SSRG International Journal of Industrial Engineering
ISSN: 2349 – 9362 / https://doi.org/10.14445/23499362/IJIE-V12I3P101

Volume 12 Issue 3, 1-7, Sep-Dec 2025

Original Article

A Framework for Assessing the IT Readiness of Retail Warehouse Control Systems for Peak Season

Pankaj Jain

Senior Manager, Retail Supply Chain & Warehouse Control Systems, Accenture, San Francisco, California, USA.

Corresponding Author : pankajs.jain.udaipur@gmail.com

Received: 15 August 2025 Revised: 28 September 2024 Accepted: 16 October 2025 Published: 03 November 2025

Abstract *- During the holiday season, retail supply chains are challenged with managing increased order volumes, lower order processing times, and customer expectations. Warehouse Control Systems (WCS) operational resiliency and performance during this peak period are essential to maintaining fulfillment velocity and accuracy. This paper presents a Holiday Readiness Scorecard approach designed to assess the readiness of WCS within Retail Distribution Center (DC) environments. The scorecard evaluates the following six readiness dimensions: System Performance and Capacity, Integration Stability, Hardware Reliability, Operational Readiness, Monitoring and Support, and Contingency Planning. By measuring readiness across these six domains, the scorecard provides a framework for correlating system readiness, identifying system vulnerabilities, prioritizing mitigations, and aligning cross-functional teams during the holiday season. The adoption of the scorecard approach enables operational readiness based on data correlation and provides insight into business continuity during the retail industry's most critical season.*

Keywords *- Retail, Supply Chain, Distribution Centers (DCs), Material Handling Equipment (MHE), Warehouse Control System (WCS), Holiday Readiness Scorecard.*

1. Introduction

The holiday season is the most intense and strategically important time of year for retailers, often driving a large portion of their annual revenue. During this critical period, customer expectations for fast, accurate, and hassle-free order fulfillment are at their highest, putting significant strain on warehouse operations. At the heart of these operations is the Warehouse Control System (WCS), a vital part of the supply chain that manages real-time task execution across key material handling equipment like conveyors, sorters, scanners, and robotics. The performance, reliability, and responsiveness of the WCS are crucial to meeting Service Level Agreements (SLAs), handling spikes in order volume, and avoiding costly disruptions.

While much attention has been paid to both research and practice in Warehouse Management Systems (WMS), order management, and inventory strategies, the IT readiness of WCS during peak retail seasons has been largely overlooked. Most existing studies on warehouse performance focus on general operations or major seasonal events like Black Friday or Christmas, but they often lack a structured approach to evaluating the WCS's preparedness under high-pressure conditions. This gap is significant, especially considering the WCS serves as the central control layer for warehouse automation. When it fails during peak periods, the consequences can be severe: throughput slows, equipment experiences downtime, SLAs are missed, and customer satisfaction takes a hit, ultimately harming the brand's reputation.

Recent advancements in warehouse automation and digital supply chain management have increased the reliance on WCS as key drivers of speed and scalability. While WMS handles the broader coordination of orders and inventory, it is the WCS that delivers execution accuracy, synchronizing the movement of conveyors, sorters, Automated Storage and Retrieval Systems (AS/RS), and robotics to ensure everything runs smoothly and efficiently. Despite this pivotal role, most industry readiness assessments concentrate on upstream processes such as inventory positioning, labor planning, or transportation logistics. Academic research similarly emphasizes optimization of WMS algorithms or demand forecasting, with limited focus on the operational reliability of WCS under high-stress seasonal conditions. This imbalance highlights the need for a structured framework dedicated to evaluating WCS readiness in peak retail contexts.

When a warehouse control system is not properly prepared, the problems go beyond just slowing down operations. During busy times, even small glitches can quickly pile up, leading to delayed orders, missed shipping deadlines,

and lost revenue. In warehouses that rely heavily on automation, any downtime or reduced performance of the WCS does not just affect one area; it creates ripple effects that disrupt connected systems, too. For businesses, these issues mean missed sales, higher costs to fix problems quickly, and damage to customer confidence. On the research side, there is a clear need to develop practical tools and methods that help companies identify and reduce these risks before they happen. Creating a clear, consistent, and easy-to-use readiness assessment framework could help close the gap between theory and real-world application.

To tackle this gap, this paper presents the Holiday Readiness Scorecard, a framework created to evaluate how prepared warehouse control systems are in retail distribution centers. The scorecard covers six key areas: system performance and capacity, integration readiness, hardware and automation reliability, operational readiness, monitoring and support infrastructure, and contingency planning. Each area includes specific, measurable checkpoints that can be scored, giving a clear and thorough picture of potential risks and how strong the system is overall.

By incorporating this scorecard into seasonal planning, retail supply chain leaders can spot potential weak points ahead of peak periods, make smarter decisions about resource allocation, and improve coordination between operations and IT teams. In the bigger picture, this framework helps bridge the gap between research and real-world application, offering a practical tool to strengthen WCS readiness. The result is a more resilient, scalable, and customer-focused supply chain, especially crucial during the busiest and most demanding time of the retail year.

2. Literature Review

The efficiency of today's retail supply chains really relies on how well the WCS, WMS, and Material Handling Equipment (MHE) work together. These systems coordinate tasks in real time to make sure orders are fulfilled quickly and accurately. But during busy times like the holiday season, the pressure on these systems ramps up, making it crucial to fully understand how well they perform and how resilient they are under stress.

Research on warehouse automation, peak season planning, and system resilience provides important insights into the challenges warehouses face and why it is so crucial to assess readiness, especially during busy times like the holiday season.

2.1. Warehouse Automation and the Role of WCS

Warehouse automation plays a key role in improving throughput and reducing reliance on manual labor in distribution centers. A Warehouse Control System (WCS) is a type of software that acts as the brain of warehouse operations, coordinating activity between the Warehouse Management System (WMS) and the automated equipment on the floor. It essentially connects the high-level planning system with the machines that carry out the work [1]. While the Warehouse Management System (WMS) handles bigger pictures like tracking inventory, managing orders, and optimizing how the warehouse operates, the Warehouse Control System (WCS) takes care of the day-to-day, real-time control of equipment. This includes things like conveyors, sorters, robots, and automated vehicles. The WCS makes sure everything moves smoothly and stays coordinated on the floor. Together, they keep the whole warehouse running efficiently, with the WMS focusing on planning and strategy, and the WCS making sure the equipment actually gets the job done in the moment [1].

In short, the WCS acts as the real-time decision-maker that keeps conveyors, sorters, and other automated equipment working together smoothly and efficiently [2]. The WCS enables high-speed decision execution by translating WMS directives into executable commands, making its stability and responsiveness essential to overall system performance [3].

2.2. Holiday Season Supply Chain Dynamics

Peak season operations in retail are characterized by compressed timelines, exponential order volumes, and increased operational complexity. During high-demand periods such as Black Friday and Cyber Monday, distribution centers experience throughput levels up to 3–5 times the average daily volume [4]. Studies highlight that such seasonal peaks expose latent inefficiencies and can lead to system failures if preparedness is lacking, particularly in IT and automation infrastructure [5].

2.3. System Readiness and Risk Management

Despite the criticality of WCS in warehouse operations, literature on structured readiness assessments specific to WCS remains limited. Most frameworks focus broadly on supply chain resilience [6] or IT disaster recovery planning [7], without addressing the real-time operational nature of WCS. However, the concept of scorecards and readiness audits has proven effective in other domains, such as ITIL service readiness [8] and manufacturing systems [9]. These tools provide measurable checkpoints that support proactive planning, performance benchmarking, and cross-functional alignment.

2.4. Integration Challenges and System Interdependencies

The WCS rarely operates in isolation. It is tightly integrated with WMS, MHE, Transportation Management Systems (TMS), and various APIs. These integrations demand synchronized and low-latency data exchange to prevent cascading failures, especially during high-volume periods. As a result, integration stress testing and throughput validation have emerged as best practices in peak-readiness planning [10].

2.5. Gaps in Current Research

Although industry reports and vendor whitepapers provide anecdotal guidance on holiday readiness for warehouse systems, there is a notable lack of peer-reviewed, systematic frameworks that quantitatively assess WCS preparedness. Most existing studies focus on general supply chain resilience, WMS optimization, or IT disaster recovery planning, without considering the real-time operational and integration demands of WCS during peak periods. This gap is particularly critical because failures in WCS during high-demand seasons can lead to throughput bottlenecks, automation breakdowns, missed SLAs, and ultimately, decreased customer satisfaction. To address this gap, there is a need for a standardized, actionable methodology that allows organizations to assess, benchmark, and improve WCS readiness in a structured way. The present research proposes the WCS Holiday Readiness Scorecard, designed to fill this gap by providing measurable checkpoints across key operational, technological, and contingency dimensions, thereby enabling retailers to proactively identify vulnerabilities and strengthen system resilience during peak demand periods.

3. Methodology

This study uses a structured design-based research approach to develop and validate a Holiday Readiness Scorecard tailored specifically for Warehouse Control Systems (WCS) within retail supply chain environments. The methodology combines industry best practices, literature insights, and operational feedback to create a practical, scalable tool for readiness assessment during peak retail periods.

3.1. Framework Design

The scorecard was designed around six critical dimensions identified through literature review and expert consultations:

- System Performance and Capacity
- Integration Readiness
- Hardware and Automation Reliability
- Operational Readiness
- Monitoring and Support
- Contingency and Recovery Planning

Each category contains a set of quantitative and qualitative checkpoints. These checkpoints were formulated based on known system failure points, throughput constraints, and real-time operational dependencies common in warehouse environments during holiday surges. Below is a suggested structure of sub-items for each dimension, based on common best practices in warehouse control systems readiness during peak retail periods.

3.1.1. System Performance and Capacity

Focus: Ensures the WCS can handle peak loads efficiently

- Peak throughput capacity (e.g., orders/hour)
- System response time under load
- Database/query performance
- Communication latency
- High volume testing was conducted and passed
- System health check and capacity assessment
- Scalability (ability to scale up resources)

3.1.2. Integration Readiness

Focus: Ensures seamless communication between WCS and external systems (e.g., WMS, etc.).

- Connection/Interface testing with external systems
- Message queue handling and error logging
- Resilience via auto-restart mechanisms
- Failover mechanisms for integrations
- Documentation of data flow and dependencies

3.1.3. Hardware and Automation Reliability

Focus: Readiness and health of physical infrastructure and automation layers.

- Preventive maintenance status of MHEs, including conveyors, sorters, scanners, and robots
- Availability of critical spares
- Health check reports of PLCs and control systems
- Calibration status of automated scanners/sensors
- Health check of IT Hardware

3.1.4. Operational Readiness

Focus: Ensures people, processes, and SOPs are prepared.

- Staff training and shift planning completed
- SOPs updated for peak season scenarios
- IT/Business subject matter experts available
- Weekend maintenance scheduled defined
- Change management freeze periods are defined

3.1.5. Monitoring and Support

Focus: Ability to detect, alert, and resolve issues quickly.

- Real-time dashboards in place
- Alerting and escalation protocols tested
- 24/7 support coverage (internal + vendor)
- SLA agreements with vendors/support teams
- Monitoring tools (e.g., Splunk, Dynatrace)

3.1.6. Contingency and Recovery Planning

Focus: Preparedness for handling failures and restoring operations quickly.

- Documented and tested disaster recovery plan
- Backup frequency and integrity checks
- Alternate workflows for manual processing
- Communication plan during system outages
- Incident response roles & responsibilities assigned

3.2. Scoring System Development

A 5-point Likert scale was developed to quantify readiness for each checkpoint:

- 1 = Not Started
- 2 = In Progress (Major Gaps)
- 3 = Partially Ready (Some Risk)
- 4 = Mostly Ready (Minor Risk)
- 5 = Fully Ready (No Known Gaps)

Each category contributes equally to the total readiness score, resulting in a maximum of 90 points. To support intuitive decision-making, a color-coded risk interpretation system (Green/Yellow/Red) was created to simplify decision-making for operations and IT leadership.

- Green (High Readiness, 70–90 points): The WCS is well prepared for holiday peaks with only minor residual risks.
- Yellow (Moderate Readiness, 50–69 points): Some vulnerabilities remain; targeted remediation required.
- Red (Low Readiness, <50 points): Significant readiness gaps exist; urgent action is needed before peak season.

This scoring framework provides both granular checkpoint-level insights and an aggregate risk signal, enabling operations and IT leadership to prioritize interventions effectively.

The overall framework and scoring workflow of the WCS Holiday Readiness Scorecard are summarized in Figure 1. The diagram illustrates how checkpoint-level evaluations across six readiness dimensions are aggregated into dimension scores, combined into a total readiness score (maximum 90), and finally mapped to readiness bands (Green, Yellow, Red) for decision-making.

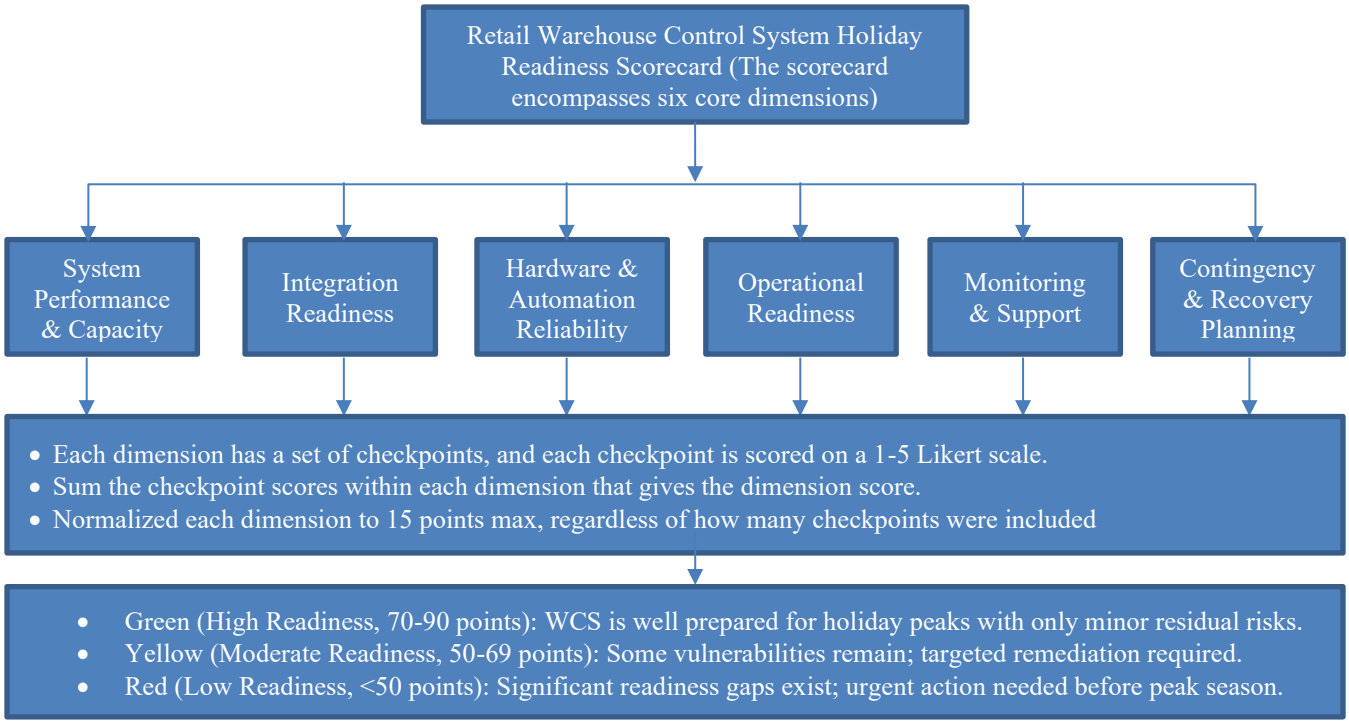

Fig. 1 WCS Holiday Readiness Scorecard Framework: dimensions, scoring process, and readiness interpretation

3.3. Expert Input and Iterative Refinement

Initial versions of the scorecard were reviewed by warehouse operations managers, WCS integrators, IT infrastructure leads, and supply chain consultants. Feedback was collected through structured interviews and a survey of peak-season readiness planning practices across two retail distribution centers. Following feedback, several revisions were made:

- Simplified category to generalize the scorecard
- Added a 5-point scoring system for each category
- Simplified technical language for broader usability
- Included contingency planning measures like manual overrides and on-call escalation mapping

3.4. Pilot Implementation

The refined scorecard was piloted in two retail distribution centers with different automation profiles:
Site A: Highly automated (conveyors, sorters, AGVs)
Site B: Semi-automated (conveyors and manual picking)

Each site used the scorecard to conduct a holiday readiness assessment for 8 weeks before peak season. The teams worked closely with cross-functional partners to complete the assessment. Pilot data helped confirm that the scoring approach was accurate and the checkpoints were easy to understand. Team ensured that everything aligned with real-world operational demands.

3.5. Data Collection and Analysis

During the pilot, the team collected both qualitative feedback and quantitative scores. To see how well the scorecard could predict future issues, they compared the identified readiness gaps to past incident reports and throughput data from previous peak seasons. They also ran a correlation analysis to check whether lower scores in certain categories matched areas where the system had previously shown stress or failed.

3.6. Results

The WCS Holiday Readiness Scorecard was piloted at two retail distribution centers, Site A (highly automated) and Site B (semi-automated), to test how well it could assess peak season preparedness. This section outlines the pilot results, including readiness scores, key gaps, and insights into how well the scorecard can predict issues and its overall usefulness in practice.

Category	Site A Score	Site B Score
System Performance & Capacity	14	11
Integration Readiness	13	9
Hardware & Automation Reliability	12	10
Operational Readiness	13	11
Monitoring & Support	14	10
Contingency & Recovery Planning	12	9
Total Score (Max: 90)	**78**	**60**

Note: The method used to calculate the site score is explained in Figure 1, which outlines the "WCS Holiday Readiness Scorecard Framework".

Site A scored in the High Readiness (78/90), indicating strong readiness with minor gaps.

Site B scored in the Moderate Readiness (60/90), indicating some vulnerabilities remain; targeted remediation is required.

3.6.1. Key Gaps Identified

Site A:

- Hardware-related issues
- Lacked formal documentation and SOPs
- Limited load testing under peak-type volume

Site B:

- System integration failures
- Lacked formal documentation and SOPs
- No plan in place to fix known issues to improve system stability and the ability to handle high volume
- No formal incident escalation plan during off-hours, including weekends and holidays
- Under-maintained MHEs include scanners, and there is no verified spare inventory.

These insights allowed both sites to prioritize their mitigation actions ahead of the holiday season.

3.6.2. Correlation with Historical Incident Data

Historical incident logs from the previous holiday season (for the same sites) were compared with low-scoring categories on the new scorecard. Notable observations:

- Site A had previously experienced minor fulfillment slowdowns during sorter overloads. This correlated with the slightly lower Hardware Reliability score.
- At Site B, system integration failures were a top contributor to delayed shipments in the previous year. This directly aligned with a low Integration Readiness score in the new assessment.

These findings suggest that the scorecard is capable of anticipating operational vulnerabilities, providing actionable insights before peak pressure reveals system weaknesses.

3.7. User Feedback and Usability

Feedback from cross-functional teams using the scorecard revealed high usability:

- 90% of participants found the scorecard clear and relevant to their roles.
- 80% reported it helped surface issues that were not previously tracked in formal readiness plans.
- Both sites indicated they would adopt the tool as part of standard peak-season planning.

The results validate the practical applicability of the WCS Holiday Readiness Scorecard in real-world warehouse environments. The scorecard supports proactive risk identification and promotes collaboration across operations, IT, and engineering teams.

4. Discussion

The pilot implementation of the WCS Holiday Readiness Scorecard revealed both the practical utility and the strategic relevance of a structured readiness assessment framework in modern retail supply chains. As fulfillment environments become increasingly reliant on automation and real-time system orchestration, ensuring that Warehouse Control Systems are fully prepared for holiday season stress is no longer optional; it is essential.

4.1. Scorecard as a Risk Mitigation Tool

The results from both Site A and Site B confirm that the scorecard effectively surfaces systemic weaknesses that may not be visible through traditional monitoring or ad-hoc checks. By requiring cross-functional input, the scorecard acts as a unifying framework that encourages holistic risk assessment and shared accountability.

4.2. Predictive Validity and Operational Impact

Correlating the scorecard outcomes with historical incident data further validated the tool's predictive power. The alignment between low-scoring areas and previous operational failures suggests that readiness scores are not just

descriptive but diagnostic. This enables warehouse teams to shift from reactive to proactive management, allocating resources to address vulnerabilities before peak demand exposes them.

Furthermore, the tool supports scalable implementation. Both sites were able to complete assessments in under a week, using only existing operational data and stakeholder workshops. This indicates that the scorecard is both lightweight and actionable, making it suitable for rapid deployment across diverse facility profiles.

4.3. Strategic Alignment and Planning Integration

Another significant finding is the scorecard's ability to bridge communication gaps between operational, IT, and engineering teams. Participants reported improved alignment around peak-season planning, as the scorecard formalized areas such as contingency planning, real-time monitoring, and hardware maintenance that are typically siloed. This positions the scorecard not just as a one-time audit tool, but as a strategic planning asset that can be embedded into annual holiday readiness cycles.

4.4. Limitations and Areas for Future Enhancement

While the pilot demonstrated the value of the scorecard, several limitations were observed:

- The current scoring system applies equal weight to all categories. In future iterations, category weighting could be customized based on facility type, automation level, or past incident frequency.
- The scorecard is currently qualitative in nature, relying on team assessments rather than system-derived KPIs. Future versions may benefit from integration with WCS logs, performance dashboards, or incident tracking systems to allow for semi-automated scoring.
- The pilot was conducted in two facilities only. A broader implementation across multiple regions and warehouses is necessary to generalize findings.

4.5. Comparative Advantage over Existing Approaches

Most prior work on retail warehouse control systems readiness and retail peak-season planning falls into one of two categories: (a) high-level industry reports that provide best-practice checklists, or (b) academic studies that analyze isolated aspects such as throughput optimization, peak monitoring, or automation reliability. While valuable, these approaches often remain fragmented, qualitative, or too narrowly focused and do not give an overall holistic assessment of the peak season readiness.

By addressing these limitations, the WCS Holiday Readiness Scorecard demonstrates a practical, predictive, and holistic improvement over existing approaches, enabling organizations not only to measure readiness but also to proactively mitigate risks before peak-season stress occurs. The scorecard fosters alignment between IT, operations, and engineering teams, bridging silos that are rarely addressed in existing approaches.

The WCS Holiday Readiness Scorecard advances beyond existing approaches in several ways:

4.5.1. Holistic, Multi-Dimensional Framework

Unlike existing reports that emphasize isolated dimensions (e.g., hardware, operation, etc), the scorecard consolidates six critical dimensions into a single unified model for overall readiness.

4.5.2. Quantified Readiness Assessment

Prior approaches often rely on descriptive checklists. The WCS Holiday Readiness Scorecard framework uses a standardized 5-point Likert scale across checkpoints, enabling quantitative scoring. This provides a measurable, comparable, and repeatable readiness assessment.

4.5.3. Predictive Alignment with Historical Failures

The pilot demonstrated that low-scoring categories correlated strongly with documented incidents in past peak seasons (e.g., sorter overloads at Site A, integration failures at Site B). This predictive validity is largely absent in existing literature.

4.5.4. Practical Usability and Speed of Deployment

Unlike simulation or optimization-based techniques reported in literature (which require extensive modeling expertise and data), the scorecard was implemented in under a week per site using existing operational data and team workshops. This makes it a lightweight, scalable tool for real-world retail operations.

4.5.5. Cross-Functional Integration

A key differentiator is the way the scorecard fosters alignment between IT, operations, and engineering teams, bridging silos that are rarely addressed in existing approaches. Literature often addresses one stakeholder group, whereas this framework provides a shared decision-making platform.

In summary, the discussion highlights that the WCS Holiday Readiness Scorecard is not merely a checklist, but a framework for operational resilience. It supports today's supply chain demands by giving teams the visibility, accountability, and insights they need to make smart decisions, especially during the busiest and most crucial times in retail.

5. Conclusion

As retail supply chains become more automated and customer expectations for speed and accuracy continue to grow, the pressure on warehouse systems, especially during peak times, is higher than ever. The holiday season, in particular, puts these systems to the test. Even minor hiccups

or delays can lead to major costs and damage a brand's reputation. That is why having a reliable and resilient warehouse control system is not just important; it is essential.

This paper outlines the context for the development of a structured and scalable Holiday Readiness Scorecard to assess and improve the readiness of WCS environments in retail distribution centers. The scorecard encompasses six critical dimensions of system and operational readiness, enabling cross-functional teams to evaluate performance risks, integration points, hardware dependencies, monitoring capabilities, and contingency planning efforts. Through pilot implementations in two distribution centers, the tool demonstrated its ability to identify high-risk areas, support proactive mitigation planning, and align stakeholders around a shared operational framework.

The positive feedback from end users and the alignment between low readiness scores and past system failures confirm the scorecard's diagnostic and predictive validity. It not only enhances situational awareness but also formalizes readiness planning as a repeatable and collaborative exercise within supply chain operations.

In an era where agility, resilience, and scalability define successful retail logistics, the WCS Holiday Readiness Scorecard offers a practical and actionable solution. Its continued development and broader adoption can serve as a foundation for data-driven peak-season preparedness, helping organizations reduce risk, improve performance, and deliver on customer promises during the most critical times of the year.

References

[1] Oliver Salvesen, Warehouse Control Systems (WCS): Ultimate Guide, 2023. [Online]. Available: https://www.autostoresystem.com/insights/warehouse-control-systems-wcs-ultimate-guide

[2] Jinxiang Gu, Marc Goetschalckx, and Leon F. McGinnis, "Research on Warehouse Design and Performance Evaluation: A Comprehensive Review," *European Journal of Operational Research*, vol. 203, no. 3, pp. 539-549, 2010. [CrossRef] [Google Scholar] [Publisher Link]

[3] J.J. Bartholdi, and S.T. Hackman, "Warehouse & Distribution Science (Release 0.96). The Supply Chain and Logistics Institute, Georgia Institute of Technology," Atlanta, USA Google Scholar, 2014. [Google Scholar]

[4] Alexander Hübner, Johannes Wollenburg, and Andreas Holzapfel, "Retail Logistics in the Transition from Multi-Channel to Omni-Channel," *International Journal of Physical Distribution & Logistics Management*, vol. 46, no. 6/7, pp. 562-583, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[5] Sunil Chopra, *Supply Chain Management: Strategy, Planning, and Operation*, 7th Ed., Pearson, 2018. [Google Scholar] [Publisher Link]

[6] Timothy J. Pettit, Keely L. Croxton, and Joseph Fiksel, "Ensuring Supply Chain Resilience: Development and Implementation of an Assessment Tool," *Journal of Business Logistics*, vol. 34, no. 1, pp. 46-76, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[7] Michael Wallace, and Lawrence Webber, *The Disaster Recovery Handbook: A Step-by-Step Plan to Ensure Business Continuity and Protect Vital Operations, Facilities, and Assets*, 3rd Ed., AMACOM, 2017. [Google Scholar] [Publisher Link]

[8] A. Cartlidge et al., ITIL Service Design, Version 3. [Online]. Available: https://wiki.en.it-processmaps.com/index.php/ITIL_Service_Design

[9] Yoram Koren, and Moshe Shpitalni, "Design of Reconfigurable Manufacturing Systems," *Journal of Manufacturing Systems*, vol. 29, no. 4, pp. 130-141, 2010. [CrossRef] [Google Scholar] [Publisher Link]

[10] Nils Boysen, René de Koster, and Felix Weidinger, "Warehousing in the e-Commerce Era: A Survey," *European Journal of Operational Research*, vol. 277, no. 2, pp. 396-411, 2017. [CrossRef] [Google Scholar] [Publisher Link]