

**TRANSPORTATION MANAGEMENT SYSTEMS AND OPERATIONAL EFFICIENCY OF BAKERY FIRMS IN RIVERS STATE**

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**Abstract**

This study investigated the relationship between transportation management systems (TMS) and operational efficiency in bakery firms in Rivers State, Nigeria. The study focused on two major components of TMS - real-time tracking and route optimization. A descriptive research design was adopted. The population of the study comprised 24 bakery firms in Rivers State. The study collected data from 20 logistics and operations personnel in 24 bakery firms using structured questionnaire. Data analysis was conducted using Pearson Product Moment Correlation via SPSS. The study revealed that real-time tracking had strong positive and statistically significant relationship with operational efficiency, while route optimization demonstrated very strong positive correlation with operational efficiency. The study concludes that TMS are essential to improved operational efficiency and recommends that bakery firms in Rivers State that seek improved operational efficiency should adopt TMS like real-time tracking and route optimization to enhance their ability to meet delivery targets and reduce wastes and redundancies.

**Keywords:** Operational efficiency, real-time tracking, route optimization, transportation management systems

**Introduction**

In today's rapidly evolving global supply chain landscape, the demand for smarter, more efficient transportation systems is paramount, especially in the food production and bakery sector. Transportation management systems (TMS) have emerged globally as strategic tools for ensuring timely delivery and reduced waste across logistics networks (Zhong et al., 2017). TMS such as real-time tracking and route optimization are now critical to proactive fleet management and enhanced supply chain visibility (Melesse & Orrù, 2025). For bakery firms that often deal with highly perishable goods, the integration of these systems is essential to maintain freshness and meet consumer expectations in a competitive market (Kerbache et al., 2020).

Operational efficiency refers to a firm's ability to utilize its resources - people, technology, and processes - in ways that minimize waste, time, and cost while maximizing output and quality (Gillespie et al., 2023). In the bakery industry, operational efficiency is not only measured by speed of delivery but also by the freshness and quality of products at the point of sale. Studies show that when firms implement effective TMS, particularly those with route planning capabilities and real-time updates, they experience improved coordination, lower delivery costs, and enhanced customer satisfaction (Souza et al., 2021; Limanska & Hrybkov, 2022).

On the other hand, real-time tracking and route optimization - represent core components of modern TMS. Real-time tracking allow logistics managers to monitor fleet movements and respond swiftly to disruptions, ensuring faster decision-making and improved accountability (Bhutta & Ahmad, 2021); while route optimization enables dynamic routing based on traffic, fuel efficiency and delivery schedules, leading to cost savings and reduced carbon emission (George, 2024; Haji et al., 2020). In bakery business, these practices have direct implications on delivery schedules and freshness windows, which are key drivers of brand reliability and repeat patronage.

Prior studies suggests that TMS enhance operational efficiency. Arowosegbe and Adegboye (2024) found that grocery supply chains leveraging optimized transportation schedules experience reduced spoilage rates by up to 18%. Similarly, Ribeiro et al. (2021) reported that TMS enhanced operational efficiency of SMEs in baking by reducing delivery turnaround time by 12%. These findings resonate with those of Melesse and Orrù (2025) that integration of real-time and predictive tracking systems improve product availability and inventory synchronization in bakery logistics.

Despite these advancements, many bakery firms in Nigeria, particularly in Rivers State, still rely on outdated transportation models that lack visibility, adaptability and responsiveness. This gap has contributed to increased costs, inefficiencies and customer dissatisfaction. Moreover, increased urban congestion and infrastructural limitations in the Nigerian context heightens the need for intelligent logistics solutions tailored to local realities.

The motivation for this study stems from the need to bridge the logistics performance gap in Nigeria's bakery subsector through the integration of smart TMS. By investigating the specific roles of real-time tracking and route optimization in improving operational efficiency, this research offer valuable insights for bakery firms aiming to scale operations, reduce delivery inefficiencies, and increase profit margins. Additionally, the study contributes to scholarly debates on localized TMS implementation in emerging economies, where contextual challenges necessitate nuanced models of technology adoption.

The primary aim of this study was to investigate the relationship between TMS and operational efficiency of bakery firms in Rivers State. The specific objectives were:

- a) To examine the extent to which real-time tracking relates to operational efficiency of bakery firms in Rivers State.
- b) To determine the extent to which route optimization relates to operational efficiency of bakery firms in Rivers State.

### **Concept of Transportation Management Systems (TMS)**

TMS are central tools in the planning, execution and optimization of physical goods movement across supply chains. They represent a digital shift from manual scheduling to intelligent, data-driven logistics planning (Nurmasari et al., 2025). Gonçalves et al. (2021) define TMS as technology-enabled tools that enhances transport reliability, minimizes process errors and streamlines logistics operations through automation and traceability. Similarly, Liu (2009) positions TMS as the foundational base for logistics enterprises, coordinating the flow of data and activities critical to efficient transportation.

TMS allow firms to synchronize transport with production, inventory and warehousing, thereby improving logistics coordination. Destanović (2018) adds that TMS play an integral role in intelligent transport systems, allowing firms to optimize logistics in both supply chain and information domains (Destanović, 2018). A wide range of functionalities makes TMS vital to contemporary logistics. TMS platforms are equipped with route optimization, load planning, shipment visibility, carrier selection, freight billing and delivery scheduling tools.

Rushton et al. (2022) highlight TMS as a powerful interface that reduces delivery errors, manages carrier performance and supports predictive logistics planning. Modern TMS architecture provide centralized coordination and real-time decision support, enhancing transparency and performance in

complex distribution environments (Kourouthanassis et al., 2023). Kolla (2024) further explains that when integrated with inventory systems, TMS ensure synchronization between stock levels and outbound deliveries, thus, reduce waste and boost responsiveness (Kolla, 2024). TMS encompass a range of tools, including real-time tracking and route optimization.

### **Real-time Tracking**

Real-time tracking has emerged as a key component in modern supply chain optimization, with empirical evidence pointing toward its capacity to enhance operational efficiency. Melesse and Orrù (2025) affirmed that real-time tracking improve visibility, reduce delays and enhance efficiency in inventory management. This technology enable firms to monitor delivery vehicles in real-time, assess route adherence, and ensure timely dispatches, all of which are crucial to baked goods that have short shelf lives. Gillespie et al. (2023) emphasized that real-time tracking enable food firms to minimize spoilage, track deviations in delivery schedules and maintain regulatory compliance.

Moreover, Irwandy and Salleh (2024) emphasized that in bakery supply chains, which often cater to time-sensitive orders and fluctuating demand, real-time monitoring allows swift adaptation to disruptions such as traffic or vehicle breakdowns. Irwandy and Salleh (2024) notes that real-time tracking systems enabled Brunei bakeries to reduce delivery lag by over 20%, which in turn improved turnaround times and optimized labor deployment. Similarly, George (2024) revealed that firms with integrated GPS and mobile tracking achieved an average 15% increase in order fulfillment efficiency; even as da Costa et al. (2023) emphasized that real-time tracking help firms avoid disruptions by rerouting deliveries dynamically.

In essence, real-time tracking provide timely data that facilitates faster decision-making and reduces manual coordination, both of which are vital in sectors like baking where freshness and punctuality are critical. The position of scholars (George, 2024; Irwandy & Salleh, 2024; Costa et al., 2023) in this regard implies that firms that adopt real-time tracking tools experience enhanced efficiency; while those without real-time tracking tools will experience delivery delays and dissatisfied customers.

### **Route Optimization**

Route optimization is critical to managing transportation costs, delivery timeliness and vehicle (resource) utilization - key pillars of operational efficiency. Bazan Flores et al. (2023) evaluated route optimization models for bakery SMEs and concluded that smart routing significantly minimized fuel consumption and delivery delays, and that by leveraging algorithms to identify faster and most cost-effective paths, bakery firms enhanced on-time delivery by 25% and reduced driver idle time.

Similarly, Kaur et al. (2023) highlighted that optimizing delivery routes based on traffic, weather and customer location data substantially decreased delivery costs while improving consistency; and argued that route optimization is not just a cost-saving tool but a strategic lever for operational agility, particularly where resource constraints exist - as is often the case in Nigeria's bakery sector.

Also, Taquíá Gutiérrez et al. (2023) reported a direct link between optimized delivery sequencing and order accuracy, which led to improved productivity and customer satisfaction. This indicates that effective route optimization positively influence firms' ability to meet demand predictably. Cadden and da Costa (2023) extended this line of inquiry by measuring the impact of algorithm-

based vehicle dispatching on fuel savings and labor utilization in bakery logistics, and found that firms that adopt advanced route optimization tools cut transport-related costs by 30% while reducing delivery time variability, thus enhancing the reliability of bakery supply operations.

In addition, Seddone (2022) observed that in complex urban environments like Port Harcourt, where unpredictable delays affect service reliability, route optimization serves as a proactive tool for navigating constraints. Seddone (2022) affirm that by prioritizing proximity, traffic density, and delivery windows, bakery firms achieve higher fleet productivity.

### **Operational Efficiency**

Operational efficiency is the ability of an organization to deliver products with minimal wasted effort or expense while maximizing output quality and customer satisfaction (Xuan et al., 2023). It is especially relevant in logistics-intensive sectors like food distribution, where precision, timeliness, and cost control are vital. Stevenson (2018) defines operational efficiency as the ratio between input resources and output performance, emphasizing the importance of streamlined processes, automation and productivity.

Christopher (2016) suggests that efficiency involves cost minimization, improved delivery speed, and maintaining service quality. Pham et al. (2020) posits that operational efficiency is critical to sustained solvency and competitive strength of logistics firms. In bakery logistics, achieving operational efficiency reduces spoilage, delays, and cost overruns, ensuring fresher deliveries and higher customer retention. Operational efficiency is typically measured using performance indicators such as optimal resource utilization, fleet utilization, on-time delivery rate, and logistics cost per unit. These metrics help organizations evaluate how effectively resources are allocated and how quickly services are delivered.

### **Transportation Management Systems and Operational Efficiency**

TMS enable firms achieve sustained efficiency in distribution operations (Umoren et al., 2021). Firms therefore rely TMS tools, including real-time tracking and route optimization in their efforts to run more robust, resilient and efficient distribution activities (Ateke et al., 2025). The underlying believe in this regard is that eliminating avoidable transportation activities and processes hasten distribution channel flows, and reduce costs (Fahimnia et al., 2015).

Prior studies underpin the link between TMS and operational efficiency. Ateke et al. (2025), examined the nexus between logistics optimization and distribution efficiency of distributors of fast-moving consumer goods (FMCG) in Rivers State, and reported that a strong positive and statistically significant association exist between logistics optimization and distribution efficiency. The study was conducted on 12 FMCG distributors in Rivers State, and collected primary data from customer service, operations and logistics managers of each firm, using a 5-point Likert scale multiple-choice questionnaire. The study used the Spearman's Rank Order correlation to test the relationship between logistics optimization and metrics of distribution efficiency (optimal resource utilization, waste reduction and cost reduction), relying on the Statistical Package for Social Sciences (SPSS) version 24.0 aided the test of hypotheses.

Relatedly, Xuan et al. (2023) assessed how logistics system efficiency influence export performance of Vietnamese firms. Using panel data from 240 firms and 80 international trade partners, the study applied fixed-effects and random-effects models, validated through the Hausman test. The study

focused on delivery time, cost, shipment tracking and service capacity indicators of logistics performance. Findings revealed that improvements in logistics efficiency in Vietnam resulted in 1.443% increase in exports, while enhancements in partner countries yielded a 0.546% growth. The study concluded that logistics systems play a critical role in boosting operational and export efficiency.

In Kumar and Bansal (2018), the influence of TMS on customer satisfaction in the Indian automotive spare parts industry was investigated. A total of 145 logistics officers were surveyed across 20 firms using self-administered instruments. The results from regression analysis showed that TMS significantly improved delivery timeliness and tracking transparency. The study concluded that TMS directly impacts customer satisfaction. Also, Ahmed and Musa (2017) explored the relationship between TMS usage and delivery efficiency in FMCG firms in Nairobi, Kenya. The researchers distributed 120 copies of questionnaire to supply chain officers and received 107 usable responses. The study employed Spearman rank correlation to analyze the data using SPSS version 20. Results showed a strong positive correlation between TMS utilization and improved distribution metrics such as vehicle turnaround time and product freshness.

Further, Jiang et al. (2019) investigated effect of TMS on distribution cost efficiency among e-commerce firms in Shanghai. A total of 170 logistics personnel from 30 e-commerce companies were surveyed using self-administered questionnaires. Data were analyzed using multiple regression in STATA. The study found that integrated TMS systems significantly reduced transportation costs, optimized vehicle usage, and enhanced order tracking. The researchers recommended further investments in digital logistics tools to support e-commerce growth. The foregoing reports suggests that TMS relates to operational efficiency. However, in view of the need to conduct statistical tests, we hypothesize as follows:

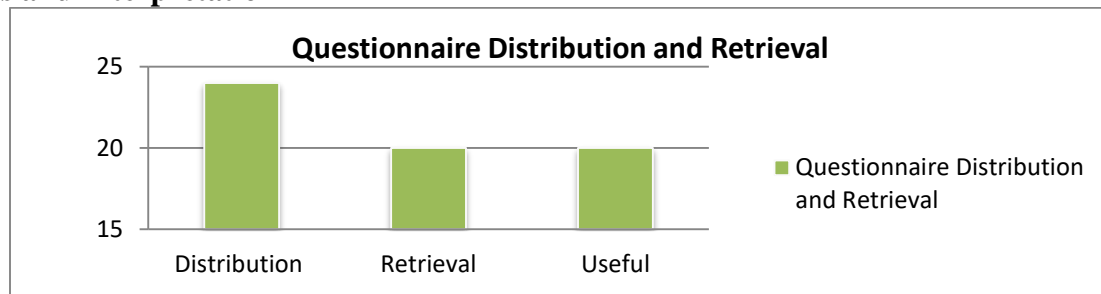
**H<sub>01</sub>:** There is no significant relationship between real-time tracking and operational efficiency of bakery firms in Rivers State.

**H<sub>02</sub>:** There is no significant relationship between route optimization and operational efficiency of bakery firms in Rivers State.

### Methodology

This quasi-experimental study adopted a correlational type of research. The population of the study consisted 24 bakeries Rivers State as listed in the Finelib.com Nigeria Directory and Search Engine (2024). The study took due to the small size of the population. Therefore, all 24 firms were included in the study, and at least one key logistics personnel from each firm were surveyed. Categories of respondents were general managers, bakery operations managers, and logistics managers. The study collected primary data using structured questionnaire whose reliability was determined using Cronbach's alpha test, with a threshold of 0.70. The test produced a coefficient of 0.98. The data collected were analyzed through descriptive and inferential statistics. The Pearson Product Moment Correlation was used to test the hypotheses formulated for the study, relying on the aid of Statistical Package for Social Sciences (SPSS) version 27.0.

## Results and Interpretation



Source: Field Survey, 2025.

Figure 1 shows the rate of questionnaire distribution and retrieval. Figure 1 shows that out of 24 copies of questionnaire distributed, 20 copies were retrieved and used.

**Table 1: Analysis of relationship between real-time tracking and operational efficiency**

Correlations			Real-Time Tracking	Operational Efficiency
Pearson (r)	Real-Time Tracking	Correlation Coefficient	1.000	.738*
		Sig. (2-tailed)	.	.000
		N	20	20
	Operational Efficiency	Correlation Coefficient	.738*	1.000
		Sig. (2-tailed)	.000	.
		N	20	20

\*. Correlation is significant at the 0.05 level (2-tailed).

SPSS output, 2025.

Table 1 shows the extent to which real-time tracking relates to operational efficiency of bakery firms in Rivers State. Pearson correlation coefficient of 0.738 indicates a strong association between the variables. The P-value of the correlation between real-time tracking relates and operational efficiency is 0.000, implying that the relationship between the variables is statistically significant. Thus, we reject the null hypothesis which denies the existence of significant relationship between real-time tracking and operational efficiency.

**Table 2: Analysis of relationship between route optimization and operational efficiency**

Correlations			Route Optimization	Operational Efficiency
Pearson (r)	Route Optimization	Correlation Coefficient	1.000	.857**
		Sig. (2-tailed)	.	.007
		N	20	20
	Operational Efficiency	Correlation Coefficient	.857**	1.000
		Sig. (2-tailed)	.007	.
		N	20	20

\*\*. Correlation is significant at the 0.05 level (2-tailed).

SPSS output, 2025.

Table 2 displays the magnitude and direction of association between route optimization and operational efficiency of bakery firms in Rivers State. The P(r) of 0.857 in the Table indicates a very

strong association between route optimization and operational efficiency of bakery firms in Rivers State. The P-value of the correlation between route optimization and operational efficiency is 0.000, implying that a statistically significant relationship exists between the variables. Thus, we reject the null hypothesis which denies the existence of significant relationship between route optimization and operational efficiency.

### **Discussion of Findings**

This study examined the link between TMS and operational efficiency of bakery firms in Rivers State. The statistical tests conducted in the study showed a strong positive correlation between real-time tracking and operational efficiency, and a very strong positive correlation between route optimization and operational efficiency. These findings support reports in extant literature that TMS as a key determinant of operational efficiency in logistics. Particularly, the findings support the report of Ateke et al. (2025) that logistics optimization enhance operational efficiency of FMCG distributors. The findings also align with the position of Melesse and Orrù (2025) that TMS like real-time tracking reduce spoilage and enhance responsiveness.

TMS firms to proactively address traffic delays, vehicle breakdowns and delivery misrouting. Bhutta and Ahmad (2021) highlight that IoT-based tracking systems help firms monitor route adherence, and improve fleet accountability and reducing product returns due to late deliveries. For bakery firms in Port Harcourt, TMS offer workaround for traditional inefficiencies occasioned by poor infrastructure and traffic congestion.

The current findings also cohere with the report of Seddone (2022) that optimized routing leads to a 30% drop in transport costs and better fleet utilization. Given the perishable nature of baked goods, minimizing transit time is essential. Our findings also support the view of Bazan Flores et al. (2023) and Taquíá Gutiérrez et al. (2023) that optimized routes reduce fuel usage, improve on-time delivery and boost overall productivity. This means route optimization is key to consistency in delivery time and reduced customer complaints. These findings affirm the need for smart logistics tools in perishable goods industries and demonstrate that integrating digital solutions into transportation management is not only strategic but essential for competitive advantage.

### **Conclusion and Recommendations**

In view of the results of the statistical analyses and the foregoing discussions, the study concludes that TMS (real-time tracking and route optimization) significantly enhance operational efficiency in bakery firms in Rivers State. Real-time tracking provides visibility that reduces delivery errors and improves responsiveness, while route optimization reduces delivery costs, fuel usage, and lateness, thus maximizing resource utilization and customer satisfaction. Thus, the study recommends bakery firms in Rivers State that seek to enhance their operational efficiency should adopt:

- a) Real-time tracking tools to monitor fleet movement, detect delays early and communicate with delivery teams in real time. This will help to reduce spoilage and increase delivery reliability.
- b) Algorithmic route planning tools that factor in traffic, fuel efficiency and customer delivery windows to reduce transit time and maximize vehicle utilization.

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