

# EVALUATING THE EFFECTS OF BIG DATA ANALYTICS ON CLINICAL AND OPERATIONAL DECISION-MAKING IN HOSPITALS IN NORTHERN GHANA

Alhassan Shaibu, University Development Studies, Ghana

## ABSTRACT

*This study aims to evaluate the influence of big data analytics on clinical and operational decision-making in Ghanaian hospitals, with particular emphasis on the Tamale Central Hospital (TCH), Tamale West Hospital (TWH), and Tamale Teaching Hospital (TTH) in the northern region. To assess how big data analytics affected clinical and operational decision-making in Ghanaian hospitals. This study used a qualitative research approach. 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. To the best of my knowledge, this research is the first to assess the impact of big data analytics in Ghanaian hospitals on clinical and operational decision-making.*

**Keywords:** Big Data Analytics, Electronic Health Records (EHRs), Clinical Decision-Making, Operational Efficiency, Data Security, Interoperability, Data Integration, Predictive Analytics, and Data Governance.

## INTRODUCTION

The amount of data pertaining to healthcare is increasing rapidly on a global scale due to the increased accessibility of new data sources such as patient-generated data, medical imaging systems, electronic health records, etc (Dziedzic et al., 2021). An estimated 2.5 quintillion bytes of data are generated daily from sources like social media, transactional systems, IoT devices, sensors, photos, and videos (DeMars, 2020). With the right analytics and algorithms, this vast quantity of data also referred to as "big data" has the potential to completely transform healthcare decision-making (Shafqat et al., 2020).

Access to high-quality healthcare in Africa is still difficult because of disjointed institutions and limited resources (Marais et al., 2019). Data-driven insights are limited by the continent's often paper-based and disjointed health information systems (AbouZahr et al., 2019). By utilizing big data, digital technology adoption in Africa can aid in addressing healthcare issues. Access in remote places is increased by telehealth. Wearable technology passively gathers data from out-of-facility activities for large-scale analysis, offering insights

into the distribution of resources and results (Njoroge et al., 2020). When linked between facilities, electronic medical records generate massive databases that allow clinicians to perform predictive analytics. This deals with obstacles to the exchange and availability of information. While these offer opportunities, health systems still need to overcome major obstacles related to infrastructure, skills, and interoperability before they can fully benefit from big data (Hussein, 2019).

In Ghanaian hospitals, the majority of decisions are made by experience because there is a dearth of high-quality data (Anabila et al., 2019). However, recent increases in Internet usage and investments in healthcare IT infrastructure have made it possible to implement a variety of digital solutions in numerous hospitals (Quansah & Boateng, 2020). This offers a way to use big data analytics to enhance patient outcomes, expedite processes, and make more informed decisions (Kwaghe et al., 2020). Due to their locations in Ghana's highly populated Greater Accra Region, Ga West Municipal Hospital (GWMH), Greater Accra Regional Hospital (GARH), and Weija-Gbawe Municipal Hospital (WGMH) offer a chance to evaluate the possible effects of big data approaches. Given their status as important hospitals in the area, it is likely that they gather and retain a sizable amount of patient data, which may be combined to create the kinds of datasets needed to use big data analytics and predictive modeling to compare outcomes to existing clinical procedures.

## Problem Statement

Clinical and operational decision-making in Ghana's healthcare system is severely hampered by the absence of patient data that is methodically gathered and examined. The majority of hospitals in Ghana still maintain disjointed, challenging to gather paper-based health records (Larbi, 2018). Decision-makers struggle with limited data and analytics, unable to track progress, identify challenges, and allocate resources effectively for national health policies and sustainable development agendas (Anabila et al., 2019).

Inefficient data usage can lead to healthcare professionals overlooking opportunities for improved diagnosis, treatment planning, and preventative measures, potentially reducing illness burden and expense (Orangi et al., 2023). Ghana's healthcare system is becoming more digital, which produces useful patient-centric data, but traditional data management techniques are not enough (Nketia & Maharaj, 2023). New big data analytics paradigms have the potential to improve Ghana's healthcare system by assisting in the resolution of problems and facilitating accurate decision-making in the fields of clinical, operational, and policy (Wally, 2021).

This could facilitate more accurate decision-making in the domains of clinical, operational, and policy. For this reason, it is timely to evaluate how big data analytics affects clinical and operational decision-making, as doing so could improve Ghana's healthcare system.

## Research Objectives

- Assess how the selected hospitals in the Northern Region currently collect, store and utilize patient healthcare data to support decision-making.
- Determine potential opportunities for improving patient outcomes and hospital operations through adoption of big data analytics in the selected hospitals.

## Research Question

- How do the selected hospitals in the Northern Region currently collect, store, and utilize patient healthcare data to support decision-making?
- What opportunities exist for enhancing patient outcomes and hospital operations through the implementation of big data analytics in these hospitals?

The study explores the potential of big data analytics to enhance resource allocation and decision-making in Ghana's healthcare sector. It evaluates current procedures and provides policymakers and hospitals with useful information. The results may enhance the performance of the industry as a whole, patient outcomes, and resource use.

## LITERATURE REVIEW

This chapter reviews big data analytics in healthcare decision-making, identifying gaps in literature and defining key concepts. It examines impact using TAM, ANT, STS, ST, ST, and DOI, and evaluates big data adoption in Ghanaian hospitals.

### Definition of Big Data

Big data refers to large datasets exceeding conventional storage, processing, and analytical capabilities (Favaretto et al., 2020). Laney's 3V model, which includes volume, velocity, and variety, is widely accepted. Volume refers to the immense amount of data, velocity represents the speed of data generation, variety represents diverse data forms, and veracity represents the uncertain quality and trustworthiness (Al-Mekhlal & Khwaja, 2019).

### Importance of Big Data

Big data is essential for optimizing consumer services and applications, but managing large volumes of structured and unstructured data presents challenges (Vassakis et al., 2018). Advanced data management tools, AI and ML techniques, and advanced analytics platforms in healthcare can improve efficiency. Proper management of big data through specialized databases and analytics solutions can deliver user-friendly insights for progress and innovation (Iqbal et al., 2020).

### Big Data Analytics

Data analytics is the process of analyzing large amounts of data using various tools, including big data analytics, to extract useful patterns and relationships from merged data from various sources. This involves examining, modeling, cleaning, and manipulating big data to facilitate decision-making and improve understanding of the data.

### Importance of Big Data

Big data is essential for efficiently enhancing consumer services and apps since vast amounts of data are generated every second from many sources (Janev et al., 2020). But handling such massive amounts of organized and unstructured data presents serious difficulties that standard software is unable to handle (Sraku-Lartey et al., 2017). High-end computing and sophisticated data management technologies are needed for storage, analysis, and the extraction of valuable insights (Dayal et al., 2013). Big data decision-making can be automated with the help of AI and ML techniques (Japar, 2024). The creation of advanced analytics platforms that work with sensor-collected data, in particular, can help increase

efficiency in the healthcare industry by enabling centralized "gathering, storing, analyzing, and visualizing" of information (Siswanto et al., 2021). Big data can therefore benefit a variety of fields by providing easily understood insights that are essential for advancement and innovation if it is managed appropriately using specialized databases and analytics solutions (Singh et al., 2023).

## Characteristics of Big Data

### Volume

Volume is the amount of data that individuals or organizations produce (Cozzoli et al., 2022). Companies in every industry are looking for ways to handle the daily volume of data that is generated. Since health-related data will be continuously acquired, there will eventually be an excessive amount of it (A. Kumari et al., 2018). The healthcare business already has an incredible quantity of data, and this amount is made even more by the addition of personal health records, x-ray images, data from clinical studies, genomic sequences from humans and other populations, etc.

### Velocity

Accumulation of data in real-time happens quickly or at a high velocity. The accumulation of data is accelerated by data indicating frequent monitoring, such as several daily blood pressure readings, EKGs, and diabetes glucose measurements (Khanra et al., 2021). Big data is processed and analyzed in almost real-time, in contrast to the periodic data loads and updates that are characteristic of standard data warehouse analytics, such as those that happen daily, weekly, or monthly. Data in healthcare might be real-time, semi-dynamic, or static (A. Kumari et al., 2018). For applications like as clinical decision support in the healthcare industry, where precise and timely data is necessary for efficient decision-making and the prompt removal of errors, this is particularly crucial. Automated decisions are unreliable without up-to-date information (Aseeri, 2023).

### Variety

Variety is the emergence of new data types, especially those derived from computers, mobile devices, and social media (Cappa et al., 2021). Examples of new data types include "content, mobile, physical data points, process, radio frequency identification, search, sentiment, streaming data, social, text, and web information, hardware data points, log data, machine data, metrics, and location or geospatial information." Additionally, standard unstructured clinical data is included in the diversity (Bharathi et al., n.d.). The healthcare sector continuously produces structured and semi-structured data as a result of the information moving from paper medical records to electronic health records (EHRs) and electronic medical records (EMRs) (Preko & Boateng, 2020). It also includes readings from medical devices, specific clinical data, computerized billing and bookkeeping, and statistics required to estimate risks. Unstructured data includes handwritten notes, paper prescriptions and medical records, X-rays, and other photos.

### Veracity

It relates to the correctness and conformity of the data. This is especially challenging for large data, since data may originate from diverse sources that cannot ensure quality and conformity to a certain display format (Awol et al., 2020). Data veracity is of special importance in healthcare due to the influence it has on patient safety and the risk posed by poor-quality or even erroneous data (Ayokanmbi, 2021). By allowing for more precise diagnoses and treatment options, high-quality data is essential for lowering healthcare expenditures without compromising quality. Data veracity is of particular significance in healthcare because it influences patient safety and because of the danger of low-quality or even inaccurate data (Ayokanmbi, 2021).

### Variability

Data whose relevance is always changing are referred to as variable (Awol et al., 2020). Crucially, the way these data are recorded might vary over time and between locations, which has an impact on the care that patients receive. This variability takes into account things like what a clinician reads in the prescription, where they received their training, the professional judgment of a colleague, and the way a patient expresses herself during the initial exam. All of these things have the potential to have a big impact on what happens in the next moment. Because of this variance, information can only be appropriately shared and utilized when the delivery process and care setting are taken into account.

### Big Data for Decision-making

The big data revolution is more potent than earlier methods of analysis. Managers may make better decisions based on facts rather than gut feeling thanks to big data. Businesses collect far more data than is required for any given purpose (Müller et al., 2024); big data helps produce predictions that are more accurate and help make better decisions. The appropriate utilization of enormous data leads to several applications of big data that support decision-making. Numerous tactics and tools improve one's ability to make decisions. Netflix and Amazon have created algorithms to look for patterns in customer searches and past purchases in order to anticipate the things that customers are likely to buy (S. Kumari & Jeble, 2020).

### Big Data in Healthcare

Big data techniques are used by a number of government agencies and private businesses to generate, store, and analyze data in order to improve services (Wang et al., 2020). The following are maybe the most promising areas where it could be utilized to implement improvements in healthcare: Healthcare analytics can reduce therapeutic expenses, predict the onset of epidemics, prevent diseases, and enhance patient happiness in general. Various sources of big data in the healthcare sector include electronic health records (EHR), patient portals, lab findings, smartphones, wearable devices, and search engine data (Štufi et al., 2020). Both organized and unstructured categories will be created from the data gathered from various sources. As the name suggests, structured data have a set and consistent format. Examples of health data that fall under structured data categories include test results, family health history, prescription lists, issue lists, EHRs, and lists of drugs and allergies. Medical unstructured data includes photos, audio, video, text, PDF documents, radiological images, pathology slides, streaming device data, faxes, PowerPoint

presentations, and communications. Unstructured data does not follow a set format. It is challenging to locate, store, and analyze significant unstructured data (Ristevski & Savoska, 2021). Using big data effectively, digitizing operations, and merging data can assist healthcare organizations of all sizes, from solo practices and HMOs to regional health networks and ACOs (Miller, 2021). There are a number of potential benefits, including as early sickness diagnosis, which allows for easier and more successful treatment; community and individual health management; and quicker and more accurate detection of health care fraud. Multiple questions may be addressed with big data analytics. Many developments or outcomes, including length of stay (LOS), can be approximated or projected based on a plethora of previous data (Fatt & Ramadas, 2018).

### **Application of Big Data Analytics in Healthcare**

The application of big data analytics to healthcare has gotten great accolades in wealthier countries. Big data in healthcare refers to health information from hospitals, doctors, patients, staff, and medical equipment that is analyzed for illness treatment, cost-cutting, and epidemic prevention (Sedkaoui, 2018). Physicians can reduce their potentially fatal risks by using big data analytics in healthcare to obtain patient data as quickly as possible. Healthcare data collection and analysis used to be laborious and time-consuming, but modern technologies have made the process quicker and more effective. In resource-poor countries, the main objectives of applying healthcare analytics are to predict and promptly address patient problems, lower treatment costs, guarantee appropriate patient involvement, inform the public about illnesses, and improve the medical inventory system. According to Kaur and Sharma (2024), hospital staff may be able to perform more effectively by utilizing big data analytics because sensors that are installed in hospital beds continuously monitor patients' blood pressure, pulse, and respiration rate. A real-time alert is sent to the physician in the event of a sudden change in pattern, lowering the risk to the patient's life. The shift manager can use big data analytics to help decide how many people to hire for hospital shifts (Merendino et al., 2018). 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, 2015).

### **Challenges of Big Data Analytics in Health Care**

People are becoming more aware of the fact that a strong healthcare system is essential to any nation's development, especially in those with little resources and weak healthcare systems. Millions of people die each year in low-income countries from diseases including malaria, HIV, and diarrhea as well as from poor access to healthcare. Many low-resource countries, such as Zambia, Ghana, India, Kenya, and Vietnam, have stepped up their efforts in recent years to boost access to high-quality healthcare in order to raise standards of treatment and promote equity. However, survey data indicates that these countries' healthcare systems do not produce better results. Big Data still presents several challenges. It is premature to declare that a standard theory of Big Data management has been developed. As a result, the problems are frequently linked to application domains, including analytical and Big Data management, semantic hurdles, and other non-technical problems. New challenges

will also be brought about by the continuous development of new techniques and technologies.

## Empirical Literature

As big data becomes more widely used in economics, researchers and practitioners are looking more closely at how big data affects corporate decision-making procedures. Until recently, researchers and managers focused solely on the technical aspects of big data, neglecting to emphasize how these qualities affect the effectiveness of decision-making procedures. Cozzoli et al. (2022) reviewed the literature to find out more about the relationship between big data utilization and corporate decision-making systems' effectiveness. The selected theoretical framework is based on research on big data management, with a particular focus on the implications that imply the use of big data may influence how businesses and organizations make decisions. This work proposes future research directions to advance understanding in this sector and adds theoretical and managerial insights to the literature on big data and decision-making.

Nettey et al. (n.d.) in their study was to demonstrate the state of the art in big data application for healthcare organization administration decision-making. There was a thorough analysis of the literature. A total of 48 articles were selected for bibliographic coupling-out of a first selection of over 5,000 items. Their bibliographies show that twenty-nine (29) of the 48 items are related. Four key research areas quality of care, quality of service, crisis management, and data management—rose from the actual substance of the 29 articles.

Furthermore, Khanra et al. (2021) carried out a thorough literature review to compile the body of knowledge regarding the application of BDA in healthcare. Assessment of forty-one empirical studies and creation of a comprehensive framework. The study's findings show that "applications of BDA in healthcare may be viewed from five viewpoints, namely, treatment of specific medical diseases, interactions among stakeholders in the healthcare ecosystem, hospital management practices, and general public health awareness."

A. Kumari et al. (2018) sought to understand how Big Data Analytics may be used in the healthcare industry to help hospital staff, doctors, and patients operate more efficiently and streamline the delivery of healthcare. The healthcare industry collected information from multiple sources. According to the author, the recent surge in healthcare data holds the key to handling the enormous amounts of patient-generated healthcare data in the present healthcare environment, as well as to improving health outcomes and lowering the steadily rising costs of healthcare. The study concludes that because big data has the potential to be a very powerful tool for acquiring, storing, managing, and protecting information in a variety of formats, it will revolutionize the overall effectiveness of running data centers.

Li et al. (2022) investigated the mediating role of data analytics capabilities and the impact of big data analytics utilization on decision-making quality using the dynamic capability theory. Data was gathered by surveying 240 agribusiness enterprises in China. The study's conclusions demonstrated that using big data analytics improved decision-making quality and that data analytics competencies acted as a mediating factor in the relationship between big data analytics use and superior decision-making. Therefore, in order to gain a competitive edge, organizations should not only encourage the use of big data analytics in their operations but also take action to improve their data analytics expertise.

Duan and Xiong (2015) recognized that there was a dearth of literature on the management of the information generated by the BDA and its integration and conjunction

with firm knowledge, despite the growing need for an organized and integrated strategy, so they set out to address it. Through empirical research using structural equation modeling and data collected from 88 Italian SMEs, the authors investigated whether BDA skills had a positive impact on company performance and the role that knowledge management played in mediating this relationship. The study's findings show that businesses with higher levels of managerial and technical BDA skills performed better, and that KM orientation greatly amplifies the impact of BDA capabilities.

## RESEARCH METHODOLOGY

### The Qualitative Approach

The viewpoint of the qualitative researcher emphasizes the significance of hearing the researcher speak and gathering firsthand information about the researcher's personal experiences related to a certain topic. It seems to focus on social processes, where the defined relationship between the researcher and the respondents is respected, rather than primarily or exclusively on findings (Pitardi & Marriott, 2021). The acceptance of qualitative research for the study was largely influenced by its features and attributes, which include the emphasis on thick definition and the collection of authentic, rich, and deep data that reveals regular patterns of behavior and meaning from the perspective of the subjects of the study.

Interpretivism was the research paradigm of choice for this study. It aims to comprehend the function of big data analytics and how it affects clinical and operational decision-making at a few Ghanaian hospitals the Tamale central hospital, Tamale west hospital and the Tamale teaching hospital in the northern region in particular. Within these institutions, interpretivism made it possible to investigate the varying subjective experiences, viewpoints, and interpretations associated with big data analytics. The researcher obtained in-depth understanding of data analytics processes and effectiveness, the connection between insights and decision-making, and adoption and implementation variables through qualitative approaches such as observations, interviews, and document analysis. The study, which uses an interpretive paradigm, recognizes the significance of comprehending the distinctive circumstances and individual viewpoints inside the chosen hospitals.

### Study Settings

The Northern Region presents a perfect environment for investigating potential integrations of big data analytics into its public health system. The regional capital, Tamale, is located in the northern region area, which is Ghana's third most populous area (Ghana Statistical Service, 2021). Primary care clinics, health centers, district hospitals, regional hospitals, and teaching hospitals are all part of the region's public healthcare system, which collectively meets the various healthcare requirements of more than 5 million people (Amoako-Sakyi et al., 2019). Serving as the primary district hospital, Tamale West Municipal Hospital provides care to 260,000 patients. Every day, GWMH provides complete outpatient, inpatient, diagnostic, and maternity treatment. More than 120 people are seen in the emergency room alone for wounds, infections, and other conditions. In order to support clinical and administrative procedures and digitally capture and track this significant throughput, GWMH uses a powerful electronic health record system.

The Tamale Teaching Hospital (TTH) is the regional referral center, receiving over 700 daily outpatients and admitting more than 60 inpatients across specialized departments



like oncology, intensive care, and surgery (Ntim, 2015). TTH's electronic health record system centrally aggregates patient data previously siloed in paper archives. This networked system offers potential for data analytics at the TTH scale of operations.

## DATA COLLECTIONS

**Participant's Demographics Characteristics Table 1**

Table 1 PARTICIPANTS' DEMOGRAPHIC DATA					
Participants'	Gender	Age Level	Group	Educational 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	Female	41-50	Tertiary	Nurse	11yrs above
Participants 12	Female	31-40	Tertiary	Nurse	1-5 years
Participants 13	Female	31-40	Tertiary	HMP	1-5 years
Participants 14	Male	31-40	Tertiary	HMP	6-10years
Participants 15	Male	41-50	Tertiary	HMP	11yrs above

Source: Authors Construction (2023) Findings

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

The study found that patient healthcare data is predominantly collected and stored using Electronic Health Record systems (EHRs). The TWH, TWS and TTH 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.

*"At the GWMH, we employ EHRs as the primary method for patient data collection. We use EHRs is used in our GARH for collecting and managing patient data. We recently switch 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.

*"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 is 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 EHRs 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 prioritizes data security, especially concerning our EHRs, and has put in place encryption and firewall systems to protect patient data. At GWMH, safeguarding data security, particularly with regard to EHRs, is our top priority.*

*We have implemented a firewall systems 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. 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 indicate 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.* Participant 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 anticipate 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 indicate concerns about data security and patient privacy, the potential for data breaches, and ensuring compliance with regulations like 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, they the study indicate 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

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. Cozzoli et al. (2022) and Li et al. (2022) both explored the link between big data analytics usage and improved decision-making, these studies highlighted that big data for decision making positively impact processes in healthcare and agriculture respectively. Similarly, the current study revealed EHR data analytics tools at TTH 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 utilization of EHR insights for clinical support and monitoring outcomes at TWH. 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 is primarily facilitated through EHR systems. At TTH, 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. TCH 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, TWH employs EHR analytics tools to generate dashboards guiding resource allocation and performance tracking. Meanwhile, TCH 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 identify 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: Cozzoli et al. (2022) and Li et al. (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 uniqueness of healthcare applications versus other sectors.

### **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. Cozzoli 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 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 adapted 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.

## **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 pertaining to 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 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.

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**Received:** 02-Sep-2024 Manuscript No. JMIDS-24-15271; **Editor assigned:** 04- Sep- -2024 Pre QC No. JMIDS-24-15271(PQ); **Reviewed:** 16- Sep -2024 QC No . JMIDS-24-15271; **Revised:** 23- Sep--2024 Manuscript No. JMIDS-24-15271(R); **Published:** 30- Sep- -2024