

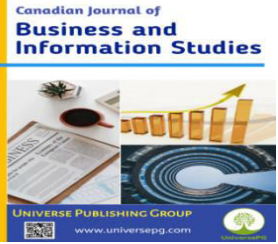


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## Examining the Standardization of Solutions for the Integration of Implementation of Warehouse Management Systems

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### ABSTRACT

Logistics, as the management of material flow in the supply chain, plays a crucial role in ensuring the efficient operation of the complete distribution network channel. Warehouse management systems (WMS) have become key IT logistics systems to facilitate this process, but managing system integrations across different industry levels and platforms can be complex. Hence, standardizing integrated system solutions used in WMS implementation is vital for logistics service providers, as investigated in this paper through a case study. Efficient management of material flow in the supply chain is crucial in logistics. Warehouse management systems have become critical IT logistics systems, integrated with external systems to enable accurate data exchange and collaboration between businesses. However, managing these integrations can be complex and time-consuming, requiring a standardized approach. A case study in a leading logistics company explores the feasibility and advantages/disadvantages of implementing standard integrated system solutions in warehouse management.

**Keywords:** Logistics, Supply chain, Warehouse, Management, Standardization, and Implementation.

### INTRODUCTION:

The supply chain serves as a conduit for coordinating all the entities involved in a business with the goal of reducing the life cycle of a product from its origin to its destination, consequently diminishing costs. This concept is applicable to any industry that operates within a dynamic environment and involves multiple business partners. A key objective of a supply chain is to expedite the delivery of materials from suppliers to consumers. A typical supply chain model is depicted below to provide insight into the entities involved. The larger and more globalized a business becomes, with an increased number of partners or entities, the supply chain expands and becomes more intricate. Consequently, managing the supply chain in an efficient

manner poses greater challenges. Logistics, a fundamental and integral component of a supply chain, enables enterprises to ensure the timely delivery of the correct product in the proper condition to the designated customer. Additionally, logistics facilitates the smooth flow of products in the reverse direction without any disruptions. Logistics models assist organizations in maintaining optimal inventory levels at all times, as illustrated by a typical logistics model shown below. IT systems play a crucial role in managing and accurately maintaining inventory while fulfilling customer orders and adhering to customer compliance. Notably, Warehouse Management Systems (WMS) are of paramount importance in the logistics industry for accomplishing these tasks. WMS

primarily aids in managing inventory at distribution or warehouse facilities based on customer requirements, as well as performing the value-added services as necessary (Alam *et al.*, 2017).

WMS enables businesses to effectively communicate and collaborate with all logistics partners, particularly in real-time, when integrated with essential external systems or partners. This necessitates systems integration to transmit accurate data to the appropriate business partner at the appropriate time. Systems integration signifies a noteworthy milestone in the implementation of Warehouse Management Systems (WMS), taking into account the multitude of business

partners, diverse systems, and various modes of communication, copious amounts of data, and potentially numerous business cultures involved. Nonetheless, it provides a competitive edge to companies by empowering them to efficiently and effectively address customer needs and market demands promptly. At the same time, it becomes increasingly intricate and burdensome for a logistics service provider to handle these various systems integrations when operating across different industry sectors, utilizing diverse integration platforms, and employing different WMS applications.

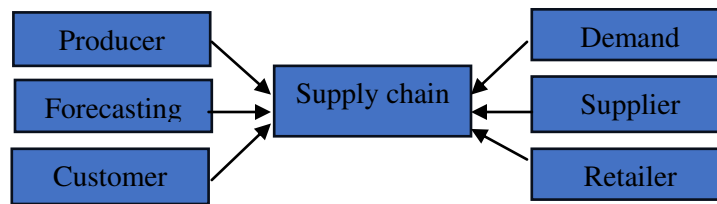


Fig. 1: A Typical Supply Chain Model.

**Review of Literature**

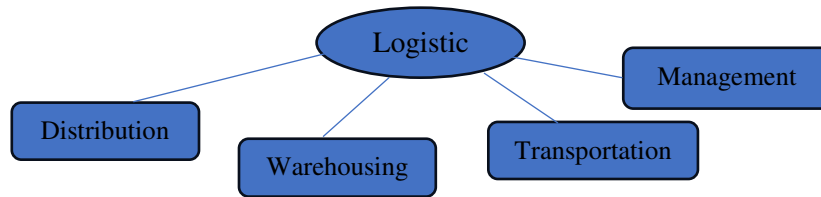
The management and optimization of warehouse space and customer inventory, as well as the tracking of inventory movements, are tasks that cannot be accomplished without the use of Warehouse Management System (WMS) applications and their integration with other applications in the current complex and unique business environment. (Dowlatshahi, S. 1996) underscores the significance of assimilation and posits a Design for Logistics model that amalgamates logistics-related matters, such as plant placement, material administration, warehousing, transportation, and packaging, into the initial various phases involved in the process of Product Design. This approach incorporates Supply Chain concerns into interfaces modeled according to four disciplines, namely Logistics engineering, Manufacturing Logistics, Design for Packaging, and Design for Transportability, the following information is presented.

To accomplish the amalgamation of logistics within the realm of product design, it is necessary to consider the characteristics of this problem and identify the actors who will promote the methods and tools to support it. Systems engineering, as described by (Guillerm, R. 2011), is a comprehensive approach that

encompasses all the necessary activities to design, develop, and verify a system, providing an optimized solution that meets the client's needs and satisfies all stakeholders. Highlight one of the common pitfalls in managing the Supply Chain (Lee, H. L., & Billington, C., 1992) which is the failure to consider inventory, distribution, and planning costs during the product-process design. They argue that the evaluation of product-process design should not only focus on functionality and performance but also on Design for Supply Chain Management (DFSCM), including costs and serviceability issues. Some Research (McAdam, R., & McCormack, D. 2001) put forth a consolidated framework for business processes that highlights the crucial role of effective communication among processes and partners within the supply chain. The aim is to attain a competitive advantage by enhancing the efficiency of the global supply chain. In a similar vein, prior research (Simatupang *et al.*, 2002) have developed an extensive taxonomy of coordination modes, encompassing logistics synchronization, information sharing, collective learning, and incentive alignment. These modes have been found to positively influence the performance of the supply chain. Despite the numerous research studies on the importance of systems integration in Logistics and Supply Chain, it is

challenging to find research and articles specifically addressing the Standardization of Systems Integration in Warehouse Management Systems (WMS) implementations. Standardizing system integration solutions is crucial for efficient and seamless operations in warehouse management (Andiyappillai, N. 2020). As the need for digitalization and automation in warehouses continues to grow, standardization becomes essential in preparation for automation (Münsberg, T. M *et al.*, 2022). Several initiatives have been proposed to achieve this, such as streamlined process flows based on offered services, automated put-away,

automated setup of new clients with a configurator, and an automation framework to standardize implementation requirements (Salamat, S. *et al.*, 2022), (O’Cearbhaill *et al.*, 2023). These initiatives have generated interest among stakeholders, particularly the streamlined process flows and configurator, which will be implemented. However, implementing these solutions on a large scale in multiple warehouses presents significant challenges. Despite the challenges, the benefits of running multiple warehouses with standardized operations are substantial.



**Fig. 2:** A Typical Logistics Model.

How can system integration solutions be standardized to improve the efficiency of warehouse management? System integration solutions can be standardized to improve the efficiency of warehouse management by implementing tools such as radio frequency identification (RFID) technology, Lean Warehousing tools, and business process management (BPM) methodology. The use of RFID technology in a web-based warehouse management system can improve efficiency, reduce data loss, and lower labor costs (Din, I. U *et al.*, 2018) Lean Warehousing tools, such as multi-criteria ABC, 5S, Kardex, and work standardization, can help increase the indicator of complete orders and improve inventory control and warehouse organization (Ambrosio-Flores *et al.*, 2020). Additionally, implementing BPM methodology can further enhance the efficiency of warehouse management by standardizing work processes and improving productivity (Lazo De La Vega Baca, M. F., & Ambrosio Flores, K. L. 2023). By integrating these solutions, warehouse operations can become more streamlined, leading to improved efficiency and customer satisfaction. What are the best practices for standardizing system integration solutions in the implementation of warehouse management?

Standardizing system integration solutions in the implementation of warehouse management involves several best practices. One approach is to streamline Universe PG | [www.universepg.com](http://www.universepg.com)

process flows based on offered services, which helps to standardize operations and improve efficiency. Another practice is to automate put-away processes, which reduces manual labor and increases accuracy (Abdoli, S., & Kara, S. 2016). Additionally, implementing an automation framework can help standardize the requirements for automation implementation (Emilie *et al.*, 2019). It is also beneficial to use a configurator to automate the setup of new clients based on predefined options, which ensures consistency and reduces errors. These initiatives have been shown to generate interest from stakeholders and can be implemented on a large scale in multiple warehouses, leading to significant benefits.

3. The Implementation of Warehouse Management Systems (WMS) and Its Integration with Other Systems Warehouse Management Systems (WMS) are software applications that enable businesses to manage and control warehouse operations, including inventory management, order processing, and transportation management (Imdad, R. S., Hamid, K., & Mehmood). The implementation of WMS involves integrating it with other systems such as enterprise resource planning (ERP) and manufacturing execution system (MES) to ensure consistency and efficiency in information control and production management (Arshad, M. F, *et al.*, 2019). The integration of WMS

with other systems is crucial for the development of a sustainable digital factory and the realization of Industry 4.0 concepts, which involve advancements in Cyber-Physical Systems (CPS), the Internet of Things (IoT), Cloud computing, and Smart Factories (Tong *et al.*, 2023). Challenges associated with WMS implementation include the need for skilled personnel, data security, and system integration (Youssef *et al.*, 2022). Future research opportunities in this field include the development of predictive analytics, the use of blockchain, and the implementation of robotic process automation (Khan *et al.*, 2022). The utilization of Warehouse Management Systems (WMS) in businesses is instrumental in facilitating the execution of warehouse and distribution processes through the use of IT applications. WMS aids in achieving inventory visibility, meeting customer order fulfillment and replenishment needs, ensuring customer compliance, and executing additional ancillary services or activities within the system to ensure traceability. The successful implementation of WMS necessitates the completion of key components or milestones as outlined in the model depicted in **Fig. 3**. Of particular importance is the integration of Electronic Data Interchange (EDI), which plays a vital role in facilitating communication flow through the channel. WMS is frequently integrated with external systems, such as Customer Host, through EDI Integration systems, commonly referred to as Middleware applications. This integration enables seamless electronic communication between Logistics and Supply Chain providers and their customers, without any disruption to business operations or the need for manual intervention. Furthermore, this integration facilitates real-time data retrieval. The diagram below illustrates the integration of WMS application with the Host system within a typical systems integration environment. Within the market, there exists a wide array of customer Host applications and WMS applications, also known as Enterprise Resource Planning (ERP) applications (Dowlatshahi, S. 1996). These applications cater to specific industry verticals, domain expertise, and supported modules. When evaluating the suitability of a Host system, a customer or Logistics service provider typically assesses its capabilities against the business requirements to select the most appropriate option. Similarly, there are

various Middleware applications available in the market. Companies assess several factors, including systems requirements, product capability, and capacity, product flexibility, and product reliability, to determine the optimal solution for achieving seamless systems integration.

### **Case study**

This case study examines the Systems Integrated Solutions offered in WMS implementations in a leading Logistics and Supply Chain company (Guillerm, R. 2011; Alsuliman BRA, and Elrayah M. 2021). Data was collected through studying and observing actual system integrations, reviewing project documentation, and consulting with Subject Matter Experts. The company has made significant investments in IT infrastructure to keep up with market changes, using a Tier-1 Middleware application to integrate their Tier-1 WMS application with customer host applications. However, the company faces challenges in developing and maintaining these integrations across different platforms and architectures, resulting in increased IT development and maintenance costs. Therefore, it is crucial for Logistics service providers to standardize integrated solutions at WMS implementations to overcome these challenges. The aim was to identify and address the factors affecting Standardized Systems Integrated Solutions and create a standardized solution. The company researched and analyzed necessary changes for each factor, including communication mode, file format, frequency/timings, templates, customer agreement, impact on ancillary tools, and EDI errors notification. Implementing the Standardized Systems Integrated Solutions resulted in benefits such as easy maintenance, faster deployment, standard processes, and automated testing. However, there are also disadvantages, including customer inflexibility and the time required for design changes. Logistics and Supply Chain providers are increasingly striving for more efficient and cost-effective Warehouse Management Systems Implementations through various initiatives, with Standardized Systems Integrations being a crucial strategic initiative that directly and significantly affects the customer.

### **CONCLUSION:**

Logistics and Supply Chain Systems facilitate accurate customer inventory management during logistics and

supply chain services. Integrating Warehouse Management Systems with external applications for Electronic Data Interchange (EDI) communication presents challenges for maintaining multiple customer support and industry verticals. Although standardized Systems Integrated Solutions benefit the company, deploying them in the current market behavior proves challenging.

#### **Future work**

Future research opportunities are proposed in this manuscript: Further investigation can be carried out to examine the influence of standardized system integrated solutions on other aspects of warehouse management systems (WMS) implementations, such as inventory management or order fulfillment. The viability of standardizing system integrated solutions in WMS implementations can be analyzed in diverse logistics and supply chain organizations to validate the findings of the case study conducted in this manuscript. Subsequent studies can concentrate on identifying strategies to tackle the challenges encountered in implementing standardized system integrated solutions, such as customer inflexibility or resistance to compliance.

Research may be conducted to evaluate the long-term benefits and drawbacks of employing standardized system-integrated solutions in the implementation of Warehouse Management Systems (WMS). This includes investigating the effects on maintenance endeavors and operational protocols.

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#### **CONFLICTS OF INTEREST:**

The author declared no conflict of interest.

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