

# Moving from Lean to Leagile: A Framework to Improve Supply Chain Performance of Fashion Garment Manufacturing

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## Abstract

It can be argued that the textiles and clothing industry does not neatly fit into either a lean or agile paradigm, instead, it is a combination of the two, driven by low margins and volatility of demand. A number of authors have indicated that these two concepts alone seem incomplete so that now the global approach is towards a hybrid supply chain model combining both lean and agile concepts. Apparel Industry possesses the twain lean and agile features independently and these concepts have been established to a greater extent. As cases of pure leanness and agility can seldom be found in real-world problems, considering both strategies can be beneficial. Analyzing the characteristics, trends, and relationships within an organization's internal and external environment as well as considering the impact of the new strategy on overall supply chain performance is much important when developing a supply chain model. This paper focuses on developing a framework to integrate Lean and Agile Concepts for improving supply chain performance in fashion garment manufacturing. A structured literature review is carried out in stages: identifying the relevant literature, structuring the review and developing a model to guide future research.

## Keywords

Fashion Garments Manufacturing, Leagile, Supply Chain Performance

## 1. Introduction

Sri Lankan apparel industry generates 3.2- 4.9 million USD annual business value by catering to the major global markets such as the US, UK, Italy, Germany, Belgium, Netherlands, Canada, etc. Apparel contribution towards total merchandise exports marks 43.91% by 2019 (Sri Lanka Exports Development Board, 2019). Apart from competing in the apparel mass market, the Sri Lankan apparel sector has now identified products with high prices such as fashion garments, sportswear, and trendy wear as high potential products possibly be creating a higher value in near future by catering to the niche market.

According to (Agrawal et al. 2018), a key feature of the present-day business is the idea that it is Supply Chains (SC) that compete, not companies and the success or failure of SCs is ultimately determined in the marketplace by the end consumer. In that, it is much more important how an organization adjusting its micro-environment and SC practices according to its dynamic macro-economic environment in order to improve SC performance and to achieve a better competitive advantage. Hence, the understanding of market place changes and customer satisfaction requirements is the key to implement successful SC strategies.

Textile and apparel is a major sector for both the industrialized and the lesser developed economies, contributing both to wealth generation and employment (Bruce et al. 2004). For the past few years, Apparel Industry has shown a significant interest in the idea of "lean manufacturing", and the wider concepts of the "lean enterprises". The focus

of the lean approach has essentially been on the elimination of waste or Muda (Agrawal et al. 2018). Sri Lankan Apparel Industry's context shows a similar focus on Lean applications. However, some previous studies provide evidence that many of the organizations that implemented lean production have experienced limited success in achieving increased organizational outcomes, such as increased competitiveness.

Lean is about doing more with less. Lean concepts work well where demand is relatively stable and hence predictable and where variety is low. Conversely, in those contexts where demand is volatile and the customer requirement for variety is high, a much higher level of agility is required (Agrawal et al. 2018). The agile SC has a number of distinguishing features. It is market sensitive with the ability to respond to actual real-time changes in demand (Bruce et al. 2004). Many researchers have advocated that a lean focused SC model appears incomplete as agility became coveted (Kant et al. 2016).

Managing the logistics and SC for textiles and apparel suppliers and retailers has to be synchronized and is driven by the exigencies of the dynamic patterns of demand, especially for fashion items and companies in textiles and clothing need to be able to respond quickly to changing markets and be able to provide quick replenishment. However, they are not able to store large quantities as products have a very short life cycle and fashion markets are seasonal (Bruce et al 2004). In consideration of obtainable time and resource limitations, the present research concentrates on fashion garments manufacturers being the frame of reference for implementing a leagile SC model to improve SC performance

Both Lean and Agile Concepts were popularized in Apparel industry a few years back and currently, these concepts have been established to a greater purview. Accordingly, knowledge regarding the lean concept and agile concept are available in both local and global contexts. Perchance argued that the textiles and clothing industry does not neatly fit into either a lean or agile paradigm, but instead it is a combination of the two driven by low margins and volatility of demand. This would ensure fast product replenishment, the building and maintaining of SC partnerships and flexibility in response to the volatility of demand from retailers It is proposed that further research should be undertaken to extend the understanding of SC management for fashion and commodity garment manufacture and supply (Bruce et al. 2004)

Many pieces of research have proved that these two concepts alone seem incomplete so that now the global approach is towards a hybrid SC model combining both lean and agile concepts. Therefore the appropriateness of the hybrid concept of a leagile SC model for fashion garments manufacturing is converged with the present research.

This marks the end of section 1 or the introduction of the paper. Section 2 declares the methodology used to conduct the research. A literature review is presented in section 3 and section 4 provides a discussion. Finally, in section 5 research paper concludes providing managerial implications and directions to future research areas.

## 2. Methodology

A structured literature review is carried out referring to the stages used by Sara et al, (2019): identifying the relevant literature, structuring the review and developing a model to guide future research. The methodology of the research is interpreted further in figure 1.

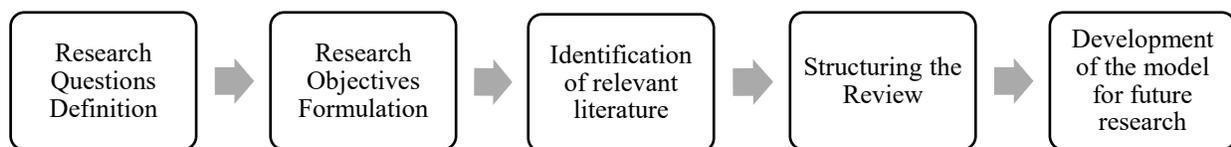


Figure 1- Methodology Flow Chart

### 2.1 Identification of Relevant Literature

Identification of relevant literature is compassed by a systematic process to make a selection of articles from different online databases (Scopus, Google Scholar, Emerald, Science Direct and Researchgate,etc.). The fundamental search was applied concerning the publications in the areas of SC Management, Manufacturing, Retailing, and SC Performance measurement and that were published in the period of 20 years, from the year 1999 to 2019, with relevant

keywords selected by the authors. “Leagile”, “SC Practices”, “SC Performance”, “Apparel”, “Drivers”, “Barriers”, “Lean”, “Agile” and “Fashion” referred to as the keywords. Fundamental selection concluded with outright 162 publications that only considered the title, abstract, and keywords of the article.

Fundamentally screened articles were opened up for additional two phases of screening in order to identify the most relevant and valid literature for the research purview. In the screening phase 1, every selected article was undergone a careful reading of the title, abstract and keywords to evaluate the propriety and the relevancy of the publication. At this Stage, articles that were not considered the leagile paradigms and that only had considered the SC performance aspect with a distinct criteria were disregarded. Screening phase 1 concluded with the remaining 100 publications forwarded to the screening phase 2.

The screening phase 2 was strictly devoted to screening the most relevant content for the current research motives. Screened 100 publications were fully evaluated by the topic, research problem, the methodology used, data collection tools and analysis along with the findings or the proposed models/ frameworks of the publication. Without exceptions, articles were evaluated twice to ensure the strict screening process and concluded selecting a total of 46 publications for further analysis.

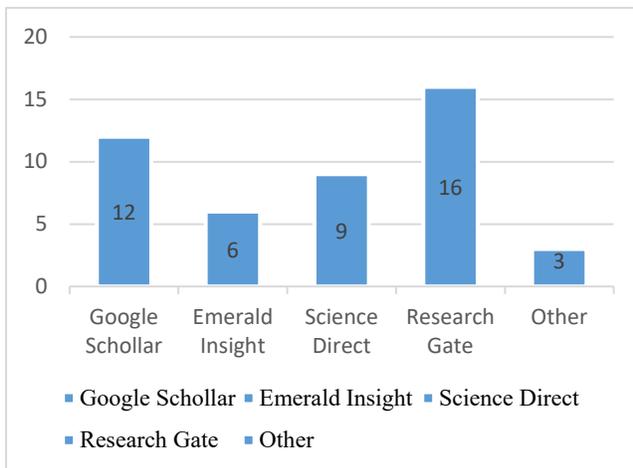


Figure 3- Number of Articles Found by Each Online Database

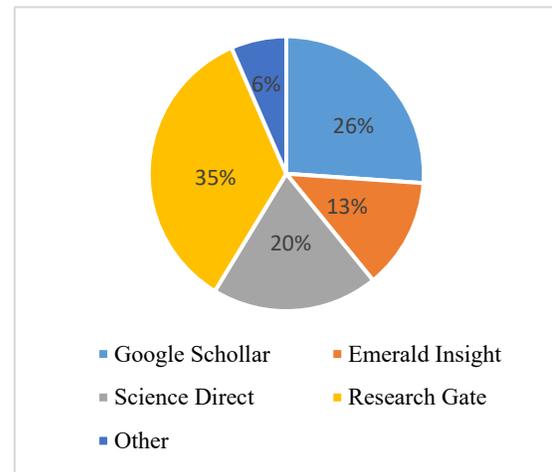


Figure 2 - % of Articles Found by Each Online Database

## 2.2 Structuring the Review

The accepted 46 publications were carefully examined under spheres of leagile practices, SC performance, drivers and barriers for SC leagility and summarized in a table under the most important sections: Research domain, published year, title, author/authors, methodology, findings, and important facts (if any). This summary table was later contributed to the conceptual designing of framework and data analysis stages.

## 2.3 Development of the Conceptual Framework

Selected articles were carefully analyzed with the intention of the development of a conceptual framework. Among 46 final publications, 30 articles involved in the development of the conceptual framework and the remaining 16 articles rendered further knowledge with regard to the research phenomenon that brought into the discussions and review purposes.

### 3. Literature Review

Analysis is compassed under four major domains in favor of structuring the review along with the development of the conceptual framework beneficial to further research purposes. The spheres of leagile practices, SC performance, internal business environmental factors, and external business environmental factors were covered.

#### 3.1 Leagile Practices

According to Moron and De Haan (2011), Cases of pure leanness and agility can seldom be found in real-world problems. Therefore, considering both strategies can be beneficial. (Galankashi and Helmi, 2016) Leagile SCs should follow lean philosophies and endure value-adding actions and waste reduction before material Decoupling Point (DP). Conversely, downstream to the material DP must be flexible and responsive to customized demands (Scholz and Mehraei 2009). Leagile enables the cost-effectiveness of the upstream chain and high service levels in a volatile marketplace in the downstream chain. (Bruce et al. 2004). The choice of decoupling point is solely based on the nature of the product and demand and the total lead-time. Hence, the choice of these strategies should be based upon a careful analysis. (Kant et al. 2016).

Both lean and agile manufacturing models require accurate and timely information about inventory, labor, and production. This commonality forms the base of bridging the two paradigms. (Kant et al. 2016). Lean operations reflect performance improvements in the areas of cost efficiency, conformance quality, delivery speed, and reliability. Notice that delivery speed and reliability are enablers of agility, which shows some overlap between leanness and agility (Hassan and Sherif. 2015). According to Banerjee and Ganjezadeh (2017), Leanness and Agility have many overlapping features and hardly exist in isolation. Based on experience and numerous research publications it is argued that leanness and agility have overall a synergistic effect on SC.

Following are the synergies of leanness and agility on business goals drawn by Banerjee and Ganjezadeh (2017):

- Customer enrichment (Agileness) is achieved by value identification in products (Leanness)
- Enhanced competitiveness (Agileness) is gained by refining flow of material and information (Leanness).
- Systematic planning (Agileness) is enhanced by performing the operation when required (Leanness)
- Communications across the organization and departments (leanness) is enhanced by adopting IT and Technology (Agileness)
- Suitable utilization of skill (leanness) is an approach to leverage people and information (Agileness).

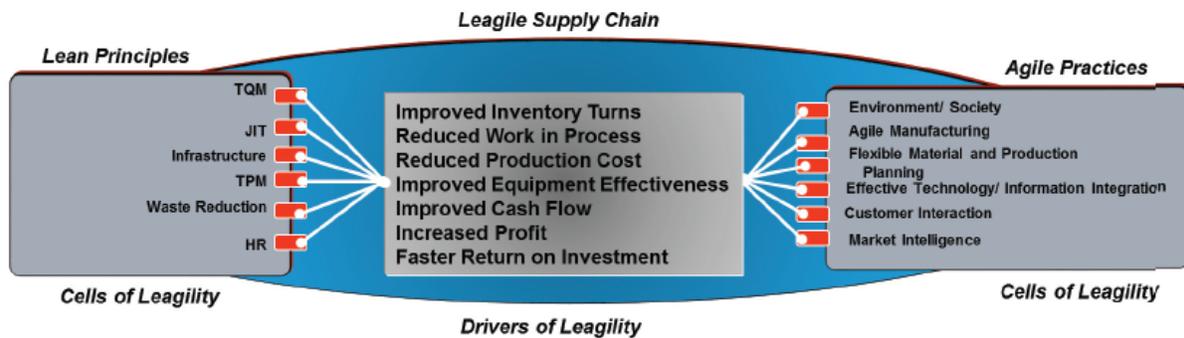


Figure 4- Lean-Agile interaction in a leagile SC (Banerjee and Ganjezadeh, 2017)

The original Toyota model of Lean Manufacturing, from which various hybrid models were developed, comprised eight tools and approaches: TPM, Five S concept: These represent a set of Japanese words for excellent housekeeping (Seiri – Sort, Seiton – Set in place, Seiso – Shine, Seiketso – Standardize and Shitsuke – Sustain), JIT, SMED, Jidoka or Zero Quality Control, Production Work Cells, Kanban, Poka Yoke. The methodology of lean thinking and lean SC has moved on since Toyota’s Lean Manufacturing model and embraced additional tools and approaches including two more: Value stream and process mapping and Lean Sigma and FIT SIGMA (Kavvadia 2012). Lean and agile manufacturing can be characterized as a collection of practices. Practices that commonly associated with lean include JIT, TQM, equipment management and total preventive maintenance, Kaizen, design for manufacturing and assembly, supplier management, human resource training and involvement, decision support systems, and variability reduction.

Practices that associated with agile comprise JIT, TQM, customer linkages, supplier alliances and information sharing, a wide range of skill training, advanced information and manufacturing technologies, decision support systems, communications, motivation, concurrent teams, worker empowerment, and modular facilities (Hassan and Sheriff 2015).

The essence of the difference between leanness and agility in terms of the total value provided to the customer is that service is the critical factor calling for agility whilst cost and hence the sales price, is clearly linked to leanness (Aitken et al. 2010). Kavvadia (2012), mentioned that in order to achieve the responsiveness required for innovative products, an agile SC should contain the following key characteristics: flexibility, market sensitivity, virtual network, postponement, and selected lean SC principles.

### 3.2 Supply Chain Performance

The effectiveness of the SC performance measurement system in terms of performance improvement is influenced by the SC context (Sara et al. 2019). Introducing the concept of Performance Improvement, a “*leagile*” SC concentrates on the ability to make the company as much faster and, at the same time, able to perform better and better under a quantitative perspective. Related practical implications are about decoupling multiple points to control with minimum stock in order to reduce cost, save time, and improve business performance indicators. (Francesco et al. 2019). Challenges for competing in the business environment make lean and agile as vital capabilities of a manufacturing organization. Both concepts are able to achieve strategic objectives (competitiveness, productivity, profitability, and survival) by improving the overall performance. (Hassan and Sheriff 2015).

With regards to performance measurement, Return on Asset (ROA), capital growth, profit growths are the indicators of a firm’s financial performance. Another very important indicator for firm performance is schedule performance managing the lead times for different orders of different destinations prudently. This schedule performance has become one of the key indicators of competitiveness for apparel firms throughout the world due to fast fashion fever and differing geographical distances from US and EU to different supplying countries (Shah et al. 2013).

### 3.3 External and Internal Business Environmental Factors

Sara et al. (2019), and many other authors have stated that analyzing the characteristics, trends, and relationships within an organization’s internal and external environment are considered one of the most important aspects of developing an appropriate SC performance measurement system. After analyzing the external and internal environment, the next step should be analyzing the structure of the targeted SC. (Sara et al. 2019). Francesco et al. (2019), mentioned that the main drivers of a leagile SC concept can be defined as follows: competitive market pressure; uncertain environment; a sense of responsiveness; service level oriented and pressure to reduce production costs. Moreover, regarding “*leagile*” effects, in addition to Suitable in volatile environments and cost-effectiveness as well as the main effects can be defined as cost-effectiveness, suitability in volatile environments and implementation of rapidity.

Study of evaluation of critical success factors revealed that use of advanced manufacturing technology is the topmost factor, the second factor is management support towards the implementation of policies, the third critical success factor is strategic management, the fourth critical success factor is training and development programs to make the system leagile (Naveen et al. 2017). Only through understanding the particular characteristics of the product type, marketplace requirements, and management challenges can the correct SC strategy be designed to ensure optimal performance and to establish competitive advantage. (Rachel et al. 2000).

A brief summary of the key literature that was supported in this study is illustrated and summarized below in Table 1-Summary of Key Literature considering the ease of further researches and studies on implementing a leagile supply chain model.

Table 1 - Summary of Key Literature

Reference	Methodology	Key Points
[Naveen et al., 2017]	Evaluation of KPIs of le-agile manufacturing using Fuzzy TISM Approach	<b>Human resource management</b> The employees growth is directly associated with the growth of firm. <b>Reduction of wastages</b> and non-value added activities tries to eliminate all wastes and all those activities which have great relevance in enhancing the value of the product <b>Customer satisfaction</b> directly related to sales. If the customer is satisfied with the product then automatically the sales will rise <b>Takt time</b> It is the time between customers raising the demand and receiving the goods. Le-agile system tries to keep the <b>inventories at the optimum level.</b>
[Hassan and Sherif, 2015]	Analytical Hierarchical Process (AHP) and Analytical Network Process (ANP)	The key characteristics of any manufacturing enterprise, directed towards strategic objectives, should be <b>waste removal and market responsiveness</b> . Both dimensions can be integrated at different levels, no matter what paradigm is followed. Waste removal adds to market responsiveness and vice versa
[Mattias and Jan, 2009]	Structured Equation Model (SEM)	The external driver considered here, the <b>competitive intensity of the industry</b> , shows that the existence of high-competitive pressure leads firms in two directions in terms of competitive strategy. The major differences in <b>performance outcomes are related to cost and flexibility</b> , such that lean manufacturing has a significant impact on cost performance (whereas agile manufacturing does not), and that agile manufacturing has stronger path coefficients leading to volume as well as product mix flexibility than lean manufacturing (even though lean significantly impacts flexibility).
[Laura et al., 2014]	Abductive Research Process	Two new types of le-agility have been illustrated and defined: le-agile with <b>vendor flexibility</b> systems, which combines the use of agile vendors with lean sourcing practices and le-agile with <b>sourcing flexibility</b> systems, which combine the use of lean vendors with agile sourcing practices.
[Ana et al., 2011]	Literature Review and a Hypothesis Testing	<b>Supply chain Integration, Information Sharing, Customer Service Management, Customer Relationship Management, Supplier Relationship, and postponement</b> are identified as major supply chain practices from the literature.
[Francesco et al., 2019]	Literature Review	The main drivers of le-agility can be defined as follows: <b>Competitive market pressure;</b> <b>Uncertain environment;</b> <b>Sense of Responsiveness;</b> <b>Service Level Oriented;</b>
[Masih, 2015]	Strategic choice, Institutional theory, and Complexity theory	This publication has discussed thoroughly the <b>supply chain uncertainty</b> and the le-agility of the supply chain

[Shah et al., 2013]	Structural Equation Modeling (SEM)	The production aspect of the le-agile manufacturing system is significantly influenced by the <b>human resource aspect</b> of the le-agile manufacturing system. Industrial up-gradation is significantly influenced by <b>Production aspect</b> of the le-agile manufacturing system <b>Frim performance</b> is significantly influenced by Industrial upgradations through the value chain.
[Thorsten et. al., 2017]	Four-Steps Delphi Study	<b>Cost Reduction, Delivery Reliability</b> , Choosing the right supply chain gets the top 3 ranks respectively as drivers of a hybrid supply chain.
[Merschmann and Thonemann, 2010]	Empirical Research	“we find empirical evidence that in environments with low <b>uncertainty</b> , companies with low <b>supply chain flexibility</b> perform better than companies with high supply chain flexibility; whereas in environments with high uncertainty, companies with high supply chain flexibility perform better than companies with low supply chain flexibility.”
[Azfar et al., 2014]	Literature Review	<b>Operational Performance</b> can be measured through Inventory Levels Quality Time Customer Satisfaction
[Sangari et al., 2015]	Literature Review and Fuzzy Logic	Dimensions for achieving supply chain agility are <b>Strategic Commitment, Infrastructures and Mechanisms, and Human/Cultural competence</b> . These dimensions are further elaborated to factors as a table which is used as a reference in this research.

After the analysis of the literature, the following conceptual framework shown in figure 3 is constructed for further research purposes.

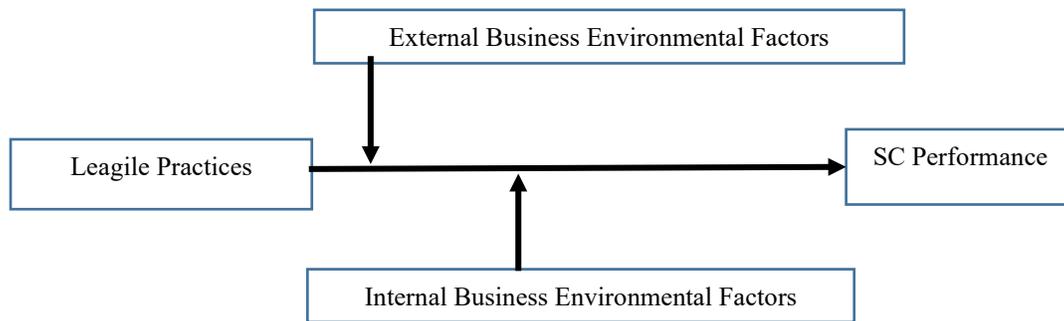


Figure 5- Proposed Conceptual Framework

The aforementioned conceptual framework can be further elaborated with the indicators of each variable. All indicators were identified by the conducted structured literature review. These indicators possibly further explained by future researches. A summarized table of elaboration on each variable is in Table 2.

Table 2. Indicators for the conceptual framework variables.

<b>Variable</b>	<b>Indicators</b>
<b>Le-agile Practices.</b>	HR Practices.
	JIT Practices.
	TQM Practices.
	TPM Practices.
	Infrastructure Practices.
	Waste Reduction.
	Continuous Improvement.
	Customer Interaction.
	Information Integration.
	Flexible Plan.
	Postponement.
	Supplier Relationship.
<b>External Business Environmental Factors.</b>	Competition.
	Environmental Uncertainty.
	The pressure to reduce cost.
<b>Internal Business Environmental Factors.</b>	SC Support.
	Production Support.
	Financial Support.
<b>SC Performance.</b>	Financial Performance.
	Operational Performance.
	Schedule Performance.
	Environmental Performance.

#### 4. Discussion

Fashion products possess a short life cycle and high demand uncertainty, therefore, exposing the SC to the risks of both stock out and obsolescence. A good example of a fashion product is trendy clothing. The challenge faced by a SC delivering fashion products is to develop a strategy that will improve the match between supply and demand and enable the companies to respond faster to the marketplace (Rachel et al. 2000). Many companies are realizing that the costs and risks associated with holding speculative inventories are too great. This is particularly true with products that have short life cycles (like personal electronics) or erratic demand (like fashion apparel), where the risks of obsolescence are high (Mason-Jones et al. 2000). Firms hankering for fashionable clothing market rather than traditional clothing would find a leagile system influencing industrial up-gradation. Consequently, the firm owners may think about increasing production lines which are able to create product varieties (Shah et al. 2013). Leagile SCs already exist in the real world. What is important is to recognize when the new paradigm is the best way forward for a particular SC so that it may be appropriately engineered from the outset (Rachel et al. 2000). Moreover, the collaborative performance that has become essential for the new business environment requires competition between SCs rather than companies. In essence, further research is required to develop a predictive SC performance management system that can be more proactive and deal with uncertainty in order to enable the SCs to respond at the right time, while minimizing costs and satisfying service-level requirements (Sara et al. 2019).

Shah et al. (2013), mentioned that variables of leagile, which are not only related to waste reduction and continuous improvement but also related to fashionable products are influencing industrial up-gradation. However, the owners and managers have to keep in mind that lean and agile manufacturing systems cannot be the same package for all the firms throughout the world. It differs from country to country due to different cultures. And this country specificity can be a driving force for industrial up-gradation through the value chain. Market winner for fashion products is available, whereas the market winner for commodities is price. Quality and lead-time are market qualifiers in both cases: price and availability are market qualifiers for fashion products and commodities respectively (Rachel et al. 2000).

Leagile practices play a major role in the development of a SC model that desired in volatile business environments with lower cost structures. A leagile SC consists of a composition of both lean and agile practices. Many authors have stated that the SC performance is directly affected by the SC practices. Leagile practices may directly impact on the SC performance reflected through the financial performance, operations performance, schedule performance as well as the environmental performance. The business environment directly influences the SC strategy selection. In order to select the most suitable SC strategy, any organization should focus on its external macro-environmental factors in this case the demand and supply uncertainty is a critical factor to be considered. The support of the internal or microenvironmental factors when implementing and practicing SC practices within the organization.

## **5. Summary and Conclusion**

This paper presents a structured literature review conducted with the aim of developing a leagile supply chain model for the apparel industry. Literature relevant to leagile supply chain model implementation from all over the world is considered as the primary data source for this review. The identification and the analysis of the literature followed a systematic process in steps of identification of literature, structuring the review and the development of the conceptual framework. After a careful analysis of the most relevant literature, this research identified four main variables that impact on SC leagility in fashion garments manufacturing. The identified variables: Leagile practices, SC performance, external business environmental factors, and internal business environmental factors. Furthermore, the present study has identified the key indicators for each variables of the proposed conceptual framework.

Current research contributes to the fulfillment of the knowledge gap between leagile practices and improvement of SC performances through leagile practices in the fashion garments manufacturing industry. This ongoing research will concentrate to evaluate each relationship and quantify the impact in the future. With the support of this proposed framework, future researches are encouraged to find and quantify the relationship between the indicators when implementing a leagile supply chain for the apparel industry. This model supports managerial decisions when implementing new supply chain practices to identify the feasibility of the new implementation under each factor mentioned in the proposed model. Apart from that, this model can be used as an analytical framework to analyze the impact of existing SC practices.

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