

## **JUST-IN-TIME INVENTORY STRATEGY AND OPERATIONAL EFFICIENCY OF DOWNSTREAM OIL AND GAS FIRMS IN RIVERS STATE**

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### **Abstract**

This study examined the relationship between Just-in-Time (JIT) inventory strategy and operational efficiency of downstream oil and gas companies in Rivers State, focusing on how JIT inventory strategy relates to delivery speed, cost reduction and resource utilization. Founded on economic order quantity model, the study adopted correlational research design with a cross-sectional approach. The population of the study comprised thirty (30) registered downstream oil and gas companies in Rivers State. Because the population was relatively small, all the companies were included in the study. Data were obtained from 128 key management staff involved in inventory and operational activities, particularly logistics managers, warehouse supervisors, procurement officers, supply chain analysts, and operations managers. The research instrument was structured on a five-point Likert scale. Three hypotheses were tested using Pearson Product Moment Correlation. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 25. Results of the analyses revealed that JIT inventory strategy relates positively to delivery speed, cost reduction and resource utilization of downstream oil and gas companies in Rivers State. Based on these findings, we concluded that, there is a positive and significant relationship between JIT inventory strategy and operational efficiency of downstream oil and gas companies in Rivers State; and recommend that downstream oil and gas firms should implement JIT systems to minimize inventory holding costs and reduce waste.

**Keywords:** Just-in-Time inventory strategy, operational efficiency, delivery speed, cost reduction and resource utilization.

### **Introduction**

Just-in-Time (JIT) inventory strategy has emerged as a critical component of modern supply chain management. JIT emphasizes minimizing waste and synchronizing production with demand to achieve operational efficiency (Chong et al., 2018). Rooted in lean production philosophy, JIT advocates reduction of inventory levels, shorter lead times, and improved process coordination to enable firms optimize resources and enhance competitiveness (Ohno, 1988; Fullerton et al., 2014).

In the context of the oil and gas sector, particularly the downstream segment that deals with refining and distribution of petroleum products, inventory control plays a crucial role due to the industry's sensitivity to demand fluctuations, price volatility, and logistical constraints (Obi & Ibekwe, 2021). Efficient inventory management, therefore, becomes essential to maintaining uninterrupted operations, reducing holding costs, and ensuring timely delivery of products.

In Rivers State, Nigeria's hub of downstream oil and gas operations, many firms grapple with inefficiencies arising from poor inventory coordination, excessive stockholding, supply chain disruptions, and high operational costs (Okonkwo & Eze, 2020). These challenges often stem

from inability to align inventory levels with market demand and production schedules, resulting in wastage, delayed deliveries, and reduced profitability.

Despite the global recognition of JIT as a driver of lean operations and performance improvement, its practical adoption and effectiveness in Nigeria's downstream oil and gas firms remain limited and poorly understood (Ugochukwu & Onwuegbuchi, 2022). Infrastructural deficiencies, irregular supply chains, and weak technological integration further constrain the realization of the benefits of JIT in the region (Olawale & Nwachukwu, 2019).

Also, there is paucity of local studies that empirically examine how JIT inventory strategy influence operational efficiency of downstream oil and gas firms in Rivers State. Most existing Nigerian studies focused on JIT applications in manufacturing or fast-moving consumer goods (FMCG) industries (Adeniran & Olayinka, 2017; Eze & Okafor, 2021), leaving a contextual vacuum in the energy sector. Consequently, there is inadequate empirical evidence linking JIT strategy to measurable improvements in operational efficiency indicators such as cost reduction, productivity, and service reliability (Nwankwo & Ugwu, 2023).

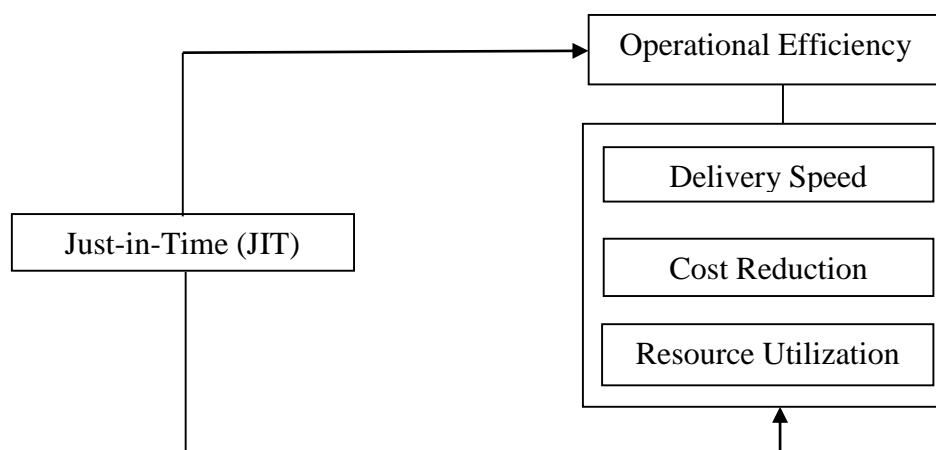
This study sought to fill this gap by examining the relationship between JIT inventory strategy and operational efficiency of downstream oil and gas firms in Rivers State. By doing so, the study provides empirical evidence to guide managers, policymakers, and stakeholders in optimizing inventory systems for sustainable operational performance in Nigeria's energy sector.

The following null hypotheses were tested in the study.

Ho<sub>1</sub>: There is no significant relationship between JIT inventory strategy and delivery speed in downstream oil and gas firms in Rivers State.

Ho<sub>2</sub>: There is no significant relationship between JIT inventory strategy and cost reduction in downstream oil and gas firms in Rivers State.

Ho<sub>3</sub>: There is no significant relationship between JIT inventory strategy and resource utilization in downstream oil and gas firms in Rivers State.



**Fig. 1:** Conceptual framework of relationship between JIT inventory strategy and operational efficiency of downstream oil and gas firms in Rivers State

**Source:** Chopra and Meindl (2019); Christopher (2016); Ghobadian and Gallear (1997).

### Theoretical Foundation: Economic Order Quantity Model

Economic Order Quantity (EOQ) model, developed by Ford W. Harris in 1913 remains a cornerstone of inventory management, as it enable firms determine the optimal order quantity

that minimizes total costs (ordering, holding, and stockout costs). This model is particularly relevant to downstream oil and gas firms in Rivers State, where maintaining uninterrupted supply and managing inventory-related costs are critical to operational efficiency. EOQ support demand forecasting and warehouse management by optimizing stock levels and ensuring timely replenishment (Oko & Agbo, 2021).

In a volatile operating environment characterized by fluctuating demand and infrastructural challenges, EOQ help firms reduce risks of stockouts and overstocking. For instance, Chukwu and Daminabo (2020) observed that fuel marketing companies in Port Harcourt that apply EOQ principles experienced better synchronization between demand forecasts and procurement schedules, leading to reduced lead times and improved customer satisfaction. EOQ thus enhances the ability of firms to maintain balance between demand and supply while controlling costs.

Amadi and Wilson (2022) further emphasized that oil marketers using EOQ in Rivers State achieved cost efficiency through reduced transportation and emergency restocking expenses. By providing a quantitative basis for procurement decisions, EOQ enables managers to align supply chain activities with financial and operational objectives. Additionally, integrating EOQ with modern systems such as Enterprise Resource Planning (ERP) enhances decision-making through real-time inventory monitoring, which strengthens responsiveness and operational agility.

Thus, EOQ is not only a theoretical model but a practical tool that drives efficiency, minimizes waste, and ensures product availability in downstream oil and gas operations. Its adoption supports cost reduction, productivity, and resilience - key dimensions of operational efficiency in a competitive and logistics-intensive sector like that of Rivers State.

### **Concept of Just-in-Time**

JIT is a production philosophy where each process produces only what is needed for the next, in a continuous flow that minimizes waste and improves efficiency (Ohno, 1988). JIT system seeks to enhance operational efficiency by reducing excess inventory, eliminating waste, and ensuring materials or products arrive exactly when required in production. It emphasizes synchronization, precision, and lean management practices that collectively improve productivity.

JIT has evolved beyond automobile manufacturing and is now widely used in industries such as retail, healthcare, and logistics, where efficiency and cost control are essential (Krajewski et al., 2019). By minimizing inventory levels, organizations can reduce holding costs, improve cash flow, and foster a culture of continuous improvement (Cheng & Podolsky, 1996). Moreover, JIT promotes responsiveness to demand fluctuations and enhances overall operational agility of firms.

However, JIT is not without challenges. Its success depends on accurate demand forecasting, dependable suppliers, and efficient logistics. Since JIT operates with minimal inventory buffers, any disruption in the supply chain such as supplier delays, transportation issues, or quality problems can cause stockouts or production halts (Christopher & Peck, 2004). Thus, effective JIT implementation requires robust risk management and supply chain coordination.

In the modern business environment, the integration of digital technologies such as real-time inventory tracking, automated ordering, and predictive analytics has further strengthened JIT

systems. These innovations improve visibility and coordination across the supply chain, mitigating traditional JIT risks. Ultimately, JIT is more than a production method it is a comprehensive management philosophy that enhances efficiency, reduces costs, and sustains competitive advantage in dynamic industries.

### **Operational Efficiency**

Operational efficiency refers to an organization's ability to deliver products in a cost-effective manner while maintaining quality and optimal resource utilization. In today's competitive global economy, it is both a strategic goal and a necessity for organizational sustainability. Achieving operational efficiency involves minimizing waste, reducing costs and improving internal processes without compromising quality. According to Slack et al. (2016), operational efficiency is realized when firms produce goods or services using minimal resources while meeting customer expectations.

A key driver of operational efficiency is adoption of lean management principles. Originating from the Toyota Production System, lean emphasizes the elimination of non-value-adding activities, continuous improvement, and maximizing customer value (Womack & Jones, 2003). Organizations applying lean approaches often experience improved process speed, cost savings, and customer satisfaction.

Advances in technology also enhance operational efficiency. Automation, enterprise resource planning (ERP) systems, and artificial intelligence streamline operations, reduce human error, and support data-driven decision-making (Davenport, 2018). In warehousing, technologies such as warehouse management systems (WMS) and predictive analytics improve inventory accuracy, shorten lead times, and optimize warehouse utilization.

In the downstream oil and gas sector, operational efficiency is particularly crucial due to capital intensity, volatile markets, and regulatory pressures. It involves optimizing human, technological, and financial resources to refine and distribute petroleum products effectively (Adeleye, 2020). Refinery process optimization through advanced process control and predictive maintenance, enhances throughput, reduces energy use, and minimizes downtime (Sorrell et al., 2009). Ultimately, operational efficiency balances cost reduction with flexibility and innovation, and enable firms maintain competitiveness, enhance profitability, and achieve long-term resilience in dynamic and resource-intensive industries.

Christopher (2016) identifies delivery speed, cost reduction and resource utilization as measures of operational efficiency. However, given the time frame and scope of the study, we adopt delivery speed, cost reduction and resource utilization to measure operational efficiency.

### **Delivery speed**

In today's competitive business environment, characterized by high customer expectations and intense market rivalry, delivery speed has become a critical determinant of operational performance and customer satisfaction. Delivery speed refers to the time taken to deliver a product or service from the point of order to the final customer, reflecting an organization's responsiveness and reliability (Christopher, 2016). It is a key dimension of logistics performance and supply chain agility, often determining customer loyalty and market competitiveness.

Fast and reliable delivery offer numerous benefits. For customers, it enhances convenience and service experience; for firms, it improves cash flow, reduces inventory risks, and strengthens

brand reputation (Kotler & Keller, 2016). In sectors with limited product differentiation, such as retail or manufacturing, delivery speed becomes a crucial competitive advantage. Lean and JIT practices enhance delivery speed by minimizing waste and reducing lead times (Chopra & Meindl, 2019; Womack & Jones, 2003).

The rise of e-commerce has amplified the importance of speed, with customers increasingly expecting same-day delivery. Companies such as Amazon achieve this through strategically located warehouses and advanced logistics networks (Hübner, 2016). However, accelerating delivery can raise operational costs, particularly in last-mile logistics, which remains the most expensive and complex segment. As Ivanov (2020) notes, excessive pursuit of speed can create supply chain vulnerabilities if not balanced with flexibility and cost-efficiency. In the downstream oil and gas sector, delivery speed is vital for ensuring continuous supply to retail and industrial users. Timely distribution prevents service disruptions and enhances customer trust (Okorie, 2021). Therefore, delivery speed remains a cornerstone of operational excellence and a key factor in sustaining competitive advantage.

### **Resource utilization**

Resource utilization is a fundamental concept in operations management. It refers to effective deployment of resources (labor, materials, equipment, time, and capital) to achieve maximum output with minimal waste (Stevenson, 2020). Effective resource utilization ensures that an organization's inputs are transformed into valuable outputs in a cost-effective manner, enhancing productivity and competitiveness.

At its core, resource utilization involves planning, allocating and managing resources to align with strategic objectives. High utilization reflects minimal idle time and efficient coordination across activities. In manufacturing, this may mean minimizing machine downtime, while in service operations, it entails balancing employee workloads to avoid overuse or underuse (Heizer et al., 2020). Misallocation or poor scheduling of resources often leads to bottlenecks, inefficiencies and increased operational costs (Slack et al., 2019). From sustainability perspective, effective resource utilization minimizes waste generation, reduces energy consumption, and supports eco-friendly practices. This aligns with principles of circular economy and triple bottom line sustainability -economic, social, and environmental performance (Elkington, 1997).

Technological advancement has further improved resource utilization through digital tools such as Enterprise Resource Planning (ERP), Internet of Things (IoT) sensors, and data analytics. These systems enable real-time tracking, predictive maintenance, and continuous performance improvement (Laudon & Laudon, 2021). However, optimal resource utilization may be hindered by limited budgets, fluctuating demand, and workforce constraints. Also, excessive focus on resource utilization may cause employee fatigue or equipment wear (Porter & Kramer, 2011). Thus, effective resource utilization requires balancing efficiency with sustainability and well-being. In today's dynamic business environment, mastering this balance enhances productivity, profitability, and long-term operational efficiency.

### **Cost reduction**

Cost reduction is a fundamental principle for organizations seeking to enhance profitability, operational efficiency, and competitive advantage. It involves systematically lowering expenses without compromising quality or performance. Unlike short-term cost-cutting, cost reduction emphasizes long-term sustainability through innovation, efficiency and improved resource utilization (Drury, 2018).



At its core, cost reduction focuses on optimizing resources by eliminating waste, reducing redundancy, and improving productivity. Key techniques include process re-engineering, lean manufacturing, automation and supply chain optimization, all of which improve responsiveness and lower operating costs (Drury, 2018). Lean management, in particular, emphasizes value creation with fewer resources by minimizing waste and streamlining operations, leading to reduced cycle times and lower inventory levels (Brynjolfsson & McAfee, 2014; Womack & Jones, 2003).

Cost reduction strengthens financial planning and strategic resource allocation. Firms that monitor and control their cost structures are better positioned to sustain profitability and withstand economic fluctuations (Horngren et al., 2012). However, true cost reduction requires a culture of continuous improvement and employee engagement, as participatory involvement helps identify inefficiencies and fosters accountability (Kotler & Keller, 2016).

Importantly, cost reduction must be distinguished from cost cutting. While the former is strategic and value-driven, the latter may compromise quality, customer satisfaction, and morale. As Porter (1985) asserts, sustainable competitive advantage arises not from indiscriminate cuts but from efficiencies that enable superior value delivery. Hence, cost reduction, when implemented strategically, strengthens financial performance, competitiveness, and long-term sustainability.

### **Empirical Review**

JIT is a strategic inventory management approach that emphasizes the delivery of materials, components, and products exactly when they are needed in the production or sales process. Originating from the Toyota Production System, JIT has become a cornerstone of lean manufacturing and a vital driver of operational efficiency across industries (Ohno, 1988). It aims to minimize waste, reduce inventory costs, shorten lead times, and enhance responsiveness and quality.

According to Ohno (1988), waste (*muda*) in the form of overproduction, waiting, and excess inventory can be reduced by aligning production schedules with customer demand. By receiving materials just in time for production, firms minimize storage costs, reduce obsolescence, and improve cash flow. This synchronization of demand and supply ensures that resources are utilized efficiently while maintaining product quality and delivery reliability.

Empirical evidence supports the effectiveness of JIT in improving operational efficiency. Fullerton et al. (2003) found that firms implementing JIT practices achieved higher productivity, improved quality control, and superior delivery performance. JIT contributes to better throughput, reduced cycle times, and enhanced responsiveness by eliminating non-value-adding activities and fostering continuous improvement.

In Nigeria, particularly within the downstream oil and gas sector, JIT adoption presents both opportunities and challenges. Eze et al. (2018) observed that while firms recognize the value of JIT, its implementation is often constrained by unreliable infrastructure, inconsistent power supply, and supplier inefficiencies. Nonetheless, companies that successfully applied JIT principles reported reduced lead times, lower inventory holding costs, and increased operational flexibility key indicators of enhanced efficiency.

Shah and Ward (2007) argue that JIT extends beyond logistics it is a holistic lean philosophy integrating total quality management (TQM), supplier collaboration, and employee

empowerment. However, reliance on precise timing and minimal inventory makes firms more susceptible to disruptions. The COVID-19 pandemic underscored these risks, prompting scholars like Christopher and Peck (2004) to advocate for a balance between lean efficiency and supply chain resilience.

Thus, JIT significantly enhance operational efficiency by reducing waste, optimizing resource use, and improving responsiveness. Yet, its success depends on supply chain reliability, technological integration, and organizational commitment to continuous improvement. For firms in emerging economies like Nigeria, JIT can deliver substantial benefits if supported by robust infrastructure, capable suppliers, and strategic risk management practices.

### Methodology

A correlational research design with a cross-sectional approach was adopted in this study to examine the relationship between the JIT inventory strategy and operational efficiency of downstream oil and gas firms in Rivers State. The population of the study comprised thirty (30) registered downstream oil and gas companies. Because the population was relatively small, no sampling technique was applied all the companies were included in the study. Data were obtained from 128 key management staff involved in inventory and operational activities, particularly logistics managers, warehouse supervisors, procurement officers, supply chain analysts, and operations managers. The research instrument was structured on a five-point Likert scale.

To ensure the reliability of the instrument, the collected data were subjected to Cronbach's Alpha reliability test, applying the 0.70 threshold recommended by Nunnally (1978). Furthermore, the construct validity of the instrument was confirmed through Exploratory Factor Analysis (EFA). The results of the reliability and validity tests are presented in Table 1.

In establishing the relationship between JIT inventory strategy and operational efficiency, the Pearson Product Moment Correlation Analysis was employed. Three hypotheses were tested, and their probability values were compared against the 0.05 level of significance. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 25. The results of the tested hypotheses are presented in Tables 2, 3, and 4.

**Table 1: Results of Reliability and Validity Tests**

S/N	Variables	Number of Items	Cronbach's Alpha Coefficients	Factor Loadings
1	Just-in-time inventory strategy	4	0.799	0.727
2	Delivery speed	4	0.740	0.876
3	Cost reduction	4	0.707	0.572
4	Resource utilization	4	0.728	0.891

Source: SPSS Output form field data

Table 1 revealed that all the variables in the study produced high Cronbach's Alpha coefficients. This shows that, there is inter-item consistency among the variables in the study. In other words, if this study is conducted again in a similar condition the results will be similar to the results of this study. Again, all the variables have high factor loadings greater than 0.4, indicating that the items and variables in the questionnaire measured what they were supposed to measure. These loadings indicated that there is no cross-loading hence there is discriminant validity.

## Results

**Table 2: Correlation between JIT and delivery speed**

		Just-in-time	Delivery speed
Just-in-time	Pearson Correlation	1	.252**
	Sig. (2-tailed)		.004
	N	128	128
Delivery speed	Pearson Correlation	.252**	1
	Sig. (2-tailed)	.004	
	N	128	128

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

Source: Field Survey, 2025.

Pearson Correlation Analysis was run to assess the relationship between JIT and delivery speed of downstream oil and gas firms in Rivers State. Using a sample of 128 respondents, drawn from 30 downstream oil and gas firms in Rivers State, the analysis revealed - as shown in Table 2 that, JIT a weak, positive and significant relationship with delivery speed of downstream oil and gas firms in Rivers State. This result is evident in the correlation coefficients of 0.252 and a probability value of  $0.004 < 0.05$ . In view of this result, the researcher rejects the hypothesized relationship between just-in-time and delivery speed.

**Table 3: Correlation between JIT and cost reduction of downstream**

		Just-in-time	Cost reduction
Just-in-time	Pearson Correlation	1	.748**
	Sig. (2-tailed)		.001
	N	128	128
Cost reduction	Pearson Correlation	.748**	1
	Sig. (2-tailed)	.001	
	N	128	128

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

Source: Field Survey, 2025.

Pearson Correlation Analysis was run to assess the relationship between just-in-time and cost reduction of downstream oil and gas firms in Rivers State. Using a sample of 128 respondents, drawn from 30 downstream oil and gas firms in Rivers State, the analysis revealed - as shown in Table 3 that, just-in-time has a strong, positive and significant relationship with cost reduction of downstream oil and gas firms in Rivers State. This result is evident in the correlation coefficients of 0.748 and a probability value of  $0.000 < 0.05$ . In view of this result, the researcher rejects the hypothesized relationship between just-in-time and cost reduction.

**Table 4: Correlation between just-in-time and resource utilization**

		Just-in-time	Resource utilization
Just-in-time	Pearson Correlation	1	.491**
	Sig. (2-tailed)		.009
	N	128	128
Resource utilization	Pearson Correlation	.491**	1
	Sig. (2-tailed)	.009	
	N	128	128

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

Source: Field Survey, 2025.



Pearson Correlation Analysis was run to assess the relationship between just-in-time and resource utilization of downstream oil and gas firms in Rivers State. Using a sample of 128 respondents, drawn from 30 downstream oil and gas firms in Rivers State, the analysis revealed - as shown in Table 4 that, just-in-time has a moderate, positive and significant relationship with resource utilization of downstream oil and gas firms in Rivers State. This result is evident in the correlation coefficients of 0.491 and a probability value of  $0.000 < 0.05$ . In view of this result, the researcher rejects the hypothesized relationship between just-in-time and resource utilization.

### Discussion of Findings

This study assessed the link between JIT and operational efficiency of downstream oil and gas firms in Rivers State. The statistical analyses conducted, revealed that JIT has a weak, positive and significant relationship with delivery speed; a strong, positive and significant relationship with cost reduction of and a moderate, positive and significant relationship with resource utilization of downstream oil and gas firms in Rivers State.

These findings are in line with findings of previous studies examined. For instance, the findings agree with the finding of Fullerton et al. (2003) who found a positive relationship between JIT practices and operational performance in U.S. manufacturing firms. These findings suggest that JIT can lead to tangible gains in efficiency by aligning operational activities with real-time demand and minimizing disruptions in the supply chain.

Our findings also align with the findings of Eze et al. (2018) that while JIT principles were acknowledged, poor infrastructure, erratic power supply, and inconsistent supplier reliability hindered its effective implementation. However, firms that successfully implemented JIT reported improved lead times, reduced inventory holding costs, and greater flexibility in responding to market fluctuations key indicators of enhanced operational efficiency.

### Conclusion and Recommendations

Based on the findings of this study, it is concluded that there is a positive and significant relationship between just-in-time inventory strategy and operational efficiency of downstream oil and gas companies in Rivers State. Thus, the application of just-in-time inventory strategy can significantly improve operational efficiency in the downstream oil and gas companies in Rivers State. Just-in-Time strategy, by minimizing excess stock and reducing storage costs, contributes to leaner operations and faster response to market demands. Therefore, it is recommended that downstream oil and gas firms should implement JIT systems to minimize inventory holding costs and reduce waste. However, successful adoption requires strong supplier relationships and efficient logistics. Management should prioritize establishing real-time communication systems and contractual agreements that ensure timely delivery and responsiveness to changing demand.

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