Applied Mathematics & Information Sciences
An International Journal

http://dx.doi.org/10.18576/amis/130415

Agility Enabling Practices to Augment the Supply Chain Performance of the Leather Footwear Industry: Developing a Fuzzy QFD based ASCM Model

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Received: 13 Feb. 2019, Revised: 10 Apr. 2019, Accepted: 14 Apr. 2019
Published online: 1 Jul. 2019

Abstract: The purpose of the research study is to understand the impact of the agility enabling practices onto the Supply Chain Performance Measures (SCPMs) in Indian leather footwear industry by means of fuzzy QFD tool. The agility-enhancing SCPMs specific to Indian leather footwear industry were identified and prioritized through Delphi study. The supply chain practices were then ascertained for the scope to achieve agility in the supply chain through factor analysis. The technical correlation between the SC practices and their relationship with agility-enhancing SCPMs was determined using Quality Function Deployment (QFD) tool. Then the supply chain practices were prioritized using fuzzy logic in QFD and a fuzzy QFD based ASCM model has been developed. Through the present study, about twelve Agility Enabling Supply Chain Practices (AESCPs) are ascertained as relevant and applicable to the Indian leather footwear industry. AESCPs having high crisp values have to be essentially implemented in leather footwear industry to augment its supply chain performance.

Keywords: Supply chain practices, Agility, Leather, Footwear, Supply chain performance, Fuzzy QFD

1 Introduction

1.1 Supply Chain Management

Supply Chain Management (SCM) is considered an integrating phenomenon to accomplish the entire flow of raw materials, end products, and information from suppliers to the ultimate customers. It also encompasses the flow of fund and information flow back to the suppliers from customers [1]. SCM is associated with sourcing and procurement of goods, planning and scheduling of production, processing of orders, management of inventory, warehousing and logistics, delivery, and after supply services to customers [2]. It is emphasized that, for effectual SCM, significant efforts should be made for continual improvement in all functions within a firm, and also that the purpose of supply chain practices should drift from being operative to become universal, collaborative and shifting from independent practices to integrative practices and arrive at an integrated approach [1,3].

1.2 Agility as a concept

Agility as a concept encompasses two main factors as (a) responding to unanticipated change in appropriate ways and in appropriate time and (b) exploiting the challenges as opportunities [4]. The agility paradigm is all about being sensitive to market changes, and respond effectively to real-time demand [5]. For an organization to excel, fast response to the needs and expectations of the customers is required in a seldom predictable fluctuating competitive conditions and intensely complex environment. This necessitates the organizations to be agile [6].

1.3 Supply Chain Management-Agility

Agility in SCM is the primary key for the organizations not only to perform better but also to be customer-relevant always. Supply Chain (SC) agility is described as building the organization capability to plan and re-plan to face the changes in the volatile market,

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supply and demand, adapt to those variants and deliver the goods or services at competitive cost, with quality meeting customer requirements along with satisfactory customer service [7]. The Agile SCM is crucial as it creates the capability to react and respond quickly and cost-effectively to capricious changes in markets and escalating levels of environmental instability, both in case of volume and variety [8,9,10]. It was found that the stakeholders ought to address the integration of relationship while incorporating agility in the organization in order to improve the SC performance [11]. The significance of agility in SC in the context of Indian manufacturing industries has been widely dealt in the literature [12,13,14].

1.4 Research Gap

The past studies indicate that needs and demands of the customers are ever changing and necessitate effective responsiveness, better quality, cost efficiency and flexibility in the supply chain to take advantage of the business opportunities. The footwear industry is associated with fashionable innovative products of low volume and high variety that have highly unpredictable demand. Whereas the Agile Supply Chain Management (ASCM) is important for all the industrial sectors, it gains more significance to those that are associated with highly dynamic market and customer requirements. The footwear production in India is about 2.06 billion pairs and accounts for about 11.63% of global footwear production and footwear exports constitute about 49% of the overall export of Indian leather and leather products during the year 2016-17 [15]. The leather footwear sector value chain is depicted in Figure 1, and the market is highly volatile bringing forth the bullwhip effect, and it gets intensified with its price elasticity.

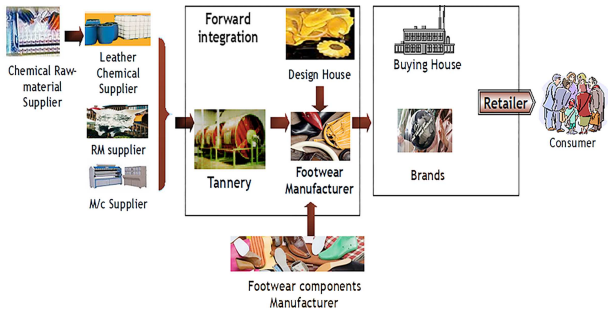

Fig. 1: Value Chain of Leather Footwear Industry (adapted from [27])

Globalization, uncertainty in demand and supply, variability in volume, diversity of product range, possible distortion of communication of information, mutable business trends, shrinking product life cycle, growth in outsourcing, extortionate process changes, variable lead time, divergent inventory and cost management of the footwear sector demand agility in the SC in order to be sustainable and competitive. Earlier research works on SC in the footwear industry did not focus much on the SC agility of the footwear sector [16,17]. Only very few research works have been carried out to study and understand the aspects that are critical for ensuring effective supply chain in leather footwear industry [18, 19]. Therefore, effective ASCM is one of the major critical aspects for ensuring the sustainability of the Indian footwear industry. However, no research has been carried out on SCM for the Indian leather footwear industry. A systematic work on ASCM to fit the concept for the Indian footwear industry is of immense benevolence to the Indian footwear industry.

1.5 Research Objectives

The present work aims at (a) identifying the performance measures/attributes that would enhance the agility capability in the SC of the Indian footwear industry (b) ascertaining those SC practices that would enable agility in the SC of the Indian footwear industry (c) determining the technical correlation amongst those agility enabling SC practices and understanding the strength of the relationship between those agility enabling SC practices and the performance measures enhancing the agility capability in the SC of the Indian footwear industry. Thus, eventually, it is proposed to develop an ASCM model appropriate to Indian leather footwear industry to enhance the agility in the SC of the industry using House of Quality (HOQ) of the Quality Function Deployment (QFD) tool. Fuzzy logic is incorporated to bring about objectivity in the ASCM model so as to make it easily adoptable by the leather footwear industry.

2 Research Design

The schematic algorithm of Fuzzy QFD based ASCM model to determine the relationship between agility enabling supply chain practices and the agility-enhancing supply chain performance measures which are specific to Indian leather footwear industry is illustrated in Figure 2.

2.1 Basis for Fuzzy QFD

The agility-enhancing SCPMs are predominantly influenced by the Agility Enabling Supply Chain Practices (AESCPs). In the present work, the AESCPs relevant to Indian footwear industry has been determined and the impact of the AESCPs on agility-enhancing SCPMs is also assessed. For assessing the said impact,

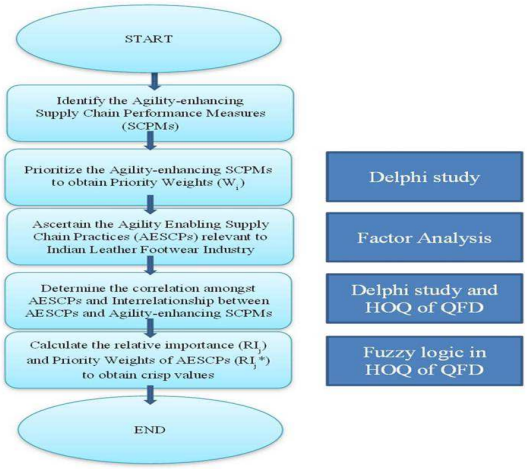

Fig. 2: Schematic representation of Algorithm followed for research work

House of Quality (HOQ) tool of the Quality Function Deployment (QFD) was found to be appropriate and hence the same was used. The practical applicability of the QFD approach to augment the agility in the SC of the organizations had been detailed by [20,21]. HOQ of QFD also provides scope for identification of possible correlations amongst the AESCPs and determination of the inter-relationship between AESCPs and agility-enhancing SCPMs with respect to implementation in the footwear industry through Delphi study. The functional relationships between them are vague or unclear and it is very hard to ascertain the relationship objectively. In classical set theory, an element may fulfill or fail to fulfill the fundamental attribute of the set and therefore it either belongs to the set or does not belong to the set. The membership is assessed in binary terms. On the other hand, a fuzzy set is a class of objects with a continuum of grades of membership. The set does not only represent the membership but also provides the information on the difference in grades between the members. Such a set is characterized by a membership function, which consigns a grade of membership varying between 0 and 1 to each object. The major advantage of choosing fuzzy set theory is for its capability of representing and processing vague data to result in objective information. And therefore, the fuzzy approach has been widely adopted in different research fields, where there is a necessity for processing imprecise or empirical information [22,23]. A fuzzy QFD based tool is proposed for achieving agility in the SC [20,24]. The fuzzy set theory has been identified as the dominant approach to deal with uncertainty while studying the quantitative models for SC performance evaluation [25]. Hence, in order to prioritize the customer requirements and for arriving at relatively objective information connected to the relationship between the AESCPs and agility-enhancing SCPMs and to prioritize the AESCPs objectively, fuzzy QFD is chosen in the present work.

3 Research Methodology and Analysis

3.1 Determination of agility-enhancing SCPMs and ascertaining priority weights (W_i)

In the present work, based on the literature reported, quality improvement, data accuracy, cost minimization, lead-time reduction, delivery speed, service level improvement, alertness, responsiveness, flexibility, innovation, technical competency, delivery reliability, customer satisfaction and minimizing uncertainty are considered as SCPMs using the scale adopted from previous research works [31,32,33] with inclusion of few more items. An expert-team was formed comprising primarily purchase manager, marketing and sales manager, and plant operations manager of different supply chain partners of Leather footwear industry. They were asked to rate the SCPMs according to their perception with respect to enhancing agility in the leather footwear supply chain. Those that were rated high were identified as the agility-enhancing SCPMs significant to leather footwear industry. Then, the 100 points were distributed amongst them by the experts in such a way that the higher points were assigned to the criteria on the basis of its importance with respect to the leather footwear industry. The weighted average of the same was computed and considered as priority weights (Wi) in the voice of the customers of QFD tool.

3.2 Determination of AESCPs

Organizations practise agile enablers based on several conceptual models of agile enterprises available in the literature, to achieve the agile capabilities [4,30]. Agility drivers, concepts and attributes for an agile enterprise had been detailed by [34] in which about 32 agile attributes were listed. Few of the agile supply chain enablers listed in the literature are the dynamics of structures and relationship configuration, the event-driven and event-based management, the end-to-end visibility of information [21].Widely ranging agile SC-attributes of about 86 are tabulated and the critical factors to achieve SC agility are listed in the literature [12,13,35].

3.2.1 Instrument and Sample

Based on the reported literature, a total of 95 agile SC-attributes have been identified. A questionnaire was then developed with the identified ASC-attributes as the

measurement items adopted mainly from [12].Then the items listed in the questionnaire were modified with deletion of about 15 items to suit to the leather footwear industry as per the suggestions from two academicians and three industrial practitioners in the field thus ascertaining the face and content validity of the questionnaire. The samples were the managerial level people associated with the SCM of the leather footwear-manufacturing units situated in the major footwear clusters in India, randomly chosen from the population data available from the directory of Council of Leather Exports (CLE). The sample population was asked to give a rating on a 5-point Likert scale (1 - strongly disagree to 5 - strongly agree) to evaluate each item based on its relevance and practical employability in leather footwear sector. The survey was carried out seeking inputs from about 838 people associated with the SC functionality and could get the responses from about 291 people with great efforts leading to the response rate of 34.72%. A response rate of 9% is pondered to be acceptable in Indian scenario and the subject-to-variable ratio of about 3.5:1 is found to be the acceptable sample size [36,37].

3.2.2 Data Analysis

The cross-sectional data collected was checked for missing values and data imputation performed. The items with standard deviation less than 0.5 were deleted. Then reliability of data was examined and few items were deleted to increase the Cronbach alpha value and arrived at an integrated Cronbach alpha value for the agile supply chain attributes equal to 0.916 for about 64 items confirming the internal consistency of data [38]. Factor analysis was performed on the reliable data obtained by survey using Varimax rotation and Principal Component Analysis (PCA) extraction method in SPSS 19.0, to summarize the correlations amongst observed variables and to reduce a large number of ASC-attributes to a smaller number of factors or agility enabling SC practices that would represent a group of ASC-attributes [39] and thus the AESCPs were determined.

The loadings on the factors indicate the correlation of different original items/variables with each factor and also the degree of correlation [40]. The loadings in excess of 0.35 are considered in the study based on the sample size greater than 250 [39]. Therefore the variables were assigned to one factor by checking all the variables for a particular factor,with factor loading (from the rotated component matrix) of items/variables above 0.35 and the cross-loadings were removed as well .by considering factor loadings above 0.35.

Cronbach alpha values were then calculated for each factor using the SPSS software. Few items were dropped to maximize the internal consistency of the factors [41]. Then the factor analysis was re-run with about 54 items and analysed for Kaiser- Meyer-Olkin (KMO) measure of sampling adequacy to scrutinize the data strength. The value was found to be 0.728 considered middling, which indicates the appropriateness of sample size to perform factor analysis. Barletts test of sphericity was computed to test the correlation amongst the items using chi-square and the data was found to be statistically significant indicating that the matrix has items with significant correlation amongst themselves [42].

The value of Cronbach alpha coefficient of each of the factors (AESCPs) was examined and it is realized that about five factors exceeded 0.7 indicating acceptable reliability, four factors with alpha coefficient of 0.6 - 0.7 indicating moderate reliability level and that other three constructs are just greater than 0.55 making its reliability questionable [38,43,44]. The Cronbach alpha is computed depending on the number of items in a scale and the average inter-item correlation. This resulted in less alpha value, as the number of items in a scale were few in number. In such cases, the Corrected Item-Total Correlations (CITC) that indicate correlations between each item and the total score were checked and it was understood that all data had item-total correlations above 0.3 [42] and the optimal mean inter-item correlation values also ranged from 0.15 to 0.5 as recommended by [45]. This indicates the reliability of the constructs (AESCPs).

Non-response bias

Non-response bias was assessed by checking whether there is a significant difference in responses between the initial and final set of respondents [46]. As per this method, the initial set of responses collected in the first 60 days that comprised 55% of the total valid response rate (162 out of 291 respondents), were compared with the final set of responses collected in the final 45 days of the data-collection period. Using a t-test, responses of the initial set and final set were compared for four randomly selected non-demographic measures such as transparent information sharing, quality ensured at every stage, flexible software for design CAD/CAM, and top management commitment. The results imply no significant mean differences at 0.05 level between the two waves of responses, indicating that there is no non-response bias in this study.

Common method bias

The samples were the mid-to-senior level managers associated with the supply chain management of the leather footwear-manufacturing units, who had significant levels of appropriate knowledge and that tends to mitigate single source bias [47]. To test for the probability of a common method bias, Harmans one-factor test was used [48]. A principal component analysis was performed on all 54 items, resulting in the extraction of 12 factors. These account for 75.9% of total variance with eigenvalues above 1, and the first factor account for just 16.75% indicating that there is no common method bias in this research study.

3.3 Determination of (a) Correlation among the AESCPs (T_{kj}) (b) Interrelationship between AESCPs and agility-enhancing SCPMs (R_{ij}) and its prioritization (RI_j^*)

The inter-relationship between AESCPs and agility-enhancing SCPMs (R_{ij}) and the correlation among the AESCPs (T_{kj}) were determined and the team of experts of the industry vetted the same. As the measures were described subjectively in the HOQ, fuzzy logic was employed to dispense with problems involving vague, and imprecise phenomena [20,24]. The linguistic findings that are necessary for understanding the relative importance of AESCPs, relationships and correlations matrices were translated into numerical values of objectivity. The degree of relationship between agility-enhancing SCPMs and AESCPs were stated by the corresponding Triangular Fuzzy Numbers (TFNs) and positioned in the HOQ matrix. In addition to this, the degree of correlation between AESCPs was also expressed by TFNs in the fuzzy HOQ. Both of these correspondences are shown in Table 1 and Table 2.

3.3.1 Triangular Fuzzy Number (TFN)

The TFN can be expressed as a triplet (a,b,c), where, $a \leq b \leq c$. When $a = b = c$, it is a non-fuzzy number by convention. The membership function can be stated as indicated below, according to the available literature [49, 50].

$$\mu_N(x) : \begin{array}{ll} (x-a)/(b-a), & x \in [a,b] \\ (c-x)/(c-b) & x \in [b,c] \\ 0 & otherwise \end{array} \quad (1)$$

If $M = (a_1,b_1,c_1)$ and $N = (a_2,b_2,c_2)$ represent two TFNs, then the necessary fuzzy calculations are performed as follows [51].

Fuzzy Addition:

$$M \oplus N = (a1 + a2, b1 + b2, c1 + c2) \quad (2)$$

Fuzzy Multiplication:

$$M \oplus N = (a1 \times a2, b1 \times b2, c1 \times c2) \quad (3)$$

Fuzzy Division:

$$M \oplus 1/N = (a1/c2, b1/b2, c1/a2) \quad (4)$$

Fuzzy and a natural number multiplication:

$$r \oplus M = (r.a, r.b, r.c) \quad (5)$$

The aim of computing the relative importance (RI_j) of AESCPs and its priority weights (RI_j^*) is to determine the AESCPs that have the most significant effect in agility-enhancing SCPMs.

$$RI_j = \sum_{i=1}^{N} W_i \oplus R_{ij}, j = 1, ..., m \quad (6)$$

$$RI_j^* = RI_j \oplus \sum_{k=j} T_{kj} \oplus RI_k, j = 1, ..., m \quad (7)$$

Then normalization was done by dividing each RI_j^* by the highest one according to the fuzzy set algebra [49]. Further, in order to rank the AESCPs, the normalized scores of RI_j^* were de-fuzzified. Suppose $M(a,b,c)$ is a TFN; then, the de-fuzzified value is computed as

$$\frac{a+2b+c}{4} \quad (8)$$

The relative importance of AESCPs, RI_j and its priority weights RI_j^* were computed using priority weights of agility-enhancing SCPMs, the relationship between AESCPs and agility-enhancing SCPMs, and correlation among AESCPs by applying the formulae (6) and (7). Then normalization of RI_j^* was done to find NRI_j^* values. The crisp values were then calculated using formula (8).

AESCPs with high crisp values imply that they have to be practically executed to enhance agility in the SC performance of the leather footwear sector. Thus, such agility enabling practices must be selected for implementation so as to augment the SC performance of the leather footwear industry.

4 Results and Discussion

4.1 Agility-enhancing SCPMs

As stated the agility-enhancing SCPMs specific to leather footwear industry were identified by expert-team through Delphi study using scale well adopted from [31,32]. They were pondered as the voice of the customer of QFD tool and are indicated in Table 3. The assigned priority weight (Wi) has also been indicated. The experts assigned information accuracy, quick response, and uncertainty minimization with higher significance, Wi of 0.1. These SCPMs have been reported as the agility-enhancing measures by earlier researchers [8,24,52]. The responses of the experts indicate that these are the attributes, which are critical to the enhancement of agility in the SC performance, and could bring about a competitive advantage. The next set of attributes identified by the experts with the Wi of 0.09 are lead-time reduction, service level improvement, quality consistency, flexibility enhancement, delivery speed, and reliability. These attributes have also been listed as the critical aspects for enhancing the agility by earlier researchers [8,19,53]. The identified agility-enhancing SCPMs are considered as more significant and relevant to the Indian footwear

Table 1: Degree of relationships, and corresponding fuzzy numbers [23]

Degree of relationship	Fuzzy number
Strong (S)	(0.7; 1; 1)
Medium (M)	(0.3; 0.5; 0.7)
Weak (W)	(0; 0; 0.3)

Table 2: Degree of correlations, and corresponding fuzzy numbers [23]

Degree of correlation	Fuzzy number
Strong positive (SP)	(0.7; 1; 1)
Positive (P)	(0.5; 0.7; 1)
Negative (N)	(0; 0.3; 0.5)
Strong negative (SN)	(0; 0; 0.3)

industry as gathered from the experts. Priority weight of Wi of 0.08 was assigned to cost efficiency and technical competency. These agility-enhancing SCPMs reported by [28,35] are considered by the experts as crucial not only for the enhancement of agility in the SC but also for the survival of the organization. Cost, quality, availability, responsiveness, speed, flexibility, innovation and competency were identified as the competitive bases(priority-wise) for leagile SCM for a company of food products industry [54]. The results of the present study are in congruence with the performance metrics used in a research study on Brazilian footwear industry, which also considered cost, flexibility, delivery time and quality as the performance criteria in developing a suitable model for SC performance measurement [19]. This corroborates the correctness and appropriateness of the identification and prioritization of the attributes of the voice of the customers of the present work.

4.2 Agility Enabling Supply Chain Practices (AESCPs)

The twelve factors identified as AESCPs representing the group of ASC attributes are shown in Table 4 along with its mean and reliability indicators, Cronbach alpha coefficient and mean inter-item correlations range, and items detailed with factor loadings and Corrected Item-Total correlations (CITC).

New product development/ replication of model shoe, centralized planning of production, systematic information sharing across all SC partners, taking leverage on core competencies of SC partners, learning organization, collaborative/ joint product development and decision making across the value chain, market sensitivity, Vendor Managed Inventory (VMI), use of IT tools/e-business to integrate activities of design, development, manufacturing and SCM, effective logistics management, production process improvement technologies and total quality management practices are the 12 AESCPs grouped using factor analysis and are considered to be relevant with reference to applicability in the leather footwear industry. This is broadly in line with the constructs of the agile supply chain for Indian manufacturing industry [37]. The agility enabling practices such as information sharing and information technology tools are in congruence with the agile enablers identified by [24] in the chemical industry producing detergents. AESCPs such as taking leverage on core competencies of SC partners, and learning organization culture with cross-functional teams are in line with the findings that external integration with SC partners are the antecedents and focus on market, learning and organizational culture types conducive for agility are identified as the drivers for cultivating SC agility in the organisation [55].

4.3 Fuzzy QFD based Agile Supply Chain Management Model for Leather Footwear Industry

The Fuzzy QFD based ASCM model describing the interrelationship between the agility-enhancing SCPMs and AESCPs specific to leather footwear industry and the technical correlation among the AESCPs in numerical values are developed using Edraw max software version 7.9.0 and is shown in Figure 3. The maximum crisp value of 0.9634 is obtained for the AESCP - Use of IT tools/e-business to integrate activities in design, development, manufacturing and SCM. This indicates that the IT tools could be effectively used for (a) communicating the observed and prognosticated changes and (b) minimizing the response time for the changes and enhances flexibility, transparency, and integration. Use of IT tools ensures transparency, visibility and quick sharing of information [8,37,56].

Though there is no sufficient statistical evidence for IT directly impacting SC agility [56], IT competence encompassing capabilities such as IT integration, and IT

Table 3: Voice of the Customer of QFD

VOICE OF THE CUSTOMER	
Agility-enhancing Supply Chain Performance Measures	**Priority weights (Wi)**
Lead time reduction	0.09
Cost efficiency	0.08
Service level improvement	0.09
Quality consistency	0.09
Uncertainty minimization	0.10
Flexibility enhancement	0.09
Delivery Speed	0.09
Delivery Reliability	0.09
Quick response	0.10
Information accuracy	0.10
Technical competency	0.08

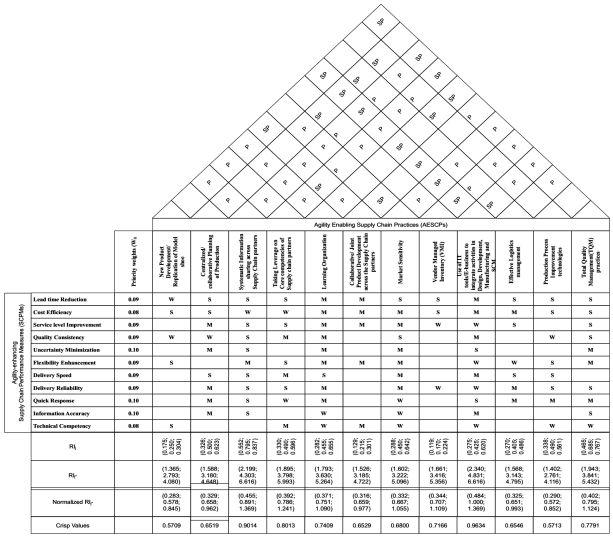

Fig. 3: A Fuzzy QFD based Agile Supply Chain Management Model for Footwear Industry

flexibility positively affects agility performance [29,52]. SC agility is not only about having the IT infrastructure, but the competence of organizations to use IT-enabled capabilities [57]. In a study on the lean, agile and leagile SC constructs for the manufacturing firms of India, information technology is identified as one of the pillars of ASCM [37]. From the present work, it is understood that the use of IT tools could bring forth agility. The flow of data and information amongst supply chain partners are critical in producing quality products. Application of IT tools enables the firm in real time to respond to the market and manufacturing requirements quickly.

The next larger crisp value of 0.9014 is obtained for the AESCP - Systematic information-sharing across all supply chain partners. The results indicate that the transfer of data across the SC is presently achieved predominantly through classical means and that there is an ample possibility of ineffective or distorted transfer of data or information. Moreover, if the data and information transfer is accomplished through electronic means then the lag in response time could be minimized significantly and the transparency and accuracy of information can be ensured. While [53] considered accessibility to information as an important dimension of SC agility; [37] considered information sharing as an important pillar for enabling SC agility in Indian manufacturing industries. It has been stated that Electronic Data Interchange (EDI) and Information Technology (IT) tools enable SC partners to make use of the real-time data and has been ranked as the second top leagile enabler to be implemented in the business of food product company [54]. Information Systems (IS) competence for agility has been defined as the degree to which the information systems applications are used by firms for information sharing with their SC partners, scouting for new market, facilitating planning and monitoring activities and supporting in the new product or service introduction [58]. Information sharing facilitates collaboration and integration between various SC members, which in turn could engender better SC agility [55]. Systematic information sharing aids top management to take a quick decision toward changes in the market, demand and supply through frequent communications with the SC partners and therefore it has been ascertained that managers of dynamic and ever changing demands or markets should implement information sharing as a positive enabler of improved SC agility [59].

The AESCP - Taking leverage on core competencies of supply chain partners, is assigned with the crisp value of 0.8013. Understanding the core competencies of the partners of the SC is construed as one of the important ASCEPs to bring about enhanced agility. It is reinforced that integration with key SC partners positively impacts SC agility of the firm [55]. It is empirically validated that there exists a positive relationship of supply and demand side competence with SC agility [9]. The relationship between (a) integration between the SC partners and (b)

Table 4: Agility Enabling Supply Chain Practices (AESCPs) with factor loadings, reliability indicators and mean value

AESCPs	ASC Attributes (measurement items)	Factor loadings	Corrected Item-Total Correlation	Cronbach alpha	Mean	Mean inter-item correlation range
TQM practices [12,60,61]	-	-	-	0.935	3.667	0.4-0.685
	Defined management goal	0.605	0.524			
	Well defined procedures and forms	0.716	0.656			
	Product/process/service design for quality	0.788	0.763			
	Trust development - internal/external	0.882	0.886			
	Quality ensured at every stage	0.773	0.826			
	Customer driven products, processes and service	0.477	0.49			
	Accurate customer voice translation	0.768	0.811			
	Scope for increasing customer value	0.831	0.883			
	Total Preventive Maintenance (TPM)	0.791	0.846			
Learning Organiation [34,52,55]				0.887	4.083	0.47-0.647
	Interchange-ability of personnel	0.641	0.665			
	Team formation and management	0.659	0.632			
	Effective training	0.746	0.588			
	Interlinking of departments	0.847	0.768			
	Intelligent/decentralized decision making	0.836	0.661			
	Minimizing resistance to change	0.827	0.697			
	Employment engagement/ empowerment	0.852	0.836			
AA				0.821	3.933	0.314-0.535
	Active data sharing with partners	0.471	0.407			
	Transparent information sharing	0.625	0.658			
	Interactive communication	0.504	0.48			
	IT driven communication	0.425	0.55			
	Supply chain wide information access	0.886	0.75			
	Data Accuracy	0.92	0.726			

AESCPs	ASC Attributes (measurement items)	Factor loadings	Corrected Item-Total Correlation	Cronbach alpha	Mean	Mean inter-item correlation range
BB				0.806	4.243	0.347-0.517
	Incorporation of IT utilities in SCM	0.695	0.5			
	Response time to customer	0.794	0.691			
	Data Management Framework	0.522	0.449			
	Elimination of paper work by IT	0.679	0.587			
	Flexible software for design - CAD/CAM	0.792	0.739			
	DSO/DIV- Fund flow management	0.61	0.471			
CC				0.657	3.78	0.370-0.405
	Effective market assessment	0.652	0.492			
	Effective forecasting method	0.526	0.478			
	Analysis of market trends	0.585	0.437			
DD				0.741	4.11	0.471-0.503
	Pull production system	0.684	0.571			
	Synchronized material movement	0.543	0.589			
	Time schedule based procurement policy	0.642	0.539			
EE				0.625	4.476	0.454
	Adoption of time compression technologies	0.853	0.454			
	Semi-automation	0.485	0.454			
FF				0.615	3.777	0.311-0.385
	Distribution networks	0.618	0.475			
	Transportation models	0.475	0.367			
	Warehousing and Procurement function	0.71	0.438			
GG				0.615	3.9	0.339-0.363
	Material planning	0.772	0.409			
	Demand supply planning	0.66	0.447			
	Flexible software for SC agility - ERP/CRM	0.465	0.426			
HH				0.565	3.641	0.394
	Product design at least price	0.521	0.394			
	Quick introduction of new products	0.786	0.394			
MM				0.587	4.232	0.416
	Supplier involvement in product development	0.362	0.416			
	Coordination and cooperation amongst SC partners	0.392	0.416			

AESCPs	ASC Attributes (measurement items)	Factor loadings	Corrected Item-Total Correlation	Cronbach alpha	Mean	Mean inter-item correlation range
LL				0.599	4.219	0.227-0.327
	Negotiation	0.364	0.316			
	Ability to change delivery times of supplier orders	0.355	0.416			
	Trust and competency of the suppliers	0.793	0.326			
	Concurrent relationship of supply chain activities	0.654	0.474			

AA-Systematic Information sharing across all supply chain partners [37,53,54,55,58]
BB-Use of IT tools/E-business to integrate activities in Design, Development, Manufacturing and SCM [8,37,52,54,56,57]
CC-Market Sensitivity [26,37,58]
DD-Vendor Managed Inventory (VMI) [54,62]
EE-Production Process Improvement Technologies [34,60,63]
FF-Effective Logistics Management [26,54,63,64]
GG-Centralized/Collaborative Planning of Production [21,55]
HH-New Product Development/ Replication of a Model Shoe [5,54]
LL-Taking Leverage on Core competencies of supply chain partners [9,34,55,59]
MM-Collaborative/ Joint Product Development across the supply chain partners [8,52,55]
ASC attributes adapted mainly from [12,13,21,34,35]

Table 5: Agility Enabling Supply Chain Practices (AESCPs) in the order of their Crisp Values

S.No.	AESCPs	Crisp Values
1	Use of IT tools/E-business to integrate activities in Design, Development, Manufacturing and SCM	0.9634
2	Systematic Information sharing across all Supply chain partners	0.9014
3	Taking Leverage on Core competencies of Supply chain partners	0.8013
4	Total Quality Management (TQM) practices	0.7791
5	Learning Organization (includes multi-skilled labour and cross-functional teams)	0.7409
6	Vendor Managed Inventory (VMI)	0.7166
7	Market Sensitivity	0.6800
8	Effective Logistics management	0.6546
9	Collaborative/ Joint Product Development across the supply chain partners	0.6529
10	Centralized/Collaborative Planning of Production	0.6519
11	Production Process Improvement Technologies	0.5713
12	New Product Development/ Replication of Model Shoe	0.5709

information sharing is discussed and indicated that the same is crucial for achieving agility [59]. Effective integration between the partners of the SC is seen as the key for understanding the competencies of the SC partners and exploitation of the same for achieving agility.

The next significant AESCP is Total Quality Management (TQM) Practices with the crisp value of 0.7791. It is understood from the responses of the experts that the Quality Assurance Systems (QAS) installed and maintained in the Indian footwear industries, by and large, could not meet the system requirements. The effectiveness of the QAS has a direct bearing on the level of agility of an organization. Therefore, the design, development, establishment, implementation, and maintenance of the right kind of TQM practices in congruence to the system requirements is perceived to bring about better agility in the SC. The quality strategy is crucial for effective supply base management and for ensuring a right response in time against the customer defined needs [60]. It is emphasized that strategies are to be formulated to ensure quality at every stage for achieving agility in the SC [12]. Whereas the primary objective of TQM is to ensure the production of quality products, it also facilitates the firms ability to respond to device corrections and corrective measures in all the management processes. This, in turn, ensures better agility. It is concluded that all the elements of TQM correlated significantly with SC coordinates and supply

management [60]. The quality relationship of an organization with the customers is positively influenced by its agility in case of international ports [61].

Learning Organization (LO) is the AESCP assigned with 0.7409. Learning organization has a multi-skilled and adaptable workforce that upgrades skill through continuous training and development [34]. Learning orientation in SC has been identified as a critical enabler of agility in SC in case of large-scale fashion and textile companies in Hongkong [52]. Learning orientation of workforce positively impacts SC agility mediated by internal integration [55]. Primarily, the vendor-partnership should be realized in the Indian leather footwear industry. Vendor-partnership across the SC would bring about the scope for understanding the core competence of the SC partners and through taking the most of the core competence would result in effective and immediate response to the changes and in turn would result in better agility. The crisp value of 0.7166 is assigned to Vendor Managed Inventory (VMI). VMI enhances the SC performance by dwindling inventory levels and improving upon customer service levels and is one amongst the top ten enablers of leagility [54, 62].

The other AESCPs such as market sensitivity, effective logistics management, collaborative/ joint product development across the value chain, centralized/collaborative planning of production, production process improvement technologies, and new product development/ replication of model shoe gain significance next to the six major AESCPs. It may be understood that the other AESCPs are also closely connected to the major AESCPs. If the major AESCPs could be achieved then the other AESCPs could also be addressed adequately.

5 Conclusion

Agility Enabling Supply Chain Practices (AESCPs) are listed as per their crisp values in Table 5. Use of IT tools/e-business to integrate activities of design, development, manufacturing and SCM, systematic information sharing across all supply chain partners with relevance to data accuracy and transparent information system through EDI, taking leverage of the core competencies of the supply chain partners, TQM practices comprising corporate culture change towards learning organization, satisfying both internal and external customers ensuring quality, organization that has learning orientation for workforce with multi-skills and cross-functional teams, inventory managed by vendors, are the AESCPs that tops the list with high crisp values. AESCPs that gained high crisp values have to be practically effected in leather footwear industry so as to augment the agility in the SC performance of the sector.

Primarily the following AESCPs shall be adopted and implemented in the Indian leather footwear industry for augmenting agility in the supply chain of the industry thus ensuring effective agile supply chain management.

- –Use of IT tools/e-business to integrate activities of design, development, manufacturing and SCM
- –Systematic information-sharing across all Supply chain partners
- –Taking leverage on core competencies of supply chain partners
- –TQM Practices
- –Learning organization (includes multi-skilled labour and cross-functional teams)
- –Vendor Managed Inventory (VMI)

The other AESCPs that could bring about agility in the SC are market sensitivity, effective logistics management, collaborative/ joint product development across the value chain, centralized/collaborative planning of production, production process improvement technologies,and new product development/ replication of model shoe. It can be understood that attainment of the major AESCPs would also ensure the attainment of the other AESCPs that are found to be important for achieving agility in the supply chain of Indian leather footwear industry.

This model can be implemented and practiced for augmenting agility in the supply chain of the Indian footwear industry. The ASCM model presented here is based on the inputs captured from the Indian leather footwear industry and therefore suitable to a greater extent to the Indian footwear industry. As the model is not practically implemented the effectiveness of the model cannot be ascertained. Therefore, it is essential to re-engineer this model (considering this broader ASCM framework) to suit better to specific units.

Acknowledgment

The authors wish to thank Dr B Chandrasekaran, Director, CSIR-CLRI,and Dr Rajendran and Dr Suganthi, Heads of the Department of Management Studies, Anna University for their immense support to carry out the research work. The authors also wish to thank Dr P Saravanan, and Dr B N Das, Heads of the Project Planning and Business Development of CSIR-CLRI and footwear industry members for their valuable suggestions and inputs towards this research work.

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