ISSN: 2583-9888
DOI: doi.org/10.51219/JAIMLD/tulasi-siva-krishna-prasad-kadiyam/690

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Vol: 7 & Iss: 4

Research Article

Event Driven Logistics Integration between SAP and Third Logistics Providers

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Citation: Kadiyam TSKP. Event Driven Logistics Integration Between SAP and Third Logistics Providers. *J Artif Intell Mach Learn & Data Sci 2024* 7(3), 3503-3508. DOI: doi.org/10.51219/JAIMLD/tulasi-siva-krishna-prasad-kadiyam/690

Received: 02 August, 2024; **Accepted:** 18 August, 2024; **Published:** 20 August, 2024

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A B S T R A C T

Modern supply chains depend on timely and reliable information exchange between enterprise resource planning systems and third-party logistics providers. However, conventional point-to-point interfaces, batch processing, and tightly coupled integrations often limit responsiveness, scalability, and end-to-end visibility. This study proposes an event-driven logistics integration framework connecting SAP S/4HANA with third-party logistics providers through SAP Integration Suite, SAP Event Mesh, application programming interfaces, electronic data interchange, and asynchronous messaging. The proposed architecture enables logistics events such as shipment creation, warehouse updates, delivery confirmation, inventory changes, and transportation status to be published and consumed in near real time across participating systems. The framework is designed to reduce integration complexity while supporting interoperability between SAP environments and heterogeneous 3PL platforms. Its expected operational benefits include improved shipment visibility, faster transportation planning, better warehouse synchronization, reduced manual intervention, and more responsive customer service. The study also examines architectural requirements related to message routing, data transformation, security, monitoring, exception handling, and system resilience. By combining event-driven communication with established enterprise integration technologies, the proposed framework provides a scalable approach for improving coordination between manufacturers, distributors, and logistics service providers in increasingly dynamic supply chain environments.

Keywords: SAP S/4HANA, SAP Integration Suite, SAP Event Mesh, event-driven architecture, third-party logistics, 3PL integration, supply chain integration, asynchronous messaging, logistics information systems

1. Introduction

Global supply chains have become increasingly interconnected, digitally dependent, and time-sensitive, requiring organizations to exchange logistics information across multiple internal and external systems with minimal delay. Enterprises using SAP S/4HANA frequently depend on third-party logistics providers (3PLs) for transportation, warehousing, freight forwarding, order fulfillment, and shipment tracking. These relationships create a strong need for reliable system-to-system integration because logistics decisions depend on the continuous exchange of operational information such as delivery orders, shipment status, inventory movements, warehouse

confirmations, transport milestones, proof of delivery, and exception notifications. When these data exchanges are delayed or fragmented, organizations can experience poor shipment visibility, inefficient planning, duplicated activities, delayed customer responses, and increased operational costs.

Traditional SAP-to-3PL integrations have often relied on point-to-point interfaces, scheduled batch transfers, electronic data interchange, and tightly coupled middleware connections. Electronic data interchange remains important in logistics because it supports standardized business document exchange between trading partners and has historically improved coordination across supply chain networks[1]. However, conventional approaches can become difficult to manage when organizations work with several logistics providers using different technologies, data formats, communication protocols, and operational processes. As the number of integration connections increases, interface maintenance becomes more complex, while changes in one system may require corresponding modifications across several connected applications. Huo, et al.[2] identified integration barriers as an important challenge in relationships between organizations and third-party logistics providers, particularly where information exchange and process alignment are weak.

The importance of information integration is well established in supply chain research. Digitally enabled integration capabilities can improve coordination between firms and contribute to stronger operational performance by supporting timely access to information across organizational boundaries[3]. Similarly, Li, et al.[4] found that information technology implementation can strengthen supply chain integration and influence organizational performance. For 3PL providers specifically, technological capability is an important resource because logistics services increasingly depend on the ability to connect electronically with customers, exchange data accurately, and coordinate processes across different systems[5]. Information sharing and process coordination are therefore central to successful logistics outsourcing relationships[6].

An event-driven architecture provides an alternative to integrations that depend primarily on periodic polling or batch processing. In an event-driven environment, a meaningful business occurrence, such as the creation of a delivery, dispatch of a shipment, change in inventory, arrival at a warehouse, or confirmation of delivery, generates an event that can be transmitted immediately to interested applications. Rather than waiting for a scheduled data transfer, subscribed systems can react when the event occurs. Event-driven approaches therefore support faster information propagation, loose coupling between applications, and greater responsiveness. Overbeek, et al.[7] demonstrated how event-driven architecture can integrate information, processes, and services across supply chain participants, while Konovalenko and Ludwig[8] highlighted the broader importance of event processing for improving supply chain coordination and responsiveness. More recent research has also emphasized the connection between business processes and complex event processing in logistics environments[9].

Within the SAP ecosystem, event-driven logistics integration can be implemented through SAP S/4HANA, SAP Integration Suite, SAP Event Mesh, APIs, EDI interfaces, and asynchronous messaging. SAP S/4HANA acts as the enterprise transactional core, while SAP Integration Suite supports connectivity, message transformation, interface orchestration, and communication with heterogeneous partner systems. SAP Event Mesh provides a mechanism for publishing and subscribing to business events, allowing 3PL applications to receive relevant logistics updates without requiring direct synchronous interaction with the originating SAP process. APIs can support structured real-time service interactions, while EDI remains valuable where logistics partners depend on established standards and document-based communication. Combining these mechanisms creates a hybrid integration architecture capable of supporting both modern and legacy 3PL environments.

The need for this architecture is closely connected to supply chain visibility. Visibility depends on the availability and accessibility of timely information across supply chain partners[10,11]. Limited visibility can prevent organizations from identifying disruptions early, adjusting transportation plans, updating warehouse operations, or providing accurate information to customers. Digital interoperability is therefore becoming increasingly important as logistics networks involve multiple independent systems and organizations[12].

This study proposes an event-driven integration framework for connecting SAP S/4HANA with third-party logistics providers using SAP Integration Suite, SAP Event Mesh, APIs, EDI, and asynchronous messaging. The study focuses on how this architecture can support real-time logistics communication while reducing integration complexity and improving scalability. Particular attention is given to shipment visibility, transportation planning, warehouse synchronization, exception management, and customer service. The paper contributes by combining established supply chain integration principles with a modern event-driven enterprise architecture suitable for heterogeneous SAP-3PL environments **(Table 1)**.

Table 1: Integration Technologies Supporting SAP–3PL Logistics Communication.

Technology	Primary Role	Typical SAP–3PL Application	Main Contribution
SAP S/4HANA	Enterprise transaction and logistics processing	Deliveries, orders, inventory and transportation data	Provides core business data and logistics events
SAP Integration Suite	Integration and orchestration	Transformation, routing and partner connectivity	Connects heterogeneous SAP and 3PL systems
SAP Event Mesh	Event distribution and asynchronous messaging	Shipment, delivery and warehouse event publication	Supports loose coupling and near-real-time communication
APIs	Synchronous service interaction	Status queries, master data retrieval and business transactions	Enables controlled application-to-application access
EDI	Standardized document exchange	Shipping instructions, invoices and logistics documents	Supports established B2B communication
Asynchronous Messaging	Decoupled message exchange	Status updates, exceptions and logistics milestones	Improves resilience and reduces direct system dependency

Despite substantial research on supply chain integration, 3PL information sharing, EDI, visibility, interoperability, and event processing, an important gap remains at the intersection of these fields. Existing studies generally examine individual dimensions such as supply chain integration, 3PL relationships, information visibility, digital interoperability, or event processing. Pan, et al.[12], for example, identify digital interoperability as a major requirement for increasingly connected logistics systems. However, less attention has been given to a unified architecture that explains how SAP S/4HANA, SAP Integration Suite, Event Mesh, APIs, EDI, and asynchronous messaging can be combined specifically for real-time SAP–3PL logistics interoperability.

This research addresses that gap by developing an integrated event-driven architecture that connects established enterprise logistics processes with modern publish-subscribe communication while retaining support for APIs and EDI. The resulting framework is intended to improve shipment visibility, warehouse synchronization, transportation coordination, scalability, and responsiveness without creating excessive point-to-point integration complexity.

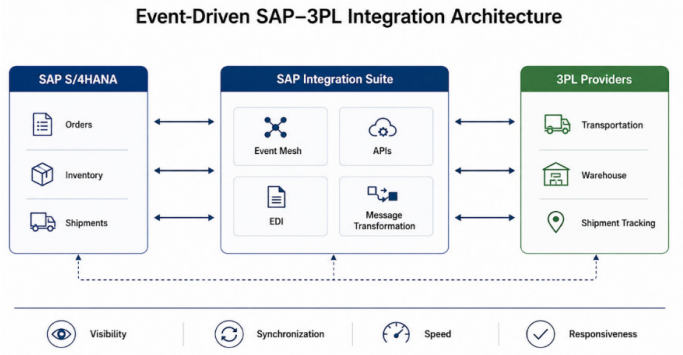

Figure 1: Event Driven SAP–3PL Integration Architecture.

The figure illustrates the proposed event-driven integration architecture connecting SAP S/4HANA with external third-party logistics providers through SAP Integration Suite and SAP Event Mesh. APIs, EDI, message transformation, and asynchronous event exchange support real-time shipment visibility, warehouse synchronization, transportation coordination, and faster operational responsiveness.

2. Proposed Event-Driven SAP–3PL Integration Architecture

proposed architecture establishes a loosely coupled, event-driven integration environment that connects SAP S/4HANA with heterogeneous third-party logistics platforms through SAP Integration Suite, SAP Event Mesh, APIs, EDI, and asynchronous messaging. SAP S/4HANA functions as the primary enterprise transaction system in which logistics activities such as sales orders, outbound deliveries, inventory movements, transportation requirements, warehouse processing, and shipment confirmations are generated. Instead of depending entirely on scheduled batch transfers or direct point-to-point connections, relevant changes in these logistics processes are treated as business events that can be distributed rapidly to external logistics partners. This approach supports greater responsiveness while reducing the technical dependencies that normally arise when several 3PL systems are connected directly to the enterprise resource planning environment.

The event flow begins when a significant logistics activity occurs within SAP S/4HANA. Events may include delivery creation, goods issue, shipment release, inventory adjustment, warehouse confirmation, transportation delay, arrival notification, or proof of delivery. Once generated, the event is published to SAP Event Mesh, which operates as the messaging layer between event producers and consumers. Events are organized and routed according to defined topics and subscriptions so that individual 3PL applications receive only information relevant to their operational responsibilities. This publish-subscribe approach allows multiple logistics systems to consume the same event without requiring SAP S/4HANA to maintain separate direct connections with every external application. Event processing is particularly valuable in logistics environments where rapid recognition of changing operational conditions can support better coordination and decision-making[8,9].

SAP Integration Suite provides the broader integration layer required to connect these events with different partner technologies. APIs can support direct service requests and real-time access to selected business information, while EDI remains suitable for standardized logistics documents exchanged with established trading partners. Message transformation capabilities enable SAP data structures to be converted into formats accepted by external warehouse management systems, transportation management systems, freight platforms, and tracking applications. This hybrid approach is important because 3PL providers vary considerably in technological maturity and integration capability. Digital interoperability therefore requires architectures capable of accommodating multiple standards, systems, and communication models[12].

Security and operational control are incorporated across the architecture through authenticated system connections, authorization policies, encrypted communication, controlled API access, event-level monitoring, logging, and exception management. Failed messages can be detected, retained, retried, or redirected for investigation rather than being silently lost. Monitoring also supports traceability by allowing administrators to determine whether a logistics event was generated, transmitted, transformed, and successfully consumed by the intended partner.

The complete process operates bidirectionally. SAP S/4HANA can publish shipment or warehouse instructions to 3PL providers, while logistics partners can return transportation milestones, inventory updates, delivery confirmations, and exceptions. These updates can subsequently trigger additional enterprise processes or customer notifications. The resulting architecture creates a continuous information flow across organizational boundaries, strengthening shipment visibility, warehouse synchronization, transportation coordination, and service responsiveness while reducing reliance on tightly coupled interfaces.

The figure compares traditional and event-driven SAP–3PL integration across key logistics performance dimensions, including real-time visibility, integration speed, scalability, warehouse synchronization, transportation coordination, and error responsiveness. The conceptual scores illustrate the expected improvement achieved through event-driven integration.

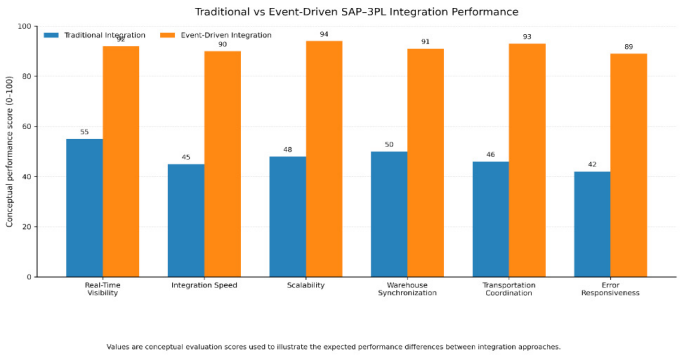

Figure 2: Performance Comparison of Traditional and Event-Driven SAP–3PL Integration.

3. Framework Evaluation and Logistics Performance Impact

The proposed event-driven SAP–3PL integration framework can be evaluated according to its ability to improve information timeliness, logistics coordination, system scalability, operational reliability, and responsiveness across enterprise and third-party logistics environments. Traditional logistics integration frequently depends on batch processing, scheduled file transfers, EDI exchanges, or tightly coupled point-to-point interfaces. Although these mechanisms remain useful for structured business transactions, they may delay the propagation of operational changes when logistics processes require immediate system responses. Event-driven integration addresses this limitation by enabling business events generated in SAP S/4HANA or external 3PL systems to be distributed to relevant applications as soon as significant logistics changes occur.

Real-time shipment visibility represents one of the most important expected benefits of the framework. Shipment visibility depends on the timely availability of accurate operational information across supply chain participants[10,11]. Under an event-driven model, milestones such as shipment creation, goods issue, carrier pickup, departure, arrival, delay, delivery, and proof of delivery can generate events that are distributed to subscribed systems. This reduces dependence on repeated status requests or scheduled synchronization. SAP users, logistics planners, customer-service personnel, and connected applications can therefore receive updated shipment information more rapidly. Improved event availability can also support earlier identification of transportation exceptions and deviations from planned delivery schedules.

The framework can also strengthen transportation planning and execution synchronization. Transportation processes frequently involve multiple parties, including manufacturers, carriers, freight forwarders, distribution centers, and logistics service providers. When changes in delivery schedules, vehicle availability, shipment status, or transportation requirements are not communicated promptly, planning decisions may be based on outdated information. Event-driven communication enables transportation-related events to trigger downstream actions without waiting for batch synchronization. For example, a shipment delay reported by a 3PL platform can immediately initiate an update within the integration environment and notify applications responsible for transportation planning, customer communication, or exception management. Such coordination supports the broader role of digital integration in improving supply chain performance identified by Rai, et al.[3] and Li, et al.[4].

Warehouse and inventory coordination can similarly benefit from continuous event exchange. Warehouse operations rely on accurate information about inbound deliveries, outbound shipments, inventory movements, picking activities, goods receipt, and stock availability. A mismatch between enterprise records and 3PL warehouse information can result in inaccurate inventory visibility, delayed replenishment, or incorrect customer commitments. Within the proposed framework, inventory and warehouse events can be transmitted between SAP S/4HANA and external warehouse management systems through SAP Integration Suite and SAP Event Mesh. This creates a more synchronized representation of logistics activity across organizational boundaries and supports the type of information-sharing capability emphasized by Valashiya and Luke[13].

Another evaluation dimension concerns integration latency and manual processing. Batch-based integrations introduce an inherent delay because information is processed according to predefined schedules rather than the occurrence of business events. Manual activities may also arise when employees must reconcile inconsistent data, investigate missing messages, or transfer information between disconnected applications. Event-driven messaging can reduce this delay by allowing events to move through the integration environment immediately after publication. APIs, EDI, and message transformation can still be used where appropriate, but SAP Integration Suite provides a common orchestration layer that reduces the requirement for separate integration logic for every connection. Cloud-enabled process integration has been associated with improvements in supply chain performance, particularly where integration technologies improve information flow across organizational systems[14].

Reliability, scalability, and resilience are equally important because logistics integration environments may involve large numbers of messages and multiple external partners. Asynchronous communication reduces the requirement for producing and consuming systems to be simultaneously available. Events can be placed within messaging queues and processed according to subscription and routing rules, thereby reducing direct dependencies between applications. As new logistics providers or applications are introduced, they can subscribe to relevant event streams without requiring substantial modifications to the original event-producing system. This provides greater scalability than an architecture dominated by individual point-to-point interfaces. Event processing also supports the detection of changing supply chain conditions and facilitates more responsive system behavior[8].

The operational impact extends to customer service and supply chain responsiveness. Accurate logistics information allows customer-service teams to provide more reliable shipment updates, identify delivery exceptions earlier, and respond more effectively to customer inquiries. Faster information exchange can also support proactive notification when transportation disruptions occur. Leuschner, et al.[15] demonstrate that effective relationships with third-party logistics providers can contribute to broader organizational performance, while Liu and Lee[6] associate integration with supply chain resilience and service performance in 3PL environments. Consequently, the proposed architecture should be assessed not only in terms of technical

integration efficiency but also according to its effect on operational outcomes.

Evaluation of the framework can therefore combine technical and logistics performance indicators. Relevant measures include event-to-consumption latency, message processing success rate, shipment visibility timeliness, inventory synchronization accuracy, integration availability, exception recovery time, number of manual interventions, partner onboarding effort, and customer-status response time. These indicators provide a structured basis for comparing event-driven integration with batch-based and point-to-point approaches. The proposed evaluation is conceptual rather than an empirical benchmark; therefore, performance values used in graphical comparisons should be interpreted as illustrative indicators of expected architectural differences rather than experimentally measured results **(Table 2)**.

Table 2: Comparison of SAP–3PL Integration Approaches.

Evaluation Dimension	Batch-Based Integration	Point-to-Point Integration	Event-Driven Integration
Information Exchange	Periodic and scheduled	Direct system-to-system	Continuous event-based exchange
Integration Latency	Relatively high	Low to moderate	Low
Real-Time Visibility	Limited	Moderate	High
System Coupling	Moderate	High	Low
Scalability	Moderate	Limited as connections increase	High
Partner Onboarding	Requires batch/interface configuration	Requires dedicated connection	Subscription and reusable integration patterns
Warehouse Synchronization	Periodic	Near real time for specific interfaces	Near real time across subscribed systems
Transportation Updates	Delayed until batch execution	Fast but connection dependent	Immediate event propagation
Failure Handling	Often dependent on batch reprocessing	Interface-specific	Queue, retry, monitoring, and exception mechanisms
Manual Intervention	Moderate to high	Moderate	Reduced
Integration Complexity	Increases with data flows	High with multiple partners	Reduced through loose coupling
Operational Responsiveness	Low to moderate	Moderate to high	High

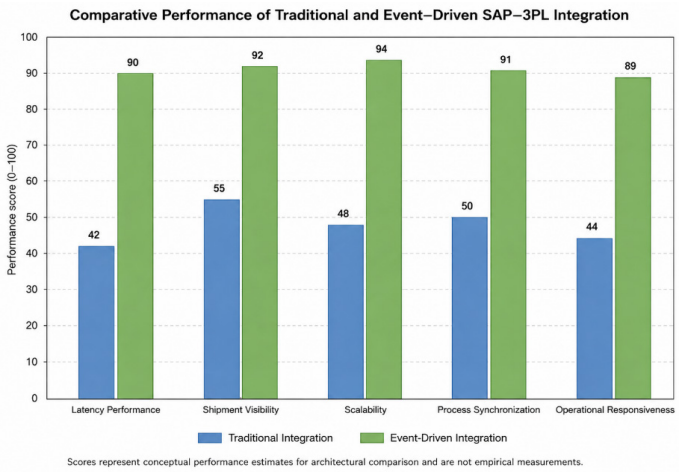

Figure 3: Comparative Performance of Traditional and Event-Driven SAP–3PL Integration.

The figure compares traditional and event-driven SAP–3PL integration across latency performance, shipment visibility, scalability, process synchronization, and operational responsiveness. The conceptual scores indicate the expected advantages of event-driven integration in supporting faster information exchange, improved visibility, stronger scalability, better synchronization, and more responsive logistics operations.

4. Discussion

The proposed event-driven SAP–3PL integration framework demonstrates how modern enterprise integration technologies can address persistent coordination problems between SAP S/4HANA environments and external logistics providers. The framework is particularly relevant in supply chains where transportation, warehousing, shipment tracking, and inventory activities are distributed across several independent systems. Traditional batch-based and point-to-point integrations can support basic information exchange, but they often create delays, technical dependencies, and maintenance difficulties when the number of logistics partners increases. By combining SAP Integration Suite, SAP Event Mesh, APIs, EDI, and asynchronous messaging, the proposed architecture provides a more flexible model for exchanging logistics information across heterogeneous platforms.

One of the most important implications of the framework is the shift from periodic data exchange to continuous event-based communication. In traditional environments, shipment or warehouse information may only become available after a scheduled interface has executed. In an event-driven architecture, changes such as goods issue, shipment departure, warehouse receipt, transportation delay, inventory adjustment, or delivery confirmation can immediately generate events for subscribed systems. This supports faster operational awareness and improves the timeliness of decisions. The approach is consistent with the wider literature on event processing, which emphasizes the value of detecting and responding to significant supply chain events as they occur[8,9].

The framework also has important implications for interoperability and scalability. Logistics ecosystems frequently involve 3PL providers with different levels of technological maturity. Some partners may support modern REST APIs and event subscriptions, while others continue to depend on EDI or established message formats. A major strength of SAP Integration Suite is therefore its ability to support multiple integration patterns within the same architecture. Event-driven communication does not eliminate APIs or EDI; instead, these technologies are combined according to business and technical requirements. This hybrid approach is especially important because effective digital interoperability depends on the ability to connect diverse systems without forcing every participant to adopt the same technology[12].

From an operational perspective, the proposed model can improve shipment visibility, transportation synchronization, warehouse coordination, and customer responsiveness. More timely information allows logistics planners to respond earlier to disruptions, warehouse teams to maintain better alignment between physical and digital inventory records, and customer-service personnel to provide more accurate shipment information. These benefits reflect the importance of information sharing and integration identified in previous 3PL and supply chain studies[13,16,17].

However, successful implementation also depends on governance, security, data quality, event standardization, monitoring, and partner readiness. Poorly designed event structures or inconsistent identifiers can reduce interoperability even when modern technology is used. Organizations must therefore establish clear event definitions, access controls, monitoring policies, retry procedures, and integration ownership. The proposed framework should consequently be viewed as both a technical and organizational model. Its value depends on combining suitable SAP technologies with disciplined governance and coordinated logistics processes. Future empirical studies should test the framework using real transaction data, measured integration latency, message volumes, onboarding effort, exception recovery times, and logistics service outcomes.

5. Conclusion

This study presented an event-driven architecture for integrating SAP S/4HANA with third-party logistics providers through SAP Integration Suite, SAP Event Mesh, APIs, EDI, and asynchronous messaging. The proposed framework addresses limitations associated with batch processing and tightly coupled point-to-point interfaces by enabling logistics events to be published, routed, transformed, and consumed across heterogeneous systems in near real time.

The architecture offers potential improvements in shipment visibility, transportation coordination, warehouse synchronization, scalability, integration resilience, and customer-service responsiveness. It also supports different levels of partner technological capability by combining event-driven communication with established API and EDI integration methods. This hybrid approach is particularly suitable for complex logistics ecosystems involving multiple external service providers.

The study further highlights that effective SAP–3PL interoperability requires more than technical connectivity. Security, governance, event standardization, monitoring, exception management, and data quality remain essential for reliable operation. Overall, the framework provides a practical foundation for developing more responsive and scalable SAP-centered logistics networks. Future research should validate its performance through real-world implementations and empirical comparison with traditional integration approaches.

6. References

1. Hill CA, Scudder GD. The use of electronic data interchange for supply chain coordination in the food industry. Journal of Operations Management, 2002;20: 375-387.
2. Huo B, Zhao X, Wang Q, et al. Barriers to third-party logistics integration: Empirical evidence from China. Industrial Management & Data Systems, 2017;117: 1738-1760.
3. Rai A, Patnayakuni R, Seth N. Firm performance impacts of digitally enabled supply chain integration capabilities. MIS Quarterly, 2006;30: 225-246.
4. Li G, Yang H, Sun L, et al. The impact of IT implementation on supply chain integration and performance. International Journal of Production Economics, 2009;120: 125-138.
5. Lai F, Li D, Wang Q, et al. The information technology capability of third-party logistics providers: A resource-based view and empirical evidence from China. Journal of Supply Chain Management, 2008;44: 22-38.
6. Liu CL, Lee MY. Integration, supply chain resilience, and service performance in third-party logistics providers. The International Journal of Logistics Management, 2018;29: 5-21.
7. Overbeek S, Janssen M, Tan YH. An event-driven architecture for integrating information, processes and services in a plastic toy supply chain. International Journal of Cooperative Information Systems, 2102;21: 343-381.
8. Konovalenko I, Ludwig A. Event processing in supply chain management: The status quo and research outlook. Computers in Industry, 2019;105: 229-249.
9. Ramos-Gutiérrez B, Reina Quintero AM, Parody L, et al. When business processes meet complex events in logistics: A systematic mapping study. Computers in Industry, 2023;144: 103788.
10. Barratt M, Oke A. Antecedents of supply chain visibility in retail supply chains: A resource-based theory perspective. Journal of Operations Management, 2007;25: 1217-1233.
11. Somapa S, Cools M, Dullaert W. Characterizing supply chain visibility: A literature review. The International Journal of Logistics Management, 2018;29: 308-339.
12. Pan S, Trentesaux D, McFarlane D, et al. Digital interoperability in logistics and supply chain management: State-of-the-art and research avenues towards Physical Internet. Computers in Industry, 2021;128: 103435.
13. Valashiya MC, Luke R. Enhancing supply chain information sharing with third party logistics service providers. The International Journal of Logistics Management, 2023;34: 1523-1542.
14. Shee H, Miah SJ, Fairfield L, et al. The impact of cloud-enabled process integration on supply chain performance and firm sustainability: The moderating role of top management. Supply Chain Management: An International Journal, 2018;23: 500-517.
15. Leuschner R, Carter CR, Goldsby TJ, et al. Third-party logistics: A meta-analytic review and investigation of its impact on performance. Journal of Supply Chain Management, 2014;50: 21-43.
16. Jayaram J, Tan KC. Supply chain integration with third-party logistics providers. International Journal of Production Economics, 2010;125: 262-271.
17. Liu C, Zhao X, Liu S, et al. Effect of information sharing and process coordination on logistics outsourcing. Industrial Management & Data Systems, 2015;115: 41-63.
18. Evangelista P, McKinnon A, Sweeney E. Technology adoption in small and medium-sized logistics providers. Industrial Management & Data Systems, 2013;113: 967-989.
19. Angeles R, Nath R, Hendon DW. An empirical investigation of the level of electronic data interchange (EDI) implementation and its ability to predict EDI system success measures and EDI implementation factors. International Journal of Physical Distribution & Logistics Management, 1998;28(9/10): 773-793.