

DIGITAL SUPPLY CHAIN ADOPTION AND OPERATIONAL EFFICIENCY OF DOWNSTREAM OIL AND GAS COMPANIES IN RIVERS STATE

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Abstract

The purpose of this study was to investigate the link between digital supply chain (DSC) adoption and operational efficiency of downstream oil and gas firms in Rivers State. This hypothesis testing study adopted a correlational research design, and obtained quantitative data from respondents in a non-contrived environment. The population of the study consisted 29 registered and functional downstream oil and gas firms operating in Rivers State. The researchers adopted a census because of the small size of the population. 5 managers were drawn from each of the 29 downstream oil and gas firms. In all, 145 managers constituted the respondents for the study. 145 copies of structured questionnaire were administered to the respondents while 126 copies were retrieved, cleaned and qualified for use. The Pearson Product Moment Correlation statistical was used to test the hypotheses formulated for the study. The results of the analysis revealed that DSC adoption significantly relates to operational efficiency of downstream oil and gas firms in Rivers State. Thus, the study concluded that DSC adoption significantly and positively correlates to operational efficiency of downstream oil and gas firms and recommends that downstream oil and gas firms should monitor and improve digitalization of their supply chain activities in other to enhance their operational efficiency.

Keywords: cost reduction, decentralized management, digital supply chain adoption, operational efficiency, resource utilization

Introduction

Rapid development of digital technologies, increased interconnectedness of the global economy and high level of environmental uncertainty are exerting immeasurable pressure on the competitive performance of supply chains. The digital economy flourished with online shopping, remote work, online education, telemedicine, and other digitalized activities during the COVID-19 pandemic. Companies that embrace digital transformation in these areas gained competitive advantage, while those that failed to adapt to the digital shift faced a delicate situation in the market.

Given the influence of digital technology development and the uncertain external environment on supply chain competitive performance, developing resilient and sustainable supply chains through leveraging digital technologies has become a top priority for organizations. There is an urgent need for research and practical implementation of digital transformation in supply chains to enhance their competitive performance at the organizational level (Sun et al., 2022).

Digital supply chain (DSC) adoption mark a number of core competencies required for balancing assorted production skills and join multiple torrents of technologies together. It is the result of prearranged set of competencies that sum up to proactive use of technology by firms that wish to transport specific good and service offerings to realize operational efficiency. DSC adoption obliges businesses to reflect on synchronization and alliance of their supply chain as indispensable in their innovative strategies.

The administration of upstream and downstream alliances chain prop up value formation for customers (Lavastre et al., 2016). Thus, nowadays, people worldwide prefer to use digital tools and devices to communicate and interact with their relatives, friends, business associates and all. In fact, market forecast presents that a quarter of the world population currently connects to the internet, whereas half of these people are active on social media platforms (Bearing Point, 2015).

Bughin et al. (2018) indicates that many digital technologies and applications are instrumental to improving the supply chain of industries; and this has led to the emergence of DSC (DSC) technologies that support companies to obtain positive change in performance. Tahiduzzaman (2017) explained that DSC is a supply chain constructed on an internet empowered competencies. A DSC has a unique embedded system and techniques that govern and manage real-time inventory levels, and assists first-rate customer interaction with items.

In research, the area of DSC adoption is attracting growing attention with such topics as 'radio frequency' and recently 'big data' being investigated. However, it is unclear how the area of DSC adoption has evolved especially in its influence on operational efficiency. Therefore, this study was designed to investigate the influence of DSC adoption on operational efficiency of oil and gas firms in Rivers State.

Theoretical Framework

The theoretical footing of this study is Resource-Based View (RBV) which postulates that organizational performance outcomes are dependent on internal resources and capabilities (Barney, 1991). A resource is anything owned or acquired by an organization, and the firm's capacity to utilize and obtain benefits from those resources (Hall, 1993, Yang, et al., 2009). As long as an organization has resources that are valuable in their own right, they will have the ability to implement value-creating tactics that cannot readily be replicated by rivals (Grant, 1996; Treece et al., 1997; Barney, 1991). Firms that have access to the best mix of knowledge-based resources and competencies will be able to maintain a long-term advantage in the market (Barney, 2012; Bowersox et al., 2003; Barney, 1991).

RBV stresses that the basis for competitive advantage of a firm lies primarily in the application of a bundle of valuable tangible or intangible resources at the firm's disposal (Wernerfelt, 1984; Rumelt, 1984; Penrose, 1959). Vandermerwe (1996) and Barney (1991) contend that the possession of tangible or intangible strategic resources enables an organization to gain competitive advantage. Tangible resources are resources that have a physical presence (like a firm's technology, property, assets, plant, and equipment, and funds).

In contrast, intangible resources are not physically present (like the knowledge and skills of employees, a firm's reputation, and a firm's culture, capabilities which are key element of intangible resources, information in form of labeling, organizational processes). In the context of this theory, resources refer to what an organization owns; while capabilities refer to what the organization can do (Barney, 1991).

Concept of Digital Supply Chain Adoption

Digitalization is changing the way companies conduct supply chain operations. Advances in digital technology are paving the way towards more interconnected activities and transparent flow of information amongst organizations, their suppliers and customers, in a manner that deliver better value to all involved (Büyüközkan & Göçer 2018). DSC refers to intelligent, customer-centric, system integrated, globally connected and data driven mechanism that leverages new technologies to deliver more accessible and affordable value (Bhargava et al., 2018).

DSC is still in its infancy (Lenka et al., 2016). But there is a growing attention to investigate how technologies and IT-enabled advances can be utilized in supply chain in its transformational route to become fully digitalized. Efforts to address DSC adoption are scattered across its different aspects (e.g. big data and cloud computing) and its respective literature appears to be unstructured and indeterminate.

DSC adoption as defined by Xue et al. (2013), is inter-organizational systems that firms carry out to digitize the processes of transaction and collaboration with their supply chain partners (upstream suppliers and downstream customers). Cecere (2016) and Bhargava et al. (2013) informs that DSC adoption is a grouping of systems that back communications and dealing amongst globally distributed organizations and partners' activities in supply chains.

The availability, scalability and openness of technologies that support DSC enable sustainable improvements in market efficiency (Lenka et al., 2016). Other benefits of DSC include speed, flexibility, global connectivity, intelligence, transparency, scalability, etc. (Hanifan et al., 2014, Schrauf & Bertram, 2016). In addition, the adoption of DSC enables businesses deliver the right products at the right time, enhance relationships between organizations and their partners, and enable more effective competition in the ever-changing digital economy (Wang et al., 2021).

Concept of Operational Efficiency

Peter Drucker refers to efficiency as “doing things right”. Several studies have emphasized the importance of efficiency as a factor that affects profitability and sustainability. Eskandari (2007) opined that a company’s overall efficiency and performance are closely related. Efficiency in organizational operations relates to the optimum utilization of its resources. To survive and prosper, firms must produce output from input efficiently. According to Wong et al. (2011), operational efficiency is a metric used to measure the output of a business from each unit of input.

Efficiency focuses on maintaining high level of productivity and providing consistent quality of product while incurring less cost, minimizing resource consumption and reducing wastes (Ateke et al., 2025; Nwulu et al., 2022). Efficiency also means optimal resource utilization and cost and waste reduction in business operations (Egbe & Aturu-Aghedo, 2023); the input-output ratio that defines a firm’s best possible outcome or the extent to which a firm optimally utilize resources and avoids redundancy in operations (Nwulu et al., 2022).

Youn et al. (2013, as cited in Ateke et al., 2025) argue that the drive for efficiency force managers to simplify operational procedures, and free-up resources for alternative uses; leading to growth and profitability. The efficiency of a firm’s operations determines its survival and growth over the long-run (Bestman & Chinyere, 2021, as cited in Ateke et al., 2025). Also, Weber (2002) notes that by improving efficiency costs are controlled, and returns to shareholders is increased. Thus, Kotler and Armstrong, (2012) aver that operational efficiency is a managerial objective that deals with how firms can maximally utilize available resources to produce good that satisfy customers, and increase earnings and profit in competitive markets.

The concept of operational efficiency encompasses practices meant to improve a company's processes to provide consistent, quality services with minimal resources. It is not only about achieving goals but streamlining operations to deliver better products at better prices and to reduce unnecessary expenses (Vereecke & Muylle, 2006). By maximizing operational efficacy, firms optimize costs, automate complex processes and have faster access to internal information (Keh et al., 2006).

Operational efficiency is inherently pluridimensional (Ateke et al., 2025) and may be decomposed into reduction of: distribution costs, order-cycle time, and wastes, optimal resource utilization and energy conservation (Sodhi et al., 2009, as cited in Nwulu et al., 2022). Additionally, decentralized management and delivery speed (Osondu & Adiele, 2021) are

recognized as proxies of operational efficiency. In this study however, cost reduction, resource utilization and decentralized management were adopted to proxy operational efficiency.

Cost reduction

One of the reasons organizations opt for operational efficiency and excellence is reduction in procurement costs. The aim of operations management is to deliver desired quality of goods to an organization at minimal cost possible. According to Eadie et al. (2007), operational efficiency when properly embraced significantly reduces procurement costs through simplification of procurement process and reduction of wastage.

Hunt et al. (2011) states that procurement costs increase due to spending on preparation of paper work, working on tender documents, advertising tenders, costs of sharing or distributing tender documents and costs of storing huge volumes of paper work and supplier records. Operational efficiency helps reduce costs because the costs of evaluating tender documents are significantly reduced (Handfield, & Bechtel, 2020).

Resource utilization

Resource utilization is the efficient use of organizational resources to maximize customer service levels, reduce lead times and optimize inventory levels. In a supply chain network, there is plethora of resources available for firms to use. These different types of resources available for different applications are: Manufacturing resources - include the machines, material handlers, tools, etc.; Storage resources - comprise warehouses, automated storage and retrieval systems; Logistics resources - engage trucks, rail transport, air-cargo carriers, etc.; Human resources - consist labor, scientific and technical personnel; Financial resources - include working capital, stocks, etc. (Mohr & John, 2020).

Decentralized management

Decentralized management is a method of maintaining several smaller warehouses spread out to different areas in order to better serve different markets or stocking different products. One of the biggest advantages of decentralizing your shipping and receiving is a reduction in delay of material handling. Another reason managers' turn to decentralized warehouses is the increased ability to store products.

This can come in handy a number of ways; you can store a higher volume of the same products to keep up with demand, or you can stock a wider range of products to better meet the needs of your customers, all while avoiding the concerns of taking up more space on your wire shelving or storage solutions with products that might not sell as fast as others. Of course, the biggest problem with decentralizing your warehousing is one of the most obvious issues: increased operating costs. Even with all the benefits in stocking and shipping that this approach brings, the fact of the matter is you're still faced with the costs of owning/renting, maintaining, and outfitting more than one warehouse, which can begin to add up after a while.

Digital Supply Chain Adoption and Operational Efficiency

Enida et al. (2015) investigated the impact of process automation on employee performance in Italy. The study found that organizations that ensure regular adoption of process automation increased their operational efficiency. Similarly, Duran and Akci (2015) investigated the impact of business process automation on supply chain performance of Indian Manufacturing firms and found that business process automation positively correlated with supply chain performance of Indian Manufacturing firms.

Also, Kamakia (2014) investigated the impact of process automation on operational efficiency of commercial banks in Kenya and revealed that process automation to a great extent, impacted operational efficiency. In their own study, Israelit et al. (2018), found similar companies that assimilate digital technologies into their supply chain speedily enrich service levels.

In addition, Ikegwuru (2022) and Rachinger et al. (2018) demonstrates that digital technology impacts supply chain performance appreciably. These studies show the importance of DSC adoption. Nonetheless, in view of the need to conduct statistical analyses, the following null hypotheses were formulated and tested at 0.05 level of significance:

Ho₁: DSC adoption does not significantly correlate to cost reduction of downstream oil and gas firms in Rivers State.

Ho₂: DSC adoption does not significantly correlate to resource utilization efficiency of downstream oil and gas firms in Rivers State.

Ho₃: DSC adoption does not significantly correlate to decentralized management of downstream oil and gas firms in Rivers State.

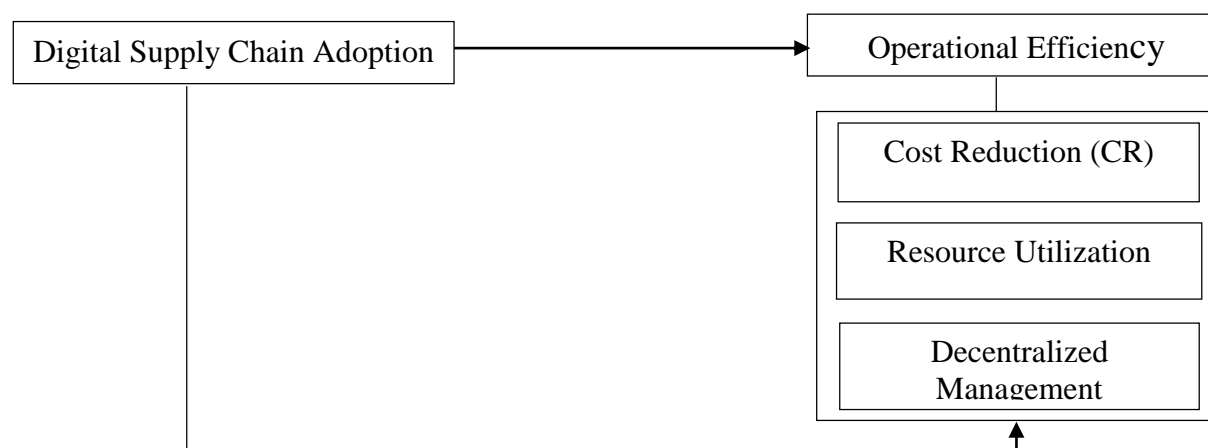


Fig. 1: Conceptual framework of influence of digital supply chain adoption on operational efficiency of downstream oil and Gas Companies in Rivers State.

Source: adopted from Buyukozkan, G. & Gocer, F. (2018).

Methodology

This study examined the correlation between of DSC adoption and operation efficiency of downstream oil and Gas Companies in Rivers State. The study adopted a correlational research design. The population of the study comprised 29 registered and functional downstream oil and gas firms operating in Rivers State. Due to the small size of the population, a census was taken. However, 5 managers were drawn from each of the 29 oil and gas firms. Primary data was obtained using structured questionnaire. The reliability of the questionnaire was determined by pretesting the instrument on 16 other managers of these firms who were not originally included in the study, using Cronbach's Alpha test. According to Ahiauzu (2006), Cronbach Alpha test shows how well questionnaire sets are positively related to one another. 145 copies of structured questionnaire were designed and distributed to top managers of 29 oil and gas firms. The Pearson Product Moment Correlation was used to assess the significance of correlation between DSC adoption and measures of operational efficiency. All the statistical tests were aided by the use of statistical package for social science (SPSS) version 23.0

Table 1: Reliability Coefficients of variable measures

S/No	Variables	Number of items	Number of cases	Cronbach's Alpha
1.	DSC adoption	5	126	0.856
2.	Cost Reduction	5	126	0.877
3.	Resource utilization	5	126	0.890
4.	Decentralized Management	5	126	0.761

Source: SPSS Output (2025)

Table 1 shows the reliability values for 4 variables. Based on the reliability results obtained above, all the variables are above the threshold of 0.70 which depicted strong construct reliability.

Table 2: Correlations for Digital supply chain adoption and Cost Reduction

		Digital supply chain adoption	Cost Reduction
Digital supply chain adoption	Pearson Correlation	1	.717**
	Sig. (2-tailed)		.000
	N	126	126
Cost Reduction	Pearson Correlation	.717**	1
	Sig. (2-tailed)	.000	
	N	126	126

**. Correlation is significant at the 0.01 level (2-tailed).

Source: SPSS Output (2025)

Table 2 shows a correlation coefficient of 0.717. This means that there is a strong positive correlation between the variables. Similarly displayed in the Table 2 is the statistical test of significance (p-value) which makes possible the generalization of our findings to the study population. From the result obtained, the sig- calculated is less than significant level ($p = 0.000 < 0.05$). Therefore, the null hypothesis earlier stated is hereby rejected. Thus, there is a significant correlations between DSC adoption and cost reduction among downstream oil and gas companies in Rivers State.

Table 3: Correlations for Digital supply chain adoption and Resource Utilization

		Digital supply chain adoption	Resource utilization
Digital supply chain adoption	Pearson Correlation	1	.858**
	Sig. (2-tailed)		.000
	N	126	126
Resource utilization	Pearson Correlation	.858**	1
	Sig. (2-tailed)	.000	
	N	126	126

**. Correlation is significant at the 0.01 level (2-tailed).

Source: SPSS Output (2025)

Table 3 shows a Pearson correlation of 0.858 on the relationship between DSC adoption and resource utilization. This value implies that a very strong relationship exists between the variables. The direction of the relationship indicates that the correlation is positive; implying that increase in efficient use of resource results from DSC adoption. Therefore, there is a very strong positive correlation between DSC adoption and resource utilization of downstream oil and gas companies in Rivers State. Also displayed in Table 3 is the statistical test of significance (p-value) which makes possible the generalization of our findings to the study population. From the results, the sig- calculated is less than significant level ($p = 0.000 < 0.05$). Therefore, the null hypothesis

earlier stated is hereby rejected. Thus, there is a significant relationship between DCS adoption and resource utilization among downstream oil and gas companies in Rivers State.

Table 4: Correlations Digital supply chain adoption and Decentralized Management

		Digital supply chain adoption	Decentralized Management
Digital supply chain adoption	Pearson Correlation	1	.703**
	Sig. (2-tailed)		.000
	N	126	126
Decentralized Management	Pearson Correlation	.703**	1
	Sig. (2-tailed)	.000	
	N	126	126

** . Correlation is significant at the 0.01 level (2-tailed).

Table 4 shows a Pearson correlation of 0.703 on the relationship between DSC adoption and decentralized management. This value implies that a strong relationship exists between the variables. The direction of the relationship indicates that the correlation is positive; implying that improvement in decentralized management results from DSC chain adoption. Also displayed in Table 4 is the statistical test of significance (p-value) which makes possible the generalization of our findings to the study population. From the result obtained, the sig- calculated is less than significant level ($p = 0.000 < 0.05$). Therefore, the null hypothesis earlier stated is hereby rejected. Thus, there is a significant relationship between DSC adoption and decentralized management among downstream oil and gas companies in Rivers State.

Discussion of Findings

The findings from this study revealed a significant positive correlation between DSC adoption and operational efficiency among downstream oil and gas companies in Rivers State. This result aligns with a growing body of literature that highlights the transformative role of digital technologies in enhancing supply chain performance, particularly in complex and logistics-intensive sectors like oil and gas. DSC technologies enable real-time visibility, predictive maintenance, demand forecasting and resource optimization (Queiroz et al., 2020; Ivanov et al., 2019).

DSC technologies also reduce operational bottlenecks, improve inventory management and enhance responsiveness to market fluctuations, ultimately boosting efficiency. In the context of the downstream oil and gas sector, which includes refining, distribution, and marketing of petroleum products, the deployment of such technologies can significantly streamline distribution logistics, minimize downtimes, and ensure product availability (Ablo, 2021; Olujobi & Olusola-Ojo, 2022).

The significant correlation observed in this study supports the findings of Kamble et al. (2020), who emphasized that firms adopting Industry 4.0 technologies in supply chain operations report improved operational metrics, including reduced lead times, enhanced asset utilization and lower operational costs. Similarly, Choi et al. (2021) noted that digital integration in supply chains enables agility and operational resilience, especially in industries prone to volatility such as oil and gas.

Furthermore, the results of this study corroborates RBV, which posits that unique resources, such as technological capabilities can lead to sustained competitive advantage (Barney, 1991). In this regard, the adoption of DSC tools becomes a valuable intangible resource that drives efficiency,

differentiates operations, and enhances firm performance in dynamic environments like Nigeria's energy sector.

However, it is relevant to note that effectiveness of DSC adoption is contingent on contextual factors such as infrastructure readiness, employee digital literacy, and regulatory support (Akinola & Sanusi, 2023). In the case of Rivers State, while there has been an increasing shift towards digitalization, infrastructural challenges and cybersecurity concerns still pose barriers to full-scale implementation. This position aligns with the observations of Okeke et al. (2022) that digital transformation in Nigeria's oil and gas sector face implementation challenges due to infrastructural deficits and skill gaps.

Conclusion and Recommendations

This study concludes that DSC adoption relates to operational efficiency of downstream oil and gas companies in Rivers State. This implies that firms embracing DSC innovations are more likely to streamline operations, reduce bottlenecks, improve inventory management, and respond swiftly to market demands. We therefore recommends that:

- 1) Downstream oil and gas companies should scale up the DSC adoption in time-consuming tasks like procurement, inventory control and production scheduling. This can be achieved through the deployment of robotic digital supply chain adoption workflow management systems, and intelligent scheduling software to reduce lead times, minimize errors, and boost productivity.
- 2) Firms should implement DSC across supply chain operations to enable seamless, secure, and real-time data exchange with suppliers and partners. This will improve order accuracy, accelerate processing cycles, and enhance coordination with external stakeholders.
- 3) Companies should adopt DSC platforms that connect core business units like finance, logistics, maintenance, and HR to a single system. Emphasis should be placed on customization to the oil and gas context, staff training, and continuous performance evaluation to ensure system effectiveness and return on investment.

Suggestions for Further Studies

This study has provided significant insights into the correlation between DSC adoption and operational efficiency of downstream oil and gas companies in Rivers State. However, there are several areas where future research could build upon and expand the current findings. Firstly, further studies are encouraged to broaden the sectorial scope by investigating the influence of DSC technologies in other industries, such as upstream oil exploration, manufacturing, agriculture, or logistics. Such studies would help to test the applicability and robustness of the findings across diverse economic sectors.

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