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A conceptual framework for integrating Robotic Process Automation in logistics audits and supply chain management

Un cadre conceptuel pour l'intégration de l'automatisation des processus robotisés dans les audits logistiques et la gestion de la chaîne d'approvisionnement

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Abstract:

Digital transformation has become a central theme in logistics auditing, especially with the increasing importance of digital technology in the organizational and societal environments. This study is based on an integrative literature review to propose a conceptual framework for integrating Robotic Process Automation (RPA) into logistics audits, aiming to enhance operational efficiency, accuracy, and strategic decision-making. The framework is structured around five stages: Requirements Analysis, Performance Analysis, Process Analysis, Structural Analysis, and Comparative Analysis. Each step of the conceptual framework is inspired by traditional audit methodologies, such as needs analysis, performance analysis, process analysis, structural analysis, and benchmarking. It leverages the capabilities of RPA to automate repetitive tasks, enhance data integrity, and instantly provide real-time process analyses on an annual basis. The findings highlight that RPA significantly enhances resilience and transparency in the supply chain by automating tasks related to invoice verification, shipment tracking, and compliance monitoring. However, organizational readiness and technological infrastructure could affect the applicability of the framework. The degree of difficulty in RPA amplitude integration with existing systems also contributes to the limitations placed on the framework's adoption. All of these reservations indicate the continued need for empirical studies to put the framework through its paces in various organizational contexts. From the viewpoint of practical contributions, the study provides actionable guidelines for organizations to implement RPA in logistics audits, emphasizing the importance of stakeholder alignment, continuous monitoring, and benchmarking against industry standards. The theoretical contribution lies in bridging the gap between RPA and auditing practices, offering a structured approach that combines traditional auditing methods with cutting-edge automation technologies.

Keywords: Audits, RPA, logistics.
Classification JEL: M15, L23, O33
Paper type: Theoretical Research

Résumé :

La transformation numérique est devenue un thème central dans l'audit logistique, notamment en raison de l'importance croissante des technologies numériques dans les environnements organisationnels et sociétaux. Cette étude s'appuie sur une revue intégrative de la littérature afin de proposer un cadre conceptuel pour l'intégration de l'automatisation robotisée des processus (RPA) dans les audits logistiques, dans le but d'améliorer l'efficacité opérationnelle, la précision et la prise de décision stratégique. Le cadre est structuré autour de cinq étapes : analyse des besoins, analyse des performances, analyse des processus, analyse structurelle et analyse comparative. Le cadre conceptuel s'appuie sur des méthodes d'audit traditionnelles, incluant l'évaluation des besoins, l'analyse des performances, l'étude des processus, l'examen structurel et l'analyse comparative. Elle exploite les capacités de la RPA pour automatiser les tâches répétitives, renforcer l'intégrité des données et fournir instantanément des analyses de processus en temps réel sur une base annuelle. Les résultats mettent en évidence que la RPA améliore considérablement la résilience et la transparence de la chaîne d'approvisionnement en automatisant des tâches telles que la vérification des factures, le suivi des expéditions et la surveillance de la conformité. Toutefois, la préparation organisationnelle et l'infrastructure technologique peuvent influencer l'applicabilité du cadre proposé. Le degré de difficulté de l'intégration de la RPA avec les systèmes existants contribue également aux limitations de l'adoption du cadre. Toutes ces réserves soulignent la nécessité continue d'études empiriques pour tester le cadre dans divers contextes organisationnels. Du point de vue des contributions pratiques, l'étude fournit des lignes directrices concrètes pour la mise en œuvre de la RPA dans les audits logistiques, en mettant l'accent sur l'alignement des parties prenantes, la surveillance continue et la comparaison avec les normes industrielles. La contribution théorique réside dans le rapprochement entre la RPA et les pratiques d'audit, en offrant une approche structurée qui combine les méthodes d'audit traditionnelles avec des technologies d'automatisation de pointe.

Mots clés : Audit, RPA, Logistique.
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1. Introduction

The COVID-19 pandemic has, thereby, exposed the vulnerabilities of traditional operational models and indicated the urgency of tighter integration of logistics with supply chain management (Ivanov, 2020). In this context, logistics audits offer a practical approach to identify inefficiencies and strengthen overall resilience (Queiroz et al., 2022). Such audits will allow companies to weigh critical performance areas and realign their operations to maintain a competitive edge in a volatile market. Building on these insights, the concept of Logistics 4.0 emerges as a natural extension of Industry 4.0. It integrates Artificial Intelligence (AI) applications, such as Robotic Process Automation (RPA), machine learning algorithms, and natural language processing, into logistics operations to enhance efficiency, transparency, and responsiveness (Tjahjono et al., 2017). While streamlining processes, the digital transformation also creates new challenges for auditors in terms of changing audit methodologies to examine interlinked systems in terms of their reliability and security, assessing data-driven decision-making, and compliance with new regulations. At the same time, however, Logistics 4.0 offers auditors advanced tools, such as real-time monitoring and predictive analytics, which they can leverage to conduct a much more comprehensive risk assessment and verify the entire system's integrity (Baryannis et al., 2019). Thus in modern audits, logistics audits will be increasingly important for assuring all stakeholders and thus ensuring competitive advantage in a rapidly digitized market.

RPA is emerging as a critical tool for enhancing efficiency and accuracy within auditing. Traditional manual auditing methods cannot compete with the rapidly increasing levels of complexity encountered in global supply chains, facing issues including time constraints and human error (Labsi et al. 2024). It is within these limitations that RPA seeks to intervene by automating repetitive auditing tasks, thereby increasing workflow efficiency and data accuracy. By employing software bots along with RPA, organizations can perform compliance checks continuously using data, flag anomalies, and maintaining higher assurance over regulatory compliance (Aalst et al., 2018). Furthermore, automation creates an opportunity for auditors to focus their attention on more strategic and analytical activities, thus driving innovation and agility within organizations. The adoption of RPA not only reduces operational risks but also drives cost savings and improve supply chain performance, positioning it as a crucial element in the future of logistics audits.

The rapid evolution of logistics systems driven by Industry 4.0 has introduced complexity and vast amounts of data, posing challenges for traditional audit methods. While technologies like AI and blockchain have already been explored in logistics audits, the integration of RPA remains a less-documented field, offering an opportunity to provide innovative perspectives.

This paper aims to propose a conceptual framework for integrating RPA into logistics audits, highlighting its potential to enhance efficiency, accuracy, and strategic value in supply chain management. The remainder of this paper is structured as follows: Section 2 provides an integrative literature review, highlighting research gaps and underscoring the originality of this study's contributions. Section 3 outlines the proposed conceptual framework. Explores the practical implications and theoretical contributions of integrating RPA into logistics audits. Finally, Section 6 concludes the paper by summarizing key insights, addressing limitations, and suggesting directions for future research.

2. Background and literature review

Logistics auditing plays a vital role in evaluating and enhancing supply chain efficiency, transportation systems, inventory management, and distribution processes. However, traditional logistics audits have been confined to manual methods and standard tools to assess compliance, operational efficiency, and performance. The emergence of Industry 4.0 has revolutionized all of those practices through advanced technologies such as the internet of things (IoT), blockchain, and big data analytics (Xu et al., 2018; Jackson et al., 2024). A review of literature will first cover traditional methods and tools for logistics auditing and would move onward to how digitalization has transformed those practices.

2.1. Traditional logistics audit methods

Often, traditional logistics audits involve an elaborate approach which may be an inventory audit, a transportation audit, or a distribution process audit. These methods often use checklists and interviews with personnel, document review, and physical inspection. To take inventory, for instance, an inventory audit would require physically counting materials in warehouses, not just relying on system counts. Traditional logistics audit methods, such as manual inventory checks and document reviews, are labor-intensive and prone to human error, with studies indicating error rates of 15–20% in complex systems (Müller et al., 2019).
These limitations have driven the need for digital transformation in logistics audits. Traditional methods include inventory management software (e.g., SAP ERP), spreadsheets, and fleet management systems (FMS), but often, ERP systems are not compatible with third-party platforms, leading to a compromise in data quality and integrity (Al-Assaf et al., 2024). Secondly, spreadsheets have become susceptible to error, with 88% of complex files containing errors (Karim et al., 2023). Such limitations are often found in transportation audits through route assessments or delivery time assessments: they are based on historical data and are also reactive in their approach (Mentzer & Konrad, 1991). Generally, interoperability issues and data silos restrict such systems from integration.

2.2. Digitalized logistics audit methods in Industry 4.0

The comprehensive digital transformation of logistics auditing under Industry 4.0 has made possible near real-time monitoring, predictive analysis, and better transparency using some emerging technologies. The IoT connects all these systems, allowing real-time data collection from sensors embedded in the warehouse, vehicles, and packages. According to (Zrelli and Rejeb, 2024), in some instances, these IoT sensors lead to astonishing reductions in inventory discrepancies. For instance, these sensors can monitor conditions within the warehouse such as temperature and humidity, as well as good location during transportation. According to (Xu et al., 2018), due to the constant vigilance, any abnormality can, therefore, be instantly captured, ultimately reducing the chance of loss or detriment. This transformation gives rise to audit automation by providing accurate and current data that limits and minimizes the possibility of a manual verification.
Artificial intelligence (AI), particularly machine learning, is another key technology for digitalizing logistics auditing. AI algorithms can analyze vast datasets, trying to identify complex patterns and risks. Considering stock out predictions as a possible application, stock out can be predicted based on demand trends and lead times on supply sources. These predictive alternatives, as per (Kogan et al., 2017), empower organizations to take proactive rather than reactive actions, which ensures that downstream positive influences happen on supply chain efficiencies. In this way, he can optimize transportation routing for many effects, including traffic, weather conditions, and fuel costs. Real-time adjustments minimize delivery times and logistics costs. Recent studies highlight AI's potential in enhancing demand forecasting and optimizing warehouse operations (Burstein and Zuckerman, 2023; Ding 2022).
Machine learning (ML) has emerged as a transformative technology in supply chain management, offering innovative solutions to enhance efficiency, transparency, and resilience. It derives risks, predicts future disruptions, and ensures compliance through machine learning in supply chain audits. Risk detection and prediction through ML models are one major

application in supply chain audits. ML models, such as decision trees (Liang, 2025), can analyze large datasets to identify key factors causing risks and predict potential disruptions. For instance, decision tree models have been successfully used to detect fraudulent orders and predict late deliveries, offering clear insights into supply chain performance (Liang, 2025). ML, thus, blockchain applications can greatly improve their collaboration with ML in tracing and transparency applications in supply chains. With a predictive algorithm developed through ML, auditors are capable of pinpointing risks that have not yet materialized. Neural networks and random forests are some of the models that have been recently applied to assess risk levels in supply chains; the degree to which subjectivity to human assessments can be reduced is now possible through much objective evaluations (Rezki and Mansouri, 2023; Burstein & Zuckerman, 2023).

ML can streamline audit processes by automating data analysis and reducing the need for manual interventions. In this regard, deep learning models such as GWO-LSTM have been proposed by (Jing & Chen, 2024) to predict audit opinions for supply chain finance and to improve prediction accuracy and audit efficiency in the analysis of data in the audit. These models can be used to identify anomalies in the auditing process and also detect fraud, thus making audits more thorough and reliable. The integration of ML with blockchain technology may serve to enhance security and transparency of the supply chain audit. The decentralized and immutable nature coupled with the prediction capabilities of ML could, therefore, yield a highly secure and auditable system of supply chain authentication (Allahham et al., 2024). The synergy of ML and IoT can facilitate real-time data processing and analysis for auditors and supply chain managers alike through tangible insights. Data is collected through the IoT devices from different points all along the supply chain, and then this data is analyzed, using ML models to predict risks and optimize operations (Thejasree et al., 2023).

Blockchain technology provides further modifications to the ordering of the logistic audit, maximizing transparent actions and data integrity. The blockchain is capable of capturing each step taken in the logistics process from production through to delivery, thereby creating an immutable and verifiable trail. According to (Dai & Vasarhelyi, 2017), this traceability is important for audit compliance, allowing for rapid verification of product origin and adherence to regulations. Moreover, the blockchain fosters collaborative approach of different stakeholders in the supply chain through the availability of a common and secure platform for data sharing. All transactions in a blockchain-based supply chain, so far, remain auditable by design. The improved traceability given to the system by blockchain is beneficial to industries that are affected by product and raw material provenance.

The role of RPA in logistics audits has strategic and managerial implications that have been given less consideration. Digital logistics audit tools broadly cover data analytics platforms, real-time monitoring systems, and blockchain solutions. Data analytics platforms include Tableau and Power BI for advanced visualizations and for interactive dashboards and collaboration of supply chain stakeholders (Few, 2012). Through IoT and AI technologies, the real-time monitoring systems track the events of logistics operations, recognize the anomalies, and interact with inventory and transport management (Xu et al., 2018). Blockchain solutions make a secure record, with compliance audit processes and enhanced collaboration between stakeholders, thus increasing supply chain transparency (Dai & Vasarhelyi, 2017). Researchers have widely studied the integration of IoT, AI, and blockchain into logistics audits, outlining their potential to improve efficiency, transparency, and decision-making (Xu et al., 2018). However, the RPA role for logistics audit remains unattended, given its strategic and managerial implications.

Table 1 summarizes key Digital techniques used in supply chain audits and their specific applications. These techniques provide a foundation for the integration of RPA and other advanced technologies into logistics audits, enabling organizations to enhance efficiency, transparency, and decision-making.

Table 1 : Digital techniques used in supply chain audits

References	Technique	Application in audits
(Apte & Petrovsky, 2016)	Blockchain	Authentication and validation of supply chain information auditing process
(Casey & Wong, 2017)	Blockchain	End-to-end traceability and the encrypted inclusion of human beings to the supply chain audit
(Suleyman & Laurie, 2017)	Blockchain	Creating robust audit trails
(Kshetri, 2018)	Blockchain	Fraud prevention and secure record-keeping in logistics
(Wang et al., 2019)	Blockchain	Automating compliance checks and reducing audit costs
(Krakau & Kaupe, 2021)	RPA	Automating repetitive, rule-based tasks in logistics audits
(Rezki & Mansouri, 2023) (Burstein & Zuckerman, 2023)	Neural Networks	Risk level prediction and objective assessment
(Jing & Chen, 2024)	GWO-LSTM Model	Audit opinion prediction
(Allahham et al., 2024)	Blockchain	Secure authentication and decision-making
(Jin, 2024)	Random Forest, Gradient Boosting Machine	Risk prediction and assessment
(Liang, 2025)	Decision Trees	Risk detection and prediction
(Shamsuzzoha & Pelkonen, 2025)	RPA	Optimize order-handling processes, including automating audit processes related to logistics order management.

Source: Table created by the author based on the references listed in the first column.

2.3. Robotic Process Automation (RPA) in Logistics Audits

The integration of RPA into logistics audits offers transformative potential by automating routine tasks such as invoice verification, shipment tracking, and performance evaluation. According to (Aalst et al., 2018), RPA can automate up to 70% of repetitive tasks in auditing, significantly reducing human error and operational costs. Similarly, Syed et al. (Syed et al., 2020) note that RPA adoption in logistics audits improves compliance checks and enhances data accuracy by streamlining data entry and validation processes. Integrating RPA along with IoT and AI in logistics makes it possible to automate every aspect of data input, anomaly detection in real time, and predictive analytics for a completely integrated audit system. IoT sensors can provide data on the location of shipments at any time, which RPA bots can analyze to provide information to flag potential delays or discrepancies, while AI algorithms can predict unforeseen risks based on historical patterns (Tiron et al., 2024; Ivanov & Dolgui, 2022; Huang, 2019). Nevertheless, RPA requires intensive adoption under certain challenges including compatibility issues within the systems, data privacy concerns, and the issue of resistance to change in an organization (Patricio et al., 2025). Through the case studies and practical examples, this paper identifies the key success factors and implementation principles to be followed during RPA adoption. Deloitte (2019) reports that organizations that deploy RPA for logistics audit have cut the invoice processing time by 50% by putting in place the bots and improving accuracy by 30%. Similarly, Accenture (Accenture, 2020) indicates that bots are capable of automating shipment tracking, which contributes to cost savings by 20% on delivery delays and 15% on customer satisfaction. It also talks about the evolving role of auditors in an automated environment, where auditors will need to possess technical competencies such as making sense of automated outputs and realizing analytics for strategic recommendations. This

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shift in audit practices as a result of the changing technology places emphasis on upskilling programs that would prepare the auditor for a digital world in future (Solanki, 2024; Mookerjee & Rao, 2021).

2.4. Methods for analyzing logistics system audits

In logistics audits, two primary research methods have been traditionally employed: qualitative and quantitative. Qualitative methods focus on understanding the context, perceptions, and strategic considerations of logistics operations. This approach typically involves techniques such as in-depth interviews, case studies, focus groups, and document analysis. Qualitative methodologies are primarily intended for an understanding of context, perceptions and strategic considerations typical of logistics operations. These are in-depth interviews, case studies, focus group discussions, and document analysis, among others. Qualitative assessments by (Christopher, 2016) in identifying the gaps between operational practice and the strategic objectives may be cited as one example. A case study by (Mentzer et al., 2001) was conducted through in-depth interviews with supply chain managers to pinpoint inefficiencies in inventory management to provide actionable advice for process improvement. However, qualitative methods are often criticized for their subjectivity and the time required to collect and analyze data. In contrast, quantitative methods rely on numerical data to evaluate logistics performance. These methods involve the collection and analysis of key performance indicators (KPIs) such as error frequencies, process costs, inventory levels, and time metrics. Rushton et al. (Rushton et al., 2022) illustrate how statistical analyses and benchmarking practices provide objective measures of operational efficiency and productivity. For instance, regression analysis is frequently used to look into relationships between logistical performance metrics like customer satisfaction and delivery time. Such quantitative data not only allows auditors to discover improvement trends over time but also establishes a benchmark comparison with industry standards. Tools like Excel, SPSS, and Tableau are used very often to aid and facilitate quantitative analysis.

In recent years, mixed methods have gained popularity in logistics audits, combining the depth of qualitative insights with the rigor of quantitative data. For example, the study by (Queiroz et al., 2023) used surveys (quantitative) and follow-up interviews (qualitative) to assess the impact of digital transformation on supply chain resilience. This approach allows researchers to triangulate findings, providing a more comprehensive understanding of logistical challenges and opportunities. With the advent of RPA and AI, quantitative methods are increasingly automated, enabling real-time data collection and analysis. For example, RPA bots can extract and analyze large datasets from ERP systems, reducing the need for manual data entry and improving audit accuracy (Aalst et al., 2018). Similarly, AI algorithms can process unstructured data from qualitative sources, such as interview transcripts, to identify patterns and trends that would be difficult to detect manually. These methods provide a basis for analysis in logistics systems; however, new ways are needed to integrate RPA and other digital technologies. A conceptual framework is to be proposed in this study for this purpose.

2.5. Research Gaps and Contributions

Despite the growing body of research on digital transformation in logistics audits, several gaps remain unaddressed. First, while technologies such as IoT, AI, and blockchain have been extensively studied, the integration of RPA into logistics audits remains underexplored. The existing literature tends to focus almost exclusively on the technical aspects of RPA; little attention is directed to its strategic and managerial implications in the context of logistics audits (Aalst et al., 2018; Syed et al., 2020). Second, there is a lack of comprehensive frameworks that guide organizations in analyzing the transformational impacts of RPA at the managerial level. Most studies tend to focus on RPA in isolation, treating it as a separate entity rather than considering it as an integral part of a broader digital ecosystem (Ivanov & Dolgui, 2022). Third, while the benefits of RPA are widely acknowledged, there is limited empirical evidence on its challenges, such as system compatibility, data privacy concerns, and organizational resistance to change (Patricio et al., 2025).

This paper addresses these gaps by proposing a conceptual framework for the integrating of RPA in the conduct of logistics audits. Unlike current approaches that often take a fragmented view, our framework offers a structured five-stage process that integrates the operational advantages of RPA with strategic insights. Through case studies and practical examples, we highlight the key success factors and implementation principles for adopting RPA, providing actionable insights for both researchers and practitioners. Moreover, our study adds to the literature by highlighting the importance of upskilling programs to equip auditors for a digitally-driven future (Solanki, 2024; Mookerjee & Rao, 2021). In doing so, we offer a comprehensive approach that bridges the gap between theory and practice.

Building upon the findings from this literature review, the next section presents a conceptual framework for RPA integration in logistics audit. The framework is structured around five sequential stages, each enriched by RPA capabilities to ensure a holistic and data driven audit process.

3. Proposed framework

In modern logistics audit practices, incorporating RPA into a mixed-method framework has the potential to transform the way audits are performed. In addition to technical automation, RPA changes the role of the auditor, brings about organizational changes, and necessitates the acquisition of novel competencies to guarantee effective human-machine cooperation. This comprehensive approach combines quantitative performance metrics with qualitative insights, utilizing RPA to automate repetitive tasks, improve efficiency, and enhance accuracy. The proposed framework is organized into five sequential stages, each bolstered by RPA capabilities to ensure a thorough and data-driven audit process. Figure 1 illustrates the structure of the proposed framework.

This framework is based on well-established theories and recent empirical studies that demonstrate the transformative potential of RPA in auditing and supply chain management. Ivancic et al. (Ivancic et al., 2019) highlight the importance of aligning logistics activities with strategic goals and monitoring operational performance through KPIs. In a similar vein, Agostinelli et al. (2021) emphasize the role of RPA in process optimization, particularly in warehouse management. Furthermore, Klingeberg et al. (2020) underscore the value of RPA-driven data extraction and analysis in achieving operational excellence. Building on these foundations, the proposed framework offers a structured approach to integrating RPA into logistics audits, providing a solid foundation for empirical analysis and practical implementation. The following section explores each stage in detail.

3.1. Stage 1: Requirements analysis

The first stage guides auditors to assess whether logistics activities align with long-term strategic goals. This stage utilizes traditional methods such as stakeholder surveys and management interviews, enhanced by RPA's ability to automatically collect data and generate real-time reports. These automated insights allow auditors to monitor key areas continuously, including adherence to quality standards, stakeholder needs, financial balance, and the feasibility of transitioning to an optimized state (Ivancic et al., 2019). RPA contributes by automating data collection and reporting, enabling real-time insights that support strategic alignment and informed decision-making.

Additionally, at this stage, auditors' roles are redefined from manual data collectors to strategic advisors. Since RPA gathers data automatically, auditors need to hone their critical thinking

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and scenario analysis abilities in order to identify insights and match them with more general organisational objectives. Internal workflows within audit teams may change as a result of this modifications, which calls for updated training.

3.2. Stage 2: Performance analysis

The second stage directs auditors to focus on operational performance, using quantitative methods to track KPIs such as bottlenecks, workforce productivity, and error frequencies. RPA enhances this stage by providing real-time monitoring and alert systems that immediately flag deviations, enabling auditors to address inefficiencies promptly and ensure optimal operational performance. The contribution of RPA lies in enabling real-time tracking of KPIs and facilitating the immediate identification of operational issues, ensuring timely and effective interventions.

3.3. Stage 3: Process Analysis

The third stage helps auditors evaluate internal logistics processes in detail, including inventory management, process cost control, and master data quality. RPA plays a key role by automating the extraction and analysis of process data, reducing manual errors, and providing accurate insights for process optimization and strategic decision-making, such as make-or-buy decisions (Agostinelli et al., 2021). The RPA contribution involves automating data extraction and analysis, ensuring accuracy and efficiency in process evaluation.
For organizations, integrating RPA at this stage demands a realignment of internal controls and greater collaboration between IT and audit departments. To make sure that automated procedures represent true business realities and adhere to organizational policies, auditors must collaborate closely with system developers and process owners.

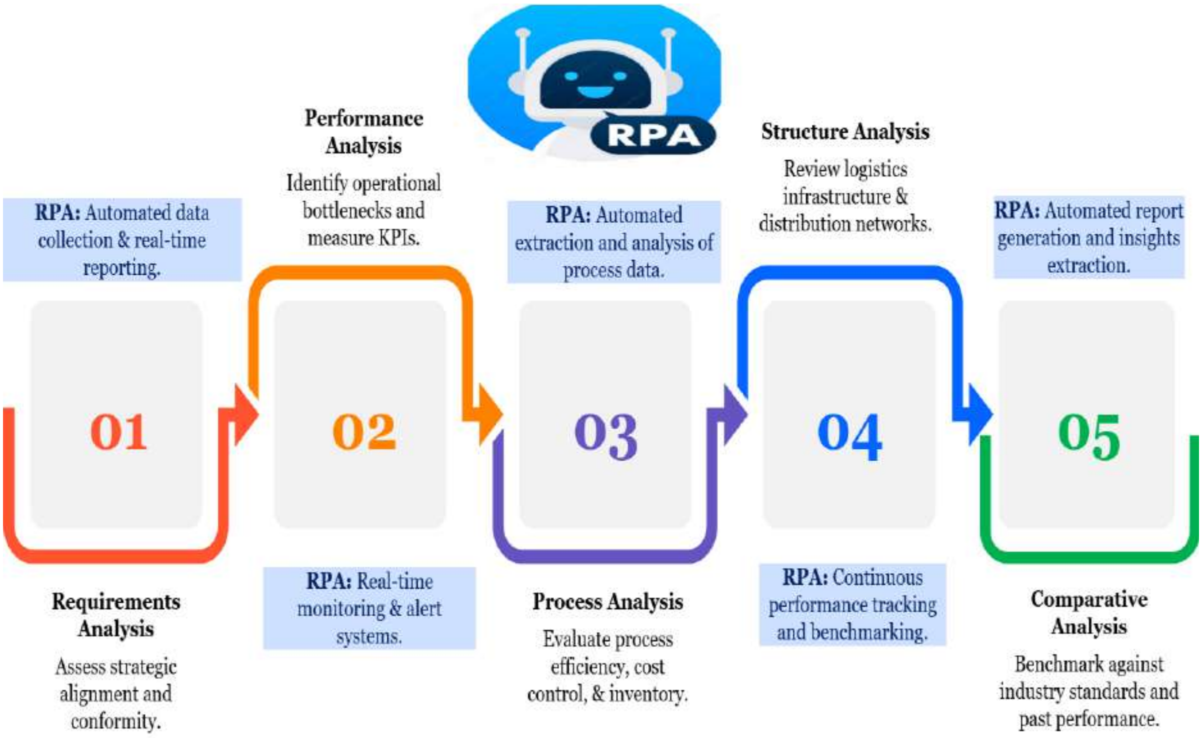
3.4. Stage 4: Structure analysis

The fourth stage guides auditors in reviewing logistics infrastructure and distribution networks. This stage combines traditional structural assessments with RPA tools. Auditors can use RPA to continuously track system performance, benchmark against industry standards, and identify structural inefficiencies or cost-generating processes. These capabilities allow auditors to drive timely interventions and ensure that logistics structures remain competitive and efficient (Klingeberg et al., 2018). RPA contributes by providing continuous performance tracking and benchmarking, enabling auditors to promote data-driven structural improvements and operational excellence.

3.5. Stage 5: Comparative analysis

The final stage instructs auditors to use benchmarking and case study methodologies to compare the organization's performance against competitors and historical data. In this stage, RPA-driven analytics process and analyze large datasets, generating automated audit reports that offers actionable insights. This allows auditors to ensure their recommendations are data-driven and strategically relevant (Lacity & Willcocks, 2017). The RPA contribution involves automating report generation and insights extraction, empowering auditors to make data-driven decisions with precision and confidence.
Although RPA improves strategic visibility for leadership by automating benchmarking and reporting, it also raises concerns regarding the transparency of automated recommendations. In order to build stakeholder trust and guarantees audit accountability, auditors must make sure that results are communicated in an ethical and clear manner.

Figure 1: Proposed framework based on RPA for logistics audits



Source: Elaborated by the author.

This integrated framework, which combines traditional mixed methods with RPA technology, offers a comprehensive roadmap for transforming logistics audits. It enhances operational efficiency, minimizes human error, and supports strategic decision-making through real-time, data-driven insights. By building on established theories and empirical studies, the proposed framework serves as a foundational guide for future empirical studies, enabling both researchers and practitioners to explore the practical applications of RPA across various organizational settings.

4. Results and Discussion

The proposed framework for incorporating RPA into logistics audits aims to overcome the limitations of traditional audit methods while tapping into the powerful benefits of automation. In this section, we explore the outcomes of implementing the framework, highlighting its advantages, the challenges faced, and its impact on both auditors and organizations.

The integration of RPA into logistics audits offers several significant benefits, as demonstrated by the proposed framework. First, RPA enhances efficiency and accuracy by automating repetitive tasks such as invoice verification, shipment tracking, and inventory reconciliation, reducing manual effort and minimizing human errors. For instance, bots can process large datasets with an accuracy rate of up to 99.9%, compared to the 90% accuracy rate typically achieved by humans (Cooper et al., 2019). Second, RPA enables real-time monitoring and reporting, allowing auditors to identify anomalies, such as delays or discrepancies, and address inefficiencies promptly. Third, RPA improves scalability by enabling auditors to test entire populations rather than relying on sampling techniques, thereby reducing risks and providing more comprehensive audit evidence (Christensen et al., 2015). Additionally, RPA frees up auditors to focus on higher-level activities that require professional judgment, such as evaluating contradictory evidence and providing strategic recommendations. Because of this change, the roles of auditors are redefined, and audit teams must adapt culturally. Instead of relying on manual validation, auditors need to acquire digital literacy, flexibility, and data interpretation skills. From an organizational perspective, this calls for not only technical infrastructure but also training initiatives, change management, and audit workflow redesigns that incorporate automated insights and human expertise. Strong leadership and communication are necessary to ensure successful adoption, as resistance to change and fear of losing one's job can also substrate.

Finally, RPA reduces operational costs and enhances supply chain resilience by ensuring continuous monitoring and optimization of logistics operations.

Despite these advantages, the implementation of RPA in logistics audits comes with its own set of challenges. One of the primary obstacles is ensuring system compatibility and addressing data quality issues. Outdated or fragmented logistics systems can impede the smooth integration of RPA, while incomplete or inaccurate records may undermine the effectiveness of automated processes. Additionally, while RPA excels at automating routine tasks, it encounters difficulties when handling exceptions that require human judgment. For instance, if there is an issue with shipment tracking, such as an unavailable carrier network or incorrect information, the RPA bot may not be able to process the request. To manage this, exceptions can be classified into two categories: common errors, which can be programmed into the RPA system for automatic resolution, and uncommon errors, requiring auditors to step in and resolve the more complex issues.

To address these challenges and further improve audit capabilities, the next step is Intelligent Process Automation (IPA), which builds on RPA by incorporating advanced technologies like machine learning, and cognitive automation (Berruti et al., 2017). IPA takes decision-making to the next level by analyzing unstructured data, such as contracts or emails, to uncover risks that traditional methods might miss. What makes IPA really powerful is its ability to adapt on the fly and learn as it goes. This makes it perfect for tasks that need human-like judgment - things like spotting risks or making sure rules are being followed. When combined with other technologies like IoT and blockchain, IPA can significantly boost logistics audits by enabling real-time data collection and ensuring the accuracy and traceability of audit trails. Furthermore, the integration of the proposed conceptual framework into cutting-edge technological infrastructures, like blockchain based systems or IoT platforms, could open the way for exciting opportunities in automated data collection, improved traceability, and decentralized audit procedures. To completely investigate the opportunities and difficulties of such integration, additional research is necessary.

While the proposed framework provides a comprehensive approach to incorporating RPA into logistics audits, it is important to acknowledge certain limitations. For one, the framework might need to be adjusted to meet the specific needs of different industries or organizational settings. For instance, sectors like healthcare or pharmaceuticals, which are heavily regulated, may require customized implementations to ensure compliance and operational effectiveness. Additionally, the rapid pace of technological advancements could make some aspects of the framework outdated. Future research should investigate how emerging technologies, such as AI and blockchain, can be integrated to further enhance the framework's functionality and adaptability. Despite these limitations, the framework offers a solid foundation for modernizing logistics audits and promoting operational excellence.

The proposed framework also has considerable practical implications for organizations aiming to upgrade their logistics audits. It ensures strategic alignment by linking RPA initiatives to organizational goals, optimizing returns on investment, and fostering innovation within supply chain operations. It assesses operational efficiency by automating routine tasks, cutting costs, and improving process accuracy. Lastly, the framework strengthens stakeholder trust by ensuring that logistics audits are conducted responsibly, in line with strategic objectives, while facilitating continuous improvement through its structured, iterative approach.

5. Conclusion and perspectives

This paper presents a comprehensive framework for integrating RPA into logistics audits, marking a significant transformation in how organizations approach supply chain management and auditing practices. This framework employs the power of RPA to automate routine tasks, boost operational efficiency, and enable real-time monitoring of logistics processes, the framework overcomes the limitations of traditional audit methods. This empowers auditors to concentrate on strategic decision-making and continuous improvement, ultimately fostering organizational resilience and enhancing competitiveness in a rapidly evolving digital business landscape. The proposed framework is organized into five sequential stages: requirements analysis, performance analysis, process analysis, structure analysis, and comparative analysis. Each stage is enhanced by RPA capabilities, ensuring a holistic approach that not only improves the accuracy and efficiency of logistics audits but also aligns audit processes with organizational goals and industry standards. The advantages of RPA, such as greater scalability, cost savings, and real-time insights, highlight its potential to revolutionize logistics audits and drive substantial improvements across organizations.

However, the successful implementation of RPA in logistics audits is not without challenges. Issues such as system compatibility, data quality, and the handling of exceptions require careful consideration. Moreover, the rapid evolution of technology and the need for organizational adaptation highlight the importance of continuous innovation and upskilling. Looking ahead, the integration of RPA into logistics audits is just the beginning of a broader transformation in supply chain management. The next frontier lies in the development of Intelligent Process Automation (IPA), which combines RPA with advanced technologies such as AI, machine learning, and cognitive automation. IPA has the potential to address the limitations of RPA by enabling more complex decision-making and adaptability to unstructured tasks. For example, IPA could assist auditors in analyzing large volumes of unstructured data, such as contracts or emails, and identifying risks that are not easily detectable through traditional methods. Furthermore, the integration of RPA and IPA with other recent technologies, such as blockchain and IoT, promises to create a fully connected and transparent supply chain ecosystem. IoT sensors can provide real-time data on shipment conditions, while blockchain ensures the integrity and traceability of audit trails. Together, these technologies can improve the resilience, efficiency, and sustainability of logistics operations.

In conclusion, this paper provides a roadmap for organizations to navigate the complexities of digital transformation by integrating RPA into logistics audits. By automating routine tasks, enhancing efficiency, and enabling real-time insights, RPA empowers organizations to achieve operational excellence and strategic alignment. However, the journey does not end here. As technology continues to evolve, so too must our approaches to logistics audits. Future research and innovation will be critical to unlocking the full potential of RPA and related technologies, ensuring that organizations remain competitive and resilient in an ever-changing business landscape.

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