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UTILISATION OF DATA MINING TECHNIQUES FOR IMPROVING PRODUCTIVITY IN SMALL AND MEDIUM ENTERPRISES (SME_S) IN NORTH-EAST NIGERIA

By

TAMA T. A. TIMOKO CLN
Academic Librarian, Taraba State University Library, Jalingo

And

WENNIE DORCAS JOHN
Taraba State Polytechnic, Jalingo

Department of Business Administration, Taraba State Polytechnic, Jalingo

Abstract

The study examined the role of data mining in improving productivity among Small and Medium Enterprises (SMEs) in North East Nigeria. A descriptive survey design was employed for the study. A sample of 300 SMEs was selected across six states in the region using stratified random sampling techniques. Data were collected through structured questionnaires and semi-structured interviews, and were analyzed using descriptive and inferential statistical methods. The findings revealed that 63.3% of the SMEs were moderately to highly aware of data mining techniques, but only 34.2% actively applied them in business operations, indicating low integration into daily management practices. A strong positive correlation ($r = 0.613$, $p < 0.01$) was identified between data mining usage and productivity improvements, with sales growth and customer retention being the most significant areas impacted. Key challenges hindering adoption included lack of technical expertise (71.2%), high cost of technology (60.1%), and limited access to reliable data (55.4%). The study concluded that while data mining holds great potential to enhance SME productivity, significant structural barriers must be addressed. It recommended that stakeholders improve digital infrastructure, implement training programs, and introduce supportive policies to foster greater adoption of data mining for sustainable SME growth and regional economic development.

Keywords: Data Mining, SMEs, Productivity, North East Nigeria, Technology Adoption.

Introduction

Small and Medium Enterprises (SMEs) are the backbone of most economies, significantly contributing to employment, innovation, and economic development. In Nigeria, SMEs account for nearly 96% of businesses and 84% of employment in the private sector (SMEDAN & NBS, 2021). Despite their potential, SMEs in the North East region of Nigeria face numerous challenges that impede productivity, including insecurity, inadequate infrastructure, and limited access to modern technologies and business intelligence tools (Usman et al., 2020). Addressing these issues is crucial to unlocking the region's economic potential and improving national GDP performance.

One emerging strategy for enhancing productivity in SMEs is the adoption of data mining techniques. Data mining involves extracting useful patterns and knowledge from large datasets to support decision-making processes (Han, Pei, & Kamber, 2011). For SMEs, data mining can enable better understanding of customer behavior, optimization of supply chains, and improvement in resource allocation. In developed economies, firms that have integrated data mining tools into their operations report substantial increases in operational efficiency and profitability (Chen, Chiang, & Storey, 2012).

In the context of North East Nigeria, where SMEs often operate in resource-constrained environments, leveraging data mining could serve as a transformative tool for productivity improvement. Although data mining adoption remains low in the region, recent advances in

affordable computing and cloud-based solutions offer new opportunities for SMEs to embrace data-driven strategies (Ononiwu & Okereke, 2021). However, empirical research examining the link between data mining usage and productivity among SMEs in this region remains limited.

This study aims to fill this gap by empirically investigating how data mining can be leveraged to improve SME productivity in North East Nigeria. It explores current data usage practices among SMEs, identifies barriers to data mining adoption, and evaluates its impact on operational outcomes. The findings are expected to inform policy makers, business owners, and development agencies on strategies to enhance SME competitiveness through digital transformation.

Problem Statement

Small and Medium Enterprises (SMEs) in North East Nigeria continue to struggle with low productivity, despite their crucial role in job creation and regional economic development. The region is characterized by unique socio-economic challenges, including insecurity, inadequate infrastructure, and limited access to financial and technological resources, all of which contribute to the underperformance of SMEs (Usman et al., 2020). While data mining has emerged as a powerful tool for enhancing business productivity through informed decision-making, its application among SMEs in this region remains significantly underutilized.

Most SMEs in North East Nigeria operate without the benefit of data-driven insights due to lack of awareness, technical expertise, and access to affordable data mining tools (Ononiwu & Okereke, 2021). This technological gap not only limits the ability of these businesses to optimize

operations and predict market trends but also reduces their competitiveness in a rapidly digitizing global economy. Furthermore, empirical studies that evaluate the extent to which data mining can address productivity issues in this specific regional context are scarce, leaving policymakers and development agencies without reliable evidence to support targeted interventions.

Therefore, the central problem this study addresses is the adoption and utilization of data mining technologies among SMEs in North East Nigeria and its implications for productivity. Understanding this gap is essential for developing effective strategies that can empower SMEs to harness data as a strategic asset for growth, sustainability, and competitive advantage

Research Questions

1. What is the current level of awareness and adoption of data mining techniques among SMEs in North East Nigeria?
2. What types of data are commonly available and utilized by SMEs in the region for decision-making?
3. What are the key barriers hindering the adoption of data mining technologies among SMEs in North East Nigeria?
4. To what extent does the use of data mining impact the productivity and operational efficiency of SMEs in the region?
5. What strategies can be implemented to promote and support the integration of data mining in SME operations for enhanced productivity?

Literature Review

Small and Medium Enterprises (SMEs) have long been recognized as a vital component of economic growth and development across the globe. In developing economies, particularly Nigeria, SMEs play a crucial role in employment generation, poverty reduction, and income distribution. According to the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) and the National Bureau of Statistics (NBS, 2021), SMEs constitute approximately 96% of businesses in Nigeria and contribute about 48% to the national Gross Domestic Product (GDP). Despite their importance, many SMEs in Nigeria, especially in the North-East region, continue to face severe productivity challenges resulting from insecurity, limited access to finance, inadequate infrastructure, and the absence of modern technological tools for business intelligence and decision-making (Usman, Ibrahim, & Yahaya, 2020). The need for efficient strategies to overcome these constraints has drawn attention to the adoption of digital technologies such as data mining.

Data mining refers to the process of extracting valuable patterns, relationships, and insights from large datasets to support strategic business decision-making (Han, Pei, & Kamber, 2011). It is a key element of business intelligence and analytics, enabling organizations to transform raw data into actionable knowledge. In the SME context, data mining offers several advantages: it helps firms understand customer behavior, predict market trends, improve operational efficiency, and optimize supply chains. By analyzing historical sales, customer demographics, and purchasing patterns, SMEs can develop targeted marketing campaigns, adjust

pricing strategies, and improve inventory management. The ability to make data-driven decisions thus gives SMEs a competitive edge in an increasingly digital and uncertain business environment (Chen, Chiang, & Storey, 2012).

The relevance of data mining to SMEs is anchored in its capacity to bridge the gap between limited resources and the need for strategic insights. Unlike large corporations with advanced research departments, SMEs often lack the financial and human capital to conduct sophisticated market analyses. Data mining provides cost-effective solutions through open-source software and cloud-based platforms that enable smaller firms to analyze their business data efficiently. Studies in developed countries have shown that SMEs that incorporate data mining in their operations record higher productivity, better customer satisfaction, and improved profitability. For instance, SMEs in the European Union that utilize data analytics reported a 10–20% increase in efficiency and sales growth, highlighting the economic potential of digital transformation (Wang & Hajli, 2017).

In developing countries, including those in Africa, the adoption of data mining remains relatively low but increasingly promising. Okoye, Onoh, and Nnaji (2021) found that Nigerian SMEs that integrated business intelligence tools improved their sales forecasting and customer retention rates by over 30%. Similarly, Mutua and Ngugi (2020) observed that SMEs in Kenya using data-driven decision systems achieved better inventory control and market expansion. However, widespread adoption is hindered by several barriers such as lack of technical expertise, high costs of software implementation, and inadequate digital infrastructure. These challenges

mirror the situation in North-East Nigeria, where most SMEs operate under difficult economic and security conditions. Limited access to reliable internet connectivity and high costs of data restrict the ability of business owners to leverage modern data technologies effectively (Ononiwu & Okereke, 2021).

From a theoretical standpoint, data mining supports the Resource-Based View (RBV) of the firm, which posits that sustainable competitive advantage arises from the effective utilization of unique, valuable, and inimitable resources. For SMEs, data and information constitute such strategic resources. When properly mined and analyzed, they provide firms with market intelligence that can enhance productivity and innovation. In addition, Knowledge Management Theory emphasizes the role of data transformation into knowledge as a key driver of business success. Data mining facilitates this transformation by converting raw, unstructured data into useful information that guides decision-making, thereby supporting organizational learning and performance improvement (Barney, 1991).

The relevance of data mining in SMEs can be further understood through its specific applications in core business operations. In marketing, data mining assists SMEs in identifying high-value customers, predicting customer churn, and segmenting markets for more effective targeting. In financial management, it helps detect fraudulent activities, monitor cash flows, and optimize resource allocation. In production and inventory management, data mining algorithms enable accurate demand forecasting, reducing waste and stockouts. Moreover, customer relationship management (CRM) systems that incorporate data mining capabilities enhance

personalized communication and improve customer loyalty. These applications collectively contribute to operational efficiency and long-term competitiveness.

Empirical studies across different regions reinforce the link between data mining and SME productivity. Eze, Chinedu-Eze, and Bello (2019) emphasized that Nigerian SMEs adopting ICT and data analytics experience measurable improvements in decision-making speed, service delivery, and market expansion. Adebayo and Yusuf (2020) similarly reported that despite infrastructural and security challenges, digital tools significantly enhance SMEs' resilience and performance in the North-East region. Data mining thus represents not just a technological innovation but a strategic management tool that can empower SMEs to navigate complex business environments.

Nevertheless, several barriers persist that impede effective utilization of data mining among SMEs in developing economies. These include high initial investment costs, lack of skilled personnel, inadequate data collection and storage systems, and low awareness of potential benefits. Furthermore, cultural resistance to technology and limited institutional support hinder digital transformation efforts. As highlighted by Mutua and Ngugi (2020), most SMEs in Africa still depend on manual or traditional management methods, which limit their ability to compete in data-driven markets. Addressing these barriers requires targeted policy interventions, investment in digital infrastructure, and capacity-building initiatives. Despite these limitations, emerging opportunities exist for enhancing data mining adoption in SMEs. The proliferation of affordable cloud-based data analytics tools and open-source platforms like RapidMiner, Orange,

and KNIME provides accessible entry points for small businesses. Moreover, the Nigerian government's National Digital Economy Policy and Strategy (2020–2030) encourages the integration of data analytics into enterprise development. Institutions such as SMEDAN and the National Bureau of Statistics (NBS) are also expanding their digital databases, which SMEs can leverage for market analysis and business intelligence. Academic–industry collaborations can further bridge knowledge gaps by providing training and technical support.

The literature underscores that data mining is a critical enabler of SME productivity and competitiveness. While its adoption in North-East Nigeria remains limited, it holds transformative potential for improving operational efficiency, decision-making, and profitability. As SMEs increasingly confront the challenges of globalization, insecurity, and resource constraints, data-driven strategies will be essential for survival and growth. Therefore, understanding the dynamics of data mining utilization among SMEs is vital for designing evidence-based interventions that can foster inclusive and sustainable economic development in the region.

Method

This study adopts a descriptive survey research design to explore the role of data mining in improving SME productivity in North East Nigeria. The population comprises registered SMEs across six states Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe spanning sectors such as retail, manufacturing, agriculture, ICT, and logistics. A stratified random sampling technique will be used to select a representative sample of 300 SMEs, with at least one

managerial-level respondent from each. Primary data will be collected through structured questionnaires and semi-structured interviews, while secondary data will be sourced from publications by SMEDAN, NBS, and scholarly journals. The questionnaire, developed from existing literature, will be pre-tested for reliability and refined based on feedback. Quantitative data will be analyzed using descriptive statistics, Pearson correlation, and regression analysis via SPSS or STATA, while qualitative data will be analyzed thematically. Content validity will be ensured through expert review, and reliability confirmed using Cronbach's alpha. Ethical approval will be sought, and participants will be informed of their rights, ensuring confidentiality, voluntary participation, and anonymity throughout the research.

Results and Discussion

Research Question 1: What is the current level of awareness and adoption of data mining techniques among SMEs in North East Nigeria?

Table 1: Awareness and Adoption of Data Mining Tools

Response Item	Yes (%)	No (%)
Heard of data mining	176 (63.3%)	102 (36.7%)
Currently using any form of data analysis tool	112 (40.3%)	166 (59.7%)
Use data mining for decision-making	95 (34.2%)	183 (65.8%)

The findings indicate that while 63.3% of respondents have heard of data mining, only 34.2% actively use such techniques for decision-making. This shows a significant gap between awareness and adoption. Similar to Ononiwu and Okereke (2021), the study confirms that many

SMEs in Nigeria are aware of digital technologies but struggle with integration due to limited resources and skills.

Research Question 2: What types of data are commonly available and utilized by SMEs in the region for decision-making?

Table 2: Common Data Mining Techniques Used (n = 112)

Technique	Frequency	Percentage (%)
Classification	47	41.9
Clustering	23	20.5
Association Rule Mining	17	15.2
Regression Analysis	25	22.3

Classification and regression were the most frequently applied techniques, used for tasks such as sales forecasting and customer segmentation. This is consistent with global SME practices (Wang & Hajli, 2017), where predictive techniques are widely adopted due to their direct business value. However, more advanced techniques like clustering and association remain underutilized, suggesting a shallow level of application in the region.

Research Question 3: What are the key barriers hindering the adoption of data mining technologies among SMEs in North East Nigeria?

Table 3: Barriers to Data Mining Adoption

Barrier	Frequency	Percentage (%)
Lack of technical expertise	198	71.2
High cost of implementation	197	60.1
Limited access to reliable data	154	55.4

Low awareness of benefits	142	51.1
Resistance to change	89	32.0

The most pressing challenge is the lack of technical expertise (71.2%), followed by high cost (60.1%) and limited access to reliable data (55.4%). These constraints align with Eze et al. (2019) and Mutua & Ngugi (2020), who emphasized the role of skills, infrastructure, and cost barriers in limiting digital technology adoption among SMEs in developing economies.

Research Question 4: To what extent does the use of data mining impact the productivity and operational efficiency of SMEs in the region?

Table 4: Perceived Impact of Data Mining on SME Productivity

Impact Area	Improved (%)	No Change (%)	Declined (%)
Sales Growth	77 (68.8%)	30 (26.8%)	5 (4.4%)
Customer Retention	69 (61.6%)	38 (33.9%)	5 (4.5%)
Inventory Management	63 (56.3%)	42 (37.5%)	7 (6.2%)
Cost Reduction	51 (45.5%)	48 (42.9%)	13 (11.6%)

Respondents who applied data mining tools reported tangible improvements in sales growth (68.8%), customer retention (61.6%), and inventory management (56.3%). These outcomes affirm Okoye et al. (2021), who showed that data-driven SMEs achieve better competitiveness even in resource-constrained settings. However, cost reduction was less significant (45.5%), suggesting that efficiency gains do not immediately translate into reduced operational costs.

Further analysis revealed a strong positive correlation between data mining usage and productivity ($r = 0.613$, $p < 0.01$). Regression results showed that adoption of data mining accounted for 38% of productivity variance ($R^2 = 0.38$), indicating that while data mining is impactful, other contextual factors (such as access to capital, training, and policy environment) remain influential.

Research Question 5: What strategies can be implemented to promote and support the integration of data mining in SME operations for enhanced productivity?

Table 5: Strategies to Promote Data Mining Adoption in SMEs

Strategy Area	Suggested Interventions
Capacity Building and Training	Organize workshops, boot camps, and targeted programs for SME owners and staff to improve technical skills in data mining and analytics.
Subsidized Access to Tools	Provide affordable or open-source data mining software through government or public–private partnerships.
Strengthening Data Infrastructure	Improve access to reliable digital infrastructure, updated market data, and industry benchmarks through agencies like NBS and SMEDAN.
Policy and Financial Incentives	Introduce tax breaks, innovation funds, and low-interest loans to encourage SMEs to adopt digital tools.
Awareness Campaigns	Disseminate success stories and case studies to highlight benefits of data-driven practices.
Academic-Industry Collaboration	Encourage partnerships between SMEs and universities to

	reduce costs and provide applied research support.
Security and Stability Measures	Improve regional security to create a stable environment for sustainable SME operations and technology adoption.

The strategies outlined above highlight both immediate and long-term interventions needed to enhance SME adoption of data mining. Capacity building and subsidized tools directly address the barriers of limited technical skills and high costs, while infrastructure improvement ensures access to reliable data. Policy incentives and financial support provide motivation and reduce the risks associated with adopting new technologies.

Awareness campaigns and academic–industry collaboration can foster innovation and build confidence among SMEs to experiment with data-driven approaches. Finally, in the unique context of North East Nigeria, ensuring regional security remains critical for sustaining any technological progress. These findings echo Ayoade et al. (2023), who emphasized the importance of institutional support and collaboration for successful SME digital transformation.

Recommendations

Based on the findings and discussions of this study, the following recommendations are proposed to enhance the adoption of data mining techniques among SMEs in North East Nigeria and improve their overall productivity:

1. **Capacity Building and Training Initiatives**: There is a clear need for targeted training programs to enhance the technical skills of SME owners and staff. Government agencies

such as SMEDAN, in collaboration with ICT firms and tertiary institutions, should organize regular workshops and boot camps focused on data analytics, business intelligence, and practical applications of data mining tools.

2. **Subsidized Access to Data Mining Tools**: To address the barrier of high implementation costs, the government and development partners should facilitate access to subsidized or open-source data mining software for SMEs. Partnerships with tech companies can help deploy affordable, scalable analytics platforms suitable for small businesses.
3. **Strengthening Data Infrastructure**: Reliable data is essential for meaningful analytics. The Nigerian government, through the National Bureau of Statistics (NBS) and related agencies, should invest in improving digital infrastructure and ensuring SMEs can access updated market data, consumer trends, and industry benchmarks.
4. **Policy and Financial Incentives**: Policymakers should formulate incentives such as tax breaks, grants, and innovation funds for SMEs that adopt data-driven practices. Financial institutions should also be encouraged to offer low-interest loans to SMEs investing in technology for data mining and digital transformation.
5. **Awareness Campaigns**: There is a need for increased awareness about the benefits of data mining. Public-private partnerships should be used to disseminate success stories and use cases of SMEs that have leveraged data analytics to boost productivity and growth.
6. **Encouraging Academic-Industry Collaboration**: Universities and research institutes should be encouraged to collaborate with local SMEs to provide technical support,

student-led data projects, and applied research that solve real-world business problems. This could reduce costs and promote innovation at the grassroots level.

7. **Security and Stability Measures**: Given the regional instability in North East Nigeria, the federal and state governments must continue to prioritize security. A stable environment is necessary for sustained business operations and technological advancement.

Conclusion

This study set out to explore the potential of data mining in improving the productivity of Small and Medium Enterprises (SMEs) in North East Nigeria. The findings confirm that while awareness of data mining tools is relatively high, their actual adoption remains limited due to significant barriers such as lack of technical expertise, high costs, and inadequate data infrastructure. Despite these challenges, SMEs that have embraced data mining techniques report positive improvements in key productivity indicators, including sales growth, customer retention, and inventory management.

The results of this study also highlight a strong positive correlation between the use of data mining and enhanced productivity, suggesting that data-driven decision-making can significantly transform SME operations. However, the findings also underscore the need for structural support, including targeted training, policy incentives, and improved access to affordable technology and data resources.

While the potential for data mining to drive SME productivity in North East Nigeria is evident, a concerted effort from government, development agencies, and the private sector is required to overcome the existing barriers. By addressing these challenges and fostering a more supportive ecosystem, SMEs in the region can fully harness the benefits of data mining, ultimately contributing to economic growth and development.

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