Communication in Physical Sciences, 2023, 9(4): 1058-1071

Human Factor in Supply Chain Management: How Workers Training Impacts Supply Chain Efficiency

Julius Femi Ademilua*, Chinyere Carlisjery Kalu and Samira Sanni
Received : 28 June 2023/Accepted: 9 September 2023/Published: 19 September 2023

Abstract: *Supply chain management (SCM) is a major backer of organizational performance, but the behavioral features of human beings (the cognitive, behavioral, and social aspects) have been ignored because all attention is placed on technology and processes. This conceptual paper looks into how worker training enhances supply chain efficiency by tackling human weaknesses such as decision-making biases and coordination problems. Using Resource-Based View (RBV) and Ability-Motivation-Opportunity (AMO) perspectives, we integrate the literature on human factors in SCM, types of training (skill-based, behavioral, and cross-functional), and how they operate to enhance performance. A proposed conceptual model views training as an antecedent that has a positive effect on efficiency through mediators of human capital development, motivation, quality of decision making, and supply chain integration, with moderation by culture, leadership support, and complexity in the supply chain. The paper furthers the development of the behavioral SCM domain by bridging the literatures on HRM and SCM, offering testable propositions and practical recommendations regarding investment in simulation-based training. Despite its conceptual nature, the framework advances the strategic importance of human capital in developing resilient and efficient supply chains.*

Keywords: *Behavioral Supply Chain Management, Human Factors, Human Resource Management Integration, Supply Chain Efficiency, Worker Training*

Julius Femi Ademilua
Logistics Management Department, Faculty of Social and Management Science, Air Force Institute of Technology, Kaduna, Nigeria
Email: femdemilua2001@yahoo.com

Chinyere Carlisjery Kalu
Office of the Provost Investigation Group, Lagos State, Nigeria
Email: carlisjery@gmail.com

Samira Sanni
Warrensburg, Missouri, United States of America
Email: sannisamira2@gmail.com

1.0 Introduction

The role of supply chain management (SCM) in enhancing organizational performance has made it critical for organizations operating in today's globalized economy (Glushkova *et al*., 2019). Good SCM provides the flow of goods, information, and finances through suppliers, manufacturers, distributors, and customers, with a direct impact on cost reductions, delivery reliability, inventory management, and customer satisfaction (Oteri *et al*., 2023). Organizations will thus create competitive advantages for themselves by providing an integrated process- procurement, production, and distribution, which enhances organizational responsiveness and operational efficiency. In the age of globalization and volatile markets, strong SCM strategies equip firms to absorb or mitigate disruptions, thereby reducing operational costs and improving profitability, proving increasingly essential thus resulting in less operational costs and greater profitability.

However, one critical element that has received comparatively limited attention in SCM advancements is the human factor which has mostly been neglected due to technological, automated, and process optimization emphasis. Digitalization offers streamlined operations,

but human decision-making, judgment, and interpersonal dynamics will continues to profoundly affect supply chain outcomes (Mukherjee, 2023). Biases in forecasting, collaboration challenges, risk perception, and other behavior aspects may exacerbate the bullwhip effect by creating inefficiencies across the supply chain. Studies have shown that the human behavior in supply chain issues remains insufficiently explored in the literature, as wrong actions taken by people affect their performance but impact stakeholders along the network (Lu *et al*., 2018).

Accordingly, employee training offers a viable approach for addressing human-related challenges in supply chain operation. Well-designed training programs will equip many individuals with skills essential for reducing errors in operations, adapting to changes, and reducing risks through better decisions and coordination (Haq *et al*., 2021). Training encourages cache accuracy on hold, transforms response time shortening, and strengthens cross-functional collaboration resulting in higher productivity and resilience. By investing in employee development employees, organizations reduce the gap in technical and behavioral competencies, and thus supply chains tend to be more reliable and agile.

However, the human elements, particularly training, remain under-explored by research and practice. Supply chains become more complex as globalization, advancing technology, and increasing unpredictable disruptions continue to occur (Ivanov *et al*., 2019). Admittedly, behavioral supply chain research is emerging; however, the implications of implementing HR practices on SCM strategies have not been systematically integrated, thus leaving knowledge gaps on how training impacts performance as a whole (Jena and Ghadge, 2021). This conceptual paper contributes towards advancing the behavioral supply chain management by integrating the HR practices such as training into supply chain strategies with synthesizing the literature on human factor. The paper is structured in the following manner: This lack of integration limits theoretical understanding of how human capital development complements supply chain strategies to drive performance outcomes. Literature review on human factors and training in SCM, a conceptual framework with propositions to be presented, discussion on implications, and conclusion towards future research endeavors.

3.0 Literature Review

3.1 Human Factors in Supply Chain Management

Supply chain management research increasingly examines human factors, i.e. cognitive, behavioral, and social factors, that influence how individuals and teams operate within supply chain processes (Hoberg *et al*., 2020). They include cognitive factors like decision making, information processing, and forecasting accuracy; behavioral characteristics such as motivation, risk perception, and reactions to uncertainty; and social aspects such as cooperation, communication, and trust among supply chain actors (Omefe *et al*., 2021). The difference between human factors and other approaches can be represented by the fact that human factors see people as the agents who guide outcomes, where individual judgment and social interaction either enhance or hinder supply chain performance (Man, 2019). It has been argued that these human elements are involved in SCM since any decisions made at any level will affect the coordination and responsiveness throughout the chain.

The key theoretical pillars underpinning the understanding of human factors in SCM include the Resource-Based View (RBV) theory, which claims that human capital—knowledge, skill, and ability—is a unique, valuable, and rare-to-substitute source of

competitive advantage (Gerhart and Feng, 2021) and aehavioral Supply Chain Management (BSCM), which has emerged as a meta-theoretical approach to bring together insights from psychology, organizational behavior, and decision sciences into supply chain management (Rintala, 2022). BSCM explains how bounded rationality, heuristics, and biases affect supply chain decisions among other things, thereby challenging assumptions of purely rational decision-making. Together, these theories emphasize that human resources are not only operational inputs but rather strategic assets in achieving supply chain success (Victoria and Omosunlade, 2020). Even with all the challenges posed by human factors in SCM, they still play a vital role. A major example is the bullwhip effect, where human behavioral inclinations, such as overreaction to demand signals or misinterpretation of information, amplify inventory variances throughout the supply chain (Tamayo *et al*., 2023). Additional examples include poor decision-making under uncertainty that leads to disruptions, for example, delayed responses to disruptions or reselecting less optimal suppliers. Empirical studies indicate that these behavioral patterns are usually from cognitive biases, lack of coordination, or poor information sharing that require addressing human factors to upgrade the resilience and performance of the supply chain (Dwivedi *et al*., 2018).

Fig.1 presents the key factors required for a successful supply chain, integrating both human and operational elements. It highlights how human factors such as skills, decision-making, motivation, and collaboration interact with operational components including processes, technology, and coordination to enhance overall supply chain efficiency and performance.

A plethora of training schemes exists in supply chain management for building workforce capabilities, which can be technical, operational, or interpersonal (Bak *et al*., 2019). The most common include skills-based training, focusing on particular competencies such as the use of inventory management software or planning logistics; cross-functional training to enhance understanding across sourcing, production, and distribution functions safety training to reduce workplace occurrences; as well as behavioral training such as decision-making simulations designed to counteract biases and improve judgment under uncertainty (Ademilua and Areghan, 2022). The application of these different orientations makes it possible for the employee to cope with all the various demands that modern supply chains place on them.

Fig. 1: Key factors for a successful supply chain, including human and operational elements in supply chain management.

3.2 Worker Training and Development in SCM

The benefits accruing from such training are huge and varied. Training programs enhance performance among individuals and teams while improving competence and confidence levels, reducing operational errors and proactive problem-solving on the part of

trained employees (Lacerenza *et al*., 2018). Another significant aspect is that enhanced resilience ensures trainees are equipped to deal with complications such as lack of supplies or exceed demand. In addition, training creates an environment of continuous improvement where employees are involved in innovation and process optimization (Van Assen, 2021). All these combine to advance the human capital in organizations, rendering them more agile and reliable under dynamic market conditions. From an operational perspective, training directly links workforce capability development to supply chain efficiency to increased productivity, improved adaptability, and broader integration of the core SCOR processes of plan, source, make, and deliver. To give an example, skilled workers would add on forecasting accuracy, selecting good suppliers, optimizing production, and ensuring on-time deliveries (El-Garaihy, 2021). Through cross-training, employees obtain a much wider viewpoint of the work, which could result in seamless coordination thereby reducing silos. This combination further adds to the overall flow efficiency and responsiveness. Empirical evidence supports such linkage, stating that effectively targeted training initiatives can lead to measurable gains in operational outcomes.

Fig. 2 illustrates the conceptual pathway through which human decision-making and behavioral factors influence supply chain outcomes and how targeted employee training mitigates these effects. It shows that cognitive biases, risk perception, and coordination challenges negatively affect supply chain performance, while structured training interventions enhance skills, judgment, motivation, and collaboration, thereby improving resilience and overall supply chain efficiency.

Fig.1: Infographic on supply chain management (SCM) concepts

3.3 Impact on Supply Chain Efficiency

Supply chain efficiency is commonly assessed using key performance metrics such as cost reduction, delivery reliability, inventory accuracy, and cycle time (Negi, 2021). Where cost reduction occurs due to reduced waste, errors, and rework; delivery reliability reflects on-time performance; inventory accuracy optimally levels stock; and shorter cycle times quicken throughput (John, 2023). Hence, these are collectively the performance measures determining how effectively a supply chain changes inputs into customer value. When human factors are optimized through training, these indicators show a significant performance improvement, hence why workforce development is considered strategic (Sgarbossa *et al*., 2020; Akinsanya *et al*., 2022).

The mechanism by which training is linked to efficiency is clear; it provides a direct causal chain of events when training enhances employees' skills and knowledge, followed by better coordination and communication between supply chain participants (Haq *et al*., 2021). The coordination built improves cycle time as it lessens variability due to operational process, demand forecasting errors, or production delays such that smoother operations are brought about and ultimately higher efficiency overall. Training about behavioral and cognitive gaps improves risk management and decision-making quality, thereby enhancing overall supply chain stability and predictability. These mechanisms indicate training as a critical enabling factor for efficiency gains (Ademilua, 2021).

Previous studies have established a positive relationship between training and positive impacts of SCM-HRM integration. Results have shown that organizations that enter into HRM-SCM alignment like investing in employee training are perhaps going to realize higher efficiency in areas such as lower costs and improved responsiveness (Islami, 2021). It is through such integrated effect that development of human capital will be supportive of supply chain goals. These are results that strengthen the argument that training should not be seen as an isolated HR activity but as a strategic lever to enhance supply chain performance.

Table 1 summarizes the key dimensions through which worker training influences supply chain efficiency. It shows that training contributes to cost reduction, delivery reliability, inventory accuracy, cycle time reduction, coordination and communication, decision quality, and HRM–SCM integration. Across these dimensions, improved employee competencies and behavioral capabilities translate into lower operational costs, enhanced responsiveness, and more stable supply chain performance, as supported by prior empirical and conceptual studies.

4. 0 Conceptual Framework

This section proposes a conceptual model that integrates human factors and worker training into supply chain management (SCM), emphasizing their role in driving efficiency. The model is grounded in two complementary theoretical perspectives: the Resource-Based View (RBV), which views human capital as a strategic resource providing sustainable competitive advantage, and the Ability-Motivation-Opportunity (AMO) framework, which explains how employee abilities (enhanced through training), motivation, and opportunities to perform contribute to organizational performance. By combining these theories, the model posits that worker training serves as a key antecedent to improving supply chain outcomes through a series of mediating and moderating mechanisms. Worker training positively impacts supply chain efficiency through mediators such as employee performance, organizational culture, and supply chain integration (Khanuja and Jain, 2022). Training develops the necessary abilities (knowledge and skills), fosters motivation (through confidence and engagement), and creates opportunities for employees to apply their competencies across supply chain processes. This integrated approach leads to enhanced coordination, reduced behavioral variability, and greater overall efficiency.Key Components of the Model.

The proposed model for understanding the impact of worker training and development on supply chain management (SCM) efficiency centers on a structured framework with four main components: antecedents, mediators, moderators, and outcomes. At the core of the antecedents are comprehensive training programs designed to build essential human capital in the supply chain workforce (Overstreet *et al*., 2019). These include skills-

based training to enhance technical competencies (such as proficiency in inventory systems or logistics software), behavioral training to improve decision-making and reduce cognitive biases that can lead to errors, and cross-functional training to foster a broader understanding of interconnected SCM roles. By equipping employees with these targeted competencies, the model posits that training serves as the foundational intervention that directly prepares individuals to navigate the complexities of modern supply chains, from procurement to distribution (Akinsanya *et al*., 2022). The mediators in the model explain the mechanisms through which training influences SCM performance.

Table 1: Impact of Training on Supply Chain Efficiency

Dimension	Description	Effect on Supply Chain Efficiency	Supporting Sources
Cost Reduction	Training reduces operational waste, errors, and rework by improving employee competence and process adherence.	Lower operational costs and improved resource utilization.	Negi (2021); Islami (2021)
Delivery Reliability	Skilled employees improve planning, coordination, and execution of logistics activities.	Higher on-time delivery performance and service reliability.	John (2023); Haq *et al*. (2021)
Inventory Accuracy	Training improves inventory accuracy data handling, stock monitoring, and system usage accuracy.	Optimal stock levels, reduced stockouts and overstocking.	Negi (2021); Sgarbossa *et al*. (2020)
Cycle Time Reduction	Improved skills reduce delays, bottlenecks, and process variability across supply chain stages.	Faster throughput and improved responsiveness.	John (2023); Ademilua (2021)
Coordination & Communication	Training improves inter-functional and inter-organizational communication and teamwork.	Reduced process variability and smoother operations.	Haq *et al*. (2021); Ademilua (2021)
Decision Quality	Enhanced cognitive and analytical skills improve forecasting, scheduling, and problem-solving.	More stable, predictable, and efficient supply chain performance.	Ademilua (2021); Akinsanya *et al*. (2022)
HRM–SCM Integration	Aligning training with SCM objectives creates strategic synergy between people and processes.	Superior efficiency outcomes: lower costs and higher responsiveness.	Islami (2021); Sgarbossa *et al*. (2020)

Human capital development acts as a primary mediator, representing the acquisition and effective application of new knowledge and skills gained through training. This is complemented by motivation, where training enhances job satisfaction, organizational commitment, and proactive behaviors among employees. Additionally, improved decision-making quality—characterized by greater accuracy, reduced biases, and better risk perception—serves as another critical mediator. Together, these factors bridge the gap between training inputs and operational outcomes, illustrating how enhanced employee capabilities translate into more efficient supply chain processes, such as better forecasting and coordination.

In this model depict contextual factors which influence whether the training effect translates to better supply chain management (SCM) efficiency or not. Organizational culture is of prime importance: collaborative environments that place a premium on knowledge sharing and teamwork are tended to amplify training benefits, while hierarchical or siloed cultures are somewhat expected to inhibit them. Leadership support is equally vital, since it makes managerial commitment to training initiative visible and employee empowerment validates application of learned skills. Supply chain complexity—such as number of tiers in the chain, geographical dispersion, or market volatility—opens up the opportunity for moderating the outcome. Well-trained people can deal more effectively with uncertainties in what is essentially a complex setting; in contrast, the model argues that the effect of training may be improved by a leadership support and culture encouraging the notion.

Ultimately, the model leads up to the result of increased efficiency in the supply chain as indicated by some tangible improvements (Negi, 2021). These include reduced bullwhip effect through better demand forecasting, lowered operational cost because of less waste and errors, improved reliability of deliveries through better coordination, greater accuracy in inventory to avoid stockout or overstocking, shorter cycle times to have faster throughput, and bringing more resilience to disruptions like supply shortages or demand shocks (Akinsanya *et al*., 2022). Thus, by connecting the antecedents, mediators, and moderators, the model conveys a comprehensive explanation of how investing in employee training at a strategic level can result in sustainable performance improvement at the supply chain operation level.

5.0 Proposed Model and Propositions

This now-turned-conceptual model in behavioral supply chain management provides a number of propositions that can be tested in the future through empirical research. The propositions result from combining the Ability-Motivation-Opportunity (AMO) framework with the Resource-Based View (RBV), explicitly linking worker training with the outcome in the supply chain, while accounting for the various intervening and moderating mechanisms (Haq *et al*., 2021). The propositions were formulated in such a way that they could be put to the test using standard quantitative methods prevalent in the discipline, such as structural equation modeling (SEM), hierarchical regression, or longitudinal studies in varying contexts.

P1: Worker training positively influences individual performance in supply chain roles. This proposed positive relationship from worker training is based on the premise that programs of skills, behavioral, and cross-functional training assist employee-level achievement in supply chain activities. Employees' abilities are enhanced in terms of technical know-how, decision-making quality, and behavioral adaptability through training. For instance, employees trained in advanced forecasting techniques or in risk assessment would demonstrate higher accuracy in demand

planning, inventory management, and order fulfillment (Sony and Mekoth, 2022). This proposition can be validated by contrasting measurement of training participation or intensity with performance criteria such as error rates, productivity metrics, or supervisor ratings in supply chain domains.

P2: Higher levels of human performance mediate the effect of training on supply chain integration. The proposition states that the positive influence of worker training towards supply chain integration occurs through enhanced human performance. Training improves performance and, ultimately, better coordination, communication, and collaboration across supply chain partners (Tarigan *et al*, 2021). Trained employees are better able to resolve conflicts, share valid data, and enter into joint planning, thus advancing their internal and external integration (Haq *et al*., 2021). Mediation analysis will help to confirm this mediation with measuring human performances as multi-item scales to assess for effectiveness in coordination and integration through well-developed constructs in SCM.

P3: Organizational culture moderates the training-efficiency link (stronger in collaborative cultures). The culture of an organization is expected to act as a moderator in the link between worker training and supply chain efficiency, with the impact mostly felt among cultures that cooperate, encourage, and endorse learning (Ghasemzadeh *et al*., 2019). In such an atmosphere, trained employees are much more likely to put into practice the new skills and knowledge they received during training since they will be given encouragement, resources, and recognition for doing so. However, in cultures characterized as being hierarchical or rigid, the trained employee would face a number of barriers, with further weakening of the training-efficiency relationship (Ghorabi *et al*., 2021). This hypothesis of moderation will be tested using moderated regression analysis or multi-group SEM, culture being assessed by using validated instruments (e.g., Cameron & Quinn's Competing Values Framework), and efficiency by composites such as cuts in costs, delivery capability, and cycle time (Amougou, 2023).

P4: Training reduces behavioral risks (e.g., bullwhip amplification effects) in environments characterized by volatility. Whereas this proposition asserts that training worsens and behavioral Supply Chain Management (BSCM), which has emerged as a meta-theoretical approach the behavioral risks that amplify supply chain inefficiencies, especially in volatile or uncertain environments (Colicchia *et al*., 2019). Training programs that address cognitive biases, enhance forecasting accuracy, and develop risk perception can aid in reducing the negative effects of overreacting to demand signals in reducing the bullwhip effect (Pournader *et al*., 2023). Employees trained in behavioral decision-making or simulation-based scenarios would also be able to smooth their ordering patterns amid market fluctuations. This might be empirically tested in extremely volatile contexts (Mak and McCurdy, 2019), like economic disruptions, measuring behavioral risk indicators like order variance amplification or inventory oscillation, with the treatment being training.

P5: Leadership support positively moderates the relationship between training and supply chain efficiency. Based on the AMO framework, this proposition holds that when leadership supports training by allocating resources to it, demonstrating desired behaviors, and reinforcing training outcomes, the relationship of training to supply chain efficiency is stronger (Haq *et al*., 2021). Supportive leaders provide an environment that motivates employees to make use of learned skills, further augmenting the training's gains (Ned and Umesi, 2023). This moderation can be tested with interaction terms in regression models, while measuring leadership support

with scales gauging transformational leadership or perceived organizational support. P6: Supply chain complexity will negatively moderate the training-efficiency link (stronger effects in simpler chains). Thus, this proposition states that training in improving efficiency in the supply chain proceeds less effectively as complexity of supply chain rises (many tiers, global suppliers, or high product variety). In this kind of environment, even very well-trained employees may find it more difficult to coordinate activities among the many dispersed but interdependent actors, which thereby reduces the overall impact of training (Bonoli and Emmenegger, 2021). The hypothesis can be tested with supply chain complexity as a moderator (the moderator is to be measured by scales on structural complexity or uncertainty), with even stronger effects of training expected in less complex chains. These six propositions can produce a solid platform for future empirical research. They may be tested individually or jointly through a larger structural model, thus providing good avenues for validating the proposed conceptual framework and for advancing the integration of human resource management with supply chain management practices.

6. 0 Discussion

6.1 Theoretical Implications

This paper makes an important theoretical contribution by integrating two traditionally distinct bodies of literature, namely, human resource management (HRM) and supply chain management (SCM). HRM research has long emphasized training and the development of human capital as drivers of individual and organizational performance of human capital towards better performance at both the individual and organizational levels; whereas SCM research has traditionally focused on technology, logistics, and process optimization (De Stefano *et al*., 2018). By integrating the Ability–Motivation–Opportunity (AMO) framework with the Resource-Based View (RBV), the proposed model demonstrates how employee training functions as a key mechanism for transforming human capital into supply chain benefits. This synthesis highlights the interdependence between HRM practices and SCM strategies deviating from the notion that human factors are peripheral to supply chain success, and rather positioning them as integral to success (de Camargo Fjorini *et al*., 2022). The model also advances behavioral supply chain management by providing a structured analytical lens for examining various cognitive, behavioral, and social influences such as biases in decision-making and communication problems, which often affect the dynamics of supply chains (Goudarzi *et al*., 2023).

The practical relevance of behavioral supply chain management (BSCM) is further strengthened by tying training interventions directly to the mediators of human performance and supply chain integration. It encourages scholars to adopt an interdisciplinary perspective that cuts across specific behavioral strands into psychology, organizational behavior, and operations management as well.

6.2 Practical Implications

For supply chain managers, the findings underscore the strategic importance of investing in employee training to enhance operational efficiency and resilience of investing in employee training programs at the strategic level in terms of added value in improving operational efficiency and resilience. Organizations should place strong emphasis on training initiatives through simulation exercises, which offer realistic practice in decision-making without risk, where demand variability and coordination challenges become a true supply chain disruption (Rezvani *et al*., 2023). Such activities—coupled with cross-functional and behavioral training—will reduce forecasting errors, enhance accuracy, and mitigate bullwhip effects, generating real benefits in

terms of reduced costs, shorter cycle times, and increased reliability of delivery. Management should integrate training into broader SCM strategies and review HR policy in line with supply chain goals via regular needs assessments and through continuous learning cultures. Such findings prove that important claims are made regarding leadership support: investment in training systems, as well as giving employees a chance to practice new skills, will increase returns on investment. Ultimately, treating training as a strategic asset rather than as a cost center can yield competitive advantages in increasingly complex and volatile supply chain environments.

6.3 Limitations and Directions for Future Research

As a conceptual paper, this one limits itself to a theoretical framework and does not subject the proposed model and propositions to any real tests. While it is based on known theories, there was no quantitative and qualitative data to validate them, so the generalizability of the findings are therefore limited. There are also assumed directional causes that can vary from one organization to another, across industries or cultures, these cannot take into account reverse causation or confounding factors such as the level of technology adoption.

Future research should concentrate on empirically validating the model through structural equation modeling, experimental designs, or case studies that would test the proposed relationships. Longitudinal studies in this area would be of immense value to measure long-term effects of investments in training on supply chain efficiency and resilience considering their dynamic nature over time. Boundary conditions and moderators may emerge through comparisons across industries—from manufacturing to retail to healthcare and logistics—where the impact of training on low-complexity supply chains would differ from that on high-complexity ones. Further extension of the framework may be considered by analyzing how emerging technologies (e.g. AI-assisted training tools) can enhance the human aspects. Such research would generate practical implications for researchers and practitioners and strengthen further the integration of HRM and SCM in the behavioral supply chain management.

7.0 Conclusion

This conceptual paper underscores the critical role of the human factor in supply chain management (SCM) and operational effectiveness. While the evolution of SCM has largely emphasized technological advancement, digitalization, and process optimization, human performance—encompassing cognitive, behavioral, organizational, and social dimensions—remains a fundamental determinant of supply chain success. Despite sophisticated systems and tools, supply chain outcomes are ultimately shaped by the people who design, manage, and operate them.

Worker training emerges as a strategic lever for building individual and collective competence, particularly in error reduction, decision-making quality, coordination across supply chain stages, and adaptive problem-solving. Well-designed and targeted training programs can mitigate behavioral risks such as the bullwhip effect, enhance responsiveness in volatile environments, and generate tangible productivity gains. These improvements manifest through cost reductions, improved delivery reliability, enhanced adaptability, and overall efficiency gains within supply chains.

This paper argues for the deliberate integration of human resource management (HRM) practices into SCM strategies. Rather than viewing training as a routine HR function, organizations should position it as a strategic investment aligned with long-term sustainability and resilience objectives in supply chain learning communities. Employee

capabilities can be strengthened through collaborative organizational cultures, strong top-management support, and the adoption of simulation-based and cross-functional training initiatives.

Future research should focus on the empirical validation of the proposed conceptual framework and examine how the integration of HRM and SCM evolves in response to increasing supply chain complexity and digital transformation. In an increasingly dynamic global environment, deliberate recognition and systematic development of the human factor through rigorous training practices are essential for building agile, resilient, and high-performance supply chains.

8.0 References

Ademilua, D. A. (2021). Cloud security in the era of big data and IoT: A review of emerging risks and protective technologies. *Communication in Physical Sciences*, 7, 4, pp. 590–604.

Ademilua, D. A., & Areghan, E. (2022). AI-driven cloud security frameworks: Techniques, challenges, and lessons from case studies. *Communication in Physical Sciences*, 8, 4, pp. 674–688.

Akinsanya, M. O., Adeusi, O. C., & Ajanaku, K. B. (2022). A detailed review of contemporary cyber/network security approaches and emerging challenges. *Communication in Physical Sciences*, 8, 4, pp. 707–720.

Amougou, R. S. E. (2023). AI-driven DevOps: Leveraging machine learning for automated software delivery pipelines. *Communication in Physical Sciences*, 9, 4, pp. 1010–1021.

Bak, O., Jordan, C., & Midgley, J. (2019). The adoption of soft skills in supply chain and understanding their current role in supply chain management skills agenda: A UK perspective. *Benchmarking: An International Journal*, 26, 3, pp. 1063–1079.

Bonoli, G., & Emmenegger, P. (2021). The limits of decentralized cooperation: Promoting inclusiveness in collective skill formation systems. *Journal of European Public Policy*, 28, 2, pp. 229–247.

Boonlua, S., Supachaiwat, J., Thongchua, K., & Mohamad, B. (2023). Linking supply chain resilience strategies for surviving major disruptions. *International Journal of Construction Supply Chain Management*, 13, 1, pp. 154–172.

Colicchia, C., Creazza, A., & Menachof, D. A. (2019). Managing cyber and information risks in supply chains: Insights from an exploratory analysis. *Supply Chain Management: An International Journal*, 24, 2, pp. 215–240.

de Camargo Fiorini, P., Chiappetta Jabbour, C. J., Lopes de Sousa Jabbour, A. B., & Ramsden, G. (2022). The human side of humanitarian supply chains: A research agenda and systematization framework. *Annals of Operations Research*, 319, 1, pp. 911–936.

De Stefano, F., Bagdadli, S., & Camuffo, A. (2018). The HR role in corporate social responsibility and sustainability: A boundary-shifting literature review. *Human Resource Management*, 57, 2, pp. 549–566.

Dwivedi, Y. K., Shareef, M. A., Mukerji, B., Rana, N. P., & Kapoor, K. K. (2018). Involvement in emergency supply chain for disaster management: A cognitive dissonance perspective. *International Journal of Production Research*, 56, 21, pp. 6758–6773.

El-Garaihy, W. H. (2021). Analysis of supply chain operations reference (SCOR) and balanced scorecard (BSC) in measuring supply chain efficiency using DEMATEL and DEA techniques. *Journal of Global Operations and Strategic Sourcing*, 14, 4, pp. 680–700.

Gerhart, B., & Feng, J. (2021). The resource-based view of the firm, human resources, and human capital: Progress and prospects. *Journal of Management*, 47, 7, pp. 1796–1819.

Ghasemzadeh, P., Nazari, J. A., Farzaneh, M., & Mehralian, G. (2019). Moderating role of innovation culture in the relationship between organizational learning and innovation performance. *The Learning Organization*, 26, 3, pp. 289–303.

Ghorabi, S. T., Jalilian, M., Sadeghifar, J., & Zavareh, M. S. A. (2021). Investigation of health-promoting behaviors of employees of a medical university: A perspective from western Iran. *Journal of Education and Health Promotion*, 10, 1, pp. 139–147.

Glushkova, S., Lomakina, O., & Sakulyeva, T. (2019). The economy of developing countries in the context of globalization: Global supply chain management. *International Journal of Supply Chain Management*, 8, 1, pp. 876–884.

Goudarzi, F. S., Bergey, P., & Olaru, D. (2023). Behavioral operations management and supply chain coordination mechanisms: A systematic review and classification of the literature. *Supply Chain Management: An International Journal*, 28, 1, pp. 140–161.

Haq, M. Z. U., Gu, M., & Huo, B. (2021). Enhancing supply chain learning and innovation performance through human resource management. *Journal of Business & Industrial Marketing*, 36, 3, pp. 552–568.

Hoberg, K., Thornton, L., & Wieland, A. (2020). How to deal with the human factor in supply chain management? *International Journal of Physical Distribution & Logistics Management*, 50, 2, pp. 151–158.

Islami, X. (2021). How to integrate organizational instruments? The mediation of HRM practices' effect on organizational performance by SCM practices. *Production & Manufacturing Research*, 9, 1, pp. 206–240.

Jena, S. K., & Ghadge, A. (2021). An integrated supply chain–human resource management approach for improved supply chain performance. *The International Journal of Logistics Management*, 32, 3, pp. 918–941.

John, B. I. (2023). Data-driven resource optimization approaches enhancing capacity planning, labor utilization, material efficiency, and continuous improvement across manufacturing project lifecycles. *GSC Advanced Research and Reviews*, 17, 3, pp. 220–236.

Kalusivalingam, A. K., Sharma, A., Patel, N., & Singh, V. (2022). Enhancing supply chain resilience through AI: Leveraging deep reinforcement learning and predictive analytics. *International Journal of AI and ML*, 3, 9, pp. 1–12.

Khanuja, A., & Jain, R. K. (2022). The mediating effect of supply chain flexibility on the relationship between supply chain integration and supply chain performance. *Journal of Enterprise Information Management*, 35, 6, pp. 1548–1569.

Lacerenza, C. N., Marlow, S. L., Tannenbaum, S. I., & Salas, E. (2018). Team development interventions: Evidence-based approaches for improving teamwork. *American Psychologist*, 73, 4, pp. 517–531.

Lu, H. E., Potter, A., Sanchez Rodrigues, V., & Walker, H. (2018). Exploring sustainable supply chain management: A social network perspective. *Supply Chain Management: An International Journal*, 23, 4, pp. 257–277.

Mak, K., & McCurdy, T. H. (2019). Simulation-based learning using the RIT market simulator and RIT decision cases. *Journal of Behavioral and Experimental Finance*, 23, pp. 12–22.

Mukherjee, D. V. (2023). *At the edge of tomorrow: unleashing human potential in the AI Era*. Notion Press.

Ned, A. E., & Umesi, C. D. (2023). Effective leadership and employee motivation for sustainable development. *Journal of Education in Developing Areas*, 31, 2, pp. 310-321.

Negi, S. (2021). Supply Chain Efficiency Framework to Improve Business Performance in a Competitive Era. *Management Research Review, 44,* pp .477-508. https://doi.org/10.1108/mrr-05-2020-0272

Omefe, S., Lawal, S. A., Bello, S. F., Balogun, A. K., Taiwo, I., Ifiora, K. N. (2021). AI-Augmented Decision Support System for Sustainable Transportation and Supply Chain Management: *A Review. Communication In Physical Sciences*. 7, 4, pp. 630-642.

Oteri, O. J., Onukwulu, E. C., Igwe, A. N., Ewim, C. M., Ibeh, A. I., & Sobowale, A. (2023). Cost optimization in logistics product management: strategies for operational efficiency and profitability. *International Journal of Business and Management. Forthcoming*, https://doi.org/10.54660/.IJMRGE.2023.4.1-852-860.

Pournader, M., Narayanan, A., Keblis, M. F., & Ivanov, D. (2023). Decision bias and bullwhip effect in multiechelon supply chains: Risk preference models. *IEEE Transactions on Engineering Management*, 71, pp. 9229-9243.

Rezvani, S., Falcão, M. J., Komljenovic, D., & de Almeida, N. M. (2023). A systematic literature review on urban resilience enabled with asset and disaster risk management approaches and GIS-based decision support tools. *Applied Sciences*, 13, 4, 2223, https://doi.org/10.3390/app13042223.

Rintala, O. (2022). *The Role of Social Agency in Supply Chain Management Decision-Making* (Doctoral dissertation, Doctoral dissertation, University of Turku]. https://www.utupub.fi/handle/10024/173733

Sgarbossa, F., Grosse, E. H., Neumann, W. P., Battini, D., & Glock, C. H. (2020). Human factors in production and logistics systems of the future. *Annual reviews in control*, *49*, pp. 295-305.

Sony, M., & Mekoth, N. (2022). Employee adaptability skills for Industry 4.0 success: a road map. *Production & Manufacturing Research*, 10, 1, pp. 24-41.

Tamayo, D. A., Orjuela-Castro, J. A., & Herrera, M. M. (2023). Assessing the Bullwhip effect in supply chain: trends, gaps, and overlaps. *Acta Logistica*, 10, 4, pp. 497-514.

Tarigan, Z. J. H., Mochtar, J., Basana, S. R., & Siagian, H. (2021). *The effect of competency management on organizational performance through supply chain integration and quality* (Doctoral dissertation, Petra Christian University).

Van Assen, M. F. (2021). Training, employee involvement and continuous improvement–the moderating effect of a common improvement method. *Production Planning & Control*, 32, 2, pp. 132-144.

Victoria, G. T. & Omosunlade, O. S. (2020)., A Qualitative Study of Teachers' Perception on the Need for Reviewing the Senior Secondary School Economics Curriculum in Kosofe Local Government, Lagos State. *Al-Hikmah Journal of Education*, 7, 2, pp. 2384-7662.

Declaration

Consent for publication

Not Applicable

Availability of data and materials

The publisher has the right to make the data public

Ethical Considerations

Not applicable

Competing interest

The authors report no conflict or competing interest

Funding

No funding

Authors' Contributions

Julius Femi Ademilua conceived the study, developed the conceptual framework, integrated RBV and AMO theories, and drafted the manuscript. Chinyere Carlisjery Kalu synthesized literature on human factors and training, strengthened theoretical arguments, and reviewed the paper. Samira Sanni organized efficiency dimensions, supported figure and table development, and revised the manuscript for clarity and rigor. All authors approved the final version.