10.48047/jocaaa.2026.35.01.58

Hybrid Automation Framework Integrating Low-Code Platforms and Custom Analytics for Supply-Chain Workflow Optimization

Nitheesh Yennampelly
Independent Researcher, USA

Received: 10.12.2025	Revised: 13.1.2026	Accepted: 31.1.2026

Abstract
The growing complexity of supply-chain operations necessitates sophisticated workflow automation solutions that balance accessibility with analytical power. Contemporary fulfillment environments demand integration of low-code platforms with custom programming capabilities to address diverse operational requirements spanning receiving, storage allocation, order picking, and returns processing. A modular framework architecture incorporates visual workflow orchestration, embedded analytical scripts, version control systems, and continuous deployment pipelines to ensure maintainability and scalability. Implementation across warehouse processes demonstrates substantial improvements in processing velocity, accuracy levels, and labor utilization patterns. Digital transformation initiatives enable real-time data synchronization across enterprise systems, eliminating information silos that historically fragmented operational visibility. The democratization of automation development through low-code technologies empowers domain experts to construct solutions directly, while specialized programming capabilities address advanced optimization requirements. Organizational impacts extend beyond operational metrics to encompass workforce development, cross-functional collaboration models, and economic sustainability through improved cost structures. Future trajectories point toward intelligent systems incorporating artificial intelligence for predictive analytics, autonomous decision-making, and continuous self-improvement, fundamentally reshaping supply-chain operational paradigms toward adaptive, resilient networks.

Keywords: Workflow Automation, Supply-Chain Operations, Low-Code Platforms, Hybrid Architecture, Intelligent Logistics

1. Introduction to Supply-Chain Workflow Automation
The present-day supply-chain environment requires new standards of efficiency in operations and decision-making precision. The contemporary fulfillment functions are rapidly increasing, pressured by the growth of e-commerce, the complexity of global logistics, and real-time customer demands. Warehouse automation refers to a continuum of technologies that are aimed at streamlining the process of material handling, inventory management, and order fulfillment. These systems are simple conveyors operated mechanically, and advanced robotic picking machines and smart software platforms that coordinate the intricate workflow operations [1]. The overall goal is the same in all the implementations: To minimize manual intervention in repetitive work and increase accuracy and throughput in warehouse operations.
The digital transformation of warehouse management systems is a vital development of the paper-based processes of the past into the combined technological environment. Installation of the modern warehouse management system presupposes the full computerization of the inventory tracking, order processing, and

10.48047/jocaaa.2026.35.01.58

resource allocation operations. This change is not just a matter of software adoption, but it is also a matter of radical operational processes and data governance framework, and the skill needs of a workforce. Companies that adopt digital warehouse management systems have to overcome such hurdles as the integration of legacy systems, data quality assurance, and management of change among the functional teams used to working according to predetermined procedures [2]. The transformation involves intensive investments in technology infrastructure, employee training sessions, and process redesign efforts to streamline operational processes to match digital capacities.

The issue of manual data processing remains a major weakness in the operations of fulfillment. Conventional warehouse practice has adopted human input to handover data to the system, verify and update the system, which has developed numerous entry points through which operational systems can introduce errors into the workflow. These manual touches cause discrepancies in inventory records, slowness in order processing, and quality control problems that ripple throughout the chain of supply. The economic consequences do not just involve the cost of short-term correction but long-term effects of the loss of customers and brand loyalty. Additionally, manual processes have linear scalability limits, and to handle any increase in volume, a proportional increase in manpower is necessary, which is an economically unsustainable model of economic operation during peak operational seasons. The automation necessity is not only related to the cost-cutting goal but to the strategic need to remain competitive in the services offered by the company in a constantly demanding market environment where the speed and accuracy of fulfillment have a direct impact on customer satisfaction and retention rates.

2. Evolution and Convergence of Automation Technologies

Historically, the future trends in warehouse automation technologies have been characterized by a shift of the solutions that are isolated and task-specific solutions to integrated and analytically capable systems. Modern fulfillment processes use a variety of automation systems in the mechanical, robotics, and software fields. Automated storage and retrieval systems give a high-density storage system with computer control in the placement and extraction of the inventory. A conveyor system helps in transporting materials within facilities and links receiving docks and storage zones, and shipping stations. Picking tasks are under the control of the robotic technologies, the articulated arms and mobile robots move within the warehouse setting to extract items to complete the orders [1]. These physical automation systems are working together with software platforms that coordinate workflows, allocate resources efficiently, and give insight into operational performance metrics.

The introduction of low-code development platforms has become a model shift to accessibility and deployment of analysis flow velocity. These data transformation pipelines are built by domain experts who do not have much programming experience using intuitive interfaces, rather than writing actual code. The democratization of the software development facilities enables the personnel to directly handle the workflow inefficiencies without the heavy use of specialized IT assets. Low-code platforms help in quick prototyping and refining process automation and compress development cycles that used to take months or more to be completed in weeks or even days. This flexibility is especially beneficial in supply-chain settings where the operational needs are constantly changing in reaction to market conditions, client demands, and changes in the business strategy [5]. The availability of low-code solutions enables citizen developers, business users who have domain-specific knowledge, to directly transfer their operational insight into automated solutions without being translated by technical experts.

At the same time, the open-source programming environment became much more mature, and languages and libraries offered advanced statistical analysis, machine learning, and optimization. Combining custom

10.48047/jocaaa.2026.35.01.58

code and visual workflow systems forms hybrid structures, which maintain the portability benefits of a low-code development environment and have access to all the computational benefits of a general-purpose programming language. Convergence allows organizations to apply the multifaceted logic of analysis to automated processes, surpassing the functionality of platform tools themselves. The mix is especially effective in applications in supply-chain management that need more sophisticated algorithms to optimize routes, forecast demand, or allocate inventory that is beyond the competency of more traditional applications of business intelligence [6].

Period	Technology Type	Primary Capability	User Accessibility
Early Era	Robotic Process Automation	Task-specific repetitive operations	Low - Technical specialists only
Mid-2010s	Automated Storage/Retrieval	High-density inventory management	Medium - Trained operators
Mid-2010s	Low-Code Platforms	Visual workflow development	High - Domain experts
Late 2010s	Hybrid Architecture	Integrated analytics with visual design	High - Citizen developers
Current	AI-Enabled Systems	Predictive and adaptive optimization	Variable - Mixed user base

Table 1: Automation Technology Evolution Timeline [1, 5, 6, 10]

3. Architectural Framework for Hybrid Automation

The framework proposed has a multi-layered architecture in place to ensure the modularity, maintenance, and scalability of various processes in a warehouse. The base layer ensures the creation of overall process mapping, where the visual flow charts will be used to record the end-to-end operational processes of receiving to shipping. This mapping activity is used to determine the automation candidates using repetitions of tasks, patterns of dependencies on data, and complexity of decision logic. At this level, process documentation will generate organizational knowledge artifacts, which will minimize reliance on employee expertise as well as support systematic improvement initiatives. The mapping methodology is applied to the flows of materials and also to the information flows, as it is clear that successful warehouse automation is expected to cover information flow as well as the physical movement of goods.

Low-code process orchestration platforms offer the technical basis for executing the mapped workflows in an executable form. These platforms provide a visual development platform where logic can be developed by dragging and dropping configurations instead of coding. Process orchestration tools align the activities of different systems and initiate action according to business rules, and direct data between applications. The architectural design focuses on modularity, whereby the reusable units capture the common patterns of operation like data validation, exception processing, and generation of notification [5]. This modularity allows the application of uniform business logic to a number of workflows and also easier maintenance with centralized component controls. As business rules vary, the change in the shared components is automatically reflected in all the related workflows, which will be consistent and will be less effort-consuming to implement.

This capability to add custom programming allows the analysis of the low-code platforms to go further than what they offer. Organizations integrate codes into visual workflows to access professional libraries of mathematical optimization, statistical modeling, and sophisticated data transformations. This hybrid

10.48047/jocaaa.2026.35.01.58
architecture allows transparency of workflows by visual representations that are understandable by the operational stakeholders, but has more advanced algorithms where analytical complexity requires programmatic flexibility. Python programming language is a specific language that is especially beneficial to visual workflow systems, and provides comprehensive libraries of data processing, numerical processing, and graphical analyses applicable to supply-chain optimization challenges [6].

Architecture Layer	Primary Function	Key Technology	Output Deliverable
Process Mapping	Workflow documentation	Visual flow diagrams	Automation candidate identification
Orchestration Platform	Workflow execution	Low-code visual tools	Modular reusable components
Analytics Integration	Advanced computation	Python embedded scripts	Optimization algorithms
Version Control	Change management	Git repositories	Tested workflow versions
Deployment Pipeline	Automated testing	Continuous integration tools	Production-ready systems

Table 2: Framework Architecture Layer Components [5, 6, 9]

4. Process-Specific Implementation Strategies

Its application in the key processes of the warehouse shows how the framework can be used in various operational settings. The application programming interface makes it easy to transfer data to and from applications, management systems, and external systems such as e-commerce storefronts, enterprise resource planning systems, and customer relationship management applications. The current APIs provide real-time availability of inventory status, order status, and fulfillment tracking data on the digital ecosystem underpinning omnichannel commerce. RESTful API designs offer uniform ways to interrogate data and initiate an action that makes warehouse systems exchange information with other partner platforms irrespective of their technical infrastructural realizations [7]. This interoperability is critical in keeping inventory accuracy across the sales channels and giving customers real-time order status across the fulfillment lifecycle.

The integration of a warehouse management system with enterprise resource planning platforms generates a single exposure across procurement, inventory management, and financial accounting capabilities. With this integration, information silos that have fragmented operational data in disconnected systems in the past are eliminated. The best practices of integration between warehouse-ERP focus on real-time data synchronization, not on batch synchronization, to make sure inventory transactions are recorded in financial records and procurement planning algorithms. The integration architecture should include the data mapping of systems that have different schema structures, error handling in case of network failures or system failures, and the audit trails showing all data transfers to be used in compliance and troubleshooting purposes [8]. Effective integration entails coordination of operational teams operating in the warehouse processes with IT personnel handling system architecture, with well-defined data governance protocols that define ownership and accountability of data quality in the integrated platforms.

Algorithmic route sequence optimisation and wave batching logic are useful in picking operations. Warehouse layouts can be converted into network graphs, and path-finding algorithms can be applied to find the minimum-distance path across the storage objects. These optimizations minimize picker travel

10.48047/jocaaa.2026.35.01.58

time, doubling throughput and saving labor at the same time, maintaining physical strain on warehouse operators to a minimum. The workflows of returns processing include condition assessment logic, which directs merchandise to suitable disposition paths, namely: resaleable to active inventory, damaged goods to operations of salvage, and defective products to quality investigation processes. Every process implementation has regular architectural patterns and flexible process logic requirements. The modular nature of the framework enables organizations to engage in the process of automation in stages, with the high-volume processes that can be used as a quick payback to the investment being made being implemented initially before the coverage can be expanded to other areas of operation within the organization as the organization grows in capacity.

Integration Type	Connected Systems	Synchronization Method	Primary Benefit
API Integration	WMS-Ecommerce	Real-time RESTful interfaces	Omnichannel inventory accuracy
ERP Linkage	WMS-Financial Systems	Continuous data synchronization	Unified operational visibility
Data Mapping	Cross-platform schemas	Structural transformation protocols	Seamless information exchange
Error Handling	Network/System failures	Automated retry mechanisms	Operational resilience
Audit Trails	All system exchanges	Transaction logging	Compliance documentation

Table 3: Enterprise System Integration Patterns [7, 8]

5. Integration of Version Control and Continuous Deployment

The implementation of software engineering principles in the analytical processes is a crucial step in the effectiveness of operations and cooperation within a team. Logistics applications that depend on data pipelines should be designed, tested, and deployed in a systematic manner that resembles the software development processes. Version control systems keep a full history of changes in workflow definitions and embedded modules of code, allowing teams to follow changes, comprehend the reasoning behind decisions, and undo the incorrect changes when required. The practice will turn weak and unrecorded workflows into managed software assets that have a visible provenance and accountability. Version control comes in especially handy in a collaborative setting where different analysts work on common workflow repositories [9]. Branching lets workflow improvements be developed in parallel without affecting production systems, and merge protocols keep contributions integrated with all respectable cleanliness.

The continuous integration and deployment pipelines are automated testing protocols, ensuring that the workflow is correct before production deployment. Automated test suites run workflows on synthetic datasets whose expected results are known to be correct, and ensure that data transformations give the expected results and that error-handling code is operating as intended. The methodical test procedure identifies a problem in integration during the early development process and before it can be introduced to the production stages, where it will cause havoc to the operations and loss of trust among the stakeholders. The testing architecture consists of several layers of validation: unit tests are done to ensure

10.48047/jocaaa.2026.35.01.58

a particular workflow component is functional in isolation, integration tests are done to ensure components communicate well, and end-to-end tests are done to ensure that the system behaves within realistic conditions. Deployment automation removes the manual deployment processes, which present the possibility of human error and, in the process, tests workflow versions, which are then deployed to production environments, as tested in testing environments.

The adoption of DevOps concepts in the sphere of analytics operations closes classical barriers between the development teams, which develop workflows, and the operations teams, which operate production systems. Such cultural and technical alignment also encourages shared responsibility towards system reliability, and development practices are focused on operational issues like monitoring, alerting, and graceful degradation when there are errors. The team-based method will help solve the issue to be solved faster in case there are anomalies in production since the development team will have direct access to operational metrics and logs that tell the debugging. Organizations that embrace these practices note significant progress in system reliability, shorter operational problems, and an increase in the velocity of the team when automation decreases the overhead costs of managing manual coordination of the development-to-deployment lifecycle.

DevOps Component	Implementation Method	Validation Approach	Organizational Impact
Version Control	Git repository management	Change history tracking	Workflow accountability
Branching Strategy	Parallel development paths	Merge conflict prevention	Collaborative development
Unit Testing	Component isolation tests	Synthetic dataset validation	Early defect detection
Integration Testing	Cross-component verification	End-to-end scenario simulation	System reliability assurance
Automated Deployment	CI/CD pipeline execution	Production environment consistency	Reduced deployment errors

Table 4: DevOps Implementation Framework [9]

6. Performance Evaluation and Operational Metrics

The effectiveness of the framework regarding enhancing the performance of the warehouse is validated through quantitative assessment on different operational dimensions. Artificial intelligence in logistics goes beyond mere automation and includes predictive analytics, prescriptive recommendations, and adaptive learning systems that can keep operational processes efficient. Machine learning algorithms are used to predict the patterns of demand using historical data on shipments and allow proactive inventory positioning, leading to low fulfillment latency. Predictive models of maintenance analyze sensor data of equipment to predict equipment failures and prevent them in advance, scheduling preventive interventions to reduce the amount of unplanned downtime. Computer vision systems are used to conduct quality control; products that are damaged or have defective packaging are detected with high accuracy compared to the human eye and the ability to perform a visual check [10]. These AI-based solutions change the reactive problem-solving approach of logistics operations to a proactive optimization, predicting the obstacles and taking corrective actions before the interference with the course of operations occurs.

10.48047/jocaaa.2026.35.01.58

The human aspect of automation implementation is just as important as the technical aspect. However, unlike the fear of job displacement, carefully used automation allows for increasing the quality of the workforce by decreasing the number of jobs that come with repetitive habits, significant physical work, and providing opportunities to concentrate on more valuable work that demands judgment and creativity. Employees move out of transactional execution jobs to supervisory jobs in which they are expected to manage automated systems, investigate exceptions that cannot be handled automatically, and participate in ongoing improvement efforts. This heightens workforce regimes to elevate job satisfaction and develop organizational capacity in the management of technology and optimization of processes [11]. The training programs equip the personnel with the changing role demands, acquisition of skills in monitoring of the systems, interpretation of data, and working towards solving problems mutually, but not in rivalry with each other.

7. Organizational and Economic Impact Analysis

The larger meanings of the automation structure implementation are not just in the short-term operational indicators but in the organization, human capital, and economic sustainability. The automated warehouse market boasts excellent growth trends, owing to the e-commerce growth, labor investment pressures, and technological maturity, which enhance the availability of solutions and profitability of investment. The market analyses can be characterized by significant and compound annual growth rates that have a multi-year character based on the recognition of automation as a strategic factor in various industries. The inflow of investment in warehouse automation technologies is growing faster since companies are trying to gain some competitive edge via operational efficiency, improvement of the level of service, and optimization of cost structure [12]. Economic calculus is not just the direct labor saved but the benefits such as improved accuracy levels of inventory, reduced fulfillment cycle time, and optimization of capacity used, which all contribute to the improved return on invested capital.

Organization effects are reflected in the formation of cross-functional teams that leverage the skills and capabilities of operations domains and technical implementation. The platforms of low-code technology make the application development process a democratic one, allowing business users to build solutions to their operational problems themselves. This empowerment will decrease reliance on centralized IT facilities, which have in the past formed bottlenecks when responding to changing business needs. The supply-chain organizations that use low-code environments claim better flexibility in customizing processes to market conditions, better employee involvement because staff members are engaged directly in improvement processes, and a faster increase in innovation cycles because of quicker movement of ideas to the operational phases [13]. The change that comes with the introduction of technology to a company is as significant as the technical capacities themselves, as it restructures power relations, communication patterns, and processes of innovation in enterprises.

The citizen developer phenomenon is a change in the workforce direction, a phenomenon that forms new positions that combine working experience and technical skills. The effective adoption, however, necessitates effective governance frameworks that manage the balance between innovation enablement and the right controls that provide security, compliance, and architectural congruency. Governance frameworks create a framework of development practices, a process of approvals of production deployments, as well as support resources to help citizen developers work around technical issues. The governance model should find fine balances between flexibility that promotes experimentation and structure that upholds organizational interests. Companies that attain this balance have experienced significant productivity as business-based development complements but does not substitute centralized

10.48047/jocaaa.2026.35.01.58

information technology functions, with each area bringing its strengths into the joint solution provision. Democratizing capacities of technology development effectively transform the organizational dynamics by making innovation capacity spread through the enterprises instead of being concentrated in the specialized functions.

8. Future Directions in Intelligent Automation

The course of warehouse automation is aimed at more autonomous systems relying on artificial intelligence to make adaptive decisions and improve itself. Efficient applications of intelligent automation in supply chains combine several technology layers that include robotic process automation of transactional processes, unstructured data interpretation with cognitive technologies, and advanced analytics with prediction and prescriptive decision-making. This stratified solution covers the entire range of operational complexity, both standard processes of data transfer and subtle decision-making processes that need contextual information. Companies that adopt an overall approach of intelligent automation note transformational effects not confined to a rise in efficiency, but also to business model innovations that can now be offered in ways previously unavailable without manual processes [14]. The combination of AI technology and physical automation systems results in self-optimizing adaptive fulfillment operations that change their operating pattern and optimize according to the observed operating conditions.

The principle of hybrid AI-human collaboration models acknowledges that the best operational performance is to be achieved when there are synergistic interactions between automated abilities and human judgment, instead of one-hundred-percent substitution of the traditional human workers with machines. In this paradigm of collaboration, tasks are delegated to either humans or machines according to relative advantages. Automation can perform repetitive high-volume work, where consistency and speed are important, whereas human beings can work on exceptions, where the problem-solving process must be creative, and the customer must be approached with empathy. The hybrid approach is especially useful in logistics scenarios where fluctuations in operations and the appearance of unforeseen circumstances often necessitate the use of adaptive reactions and responses instead of the fixed algorithmic behaviors [15]. This will need careful assignment of tasks, user-friendly interfaces that allow them to interact well with the machines, and organizational cultures that recognize the use of technology as an augmentation and not a threat to the security of the workforce.

The cognitive supply chain consulting strategies focus on creating robust, responsive supply chain networks that can withstand disruptions by ensuring greater visibility, predictive intelligence, and reconfiguring the network on demand. These strategic frameworks combine operational technology and analytical platforms and collaboration ecosystems that link trading partners. Cognitive supply chains use data provided by different sources, such as IoT sensors and transaction systems, among other external information feeds, to ensure overall situational awareness. This data is processed by highly sophisticated analytics platforms to discover patterns, forecast future states, and suggest the best course of action that would help in addressing usual optimization challenges as well as crisis response situations [16]. The vision includes supply chains that are experience-driven and that constantly review the operational parameters and strategic setups to enhance performance with time. Companies that seek cognitive supply chain competencies place themselves in a competitive advantage of surviving in a world full of uncertainty, where technological sophistication acts as a competitive advantage in more sophisticated global marketplaces.

10.48047/jocaaa.2026.35.01.58

Conclusion

The modern supply-chain operations demand advanced automation systems that combine low-code extreme simplicity with programmatic scalability. The modular structure that incorporates the visual workflow design, embedded analytic functions, version control discipline, and automated deployment processes provides a realizable enhancement of fulfillment operations. Companies that adopt these frameworks achieve significant improvements in the speed of processing, precision in operations, and labor effectiveness, and develop dynamic resources that are vital in overcoming the turbulence in the market. By democratizing the creation of automation, the operational staff have the power to fix process weaknesses at their own level and shorten the cycles of innovation and create cultures of continuous improvement. Nonetheless, effective implementations require keen interest in change management, governance frameworks that are flexible but that possess the right controls, and workforce development programs that equip staff with emerging new roles. Further change is made possible by future development towards cognitive supply chains with the introduction of artificial intelligence, predictive analytics, and the ability to make autonomous decisions. The strategic imperative involves the creation of strong adaptive networks of operations that can survive in the face of uncertainty by being technologically advanced. Companies that adopt hybrid automation systems make themselves competitive in terms of operational excellence, service differentiation, and economic sustainability. The way forward is the incremental implementation that starts with the high-impact processes, programmed enhancement of capabilities in both technical and operational areas, and a long-term commitment to adopting emerging technologies as the supply-chain complexity keeps increasing.

References

[1] Maureen Walsh, "Types of Automation Used in Fulfillment Warehouses," DCL, 2025. [Online]. Available: https://dclcorp.com/blog/fulfillment/automated-fulfillment/

[2] Natesan Andiyappillai, "Digital Transformation in Warehouse Management Systems (WMS) Implementations," International Journal of Computer Applications, 2020. [Online]. Available: https://www.researchgate.net/profile/Natesan-Andiyappillai/publication/339986803

[3] Alteryx Inc., "Alteryx One." [Online]. Available: https://help.alteryx.com

[4] Daniel Feltham-Lauzon, "Data Visualization for Decision-Making in Distribution and Logistics," ArcherPoint, 2025. [Online]. Available: https://archerpoint.com/data-visualization-decision-making-in-distribution-and-logistics/

[5] Kissflow, "Streamlining Business Operations: What Agility With Low-Code Process Orchestration Can Look Like," 2025. [Online]. Available: https://kissflow.com/blog/streamlining-business-operations-low-code-process-orchestration/

[6] Capitalize Analytics, "Alteryx and Python: Better Together." [Online]. Available: https://capitalizeconsulting.com/alteryx-and-python/

[7] Shopify, "Ecommerce APIs: Types and Integration Guide." [Online]. Available: https://www.shopify.com/enterprise/blog/ecommerce-api

[8] Monica Yadav, "Best Practices For Integrating Warehouse Management With ERP," DCKap, 2024. [Online]. Available: https://www.dckap.com/commerce/blog/best-practices-for-integrating-warehouse-management-with-erp/

[9] Donal Tobin, "How to Build Data Pipelines for the Logistics Industry - 2026," Integrate.io, 2025. [Online]. Available: https://www.integrate.io/blog/data-pipelines-logistics-industry/

10.48047/jocaaa.2026.35.01.58

[10] Element Logic, "The True Role of AI in Logistics." [Online]. Available: https://www.elementlogic.net/us/blogs/the-true-role-of-ai-in-logistics/

[11] Scott Cawood, "How Automation Is Making Work More Human," Forbes, 2023. [Online]. Available: https://www.forbes.com/sites/forbesbooksauthors/2023/09/12/how-automation-is-making-work-more-human/

[12] GrandViewResearch, "Warehouse Automation Market (2024 - 2030)." [Online]. Available: https://www.grandviewresearch.com/industry-analysis/warehouse-automation-market-report

[13] Trace, "Enhancing Supply Chain Management with Low-Code Technologies with Trace," 2024. [Online]. Available: https://www.traceconsultants.com.au/thinking/enhancing-supply-chain-management-with-low-code-technologies

[14] Brock Lambert, "How to spread intelligent automation and AI across your supply chain," EY, 2023. [Online]. Available: https://www.ey.com/en_us/alliances/intelligent-automation-for-supply-chains

[15] Tanmay Dashaputre, "Enhancing Logistics Efficiency through a Hybrid AI-Human Collaboration Model: A Case for Operational Optimization," SSRN Electronic Journal, 2024. [Online]. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4993111

[16] TCS, "TCS Cognitive Supply Chain Consulting." [Online]. Available: https://www.tcs.com/what-we-do/industries/retail/solution/resilient-supply-chain-retail-challenges