Library Progress International
Vol.44 No. 3, Jul-Dec 2024: P. 18691-18714

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

Optimizing Logistics Performance through Integrated Collaboration: A LeAgile Supply Chain Management Perspective in the UAE

Adv. Aswin S. Nair[1], Dr. Byju John[2]

[1]Research Scholar, Ph.D. in Management, University of Kalinga, Raipur, Chhattisgarh
draswinsnair5@gmail.com
[2]Professor, Department of Management, University of Kalinga, Raipur, Chhattisgarh
byju.john@kalingauniversity.ac.in

How to cite this article: Aswin S. Nair, Byju John (2024) Optimizing Logistics Performance through Integrated Collaboration: A LeAgile Supply Chain Management Perspective in the UAE. *Library Progress International,* 44(3), 18691-18714.

ABSTRACT

In light of dynamic market conditions, exacerbated by the global COVID-19 pandemic, there is a pressing need for businesses to enhance their Supply Chain Management (SCM) strategies. The surge in e-Commerce, technological evolution, disruptions in supply chains, and the imperative for collaborative risk management underscore the critical necessity for innovative and resilient SCM practices, forming the basis for this study. This study explores the integrated concepts of supply chain management (SCM) and logistics, focusing on their symbiotic relationship and impact on logistics performance. Emphasizing the significance of efficient logistics in enhancing customer value and cost-effectiveness, the research investigates the potential benefits derived from lean and agile logistics systems. The study employs a comprehensive approach, integrating lean logistics to optimize material flow and reduce waste and costs, while agile logistics enhances flexibility and responsiveness to dynamic demands. The goal is to develop a robust framework for designing a lean-agile supply chain, ultimately aiming to improve supply chain partnerships and overall logistics performance. The findings of this research contribute valuable insights to logistics companies, guiding them toward more effective supply network management. By understanding and leveraging the synergies between lean and agile logistics within the SCM landscape, organizations can enhance their logistics performance and adapt to the evolving demands of the market. This research adds to the existing body of knowledge by elucidating the integrated dynamics of SCM and logistics, specifically emphasizing the coalescence of lean and agile logistics systems. The proposed framework provides a practical guide for logistics companies seeking to optimize their supply networks and improve overall logistics performance.

KEYWORDS*: Supply Chain Management (SCM), Lean Supply Chain (LSC), Agile Supply Chain (ASC), LeAgile, Supply Chain Partnerships, Logistics Performance.*

INTRODUCTION:

Supply chains are the foundation of commercial activity and investment flows (Moran et al., 2020). They have made it feasible for more goods, such as raw materials to finished goods, to cross borders than ever before, which is crucial for developing countries and businesses. Customers have several options for purchasing the same or very similar goods in today's competitive market, which puts businesses under huge pressure to differentiate their service offerings and leads many to envisage the supply chain **(Nagy et al., 2018).** Unified, user-friendly Supply Chain Management (SCM) software tools are already being used by firms to provide succeeding with same-day delivery, legitimate deliveries, and simple returns. It's a tweak that has profoundly amended how businesses view the supply chain. Cost reduction is no longer the focus of SCM. As more clients select value-added, premium fulfillment choices, it's about growing market share, service differentiation, and even boosting revenues are key areas businesses need to focus on **(Cole et al., 2019).** However, there are stronger and more regular threats for them, nevertheless, as recent severe diversions have demonstrated. Thus, the ability to withstand current and impending shocks, such as health issues, climate change, and geopolitical conflicts, has become more crucial.

In 2020, everyone around the world understands the scope of how crucial supply chains are. Companies and customers have realized the potential of the supply chains that are robust and adaptable when supplies failed to transpire and if manufacturers were incapable of acquiring necessary goods **(Sharma et al., 2020).** Now more than ever, organizations are examining their global supply chains and the technology trends that underlie them to see how they are useful to prospect their operations **(Mohan et al., 2019).** Customers are not the only ones profiting from unprecedented degrees of comfort and diversity brought about by modern technology. Supply chains now have a huge array of new chances because of the advent of digital platforms. Now, suppliers can conduct business directly with retailers or clients using slick digital interfaces. Even the components of the supply chain itself, from planning to production to inventory management to fulfillment, can now be acquired "as-a-service" from outside vendors and controlled through platforms **(Esmaeilian et al., 2020).**

The supply chains of the future appear to be sophisticated, prescient, and innovative **(Koberg and Longoni, 2019).** To monitor and correct impulsively discovered disparities between actual and planned performance, they will collect data from an ever-growing variety of sensors, cameras, and apps. Business-leading companies are already under pressure from an exponential rise in the volume of data at their scrapping to hire specialized analysts who can translate that data into insights that can reduce costs, diversify product offerings, and boost sales. In addition to data scientists, businesses of the future will need specialists in AI, blockchains, robots, and cybersecurity **(Modgil et al., 2021).** Successful businesses, though, aren't merely looking to hire the hottest digital talent and declaring the issue resolved. They are creating plans and initiatives that constantly improve their workforces and equip them to adapt to a constantly shifting environment. According to Gartner's report of the Future of Supply Chain 2021, 23% of supply chain leaders aspire to own a digital ecosystem by 2025, which is just 1% at the moment **(Damoska Sekuloska, & Erceg, 2022).** According to a commissioned study carried out by Forrester Consulting on behalf of KPMG in July 2020, 67% of organizations claim to have accelerated their digital transformation strategy in SCM since COVID-19 **(Mesquita et al., 2022).**

Companies have built vast global supply networks for the previous thirty years by making use of the continuously growing scale economies in global logistics **(An et al., 2021).** Low-cost manufacturing centers are currently connected in Asia to crucial markets in the Europe and US through reliable, efficient air and sea transportation **(Rodrigue, 2021).** The cost reductions from labor arbitrage, which were crucial enough to more than compensate for the price of shipping items far distances to marketplaces or the additional expenditure of storing inventories in long pipelines, were a important driving force for this global sourcing **(Ailawadi & Singh, 2021).** However, the recent pandemic's effects on logistics networks have made supply chain managers' problems worse. These managers have a tendency to narrowly focus on their manufacturing partners and less on their geography and the ties that connect them **(Soto-Acosta, 2020).** The supply chain typically includes four key components. These are Purchasing & Procurement, Operations, Integration, and Distribution & Logistics. To effectively fulfill demand and guarantee timely, full delivery, the supply chain needs cooperation for working with both external and internal partners to continue an ideal progression along the supply chain. Lean and Agile methodologies can be applied to every SC component to improve business performance. It is evident that managers can increase supply chain transparency, promote more ethical and ecological goals, and exercise more leverage over supply chain segments that are hostile to positive change by collaborating with a supply chain partner (Dubey et al., 2021). In this research, therefore, we present a framework that enables a lean-agile supply chain-based model for the purpose of improving logistics performance with the integration of supply chain collaboration.

The global SCM market size is predicted to become greater, at a Compound Annual Growth Rate (CAGR) of 9.4% over the forecast span, from USD 28.9 billion to USD 45.2 billion from 2022 to 2027 **(Vitale et al., 2022)**. The upsurge growth of retail and eCommerce market globally have driven need for more transparency and visibility in supply chain data and processes. Additionally, the supply chain sector has been evolving due to technological advancements, and the incorporation of AI capabilities into SCM products would present attractive potential for SCM vendors in recent times.

Supply networks vary in their leanness and agility depending on the types of business they do. However, the COVID-19 pandemic's implications on supply and demand have ripple effects on SCM and supply chain operations, stressing the need for greater flexibility to lower epidemic and demand risks. In the latter half of 2020, 200 senior-level supply chain executives participated in a survey by Ernst & Young (EY), US.

Figure 1: Global Supply Chain Market Trend
(Image Source: POLARIS MARKET RESEARCH)

According to the research, the pandemic's severe disruption, businesses are being forced to fortify their supply lines through collaboration and networking. Additionally, an international business risk management framework needs to be used to analyse the broad and catalytic outcome of the pandemic on the supply chains of multi-national corporations. Due to this unpredictability, breakthrough insights, strategies, approaches, and ways of thinking are considered essential by the world's most active industries.

BACKGROUND:

Supply Chain Management (SCM) is integral to business operations, tracing its origins to logistics and overseeing the flow of goods from suppliers to consumers (Richey et al., 2022). However, challenges arise due to limited end-to-end transparency with outdated technologies **(Kamalahmadi et al., 2022).** The emergence of modern digital technologies, like robotics, AI, predictive analytics, and automation, holds the potential to revolutionize and replace traditional SCM practices **(Helo & Hao, 2021).** Enhanced SCM procedures not only reduce waste, lower expenses, and boost efficiency but also contribute to increased competitiveness and customer loyalty through customized logistics and automation **(Wu, 2021; Yan et al., 2022).** The digital evolution of supply chains, driven by technologies like IoT, cloud computing, AI, and blockchain, signifies the transition to Industry 4.0, addressing both current and anticipated challenges in SCM **(Caiado et al., 2022).**

LEAN SUPPLY CHAIN (LSC):

Lean Supply Chain (LSC) involves collaborative efforts among businesses to enhance resource utilization, flexibility, cost efficiency, and overall supply chain operations. It focuses on implementing Lean principles strategically, relying on strong connections, accessible data, and ongoing progress monitoring **(Paul et al., 2019).** Historically challenged by resource constraints, LSC emphasizes effective coordination and management of informational, physical, and monetary flows across multiple agents **(Novais et al., 2020).** LSC addresses the challenge of supplier and manufacturer control by promoting lean Supply Chain Management, leading to improved inventory management and cost reduction through waste elimination **(Gil-Vilda et al., 2021).** The lean concept, originally introduced by John Krafcik, aims to achieve total cost elimination by minimizing deviations from flawless execution in delivering sustained customer satisfaction **(Gil-Vilda et al., 2021).** Lean management, known for cost reduction, efficient processes, and value-added activities, complements Agile strategies, which respond to demand changes promptly **(Abdelilah et al., 2021).**

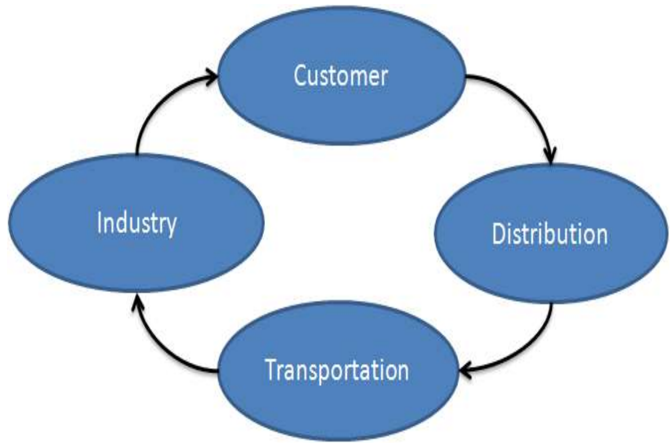

Figure 2: Lean Supply Chain Management
(Image Source: Goldsby, Griffis, & Roath, 2006)

AGILE SUPPLY CHAIN(ASC):

The Agile Supply Chain (ASC) strategy, influenced by Fisher's model, prioritizes swift adaptation to changing consumer needs through information sharing and market sensitivity **(Fisher, 1997; Christopher, 2000; Dubey et al., 2020).** Employing strategies like postponed fulfillment, rapid replenishment, and make-to-order, it aims to meet market expectations and allocate capacity for unpredictable demand **(Lalmazloumian et al., 2016; Stewart & Ivanov, 2019).**

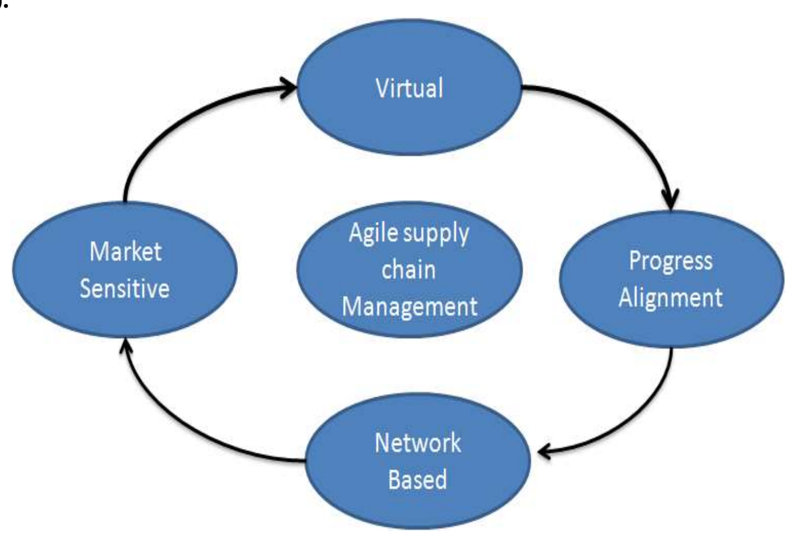

Figure 3: Agile Supply chain Management
(Image Source: Christopher, 2000)

LEAGILE: LEAN SUPPLY CHAIN – ASC:

The ASC is suitable for significant demand and supply volatility, while the Lean Supply Chain (LSC) is apt for predictable demand and constrained product diversity **(Agarwal et al., 2006).** Despite differences, both approaches offer long-term strategies for achieving flexibility and cost-effective supply chain management, culminating in the hybrid "leagile" or "league" model **(Martin & Towill, 2000; Goldsby, Griffis, & Roath, 2006).** Decoupling points in supply chains may need a combination of Lean and Agile methods, emphasizing lean upstream and agility downstream **(Mason-Jones et al., 2000).** The distinction lies in market responsiveness, with LSC prioritizing cost reduction through mass production, while ASC focuses on individualized production in response to market demand. The choice between agile and lean depends on organizational goals, with LSCs being more cost-effective and predictable, and ASCs offering adaptability and quick response to market changes.

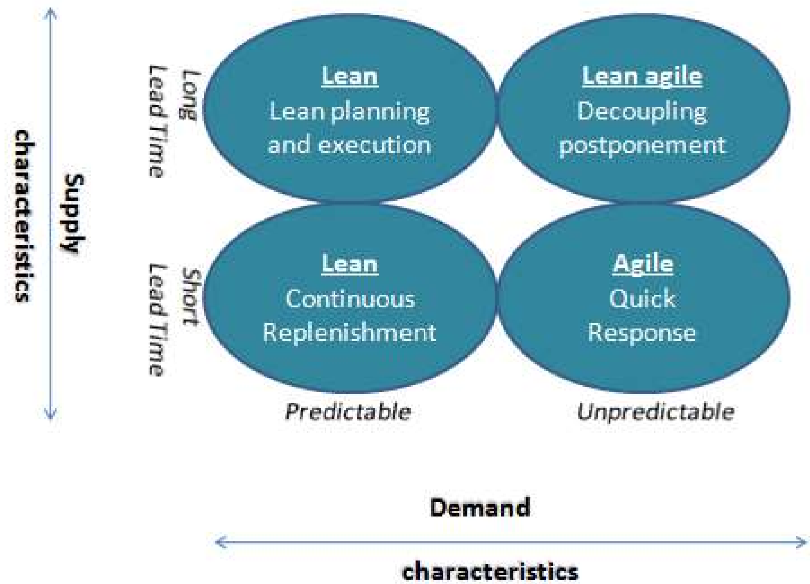

Figure 4: Lean – Agile Supply Chain Management
(Image Source: Ambe, 2009)

LOGISTIC PERFORMANCE:

Logistics tasks, encompassing customer service, demand planning, transportation, and more, involve information exchange and joint planning, with strategic planning playing a lesser role **(Sandberg, 2007).** The performance of logistics operations is measured by indicators such as costs, timeliness, and reliability, with critical criteria including lead-time, error-free delivery on-time delivery, and among supply chain partners **(Hotrawaisaya et al., 2014; Vieira et al., 2016).** The emphasis on indicators like order fill rate, damaged orders, and urgent order delivery highlights the importance of effective logistics communication in ensuring operational success.

LITERATURE REVIEW:

The literature review synthesizes recent academic research (2019-2022) on Lean-Agile Supply Chain Management (SCM) and logistics performance. Noteworthy findings include Fadaki et al.'s exploration of Divergence from Leagility (DFL) as a method to balance supply chain elements, Mishra et al.'s use of the Theory of Constraints (TOC) in humanitarian operations, and Chandak et al.'s emphasis on Supply Chain Strategies (SCS) and flexibility in Indian automobile organizations. Zimmermann et al. and Piya et al. contribute insights into the application of lean, agile, and leagile strategies across different sectors, including automotive, construction, and oil & gas industries. Additionally, studies by Kawa & Maryniak, Manville et al., Thanki & Thakkar, and Yunus delve into areas such as e-commerce, Lean Supply Chain Management (LSCM) in aerospace, key performance indicators, and the connection between supply chain collaboration and innovation. This comprehensive review serves as a foundation for understanding the current state of research in Lean-Agile SCM and its implications on logistics performance across diverse industries and contexts.

RESEARCH GAPS:

While numerous research papers have explored Lean SCM, Agile SCM, and LeAgile SCM, notable research gaps emerge from the literature review. Firstly, while LEAGILE SCM is acknowledged as effective, empirical evaluations specific to the logistics industry in international forums are lacking. Existing studies often neglect the challenges and inconsistencies associated with LEAN, Agile, or LEAGILE techniques. The dearth of standardized models or conceptual frameworks to address these challenges and guide policy makers is a significant gap. Moreover, limited research has focused on supply chain collaboration aligned with Lean or Agile SCM concepts, and studies that do exist often suffer from small sample sizes or inadequate sampling techniques. The majority of existing research has been conducted on industries in European and Western countries, neglecting the unique challenges faced by the UAE's logistics sector. Quantifying supply chain performance remains a pervasive issue, calling for a multi-method approach and recognized indicators of logistics performance as accurate proxies for supply chain performance. These research gaps highlight the need for further empirical studies in the UAE logistics industry, a focus on challenges, and the development of robust frameworks to guide industry practices and policies.

PROBLEM STATEMENT:

In the rapidly evolving landscape of logistics in the United Arab Emirates (UAE), there is a pressing need to enhance performance. This study addresses the gaps in understanding the impact of Lean-Agile supply chain capabilities and the dynamics of internal and external supply chain collaboration on logistics performance. By investigating these interrelated factors, the research aims to provide actionable insights that contribute to the optimization of logistics operations within the UAE context.

RESEARCH OBJECTIVES:

The main goal of this present research is to provide actual evidence supporting the hypothesis that LEAN and AGILE supply chain capabilities have a favourable impact on overall logistics performance in the logistics industry in the context of United Arab Emirates. Consequently, the study's objectives are as follows:

1. To evaluate the significance of Lean-Agile SCM capabilities on the logistics performance in logistics services sector in UAE
2. To evaluate the significance of Internal Supply Chain Collaboration (SCC) on logistics performance in logistics services sector in the UAE
3. To analyse the effect of External Supply Chain Collaboration (SCC) on logistics performance in logistics services sector in the UAE

PROPOSED RESEARCH MODEL:

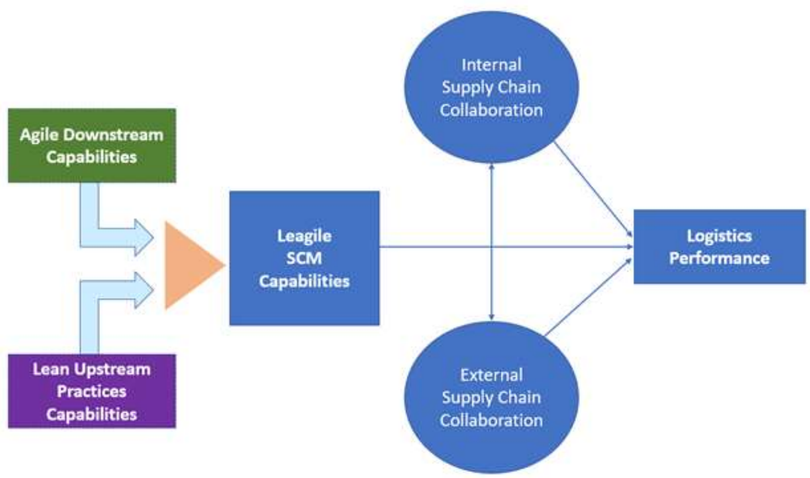

Fig 5: Proposed Research Model

PROPOSED RESEARCH HYPOTHESIS:

H1: Lean-Agile supply chain capabilities have significant impact on the logistics performance.

H2: Internal supply chain collaboration positively influence on the logistics performance.

H3: External supply collaboration positively influence on the logistics performance.

H4: The interaction of the internal and external supply chain collaboration will maximize the overall logistics performance.

H5: The interaction of the internal and external supply chain collaboration moderates the effect of Lean –Agile supply chain capabilities on the logistics performance.

RESEARCH METHODOLOGY:

This research adopts a quantitative approach, employing purposive sampling to select 150 participants from diverse departments within Logistics Service Firms actively engaged in Lean and Agile SCM projects in the UAE. A structured questionnaire, aligning with the study's conceptual framework and variables derived from an extensive literature review, was meticulously designed to capture insights into SCM practices, collaboration, and logistics performance. The targeted sample of 150 employess from the UAE’s logistics sector using purposive sampling were chosen deliberately for their expertise, allowed for a nuanced exploration of the research questions and testing of formulated hypotheses. The questionnaire served as the primary tool for eliciting quantitative data, and its systematic deployment ensures the reliability and relevance of the findings. The data underwent Structural Equation Modeling (SEM) analysis is SPSS Software.

DATA ANALYSIS:

DEMOGRAPHIC CHARACTERISTICS:

Table 1 Demographic Characteristics (Part 2)

Age		
	Frequency	**Percent**
35 - 40 Years	85	28.3
41 - 45 Years	122	40.7
46 - 50 Years	61	20.3
50 Above	32	10.7
Total	300	100.0
Mean	2.13	
Std. Deviation	0.95	
Education		
	Frequency	**Percent**
Under Graduate	37	12.3
Graduate	121	40.3
Post-Graduate	64	21.3
PhD	78	26.0
Total	300	100.0
Mean	2.61	
Std. Deviation	1.00	
Marital Status		
	Frequency	**Percent**
Married	145	48.3
Un-Married	155	51.7
Total	300	100.0
Mean	1.52	
Std. Deviation	0.50	
Experience Level		
	Frequency	**Percent**
0-2 years	58	19.3

3-5 years	74	24.7
6-10 years	84	28.0
10+ years	84	28.0
Total	300	100.0
Mean	2.65	
Std. Deviation	1.09	

The demographic data provided includes information on four important variables: Age, Education, Marital Status, and Experience Level. The age distribution of participants reflects a diversified sample. Between the ages of 41-45 comprises the largest proportion of respondents, accounting for 40.7% of the total. The second largest demographic consists of individuals in the age range of 35 to 40, or 28.3% of the overall population. The demographic breakdown of the sample reveals that individuals between the ages of 46 and 50 constitute 20.3% of the total participants, whereas those aged 50 and above account for 10.7% of the sample. The average age of the respondents is 2.13, and the standard deviation (σ) is 0.95, indicating a relatively narrow distribution centered around the mean. The respondents' educational backgrounds are diverse, with the biggest share possessing a doctorate degree, accounting for 40.3% of the sample. The percentage of individuals holding post-graduate degrees is 21.3%, whereas those with a Ph.D. account for 26.0%. The undergraduate population represents the smallest demographic, accounting for 12.3% of the overall total. The average education level is 2.61, with a σ of 1.00, suggesting a moderate degree of variation in educational achievement.

The distribution of participants' marital status is well balanced, with 48.3% of them married and 51.7% single. The average marital status score is 1.52, with a σ of 0.50. This indicates a slightly higher incidence of unmarried participants, but the overall distribution is relatively balanced between married and unmarried individuals. In terms of experience, the study participants demonstrate varying levels of professional experience. The distribution of experience categories indicates that 28.0% of respondents possess 0-2 years of experience, 24.7% having 3-5 years of experience, and an additional 28.0% have 10 or more years of experience. The average experience level is 2.65, with a σ of 1.09. This suggests a moderate degree of variability in the professional experience of the participants.

Table 2 Demographic Characteristics (part 2)

Job Role		
	Frequency	**Percent**
Logistics Manager	57	19.0
Supply Chain Analyst	110	36.7
Warehouse Supervisor	85	28.3
Operations Manager	48	16.0
Total	300	100.0
Mean	2.41	
Std. Deviation	0.97	
Department		
	Frequency	**Percent**
Logistics	41	13.7
Supply Chain	88	29.3
Operations	85	28.3
Information Technology	22	7.3
Quality Assurance	64	21.3
Total	300	100.0
Mean	2.93	
Std. Deviation	1.33	
Organization Level		
	Frequency	**Percent**

Frontline Employees	60	20.0
Middle Management	71	23.7
Senior Management	91	30.3
Executive Leadership	78	26.0
Total	300	100.0
Mean	2.62	
Std. Deviation	1.08	
Geographic Location		
	Frequency	**Percent**
Regional	110	36.7
National	127	42.3
International	63	21.0
Total	300	100.0
Mean	1.84	
Std. Deviation	0.74	

The distribution of participants across various job roles in terms of job role indicates a diverse representation within the workforce. The predominant position observed in the sample is that of a Supply Chain Analyst, accounting for 36.7% of the total. The percentage breakdown of job roles within the organisation is as follows: Logistics Managers comprise 19.0%, Warehouse Supervisors make up 28.3%, and Operations Managers account for 16.0% of the total. The average job role score is 2.41, accompanied by a σ of 0.97. This shows a moderate degree of variability in the job roles of the participants. The study involves participants from various departments, highlighting the diverse and interdisciplinary nature of the workforce. The field of Supply Chain exhibits the largest representation, making up 29.3% of the total, with Operations coming in close follow, which represents 28.3%. The allocation of resources in the total sample is as follows: Quality Assurance accounts for 21.3%, Information Technology constitutes 7.3%, and Logistics makes up 13.7%. The average departmental score is 2.93, with a σ of 1.33, suggesting a significant variation in the departmental affiliations of the participants.

The organisational hierarchy of the participants reflects a diverse range of roles, spanning from Frontline Employees to Executive Leadership, in terms of organisational level. The category with the highest representation is Senior Management, accounting for 30.3% of the total. Following that, Frontline Employees make up 20.0%, Middle Management accounts for 23.7%, and Executive Leadership represents 26.0%. The average organisation level score is 2.62, with a σ of 1.08, indicating a moderate level of variation in the participants' positions within their respective organisations. The distribution of participants across various geographic locations demonstrates the study's geographical reach. The highest level of representation is observed at the national level, accounting for 42.3%. This is followed by the regional level, which stands at 36.7%. Lastly, the international level of representation is recorded at 21.0%. The average geographic location score is 1.84, with a σ of 0.74, indicating a relatively narrow distribution centred around the mean.

H1: *Lean-Agile supply chain capabilities have significant impact on the logistics performance.*

The path analysis offered illustrates the relationships between Lean-Agile supply chain capabilities, marked by the variable "Lean Agile," and logistics performance, as well as particular features of Lean-Agile supply chain capabilities designated by "LeanAS" and "AgileAS." The strength and direction of these interactions are shown by the standardised coefficients. With a standardised coefficient of 0.588, the association between Lean-Agile supply chain skills and total logistics performance is determined to be significant ($p = 0.011$). This indicates a positive effect, demonstrating that as Lean-Agile supply chain skills improve, logistical performance improves. A more detailed examination of Lean-Agile supply chain capabilities into various components indicates variable effects on logistics performance. Notably, with standardised coefficients ranging from 0.622 to 0.779, LeanAS11, LeanAS12, LeanAS16, LeanAS17, and AgileAS1 have substantial positive associations with logistical performance. AgileAS8, on the other hand, has a negative connection with a standardised coefficient of -0.390.

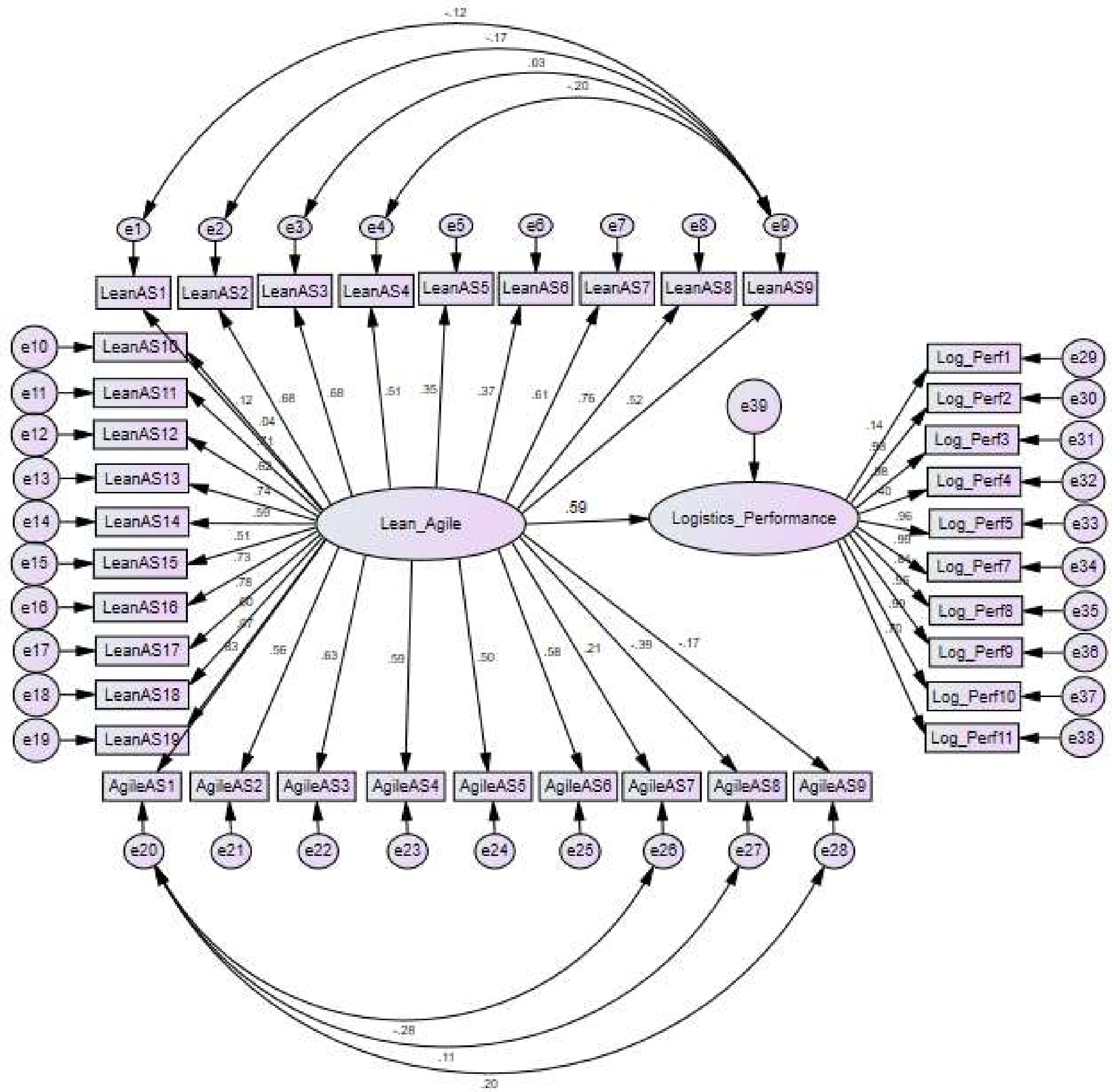

Figure 6 SEM Model (Impact of Lean-Agile on Logistic Performance)

The Lean-Agile supply chain capabilities and their components impact logistics performance, as illustrated by the arrows heading towards "Logistics Performance" in the route analysis. Log_Perf2, Log_Perf3, Log_Perf5, Log_Perf7, Log_Perf8, Log_Perf9, Log_Perf10, and Log_Perf11, for example, all exhibit strong positive correlations with Lean-Agile supply chain skills. The route analysis reveal that Lean-Agile supply chain skills have a substantial and beneficial influence on logistics performance.

Variables used in model fit summary tables are as follows:

χ^2: Chi-square

df: Degrees of freedom

NFI: Normed Fit Index

IFI: Incremental Fit Index

GFI: Goodness of Fit

RFI: Relative Fit Index

CFI: Comparative Fit Index

RMR: Root Mean Square Residuals

RMSEA: Root Mean Square Error of Approximation

Table 3 - Model fit summary

Variable	**Value**
χ^2	1179.509
df	500
CMIN/DF	2.359
P value	.000
GFI	.941
RFI	.927
NFI	.936
IFI	.928
CFI	.943
RMR	.072
RMSEA	.064

The fit quality is deemed acceptable, representing how well the sample data fits ($\chi2$ = 1179.509). Key fit indices, including NFI (.936), IFI (.928), GFI (.941), RFI (.927), and CFI (.943), all surpass the 0.90 benchmark. Additionally, RMR (0.072) and RMSEA (0.064) values are below the critical 0.080 threshold. In summary, the results shows a good fit for the presented model, including RMSEA of 0.064, RMR of 0.072, GFI of 0.941, and CFI of 0.943.

H2: *Internal supply chain collaboration positively influence on the logistics performance.*

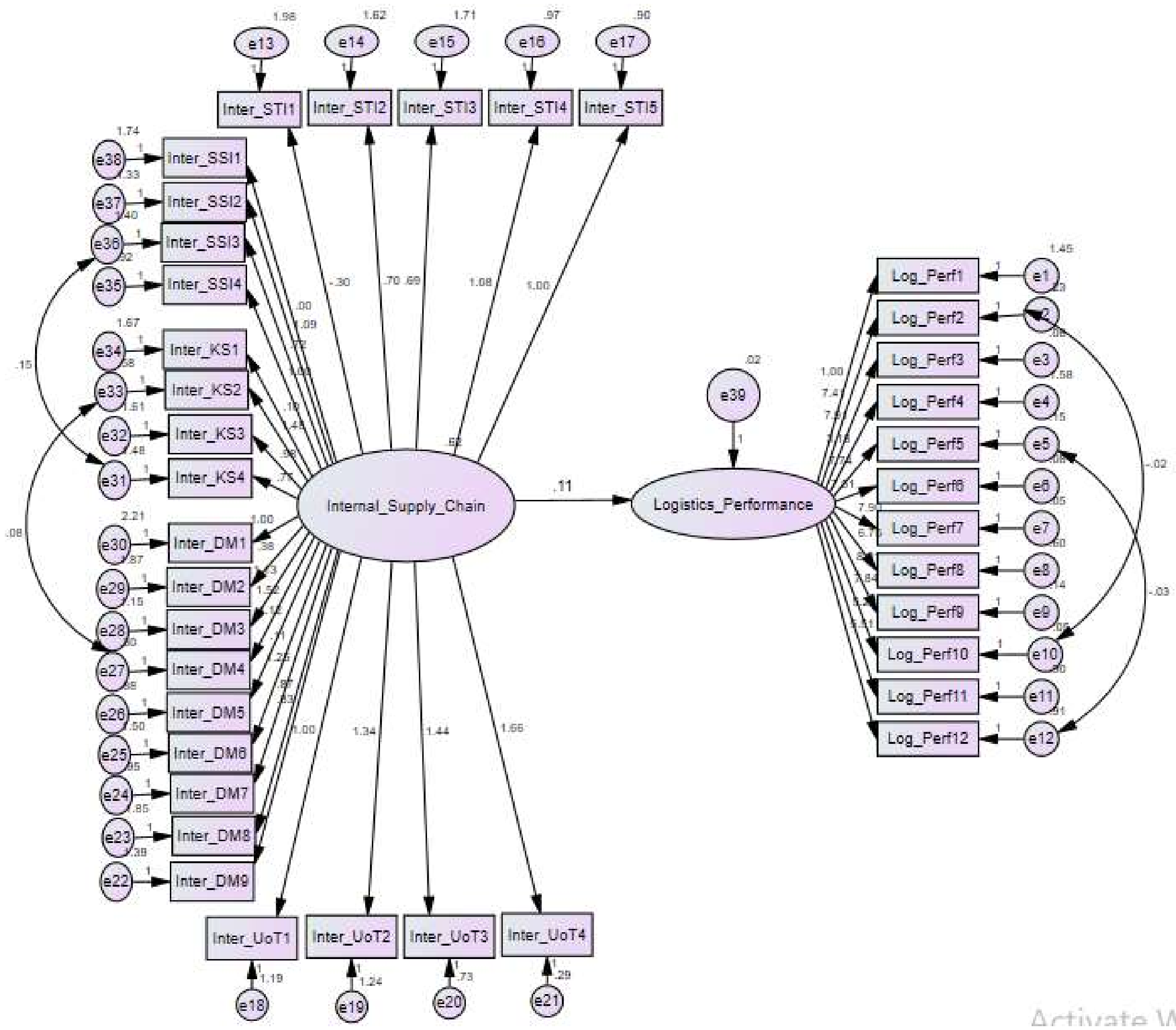

Figure 7 SEM Model (Effect of Internal supply chain on the logistics performance)

The purpose of the path analysis is to investigate the correlation between internal supply chain collaboration and logistics performance. These variables are referred to as "Internal Supply Chain" and "Logistics Performance" in the analysis. The standardised coefficients provide insight into the magnitude and direction of these relationships. The findings suggest that Logistics performance and internal supply chain collaboration have a statistically significant positive association (p = 0.016), as indicated by a standardised coefficient of 0.516. This discovery implies that as internal supply chain collaboration intensifies, there is a corresponding enhancement in logistics performance. To further explore the elements of internal supply chain collaboration, a number of variables have been identified, each with its own standardised coefficient. It is worth mentioning that Inter_STI4, Inter_STI3, Inter_STI2, Inter_SSI2, Inter_SSI3, Inter_KS2, Inter_KS3, Inter_DM2, Inter_DM3, Inter_DM4, Inter_DM5, Inter_DM7, Inter_DM8, Inter_DM9, Inter_UoT2, Inter_UoT3, and Inter_UoT4 demonstrate noteworthy positive correlations with internal supply chain collaboration. Nonetheless it's important to noted that Inter STI1 and Inter_DM6 exhibit a negative correlation. The path analysis also encompasses pathways from internal supply chain collaboration to specific logistics performance variables, which are referred to as Log_Perf1 to Log_Perf12. Each of these pathways demonstrates positive relationships, highlighting the significant influence of internal supply chain collaboration on diverse facets of logistics performance. The results provide evidence to support the hypothesis that internal supply chain collaboration has a favourable impact on logistics performance. The standardised coefficients of significance demonstrate the strength of these relationships, with specific elements of internal supply chain collaboration making a positive contribution to the overall impact.

Table 4 Model fit summary

Variable	Value
χ^2	2311.684
df	171
CMIN/DF	13.519
P value	0.000
RFI	.938
GFI	.961
IFI	.949
NFI	.934
CFI	.922
RMR	.05
RMSEA	.021

The fit quality is considered acceptable, presenting how well the sample data fits ($\chi 2$ = 2311.684). Key fit indices, including NFI (.934), RFI (.938), IFI (.949), GFI (.961), and CFI (.922), all exceed the 0.90 benchmark. Additionally, RMR (0.05) and RMSEA (0.021) values are below the critical 0.080 threshold. In summary, the results shows a good fit for the presented model, encompassing RMSEA of 0.021, RMR of 0.05, GFI of 0.961, and CFI of 0.922.

H3: *External supply collaboration positively influence on the logistics performance.*

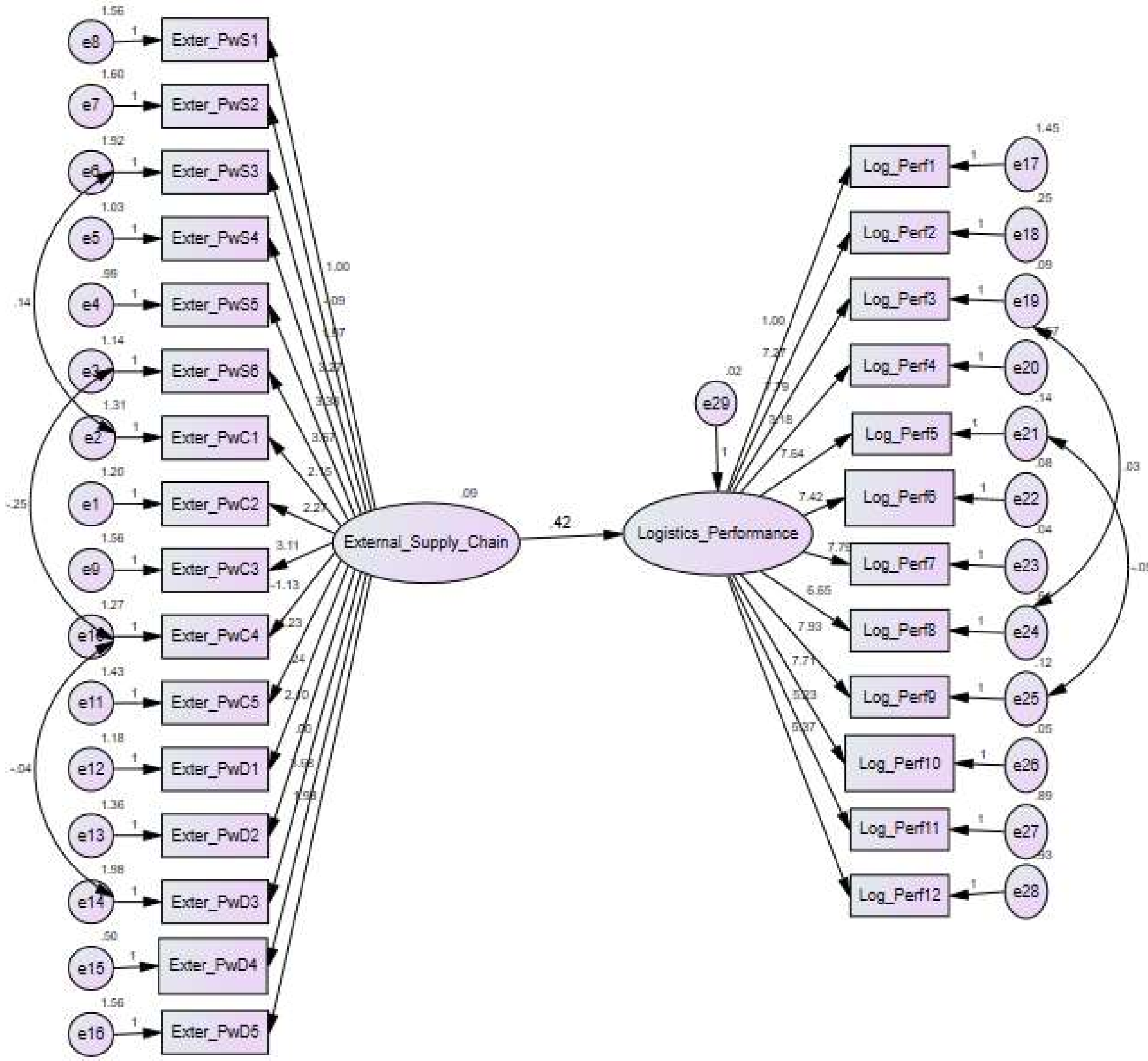

Figure 8 SEM Model (Impact of External supply collaboration of Logistic Performance)

The purpose of the path analysis is to examine the correlation between external supply chain collaboration, denoted as the variable "External Supply Chain," and logistics performance. The standardised coefficients in the analysis offer valuable insights into the magnitude and direction of these relationships. The results indicate a statistically significant positive effect of external supply chain collaboration on logistics performance (p = 0.036), with a standardised coefficient of 0.694. This implies that when organisations strengthen their collaboration with external partners in the supply chain, there is a corresponding enhancement in logistics performance. When analysing the specific elements of external supply chain collaboration, several variables exhibit notable positive correlations with the overall construct. It is worth noting that Exter_PwC1, Exter_PwS6, Exter_PwS5, Exter_PwS4, Exter_PwS3, Exter_PwC3, Exter_PwD2, Exter_PwD4, and Exter_PwD5 demonstrate favourable associations with external supply chain collaboration. However, the variables Exter_PwS2, Exter_PwC4, and Exter_PwC5 exhibit negative relationships. The path analysis also encompasses pathways from external supply chain collaboration to specific logistics performance variables, which are denoted as Log_Perf1 to Log_Perf12. Each of these pathways demonstrates positive relationships, emphasising the significant influence of external supply chain collaboration on different aspects of logistics performance. The analysis provide support for the hypothesis that external supply chain collaboration has a positive impact on logistics performance. The standardised coefficients of significance demonstrate the strength of these relationships, with individual components making positive contributions to the overall impact.

Table 5 Model fit summary

Variable	Value
χ^2	59.105
df	28
CMIN/DF	2.111
P value	.001
GFI	.943
RFI	.957
NFI	.996
IFI	.975
CFI	.998
RMR	.038
RMSEA	.067

The structural model, the quality of fit was the acceptable representation of the sample data (χ^2 (28) = 59.105, NFI = 0.996; IFI = 0.975, GFI = 0.943, RFI = 0.957 and CFI = 0.998 which is significantly greater than 0.95 and the 0.90 threshold proposed by **Byrne (1994).** Similarly, RMSEA = 0.067 and RMR =0.038 values are below the critical value of 0.080.

H4: *The interaction of the internal and external supply chain collaboration will maximize the overall logistics performance.*

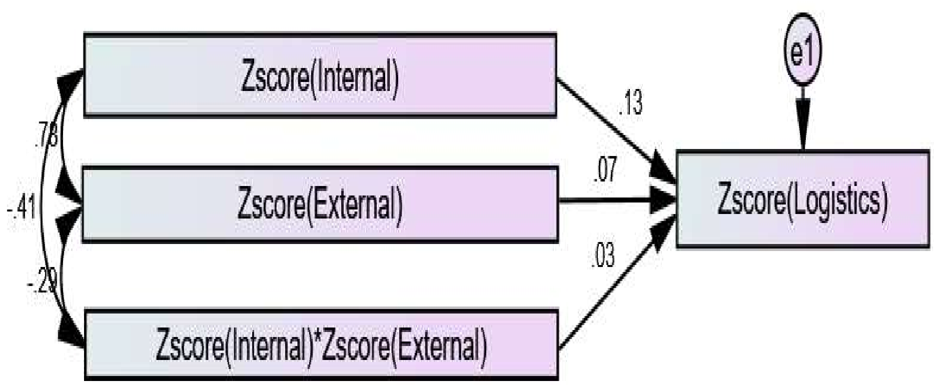

Figure 9 Moderating effect of Logistics Performance

Table 6 : Regression Weights (Group number 1 - Default model)

Path	Estimate	S.E.	Standardized Estimates	C.R.	P
Zscore(Logistics)<--- Zscore(Internal)	.214	.162	.127	1.322	***
Zscore(Logistics)<--- Zscore(External)	.118	.145	.074	.814	***

The SEM examining the association between Zscore(Internal) and Zscore(Logistics), with moderation by

Zscore(External), is presented in Table 30. This comprehensive analysis allows for testing all relevant paths, considering measurement errors and feedback directly within the model. Zscore(Internal) is positively and significantly linked with Zscore(Logistics) (β=0.127, P>05), according to the hypothesis that emerged from the route analysis. Zscore(External) is significantly and positively associated with Zscore(Logistics) (β= .074, P<.05).

Moderation testing:

The moderation analysis is managed by treating, the independent variables in this scenario are Zscore(Internal), the dependent variable is Zscore(Logistics), and the moderator variable is Zscore(External). The standardized scores of the variables are used to build interaction terms in SPSS, which is then used to calculate the findings.

Table 7 : Regression Weights (Group number 1 - Default model)

Path	**Estimate**	**S.E.**	**Standardized Estimates**	**C.R.**	**P**
Zscore(Logistics)<--- Zscore(Internal)*Zscore(External)	.037	.078	.029	.473	***

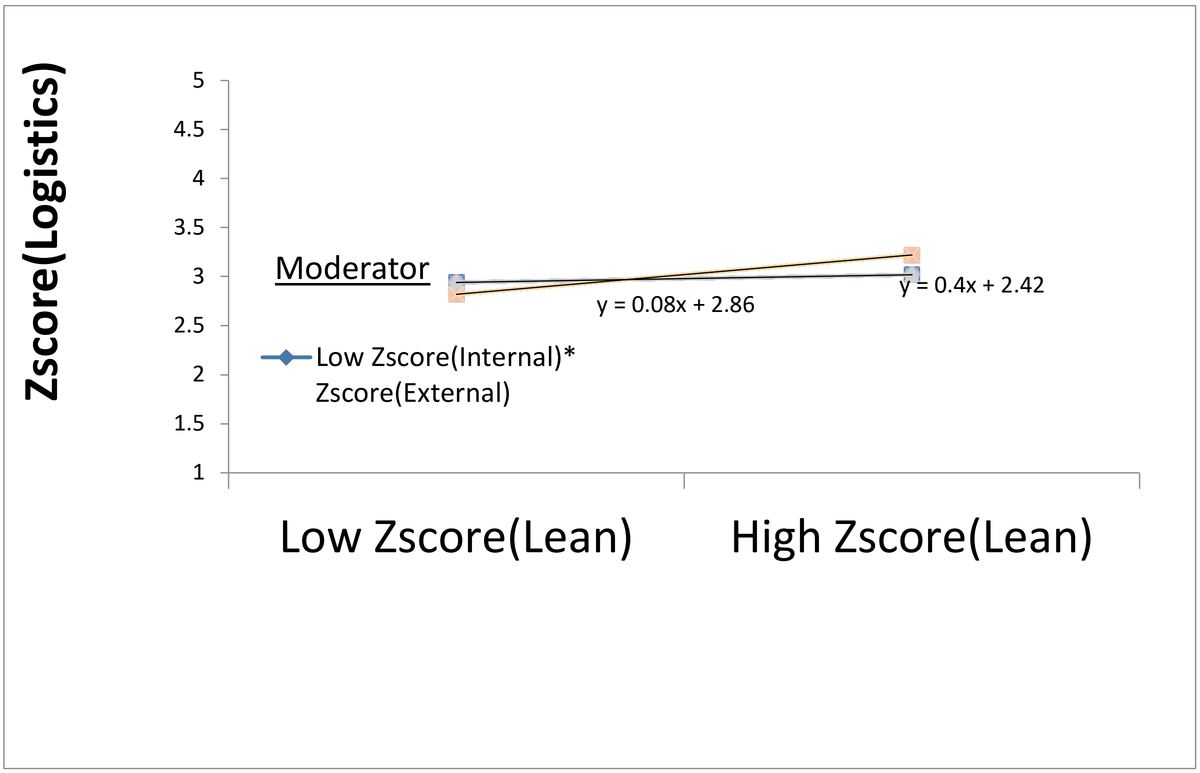

Figure 10 Two way interaction Model graph

We tested the Zscore(External) as a moderator. The findings show that Zscore(Logistics) is positively and significantly influenced by the interaction term between Zscore(Internal) and Zscore(External) (β=.029, P<.05). The finding shows that, in contrast to the relationship's predicted nature, there is statistical support for Zscore(External)'s moderating effect in our data. The fit indices of the model indicate that factors found to be significant at p>0.05 indicate that it fits the data well (see Table 2). The model fit was evaluated using various global fit indices and 'r' to assess the consistency between the hypothesized model and the available data. Based on the results in the aforementioned table, there is an association between Zscore(Internal) and ZScore(Logistics) is evident, especially when considering the moderating effects of ZScore(External).

Table 8 Model fit summary

Variable	Value
χ^2	395.248
df	128
CMIN/DF	3.0878
P value	.069
GFI	.948
RFI	.954
NFI	.946
IFI	.952
CFI	.952
RMR	.056
RMSEA	.041

The fit quality is considered acceptable, demonstrating how well the sample data fits ($\chi 2$ = 395.248). Key fit indices, including NFI (.946), IFI (.952), GFI (.951), RFI (.948), and CFI (.952), significantly surpass the 0.90 threshold. Additionally, RMR (0.056) and RMSEA (0.041) values are below the critical 0.080 threshold. In summary, the results shows a good match for the model that was presented, with a 0.056 RMR, 0.948 GFI, and 0.952 CFI.

H5: *The interaction of the internal and external supply chain collaboration moderates the effect of Lean –Agile supply chain capabilities on the logistics performance.*

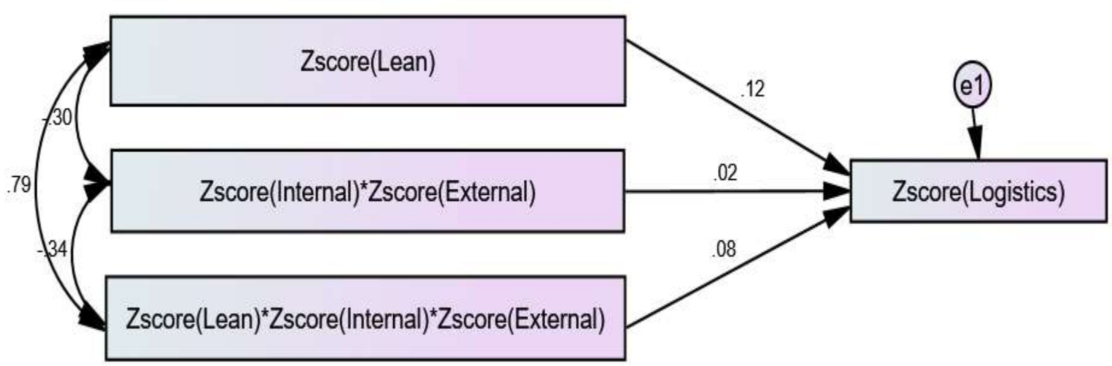

Figure 11 Moderation effect Model

Table 9 : Regression Weights (Group number 1 - Default model)

Path	Unstandardized Estimate	S.E.	Standardized Estimates	C.R.	P
Zscore(Logistics)<---Zscore(Lean)	.109	.158	.12	.693	.009
Zscore(Logistics)<---Zscore(Internal)* Zscore(External)	.135	.096	.02	1.404	***

The SEM examining the association between Zscore(Lean) and Zscore(Logistics), with moderation by

Zscore(Internal)* Zscore(External), is presented in Table 3. This comprehensive analysis allows for testing all relevant paths, considering measurement errors and feedback directly within the model. The path analysis hypothesis indicates a positive and substantial correlation between Zscore (Lean) and Zscore (Logistics) (β=0.12, P>05). Zscore(Internal)* Zscore(External) is significantly and positively associated with Zscore(Logistics) (β= .002, P<.05).

Moderation testing:

The moderation analysis is conducted by treating, Zscore(Lean) as independent variables, Zscore(Logistics) as dependent variable, and (Zscore(internal) * Zscore(External)) * Zscore(Lean) as moderator variables. Using SPSS, interaction terms are created using the standardized scores of the variables to calculate the results.

Table 10 Regression Weights

Path	**Unstandardized Estimate**	**S.E.**	**Standardized Estimates**	**C.R.**	**P**
Zscore(Logistics)<-- Interaction(Zscore(internal)* Zscore(External))*Zscore(Lean)	.033	.083	.08	.401	***

We tested the Zscore(Internal) *Zscore(External) as a moderator. Result shows that interaction term of Zscore(Lean) and Zscore(Internal) *Zscore(External) exerts significant and Positive a influence on Zscore(Logistics) (β= .08, P<.05). The outcome demonstrates that, in contrast to the relationship's predicted nature, there is statistical support for the moderating function of Zscore(Internal)* Zscore(External) in our data.

The fit indices of the model indicate that it is a good fit to the data, with factors found to be significant at p>0.05 (as shown in Table 4). The model fit was evaluated using various global fit indices and 'r' to assess the consistency between the hypothesized model and the available data. Based on the results in the aforementioned table, there is an association between Zscore(Lean) and Zscore(Logistics) is evident, especially when considering the moderating effects of Zscore(Internal)*Zscore(External).

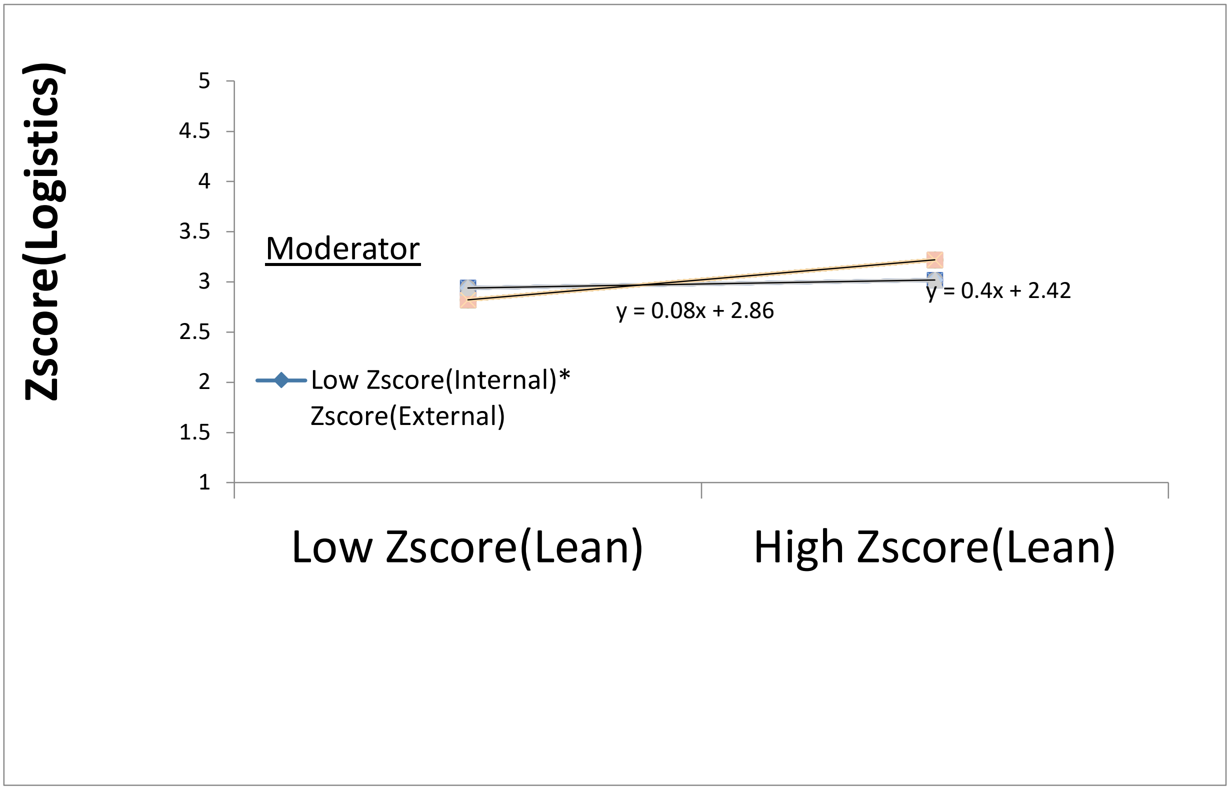

Figure 12 Two way interaction Model graph

Table 11 Model fit summary

Variable	Value
χ^2	321.45
df	45
CMIN/DF	2.551
P value	.063
RFI	.946
GFI	.953
IFI	.965
NFI	.942
CFI	.965
RMSEA	.048
RMR	.042

The fit quality is considered acceptable, indicating how well the sample data fits ($\chi 2$ = 321.45). Key fit indices, including NFI (.942), IFI (.965), GFI (.953), RFI (.946), and CFI (.964), significantly exceed the 0.90 threshold. Additionally, RMR (.042) and RMSEA (.048) values are below the critical 0.080 threshold. In summary, the results suggest a good fit for the presented model, including RMSEA of 0.048, RMR of 0.042, GFI of 0.951, and CFI of 0.965.

H: To prove LEAGILE is having good logistic performance when compared with LEAN and AGILE Alone.

Table 3 Descriptives

Logistics Performance				
	N	Mean	Std. Deviation	Std. Error
LEAN-methodology	100	1.4966	1.42785	.14279
AGILE-methodology	100	3.5446	.96543	.09654
LEAGILE methodology	100	4.2896	1.12356	.11236
Total	300	3.1102	1.67355	.09662

The provided tables present a comprehensive analysis of the Logistics Performance across three methodologies: LEAN-methodology, AGILE-methodology, and LEAGILE methodology. In Table 13, for every methodology, the mean, SD, and standard error are shown in the descriptive statistics. LEAN-methodology has a mean Logistics Performance of 1.4966, AGILE-methodology has a mean of 3.5446, and LEAGILE methodology has the highest mean at 4.2896. These values suggest that, on average, LEAGILE methodology demonstrates superior logistics performance compared to LEAN and AGILE alone.

Table 4 - ANOVA

Logistics Performance					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	418.341	2	209.171	148.235	.000
Within Groups	419.089	297	1.411		
Total	837.430	299			

The ANOVA results indicate a significant difference in mean Logistics Performance among the three methodologies (F = 148.235, p = .000). The between-groups sum of squares (418.341) is much more than the sum of squares within groupings (419.089), supporting the conclusion that there are substantial differences in logistics performance across the methodologies.

Table 5 Robust Tests of Equality of Means

Logistics Performance				
	Statistic[a]	df1	df2	Sig.
Welch	120.787	2	193.561	.000
a. Asymptotically F distributed.				

Table 15 presents the findings of the Welch test, a robust test of equality of means. The significant Welch statistic (120.787, p = .000) further reinforces the evidence that the mean Logistics Performance differs significantly among the methodologies.

Table 6 Multiple Comparisons

Dependent Variable: Logistics Performance					
	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.
Tukey HSD	LEAN-methodology	AGILE-methodology	-2.04801*	.16799	.000
		LEAGILE methodology	-2.79301*	.16799	.000
	AGILE-methodology	LEAN-methodology	2.04801*	.16799	.000
		LEAGILE methodology	-.74500*	.16799	.000

	LEAGILE methodology	LEAN-methodology	2.79301*	.16799	.000
		AGILE-methodology	.74500*	.16799	.000
*. The mean difference is significant at the 0.05 level.					

The multiple comparisons in Table 16, specifically Tukey's Honestly Significant Difference (HSD) test, provide detailed insights into the specific differences between the methodologies. The mean differences between LEAGILE methodology and both LEAN-methodology and AGILE-methodology are statistically significant (p = .000), supporting the hypothesis that LEAGILE has better logistics performance compared to LEAN and AGILE individually. Additionally, the mean differences between LEAN-methodology and AGILE-methodology are also significant, indicating disparities in logistics performance between these two methodologies. The analysis support LEAGILE methodology has superior logistics performance when compared with LEAN and AGILE methodologies individually. The consistent significance across multiple tests and the large mean differences provides robust evidence to affirm the hypothesis.

DISCUSSION:

The comprehensive analysis conducted in this study provides valuable insights into the relationship between Lean-Agile supply chain capabilities, internal and external supply chain collaboration, and their impact on logistics performance within the organizational context under investigation. The key hypotheses were systematically tested, and the results advance our knowledge of the intricate dynamics of supply chain management.

Hypothesis 1 (H1) posited that Lean-Agile supply chain capabilities significantly influence logistics performance. The results of the path analysis support this hypothesis, revealing a statistically significant and positive correlation between Lean-Agile supply chain capabilities and logistics performance. This underscores the importance of developing and integrating Lean-Agile capabilities to enhance overall logistics performance.

Hypothesis 2 (H2) suggested that internal supply chain collaboration positively affects logistics performance. The data analysis confirmed this hypothesis, showing a statistically significant positive correlation between internal supply chain collaboration and logistics performance. This emphasizes the strategic importance of fostering cooperation within the internal supply chain processes to optimize logistics outcomes.

Similarly, Hypothesis 3 (H3) proposed a positive relationship between external supply chain collaboration and logistics performance. The path analysis results supported this hypothesis, indicating a statistically significant positive correlation between external supply chain collaboration and logistics performance. This underscores the importance of building strong partnerships with external stakeholders to positively impact logistics performance.

Hypothesis 4 (H4) suggested that the synergy between internal and external supply chain collaboration optimizes overall logistics performance. The findings indicated a positive and significant correlation between both external and internal supply chain collaboration and logistics performance. However, the moderation analysis revealed a complex relationship, contrary to the initial hypothesis, emphasizing the need for a nuanced understanding of the interplay between internal and external collaboration in optimizing logistics performance.

Hypothesis 5 (H5) proposed that the interplay between internal and external supply chain collaboration serves as a moderating factor in the impact of Lean-Agile supply chain capabilities on logistics performance. The results highlighted a noteworthy and statistically significant effect of the interaction term on logistics performance, emphasizing the importance of considering both internal and external collaboration to maximize the benefits of Lean-Agile capabilities.

Hypothesis 6 (H6) aimed to prove that LEAGILE methodology demonstrates superior logistics performance compared to LEAN and AGILE methodologies individually. The comprehensive analysis of descriptive statistics, ANOVA, and multiple comparisons consistently supported this hypothesis, providing robust evidence that LEAGILE methodology outperforms LEAN and AGILE methodologies in terms of logistics performance.

In practical terms, these findings offer valuable guidance to professionals in the field of SCM. The study underscores the complexity of supply chain dynamics and advocates for a comprehensive approach, including the strategic development of Lean-Agile capabilities, promotion of internal collaboration, and cultivation of effective external partnerships. By embracing such a holistic perspective, organizations can position themselves to achieve optimal results in the realm of logistics performance.

CONCLUSION:

This study has systematically investigated the intricate interplay of Lean-Agile supply chain capabilities and internal and external supply chain collaboration, assessing their collective impact on logistics performance within the specific context of SCM. The empirical findings validate the significance of Lean-Agile principles, emphasizing their positive correlation with enhanced logistics performance in the realm of SCM. Moreover, the study underscores the pivotal roles of internal and external collaboration, revealing their individual contributions to logistics efficiency within SCM. The nuanced relationship between these collaboration forms further highlights the need for organizations to navigate these dynamics strategically in the field of SCM. Additionally, the comparative analysis of LEAGILE methodology against LEAN and AGILE methodologies substantiates the superiority of the integrated approach in optimizing logistics performance within the SCM domain. These insights contribute to the broader discourse in supply chain management, providing practical implications for organizational strategies aimed at improving logistics performance in the specific context of SCM.

REFERENCE:

Abdelilah, B., El Korchi, A., & Amine Balambo, M. (2021). Agility as a combination of lean and supply chain integration: how to achieve a better performance. *International Journal of Logistics Research and Applications*, 1-29.

Agarwal, A., Shankar, R., & Tiwari, M. K. (2006). Modeling the metrics of lean, agile and leagile supply chain: An ANP-based approach. *European journal of operational research*, *173*(1), 211-225.

Ailawadi, S. C., & SINGH, P. R. (2021). *Logistics and Supply Chain Management*. PHI Learning Pvt. Ltd.

Ambe, I. M. (2009). Agile supply chain: strategy for competitive advantage. In *The Proceedings of 5th International Strategic Management Conference* (p. 659).

An, H., Razzaq, A., Nawaz, A., Noman, S. M., & Khan, S. A. R. (2021). Nexus between green logistic operations and triple bottom line: evidence from infrastructure-led Chinese outward foreign direct investment in Belt and Road host countries. *Environmental Science and Pollution Research*, *28*(37), 51022-51045.

Caiado, R. G. G., Scavarda, L. F., Azevedo, B. D., de Mattos Nascimento, D. L., & Quelhas, O. L. G. (2022). Challenges and benefits of sustainable industry 4.0 for operations and supply chain management—A framework headed toward the 2030 agenda. *Sustainability*, *14*(2), 830.

Christopher, M. (2000). The agile supply chain: competing in volatile markets. *Industrial marketing management*, *29*(1), 37-44.

Cole, R., Stevenson, M., & Aitken, J. (2019). Blockchain technology: implications for operations and supply chain management. *Supply Chain Management: An International Journal*, *24*(4), 469-483.

Damoska Sekuloska, J., & Erceg, A. (2022). Blockchain technology toward creating a smart local food supply chain. *Computers*, *11*(6), 95.

Dubey, R., Bryde, D. J., Foropon, C., Graham, G., Giannakis, M., & Mishra, D. B. (2020). Agility in humanitarian supply chain: an organizational information processing perspective and relational view. Annals of Operations Research, In press.

Dubey, R., Bryde, D. J., Foropon, C., Tiwari, M., Dwivedi, Y., & Schiffling, S. (2021). An investigation of information alignment and collaboration as complements to supply chain agility in humanitarian supply chain. *International Journal of Production Research*, *59*(5), 1586-1605.

Esmaeilian, B., Sarkis, J., Lewis, K., & Behdad, S. (2020). Blockchain for the future of sustainable supply chain management in Industry 4.0. *Resources, Conservation and Recycling*, *163*, 105064.

Fisher, M.L., 1997, What is the right supply chain for your product?, *Harvard Business Review*, 75, 105-117.

Gil-Vilda, F., Yagüe-Fabra, J. A., & Sunyer, A. (2021). From Lean Production to Lean 4.0: A Systematic Literature Review with a Historical Perspective. *Applied Sciences*, *11*(21), 10318.

Goldsby, T. J., Griffis, S. E., & Roath, A. S. (2006). Modeling lean, agile, and leagile supply chain strategies. *Journal of business logistics*, *27*(1), 57-80.

Helo, P., & Hao, Y. (2021). Artificial intelligence in operations management and supply chain management: an exploratory case study. *Production Planning & Control*, 1-18.

Hotrawaisaya, C., Chandraprakaikul, W. and Suthikarnarunai, N. (2014). Performance improvement by logistics collaboration management model for orchid flower industry in Thailand, Engineering Management Research, Vol. 3, No. 2, pp. 52-68.

Kamalahmadi, M., Shekarian, M., & Mellat Parast, M. (2022). The impact of flexibility and redundancy on improving supply chain resilience to disruptions. *International Journal of Production Research*, *60*(6), 1992-2020.

Koberg, E., & Longoni, A. (2019). A systematic review of sustainable supply chain management in global supply chains. *Journal of cleaner production*, *207*, 1084-1098.

Lalmazloumian, M., Wong, K. Y., Govindan, K., & Kannan, D. (2016). A robust optimization model for agile and build-to-order supply chain planning under uncertainties. *Annals of Operations Research*, 240(2), 435–470

Martin, C., & Towill, D. R. (2000). Supply chain migration from lean and functional to agile and customised. *Supply Chain Management: an international journal*.

Mason-Jones, R., Naylor, B., & Towill, D. R. (2000). Lean, agile or leagile? Matching your supply chain to the marketplace. *International Journal of Production Research*, *38*(17).

Mesquita, A., Silva, P., Oliveira, A., Oliveira, L., & Sequeira, A. (2022). Surviving the COVID-19-Accelerated Digital Transformation: The Case of Portuguese SME and the Role of YBS Project. In *Advances in Tourism, Technology and Systems: Selected Papers from ICOTTS 2021, Volume 2* (pp. 97-109). Singapore: Springer Nature Singapore.

Modgil, S., Gupta, S., Stekelorum, R., & Laguir, I. (2021). AI technologies and their impact on supply chain resilience during COVID-19. *International Journal of Physical Distribution & Logistics Management*, *52*(2), 130-149.

Mohan, S. V., Dahiya, S., Amulya, K., Katakojwala, R., & Vanitha, T. K. (2019). Can circular bioeconomy be fueled by waste biorefineries—A closer look. *Bioresource Technology Reports*, *7*, 100277.

Moran, D., Giljum, S., Kanemoto, K., & Godar, J. (2020). From satellite to supply chain: New approaches connect earth observation to economic decisions. *One Earth*, *3*(1), 5-8.

Nagy, J., Oláh, J., Erdei, E., Máté, D., & Popp, J. (2018). The role and impact of Industry 4.0 and the internet of things on the business strategy of the value chain—the case of Hungary. *Sustainability*, *10*(10), 3491.

Novais, L., Maqueira Marín, J. M., & Moyano-Fuentes, J. (2020). Lean production implementation, cloud supported logistics and supply chain integration: Interrelationships and effects on business performance. *International Journal of Logistics Management*, 31(3), 629–663.

Paul, S. K., Asian, S., Goh, M., & Torabi, S. A. (2019). Managing sudden transportation disruptions in supply chains under delivery delay and quantity loss. *Annals of Operations Research, 273*(1–2), 783–814.

Polaris Market Research. *Global Supply Chain Management Market Size Global Report, 2022 – 2030*, Jul 2022, https://www.polarismarketresearch.com/industry-analysis/supply-chain-management-market

Richey, R. G., Roath, A. S., Adams, F. G., & Wieland, A. (2022). A responsiveness view of logistics and supply chain management. *Journal of Business Logistics*, *43*(1), 62-91.

Rodrigue, J.-P. (2021). Transport modes and globalisation. In R. Vickerman (Ed.), International Encyclopedia of Transportation (Vol. 5, pp. 38-44). Elsevier Ltd. UK.

Sandberg, E. (2007). Logistics collaboration in supply chains: practice vs. theory. The International Journal of Logistics Management, Vol. 18, No. 2, pp. 274-293.

Sharma, A., Adhikary, A., & Borah, S. B. (2020). Covid-19′ s impact on supply chain decisions: Strategic insights from NASDAQ 100 firms using Twitter data. *Journal of business research*, *117*, 443-449.

Soto-Acosta, P. (2020). COVID-19 pandemic: Shifting digital transformation to a high-speed gear. *Information Systems Management*, *37*(4), 260-266.

Stewart, M., & Ivanov, D. (2019). Design redundancy in agile and resilient humanitarian supply chains. *Annals of Operations Research*, In press. Doi: https://doi.org/10.1007/s10479-019-03507-5.

Vieira, J. G. V., Mendes, J. V. and Suyama, S. S. (2016). Shippers and freight operators perceptions of sustainable initiatives. Evaluation and Program Planning, Vol. 54, pp. 173-181.

Vitale, I., Dondo, R. G., González, M., & Cóccola, M. E. (2022). Modelling and optimization of material flows in the wood pellet supply chain. *Applied Energy*, *313*, 118776.

Wu, C. H. (2021). A dynamic perspective of government intervention in a competitive closed-loop supply chain. *European Journal of Operational Research*, *294*(1), 122-137.

Yan, X., Liu, W., Lim, M. K., Lin, Y., & Wei, W. (2022). Exploring the factors to promote circular supply chain implementation in the smart logistics ecological chain. *Industrial Marketing Management*, *101*, 57-70.