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Harnessing technology innovation and process excellence: Integrating lean six sigma, business process management, and strategic alignment to enhance supply chain agility and organizational performance

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A B S T R A C T

In today's altering business climate, supply chain agility has emerged as a key component of organizational success and competitive advantage. The performance of a company can be significantly impacted by its supply chain's capacity to react swiftly to changes in consumer requests, market circumstances, and other variables. This study examines the empirical effect of supply chain agility on organizational performance through the lens of Lean Six Sigma, business process management (BPM), technology innovation capabilities, and strategic alignment. The research methodology employed is a quantitative analysis of survey data collected from 187 supply chain professionals across different retail companies located in Dubai, UAE. The study findings indicate that supply chain agility has a positive and significant effect on organizational performance. The implementation of Lean Six Sigma, BPM, technology innovation, and strategic alignment also strengthens the relationship between supply chain agility and organizational performance. Furthermore, to increase supply chain agility and improve organizational performance, firms should invest in these aspects, promote a culture of continuous improvement and innovation, and work with supply chain partners.

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1. Introduction

Supply chains exposed to high risks have a lesser tendency to be efficient (Barusman & Habiburrahman, 2022); however, supply chain managers are continuously faced with the challenge of reducing these risks (Jia & Wang, 2019). Quality management (QM) and supply chain agility are two different management philosophies focused on separate organizational goals. It can be argued that both have the same primary goal—customer satisfaction—but QM concentrates on internal factors, whereas supply chain agility is directed towards the management of external parameters. Since there is a need to integrate both external and internal aspects, a consolidated framework should be established. Practically, implementing such an integrated framework is generally strenuous due to vague definitions, incompatible starting points and origins, along with diversified primary goals. As the central goal here happens to be customer satisfaction in all cases, both supply chain agility and quality management aim discretely at improving not only organizational performance but also the overall productivity of the entire supply chain. Jia and Wang (2019) believe that supply chain agility will be integral to future competitiveness. However, some of the most significant benefits of supply chain agility include more relevant and better-timed data with enhanced visibility, the ability to have a faster execution response than market competitors, and more collaborative and consolidated supply chain partner relationships. All these help enable accelerated, better, and rapid responses to newly emerging opportunities. Various retail companies have sustained improved change to their organizational performance by managing supply chain risks through minimal changes to their business models, for example, by adopting Lean Six Sigma (L6S) practices (Patel & Patel, 2021).

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The management approaches to significantly improve supply chain agility include adopting Lean Six Sigma (L6S), Business Process Management, Technology Innovation Capabilities, and Strategic Alignment, which will consequently improve organizational performance. L6S is deployed by firms as a development approach as it offers multidimensional solutions to various challenges and problems companies are facing these days, hence adding more value to organizations. The domain of supply chain agility and management also caters to customer focus and supplier quality management. Previous research shows that L6S can effectively generate more financial gains alongside significantly improving customer relationships. It is also quite efficacious when it comes to improving supply chain processes to make them more flexible, safe, less risky, agile, vigorous, and robust. However, for this to happen, managers have to expand their horizons and look beyond specific internalized processes while also considering the possibility of completely managing quality via an improved supply chain. Some companies are also using combinations of quality management philosophies and naming them Lean Six Sigma. Some of them have also had remarkable success stories regarding the integrated use of L6S and its role in revamped supply chain performance. However, no study has yet validated the impact of L6S on supply chain agility.

Another profitable practice for analyzing organizational performance is Business Process Management. It allows executives and managers to have a certain amount of control over organizational processes so that they can look for loopholes and ultimately be able to successfully accomplish the alignment of business operations with organizational goals (Suša Vugec et al., 2020). It is one of the most critical aspects as it helps to reduce operational costs while simultaneously improving performance. Organizations are continuously striving to boost employees' productivity and work performance for better competition. BPM is not only concerned with improving efficiency in the business, but it is also concerned with the processes and activities conducted while making decisions to bring change and improvement within the organization, which will, side by side, increase performance to satisfy customers. When BPM is precise enough, it has the ability to generate a procedure with excellent infrastructure. There has been some research on this aspect in the tourism sector; however, much more needs to be proven on the retail side.

Furthermore, supply chain agility and performance are also affected by the technology innovation capabilities of a state. As the world develops and relies more on technology, it is obvious that all conventional supply chain models would ultimately have to shift to digital ones in order to sustain advanced transportation means, production models, and consumer experiences. However, the state of development of any republic largely influences supply chain agility; this is exceptionally evident and true for developing states. The conventional supply chains, particularly those of developing nations, have failed to effectively keep up with the ever-increasing innovations and breakthroughs brought forth by technological industrial advancements, despite all the above-mentioned advantages. The reason is the limited monetary resources and unsupportive incentive strategies and programs that can aid in the subsidization of the industry. Moreover, latest research finds that, in developing countries, insufficient coordinated efforts and comparatively inadequate institutional regulations are also hindering the IT innovation needed to effectively bring about supply chain agility. Lastly, the factor under discussion is Strategic Alignment. Agile and lean are the ideal types of strategic supply chain approaches. Hypothetically, agile strategies are suitable for differentiators, whereas lean policies are more fitting for efficient innovators. Saetta and Caldarelli (2020) are of the opinion that effective performance can be created by executing supply chain strategic choices. This performance can then be moderated by the extent of integrated supply chain development potential, be it majorly focused on external or internal integration. Aslam et al. (2020) have further characterized that various forms of technology can be opted for in accordance with the supply chain strategic alignment. Integrative supply chain technologies are consistent with a response-oriented approach, whereas functional supply chain technologies are more suited for efficiency-oriented methodologies.

Supply chains are exposed to interference, volatility, instability, and disruption, now more than ever. Multiple factors are contributing to these current circumstances. Various systematic liabilities, for example, IT failures, cyberattacks, talent deficits, pandemics, and epidemics, resulting in conventional operational failures and sudden cessation of the global economy, cause significant implications for the feasibility and practicality of ongoing business processes and operations. Therefore, acquiring supply chain agility is extremely fundamental for organizations in order to adapt, endure, survive, grow, and develop in case any operational and/or strategic disruptions emerge. Supply chain agility, between members and collaborators of that supply chain amongst several different political, geographical, and cultural environments, is one of the most fundamental characteristics of a supply chain that is crucial for its resilience in critical times. Research depicts that a notable number of disruptions throughout the supply chain are caused by sub-suppliers and suppliers of a certain corporation (Saetta & Caldarelli, 2020).

The same was acknowledged in the literature from time to time; hence, the degree of empirical and theoretical interest has been expanding; however, the progress since then has been limited. It is understandable that this is largely because of insufficient conceptualization and theory-building research and reports that might present deeper insights into the morphology of enhanced supply chain agility. Current conceptual and theoretical studies are predominantly generic by nature and majorly focused on the state of the art in regards to supply chain agility. However, apart from this, there is an emerging line of research focusing specifically on the antecedents of supply chain agility (Durach et al., 2015). Our research is an effort to contribute to the aforementioned debate, focusing mainly on the relationship of supply chain agility and performance with Lean Six Sigma, Business Process Management, Technology Innovation Capabilities, and Strategic Alignment at Dubai SME retail companies.

2. Literature Review and Hypotheses Development

This research exclusively focuses on the organizational performance of small and medium-sized retail enterprises in Dubai, by taking into account Lean Six Sigma, Business Process Management, Technology Innovation Capabilities, and Strategic Alignment, with supply chain agility as a mediator. An information system is an integrated set of elements for data collection, delivery, storage, and processing that provides information for practice. It is important to note that this information is required for both management and operations in both corporate and non-profit organizations. Computer and telecommunications information technology underpins almost all modern organizations' information systems. These are computer-generated information systems. Business Process Management is based on theories and applications from business administration and computer programming. Business Process Management is a management theory that has been around since the late 1990s and is based on process-oriented movements. So many management concepts and procedures have been linked to business process management studies. A business program is a set of tasks that are completed collaboratively in a technological and organizational system (Alzoubi et al., 2022). The business procedure was specifically represented by the business process management framework among the operations and implementation restrictions. Individuals were able to evaluate, improve, and enforce Business Process Management once it was established. Traditionally, the business process has been carried out manually using highly educated people, company rules, and established protocols. The organization now has more extra benefits by implementing Information Technology (IT), such as the Business Process Management System, to coordinate activities associated with the business.

2.1 Lean Six Sigma (L6S)

Lean Six Sigma (L6S) strongly focuses on project functions, procedures, practices, and developmental work; hence, it can be useful in the manufacturing, industrial, and service divisions (Avunduk, 2019). There have been no contradictions amongst the objectives of L6S so far. L6S focuses on process flow and waste, alongside design and its variations. It is a renowned development approach for corporations (Drohomeretski et al., 2014). L6S is essentially consumer value-driven and includes waste elimination, effectively using resources, collaborative supply chain management, regular improvement, teamwork, and compact organizational structures (Carvalho et al., 2011). The Lean Six Sigma methodology offers an array of standardized solutions to everyday problems and improves processes throughout the complete value chain. Resources are wasted if consumed without adding value. Seven different types of wastes that are of no value are: defects, transportation, motion, inventory, over-production, over-processing, and waiting. An eighth waste, namely inappropriate design, was proposed later by Bharsakade et al. (2021). L6S is established on principles, objectives, and values which are portrayed through procedures, methods, devices, and tools. There is enough substantial data suggesting that L6S tools and methods have helped in improving organizational processes and operations of corporations in different sectors because it is a well-established process. Therefore, through these processes, organizational performance can be improved. Despite some limitations, L6S is also acknowledged as one of the most effective business development practices, put into effect by various top-notch organizations for about 30 years now (Aburayya et al., 2020). This methodology enhances business processes by controlling and understanding variation and minimizing poor-quality expenditures.

The L6S methodology suggests a direct correlation between consumer satisfaction and product defects. The effectiveness of L6S is established on practicing statistical methods to identify defects and flaws, enhancing processes, while simultaneously making sure that customers' voices are well-responded to (Snee, 2010). Hence, L6S significantly predicts supply chain agility at Dubai small enterprise retail companies.

Moreover, L6S has standard training modules, ranging from basic to extensive and comprehensive courses, as well as specifically designed courses for management and design. These days, various big corporations as well as some SMEs are incorporating the L6S strategy. L6S is more effective when there is low variety, high volume, and anticipated demand with a definite supply; hence functional products are easily put forth. On the other hand, in unstable and highly variable supply chains, where consumer demands can usually not be predicted, agility at a much greater level is required. L6S strives to find the best possible ways of managing variability for creating capability by utilizing available resources more efficiently than conventional systems. Leanness might be regarded as an aspect of agility under certain conditions for the organization to precisely meet customer demands promptly (Ramakrishna & Alzoubi, 2022). Hence, it can be said that organizational performance is significantly impacted by Lean Six Sigma through the mediating role of supply chain agility. Based on the above discussion, the following hypotheses have been developed:

H_1: *Lean Six Sigma has a positive statistical effect on Supply Chain Agility in the Dubai Retail Industry.*
H_2: *Lean Six Sigma has a positive statistical effect on Organizational Performance, mediated by Supply Chain Agility, in the Dubai Retail Industry.*

2.2 Technology Innovation Capabilities

Technology innovation capabilities refer to an organization's ability to create and implement new technological products, services, or processes. In today's fast-paced business environment, technology innovation is a crucial element of competitive advantage. As stated by Almaazmi et al. (2021), by investing in technology innovation capabilities, organizations can develop tools and systems that provide real-time visibility into their supply chains, allowing them to identify potential disruptions and

respond quickly. Additionally, technology innovation capabilities can facilitate collaboration between supply chain partners, enabling faster decision-making and problem-solving. According to Del Solfa et al. (2023), organizations with strong technology innovation capabilities can quickly adapt their supply chains to changes in customer demand, supplier capacity, or other market conditions. For example, they can use advanced analytics and machine learning algorithms to optimize inventory levels, adjust production schedules, or redesign their logistics networks. Some studies highlight that by using technologies such as blockchain, the Internet of Things (IoT), or artificial intelligence (AI), organizations can improve the traceability and security of their supply chains, reducing the risk of counterfeiting, fraud, or theft (Almaazmi et al., 2021). Moreover, technology innovation capabilities can help organizations identify and mitigate potential disruptions, such as natural disasters, geopolitical conflicts, or supply chain disruptions. Based on the above discussion, the following hypotheses have been developed:

H_3: *Technology Innovation Capabilities has a positive statistical effect on Supply Chain Agility in the Dubai Retail Industry.*
H_4: *Technology Innovation Capabilities has a positive statistical effect on Organizational Performance, mediated by Supply Chain Agility, in the Dubai Retail Industry.*

2.3 Strategic Alignment

When it comes to the strategic implementation process, a few strategic alignment experts emphasize that there are several different perspectives to view strategic alignment, for example, by organizational and administrative context, vertical and horizontal strategic alignment (van der Westhuizen & Niemann, 2022). Vertical alignment involves the configuration of functional strategy relations alongside business or corporate policies, as poor performance is linked with the misalignment of functional aspects and the inability to decipher goals at the organizational level. Whereas lateral/horizontal alignment is defined as calculated decision stability amongst various functions. This supply chain strategic approach is quite closely linked with the policies of the manufacturing sector. This opinion, confirmed by van der Westhuizen and Niemann (2022), also stresses that strategic alignment, along with the compatibility of all internal procedures and methods in the sphere of manufacturing operations with external developments both downstream and upstream, would overall generate business process efficiency. Collaboration is the main key factor for an agile supply chain. Hence, we can conclude that Strategic Alignment can directly influence Supply Chain Agility.

Therefore, the set of competitive priorities of the manufacturing sector must be transformed into strategic decisions and activities where suppliers and consumers are concerned. One such survey conducted by Ahmed and Huma (2021) revolved around 80 different manufacturers in the US. Out of those, only 13% had been able to align their set of priorities of manufacturing divisions with supply chain processes within the reach of consumers and suppliers. Four sets of competitive priorities in the manufacturing/operations sector have been introduced by Jia and Wang (2019). They are all interchangeable, a substitution or a trade-off by nature. This also suggests that the range of supply chain strategies will regulate the choices of competing priorities in various manufacturing sectors. Four of those competing priorities (in manufacturing strategy dimensions) are groundbreaking production cost, the extent of flexibility, product quality, and swift delivery. Competitive priorities of the production sector, for example, leading the way for effective production costs, will eventually be supportive to achieve better organizational performance if the alignment of agile supply chain policies is focused towards efficient supply processes. Hence, it would not be a false deduction to conclude that Strategic Alignment enhances Organizational Performance with the mediating role of Supply Chain Agility.

Otherwise, the responsive alignment of supply chain strategy will be retained if the organization is capable enough to accomplish excellence in flexibility and quality performance. Based on the above discussion, the following hypotheses have been developed:

H_5: *Strategic Alignment has a positive statistical effect on Supply Chain Agility in the Dubai Retail Industry.*
H_6: *Strategic Alignment has a positive statistical effect on Organizational Performance, mediated by Supply Chain Agility, in the Dubai Retail Industry.*

2.4 Business Process Management

According to Suša Vugec et al. (2020), business process management is a tool which offers the organization a chance to step back and look into business operations by examining the processes and activities conducted in order to create a powerful and effective organization. This tool allows one to evaluate current business situations to examine and adapt the changes required in different fields of operations. These can also benefit firms by avoiding the wastage of valuable resources, minimizing waste involved during various steps of the supply chain, alongside helping them to move on from conventional functionalism to progression orientation which will ultimately enhance processes and productivity (Nowak et al., 2022). Hence, Business Process Management is an effective and imperative tool for improving Organizational Performance with the mediating role of Supply Chain Agility. Not only this, it permits the organization to monitor the digital process when the job is completed within the firm so that the organization can efficiently achieve optimal performance and seize future opportunities.

The term 'improvement' can have a variety of connotations depending on the organization's aims. Using a business management tool helps in reducing cost, directing the organization to execute improvements in efficiency, and reducing the margin of error which can be made by humans. These are all considered typical types of achievement, which can also be

known as smaller targets for companies. Bringing changes in reforms is known as a one-time event but it has a long-term impact and presence. BPM allows you to take prompt decisions in all processes (Suša Vugec et al., 2020). As commercial products are manufactured using a multi-stage procedure instead of single-stage methods, BPM helps to effectively cater to all consumer demands while keeping the processes aligned. It also helps in building and retaining customer relationships, maintaining consumer loyalty, reviewing and acting upon their complaints, and prioritizing customer satisfaction. The three main dimensions it caters to are process quality control, consumer satisfaction, and organizational control. BPM enables swift access to consumer demands, needs, and questions, facilitating and improving quality consumer service by keeping supply chain processes continuously in an effective loop. Henceforth, the direct link between Business Process Management and Supply Chain Agility is established.

Business process management is a lengthy process comprising five different steps and therefore it is considered to be of significant value to the organization's performance altogether. Factors like demand management, order management, replenishment, process optimization, just-in-time inventory, etc. are all accomplished through effective business process management. Moreover, in many cases, business process management mainly acts as a catalyst in the process where a firm is aiming to improve its overall performance. In companies where sustainability is at the heart of operating activities, it is believed that this move towards sustainability is mainly to cater to the extensive competition faced in different industries. Based on the above discussion, the following hypotheses have been developed:

H_7: *Business Process Management has a positive statistical effect on Supply Chain Agility in the Dubai Retail Industry.*
H_8: *Business Process Management has a positive statistical effect on Organizational Performance, mediated by Supply Chain Agility, in the Dubai Retail Industry.*

2.5 Organizational Performance

The measure of performance refers to measurements of the performance of processes, projects, and people. The efficiency of the processes should be correctly assessed to correlate them with objectives and targets. To track progress and ensure that targets are accomplished, business process management projects need certain benchmarks and standards (Aman-Ullah et al., 2022).

Agile supply chains can only be set out with dependence on data accuracy and market sensitivity. Any market-oriented industry would always have the primary goal of building close-knit relationships with consumers (Silva et al., 2019). This helps in acquiring quick and accurate customer data, which ultimately leads to prompt production, hence achieving their ultimate goal of enhancing Organizational Performance. For this to be properly implemented, thriving manufacturers always seize the opportunity of grabbing the latest trends by using a variety of resources. Data is analyzed on a daily basis to keep the circle effectively and continuously going, while keeping replenishment demands in check as well, since the objective is to keep the product rolling in the market. Based on the above discussion, the following hypothesis has been developed:

H_9: *Supply Chain Agility has a positive statistical effect on Organizational Performance in the Dubai Retail Industry*.

3. Methodology and Research Design

This research is based on a quantitative, cross-sectional study research design in order to test the interrelationships between Lean Six Sigma, Business Process Management, Technological Innovation Capabilities, Strategic Alignment, Supply Chain Agility, and Organizational Performance in the retail industry in the UAE. The quantitative methodology was chosen due to the fact that it is possible to measure the latent constructs objectively, researcher bias is reduced, and generalizable statistical inferences can be made using Structural Equation Modeling (SEM).

3.1. Reasoning and Justification of Sampling Strategy

The research used a purposive sampling method by selecting supply chain and operational professionals who have firsthand experience with organizational processes, technology adoption, and agile operational practices. The main reason random sampling was not chosen to minimize selection bias was that it was not feasible due to limited access to internal managerial employees and issues of confidentiality in UAE-based organizations. Thus, purposive sampling was used to assure high quality and relevance of the data by ensuring that only respondents with the relevant expertise were included.

Thirty-four retail firms in Dubai were contacted. Five hundred questionnaires were administered through corporate email channels, with the help of supply chain and administration units. Among these, 382 were returned, which is equal to a 76 percent response rate. Upon data screening for missing and invalid responses, 187 valid questionnaires were retained to be analyzed.

The 187 sample size exceeds the minimum sample required to conduct PLS-SEM analysis (10 times the maximum number of structural paths or items in a given construct) by far, which is sufficient to guarantee adequate statistical power and model stability.

3.2. Data Collection Procedures

A structured online questionnaire designed in Google Forms was used for data collection. The instrument included 35 items that were rated using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The questionnaire was designed in six parts in accordance with the key constructs:

- Supply Chain Agility (6 items)
- Organizational Performance (6 items)
- Technological Innovation Capabilities (5 items)
- Strategic Alignment (5 items)
- Lean Six Sigma (7 items)
- Business Process Management (5 items)

The respondents were top officers, managers, and supervisors of operations, logistics, supply chain, and procurement departments.

3.3. Instrument Development and Validity Testing

The measurement tool was based on peer-reviewed and established scales, which are common in supply chain and operations management research. To guarantee content validity, three academic and two industry professionals from the UAE retail supply chain industry reviewed the first draft of the questionnaire. According to the experts' comments, some slight modifications were made to improve clarity, relevance in context, and language. To establish face validity, a pilot study was carried out with 30 respondents who were considered to be out of the main dataset. Items that were unclear or poorly understood were narrowed down. Factor loadings, Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) were subsequently confirmed for construct validity, i.e., convergent and discriminant validity, during the assessment of the PLS-SEM measurement model.

3.4. Statistical Analysis

The final data was examined with SmartPLS 3.0, which is suitable for dealing with complex models, non-normal data, and theory development. The analysis was performed using the conventional two-step procedure of SEM:

3.4.1. Measurement Model Assessment

- Reliability (Cronbach's α, CR)
- Convergent validity (Factor Loadings, AVE)
- Discriminant validity (HTMT Criterion)

3.4.2. Structural Model Assessment

- Path coefficients and significance (bootstrapping 5000 resamples)
- R^2 and effect sizes (f^2)
- Predictive relevance (Q^2)
- Mediation testing

3.5. Research Model

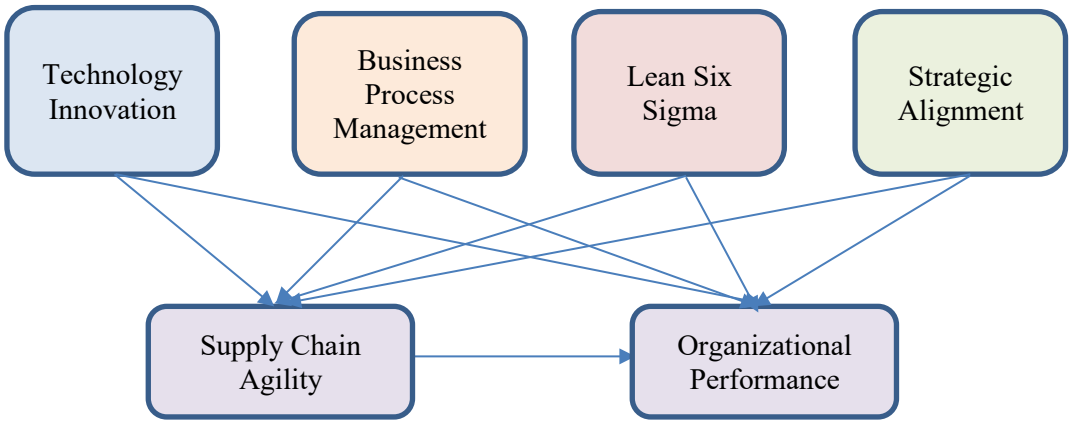

Fig. 1. Research Model (prepared by authors)

4. Data Analysis

We utilized SmartPLS 3 to assess our measurement and structural model following a two-stage approach. The PLS algorithm was utilized for the assessment of the measurement model and bootstrapping for testing our hypotheses, while PLS blindfolding was utilized to check the quality of both measurement and structural models.

4.1 Demographic Statistics

Detail on demographics is given in Table 1.

Table 1
Demographic Statistics

Feature	Description	Frequency	Percent
Gender	Male	118	63.1
	Female	69	36.9
	Total	187	100
Age	18-30 Years	82	43.9
	31-40 Years	89	47.6
	41-50 Years	16	8.6
	Total	187	100
Education	High School	25	13.4
	Bachelors	119	63.6
	Masters	41	21.9
	PhD	2	1.1
	Total	187	100
Experience	1-5 Years	89	47.6
	6-10 Years	36	19.3
	11-15 Years	37	19.8
	15+ Years	25	13.4
	Total	187	100

4.2. Descriptive Analysis

Data on means, standard deviation, and construct inter-correlations is given in Table 2. As expected, all variables had positive and significant correlations.

Table 2
Mean, SD and Correlations

	Mean	SD	L6S	BPM	TIC	SA	SCA	OP
L6S	3.82	0.47	1					
BPM	3.7	0.53	.297*	1				
TIC	3.73	0.54	.355*	.495*	1			
SA	3.88	0.48	.279*	.439*	.484*	1		
SCA	3.82	0.46	.522*	.567*	.617*	.598*	1	
OP	4.17	0.54	.258*	.325*	.293*	.307*	.496*	1

Note: N = 187, *p < .05

4.3 Measurement Model Assessment: Aligned with the suggestion of Khan et al. (2018), VIF values were checked to be less than 5 for each block of exogenous and endogenous variables, to rule out common method bias (CMB). VIF values beyond 5 are an indication of CMB. Our VIF values ranged between 1.8 and 4.425 for all six blocks of measured and latent variables, which ruled out CMB in our data.

Aligned with Hair et al. (2010), a reflective higher-order constructs model was deemed appropriate to be evaluated for the measurement. The following methods are involved in assessing and validating the reflective measurement model.

Factor Loadings: The measure is said to be reliable when its factor loadings (FL) are above 0.50. Using a benchmark range of factor loading quality, i.e., excellent (0.71), very good (0.63), good (0.55), fair (0.45) to poor (<0.32), most of our scale factor loadings were above 0.71 (see Table 3 and Figure 2), so the basis for the reliability of our measures was established.

Internal Consistency: The threshold for reliability of the measure is > 0.7 scores of Cronbach's α for each measure. Our estimations met the criteria very well (see Table 3 and Fig. 2). However, owing to the underestimation problem with Cronbach's α, there is a need for a greater estimation of true reliability (Garson, 2012). As shown in Table 3, our model adequately met the acceptable values of CR, i.e., > 0.7 for confirmatory purposes (Hair et al., 2018).

Convergent Validity: This is the extent of agreement in several trials at quantifying exactly the same theory using varied approaches. For convergent validity, the AVE (average variance extracted) should be greater than 0.5. The AVE values in Table 3 almost all met the criteria to establish the convergent validity of the constructs.

Discriminant Validity: We concluded discriminant validity based on HTMT < 0.85. Table 4 shows that all HTMT ratios were below 0.85. So, we concluded that our constructs had sufficient discriminant validity.

Quality of the Measurement Model: The eminence quality of the measurement model is assured through its predictive validity, which is calculated by utilizing the values of communality (H^2). All of these values were positive for all blocks (Table 3), hence ensuring the predictive validity/eminence quality of the measurement model.

Table 3
Reliability and Validity of Measurement Model

Construct	Cronbach's α	CR	AVE	FL
BPM	0.905	0.906	0.617	> 0.74
TIC	0.881	0.881	0.598	> 0.68
L6S	0.874	0.873	0.497	> 0.65
OP	0.895	0.894	0.588	> 0.62
SA	0.868	0.862	0.56	> 0.62
SCA	0.854	0.857	0.503	> 0.52

Table 4
Discriminant Validity (HTMT) and Quality of the Measurement Model (H^2)

	BPM	TIC	L6S	OP	SA	SCA	H^2
BPM	--						0.55
TIC	0.555	--					0.512
L6S	0.33	0.4	--				0.425
OP	0.362	0.33	0.29	--			0.516
SA	0.494	0.549	0.318	0.349	--		0.475
SCA	0.644	0.711	0.602	0.566	0.694	--	0.418

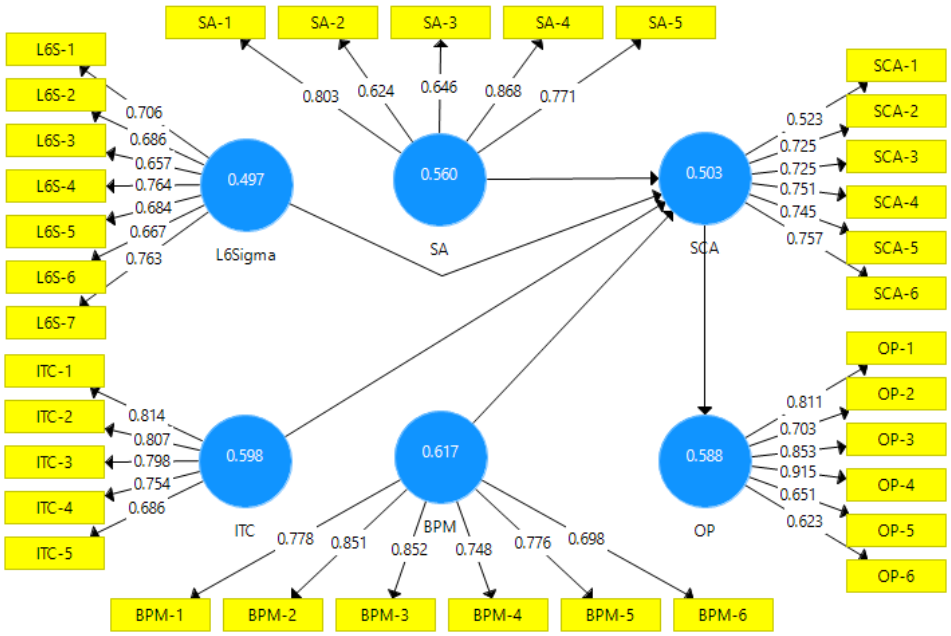

Fig. 2. Measurement Model

4.4. Structural Model Assessment: A structural model shows the relationship between constructs and related theories based on existing literature. Our model has two types of relationships: direct effects and mediation analysis.

Pertaining to direct relationships, the path modeling results underlined a significant positive relationship between L6S and SCA (β = .304, t = 4.002, p < .000), hence supporting Hypothesis 1. Similarly, bootstrapping results also found a significant positive relationship between BPM and SCA (β = .224, t = 2.642, p = .009), thus confirming Hypothesis 3. There was also a positive relationship between TIC and SCA (β = .272, t = 3.448, p = .001), which confirmed the approval of Hypothesis 5. Hypothesis 7 was also approved as SA had a positive and significant impact on SCA (β = .338, t = 4.767, p < .001). The last direct hypothesis, H9, was supported as well, as SCA impacted OP significantly and positively (β = .574, t = 8.863, p < .001). Following Cohen (1988), we also analyzed the f^2, which showed that the change in effect size for the predictor variables was small to large, so all variables had significant contributions in the overall mediation model. R^2 values suggested that SCA received an overall 75.7% and OP received 32.8% variance from the respective predictors (see Table 5, see Fig. 3).

Table 5
Hypotheses Testing

Path	Estimate	SE	t-value	p-value	f²	95% CI	Status
H_1: L6S → SCA	0.304	0.076	4.002	0.000	0.309	[0.154, 0.453]	Supported
H_2: L6S → SCA → OP	0.174	0.044	3.942	0.000	-	[0.087, 0.260]	Supported
H_3: BPM → SCA	0.224	0.085	2.642	0.009	0.129	[0.056, 0.393]	Supported
H_4: BPM → SCA → OP	0.128	0.052	2.467	0.014	-	[0.025, 0.231]	Supported
H_5: TIC → SCA	0.272	0.079	3.448	0.001	0.171	[0.116, 0.428]	Supported
H_6: TIC → SCA → OP	0.156	0.052	2.991	0.003	-	[0.054, 0.258]	Supported
H_7: SA → SCA	0.338	0.071	4.767	0.000	0.296	[0.198, 0.478]	Supported
H_8: SA → SCA → OP	0.194	0.044	4.43	0.000	-	[0.107, 0.281]	Supported
H_9: SCA → OP	0.574	0.065	8.863	0.000	0.489	[0.446, 0.701]	Supported

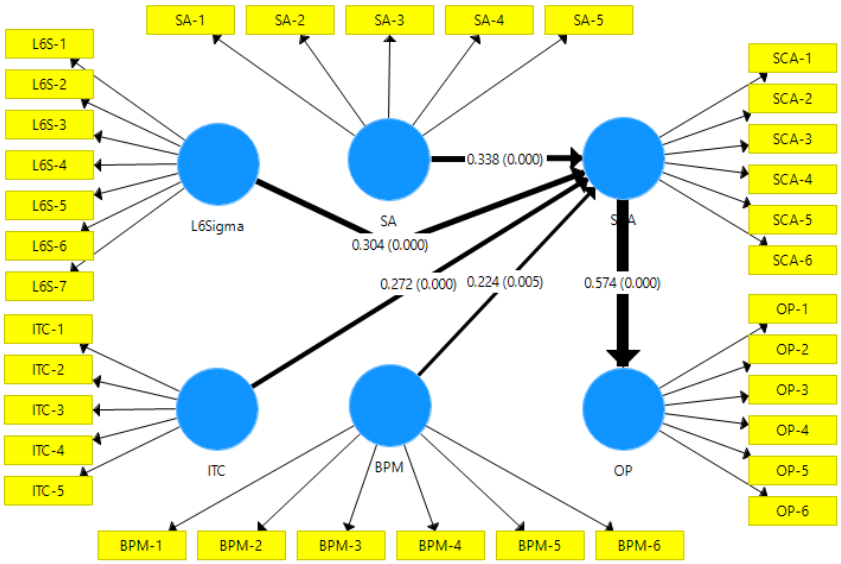

Fig. 3. Structural Model Output (Beta Coefficients)

Mediation Analysis: We followed Shabbir and Gardezi (2020) to test our mediation analysis. The results presented in Table 5 provide a comprehensive overview of the mediation analysis conducted in this study, highlighting the direct effects of the variables as well as the mediated relationships through Supply Chain Agility (SCA).

L6S → SCA → OP (H1 and H2): The direct effect of Lean Six Sigma (L6S) on SCA is significant (Estimate = 0.304, p = 0.000), with a 95% confidence interval ranging from 0.154 to 0.453, indicating a robust positive impact. Another positive relationship (Estimate = 0.174, p = 0.000) with a confidence interval of [0.087, 0.260] can be seen between L6S and SCA to OP. This validates that SCA mediates the relationship between L6S and organizational performance, which helps in the overall effect of L6S on performance with increased agility.

BPM → SCA → OP (H3 and H4): In the same way, Business Process Management (BPM) demonstrates a significant positive impact on SCA (Estimate = 0.224, p = 0.009) with a confidence interval of [0.056, 0.393], which proves the positive contribution of BPM to agility. The hypothesis is also upheld by the mediation effect (BPM → SCA → OP) (Estimate = 0.128, p = 0.014) and the confidence interval [0.025, 0.231], showing that SCA partially mediates the relationship between BPM and organizational performance.

TIC → SCA → OP (H5 and H6): The findings indicate that Technological Innovation Capabilities (TIC) have a positive impact on SCA (Estimate = 0.272, p = 0.001), with a confidence interval of 0.116 to 0.428, which can be regarded as the fact that TIC has a positive effect on SCA. The mediation path (TIC has an estimate = 0.156, p = 0.003 with confidence interval of [0.054, 0.258]) is also significant, which will prove that the effect of TIC on organizational performance is mediated by SCA.

SA → SCA → OP (H7 and H8): SCA has a strong direct impact from Strategic Alignment (SA) (Estimate = 0.338, p = 0.000), and the confidence interval ranges between 0.198 and 0.478, which corresponds to a strong relationship. The mediation (SA → SCA → OP) is very important (Estimate = 0.194, p = 0.000), with a confidence interval of 0.107 to 0.281, and it underlines that strategic alignment is very important in increasing supply chain agility, which consequently leads to improved organizational performance. The f² value (0.296) also brings out a strong influence of SA on SCA and OP.

SCA → OP (H9): The direct relationship between Supply Chain Agility (SCA) and Organizational Performance (OP) has a significant and strong estimate (Estimate = 0.574, p = 0.000) with a very high f^2 (0.489), which means that SCA is a significant contributor to the improvement of organizational performance. This relationship has a confidence interval of [0.446, 0.701], which again proves the strength of this result (Khan et al., 2018).

The findings of the mediation analysis are highly in favor of Supply Chain Agility (SCA) as a significant mediator in the association between Lean Six Sigma, Business Process Management, Technological Innovation Capabilities, Strategic Alignment, and Organizational Performance. The confidence intervals of all the significant paths do not contain zero, thus lending weight to the solidity of the results. These findings highlight the significance of supply chain agility as a pivotal driver of organizational performance, supported by multiple strategic and operational practices like L6S, BPM, TIC, and SA. The moderating effect of externalities such as market conditions or the regulatory environment that might affect the strength of these relationships in various industries could also be addressed in future research studies.

Quality of Structural Model: The eminence quality or the predictive relevance was measured by means of Stone-Geisser's Q^2, R^2, and goodness of fit (GOF). Q^2 is used to measure the eminent quality of the structural model. Positive values of Q^2 (>0) are acceptable for good quality/predictive relevance of a structural model. R^2 is the measure of overall effect size. As indicated in Table 6, 38.2% of the variance in L6S' effect (though L6S is exogenous here, this might be a mislabeling; it likely refers to variance explained in the endogenous constructs via the model's paths) is explained. More relevantly, the model explains 80.2% of the variance in SCA and 34.2% of the variance in OP. GOF is measured by combining effect size and convergent validity, with an acceptable limit of 0 to 1. Our GOF values were well acceptable, which confirmed the overall fitness of our structural model. Moreover, multicollinearity for the structural model was also assessed. VIF values beyond 5 are an indication of model contamination with path collinearity (Kock, 2015). VIF values in Table 6 showed that our structural model was free of such issues.

Table 6
Quality of Structural Model

Construct	Q^2	R^2	AVE	GOF	VIF
L6S	0.146	0.382	0.497	0.436	3.851
BPM	0.247	0.446	0.617	0.525	4.425
TIC	0.288	0.536	0.598	0.566	4.164
SA	0.248	0.518	0.56	0.539	3.856
SCA	0.369	0.802	0.503	0.635	1.8
OP	0.163	0.342	0.588	0.448	3.938

5. Discussion of results

The analysis provided fascinating insights into the path connecting nine hypotheses proposing the relationship of Lean Six Sigma (L6S), Business Process Management (BPM), Technology Innovation Capabilities (TIC), and Strategic Alignment (SA) with Organizational Performance (OP), with the mediating role of Supply Chain Agility (SCA).

We found the analysis for our research hypothesis H_1, that L6S is positively associated with OP (through SCA), and H2, presenting the relationship of L6S with OP with the mediating role of SCA, offers new insights into organizational effectiveness by upholding lean activities in the retail industry. In this regard, there is enough strong evidence to demonstrate that L6S practices and methodologies have assisted in enhancing organizational processes and operations of businesses across various sectors (Snee, 2010). Additionally, Lean Six Sigma may boost supply chain agility by enhancing productivity, quality, and customer service, but it's crucial for businesses to recognize its limitations and customize the methodology for their particular supply chain environment. In order to improve supply chain agility in highly dynamic and uncertain situations, organizations should also think about merging Lean Six Sigma with other techniques, such as agile or adaptive supply chain management, to improve organizational performance.

As far as the empirical studies are concerned, by increasing the effectiveness and efficiency of supply chain processes, BPM can have a substantial impact on supply chain agility. BPM can assist companies in streamlining their activities, minimizing waste, and enhancing process efficiency through the identification and analysis of supply chain processes. This means that businesses can respond more promptly to changes in consumer demand or supply chain issues. Conversely, the study results emphasize that the implementation of technological innovation capabilities may positively impact the responsiveness, effectiveness, and quality of the supply chain, which will positively influence organizational performance, consistent with previous research (Hirzallah & Alshurideh, 2023). The proponents of technology innovation capabilities believe that they can improve supply chain agility in a number of ways. To begin with, they can enhance supply chain visibility and co-operation so that organizations are able to locate any possible disruption and react promptly. Through innovative analytics and real-time data, organizations will be able to make effective decisions and prevent risks before they develop into significant issues. Empirically, it has been proven that technology innovation capabilities can increase the flexibility and responsiveness of a supply chain (Shahzad et al., 2022). As an example, advanced tools for planning and scheduling can be used by organizations to optimize their stocking, production, and logistics networks, which allows organizations to react promptly to evolving market conditions. Moreover, technology innovation capabilities can minimize supply chain risks by enhancing the

traceability and security of products and services. With the help of blockchain, IoT, or AI, organizations will be able to detect possible fraud, counterfeiting, or theft and react in a timely manner.

Additionally, the results indicate that strategic alignment has a positive effect on the performance of an organization. An aligned supply chain which is supported by the overall organizational strategy can offer a better response to changing customer demands, processes, and risk reduction. In addition to this, strategic alignment has the potential to enhance collaboration and coordination of supply chain partners, which will lead to an increase in supply chain visibility and better decision-making.

5.1 Practical Implications

The practical implications of this research for organizations, particularly the retail sector or organizations that thrive on supply chain management and technological advancement, would be derived from the results of this research. Having analyzed the relationships among Lean Six Sigma (L6S), Business Process Management (BPM), Technological Innovation Capabilities (TIC), Strategic Alignment (SA), Supply Chain Agility (SCA), and Organizational Performance (OP), this research paper will provide the importance of supply chain agility as the mediator of connections between strategic practices and organizational performance.

Enhanced Focus on Agility: The positive effect of SCA on organizational performance (0.574) and its mediation in several significant relationships (e.g., L6S → SCA → OP, BPM → SCA → OP, and SA → SCA → OP) attests to the importance of companies investing in the establishment of agile supply chains. Supply chain agility helps the company to respond swiftly to any changes in the market, consumer demands, and technological changes, and this is more important in the current competitive and fast-paced business world. It is beneficial for organizations to become more flexible and adaptable not only to survive upheavals but also to transform them into opportunities for technological innovation and market leadership.

Strategic Alignment as a Lever of Agility: The strength of the effect of strategic alignment ($f^2 = 0.296$) means that a firm must ensure that its corporate strategies and supply chain strategies are closely connected. This integration is beneficial in supporting the flow of information and resources between departments, which in practice leads to agility. Practically, it means that top managers should ensure that objectives of the supply chain should be integrated with general organizational objectives to generate a culture of cross-functional collaboration. Strategic alignment is a concept that can be employed as a foundation to drive innovation, particularly in functions that require instant intervention to combat alterations in technological and market trends.

Investment in Lean Six Sigma and BPM Practices: L6S (impact on agility $f^2 = 0.309$) and BPM (positive impact $f^2 = 0.129$) both have a significant impact on SCA. Such findings show that companies should not cease investing in process improvement tools such as Lean Six Sigma to process operations, reduce waste, and enhance performance. With L6S and streamlined BPM processes, firms can possess more streamlined and adaptable supply chain procedures that can support quicker decision-making and increased responsiveness to external influences, as each must ensure a competitive edge.

The study reveals that Technological Innovation Capabilities (TIC) are established to have a positive impact on SCA that subsequently results in the improvement of organizational performance. Agility and innovation should be major facilitators of technology for organizations. Modern technologies, such as IoT and Industry 4.0 technologies, may be used to make firms quite efficient and responsive in their operations. Specifically, the integration of IoT-aware systems may provide dynamic data analytics so that firms could monitor and optimize supply chain performance in real-time. This can result in informed decision-making, better response to changes in demand, and greater sustainability practices.

6. Conclusion

The empirical investigation suggests that supply chain agility positively impacts organizational performance. A more agile supply chain can improve the delivery of products and services, increase customer satisfaction, reduce lead time, lower costs, and improve quality. Additionally, supply chain agility can help organizations respond quickly to changes in market conditions, adapt to new technologies, and mitigate supply chain risks. It is essential for organizations to carefully evaluate the benefits and costs of implementing supply chain agility and ensure that it aligns with their strategic objectives. Organizations may also consider factors such as supplier relationships, internal capabilities, and technology infrastructure to determine their level of agility. While the positive impact of supply chain agility on organizational performance is evident, it is crucial to assess the costs and trade-offs before implementing it, implementing a strategic approach to supply chain agility, and ensuring that it aligns with their overall objectives to achieve sustainable performance improvement. Furthermore, supply chain agility can improve customer satisfaction and loyalty. Retailers that can deliver products quickly and reliably to customers are more likely to gain their trust and loyalty. By leveraging supply chain agility, retailers can also offer greater product variety and customization, enhancing the customer experience and increasing sales.

7. Recommendations And Future Work

Based on the critical analysis of the impact of supply chain agility on organizational performance, the following recommendations and future work can be suggested:

- Developing a framework that includes key performance indicators (KPIs) to measure supply chain agility and its impact on organizational performance. The framework should also consider the role of factors such as Lean Six Sigma, business process management, technology innovation capabilities, and strategic alignment.
- Investing in technology innovation capabilities such as big data analytics, cloud computing, and artificial intelligence to improve supply chain visibility and collaboration. However, they may carefully evaluate the costs and benefits of IT investments and ensure that they align with their overall objectives.
- Organizations may foster a culture of continuous improvement and innovation to ensure that the supply chain remains agile and responsive to changing market conditions. This can be achieved through employee training and development programs, incentive systems, and organizational structures that support innovation.
- Developing a supply chain risk management plan to mitigate risks associated with supply chain disruptions. The plan should include measures such as supply chain mapping, supplier risk assessments, and contingency planning.
- Organizations should consider collaborating with supply chain partners to improve supply chain visibility, enhance coordination, and align incentives across the supply chain. This can be achieved through the development of collaborative relationships, joint planning, and sharing of information.

Future studies are expected to develop a comprehensive framework that considers the impact of all factors that influence supply chain agility and its impact on organizational performance in various sectors. Investigate the role of emerging technologies such as blockchain and the Internet of Things (IoT) in improving supply chain agility and organizational performance. Conduct longitudinal studies to evaluate the sustainability of supply chain agility and its impact on organizational performance over time. Moreover, investigate the impact of supply chain agility on other performance measures such as social and environmental sustainability.

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