

Big Data Analytics and Supply Chain Performance: Evidence from Ghanaian Firms

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ABSTRACT: Big data analytics (BDA) has become a transformative driver of competitiveness in supply chain management (SCM). It offers opportunities for efficiency, cost reduction, and enhanced customer satisfaction. Yet, adoption in developing economies remains limited due to infrastructural, financial, and skills-related challenges. This study examines the experiences, strategies, barriers, and outcomes of BDA adoption in Ghanaian supply chains. Using a survey of 205 managers and executives in the Greater Accra Region, the research employed descriptive statistics, chi-square tests, correspondence analysis, and logistic regression to analyze adoption patterns and predictors. Findings reveal that large firms are significantly more likely to adopt BDA, implement enterprise-wide strategies, and derive greater benefits compared to small and medium-sized enterprises (SMEs). Barriers include high investment costs, limited executive support, and concerns over data security. Professional capacity and operational experience emerged as significant predictors of future adoption. The study contributes to the literature by providing empirical evidence from Ghana, offering insights into the unique challenges of digital transformation in Sub-Saharan Africa. Policy recommendations emphasize investment in infrastructure, capacity building, and targeted support for SMEs to bridge the digital divide.

KEYWORDS: Big Data Analytics, Supply Chain Management, Ghana, Implementation, Barriers, Performance

1. INTRODUCTION

The global business environment has been transformed by advances in information technology, leading to an explosion of data across industries. Big data, often defined by the five “Vs”—volume, velocity, variety, veracity, and value—represents both an opportunity and a challenge for supply chain management (SCM). Effective use of big data analytics (BDA) can improve forecasting accuracy, reduce inefficiencies, enhance real-time decision-making, and deliver sustainable competitive advantages.

In developed economies, firms have rapidly integrated BDA into their supply chain processes. Retail giants such as Walmart and Amazon, for instance, use real-time analytics to optimize inventory and demand planning. Manufacturers leverage predictive maintenance tools to reduce downtime, while logistics providers employ prescriptive models to optimize routing and minimize costs. Such applications

demonstrate the potential of BDA to revolutionize supply chain practices globally.

However, adoption in developing economies is limited. In Sub-Saharan Africa, challenges such as unreliable infrastructure, high investment costs, shortage of skilled personnel, and data security concerns hinder effective use of BDA. Ghana provides a compelling case study: while it is one of West Africa’s most dynamic economies, many of its firms, particularly small and medium-sized enterprises (SMEs), continue to rely on traditional supply chain practices.

This study investigates how Ghanaian firms are engaging with BDA, the strategies they employ, the barriers they face, and the outcomes of adoption. The analysis is based on empirical data from 205 supply chain managers and executives. The research makes three contributions:

1. It provides rare empirical evidence on BDA adoption in Ghana, addressing a gap in the literature on digital transformation in Africa.

2. It highlights the specific barriers—financial, technical, and organizational—that shape adoption outcomes in developing economies.
3. It offers practical and policy recommendations for enhancing supply chain competitiveness in Ghana and similar contexts.

The remainder of this paper is structured as follows: Section 2 reviews the relevant literature, Section 3 outlines the methodology, Section 4 presents and discusses the findings, and Section 5 concludes with implications and recommendations.

2. LITERATURE REVIEW

2.1 Big Data in Supply Chain Management

Big data refers to large and complex datasets that exceed the capacity of traditional data-processing methods. Its application in SCM involves analyzing diverse sources such as procurement records, logistics operations, customer transactions, and IoT sensor data. BDA enables firms to derive insights that improve demand forecasting, risk management, and operational efficiency (Wamba et al., 2015).

2.2 Benefits of BDA Adoption

The benefits of BDA in SCM are widely documented. First, it enhances **decision-making** by providing timely insights that reduce uncertainty (Dubey et al., 2018). Second, it improves **operational efficiency** through better inventory control and logistics optimization. Third, it provides **competitive advantage**, allowing firms to respond faster to market dynamics. Finally, it contributes to **sustainability**, enabling resource efficiency and reduced waste (Wang, Gunasekaran, & Ngai, 2016).

2.3 Barriers to Adoption

Despite these benefits, adoption faces significant barriers.

- **Technological barriers:** high investment costs, lack of data integration, weak infrastructure.
- **Human capital barriers:** shortage of skilled professionals in analytics and data science.
- **Organizational barriers:** resistance to change, weak executive support, absence of a data-driven culture.
- **Data-related barriers:** concerns over security, privacy, and data quality.

These challenges are especially severe in developing economies where firms face resource constraints (Agyabeng-Mensah, Ahenkorah, & Afum, 2020).

2.4 BDA in Emerging Economies

Empirical evidence from Africa illustrates both opportunities and constraints. In Nigeria, BDA has been applied in oil and gas to improve efficiency (Okafor & Ezenwafor, 2018). In Kenya, analytics supports agricultural supply chains, enhancing productivity

and market access. In Ghana, while initiatives such as digital government platforms and NHIA biometric systems show progress, most firms rely on basic ICT tools and face challenges scaling up adoption (Boateng & Effah, 2015).

2.5 Research Gap

While BDA adoption in developed economies is well studied, empirical research in Sub-Saharan Africa remains limited. Few studies have examined Ghana specifically, despite its growing supply chain sector. This study addresses this gap by analyzing the adoption, challenges, and outcomes of BDA in Ghanaian firms.

3. METHODOLOGY

3.1 Research Design

This study employed a **quantitative design** based on surveys and supplementary interviews. A structured questionnaire was administered to capture firm characteristics, adoption experiences, barriers, and outcomes.

3.2 Population and Sampling

The study focused on supply chain managers and executives in the Greater Accra Region of Ghana, the country's business hub. Using purposive sampling, 226 individuals were approached, and **205 valid responses** were received (90.7% response rate). Respondents included CEOs, managers, and supply chain professionals across multiple industries.

3.3 Data Collection

The questionnaire was divided into four parts: demographics, adoption experiences, professional capabilities, and adoption outcomes. Semi-structured interviews were also conducted with selected managers to provide qualitative insights.

3.4 Variables and Measures

- **Independent variables:** firm size, annual sales revenue, years of operation, professional capabilities, and industry.
- **Dependent variables:** adoption of BDA, adoption strategies, outcomes, and intentions to adopt new tools.

3.5 Data Analysis

SPSS was used for analysis. Techniques included descriptive statistics, chi-square tests, t-tests, correspondence analysis, and binary logistic regression. The regression model estimated the likelihood of future adoption as a function of firm characteristics and professional capabilities.

3.6 Reliability and Validity

The instrument was pre-tested to enhance reliability. Validity was ensured by adapting measures from established studies (Wamba et al., 2015; Dubey et al., 2018). Ethical protocols such as voluntary participation and confidentiality were observed.

4. RESULTS AND DISCUSSION

4.1 Firm Experiences

Adoption was reported by **80% of firms**, with larger firms far more likely to integrate BDA. A chi-square test confirmed a significant association between firm size and adoption ($\chi^2 = 68.226$, $p < 0.001$). SMEs struggled due to resource limitations, echoing global findings (Hofmann, 2017).

4.2 Challenges

Barriers differed by firm size. SMEs cited high costs, lack of executive support, and security issues. Larger firms emphasized privacy concerns, unclear business cases, and execution challenges. These confirm both financial and organizational barriers noted in prior studies (Agyabeng-Mensah et al., 2020).

4.3 Adoption Strategies

About 90% of firms had some strategy for BDA. Larger firms implemented enterprise-wide strategies, while SMEs tended to apply analytics in isolated processes. Chi-square tests confirmed size-strategy association ($\chi^2 = 65.022$, $p < 0.001$).

4.4 Professional Capabilities

Most firms (91.2%) had staff with analytics expertise. Chi-square tests showed significant links between operational experience and professional capacity ($\chi^2 = 8.570$, $p = 0.036$). Established firms were more likely to have skilled professionals.

4.5 Tools Used

Large firms adopted advanced tools such as SAP Ariba, Deloitte Supply Chain Solutions, and Halo Analytics. SMEs relied on simpler tools such as Qlik Supply Chain Analytics. Interest in adopting new tools was limited (41%), reflecting cautious investment behavior compared to global peers.

4.6 Outcomes

Benefits included improved customer service, efficiency, integration, and responsiveness. Firms with over five years of experience reported greater gains. Correspondence analysis confirmed that outcomes increased with operational maturity.

4.7 Predictors of Future Adoption

Logistic regression showed that **experience** ($p = 0.007$), **professional capacity** ($p = 0.029$), and **annual sales revenue** ($p = 0.030$) significantly predicted intentions to adopt. Industry type was not significant. This indicates that financial strength and skilled staff are critical to future adoption.

4.8 Discussion

The findings confirm global patterns—resources and skills drive adoption—but also reveal Ghana-specific barriers such as infrastructural weaknesses and limited regulatory frameworks. A clear **digital divide** exists: larger firms progress with enterprise-wide adoption, while SMEs risk exclusion.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

BDA adoption in Ghana is uneven but growing. Large firms with financial strength and professional skills benefit most, while SMEs face barriers. Key predictors of future adoption include operational experience, revenue, and analytics capacity.

5.2 Managerial Implications

- Treat BDA as a **strategic investment**.
- Build **staff capacity** in analytics.
- For SMEs, adopt tools **incrementally** to manage costs.

5.3 Policy Implications

- Provide **financial incentives** to support SMEs.
- Invest in **digital infrastructure** and cybersecurity.
- Foster **partnerships** between large firms, SMEs, and academic institutions for skills transfer.

5.4 Limitations and Future Research

The study focused on Greater Accra; future research should extend to other regions. Longitudinal and cross-country studies in Africa would provide richer insights.

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Appendix A

Table A1. Method of Sampling.

Indicators		Frequency	Percent (%)
Number of employees	0–9	16	7.8
	10–49	27	13.2
	50–249	55	26.8
	250–549	61	29.8
	>550	46	22.4
Industry	75	36.6	75
	42	20.5	42
	19	9.3	19
	69	33.7	69
Annual sales revenue	Under €5 million	16	7.8
	€6–10 million	23	11.2
	€11–25 million	31	15.1
	€26–50 million	45	22.0
	€51–75 million	30	14.6
	€76–100 million	19	9.3
	Over €101 million	41	20.0
Years of operating experience	Less than 1 year	41	20.0
	1–5 years	94	45.9
	5–10 years	55	26.8
	More than 10 years	15	7.3
Total		205	100.0