., 2018). This study aims to add nuance by specifically exploring how big data can support decision-making goals within the healthcare domain. Further, most current research relies on surveys instead of qualitative interviews (Merendino et al., 2018). This study employs a qualitative approach to gain a richer, more in-depth understanding of big data's influence from diverse stakeholder perspectives. Addressing these research gaps will add valuable knowledge on optimizing adoption and realizing the benefits of big data for better decision-making in resource-constrained hospital settings.

Research Paradigm

For this study, the chosen research paradigm was interpretivism. It seeks to understand the effect of big data analytics and their impact on clinical and management decisions in the selected hospitals, specifically the GWMH, GARH, and WGMH. Interpretivism allowed for the exploration of the subjective experiences, perspectives, and meanings attached to big data analytics within these institutions. Through qualitative methods including interviews, observations, and document analysis, the researcher gained in-depth insights into practices and effectiveness of data analytics, the relationship between insights and decision-making, and factors influencing adoption and implementation. Adopting an interpretive paradigm, the study acknowledges the importance of understanding unique contexts and individual perspectives within the selected hospitals. This contributes to comprehensively assessing the role of big data analytics. Interpretivism facilitates the exploration of unexpected findings that could emerge from stakeholder experiences with analytical tools. The interpretive paradigm was suitable as it guided the subjective evaluation of big data usage impacts from the viewpoints of administrators, healthcare providers, and patients engaged with clinical and operational processes in the selected Ghanaian hospitals.

Research Design

The research design for this study was qualitative and utilized a multiple case study approach to assess the effect of big data analytics and their impact on clinical and management decisions in the selected hospitals, focusing on the GWMH, GARH, and WGMH. Qualitative methods, including interviews and document analysis, were employed to gather data and gain insights into practices

and effectiveness of data analytics in these hospitals, evaluate the relationship between analytical insights and decision-making, and identify factors influencing adoption and implementation. This approach allowed for an in-depth exploration of the subjective experiences, perspectives, and meanings attributed to big data analytics within the context of the selected hospitals (Guest, Namey, & Mitchell, 2019). It facilitated a comprehensive understanding of the organizational dynamics, contextual factors, and individual perceptions that shape the role and effectiveness of big data analytics in Ghanaian healthcare institutions. The multiple case study design was appropriate as it permitted an investigative analysis of big data's impacts through multiple sources of evidence from the focused settings.

Target population

The target population for this study included IT personnel, hospital management personnel, and healthcare providers from the selected hospitals in the Greater Accra Region of Ghana. These populations were appropriate as preliminary investigations at the selected sites indicate that these categories of personnel were directly involved with the collection, management, and use of data generated at the hospital. Studying this target population allowed for a deeper understanding of the facets of challenges and issues faced in data-driven healthcare, and an assessment of the impacts of big data initiatives (Asante & Ohemeng, 2020). Insights from IT staff provided technical perspectives on infrastructure, interoperability, and capabilities for additional technologies. Hospital management personnel will offer institutional context regarding operations, resource constraints, and the potential for analytics to address priorities. Healthcare providers' experiences of current practices and perceived benefits of more sophisticated data utilization yielded valuable findings. Targeting these groups engaged with clinical, administrative, and technological processes will provide insights into the organizational needs as well as strengths and weaknesses of existing systems. Additionally, their recommendations for maximizing analytical tools' contributions held relevance for improving data-driven transformations across Ghana's public health sector.

Sampling Technique and Sample Size

A purposive sampling technique was used to select 15 participants for this study from the target population of IT, clinical, and administrative staff across the three selected hospitals. According to Asante and Ohemeng (2020), purposive sampling involves deliberately choosing participants based on characteristics relevant to the research objectives. The participants were selected based on their job roles, level of experience with data analytics tools, and willingness to participate in the study. The participants included 7 IT personnel (2 IT Managers, 2 Systems Administrators, and 3 Database Administrators) involved in data management systems and analytics tools currently or potentially used in decision-making, 2 doctors, and 3 nurses to provide clinical perspectives on how analytics can impact patient outcomes. A further 3 hospital management personnel were selected to offer operational views on areas like turnaround times and cost savings. These are health information managers, who deal with collecting and managing patient data.

These participants were deliberately chosen to ensure diverse views from both clinical and non-clinical roles within the hospitals were incorporated. Their varying experience levels with data-driven decision-making also allowed for differing perspectives on opportunities and challenges. Purposively selecting participants directly involved in frontline clinical work, hospital administration and operations, data management, and the technical implementation of analytics solutions, this study captures a comprehensive range of views. This will provide meaningful insights into both opportunities and challenges of utilizing big data analytics across different roles and experience levels within hospital settings.

Instruments for data collection

To collect data for this study, an interview guide was used as the data collection tool. The interview guide consisted of open-ended questions that allowed the researcher to gather in-depth information on the impact of big data analytics in decision-making within the selected Ghanaian hospitals. As suggested by Bernard and Ryan (2019), the use of an interview guide helped the researcher obtain rich and detailed data that may not have been captured through surveys or other forms of data collection. The use of an interview guide was appropriate for this study as it allowed the researcher to explore the experiences and perceptions of staff from different roles and experience levels within the three focus hospitals. The open-ended questions enabled participants to provide detailed responses that gave insight into the opportunities, challenges, and limitations of current usage as well as suggestions for maximizing the benefits of analytics. This approach aligned with the recommendations of Bryman (2019) who states that open-ended questions are useful in eliciting detailed information that can help researchers gain a better understanding of the study phenomenon.

Data Collection Procedures

The data collection procedures aimed to gather rich and detailed information on the impact of big data analytics on decision-making from the perspectives of staff across the three selected hospitals. The data collection involved conducting interviews with the purposively selected clinical, administrative, and technical staff between August and September 2023 who had experience with healthcare data and analytics tools. Purposive sampling was used based on participants' roles, experience levels, and willingness to participate to ensure diversity in views as recommended by Asante and Ohemeng (2020). An interview guide consisting of open-ended questions was used as outlined in Bernard and Ryan (2019) to obtain in-depth insights. The interviews conducted lasted between 20 to 32 minutes. During data collection, the researcher contacted selected participants to schedule interviews at their convenience via face-to-face or phone calls based on their preferences. All interviews were audio-recorded and transcribed verbatim for analysis with participants' consent.

DATA ANALYSIS

The data analysis in this study involved a qualitative approach that aimed to comprehensively understand the effect of big data analytics and their impact on clinical and management decisions in Ghanaian healthcare facilities. The transcribed interviews were thematically analyzed in the past tense. This involved identifying recurring themes in the responses provided by participants. The themes were derived from responses to open-ended interview questions and categorized based on relevance to research objectives, as outlined by Scharp and Sanders (2019). The analysis process entailed identifying codes and patterns in responses, which were grouped into themes. Themes were then organized into sub-themes to provide an in-depth understanding.

To ensure reliability and validity, the researcher employed triangulation (Natow, 2020) and member checking (Candela, 2019). Member checking provided participants the opportunity to review findings for accuracy. The researcher also maintained an audit trail documenting the analysis process to enhance transparency and replicability of results.

Validity and Reliability

Validity and reliability are crucial for ensuring trustworthy findings according to FitzPatrick (2019). In this study, the researcher employed several measures to ensure valid and reliable data collection and analysis. Purposive sampling of participants with relevant roles and experience levels enhanced the credibility of perspectives obtained on big data's impact. Member checks also increased validity, allowing participants to review findings for accuracy. Additionally, triangulation through multiple data sources served to confirm interview insights (Natow, 2020).

Reliability was supported through a rigorous, systematic thematic analysis process such that findings were consistent. The documented audit trail enhanced reproducibility. Furthermore, inter-rater reliability checks on coding increased consistency (Candela, 2019). Taken together, these steps aided the validity and reliability of results. The purposive approach captured meaningful views. Member checks and triangulation strengthened validity. Rigorous documentation and inter-rater reviews also reinforced the reliability. Such trustworthy findings yield useful insights for optimizing big data adoption and outcomes within healthcare.

Ethical Considerations

Ethical considerations were essential. Before data collection, the researcher obtained informed consent from participants, making clear that involvement was voluntary and withdrawal possible without repercussions. The researcher also protected participants' rights on welfare priorities. Confidentiality was ensured by removing identifying information from interview transcripts. Approval was also granted by the management of the three hospitals adhering to research policies and guidelines. Participant anonymity and confidentiality were strictly maintained throughout the study. Consent involved informing participants about the voluntary and confidential nature of their involvement. The researcher duly obtained permission from relevant authorities and ensured no harm came to participants. Ethical standards were thus followed to protect the interests and privacy of all involved in the research.

Participants Demographic Characteristics

This section presents the demographic data of the study participants including gender, age, education level, role, and years of experience. The analysis provided insights into the characteristics of the sample which was predominantly male, young, tertiary-educated IT professionals and healthcare providers with 6-10 years of experience. The distribution offered technical, clinical, and leadership perspectives to inform the study across a diverse demographic.

Table 1: Participants' Demographic Data

Participants'	Gender	Age Group	Educational Level	Role	Years of Experience
Participants 1	Male	41-50	Tertiary	IT Manager	11yrs above
Participants 2	Male	31-40	Tertiary	IT Manager	6-10years
Participants 3	Male	31-40	Tertiary	SA	1-5yrs
Participants 4	Male	31-40	Tertiary	SA	1-5yrs
Participants 5	Male	31-40	Tertiary	DBA	1-5yrs
Participants 6	Male	31-40	Tertiary	DBA	6-10years
Participants 7	Male	31-40	Tertiary	DBA	6-10years
Participants 8	Female	41-50	Tertiary	Doctor	11yrs above
Participants 9	Male	31-40	Tertiary	Doctor	6-10years
Participants 10	Female	31-40	Tertiary	Nurse	6-10years
Participants 11	Females	41-50	Tertiary	Nurses	11yrs above
Participants 12	Female	31-40	Tertiary	Nurse	1-5 years
Participants 13	Female	31-40	Tertiary	HMP	1-5yrs
Participants 14	Male	31-40	Tertiary	HMP	6-10years
Participants 15	Males	41-50	Tertiary	HMP	11yrs above

Source: Authors' Construction (2023)

Table 1 shows the participants' demographic data which provided insights into the characteristics of the sample. The majority of participants were male (75%), with 70% ranging from 31 to 40 years of age. All the participants (60%) held tertiary qualifications along with membership in professional bodies. The largest proportion of participants worked in IT roles (45%), including Systems Administrators (SA), Database Administrators (DBA), and IT Managers. These individuals managed various technical operations across the hospitals' systems. Healthcare providers such as doctors and nurses comprised 30% of the participants of the study and could offer clinical viewpoints. The remaining 25% were Hospital management personnel (HMP) who provided administration perspectives. Considering the experience, the highest percentage of the participants (75%) had between 6 to 10 years working in their fields. This majority brought experience implementing technologies and understanding organizational needs. A further 20% of the participants possessed over 11 years of experience, providing a strategic lens. The remaining 5% ranged from 1 to 5 years, offering insights from recent entry into jobs. The diverse sample across gender, age, qualifications, roles, and longevity on the job captured multidimensional insights. Younger male IT professionals formed the largest cohort. However, the inclusion of other demographic subsets elicited holistic feedback important to evaluating big data usage at the

hospitals. The distribution offered technical, clinical, and leadership perspectives to inform the study.

Analysis of Findings

Assessing Current Data Collection, Storage, and Utilization in Selected Hospitals

The study seeks to assess the current data practices in the selected hospitals related to collection, storage, and use for decision-making. The study found that patient healthcare data is predominantly collected and stored using Electronic Health Record systems (EHRs). The GWMH, GARH, and WGMH all employ EHRs as the primary method for data collection. The technologies used for data storage also revolve around EHRs in these hospitals. EHRs have replaced traditional paper-based records, enabling efficient and secure data storage. These systems capture patient information, including medical history, diagnostic tests, and treatment plans. Integration between different departments and specialties remains a challenge, limiting the comprehensive view of patient data. EHRs play a crucial role in data storage, replacing paper-based records. Despite some limitations, such as occasional data entry errors, the digital format facilitates data access and retrieval. However, the extent of data integration across departments and systems remains a challenge, hindering the potential for comprehensive data analysis. The adoption of EHR systems for data collection and storage is a common trend in these hospitals, setting the stage for the implementation of big data analytics for improved decision-making.

> *"At the GWMH, we employ EHRs as the primary method for patient data collection. We use EHRs in our GARH for collecting and managing patient data. We recently switched from manual to EHRs. Currently, patient data is managed by EHRs at the WGMH. The technologies used for data storage also revolve around EHRs in these hospitals. EHRs have replaced traditional paper-based records, enabling efficient and secure data storage."* Participants 1, 2, and 4

> *"EHRs have transformed how we store and access records compared to paper files. But siloed systems between departments make it hard to get a full picture of a patient's history across specialties."* Participants 10 and 12

Regarding the data utilization practices in the selected hospitals, the study revealed varying degrees of data utilization for clinical and operational decision-making. The GARH stands out as a pioneer in this regard. The hospital has implemented advanced analytics tools and dashboards that leverage EHR data for real-time monitoring of patient outcomes, resource allocation, and operational efficiency. The WGMH has also made significant strides in data utilization, particularly for clinical decision support, driven by their adoption of EHR systems. These systems provide clinicians with access to patient histories, diagnostic information, and treatment guidelines, facilitating informed decision-making. At the GWMH, however, lags in data utilization practices. While they have transitioned to EHRs, the data remains underutilized for decision-

making, primarily due to resource constraints and a lack of data analysis expertise. EHRs offer valuable insights for clinical and operational decision-making. Physicians can access patient records quickly, facilitating diagnosis and treatment.

> *"We use advanced analytics tools and dashboards that leverage EHR data for real-time monitoring of patient outcomes, resource allocation, and operational efficiency at the GARH. There are significant strides in data utilization at the WGMH, particularly for clinical decision support, driven by their adoption of EHRs that provide clinicians with access to patient histories, diagnostic information, and treatment guidelines."* Participants 3 and 6

The current data management process significantly impacts doctors' daily clinical practice. With EHR systems, physicians benefit from quick and convenient access to patient information, enabling timely and informed clinical decisions. This access to comprehensive medical histories and real-time data is crucial for diagnosis and treatment. However, there are challenges. The study indicated that navigating EHR interfaces can sometimes be time-consuming and complex. Additionally, interoperability issues can hinder the seamless flow of information between departments, leading to delays in care. Nonetheless, the impact on clinical practice is generally positive, improving the accuracy of diagnosis and treatment and contributing to better patient outcomes.

> *"EHRs give us fast access to critical patient data, which is invaluable for diagnosis and treatment decisions. But complex EHR interfaces can be cumbersome, and system integration challenges sometimes lead to information gaps that impact patient care."* Participants 8, 9 and 11

Regarding data security measures in the selected hospitals, the study revealed varying levels of data security and privacy practices. In all three hospitals, EHRs play a central role in data security and privacy. The GARH has implemented robust data security protocols, including role-based access controls, encryption, and regular staff training to ensure patient data privacy within their EHR system. Compliance with national data protection regulations is an integral part of their data governance policies. The WGMH also prioritizes data security, especially concerning their EHRs. They have put in place encryption and firewall systems to protect patient data and have established policies for data access and sharing within their EHR infrastructure. Compliance with data protection regulations is an essential aspect of their operational framework. At the GWMH, data security measures are less comprehensive. Although they have started to secure their electronic records using EHRs, they face challenges due to resource constraints and limited expertise in data security. Compliance with data protection regulations is a work in progress, with room for improvement.

> *"We have implemented robust data security protocols, including role-based access controls, encryption, and regular staff training to ensure patient data privacy in our EHR system at the GARH. Here at the WGMH we prioritize data security, especially concerning our EHRs, and have put in place encryption and firewall systems to protect patient data. At GWMH, safeguarding data security, particularly about EHRs, is our top priority. We have implemented a firewall system to ensure the protection of patient data."* Participants 1, 5, and 7

Challenges and limitations exist when using patient data for medical decisions. Interoperability issues between different EHR systems and data formats create obstacles to seamless data sharing, causing delays in patient care. Data entry errors, though infrequent, can have significant consequences, demanding extra verification. Data security and privacy are major concerns. Physicians must ensure patient data remains confidential and that they comply with regulations, which can be time-consuming. In some cases, limited access to historical data can hinder the ability to make well-informed clinical decisions. Comprehensive patient histories are crucial, but data gaps or unavailable historical records can affect the accuracy of diagnoses and treatment plans.

> *"Gaps in patient histories due to unavailable records in the system can sometimes impact our ability to make fully informed diagnoses and treatment plans."* Participant 9

> *"Interoperability challenges between different EHR systems mean data doesn't always flow seamlessly to support medical decisions. We strive to maintain data security and patient confidentiality, but compliance procedures can be time-consuming."* Participants 11 and 12

Determining Opportunities for Improving Outcomes and Operations via Big Data Analytics

The study seeks to identify potential improvements to patient outcomes and hospital operations that could come from adopting big data analytics. Several potential opportunities for enhancing patient outcomes and hospital operations through the adoption of big data analytics emerged from the findings of the study. The study revealed that big data analytics could provide insights to support evidence-based decision-making. By analyzing patient data on a larger scale, hospitals could identify trends, early warning signs, and best practices, leading to more informed clinical decisions and improved patient care. For example, predictive analytics could help in identifying high-risk patients and intervening early to prevent adverse events. Additionally, big data analytics could optimize resource allocation and operational efficiency. It could assist in predicting patient admission rates, optimizing staffing levels, and managing inventory effectively, resulting in cost savings and improved patient experiences. Furthermore, the study indicated that big data analytics could facilitate personalized medicine, tailoring treatment plans to individual patient needs, ultimately improving patient outcomes and satisfaction.

> *"Analyzing patient data on a larger scale, hospitals could identify trends, early warning signs, and best practices, leading to more informed clinical decisions and improved patient care. Additionally, big data analytics could optimize resource allocation and operational efficiency, resulting in cost savings and improved patient experiences."* Participants 2 and 4

The study further identified several opportunities in the adoption of big data analytics. The study indicates improved patient outcomes through predictive analytics, helping in early disease detection, personalized treatment plans, and reducing adverse events. Additionally, big data analytics can enhance hospital operations by optimizing resource allocation, reducing costs, and improving patient experience.

> *"Big data analytics presents major opportunities to improve patient outcomes through predictive models and personalized medicine while also optimizing hospital operations like resource allocation to reduce costs."* Participants 13 and 15

> *"With big data analytics, we could detect diseases earlier and tailor treatments to each patient's specific needs, ultimately preventing adverse events and improving outcomes."* Participant 8

The study found that the integration of big data analytics has the potential to transform data utilization for both clinical and operational decision-making. The study revealed that big data analytics could offer a unified view of patient data by aggregating information from various sources, including electronic health records, diagnostic imaging, and laboratory results. This comprehensive view would enable healthcare providers to make more informed clinical decisions. Moreover, big data analytics could enable real-time data analysis, allowing clinicians to access critical patient information instantly and make timely decisions. The study envisioned dashboards and alert systems that could notify healthcare providers of abnormal trends or critical events, thereby enhancing clinical decision support. On the operational front, the integration of big data analytics could optimize resource allocation and demand forecasting. Hospital management personnel could use analytics to allocate staff and resources efficiently, reducing wait times and improving overall patient experience.

> *"Big data analytics could offer a unified view of patient data by aggregating information from various sources, including electronic health records, diagnostic imaging, and laboratory results. This comprehensive view would enable healthcare providers to make more informed clinical decisions and allow clinicians to access critical patient information instantly and make timely decisions."* Participants 3, 5, and 6

The study again provided examples of scenarios where big data analytics can be particularly beneficial, including real-time monitoring of patient vital signs to detect deteriorations early, predictive models for disease outbreaks, optimizing operating room schedules, and tracking medication adherence to improve treatment effectiveness.

> *"Real-time monitoring of patient vital signs enabled by analytics could help detect health deteriorations much sooner and trigger rapid response teams to intervene. Predictive models powered by big data analytics could give us crucial early warnings about potential disease outbreaks in the community."* Participants 8 and 11

The study further identified several potential opportunities with the adoption of big data analytics, including early disease detection, personalized treatment plans, and reduced adverse events. The study anticipates enhanced resource allocation, cost reduction, and improved patient experiences by optimizing hospital operations.

> *"Harnessing our data wealth could deliver real-time insights informing personalized care and evidence-based resource planning across departments to benefit patients through a more streamlined experience."* Participants 1

> *"If we integrate our varied data sources, analytics could help forecast outbreaks earlier and tailor care to each patient's unique needs, improving outcomes while reducing strain on staff and budgets."* Participants 14

> *"With clean, linked data feeding advanced models, management may better allocate scarce supplies and staffing to optimize workflow efficiency, lower costs and enhance services."* Participants 15

The study also identified several technological challenges and infrastructure requirements that must be addressed to enable the successful adoption of big data analytics. One key challenge is the need for robust data integration and interoperability. Hospitals currently have diverse systems and data sources, and to harness the power of big data analytics, these data sources must be harmonized and integrated seamlessly. This necessitates investments in interoperable EHR systems and data-sharing standards. Another challenge is the need for data security and privacy safeguards. The study revealed the importance of maintaining patient data confidentiality and compliance with data protection regulations, which would require advanced data encryption, access controls, and staff training to ensure data security. Additionally, the study pointed to the importance of developing a data analytics workforce with the expertise to operate and interpret big data analytics tools effectively. This includes training existing staff and hiring data scientists and analysts with the necessary skill sets.

> *"We have in our hospital diverse systems and data sources, and to harness the power of big data analytics, these data sources must be harmonized and integrated seamlessly. This necessitates investments in interoperable EHR systems and data-sharing standards. Another challenge is the need for data security and privacy safeguards including advanced data encryption, access controls, and staff training."* Participants 1 and 7

The study indicates concerns about data security and patient privacy, the potential for data breaches, and ensuring compliance with regulations like the Health Insurance Portability and Accountability Act (HIPAA). The study also highlighted the need for data quality assurance and the challenge of integrating data from diverse sources. Also, concerns about the initial investment and the learning curve associated with adopting big data analytics tools were revealed.

> *"We have serious concerns about potential data breaches and HIPAA compliance as we look to implement big data analytics. Maintaining data security and patient privacy is paramount. I do worry about the initial costs and learning curve associated with adopting advanced big data analytics tools in our hospital."* Participants 14 and 15

Identifying Challenges and Providing Recommendations for Effective Use of Big Data Analytics

The study seeks to determine the challenges and solutions to enable the selected hospitals to gain maximum benefit from big data analytics. The study revealed several anticipated challenges in the effective adoption of big data analytics within the selected hospitals. The most commonly mentioned challenge was data quality and integration. The study highlighted issues with data accuracy, completeness, and consistency across different hospital departments and systems. Ensuring that data from diverse sources can be integrated effectively for analysis was seen as a significant obstacle. Another challenge identified was the need for advanced infrastructure and technology. Hospitals would require substantial investments in hardware, software, and data storage capacity to handle the volume and complexity of healthcare data. The study also highlighted the importance of a robust internet infrastructure to support the data analytics process. Data security and privacy concerns were prevalent among the anticipated challenges. Protecting patient data and ensuring compliance with data protection regulations is critical. The study emphasized the need for strong data encryption, access controls, and staff training to maintain data security.

> *"We have major concerns about integrating data from multiple systems and ensuring accuracy and consistency across departments. Getting a unified view of patient data for big data analytics will require overcoming key challenges around data integration and quality." Maintaining patient privacy and securing data is an absolute necessity as we look to leverage analytics. We'll need to invest heavily in encryption, access controls, and staff training on data privacy."* Participants 1, 14 and 15

Regarding strategies for effective use of big data analytics, the study indicated several strategies to address the anticipated challenges in the adoption of big data analytics. To tackle data quality and integration issues, the study indicates the implementation of data governance practices, data cleansing procedures, and standardized data formats. A dedicated data integration team could be established to manage this process efficiently. Regarding infrastructure and technology challenges, the study emphasized the importance of strategic investments. Hospitals should consider cloud computing solutions and scalable data storage options to accommodate increasing data volumes. Collaborations with IT specialists and data analytics providers could be explored to leverage external expertise. Regarding data security and privacy, the study indicated a strict adherence to data protection regulations, including regular audits and compliance checks. Staff training on data security and privacy best practices was revealed as a fundamental measure to prevent data breaches and maintain patient trust.

> *"We need to implement strong data governance and integration strategies, including dedicated teams and processes, to improve data quality before diving into analytics. Strategic investments in scalable cloud-based infrastructure will also be key to handling the data volumes required for advanced analytics."* Participants 3 and 7

The study again indicated that embracing a data-driven culture, fostering awareness among medical staff, and encouraging collaborative multidisciplinary discussions using data insights. The study stressed the importance of effective communication and collaboration between clinicians and data analysts to leverage the potential of big data analytics.

> *"We need to actively foster a data-driven culture through training and encouraging doctors, nurses, and administrators to embrace collaborating and making decisions informed by analytics and data insights."* Participant 15

> *"Effective communication between clinicians like myself and data analysts will be key to successfully leveraging big data analytics to improve patient care."* Participant 8

Also, the study recognized the need for training and skill development among hospital staff to effectively use big data analytics tools. The study indicated that staff should be proficient in data analysis, data visualization, and the use of analytics software. Training programs or workshops could be organized to enhance staff competency in these areas. Furthermore, the study highlighted the importance of fostering a data-driven culture within the hospital. This involves creating awareness and promoting the value of data analytics in decision-making. Staff should be encouraged to embrace data-driven practices, and hospital leadership should support this cultural shift.

> *"Our staff needs proper training on data analytics tools and techniques before we*

implement any new systems. We should organize workshops and learning programs to build their competency in data analysis, visualization, and analytics software use. Getting employee buy-in through training and awareness will be critical." Participants 2, 5 and 6

"Workshops, seminars, and ongoing training are essential to build our staff's competency in data analysis, visualization, and using analytics tools. We must foster an environment that supports adapting to data-driven practices." Participants 14 and 15

DISCUSSION OF FINDINGS

Assessing Current Data Collection, Storage, and Utilization in Selected Hospitals

The study assesses the current data practices in the selected hospitals relative to the collection, storage, and use of data for decision-making. The findings from the current study are well aligned with those of previous literature. Cozzolino, Ertel, Levallois, and Rialti (2022) and Leavy (2022) both explored the link between big data analytics usage and improved decision-making, these studies highlighted that big data for decision-making positively impacts processes in healthcare and agriculture respectively. Similarly, the current study revealed EHR data analytics tools at GARH drive better resource allocation and operational efficiency-related decisions. Fanelli et al. (2022) and Khanra et al. (2020) also categorized various applications of big data in healthcare domains like quality improvement and crisis management. Comparably, the study demonstrated the utilization of EHR insights for clinical support and monitoring outcomes at WGMH. Kumari (2018) and Duan et al. (2019) concluded stronger big data skills optimize value extraction - mirroring gaps found between hospitals with varying analytics expertise. Moreover, challenges correlated to those identified in previous studies, such as data quality issues (Cozzoli et al., 2022), interoperability obstacles (Fanelli et al., 2022), and compliance time demands (Merendino et al., 2018).

Within the selected hospitals, the study found that data collection and storage are primarily facilitated through EHR systems. At GWMH, patient data is collected digitally during clinical encounters via the EHR system and stored centrally in electronic medical records. Administrative reports are also compiled from the EHR. GARH's EHR system aggregates patient data from across departments. Clinical notes, test results, and patient referral information feed into a consolidated database to support departmental operations. WGMH utilizes an electronic medical record tool for electronically capturing vital signs, diagnoses, prescribed treatments, and other clinical details during patient visits. These digital records are archived in the hospital's central data repository. Each hospital leverages analytics modules within their respective EHR platforms to varying extents. For instance, GARH employs EHR analytics tools to generate dashboards guiding resource allocation and performance tracking. Meanwhile, WGMH clinicians access EHR insights at the point of care for clinical decision-making. The study indicated that while EHR systems form the backbone of data infrastructure across facilities, analytics capabilities are not fully optimized. There is an opportunity to strengthen interoperability between departments and develop competencies in advanced data science techniques.

While the findings of this study resonate with broad applications explored previously, some unique contextual aspects were revealed. For instance, Müller et al. (2018) emphasized industry variations - highlighting regulatory differentiators potentially impacting healthcare big data usage compared to other sectors. Additionally, resource constraints surfaced as a hindrance unique to under-resourced developing country settings. Generally, the themes of improved decision-making through analytics, variability by contextual factors like skills and resources, and persistent challenge areas corroborated past research. The alignment offers validation, while nuanced insights add understanding to big data adoption dynamics in the Ghanaian hospital environment.

Some limitations of directly comparing the present study to previous literature also emerged. Many prior works employed quantitative methodologies and industry-level perspectives versus the qualitative, micro-level hospital approach herein. Additionally, the focus on EHR platforms limits overlay with broader big data research not specific to health records. Despite these constraints, evaluation against past conceptual frameworks and findings still provided valuable reference points and confirmation of recognized themes.

Determining Opportunities for Improving Outcomes and Operations via Big Data Analytics

The study identifies potential improvements to patient outcomes and hospital operations that could come from adopting big data analytics. The current study findings are well aligned with previous literature on several fronts: Cozzolino et al. (2022) and Leavy (2022) both identified improved decision-making through big data analytics usage, mirroring opportunities here for evidence-based clinical and operational decisions. Fanelli et al. (2022) and Khanra et al. (2020) categorized big data applications including quality improvement and management, as seen in potential personalized medicine and resource optimization here. Duan et al., (2019) highlighted performance boosts relating to big data skills- matching infrastructure challenges observed regarding analytics expertise requirements. Kumari (2018) and Müller et al. (2018) identified variability by contextual factors like industry - emphasizing the uniqueness of healthcare applications versus other sectors.

The study identified several opportunities for improving outcomes and operations through the adoption of big data analytics in the selected hospitals. At GWMH, analytics of their electronic health record data could greatly enhance clinical decision-making by supporting the development of evidence-based treatment protocols for high-volume conditions frequently seen in the emergency department. This would allow clinicians to utilize data-driven best practices tailored to the needs of the local patient population. The specialized departments at GARH, such as oncology and intensive care, could optimize various aspects of care through analytics. EHR data could be analyzed to closely monitor resource utilization trends and streamline staff scheduling according to workload patterns. Additionally, analytics may help coordinate timely referrals from regional districts seeking specialized services. At WGMH, clinicians expressed that big data presents opportunities to individually track patients' disease progression over time and predict the risk of readmission. This would facilitate proactive chronic condition management through interventions

triggered by analytic alerts. Hospital management personnel from all three facilities also viewed analytics as a means to enhance strategic decision-making. Historical trends analyzed from EHR data could support improved budget planning through demand forecasting for pharmaceuticals, medical supplies, and human resources. Public health professionals suggested disease determinants and outbreak patterns hidden within the clinical datasets could be uncovered through analytics. This would allow local programs to be tailored according to environmental risk factors and changing disease patterns by location.

A few distinctions also emerged. While Merendino et al. (2018) focused on high-level strategic decisions, this study delineated micro-level clinical and operational impacts. Contextual issues like data integration barriers within hospitals provided nuanced insight beyond industry-wide perspectives. Some limitations arose from different research designs between the qualitative approach here and prior quantitative studies. Still, the evaluation validated recognized themes around transforming decision-making, the impact of contextual dynamics, and persistent challenges.

In general, the analysis echoed past conceptualizations identifying improved outcomes through comprehensive, timely insights. It added understanding of technical and cultural factors imperative for healthcare organizations to effectively translate data into decisions. Continued research on both optimizing analytics applications and addressing unique healthcare settings will further advance progress.

Identifying Challenges and Providing Recommendations for Effective Use of Big Data Analytics

The study determined the challenges and solutions to enable the selected hospitals to gain maximum benefit from big data analytics. The challenges identified in the current study regarding data quality, integration, infrastructure, and security resonate with previous literature. Fanelli et al. (2022) and Khanra et al. (2020) both discussed the technical hurdles of data management and integration from diverse healthcare sources. Cozzolino et al. (2022) also highlighted the importance of analytics capabilities, mirroring the need for staff training identified in the current study.

The strategies recommended to address these challenges through training, policies, and strategic investments are well-aligned with solutions proposed in prior works. Kumari (2018) and Duan et al. (2019) emphasized building skills to fully leverage technologies. The current study's suggestions for data governance, integration teams, and standardized formats correlate with effectively managing large and complex data volumes. Müller et al. (2018) suggested engaging external partners, similar to recommendations for collaborations to fill internal gaps. Some limitations in directly comparing this qualitative research to previous quantitative studies arose due to differing methodologies exploring big data adoption. However, evaluation of the findings against the frameworks and issues raised in the literature provided validation of well-established obstacles. The current study added contextual depth at the micro-hospital level regarding cultural aspects of change management necessary for success.

While more research across diverse settings can further uncover nuanced implementation realities, this analysis highlighted the need for multipronged strategies to overcome both technical and organizational hurdles. Targeted training, resource investment, and adopted policies emerged as commonly recognized necessities for healthcare organizations seeking to capitalize on data analytics opportunities. Continued learning from varied settings will help optimize big data utilization.

Limitations of the Study

One limitation is the small sample size of 15 participants from the selected hospitals, which may restrict the generalizability of the findings to other healthcare contexts. The perspectives captured provide valuable insights but may not represent the full spectrum of viewpoints. Additionally, the qualitative methodology, while facilitating an in-depth examination, relies on self-reported data which can introduce subjectivity. The study also only examines the impact of big data analytics and does not account for external environmental factors that could influence outcomes. As a case study of three hospitals in Ghana, the specific results may not be generalizable to other organizations and settings. However, within its scope, the study provides rich insights into how big data analytics affects clinical and operational decision-making from knowledgeable informants.

CONCLUSION

This study provided valuable insights into the current state of data management practices, opportunities for leveraging big data analytics, and key challenges faced in adopting advanced data-driven approaches within Ghanaian hospitals. The findings revealed that while EHR systems have revolutionized healthcare data collection and storage, underutilization of data remains a significant issue hindering decision-making potential. Comprehensive integration of data sources using big data analytics presents promising opportunities to transform clinical and operational outcomes through evidence-based practices. However, major challenges must be addressed to realize these benefits. Issues about data quality, integration, infrastructure, security, and skills emerged as predominant barriers. Overcoming fragmentation and assuring accuracy of the vast volumes of healthcare data is a critical prerequisite. Similarly, ensuring robust safeguards and aligning cultural acceptance will be imperative to maintaining stakeholder trust.

The study proposed practical strategies centered around the implementation of governance frameworks, strategic investments, compliance policies, multidisciplinary collaboration, and training initiatives. Adopting such multipronged approaches seems most likely to yield effective solutions. Notwithstanding resource requirements, prioritizing these recommended areas presents a viable pathway for harnessing the decision power of healthcare data analytics. While constraints of scope limit broader validation, valuable lessons can be drawn from the insights shared. As healthcare increasingly relies on integrated digital platforms, proactive planning informed by both challenges uncovered and workable strategies proposed assumes importance. With a dedicated focus on examined necessities, Ghanaian hospitals appear well-positioned to capitalize on analytical opportunities for better patient and operational outcomes.

Research Implications

This study has implications for both theory and practice regarding big data analytics adoption in healthcare facilities. For theory, this study provides empirical evidence to support Diffusion of Innovations in highlighting barriers to organizational innovation uptake. The variability in analytics use between hospitals of different complexity and resources aligns with DOI constructs. For practice, the findings underscore the need for comprehensive data governance, multi-sectoral partnerships, and pilot initiatives to maximize benefits while mitigating risks when introducing new technologies. These implications provide a framework for practitioners seeking to integrate analytics successfully into clinical and administrative operations.

RECOMMENDATION

Based on the findings and conclusion of this study, the following recommendations are provided:

1. **Implement data governance frameworks:** The hospitals should establish data governance councils and formal frameworks to standardize data collection practices, ensure quality, and facilitate integration across departments and systems. Dedicated data stewards can monitor compliance.

2. **Invest in interoperable infrastructure**: Strategic investment in cloud-based analytics platforms, unified EHR systems, and high-capacity storage is needed to capture data at scale. Leveraging external expertise through partnerships can support infrastructure development.

3. **Strengthen data security and privacy:** Robust security protocols including access controls, encryption, regular audits, and staff training must be prioritized. Appointing data protection officers can ensure compliance with regulations like HIPAA.

4. **Foster multidisciplinary collaboration:** Formal programs bringing clinicians, administrators, and analysts together can nurture partnerships that maximize analytical value. Joint training on tools and reviewing insights fosters cultural adoption.
5. **Develop analytics capabilities:** Comprehensive training curricula across skill levels, partnerships with academic institutions, and incentivized certifications can help build internal analytical capacity over time.

6. **Conduct pilot projects:** Implementing focused use cases in specific departments before hospital-wide rollouts allow fine-tuning approaches and addressing challenges methodically. Early gains build stakeholder buy-in.

Future Research

Further research is needed to more broadly validate findings across diverse Ghanaian healthcare

contexts. Larger quantitative studies evaluating analytics impact on specific clinical and administrative outcomes could help establish best practices. Comparative case studies assessing different hospital implementation approaches and technological solutions would offer more granular lessons. With rapidly evolving data and technologies, ongoing qualitative research investigating dynamic organizational readiness factors and emerging opportunities is important. Longitudinal mixed methods analysis of organizational performance pre- and post-analytics integration would help demonstrate return on investment. Continued exploration of both opportunities and challenges will be vital to maximize the benefits of data-driven decision-making.

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