A Digital Enterprise Architecture Framework for Enhancing Supply Chain Efficiency in the FMCG Sector

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Article history

Received:
4 May 2025

Received in revised form:
10 May 2025

Accepted:
20 May 2025

Published online:
27 June 2025

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Abstract

This study proposes a Digital Enterprise Architecture (EA) Supply Chain Management (SCM) Framework for MSM Malaysia Holdings Berhad to enhance operational efficiency and agility. The framework integrates digital technologies such as the Internet of Things (IoT) with enterprise architecture concepts, addressing traditional SCM challenges like manual processes and fragmented systems. A comprehensive literature review underscores the need for automation and system integration. The research employs qualitative methods, including in-depth interviews with five MSM experts, focus group discussions, and document analysis to map current SCM processes, identify inefficiencies, and design a new set of procedures. The newly developed processes align with organizational objectives, leveraging ArchiMate Notation to visually represent the processes. This framework aims to streamline operations and drive digital transformation in the FMCG sector.

Keywords: *Digital Enterprise Architecture, Fast-Moving Consumer Goods (FMCG), Real-Time Data Integration, Supply Chain Management, Transportation Management System*

1. Introduction

The evolving FMCG sector faces mounting challenges as traditional supply chain methods struggle to meet modern demands. The adoption of digital technology and Industry 4.0 concepts has considerably impacted the evolution of global supply chains, notably in the Fast-Moving Consumer Goods Manufacturing (FMCG) sector. This shift demands rethinking existing Supply Chain Management (SCM) approaches, frequently typified by manual procedures and fragmented systems. The FMCG business's inherent complexity, high volume production, quick product turnover, and severe quality expectations highlight the need for a digital SCM framework that improves operational efficiency and consumer responsiveness [1, 2]. Digital transformation, particularly through technologies like IoT and AI, is essential to overcoming inefficiencies in supply chains. Enterprise Architecture (EA) plays a crucial role by aligning IT strategies with business goals, enabling real-time data integration and system coherence [3].

Enterprise Architecture (EA) is critical in the digital transformation path. It is a basic component that promotes adopting digital solutions, ensuring that all business

DOI:10.11113/oiji2025.13n1.308

sections work towards shared goals [1]. Integrating EA concepts into SCM procedures can help supply chain partners coordinate better, expedite information flow, and decrease operational redundancy [2, 3]. This alignment improves operational efficiency and promotes innovation, allowing businesses to adapt more proactively to market shifts and consumer expectations.

Introducing a Digital Enterprise Architecture Supply Chain Management Framework is critical for businesses like MSM Malaysia Holdings Berhad (MSM) because it provides a systematic method to harmonise business and IT strategy. This architecture allows for the seamless integration of multiple organisational components, boosting process optimisation and strategic agility [1, 2]. Companies may improve data integration and supply chain visibility by embracing digital technologies crucial for making real-time decisions and responding to changing market circumstances [1, 3]. The framework intends to solve the FMCG sector's issues, such as the requirement for quick adaptation to customer tastes and the management of complex, multi-tier supply chains.

However, implementing digital SCM systems is not without obstacles. Organisations must deal with data privacy concerns, reluctance to change, and the integration of different systems and technologies [4]. The growing emphasis on data protection, especially in light of rules like the General Data Protection Regulation (GDPR), needs rigorous data management throughout supply chains. Furthermore, the lack of established evaluation indicators for digital SCM solutions complicates determining their performance and compatibility with business goals [2]. Addressing these problems requires a rigorous approach involving empirical validation and stakeholder interaction to verify that the suggested framework is feasible and scalable within the FMCG business.

The study aims to bridge the gap between theoretical knowledge and actual application by creating a complete Digital Enterprise Architecture Supply Chain Management Framework for MSM Malaysia Holdings Berhad. This framework optimises SCM operations and provides a plan for digital transformation in the FMCG business. By thoroughly investigating existing SCM processes, defining critical components, and rigorously assessing the framework, this study aims to contribute to academic debate and industry practitioners' strategic imperatives.

2. Literature Review

The fast expansion of global markets and technology breakthroughs have profoundly changed the SCM environment, notably in the FMCG industry. As customer expectations become more complicated and rapid, classic SCM approaches are becoming increasingly inadequate to handle the requirements of a dynamic and linked environment. By reviewing significant advancements in SCM, the role of smart technologies, the particular issues encountered by the FMCG industry, and the strategic relevance of EA, this study attempts to give a thorough picture of SCM's current condition and future trajectory. The integration of these domains provides a path for creating a strong Digital EA-SCM architecture capable of changing traditional supply chains into resilient and responsive networks that can survive in the dynamic FMCG market.

2.1 The Limitations of Traditional Supply Chain Management (SCM)

The changing environment of the FMCG industry highlights the critical need for a paradigm shift in SCM. Traditional techniques, which have traditionally depended on sequential, isolated processes, are rapidly failing in the face of expanding global complexity and rising customer demands [1]. While these traditional models have served as the foundation of logistical coordination, they fail to meet the needs for agility, real-time response, and comprehensive visibility that modern supply chains require [2]. According to the literature, modern supply chain frameworks must go beyond just orchestrating material flows and embrace a more integrated and collaborative strategy that uses technological improvements to optimise overall supply chain performance [3].

One key critique against traditional SCM approaches is their inability to respond to rapid market changes and disruptions. This rigidity is especially harmful in the FMCG industry, where supply chains must be adaptable and responsive to changing customer needs and global market dynamics [1]. The current literature advocates for a strategy shift towards digital transformation, which addresses the limits of old models while increasing operational efficiency via enhanced data analytics and real-time visibility [2]. This reassessment of SCM techniques is critical for developing robust supply chains that survive in the dynamic FMCG market.

2.2 The Role of Smart Technologies in Modernizing SCM

Smart technologies, such as the Internet of Things (IoT), have transformed supply chain operations by offering new levels of automation and connection. IoT-enabled devices offer real-time data transmission, increasing visibility across the supply chain and enabling predictive analytics to anticipate future disruptions [1, 2]. This transition from reactive to proactive, data-driven decision-making marks a significant change from previous SCM practices. Despite the potential benefits, the research identifies many impediments to efficient IoT adoption, such as technology fragmentation and a lack of defined protocols for data integration [3-6].

The FMCG sector's technical diversity and complexity make incorporating IoT into SCM even more difficult. To fully achieve the potential of IoT, a unified framework is required that not only combines sophisticated technology but also resolves systemic impediments such as legacy systems and data silos. Overcoming these constraints requires a coordinated effort to build standardised data protocols and promote interoperability across diverse systems, guaranteeing that technology breakthroughs may be successfully utilised to boost SCM performance [1].

2.3 Challenges in Digital Transformation for the FMCG Sector

Despite the promising possibilities of smart technology, the FMCG industry has particular hurdles in implementing these advancements. The sector's high product movement velocity and broad stakeholder base result in complicated supply chain dynamics, each with unique data needs and operational limits [1]. Established data silos and outdated systems exacerbate these issues since they are frequently difficult to integrate with contemporary digital solutions[2]. The widespread problem of mismatch between technology capabilities and business objectives reveals a reluctance to invest in revolutionary digital efforts due to perceived risks and unclear rewards.

Addressing these difficulties involves more than simply technology innovation; it also necessitates a strategic rethinking of organisational culture and a focus on change management. The effective adoption of digital SCM systems depends on creating an environment that encourages continual learning and adaptation. Organisations must emphasise aligning technical investments with business objectives, fostering a change-friendly culture, and ensuring all stakeholders are involved in the transformation process. This holistic strategy is critical for overcoming digital transformation challenges and generating long-term benefits in supply chain performance.

2.4 Enterprise Architecture (EA) as an Enabler for Digital SCM

EA emerges as a major facilitator for successfully incorporating digital technology into the SCM system. EA gives a comprehensive picture of the organisation, bridging the gap between business strategy and technical execution by integrating digital activities with overall business objectives [1, 2]. EA creates a structured design to integrate diverse systems and processes seamlessly, improving operational coherence and strategic agility. EA-driven approaches may dramatically reduce the risks associated with digital transformation by providing a clear path for technology adoption, process reengineering, and stakeholder involvement [3].

An EA also helps build robust and agile supply chains that survive the FMCG industry's turbulent dynamics. By harmonising business and IT goals, EA helps businesses to adapt more effectively to market disruptions and changing customer needs [1-3]. Furthermore, EA promotes a culture of continuous improvement by promoting process review and incorporating input from all company levels. This complete approach promotes EA as a technical foundation and a strategic instrument for advancing innovation and sustainability in the FMCG industry[4].

2.5 Towards a Digital EA-SCM Framework for the FMCG Industry

The gap analysis highlights three major study themes: new system implementation, system integrations, and centralised dashboards, compared to crucial SCM services, including order, truck, and warehouse allocation, communication, and real-time lead-time processing. Studies on "New System Implementation" [1, 2] propose new technology while ignoring comprehensive integration and error management. "System Integrations" research [3] emphasises unified systems but ignores real-time processing and resource allocation. "Centralised Dashboard" investigates stress visibility and control but falls short of operational integration [4-6]. The findings are reported in Table 1.

Table 1: Gap Analysis of SCM Digitalisation for the FMCG Industry

DIGITALISATION COMPONENTS	Reference	FMCG BUSINESS PROCESS							
		Order Allocation	Truck Allocation	Warehouse Allocation	Communication	Lead time processing (Real-time)	Error Handling improved accuracies	Tracking and Monitoring	Streamline processing /operations
New System Implementation	[1]	/			/	/			/
	[2]				/				/
	[3]	/		/		/	/		/
	[4]	/	/	/			/		/
	[5]					/	/		/
System Integrations	[6]		/	/	/	/	/	/	/
	[7]			/		/	/	/	/
	[8]				/	/	/	/	
	[9]				/	/		/	
Centralised dashboard	[10]			/		/	/	/	/
	[11]		/			/	/	/	/
	[12]			/		/		/	/

To summarise, incorporating digital technology and EA concepts into SCM frameworks is critical for FMCG firms to preserve their competitive edge and operational efficiency. As the sector changes, using such frameworks will be crucial for organisations looking to prosper in an increasingly digital and interconnected marketplace.

3. Methodology

This study employed a multi-phase, qualitative approach to develop a Digital Enterprise Architecture (EA) Supply Chain Management (SCM) Framework for MSM Malaysia Holdings Berhad. The methodology was implemented across several stages, each designed to provide valuable insights into MSM's supply chain processes and inform the development of the proposed framework.

Step 1: Literature Review

The first phase involved an extensive literature review, which provided the theoretical foundation for the research. The review focused on identifying key trends in digital supply chain management, including the role of emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and real-time data integration. The review also assessed best practices for digital transformation in SCM and evaluated theoretical frameworks and models relevant to enterprise architecture and supply chain management. The findings from the literature review helped shape the overall research approach and informed the data collection methods used in subsequent stages.

Step 2: In-Depth Interviews

After the literature review, the research proceeded with in-depth interviews conducted with five MSM business and technology experts. These experts,

including senior managers and technology officers, provided valuable qualitative data regarding the existing SCM processes at MSM. The semi-structured interview technique allowed for open-ended questions and flexibility in responses. The interviews revealed several key challenges, including the reliance on manual processes, limited real-time data visibility, and fragmented communication across departments. The findings from the interviews served as the foundation for the gap analysis.

Step 3: Document Analysis

Parallel to the interviews, a document analysis was conducted, reviewing MSM's current SCM process maps, Standard Operating Procedures (SOPs), and performance reports. This step provided a detailed understanding of MSM's operational workflows and highlighted inefficiencies such as delays in order fulfillment and the lack of system integration. The document analysis also identified technological gaps, such as outdated systems and data silos, which limited the efficiency of MSM's supply chain.

Step 4: Gap Analysis

The data gathered from the interviews and document analysis were synthesized into a gap analysis. This phase involved comparing the current SCM processes at MSM with the desired state enabled by digital technologies. The gap analysis identified significant inefficiencies in areas such as manual data entry, poor real-time visibility, and system fragmentation. These findings were used to inform the design of the Digital EA-SCM Framework, ensuring that it addressed the critical challenges identified through the analysis.

Step 5: Digital EA-SCM Framework Development

Based on the gap analysis results, a Digital EA-SCM Framework was developed to integrate digital technologies and streamline MSM's supply chain operations. The proposed framework incorporates IoT-enabled devices, Transport Management Systems (TMS), and Customer Relationship Management (CRM) systems to enhance real-time data flow, automation, and system integration. The framework was modelled using ArchiMate notation, a widely recognised enterprise architecture tool, to visually represent the relationships between business processes, technology, and data. This model provided a clear and structured approach to integrating digital technologies into MSM's supply chain processes.

Step 6: Triangulation and Data Validation

To ensure the reliability and credibility of the findings, triangulation was employed. This technique involved cross-validating interview data and document analysis to ensure consistency and accuracy. Additionally, feedback was gathered from the MSM experts on the proposed Digital EA-SCM Framework. This feedback helped refine the framework and ensure it practically applied to MSM's operations. The validation confirmed that the framework effectively addressed the identified inefficiencies and aligned with MSM's strategic goals. Table 2 shows the research steps in this study.

Table 2: Summary of Methodology Steps in this Study

Step	Description	Objective	Participants	Techniques
1. Literature Review	Review of trends in digital SCM and EA models.	Build theoretical foundation.	N/A	Systematic literature search, content analysis.
2. In-Depth Interviews	Interviews with 5 MSM experts.	Identify SCM inefficiencies and improvement opportunities.	5 MSM experts	Semi-structured interviews, thematic analysis.
3. Document Analysis	Review of MSM SCM process maps, SOPs, and performance reports.	Identify inefficiencies and technological gaps.	N/A	Systematic document review, content analysis.
4. Gap Analysis	Comparison of current and desired SCM processes.	Identify areas for improvement.	N/A	Comparative analysis.
5. Digital EA-SCM Framework Development	Design a framework using ArchiMate notation.	Propose a solution to streamline and integrate SCM.	N/A	Architecture modeling, process redesign.
6. Triangulation and Data Validation	Cross-reference findings and gather feedback from stakeholders.	Validate findings and framework design.	MSM experts	Triangulation, stakeholder feedback.

4. Analysis and Findings

The analysis reveals significant inefficiencies in MSM's current SCM processes, including manual order tracking, fragmented communication, and limited real-time visibility. These inefficiencies cause delays and inaccuracies, hindering decision-making. The proposed Digital EA-SCM Framework introduces a more integrated approach using automated systems like a Transport Management System (TMS) and a Customer Relationship Management (CRM) system. The new framework addresses inefficiencies, improves data accuracy, and provides real-time updates, significantly enhancing supply chain agility and performance.

The analysis and findings of this study began with a thorough review of existing order processing workflows, which revealed many major inefficiencies, such as manual data input, limited real-time visibility, and fragmented communication among departments. These challenges, which have long plagued the organisation's supply chain operations, resulted in late delivery and impaired data accuracy, impeding effective decision-making. The proposed Digital EA-SCM Framework seeks to address these issues by introducing a more structured and integrated approach, utilising advanced digital technologies such as a Transport Management System (TMS) and a Customer Relationship Management (CRM) system to streamline and automate supply chain processes.

One of the study's most noteworthy conclusions is the revolutionary effect of automating existing manual operations. The "As-Is" study found that relying on manual interventions for order formation, allocation, and tracking has resulted in multiple bottlenecks, with repeated delays and mistakes. MSM may dramatically minimise these inefficiencies by adopting the "To-Be" paradigm, which includes

automated processes and centralised data repositories (Saberi et al., 2018). Integrating TMS and CRM systems goes beyond just automating mundane processes; it creates a single source of truth for all stakeholders. This aggregation improves data accuracy and reduces the possibility of human mistakes. Such a change will provide significant time efficiencies and optimise resource allocation, resulting in a more agile and effective supply chain, as illustrated in Table 3.

Table 3: Proposed Components based on Business, Data, Application, and Technology Layers

Layers	Component	Description
Business	Enterprise Architecture (EA)	A framework for aligning business processes and IT infrastructure, providing a structured approach to integrating digital technologies into supply chain management.
	Supply Chain Management (SCM)	Coordinate and manage all sourcing, production, and logistics activities to enhance efficiency and responsiveness.
	Stakeholder Engagement	Involving key stakeholders throughout the process ensures the framework meets organisational needs and secures stakeholder buy-in.
	Iterative Refinement	Continuous improvement of the framework based on stakeholder feedback and performance evaluation to enhance its applicability and effectiveness.
Data	Data Integration	Seamless connectivity between different systems (TMS, CRM, Infor M3) to ensure real-time data flow and eliminate data silos.
	Real-Time Data Dashboards	Centralised dashboards provide stakeholders with up-to-date information on key performance indicators, order statuses, and inventory levels.
Application	Customer Relationship Management (CRM)	The system will systematically manage customer interactions, order requests, and feedback, improving customer service and engagement.
	Transport Management System (TMS)	Automated system for managing and optimising transportation operations, including route planning, vehicle tracking, and shipment scheduling.
Technology	Automation	Implementation of automated workflows to reduce manual data entry, minimise errors, and improve process efficiency.
	System Interconnectivity	Integrating new digital systems with existing infrastructure ensures smooth data exchange and operational consistency.

Furthermore, the study emphasises the need for real-time data integration in developing a more agile supply chain. The suggested system highlights real-time data dashboards that provide complete insight into all parts of the order processing operation. This functionality allows stakeholders to follow important performance metrics, check order statuses, and respond quickly to interruptions [13]. Real-time data visibility increases departmental cooperation and boosts customer service by giving accurate and fast order status updates. As a result, the ability to use real-time data analytics is a significant facilitator of operational agility and a critical aspect in preserving a competitive edge in the quickly expanding FCGM market. Figure 1 illustrates the Target Architecture Motivation for MSM using an Archimate Notation Diagram.

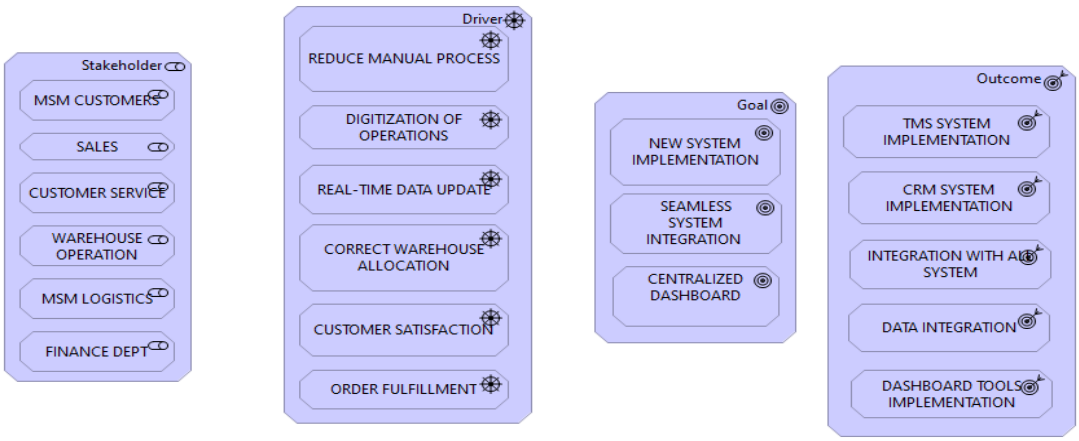

Figure 1: Target Architecture Motivation for MSM

The study enhanced the model via intensive discussion with key stakeholders to suit the organisation's unique requirements and challenges. This participative approach ensured the framework was theoretically solid and practical, allowing for seamless incorporation into the organisation's current operations. A complete record of the present processes was obtained when reviewing MSM's order processing operations. This entailed obtaining extensive information about the individuals involved, the procedures followed, the systems used, and the results produced. Figure 2 depicts these processes further. MSM's existing order processing system confronts several issues, including manual procedures, a lack of integration, and limited real-time visibility, all resulting in inefficiencies.

1. **Sales Request Visibility:** Poor order management due to untracked verbal or email requests.
2. **Incorrect SKU Information:** Inaccurate SKU information from Sales causes data entry errors and delays order fulfilment while Customer Service (CS) corrects faults.
3. **Manual Allocations:** Handling stock and vehicle allocations manually is time-consuming and prone to mistakes.
4. **Delayed Data Updates:** Slow warehouse and vehicle allocation data updates lead to delayed delivery, particularly for crucial orders.
5. **Fulfilment Visibility:** CS lacks real-time visibility into truck deliveries, resulting in outdated statuses and hindering the fulfilment process.
6. **Missing Proof of Delivery (POD):** Manual Proof of Delivery (POD) paperwork is frequently lost, affecting customer billing.

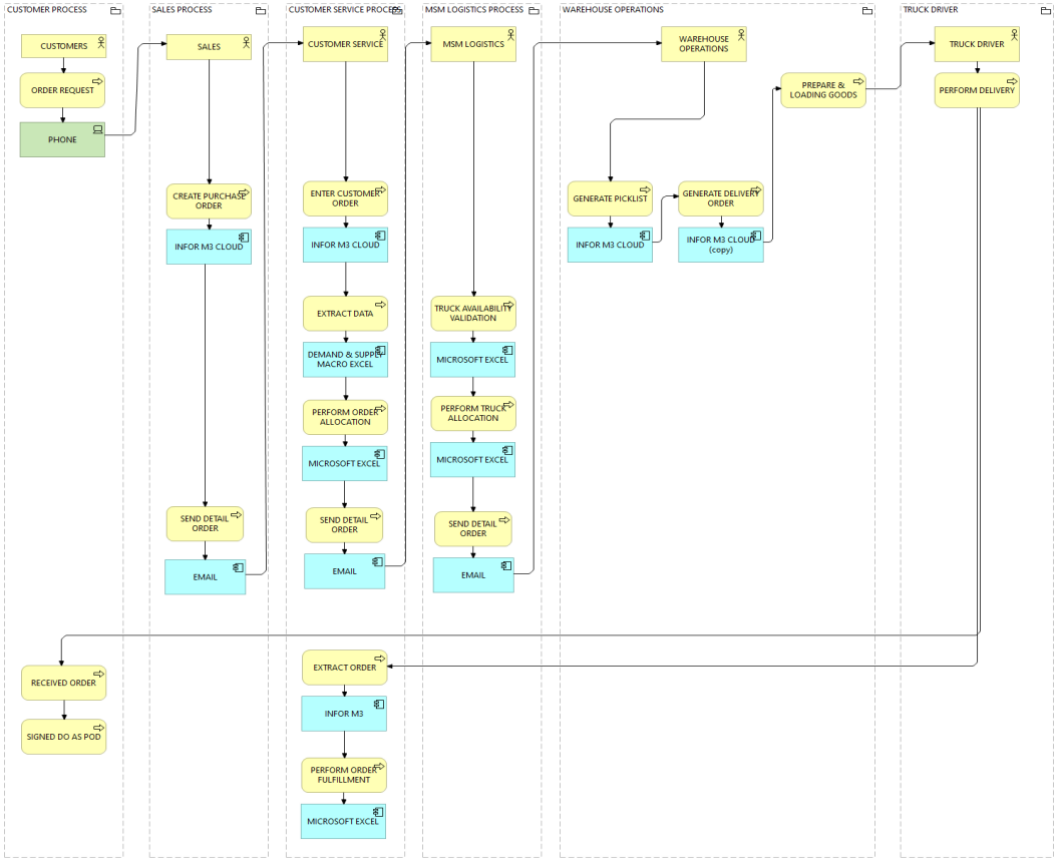

Figure 2: As-Is Process for Order Processing

The suggested To-Be process solves these problems by combining a Transport Management System (TMS) with a Customer Relationship Management (CRM) system. The TMS will automate truck allocation and logistics, while the CRM will handle customer contacts and order administration. This will decrease manual chores and mistakes and provide real-time data visibility, resulting in faster, more accurate, and more efficient order processing and supply chain processes. This is evident in Figure 3.

The findings of this study give persuasive proof of the benefits that a well-structured Digital EA-SCM Framework may provide to the FCGM business. The suggested model provides a strategic route for MSM to improve its supply chain operations by addressing the key concerns highlighted in the initial research and adding cutting-edge digital technologies. The study also provides the framework for future research, implying that more investigation into incorporating emerging technologies such as blockchain and artificial intelligence might add levels of efficiency and security to the supply chain. Overall, the study adds to the scholarly debate on digital transformation in SCM and offers useful insights for industry practitioners looking to traverse the intricacies of modern supply chains efficiently.

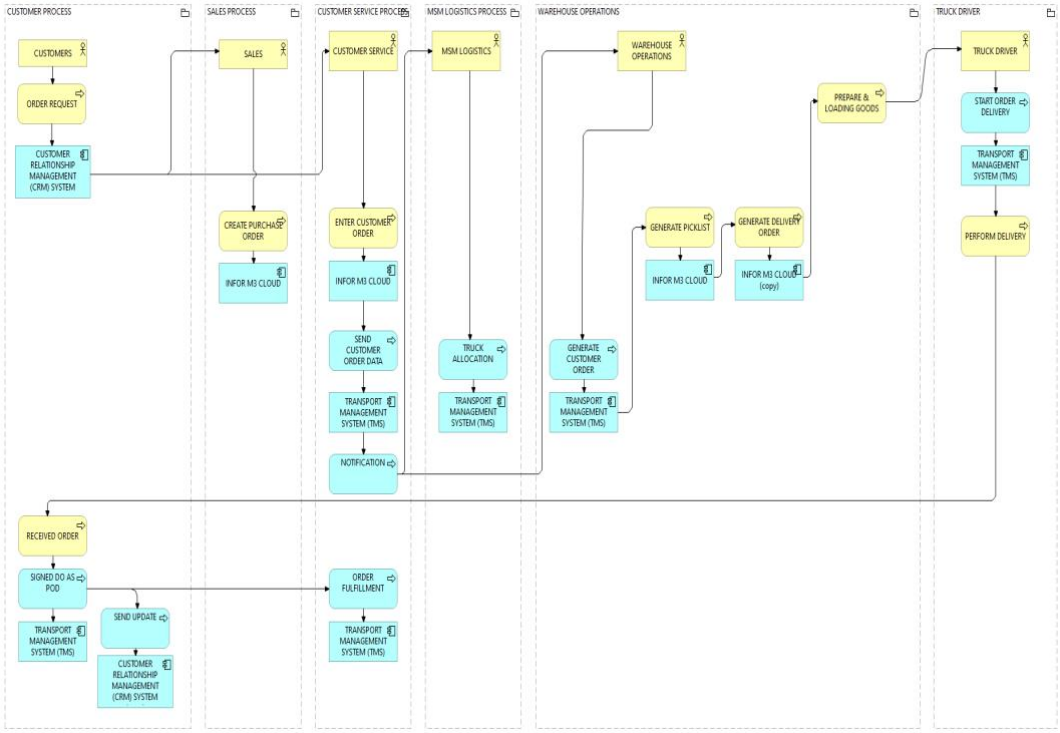

Figure 3: To-Be Order Processing.

5. Conclusion and Recommendation

The analysis emphasises that while numerous studies target certain aspects of SCM, they frequently do so in isolation, ignoring the fundamental interdependencies necessary for a cohesive and effective supply chain. Areas like warehouse allocation and thorough error handling are underexplored, implying that these functions are under-represented in current research. This emphasises the necessity for a comprehensive Digital EA-SCM Framework that combines all critical functions, fits with organisational goals, and uses real-time data analytics. Integrating digital technology and EA concepts into SCM frameworks is critical for FMCG companies to maintain a competitive advantage and operational efficiency. The proposed MSM framework marks a significant step towards these objectives, providing a model that may be used by comparable businesses dealing with the complexity of modern supply chains. As the FMCG sector advances, adopting such frameworks will become critical for organisations seeking to compete in a more digital and linked environment [13, 14].

This study represents a significant step in improving MSM's supply chain management by building the Digital EA-SCM Framework. The framework's emphasis on automation, system integration, and real-time data management provides a solid foundation for increasing operational efficiency and resilience. By integrating with wider digital transformation projects, MSM will be better positioned to manage existing supply chain difficulties and respond to changing market needs. This enables the organisation to maintain a more efficient and responsive supply chain, resulting in a competitive advantage.

The following phase of this study will focus on refining and expanding the proposed framework by incorporating emerging technologies such as blockchain

for improved data security and traceability and artificial intelligence to help with decision-making through advanced analytics and predictive modelling. Pilot implementations will be carried out to examine the framework's real-world applicability, followed by extensive data gathering and analysis to determine the impact on supply chain efficiency and resilience. Stakeholder comments will help to fine-tune the model and ensure its flexibility to the changing demands of the FMCG sector. Furthermore, future studies will look at the framework's scalability in various scenarios within the FMCG sector to define a new benchmark for digital transformation in supply chain management.

Acknowledgements

This study was funded by Universiti Teknologi Malaysia Matching Grant Q.K130000.3056.04M72.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

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