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Article

Evaluating the impact of big data analytics in rural-based hospitals

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Abstract: While the healthcare landscape continues to evolve, rural-based hospitals face unique challenges in providing quality patient care amidst resource constraints and geographical isolation. This study evaluates the impact of big data analytics in rural-based hospitals in relation to service delivery and shaping future policies. Evaluating the impact of big data analytics in rural-based hospitals will assist in discovering the benefits and challenges pertinent to this hospital. The study employs a positivist paradigm to quantitatively analyze collected data from rural-based hospital professionals from the Information Technology (IT) departments. Through a comprehensive evaluation of big data analytics, this study seeks to provide valuable insights into the feasibility, infrastructure, policies, development, benefits and challenges associated with incorporating big data analytics into rural-based hospitals for day-to-day operations. The findings are expected to contribute to the ongoing discourse on healthcare innovation, particularly in rural-based hospitals and inform strategies for optimizing the implementation and use of big data analytics to improve patient care, decision-making, operations and healthcare sustainability in rural-based hospitals.

Keywords: big data analytics; hospital; healthcare; decision making; patient care

1. Introduction

Globally, rural-based hospitals play a critical role in the local communities by providing emergency medical services to the citizens (Malelelo-Ndou et al., 2019; Miller et al., 2020; Nevhutalu, 2016). Rural-based hospitals are strategically situated to ensure accessibility for residents in remote areas, by minimizing distances and enhancing timely access to healthcare services (Nevhutalu, 2016). However, most of these hospitals have limited specialized medical doctors (Malelelo-Ndou et al., 2019; Nevhutalu, 2016). Furthermore, they are strategically designed to provide free medical treatments to the citizens (McCarthy et al., 2021; Nevhutalu, 2016).

In the dynamic landscape of healthcare, the challenges faced by rural-based hospitals are particularly distinctive, shaped by limited resources and geographical location isolation (Nevhutalu, 2016). Rural-based hospitals have a unique setting as they are specifically designed to address the healthcare needs of patients residing in rural areas, particularly those who do not have access to urban healthcare facilities (McCarthy et al., 2021; Miller et al., 2020). The evolving nature of healthcare demands innovative solutions to ensure the delivery of high-quality patient care in these unique settings (Nevhutalu, 2016). One of the innovative solutions for addressing these challenges is the integration of big data analytics in rural-based hospitals to improve their healthcare systems (Palanisamy and Thirunavukarasu, 2019; Roy, 2016).

Big data analytics refers to the process of analyzing and interpreting large and complex datasets, commonly known as big data. Big data is analyzed to uncover

valuable insights, undisclosed correlations, concealed patterns, trends and other business insights through advanced tools designed to analyze large volumes of data with high speed and diverse formats (Faridoon et al., 2023; Kelvin and Morrisson, 2023; Popovič et al., 2018). This analytical approach involves the use of advanced tools, technologies and algorithms to extract meaningful information from massive amounts of structured and unstructured data (Rehman et al., 2021; Seefong et al., 2023). The goal of big data analytics is to gain a deeper understanding of the data, make informed decisions and identify opportunities for improved efficiency, innovation and competitiveness (Ramesh and Santhi, 2020; Yu et al., 2021).

Even though there are limited resources in rural-based hospitals, they are progressively adopting big data analytics to improve hospital operations, decision-making and patient care (Batko and Ślęzak, 2022; Gomes et al., 2022; Imran et al., 2021). Regardless of the evidence of a gradual increase in the adoption of big data analytics in rural-based hospitals, there is a lack of a study that empirically evaluates the impact of big data analytics in these hospitals. As the healthcare industry undergoes a paradigm shift towards data-driven decision-making, this research bids to shed light on the impact of big data analytics in rural-based hospitals. By doing so, this study seeks to empirically evaluate the impact of BDA in rural-based hospitals.

The study is structured into six sections. Section 2 provides an overview of how the literature was searched and a literature review on big data analytics in healthcare institutions. Section 3 outlines the research methodology, highlighting the research approach, population and sampling method, focusing on the selection of rural-based hospitals and the personnel who participated in the questionnaire. Furthermore, this section explores how data was collected from the selected participants and analyzed. Section 4 presents the empirical analysis of the results of this study, while Section 5 discusses findings related to the impact of big data analytics in rural-based hospitals. Finally, Section 6 concludes the study and offers insights.

2. Literature review

In this study, the researchers followed PRISMA guidelines to search for literature relevant to this study (Fleming et al., 2014; Okoli and Schabram, 2012). The literature was searched from the following databases: ACM digital library, ScienceDirect, Ebscohost, Proquest (ABI/INFORM collection), Scopus and IEEE Xplore digital library. These databases were chosen because they are the most used databases in Information Systems (Levy and Ellis, 2006). To retrieve different sources from the database, the following keywords were used: (1) “Big data analytics” AND “Rural-based hospitals”, (2) “Big data” AND “Rural-based Hospitals”, (3) “Big data analytics” AND “Hospitals”, (4) “Big data” AND “Hospitals”, (5) “Big Data Analytics” AND “Rural-based healthcare”, (6) “Big data” AND “Rural-based healthcare”, (7) “Big data analytics” AND “healthcare”, and (8) “Big data” AND “healthcare”.

The search was limited to peer-reviewed articles published between 2017 and 2023. An initial search from the used database retrieved 147 articles. Then, the researchers reviewed the title, keywords, abstracts, introduction and conclusion during the initial screening to identify relevant studies. Therefore, 112 sources were excluded.

Later on, the full text was read to assess the relevance of the articles to be included in the review pool. Furthermore, 13 articles were excluded because they were irrelevant to this study. Furthermore, backward and forward searches were used to add 5 articles that are relevant to this study. This approach assisted the researchers in reviewing 27 articles that are relevant to this study.

2.1. Big data

In the digital era, decision-making relies significantly on digital information (Brossard et al., 2022; Mashau and Mokwena, 2017; Zolbanin et al., 2022). Lately, institutions have been engulfed by the abundance of big data, which provides a vast volume of information for managers to improve their ability to make informed decisions (Hiremath et al., 2023; Kelvin and Morrisson, 2023).

Various scholars describe big data as enormously large and complex sets of data that are difficult to analyze through traditional processing applications (Hiremath et al., 2023; Sazu and Jahan, 2022; Seefong et al., 2023). Big data technologies enable organizations to derive valuable insights, make data-driven decisions and uncover patterns or trends that may not be apparent with traditional data processing methods (Faridoon et al., 2023; Kelvin and Morrisson, 2023). This field has wide-ranging applications across industries, including healthcare, finance, marketing and more, contributing by enhancing efficiency, promoting innovation and assisting decision-makers with information in order to make an informed decision (Gomes et al., 2022; Kaur et al., 2021).

Big data encompasses the collection, storage, analysis and visualization of vast amounts of information, often characterized by the five Vs as depicted below (Palanisamy and Thirunavukarasu, 2019; Roy, 2016; Sazu and Jahan, 2022):

- Velocity: represents the speed at which data is generated, processed and updated. Big data is often generated rapidly, requiring real-time or near-real-time processing to extract meaningful insights.
- Volume: refers to the sheer size of the data generated or collected, often in terabytes, petabytes, or beyond. Big data involves massive datasets, challenging traditional data processing systems in terms of storage and analysis.
- Veracity: refers to the reliability and accuracy of the data. Big data sources may contain inconsistencies, errors, or uncertainties, making it crucial to assess and enhance data quality for reliable analysis.
- Variety: encompasses the diversity of data types and sources, including structured, semi-structured and unstructured data. Big data can originate from various sources, such as text, images, videos, social media and more, necessitating versatile processing methods.
- Value: represents the usefulness and meaningful insights derived from analyzing big data. The ultimate goal of big data initiatives is to extract valuable insights that contribute to informed decision-making, innovation, and improved business outcomes.

Within healthcare institutions, big data is characterized by a substantial volume of health-related data collected from diverse data sources (Kaur et al., 2021; Leow et al., 2023; Palanisamy and Thirunavukarasu, 2019). These encompass physician notes,

electronic health records (EHR), medical imaging, lab reports, *X*-Ray reports, case history, diet regimens, genomic sequencing, payer records, pharmaceutical research, wearables, medical devices, and various other unmentioned sources (Benzidia et al., 2021; Kaur et al., 2021; Zolbanin et al., 2022). Big data analytics tools that can perform all these are known as productive tools (Kaur et al., 2021).

Globally, most rural-based hospitals use distributed systems to collect data from patients (Leow et al., 2023; Malelelo-Ndou et al., 2019; McCarthy et al., 2021). Through this system, patients can make appointments to see healthcare practitioners (Nevhutalu, 2016). These systems require internet connectivity to collect data in real-time (Malelelo-Ndou et al., 2019). On the other hand, rural-based hospitals use local storage systems like EHR systems to store patient medical information in operational databases (Nevhutalu, 2016). In some rural-based hospitals, storage is also augmented by cloud-based solutions (Leow et al., 2023; McCarthy et al., 2021).

Therefore, productive tools of BDA, including Hadoop and Spark, are used in distributed systems for fast data processing, respectively (Brossard et al., 2022; Leow et al., 2023). Furthermore, for processing raw data into dashboards that assist organizations in decision-making, they use Power BI, Tableau, SAS, and QlikView, to name a few (Sazu and Jahan, 2022). These tools offer advanced analytics capabilities, making them indispensable for handling and deriving insights from big data sets (Leow et al., 2023).

The literature shows that healthcare institutions may gain insight from big data by using Apache Flume, Apache Sqoop or Kafka to collect big data from the source systems and using Apache Sqoop to effortlessly import patient data from their MySQL database into the Hadoop Distributed File System to store big data safely (Batko and Ślęzak, 2022; Brossard et al., 2022; Shafqat et al., 2020). Therefore, healthcare institutions with these securely stored data may harness the power of Apache Spark to analyze the big data using Spark SQL to discover trends, patterns and insights (Hiremath et al., 2023; Shafqat et al., 2020). Furthermore, they can perform complex queries using Apache Hive to transform information into actionable intelligence (Shafqat et al., 2020). With the actionable intelligence or insight at their disposal, they can use Tableau, QlikView or Zeppelin to generate visualizations to present the findings in the form of dashboards (Hiremath et al., 2023). This will enable healthcare professionals to be responsive since they will be able to flag issues earlier (Brossard et al., 2022; Leow et al., 2023).

2.2. Big data analytics

Big data analytics refers to the process of examining and extracting meaningful insights from large and complex datasets (Faridoon et al., 2023; Kelvin and Morrisson, 2023; Shafqat et al., 2020). The goal is to uncover hidden patterns, correlations, trends, and other valuable information that can aid in decision-making, strategic planning, and problem-solving (Khanra et al., 2020; Sazu and Jahan, 2022). There are numerous tools and technologies used for big data analytics, ranging from data storage and processing frameworks to visualization and machine learning tools (Gomes et al., 2022; Popovič et al., 2018).

The literature shows that leveraging big data analytics involves discovering concealed patterns, unearthing unknown correlations and extracting valuable business insights through big data tools designed to analyze vast volumes of data, high-variety and high-velocity information (Rehman et al., 2021; Sazu and Jahan, 2022; Shafqat et al., 2020). Furthermore, the literature shows that various organizations are adopting innovative big data technologies and solutions like Hadoop, MapReduce, Hadoop Hive, Spark, Presto, Yarn, Pig, NoSQL databases and others to enhance their capabilities in conducting big data analytics (Imran et al., 2021; Lakshmanaprabu et al., 2019; Leow et al., 2023).

Therefore, incorporating big data analytics technologies has the potential to generate value in the strategic planning and operational aspects of healthcare institutions (Benzidia et al., 2021; Imran et al., 2021). The value generated from investments in big data analytics in healthcare institutions is multifaceted, encompassing improvements in decision-making, patient outcomes, operational efficiency, cost management, research capabilities and overall healthcare quality (Gomes et al., 2022; Palanisamy and Thirunavukarasu, 2019; Roy, 2016).

In healthcare institutions, the application of big data analytics encompasses various techniques, including statistical analysis, machine learning, data mining and predictive modeling (Gomes et al., 2022; Shafqat et al., 2020). Various healthcare entities utilize these analytical tools to gain deeper insights into patient profiles, streamline hospital processes, enhance operational efficiency and foster innovation (Batko and Ślęzak, 2022; Hiremath et al., 2023; Kaur et al., 2021). In general, big data analytics plays a pivotal role in guiding organizations to make well-informed decisions, identify opportunities and tackle challenges in the contemporary data-intensive and rapidly evolving business environment (Brossard et al., 2022; Leow et al., 2023).

Moreover, the integration of big data analytics with big data applications in healthcare institutions holds the potential to advance shared knowledge, monitor the outcomes of prevention-focused strategies and optimize the management of patients (Rehman et al., 2021; Yu et al., 2021). This aspect, often overlooked by managers, engineers and policymakers, presents an opportunity for exploration within the healthcare institution (Khalifa et al., 2021; Khanra et al., 2020). The literature shows that big data analytics has a great impact, mostly in urban healthcare institutions (Brossard et al., 2022; Kelvin and Morrisson, 2023; Ramesh and Santhi, 2020).

3. Research methodology

3.1. Research approach

According to Saunders, Lewis and Thornhill (2019) research approach is described as the set of beliefs, assumptions and methodologies that guide a researcher's approach to studying a particular phenomenon. It encompasses the worldview, philosophical foundations and theoretical framework that shape the research process (Creswell, 2014; Kothari, 2004). In most studies, there are two major research paradigms that are often used, namely the positivist and intensivist paradigms. In this study the researchers employed a positivist approach to inform their investigation, aiming to comprehend the phenomenon related to the subject (Borgstede and Scholz, 2021; Myers, 2013; Saunders et al., 2019). This scientific method was

applied to evaluate the impact of big data analytics in rural-based hospitals. The study focused particularly on a rural-based hospital in South Africa that collects big data from various sources.

3.2. Population unit and sampling methods

The population unit of this study consists of four rural hospitals located in the Limpopo province of South Africa. This population unit was chosen due to its proximity to the research institution and the presence of an ample number of rural-based hospitals. All four rural-based hospitals were selected using convenience sampling. In these hospitals, respondents were selected from the Information and Communication Technology (ICT) departments. Furthermore, respondents from the ICT department included both computer users and non-computer users working as data collectors.

Therefore, a total of 200 individuals were selected through simple random sampling techniques. The choice of simple random sampling was based on its reputation as a straightforward and unbiased method for selecting a representative sample from a larger population, providing an equal opportunity for all participants to be included.

3.3. Data collection

In this study, data was collected through a structured questionnaire to gather data that assisted in evaluating the impact of big data analytics in rural-based hospitals. The questionnaire was informed by the literature review of the sources that are relevant to big data analytics in health-care institutions. Furthermore, a pilot study to improve the questionnaire was conducted in one urban-based public hospital with a sample of 8 respondents. Feedback from this pilot was used to revise the initial questionnaire for clarity. Finally, the questionnaire was submitted to the ethics committee for approval before the data collection exercise for this study.

The questionnaire exclusively consisted of closed-ended questions to facilitate standardized responses and quantitative data analysis. It covered significant aspects related to the benefits and challenges of big data analytics in rural-based hospitals with the aim of evaluating respondents' views on the impact of integrating big data analytics into rural-based hospitals' daily operations.

3.4. Data analysis

In this study, data was analyzed using both Statistical Package for the Social Sciences (SPSS) and Microsoft Excel tools. In addition, these tools were used to perform descriptive analysis and inferential statistics to analyze the collected data. The objective of the data analysis was to identify patterns, correlations, and trends within the responses. The information from the data analysis provided valuable insights into the impact of big data analytics in rural-based hospitals. Out of the 200 questionnaires that were distributed, only 174 questionnaires were returned. However, 17 were incomplete and subsequently excluded from the analysis. The remaining 150 questionnaires were analyzed.

4. Empirical analysis results

4.1. Demographic details

The section commences by depicting the demographic details of the respondents as depicted in **Table 1** below. The sampled respondents' gender distribution reveals a slightly higher representation of females (59.3%) compared to males (40.7%). This balanced gender composition is crucial for ensuring diverse perspectives in the study, especially considering the potential influence of gender on attitudes and perceptions.

Evaluating the age distribution, a small percentage of participants (12.0%) fell within the 22–29 age range, while 24% were aged 45 and above. The majority, however, ranged between the 30–36 age group (30.7%) and the 37–44 age group (32.7%). This diversity proves advantageous in capturing a wide array of experiences and viewpoints, given that different age groups may exhibit varying levels of familiarity and comfort with technology, including big data analytics tools.

Ninety-eight point seven percent (98.7%) of respondents are similarly diverse in terms of educational background, with a significant proportion holding university degrees. Specifically, 6.7% of respondents only have a matric certificate, while 21.3% of respondents possess a diploma, 34.7% hold a bachelor's degree, and the highest proportion (36.0%) hold postgraduate qualifications. This suggests that rural-based hospitals boast a well-balanced sample of educated staff, potentially enhancing their capacity to comprehend and engage with complex topics like big data analytics.

Table 1. Demographic details.

Characteristics	Frequency	%
Q1: Gender		
Male	61	40.7
Female	89	59.3
Q2: Age		
22–29	18	12.0
30–36	46	30.7
37–44	49	32.7
45 and above	37	24.7
Q3: Level of education		
Matric	10	6.7
Diploma	32	21.3
Bachelor degree	52	34.7
Postgraduate degree	54	36.0
None	2	1.3
Q4: Computer literacy skill proficiency		
Very low	12	8.0
Low	12	8.0
Average	20	13.3
Good	49	32.7
Excellent	57	38.0

In **Table 2** below, the results highlight the massive use of big data analytics tools within rural-based hospitals. The data shows that all sampled hospitals (100%) used

big data analytics tools, and similarly, all the participants had experience using these tools. The results show that these hospitals have used big data analytics for a sufficient period. The majority of participants (40,7%) indicated that their hospitals had used BDA for 3 to 4 years, while 26% of participants had used BDA tools for 1 to 2 years, and 20.6% participants used these tools for 6–8 years. A smaller proportion of 12.7% participants, have indicated that rural-based hospitals have used BDA tools for 9 years or more. When it comes to their experience with BDA tools, 38.0% of participants indicated that they had between 3 and 5 years of experience, followed by 22.7% of participants with 11 to 15 years of experience and 15.3% of participants with 6 to 10 years of experience. The results show a well-balanced and important usage of BDA tools in rural-based hospitals. Furthermore, the experience depicts that there is a good mix of novices and experts in terms of using BDA tools in rural-based hospitals.

Table 2. Big data analytics experience.

Characteristics	Frequency	%
Q1: Does your hospital use big data analytics tools		
Yes	150	100
No	0	0
Q2: How long has your hospital using big data analytics tools		
None	0	0.0
1–2 years	39	26.0
3–5 years	61	40.7
6–8 years	31	20.6
9 years and more	19	12.7
Q3: Do you have big data analytical tools experience		
Yes	150	100
No	0	0.3
Q4: How many years of experience using big data analytics tools		
None	0	0.0
1–2 years	17	11.3
3–5 years	57	38.0
6–10 years	23	15.3
11–15 years	34	22.7
16 years and more	19	12.7

4.2. Results on the impact of big data analytics on rural-based hospitals

The results presented in **Figure 1** illustrate the benefits derived from rural-based hospitals from the use of big data analytics. The data reveals that 91% of participants acknowledged that integrating big data analytics into healthcare institutions has enhanced decision-making processes. Additionally, around 89% of respondents noted improvements in customer service, while 88% highlighted a reduction in operational costs due to the adoption of big data analytics. Approximately 73% of participants indicated that employee productivity has been enhanced, and 68% reported an increase in revenue as a result of incorporating big data analytics. Furthermore, about 41% of respondents emphasized that the adoption of big data analytics is fostering better information sharing within healthcare institutions.

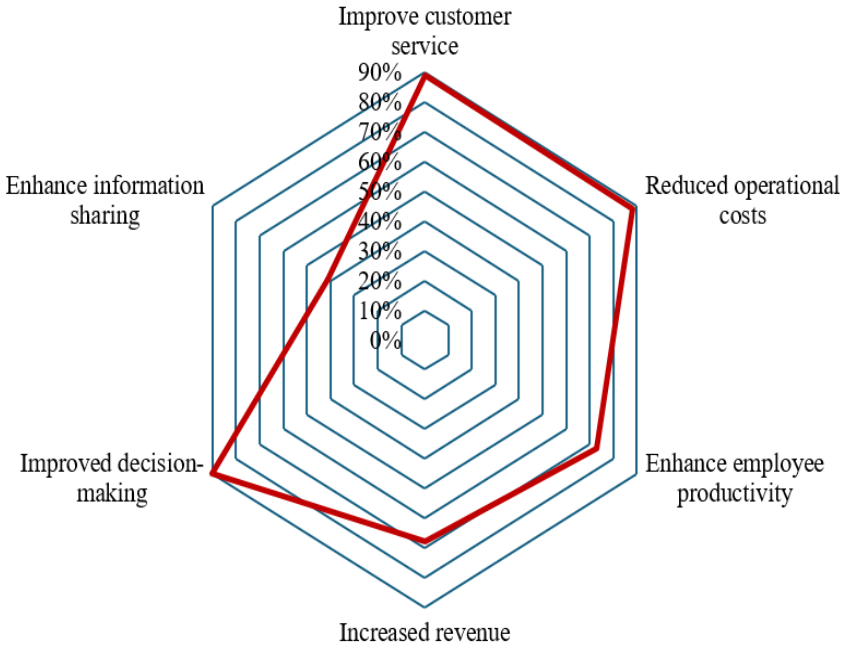

Figure 1. Benefits of big data analytics in rural-based hospitals.

The survey results depicted in **Table 3** and **Figure 2**, provide valuable insights on the impact of big data analytics in organizational decision processes within rural-based hospitals. A notable 44.6% of respondents agreed and 4.0% strongly agreed that rural-based hospital decision processes are dependent on information obtained from big data analytics. However, substantial results of 46.0% expressed that respondents were uncertain that decision processes are dependent on information obtained from big data analytics. However, 4.7% of the respondents disagree indicating a varied perception that rural-based hospital decision processes are dependent on information obtained from big data analytics.

Interestingly, the survey suggests a high reliance on big data analytics among decision-makers in rural-based hospitals. A striking 6.7% and 92.0% of respondents agreed and strongly agreed that decision-makers in these hospitals use information produced from big data analytics to inform their decisions. This emphasizes the significant impact and integration of big data analytics in shaping the decision-making landscape in the context of rural healthcare.

Furthermore, the survey explored the accessibility and quality of information facilitated by big data analytics tools. A substantial 83.3% strongly agreed that these tools enable information to be easily and readily accessible. Additionally, 78.0% agreed that big data analytics tools assist in producing high-quality information. These results highlight the perceived efficiency and effectiveness of big data analytics tools in enhancing information accessibility and quality within rural-based hospitals.

Table 3. BDA statements.

Statements	Agree	Strong Agree	Uncertain	Disagree	Strong Disagree
Organizational decision processes are dependent on information obtained from big data analysis	44.6%	4.0%	46.0%	4.7%	0.7%
The rural-based hospitals' decision-makers use information produced from big data analytics to make decision	6.7%	92.0%	0.7%	0.0%	0.6%
Big Data analytics tools enable information to be easily and readily accessible	15.3%	83.3%	0.7%	0.7%	0.0%
Big data analytics tools assist in producing high-quality information	20.7%	78.0%	1.3%	0.0%	0.0%
Using big data analytics improves rural-based hospitals' performance	12.0%	83.0%	2.0%	3.0%	0.0%
Using big data analytics in rural-based hospitals improves employees' performance	8.0%	87.3%	3.3%	1.4%	0.0%
Using big data analytics in rural-based hospitals enhances patients' healthcare	10.0%	87.3%	2.0%	0.7%	0.0%
In general, big data analytics improves rural-based hospitals' service delivery	6.7%	92.0%	1.3%	0.0%	0.0%
Big data analytics play a significant role in supporting rural-based hospitals' strategy	14.0%	85.3%	0.7%	0.0%	0.0%

When it comes to performance outcomes, the survey respondents indicated positive associations with the use of big data analytics. A notable 83.0% agreed that using big data analytics improves rural-based hospitals' overall performance and 87.3% agreed that it enhances employees' performance. Moreover, a significant 87.3% agreed that using big data analytics in rural-based hospitals enhances patients' healthcare. These findings suggest a positive correlation between the integration of big data analytics and performance improvement in various aspects of healthcare delivery within rural settings.

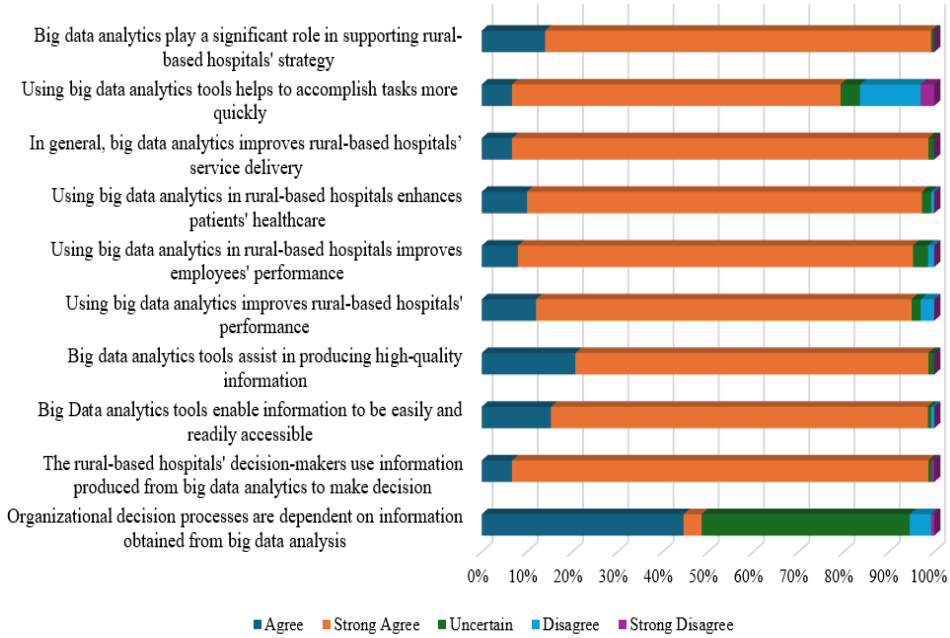

Figure 2. Attributes to empirically evaluate the impact of big data analytics in rural-based hospitals.

5. Discussion of the results

The results revealed a balanced representation in terms of gender, underlining the importance of incorporating diverse perspectives into the study. This emphasis on diversity becomes crucial, especially considering the potential influence of gender on attitudes and perceptions within the context of the study. Additionally, the exploration of age demographics was conducted to elicit a varied range of opinions and capture a broad spectrum of experiences. The results show that different age groups have used big data analytics in rural-based hospitals, and due to this, staff may hold distinct perceptions regarding the use of innovation in organizational settings (Mashau and Mokwena, 2017; Rogers, 2003). Similarly, organizations that have different age groups that are using innovation are likely to see its impact fast (Faridoon et al., 2023; Miller et al., 2020).

In addition, the study uncovered a well-balanced distribution in terms of education levels and computer literacy skill proficiency among respondents. This balanced profile suggests a positive influence on the potential adoption of big data analytics in rural-based hospitals, as the staff demonstrates a readiness to engage with and embrace new technologies, including big data analytics tools (Kelvin and Morrisson, 2023; Palanisamy and Thirunavukarasu, 2019). Scholars have consistently asserted the paramount role of education and computer literacy in the successful adoption of new technologies in order to see their value to organizations (Brossard et al., 2022; Kelvin and Morrisson, 2023; Rogers, 2003). These demographic characteristics collectively contribute to a favorable environment for the effective integration of big data analytics tools in rural healthcare settings (Faridoon et al., 2023; Miller et al., 2020).

The survey results reveal that the integration of big data analytics has a substantial positive impact on decision-making processes in rural-based hospitals. This aligns with existing literature highlighting the crucial role of big data analytics in decision-making (Yu et al., 2021). Decision-makers rely on information derived from big data to make well-informed decisions, leading to cost savings and the preservation of organizational resources (Benzidia et al., 2021; Yu et al., 2021).

In addition, the findings collectively emphasize the increasing importance of big data analytics within rural hospitals. Existing literature widely asserts that these tools enhance information accessibility, quality, and overall performance outcomes in healthcare institutions (Gomes et al., 2022; Seefong et al., 2023; Zolbanin et al., 2022). Additionally, the results align with the literature suggesting that integrating big data analytics in organizations enhances service delivery to clients (Leow et al., 2023; Popovič et al., 2018).

6. Conclusion

This study evaluated the impact of big data analytics in rural-based hospitals. The data were collected through a structured questionnaire to gather data from rural-based hospitals' staff to assist in evaluating the impact of big data analytics. The data were later analyzed using descriptive analysis and inferential statistics. The objective for this analysis was to identify patterns, correlations and trends from the data.

The demographic information patterns revealed a diverse and well-educated sample with a balanced gender distribution. Furthermore, the trends showed that the majority of participants had a high level of computer literacy and this is seen as a crucial factor for the successful use of big data analytics tools and determining its impact in rural-based hospitals.

In addition, the study also showed that big data analytics had a significant impact in rural-based hospitals because decision-makers rely on the information produced by big data analytics tools to support their decisions. Furthermore, big data analytics improves rural-based hospitals' service delivery. Therefore, rural-based hospitals may integrate big data analytical tools into decision-support systems in order to have access to real-time dashboards and predictive analytics models. Tools like Power BI and Tableau can be used to visualize analyzed big data for quick and informed decision-making. In addition, rural-based hospitals can partner with technology providers to customize their big data analytics platforms to improve usability and impact.

The scope of this study was limited to Limpopo province and may not be generalizable to rural healthcare in other provinces with healthcare with different characteristics and resources. However, future studies may consider exploring the impact of big data analytics in rural-based hospitals in other provinces. In addition, the future study may employ the interview technique to triangulate the quantitative data presented in this study. This can be done by sampling experts in the BDA field. On the other hand, future studies may explore the cost involved in implementing big data analytics in rural-based hospitals. A cost-benefit analysis study may assist policymakers in resource allocation decisions when it comes to big data analytics projects. Lastly, the researchers may explore and adapt big data analytics strategies to align with the unique needs of rural healthcare contexts.

Author contributions: conceptualization, TMR, WM and NLM; investigation, TMR; data collection, TMR; methodology, TMR and NLM; writing—review and editing, TMR, WM and NLM; resources, WM and NLM; supervision, WM; validation, WM and NLM; data curation, NLM; formal analysis, NLM; project administration, NLM; writing—original draft, NLM. All authors have read and agreed to the published version of the manuscript.

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