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Order Processing Delay in Logistics: A Review of Quality and Maintenance Approach

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Abstract

Delays in order processing are a serious concern in logistics and affect customer service, operational efficiency, and supply chain performance. This paper systematically investigates order processing delays and examines how quality management and maintenance approaches can be employed to reduce them. The paper is based on a Structured Literature Review (SLR) of peer-reviewed academic articles published between 2020 and 2025. We have organized the causes of delays into operational (e.g. equipment failures, manual inefficiencies, data errors) and regulatory aspects (e.g. transport documentation, and legal requirements) and explored quality management approaches to reduce errors, wastage and ensure consistent quality during order processing (Total Quality Management {TQM}, Six Sigma, Kaizen, ISO 9001, Lean Six Sigma). We also reviewed maintenance approaches, starting from a traditional preventive maintenance approach, to a diagnostic maintenance approach that integrates predictive and prescriptive methods using artificial intelligence (AI) to reduce the chance of unplanned downtimes and improve system reliability. This proposal has developed an integrated conceptual model that uses quality and maintenance interventions to target root causes for delays in the logistics value chain. The dual-intervention model presents a whole-scale solution to improve order-filling performance. The framework is essential to provide original value to logistics research and literature and connecting process and equipment perspectives while also providing practical implications for actionable steps for freight forwarders, third-party logistics (3PL) operations, and logistics managers that intend to build their operations to be a resilient and delay-resistance organization. Future research could include empirically testing it and looking at actual data and a systems thinking perspective.

Introduction

Order processing in logistics refers to the systematic activities involved in confirming, picking, packing, documenting, and handing over customer orders for delivery. Akturk et al. (2022) describe this stage as the e-commerce firm fetching items from its warehouse and preparing them to be picked up or dropped off with the shipping vendor. Timely order

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processing is a critical element to maintain promised delivery timelines, forming a crucial link between sales commitment and actual delivery performance (Mohamed and Coutry 2015). Despite its importance, delays in order processing can occur for various reasons, both factual and legal. Sosedová et al. (2021) state that factual delays may result from the problems with loading, unloading, equipment failure, theft, or damage and legal impediments such as incomplete transport documents, export prohibitions, or statutory limitations on the transport of dangerous goods. The causes of order processing delays are further summarized in Figure 1, which highlights both factual and legal impediments.

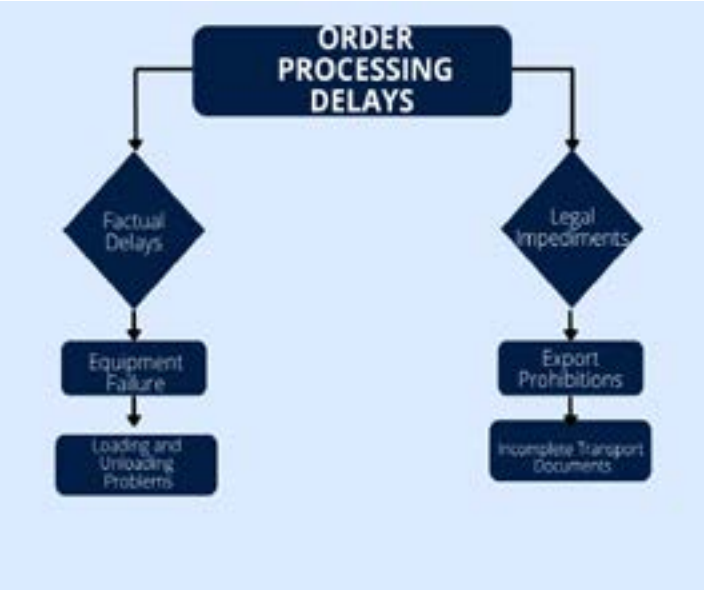

Figure 1. Causes of order processing delays in logistics
Source: Sosedová et al. (2021)

Tukamuhabwa et al. (2023) describe how such delays provide friction to smooth logistics operations and extend the lead time and possibility of meeting the customer's expectations. Order filling delays may be particularly problematic because they directly influence customer satisfaction. The longer the preparation and handover of the product to the courier, the more frustrated the customer is likely to feel, and assign lower ratings to the service. Logistics service quality improvements to faster and more certain order preparation and handover, and the motive of such work, have been linked positively to customer satisfaction (Do et al. 2023). Vakulenko et al. (2024) note how the focus on customer journey can help businesses map how consumers interact and experience their fulfillment journey by touching different touch points, and help them frame the opportunity to understand how and where the processing bottleneck diminishes service quality.
Do et al. (2023) consider in logistics moving and storage is an important manifestation of streamlining efficiencies for materialization of flow and distribution cost mitigation. Valuable as they may be, lost opportunities from slow and error-prone processing affects cost, availability, and seamless movement of merchandise and services (Tukamuhabwa et al. 2023) These challenges motivate a focus on quality and maintenance strategies within order processing systems. Tight management control, quality standards, and preventive maintenance of equipment can reduce documentation delays, avoid errors, and build greater process consistency (Mohamed and Coutry 2015). In turn, these measures support higher customer satisfaction and sustained competitive advantage.

Research Objectives

The objective of this review is to systematically analyze the causes of order processing delays in logistics and evaluate potential solutions through quality and maintenance interventions. Specifically, the study aims:
a) To identify key operational and regulatory causes of order processing delays.
b) To examine the role of quality management approaches (e.g., TQM, Six Sigma, Kaizen) in mitigating delays.
c) To assess the impact of maintenance strategies, including AI-based predictive and prescriptive maintenance, on order fulfilment performance.
d) To develop and validate an integrated framework that links root causes with targeted interventions and outcomes.

Hypotheses

The following hypotheses are formulated based on a preliminary synthesis of existing literature and are intended to guide the structure and conceptual direction of this review. Each hypothesis is further supported by the literature reviewed in subsequent sections.
H1: Operational and regulatory causes significantly contribute to delays in order processing.
H2: Quality management approaches (e.g., TQM, Six Sigma, Kaizen, ISO) effectively address process-related causes of order processing delays.
H3: Maintenance strategies (including preventive, predictive, and AI-based maintenance) effectively mitigate equipment-related causes of delays.
H4: The combined implementation of quality management and maintenance strategies significantly reduces order processing delays and enhances process consistency and customer satisfaction.

Literature Review

Order Processing in Logistics

Order processing represents an important area of logistics management involving everything from when a consumer places an order to when that product is delivered and enacted, and is a key factor determining the success of online businesses

(Nguyen et al. 2018). Order processing is an important function of marketing logistics, which ties together several tasks including demand forecasting, inventory management, warehousing, transportation International, and distribution (Polishchuk et al. 2024). According to James and Inyang (2022) order processing management is the conscious coordination, planning, and execution of an order when it is received, sorted, and supposed to be delivered to consumers in a way that meets their needs satisfactorily. Typically, an order processing system uses the "picker-to-item" process in warehouses where workers manually travel through aisles to collect products for either single or batch orders, which can be a time-consuming and labour-intensive practice (especially if it is a large circumference) (Zhang et al. 2025). However, recent developments, new smart warehousing technologies, like Warehouse Management Systems (WMS), Enterprise Resource Planning (ERP) systems, and the Robot Mobile Fulfillment System (RMFS) have made labor-intensive order processing systems a thing of the past (Zhang et al. 2025). They argue that even small and medium-sized manufacturers can substantially enhance their competitiveness by adopting effective order processing management practices, including order placement, order sorting, and delivery management, along with sound logistics practices such as transportation, inventory, and warehouse management (James and Inyang 2022). The sequence of order processing in logistics can be summarized as shown in Figure 2, which depicts the systematic progression of activities from order initiation to final delivery.

Causes of Order Processing Delays

Delays in order processing in logistics naturally occur from a combination of operational, technological, and human contributors. Inefficiencies, such as outdated or manual picker methods, disconnected pick paths, and no standard operating procedures, created significant delays along the way to on-time order fulfillment (Zhang et al. 2022). Data and information issues, such as wrong product codes, inaccurate inventory numbers, or inconsistent order specifications, lead to unnecessary interruptions in operations where confirming and re-doing the work (Helm et al. 2024). Workforce skills gaps also lead to delays where limited training or inexperienced employees could not navigate the complex orders or had very little knowledge and comfort with digital innovations (Bijmolt et al. 2021). There are issues related to digitalization, absence of digitalization strategies, slow technology adoption also exacerbates these coordination failures and lack of coordination between cross-channel information flows (Polishchuk et al. 2024). Zhang et al. (2025) point out that the picker-to-item model in manual order-picking systems still takes a long time especially in the case of larger or complex orders, which speaks to the importance of process redesign. In summary, the causes discussed above reveal that managing order processing delays is very complex and requires an integrative approach of process standardization, building workforce capabilities, keeping equipment maintained, ensuring good data quality, and encouraging cross-functional teamwork to succeed.

These results clearly indicate that a variety of operational causes (such as manual inefficiencies, labor shortages, equipment failures, and lack of interdepartmental coordination) contribute to delays in order processing. In addition to regulatory or legal impediments, such as incomplete transport documents, export prohibitions, or statutory limitations on the transport of dangerous goods, also contribute significantly to delays, as highlighted by (Sosedová et al.2021), This supports the position that both operational and regulatory causes account for delays in order processing, as proposed in Hypothesis 1 (H1). Understanding the root causes of order processing delays provides the foundation for identifying effective solutions. One area where organizations have actively sought to address these delays is quality management. The next section therefore, explores quality management approaches and their role in improving logistics processes.

Quality Management Approaches

Quality management methods are essential to obtain consistency, reliability, and customer satisfaction through organizational processes. Quality control functions by ensuring that products meet customer requirements by eliminating defects through inspection and statistical techniques such as statistical quality control and statistical process control (Liu et al., 2023). Both of these will help create the basis for the quality management system. Recent studies have noted the development of quality management principles within supply chain management, or Supply Chain Quality Management (SCQM), to improve organizational performance with upstream partners and downstream partners associated with supply chain coordination (Chau et al., 2021). Aligning quality initiatives along the supply chain can provide firms more seamless, competitive positions in the marketplace. Furthermore, it is essential to consider feedback-based interventions; for example, voice-assisted technologies, and timely and frequent and specific feedback reduce order picking errors and improve the fulfillment process as a whole productivity (Zhang et al., 2022). This demonstrates the importance of continuous feedback and subsequent worker learning as an important component of maintaining quality standards, together, these factors show a unique way of understanding how a quality management approach supports operations to be error-free, efficient, and customer-centric. Collectively, these quality management approaches demonstrate their potential to streamline processes, reduce operational inefficiencies, and enhance order fulfillment reliability in logistics systems. These insights support **Hypothesis 2 (H2)**, which posits that quality management approaches can effectively address process-related causes of order processing delays. A comparative overview of these quality management approaches is presented in Table 2.1

Approach	Principles	Benefits	Limitations
Total Quality Management (TQM)	Organization-wide continuous improvement involving all employees (Owusu-Kyei et al., 2023)	Enhances quality culture, reduces order errors, improves supplier relations and customer satisfaction (Marjan et al., 2022)	Requires strong leadership commitment and cultural change
Six Sigma	Data-driven, statistical defect reduction through DMAIC framework (Adeodu et al., 2023)	Reduces variation, improves process cycle efficiency, decreases non-value-added time (Adeodu et al., 2023)	Resource-intensive; requires trained experts
ISO 9001	Standardized quality management systems and documentation (Rogala & Wawak, 2021)	Ensures consistency, recognized internationally, strengthens customer trust (Owusu-Kyei et al., 2023)	Can become bureaucratic if poorly implemented
Kaizen	Incremental continuous improvement with employee participation (Syaputra & Aisyah, 2022)	Low-cost, sustained improvements, high employee engagement, fosters problem-solving (Syaputra & Aisyah, 2022)	May be slow to show large impacts
Lean Six Sigma	Integration of waste reduction (Lean) with defect reduction (Six Sigma) (Adeodu et al., 2023)	Improves speed and quality; removes waste	Complex to sustain without ongoing training

Table 2.1: Comparison of Quality Management Approaches in Logistics
Source: Author's own

Maintenance Approach

As stated above, quality management approaches such as TQM, Six Sigma, ISO Standards, and Kaizen are systematic, engaging people and involving data/data-driven approaches to reduce errors and waste throughout a logistics process. These strategies will deliver products and services to customers with minimum variability and waste. However, equally important is the operational and physical readiness of the systems within which the processes operate. A maintenance strategy, therefore, becomes a complementary pillar to quality strategies, providing stability and reliability for a production and logistics system to operate with minimal disruption. The following section will examine how maintenance strategies, moving from reactive to predictive and prescriptive strategies, interact with quality management strategies to further reduce order processing time and improve supply chain responsiveness.

Maintenance strategies play a key role in decreasing order processing delays within logistics and manufacturing systems. Historically, reactive maintenance (run-to-fail) responded to faults only when breakdowns actually occurred (by that time it was too late), which caused delays due to unpredictable downtime, emergency repairs, and seriously disrupted schedules; all of which delayed order fulfilment and compromised customer satisfaction (Celestin 2023; Sala et al. 2025). As manufacturing systems became more complex, preventive maintenance evolved, where maintenance interventions were decided based on time intervals to help prevent failures and ensure steady production; yet poorly timed preventive activities may still cause unnecessary downtimes and interrupt order flows (Çınar et al. 2020).

Condition-based maintenance (CBM) allowed organizations to gain an edge over preventive maintenance by monitoring the condition of an asset in real time, to discover deterioration and only conduct maintenance when required. This allowed for more focused interventions and mitigated production halts, notwithstanding the scheduling of interventions remains unpredictable and disrupts an organization's order consistency (Sala et al. 2025). Predictive maintenance has become possible through the use of Industry 4.0 technologies (IOT, big data, machine learning), and has reshaped existing knowledge of maintenance practices. Using predictive algorithms, we can forecast failures before they occur to avoid unexpected breakdowns, stabilize throughput, and reduce bottlenecks in production and delivery; sounding familiar across related research and being an important driver for better order processing (Dalzochio et al. 2020). According to Dalzochio et al. (2020), predictive maintenance enhances productivity, reduces system failures, and fosters resource efficiency through the development of self-aware cyber-physical systems, although barriers to data quality, real-time assessment, and adaptive algorithms have not yet been overcome. Prescriptive maintenance builds on these predictive elements by recommending exact, inexpensive maintenance activities to enhance equipment availability and limit interruptions within an order process (Sala et al. 2025). Moreover, A.I.-based aintenance logistics, such as autonomous inspection robots and smart scheduling "tools" may further assist in reducing disturbances in intricate environments (Ukato et al. 2024). Altogether, modern data-driven maintenance strategies, from preventative to predictive and prescriptive, are significant in reducing equipment-related disruption in order processing and delivering levels of high service in logistics and manufacturing activities. This evidence reinforces that maintenance strategies—especially predictive and AI-based strategies—are a vital step in helping mitigate equipment-related disruptions in a process that is often out of time with the production order processing. By contributing to more consistent and reliable operation through the reduction of unplanned downtimes, maintenance strategies assist in the more predictable and timelier the fulfil potential to fulfill an order. The literature reviewed here supports Hypothesis 3 (H3) which states that maintenance strategies can help mitigates delays in order processing as causes of equipment-related issues.

Research Gap

Based on the above literature review, an integrative understanding emerges that highlights how both quality management approaches and maintenance strategies can jointly address the multiple causes of order processing delays. The proposed framework presents a new combined quality improvement and maintenance interventions framework to reduce order processing delays, which are poorly dealt with in the consolidated models of the academic literature. The framework targets both the dual-theory of delays (operational (factual) and regulatory (legal) setbacks), and links various interventions including de facto quality management (TQM, Six Sigma, Kaizen, ISO) with sophisticated maintenance strategies (preventive/predictive/prescriptive/AI interventions) in a combined disciplines vehicle. The dual-intervention model offers the opportunity to understand interventions for inefficiencies in processes, in addition to the reliable operation of equipment, system uptime, and coordination across intra and inter-organizational functions. To our knowledge, there exists no study that provides a unified framework to systematically link the root causes of both fact and legal delays with quality management practices and intelligent maintenance practices. For this reason, this framework demonstrates original contributions to the literature. It informs freight forwarders, 3PL's and logistics organizations of a practical and scalable framework. While it is not intended to be fully prescriptive (at this stage) to improve order processing performance in logistics and supply chain practices, it does seek to inform practitioners and urge academics to consider further research that brings together systems dynamics and complexity theory in real-world situations of logistics and supply chain operations.

Thus, the integrated framework developed in this study aligns with Hypothesis 4 (H4), which proposes that the combined implementation of quality management and maintenance strategies significantly reduces order processing delays and enhances process consistency and customer satisfaction. By addressing both process inefficiencies and equipment reliability in a unified manner, the framework contributes a comprehensive model for managing order delays in logistics systems.

Research methodology

Research design

The research used a Structured Literature Review (SLR) methodology to comprehensively understand the reasons for order-processing delays in logistics and to assess the potential of quality management and maintenance strategies to reduce delays. SLR (Structured Literature Review) methodology ensures that synthesis of existing knowledge, an identification of conceptual gaps and a basis for developing a comprehensive framework for improving logistics performance is transparent, replicable and objective.

Initial literature scanning

The research began with an exploratory review of the literature to ascertain themes that recurred in the contexts of logistics delays, order fulfilment inefficiencies, quality

management practice, and maintenance strategy. The aim of the initial scanning was to narrow the focus of the review, define research aims and objectives, and research hypotheses, and how to structure thematic areas for review.

Literature Search Strategy

A detailed and recurring search strategy was used through peer-reviewed academic databases. Boolean operators (AND/OR) and word variations were used to capture relevant literature. The search was restricted to publications between 2020 and 2025 which discussed order processing delays, quality management procedures, maintenance, and improvements to supply chain processes.

Inclusion and Exclusion Criteria

The following criteria were used to ensure the quality and relevance of the review:

Inclusion:

. Peer-reviewed journal articles
. Published between 2020 and 2025
. Written in English
. Focused on logistics, order processing delays, quality management, maintenance, or supply chain optimization

Exclusion:

. Non-academic sources or trade magazines
. Conference abstracts without full-text availability
. Articles unrelated to logistics or order processing delays

Article Screening and Selection

The article screening process was conducted in three stages: (1) title screening, (2) abstract screening, and (3) full-text review. Duplicate and irrelevant articles were systematically removed. Only those studies that directly aligned with the research objectives and hypotheses were retained for further analysis.

Thematic Coding and Analysis

The selected articles were categorized into four key thematic areas:
. Causes of order processing delays
. Quality management approaches
. Maintenance strategies
. Integrated models and frameworks

Thematic analysis was used to identify the patterns and characteristics that developed across all domains. The analysis highlighted the logical connections between the causes of delays when processing orders, the interventions taken (maintenance and quality strategies) and those operational outcomes. These synthesized insights initiated the hypotheses we developed and the conceptual framework that was created.

Results and Discussion

The review of literature revealed a multidimensional set of factors contributing to delays in logistics order processing. Among the most frequently reported causes, operational inefficiencies such as manual picker-to-item systems, poor data quality, inadequate employee training, and equipment breakdowns emerged as central concerns (Polishchuk et al., 2024). These factual causes are compounded by regulatory and legal impediments including incomplete transport documents and statutory export restrictions, as highlighted by Sosedová et al. (2021), making the dual nature of delays—both operational and legal—a critical focus of analysis. In response to these issues, various quality management approaches were extensively studied for their mitigating impact. Total Quality Management (TQM), Six Sigma, ISO 9001 and Kaizen were the most widely used frameworks used in the studies, offering a variety of tools that can positively impact process consistency, variation, and customer satisfaction (Adeodu et al., 2023). In addition to quality approaches, we have seen an increased focus on maintenance approaches in the recent research. Zero in on the current move towards Artificial Intelligence based predictive and prescriptive maintenance systems away from reactive and preventive models. Predictive and prescriptive systems are major improvements in reducing equipment interruptions and increased uptime (Dalzochio et al., 2020; Sala et al., 2025). However, the literature also reflects a gap in integrated applications of these approaches; few studies address an integrated framework combining quality and maintenance strategies to address order processing delays.
To address this specific gap, the current study proposes an integrated framework that brings together quality management systems such as TQM, Six-Sigma, Kaizen, ISO, etc. and advanced maintenance strategies such as preventive, predictive, and artificial intelligence-based maintenance strategies. By mapping these interventions against operational and regulatory causes of order delays, the framework provides a structured approach to enhance consistency of processes, reduce breakdown-related interruptions, and improve order fulfillment performance. Overall, this unified model not only directly addresses the fragmented consideration of quality and maintenance in the existing literature, but also provides a generic solution for

logistics organizations to initiate reduced order processing delays and address supply chain performance.

A thematic word cloud created from 527 peer-reviewed articles (2020-2025) using Biblioshiny in R retrieved through a focused Boolean search in Scopus—TITLE-ABS-KEY("order processing" OR "order fulfillment" OR "order delay*" OR "order cycle time") AND TITLE-ABS-KEY(logistics) AND TITLE-ABS-KEY("quality management" OR "process maintenance" OR "reliability" OR "preventive maintenance" OR "total productive maintenance")—illustrated the appearance of "supply chain management," "decision making," "machine learning," and "optimization" as some of the most frequently appearing words (Figure 5). This highlights the emphasis on data-driven, resilient, and efficiency-seeking alternatives to managing logistics-related delays within the literature

Figure 2. Word cloud of frequently occurring terms in 527 Scopus articles (2020–2025) related to logistics delays, quality management, and maintenance strategies.

The thematic word cloud, derived from 527 peer-reviewed articles (2020–2025), visually reinforces the multidimensional focus of the existing literature on logistics-related delays. The prominence of terms such as **"supply chain management," "decision making," "optimization," "machine learning,"** and **"sustainability"** highlights a growing academic and practical interest in **data-driven, AI-integrated, and efficiency-oriented strategies**. These frequently occurring terms signal the field's increasing shift from traditional manual operations toward intelligent and automated solutions.

Conclusion and Implications

The study examined the ongoing problem of order processing. The study introduced a dual-intervention framework based on quality management and maintenance practices to tackle the root causes. It conducted a review of peer-reviewed literature published between the years 2020 and 2025. The study represents the multi-dimensionality of delays from two perspectives, operational and regulatory delays. These findings confirm hypothesis 1 (H1), which shows that delays in order processing are a factor of internal and external influences. The study established the utility of some quality management ideas or quality management tools to reduce inefficiencies in order processing. There was support for quality management approaches including Total Quality Management (TQM), Six Sigma, Kaizen, ISO 9001 and Lean Six Sigma. Qualitative approaches serve to provide systematic ways to reduce variability in processing, errors, and ultimately increase customer value and customer satisfaction. Hypothesis 2 (H2) was supported for quality management approaches to enhancing order processing. The study also draws attention to the importance of maintenance practices to reduce delays now and for the future. Many new technologies are being deployed under Industry 4.0 including artificial intelligence, predictive and prescriptive maintenance, and can reduce delays caused by equipment-related outages. Hypothesis 3 (H3) is supported in that new technologies can reduce failures connected to delays in order processing.

The main contribution of this research includes a new integrated dual-intervention model for the first time that simultaneously deals with process and equipment challenges. The integrated framework links quality improvement and intelligent maintenance approaches to identify and offer a holistic solution to enhance order processing performance at scale. The integrated approach strongly relates to Hypothesis 4 (H4), which proposes that implementing combination of quality and maintenance strategies offers significant and reliable performance improvements regarding process consistency and customer satisfaction. This study provides major insights relevant to logistics and inventory management professionals, outsourced third-party logistics (3PL) providers, and broader supply chain strategists such as Integrated strategy, Workforce Development and Investment in technology that offers a higher level of control over disruptions. By adopting the dual-intervention model and implementing an approach to solving process delays on returns, order processing speed will improve, while also enabling resilient and customer-focused delivery. From a theoretical standpoint, this research contributes a novel

perspective by bridging two often separately treated areas in logistics literature—quality management and maintenance strategies. While previous studies have focused on one dimension or the other, this paper demonstrates the need for an integrated approach to address the complex nature of order processing delays. The dual-intervention model thus extends current theoretical models and invites further interdisciplinary discussion within logistics and operations management research.

Future Research Directions and Limitations

This study is based on a structured literature review of secondary data and is the conceptual output of the study. There was no empirical validation of the framework, the review was limited to the available literature published from the period of 2020 to 2025, and the model as presented is intended to be representative of the logistics industry generally may require adaptation for specific areas of logistics such as healthcare, cold chain, and defense logistics. There are a number of pathways for future researchers to take to empirically validate the dual-intervention model informed through the use of cases, simulations, and/or surveys. The interplay of quickly-evolving digital technologies (IoT, blockchain, digital twins, etc.) may all be worth exploring in relation to the proposed framework. Longitudinal studies could offer important insights into how different organizations who have indeed implemented quantitative quality and maintenance systems as an integrated whole influence longer-term logistics performance and customer loyalty.

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