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Improving the benefits and costs on sustainable supply chain finance under uncertainty

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ABSTRACT

Prior studies in sustainable development have been conducted since its introduction, however, there is evidence in the literature that sustainable supply chain finance is still lacking, in particular, in relation to developing measurements to analyze the benefit and cost attributes. Furthermore, these studies did not also identify an ideal hierarchical structure, which is key for accuracy of decisions making. Hence, this paper contributes to the literature by constructing a set of measurements and analyzing the benefits and costs in the textile industry. In this paper, a fuzzy interpretive structural model was developed to build a hierarchical model, and a fuzzy TODIM was applied to determine the linguistic preferences and identify the benefits and costs. The results obtained show that sustainable supply chain finance improves firms' competitive advantages through multiple attributes, which imply that collaboration value innovation, strategic competitive advantage and financial attributes are the most important aspects for improving firm's performance. The results also indicate that to build a successful sustainable supply chain finance, firms should upgrade the synchronization of financial-related decisions, obtain price and cost information, focus on product and service quality, and ensure the dispersion of dependent and interdepartmental interactions.

1. Introduction

Since the introduction of sustainable development (SD) by the Brundtland Commission (WCED, 1987), much attention has been drawn to this field throughout the years as more and more works (e.g. Lukman and Glavič, 2006; Shi et al., 2017; Tseng et al., 2008, etc.) have proven its capability, from various aspects such as sustainable integrated environmental and management attributes, to achieve triple bottom line (TBL). Being considered as one of the major sectors for economic development, the textile industry, particularly in developing countries, which is often known for its compound production processes, considerable chemical consumption and use of extensive natural resources, has significant potential for studies due to its lack of SD (Moore and Ausley, 2004; Kocabas et al., 2009; Verma et al., 2012). SD is achieved by targeting TBL, which considers environmental quality, social equity, and economic benefits (Shaker and Sirodoev, 2016). To succeed in dynamic global competition and to fulfill SD requirements, both operations and resources must be optimized to achieve sustainable competitive advantage (Liu, 2013; Liu and Liang, 2015). However, Caiado et al. (2017) found that there is a lack of comprehensive studies on SD in industries, as well as in firms and their operational processes. In addition, the financial flow along the supply chain is a crucial aspect that has an essential role in SD. There is evidence that insufficient attention has been paid in this research domain (More and Basu, 2013; Basu and Nair, 2012). A study on sustainable supply chain finance (SSCF) is, therefore, needed to address this gap as a contribution to the existing literature. Given the globalized and segregated supply chains under the current competitive market, a successfully developed SSCF is even more crucial than before to ensure an efficient management of these supply chains.

Prior studies that mentioned supply chain finance (SCF) solely considered economic aspects (Raghavan and Mishra, 2011; Gupta and Dutta, 2011; Yan et al., 2016) and they are often perceived to be profoundly lacking in completeness and continuity. The apparent SCF benefits, such as facilitating more extended payment conditions for customers and determining more excellent ways for suppliers to access financing, are often unclear (Wuttke et al., 2016). These studies have demonstrated that integrated SD's perspectives are lacking of clear

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defined benefits and costs and a connection among TBL perspectives; in addition, these perspectives are also falling short of empirical and theoretical verification (Hubbard, 2009; Keeys and Huemann, 2017; Caiado et al., 2017). Notably, Lozano (2008) argued that studies have been increasingly recognizing TBL's role in contributing to SD; however, these studies have not yet clearly explained how the attributes are linked or how they contribute to the TBL. Tseng et al. (2018) develop a SSCF model under uncertainty to identify the deficiencies of financing patterns. Yet, it is crucially important to identify the challenges for SCF, related to SD and its widespread applications in supply chains (More and Basu, 2013). Additionally, existing studies have not noticeably discussed SSCF. Hence, this study proposes that through SSCF, the affiliated partners of SD and SCF obtained a win-win situation through efficient coordination and cooperation.

Although prior studies have attempted to enhance the understanding of SSCF, they do not indicate how the hierarchical structure is formed during the financial analysis process, which is key to achieve SSCF targets (Basu and Nair, 2012; Gupta and Dutta, 2011; Hofmann, 2005). Therefore, to address this key criterion, a fuzzy interpretive structural modeling (FISM) was developed to construct the hierarchical structure and a fuzzy TODIM was adopted to identify the decisive benefits and costs of attributes that enhance the SSCF model since they have not yet been identified (Gomes and Rangel, 2009; Tseng et al., 2014). Specifically, this study uses the characteristics of fuzzy TODIM to explore SSCF and determines which attributes needed to be improved, so as to enhance the performance. In essence, this study contributes to the literature by distinguishing SSCF attributes in terms of benefits and costs based on linguistic preferences and by increasing the understanding of these attributes. Hence, the following questions were established to be addressed:

1 What are the unique SSCF attributes in the hierarchical structure?
2 What attributes should be improved to enhance SSCF in the textile industry?

The following study is structured as follows: Section 2 provides a review of the related existing studies on SD and SCF and Section 3 describes the industrial background as well as the fuzzy TODIM. Section 4 provides the results of the data analysis and related findings, and the followed by Section 5 discussing the managerial and theoretical implications. The final section provides the concluding remarks and the discussion of possible directions for future studies.

2. Related work

This section provides a discussion on SD and SCF as well as the method and measures employed in this study.

2.1. Sustainable development

The Brundtland Commission's report (WCED, 1987) defined SD as *"development which meets the needs of current generations without compromising the ability of future generations to meet their own needs"*. Lukman and Glavič (2006) indicated that SD addresses specific needs to achieve TBL. Much studies have analyzed a range of dimensions of SD (Tseng et al., 2008; Lan and Tseng, 2017; Shi et al., 2017). For instance, Tseng et al. (2008) applied a sustainable production framework to assess the relative effectiveness of the development of attributes in environmental and management activities that are useful for reviewing and improving strategic SD in firms. Lozano et al. (2016) stated that firms have been accused of being responsible for negative impacts on the environment and society. SD requires collaboration in the form of integrative thinking and important actions taken by firms unless these firms have complete knowledge or control of the TBL (Keeys and Huemann, 2017). Prior studies have indicated that SD appears on multiple levels, but few studies have explained how the multi-level structure is formed.

Bebbington and Larrinaga (2014) argued that there might be a potential breakthrough in the linkage between environmental and social issues. Caiado et al. (2017) reviewed prior studies and compared decision-making tasks, which led to better financial, environmental and social outcomes. Müller et al. (2015) linked SD directly with environmental impacts through economic performance. It is often argued, in the literature, that firms require a set of measurements for decision making to improve economic and environmental performance. Economic measures are needed to mitigate undesirable impacts on the environment and to maximize positive social impacts (Shi et al., 2017). In particular, Lozano et al. (2015) described firms' activities, including actively seeking to contribute to the balance of the TBL, while addressing the firm's operations, production, management and strategies related to stakeholders. Hence, there is a need to balance the TBL, especially if the firm only focuses on SCF, and a benefits and costs analysis is crucial to be developed. This justifies the contribution of this study achieving SSCF and presenting the associated key measurements.

2.2. Supply chain finance (SCF)

Hofmann (2005) claimed that "*SCF is an approach for two or more organizations in a supply chain, including external service providers, to jointly create value through the means of planning, steering, and controlling the flow of financial resources on an inter-organizational level*". Klapper (2006) discussed the role of SCF in promoting revenue growth and obtaining benefits through the reduction of inventories and financial costs. In addition, Liu et al. (2015) argued that SCF impacts a firm's capability to adopt SD in supply chain networks through the use of innovative financing solutions and the creation of bridges between supply chain members (Arani and Torabi, 2018). More and Basu (2013) conducted a case study stating that because of competitive pressure, SCF faced a range of complex challenges. Therefore, it is important to analyze and understand the challenges to build strategies for SCF with the purpose of reducing risks of losing competitiveness. A lack of knowledge and coordination between supply chain parties involved in SCF have been proven leading to its ineffectiveness (More and Basu, 2013; Arani and Torabi, 2018). SCF requires close coordination to respond to changing environment, achieve sustainable competitive advantage and meet the SD requirements.

Most of the prior studies that mentioned SCF only consider the economic perspective (Raghavan and Mishra, 2011; Gupta and Dutta, 2011; Yan et al., 2016). For instance, Camerinelli (2009) mentioned that SCF is focused on short-term solutions provided by financial institutions, particularly regarding accounts payable and receivable. Gomm (2010) claimed that SCF does not involve a financial institution but rather is focused on working capital management, inventories and fixed asset financing. Thus, the SCF perspective is more short-term-oriented, and firms are unable to solve the various challenges (Caniato et al., 2016). More and Basu (2013) argued that it is important to identify the critical challenges related to SCF as they pertained to SD to allow for its widespread application in supply chains. Thus, SCF needs to focus on all the related aspects to achieve SD, and it is necessary to explore the specific aspects of SSCF. In essence, a balanced SCF is necessary for SD.

2.3. Existing methods

Caiado et al. (2017) employed a systematic review method to locate relevant existing studies based on previously formulated study questions and to evaluate the respective contributions to SD. Lozano (2012) used a diversity of valuation methods to help firm leaders better understand how to improve firms' contributions to sustainability. In addition, More and Basu (2013) used an extensive survey to examine the different challenges related to SCF, and Liu et al. (2015) discovered new insights related to the emerging phenomenon of SCF by using a literature review and a survey. Prior studies, e.g. Wuttke et al. (2016) and

Caniato et al. (2016), have described the hierarchical structure of SCF. However, only a few studies have indicated where the hierarchical structure is derived from. For instance, Wuttke et al. (2016) confirmed that supply chain performance can be improved by facilitating longer payment terms for buyers and better access to financing for suppliers. There is evidence for some hesitation regarding SCF adoption. However, this hesitation may be due to the conflicts among the stakeholders. Caniato et al. (2016) showed that supporting SCF leads to supply chain linking with working capital, and this process provides a reference forming a hierarchical framework that links the solutions with moderating attributes. In the literature, several studies have indicated that SD needs to be supported by economic aspects (Tseng et al., 2014; Tseng et al., 2008; Shi et al., 2017). Nevertheless, in relation to SSCF, no prior studies have developed a set of measurements or have analyzed the attributes of the benefits and costs associated to it.

To address this gap, Salomon and Rangel (2015) proposed TODIM as a multi-criteria decision-making (MCDM) method. TODIM is the acronym for interactive and multi-criteria decision making in Portuguese, which requires numerical values for evaluating alternatives related to the benefits and costs criteria. This method has been successfully used and is acknowledged for its various applications (Chen et al., 2015). Additionally, TODIM is able to describe the decisions made between risk-based alternatives and the actual choice models rather than only determining the optimal decisions. Renato and Talles (2012) used fuzzy TODIM for assembly decision making and proved the effectiveness of this method in situations whereby a group of decision makers were involved. Therefore, this method has been proven to be effective in identifying the benefits and costs of specific attributes. This approach helps firms build their competitive advantage by conducting an in-depth assessment of multiple attributes. This measurement is calculated as the sum of all the criteria used for the relative benefits and costs of these attributes or alternative solutions. However, no prior study was conducted on achieving SSCF or had used TODIM to clarify this issue. Hence, this study proposes a hybrid method, aimed at adopting FISM to build the hierarchical structure measurement and applying fuzzy TODIM to identify the benefits and costs of the attributes of SSCF. This discussed in more detail in the following sections.

2.4. Proposed attributes

A list of attributes can be found in the existing literature based on the works of Raghavan and Mishra (2011), Wuttke et al. (2013), Tseng et al. (2014), Marshall et al. (2015), Boon-itt et al. (2017), Liao et al. (2017) and Shi et al. (2017), which consists of thirty-three criteria related to sustainable supply chain finance and are shown in Table 1. More and Basu (2013) determined that the financial-related innovative information sharing (C1) is an external attribute that may influence the effectiveness of deliberate learning mechanisms that are used for innovation (Liao et al., 2017). Decision synchronization is an attribute that measures the degree of supply chain collaboration. Some studies have indicated that the synchronization of financial-related decisions (C2) includes joint planning and development and financial-related decisions regarding sustainable supply chain of management (SSCM). Chauffour and Malouche (2011) claimed that failures regarding SCF were caused by a lack of sufficient capital to cover the obligations of the businesses. Cash flow incentive alignment (C3) measures the degree of financial collaboration by investigating the alignment of supply chain partners (Liao et al., 2017).

A firms' operational capability is the ability to manage and balance customer needs by using demand updates to accurately forecast demand and service provision (Boon-itt, 2009; Tseng et al., 2014). The supplier relationship management process capability (C4) measures the ability to develop, manage and maintain close and long-term relationships with suppliers. The synchronized management on the service performance management process capability (C5) is the ability to manage and improve the performance of service processes and support coordination and collaboration in the supply chain to improve service performance. This capability improves the operational efficiency on a real-time basis and enhance their information and technology management process capability (C6). A scale that is larger than the service delivery management process and the scope of ordering process management includes the receipt of orders through the provision of services to customers (C7). The maintenance and development of long-term relationships with customers refers to the customer relationship management process capability (C8). The demand management process capability (C9) is the ability to manage and balance customer needs by using updated demand information to accurately forecast demand and provide services. The capacity and resource management process capability (C10) is the ability of resource management and service capacity to meet demand with an optimal service capacity.

At the firm level, a strategic competitive advantage guides the operational capability of the firm. Kristal et al. (2010) emphasized the role of supply chain strategy in effectively improving a firm's competitive advantage and SD through decreasing costs, increasing profits and improving environmental performance. Price and costs information (C11) is used as a competitive advantage to ensure firms can provide either the lowest price or a price as low as that of the competitors' product or service (Liao et al., 2017). Product or service quality (C12) indicates whether firms are able to meet customer's needs and maintain customer satisfaction. Hamilton (2006) stated that the substantial loss of customers and market value causes an organization to cease operations in its current form. Hence, providing more benefits to the customers and attracting customers improve the benefits related to SD. Delivery dependability (C13) occurs when the firm has guaranteed market demand for the product or service. However, product innovation (C14) helps firms adapt to the different needs of customers by providing

Table 1
Proposed criteria.

	Criteria
C1	financial-related innovative information sharing
C2	Synchronization of financial-related decisions
C3	Cash flow incentive alignment
C4	supplier relationship management process capability
C5	Service performance management process capability
C6	information and technology management process capability
C7	provision of services to customers
C8	customer relationship management process capability
C9	demand management process capability
C10	Capacity and resource management process capability
C11	Price and cost information
C12	Product or service quality
C13	Delivery dependability
C14	product innovation
C15	Time to market
C16	Buyer credit
C17	Inventory/work-in-progress financing
C18	suppliers to support ongoing work, and reverse factoring
C19	Enhancing SCF in networks
C20	Electronic platforms
C21	Letters of credit
C22	Open account credit
C23	Bank loans for financing the supply chain
C24	the working capital position of a buying firm
C25	the working capital position of the upstream supply chain
C26	Pooled dependence
C27	Dispersion of dependence
C28	Supplier integration
C29	interdepartmental interaction
C30	Interdepartmental collaboration
C31	pre-shipment or post shipment financial supply chain management
C32	cash flow risk (buyer)
C33	Supply chain disruption risk

Noted: Raghavan and Mishra (2011); Wuttke et al. (2013); Tseng et al. (2014); Marshall et al. (2015); Boon-itt et al. (2017); Liao et al. (2017); Shi et al. (2017).

customized products. Time to market (C15) competitive advantage refers to the ability of a firm to promptly offer a product or service to a customer (Hill and Jones, 2001; Liao, et al., 2017).

Financial practices support the firms' SD and SCF activities. Wuttke et al. (2013) studied SCF and identified financial practices, which include eight criteria. Buyer credit (C16) is a long-term finance provided by financial organizations. Inventory/work-in-progress financing (C17) occurs when buyers provide loans to suppliers to support ongoing work, and reverse factoring (C18) refers to when the supplier obtains credit from a bank and pays interest when a purchase is made. The purchaser pays the original debt according to the terms of payment. Enhancing SCF in networks (C19) is an automated solution that allows firms to buy reverse cover systems that include the entire provider base, which often increases the flexibility and transparency in the payment process. Electronic platforms (C20) refer to systems provided by third parties that connect electronic trading partners with financial institutions to automate payment processes. Letters of credit (C21) are guarantees provided by financial institutions to exporters which include default risk. Open account credit (C22) refers to the credit that a buying firm receives from suppliers that do not officially provide securities or involve third party securities. Bank loans used for financing the supply chain (C23) refer to short-term or medium-term financing that is provided by a bank and is generally related to working capital and pre-export financing.

The financial practices needed to understand the working capital position of a buying firm (C24) help a firm to understand the difference between current assets and current liabilities. The working capital of the purchasing firm refers to the suitability of the working capital of the purchasing firm. Working capital is considered appropriate if it is not too high (risk inefficient) or too low (liquidity risk) and it refers to the working capital position of the upstream supply chain (C25). The working capital position of upstream suppliers indicates the suitability of the working capital of upstream supply chains. Pooled dependence (C26) is the degree to which the firm requires another firm to combine the dependence of all the relationships between a focused firm and its suppliers. In other words, pooled dependence refers to the extent to which a firm buys its suppliers for survival. In addition, the dispersion of dependence (C27) is a fixed level of Givena based on the degree to which a focal firm depends on multiple suppliers (highly dispersion) or relatively few (low dispersion). Supplier integration (C28) refers to the unification through a series of interoperability practices between suppliers (Wuttke et al., 2013).

The coordination and cooperation among the supply chain firms is represented by interdepartmental interaction (C29), which is a transaction-oriented approach that includes the exchange of information and documentation between the finance department and the firm. Interdepartmental collaboration (C30) occurs when two members of different departments work in groups and share interests and goals. Collaboration promotes informal exchanges of information. There are many attributes that need to be addressed before considering coordination and cooperation. For instance, pre-shipment or post shipment financial supply chain management (C31) includes the planning, management and control of all the processes and transactions related to the financial flows of the supply chain that are carried out before (or after) delivering a product and includes controlling the quality of products and releasing invoices. In addition to the levels of coordination and cooperation, the cash flow risk (buyer) (C32) must be determined. The cash flow risk refers to any deviations in the expected cash flow, e.g. focusing solely on special/specific buyers lead to unexpected costs related to paying the supplier with situations that are not-profitable (supplier default) or costs that are higher than expected (supplier efficiency). The focus of each specific supplier needs to ensure that the cash flow is more flexible and reliable. Supply chain disruption risk (C33) affects a purchasing firm when the supplier fails to pay their obligation and provide cash flow.

3. Methods

This section describes the methods used in this study, which include the FISM, theoretical perspectives with TODIM and the procedures in the proposed method to obtain the analytical results.

3.1. Fuzzy interpretive structural modeling (FISM)

Fuzzy set theory addresses uncertainty during the assessment process and transforms experts' judgments into quantitative values. This method reduces uncertainty in the decision-making process; however, the problem being analyzed retains its complexity. To overcome this issue, ISM is used to simplify this complexity and transform the problem into a hierarchical system to increase the decision making accuracy (Wu et al., 2018). FISM introduced to identify the hierarchical sequences in the practical situation, and many studies have been applied based on FISM (Ragade, 1976; Govindan et al., 2009; Bhosale and Kant, 2016; Wang et al., 2018).

Supposed there are e experts that are requested for assessing x proposed criteria. Based on the FISM feature, experts just need to make the half part of the parallel assessment. Each assessment from the expert is denoted as $C^e = \begin{bmatrix} c^e_{x1} & c^e_{x2} & \cdots & 1 \\ c^e_{(x-1)1} & c^e_{(x-1)2} & \iddots & \\ \vdots & 1 & & \\ 1 & & & \end{bmatrix}$. These assessments are expressed using a linguistic scale, as shown in Table 2, which needs to be shifted into a fuzzy set matrix, as below.

$$\tilde{C}^e = \begin{bmatrix} & \tilde{c}^e_1 & \tilde{c}^e_2 & \cdots & \tilde{c}^e_x \\ \tilde{c}^e_1 & 1 & & & \\ \tilde{c}^e_2 & \tilde{c}^e_{21} & 1 & & \\ \vdots & \vdots & \vdots & \ddots & \\ \tilde{c}^e_x & \tilde{c}^e_{x1} & \tilde{c}^e_{x2} & \cdots & 1 \end{bmatrix} = [\tilde{c}^e_{op}]_{\frac{x(x-1)}{2}} \tag{1}$$

where each matrix C^e represents the individual expert judgment on the influence among criteria.

The variable $\tilde{c}^e_{op}$ is re-written as $(\tilde{l}^e_{op}, \tilde{m}^e_{op}, \tilde{r}^e_{op})$. However, this set of values do not include the real number for the computation. Hence, the following equations are used to generate the exact crisp values.

Normalizing process

$$l^e_{op} = \frac{[\tilde{l}^e_{op} - \min(\tilde{l}^e_{op})]}{\theta},\ m^e_{op} = \frac{[\tilde{m}^e_{op} - \min(\tilde{m}^e_{op})]}{\theta},\ r^e_{op} = \frac{[\tilde{r}^e_{op} - \min(\tilde{r}^e_{op})]}{\theta} \tag{2}$$

where $\theta = \max(\tilde{r}^e_{op}) - \min(\tilde{l}^e_{op})$.

Obtaining the normalized value (t^e_{op}) and (u^e_{op})

$$t^e_{op} = \frac{m^e_{op}}{(1 + m^e_{op} - l^e_{op})},\ u^e_{xy} = \frac{r^e_{op}}{(1 + r^e_{op} - m^e_{op})} \tag{3}$$

Calculating the total normalized crisp value (n^e_{op})

$$n^e_{op} = \frac{[t^e_{op}(1 - t^e_{op}) + (u^e_{op}) \times (u^e_{op})]}{(1 - t^e_{op} + u^e_{op})} \tag{4}$$

Table 2
Linguistic variables for corresponding triangular fuzzy numbers (TFN).

Linguistic Variables	$\tilde{c}^e_{op}$	Corresponding TFN $(\tilde{l}^e_{op}, \tilde{m}^e_{op}, \tilde{r}^e_{op})$
No influence	*NI*	(0.0, 0.1, 0.3)
Very low influence	*VL*	(0.1, 0.3, 0.5)
Influence	*I*	(0.3, 0.5, 0.7)
High influence	*HI*	(0.5, 0.7, 0.9)
Very high influence	*VH*	(0.7, 0.9, 1.0)

Note: this table was proposed by Wu et al. (2018).

Mapping these crisp values into an aggregating matrix

$$\bar{n}_{op} = \frac{\sum_{o,p=1}^{e}(n_{op}^{e})}{e} = [\bar{n}_{op}]_{\frac{x(x-1)}{2}},\ e = 1,2,3,\ \cdots j \tag{5}$$

Exploring the threshold values through the following equations generates the total reachability matrix

$$\begin{matrix} \bar{h}_{op} = [\frac{\sum_{o=1}^{x}(\bar{n}_{op})}{x}]_{x\times 1} \\ \bar{v}_{op} = [\frac{\sum_{p=1}^{x}(\bar{n}_{op})}{x}]_{1\times x} \end{matrix},\quad if \begin{matrix} \bar{n}_{op} \geq \bar{h}_{op} \\ \bar{n}_{op} \geq \bar{v}_{op} \end{matrix},\ \textit{the value is } 1;\ \textit{otherwise, the value is } 0 \tag{6}$$

From the above transformation, reachability can be presented into binary form and re-written as

$$B = [\bar{b}_{op}]_{x\times x} \tag{7}$$

Subsequently, classifying the intersection set (I)

$$if \begin{matrix} \bar{b}_{o} = 1,\ R = \{\bar{b}_1,\ \bar{b}_2,\ \cdots \bar{b}_x\} \\ \bar{b}_{p} = 1,\ A = \{\bar{b}_1,\ \bar{b}_2,\ \cdots \bar{b}_x\} \end{matrix},\ I = R \cap A \tag{8}$$

where I denotes the binary matrix $\begin{bmatrix} i_{11} & i_{12} & \cdots & i_{1x} \\ i_{21} & i_{22} & \cdots & i_{2x} \\ \vdots & \vdots & \ddots & \vdots \\ i_{x1} & i_{x2} & \cdots & i_{xx} \end{bmatrix} = [i_{op}]_{x\times x}$.

Attained the driving powers (D) establishes the structure through applying the following equation (Note: more detail how to obtain D can be found in Eq. (13) of Wu et al. (2018)).

$$D = [\sum_{o=1}^{x} i_{op}]_{1\times x} = [i_p]_{1\times x} \tag{9}$$

3.2. Prospect theory with TODIM

Functional values in lead theory can be expressed in the form of a power law:

$$\mu(\tau) = \begin{cases} -\sigma(-\tau)^{a},\ x < 0 \\ \tau^{b},\ x \geq 0 \end{cases} \tag{10}$$

where a and b represent the parameters in terms of the benefits and costs function, respectively. The parameter σ expresses the feature that costs are higher than the benefits under risk aversion such that $\sigma > 1$. Fig. 1 shows the S shape prospect value function, which has concave

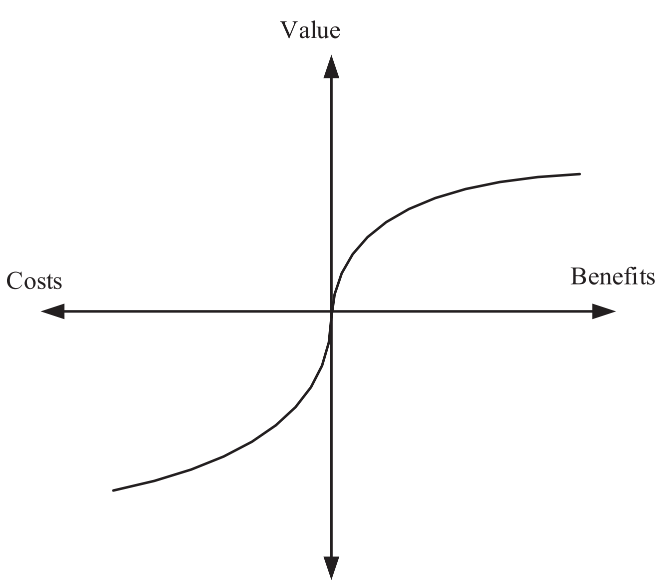

Fig. 1. Value function of the TODIM method (Gomes and Lima, 1992).

and convex sections for the benefits and costs. Kahneman and Tversky (1979) proposed that a and b need to equal 0.88, and σ should be 2.25 to ensure the value is consistent with empirical data. The σ was between 2.0 and 2.5; therefore, a and b were 0.92 and 0.89, respectively (Abdellaoui, 2000).

Zhang and Lu (2003) proposed adopting group decisions making to address fuzzy preferences. Subsequently, Krohling and de Souza (2012) developed fuzzy TODIM through combining prospect theory and fuzzy numbers into MCDM. This study extended the proposed method features as decision makers have their own opinions regarding judging and assigning the weights; these opinions are apparent in the linguistic preferences for aspects, and each selected criterion includes the different assessments from different decision makers. The utility aggregation is used to derive a common preference from the MCDM method; however, this is due to the preference of decision makers over the fuzzy matrices.

This study uses FISM to formulate the aspects based on their related levels. Suppose that there are x criteria for y aspect, and these are assessed by a decision-making group that includes e experts. These assessments are denoted as fuzzy decision matrix D, as shown in the following equation.

$$D^{e} = \begin{matrix} & \begin{matrix} A_1 & A_2 & \cdots & A_y \end{matrix} \\ \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_x \end{matrix} & \begin{bmatrix} d_{11}^{e} & d_{12}^{e} & \cdots & d_{1y}^{e} \\ d_{21}^{e} & d_{22}^{e} & \cdots & d_{2y}^{e} \\ \vdots & \vdots & \ddots & \vdots \\ d_{x1}^{e} & d_{x2}^{e} & \cdots & d_{xy}^{e} \end{bmatrix} \end{matrix} = [d_{ab}^{e}]_{x\times y} \tag{11}$$

where, d_{ab}^{e} represents the rating of the criteria based on the aspects. The weight vector $V^{e} = [v_1^{e},\ v_2^{e},\ \cdots v_n^{e}]$ consists of each weight v_a^{e} for each criterion and must fulfill the requirements $0 \leq v_a^{e} \leq 1,\ \sum_{y=1}^{a} v_a^{e} = 1$.

These individual matrices need to be aggregated into a common matrix through adopting the following equation.

$$D = \frac{\sum_{y=1}^{a} d_{ab}^{e}}{e} = [d_{ab}]_{x\times y} \tag{12}$$

These criteria must be categorized into either benefit d_{ab}^{B} or cost d_{ab}^{C} through the equations below.

$$d_{ab}^{B} = \frac{d_{ab} - \min(d_{ab})}{\Delta},\ d_{ab}^{C} = \frac{\max(d_{ab}) - d_{ab}}{\Delta} \tag{13}$$

where $\Delta = \max(d_{ab}) - \min(d_{ab})$.

The relation of each criterion C_α over each criterion C_β is computed through the following equations.

$$f(C_\alpha,\ C_\beta) = \sum_{y=1}^{a} \tau_y(C_\alpha,\ C_\beta)\ \forall\ (\alpha,\ \beta) \tag{14}$$

$$\begin{cases} If\ (d_{\alpha y} - d_{\beta y}) > 0,\ \tau_y(C_\alpha,\ C_\beta) = \sqrt{\frac{\mu}{(\sum_{y=1}^{a}\mu)}} \times d(d_{\alpha y} - d_{\beta y}) \\ If\ (d_{\alpha y} - d_{\beta y}) = 0,\ \tau_y(C_\alpha,\ C_\beta) = 0 \\ If\ (d_{\alpha y} - d_{\beta y}) < 0,\ \tau_y(C_\alpha,\ C_\beta) = (\frac{-1}{\sigma})\sqrt{\frac{(\sum_{y=1}^{a}\mu)}{\mu}} \times d(d_{\alpha y} - d_{\beta y}) \end{cases} \tag{15}$$

where μ represents the weight of criterion C_α divided by the referred criterion C_β, $d(d_{\alpha y} - d_{\beta y}) = \sqrt{(d_{\alpha y} - d_{\beta y})^2} = \sqrt{(d_{\alpha y})^2 - 2(d_{\alpha y})(d_{\beta y}) + (d_{\beta y})^2}$.

The function of $\tau_y(C_\alpha,\ C_\beta)$ is to recognize the contribution of criterion y to function $f(C_\alpha,\ C_\beta)$ while comparing aspect α with β. The variable σ represents the attenuation attribute of costs based on the problem on hand. According to Eq. (14), there are three types of situations; first, the value of $(C_\alpha - C_\beta)$ is positive, which means there is a gain; second, the value of $(C_\alpha - C_\beta)$ is zero; and third, the value of $(C_\alpha - C_\beta)$ is negative, which means there is a cost. Then, the final matrix of ascendency can be obtained through summing the fractional

Table 3
Hierarchical framework with grouping aspects.

Aspects	Proposed Criteria	Level
Operational Capability (AS1)	C18	1
	C5, C10, C19, C20, C26, and C29	2
Finance Category (AS2)	C13 and C25	3
	C12, C22, and C27	4
	C1, C4, C14, C15, and C32	5
Collaboration Value Innovation (AS3)	C17	6
	C2, and C8	7
Strategic Competitive Advantage (AS4)	C7, C9, C16, C30, and C31	8
Financial Practices (AS5)	C3, C6, C11, C21, C23, C24, C28, and C33	9

matrices of ascendency for each aspect. Finally, the final matrix of ascendency must be normalized to obtain the global value of criterion α through the following equation.

$$\rho_\alpha = \frac{\sum \rho(\alpha, \beta) - min \sum \rho(\alpha, \beta)}{max \sum \rho(\alpha, \beta) - min \sum \rho(\alpha, \beta)} \quad (16)$$

The ranking of the criteria is based on the value of ρ_α, and criteria with better performance have a higher value of ρ_α.

3.3. Proposed approach

1. The relevant information was collected from the literature and confirmed by experts (which is introduced in more detail in the following sections) to ensure its reliability. Then, the experts need to assess the collected criteria based on their professional knowledge and experiences to structure the criteria into aspects. However, the assessment uses linguistic variables, and Table 3 and Eq. (1) are used to transfer the information into a fuzzy set matrix.
2. Each fuzzy set matrix needs to apply Eqs. (2)–(4) to attain the crisp values. These crisp values must be integrated into the aggregated matrix for further computation. Subsequently, Eqs. (5)–(9) structure the hierarchical framework and group the criteria into aspects.
3. Because the weighting function is not linear, prospect theory is adopted and Eq. (10) is necessary. In addition, Eqs. (11)–(13) are used to determine the types of costs and benefits.
4. The global value of aspects can be generated through implementing Eqs. (14)–(16). Then, the ρ_α values are used to rank the aspects; the most important aspects have the highest ρ_α. In Eqs. (14) and (15), $\tau_y(C_\alpha, C_\beta)$ plays an important role in adjusting the value function using prospect theory, a S-shaped function, as shown in Fig. 1. The concave line in the upper-right side represents the benefit function; in contrast, the convex line in the lower-left part represents the cost function. Moreover, the concave section reflects risk aversion regarding the benefit and the convex section represents the propensity for risk regarding costs.

4. Empirical results

This section discusses the industrial background and the analytical results for SSCF using FISM and TODIM.

4.1. Industry background

The textile industry has rapidly experienced SD in recent years, and SD plays an important role in the socio-economic development of the country. There is considerable demand for labor in this industry (Luong et al., 2016). To increase its competitiveness, their textile industry is determining the direction of supply chain networks. The industry needs high-quality human resources to meet the quality standards that helps to meet its SD goals. Based on the history of the industry, promoting RMP and considering eco-innovation are effective ways for the industry to enhance SD. However, the industry has encountered great challenges in SCF and meeting the customer demand. Nevertheless, the industry has not only promoted SCF but also has balanced TBL perspectives. The industry needs to focus on SSCF because of its benefits and enhance quality with value added.

This industry is a classic case of SCF that is determined by the buyers; final products must go through many procedures and production processes that are often conducted in several countries involved in the supply chain network. The original brand manufacturers are concerned because of the mass consumption that is available through their supply chain networks. The industry has noted that SCF is important for manufacturers. However, there is a need to determine a set of TBL requirements. This study shows that the textile industry must pay attention to core investment and selection that avoids overlooking SCF. SD needs to be included in the operations. This study invited twenty-five textile industrial professionals (predominantly manufacturers in Vietnam, Philippines, Mainland China and Taiwan at managerial levels with at least three years' working experience) and twenty-five academicians (from Philippines, Mainland China and Taiwan with research in the relevant field) to involve in this assessment. This study considers SSCF to explore specific aspects that can improve the performance of textile industry.

4.2. Analytical results

This study follows the proposed four analytical steps and the equations applied in this study to obtain the analytical result.

Step 1: Collecting responses from industrial and academic experts: to enhance the reliability of this study, selected criteria were assessed by seven practitioner experts with professional knowledge and experiences. Each expert has at least ten years of working experience in the relevant industry, which enhances the validity of the assessment. However, the assessments are presented in terms of linguistic variables, as Table 4 shown.
Step 2: Transforming corresponding TFN into crisp values: the information from each respondent is transformed into corresponding TFN by contrasting the information with Table 2 (as shown in Table 5). Eqs. (1)–(4) generated the crisp values for each expert, as shown in Table 6.
Step 3: Structuring the framework and grouping the criteria: Eq. (5) compiles the aggregated matrix, as shown in Table 7. Table 3 shows the hierarchical framework and grouping criteria for aspects through applying Eqs. (5)–(9). The results show that operational capability (AS1) includes C5, C10, C18, C19, C20, C26, and C29; the financial category (AS2) includes C1, C4, C12, C13, C14, C15, C22, C25, C27, and C32; collaboration value innovation (AS3) includes C2, C8, and C17; strategic competitive advantage (AS4) includes C7, C9, C16, C30, and C31; and finally, C3, C6, C11, C21, C23, C24, C28 and C33 are related to financial practices.
Step 4: Defuzzying the TFN and reassessing the criteria for the aspects: Table 8 presents the criteria that are assessed by experts and are considered as aspects. Eqs. (2)–(4) were repeated to use the TFN to transform the total weight of the matrices into approximated performance matrices. Linguistic preference was used to transform measures into TFN to eliminate fuzziness and synthesize measures into a crisp value (as shown in Table 9).

Eqs. (10)–(15) are used to obtain the ascendency of $\tau_y(C_\alpha, C_\beta)$ for each criterion. The following computational processes were determined using Eq. (15). For instance, if $\sigma = 1$, $\mu_{21} = 0.65$and $\mu_{31} = 0.65$, then $(d_{21} - d_{31}) > 0$ (indicating a benefit) and $\tau_1(C_2, C_3) = \sqrt{\frac{\mu}{(\sum_{y=1}^{a} \mu)}} \times$

Table 4
The assessment of the criteria by expert 1.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33
C1	HI	NI	VL	VH	VH	VL	VL	NI	NI	VH	VH	NI	VL	I	VH	VL	HI	VL	HI	VL	I	I	VH	VL	VL	NI	VH	NI	I	VH	I	HI	–
C2	HI	HI	I	NI	I	VL	HI	VL	I	VL	VH	VL	HI	VH	HI	VL	VL	I	HI	VL	NI	NI	VH	VL	VL	HI	I	HI	VL	I	VH	–	
C3	NI	NI	I	VH	VH	NI	VL	HI	HI	HI	HI	I	I	NI	VL	VH	I	VL	HI	I	VH	VH	NI	VL	HI	VH	NI	HI	HI	VL	–		
C4	NI	HI	VH	VL	I	VH	NI	HI	I	HI	HI	HI	VH	I	VH	VH	HI	VL	NI	I	I	VH	VH	NI	VH	VL	NI	HI	I	–			
C5	HI	VH	VL	I	I	VH	I	I	VH	HI	VL	HI	VL	VL	NI	VL	I	VH	NI	VH	HI	NI	VH	HI	HI	HI	VH	HI	–				
C6	VH	VH	NI	NI	VL	NI	VL	NI	I	VL	VL	NI	HI	HI	I	VL	HI	VL	NI	VL	I	HI	NI	I	VL	VH	HI	–					
C7	I	I	VH	VH	VL	VH	VH	I	VL	HI	I	I	HI	I	I	NI	HI	VL	VL	HI	VL	VH	NI	I	VL	VL	–						
C8	VH	I	HI	VL	VL	HI	HI	VL	HI	VH	NI	NI	VH	VH	VL	VH	HI	VH	VH	I	I	VH	NI	VH	HI	–							
C9	I	I	VH	I	NI	VH	I	I	VL	I	HI	NI	VL	VH	VH	NI	I	VH	VH	HI	VH	HI	HI	NI	–								
C10	VH	NI	NI	VH	HI	NI	VL	HI	NI	NI	VL	NI	HI	VL	NI	I	NI	I	HI	VL	NI	NI	VL	–									
C11	VH	NI	HI	HI	HI	VL	HI	HI	HI	I	NI	VL	VL	NI	VH	I	I	VH	VH	VH	I	HI	–										
C12	I	VL	HI	VL	VL	VH	VL	I	VL	NI	I	VH	NI	NI	NI	NI	I	HI	NI	NI	I	–											
C13	VH	I	VL	I	I	VH	VL	HI	HI	VH	VL	VH	VL	NI	VL	VL	VH	NI	I	I	–												
C14	VL	NI	NI	VH	NI	I	HI	NI	I	VL	I	VH	NI	VH	VH	VH	VL	I	VH	–													
C15	VL	VH	NI	HI	VH	VH	VL	VL	VH	VH	I	HI	NI	I	VL	VL	NI	VH	–														
C16	VL	NI	VH	I	I	VH	VH	NI	VH	VH	VH	VH	NI	I	VH	I	VH	–															
C17	I	VL	NI	HI	HI	VH	VL	NI	I	I	VH	I	I	VH	I	VH	–																
C18	I	HI	NI	HI	I	VH	NI	VL	NI	HI	I	VH	I	NI	VL	–																	
C19	VH	I	NI	VH	NI	NI	I	VH	NI	NI	I	VL	HI	HI	–																		
C20	NI	HI	NI	VH	NI	I	VL	NI	VL	NI	HI	VH	VH	–																			
C21	VL	VH	HI	HI	NI	I	VL	HI	VH	I	VH	VH	–																				
C22	HI	NI	VL	VH	NI	NI	VH	I	I	NI	VH	–																					
C23	I	VH	VL	I	VH	NI	VL	NI	VL	VL	–																						
C24	VH	VH	HI	I	I	I	HI	VH	VL	–																							
C25	NI	HI	HI	I	HI	I	I	VL	–																								
C26	I	VL	VL	NI	HI	HI	I	–																									
C27	HI	HI	I	VH	NI	HI	–																										
C28	I	HI	I	VL	I	–																											
C29	VL	NI	NI	VL	–																												
C30	VH	VL	I	–																													
C31	HI	I	–																														
C32	NI	–																															
C33	–																																

Table 5
Transferred fuzzy set matrix for expert 1.

	C1			C2			C3			C4			C5			……	C30			C31			C32			C33		
	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	……	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$	$\tilde{l}^e_{op}$	$\tilde{m}^e_{op}$	$\tilde{r}^e_{op}$
C1	1.0	1.0	1.0													……												
C2	0.0	0.1	0.3	1.0	1.0	1.0										……												
C3	0.5	0.7	0.9	0.3	0.5	0.7	1.0	1.0	1.0							……												
C4	0.7	0.9	1.0	0.1	0.3	0.5	0.3	0.5	0.7	1.0	1.0	1.0				……												
C5	0.1	0.3	0.5	0.0	0.1	0.3	0.0	0.1	0.3	0.1	0.3	0.5	1.0	1.0	1.0	……												
C6	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.1	0.3	0.5	0.3	0.5	0.7	……												
C7	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1.0	0.0	0.1	0.3	……												
C8	0.3	0.5	0.7	0.1	0.3	0.5	0.1	0.3	0.5	0.0	0.1	0.3	0.5	0.7	0.9	……												
C9	0.0	0.1	0.3	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	……												
C10	0.7	0.9	1.0	0.7	0.9	1.0	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	……												
C11	0.3	0.5	0.7	0.7	0.9	1.0	0.1	0.3	0.5	0.3	0.5	0.7	0.7	0.9	1.0	……												
C12	0.5	0.7	0.9	0.0	0.1	0.3	0.1	0.3	0.5	0.7	0.9	1.0	0.0	0.1	0.3	……												
C13	0.1	0.3	0.5	0.7	0.9	1.0	0.5	0.7	0.9	0.5	0.7	0.9	0.0	0.1	0.3	……												
C14	0.0	0.1	0.3	0.5	0.7	0.9	0.0	0.1	0.3	0.7	0.9	1.0	0.0	0.1	0.3	……												
C15	0.7	0.9	1.0	0.3	0.5	0.7	0.0	0.1	0.3	0.7	0.9	1.0	0.0	0.1	0.3	……												
C16	0.3	0.5	0.7	0.5	0.7	0.9	0.0	0.1	0.3	0.5	0.7	0.9	0.3	0.5	0.7	……												
C17	0.3	0.5	0.7	0.1	0.3	0.5	0.0	0.1	0.3	0.5	0.7	0.9	0.5	0.7	0.9	……												
C18	0.1	0.3	0.5	0.0	0.1	0.3	0.7	0.9	1.0	0.3	0.5	0.7	0.3	0.5	0.7	……												
C19	0.1	0.3	0.5	0.7	0.9	1.0	0.0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1.0	……												
C20	0.1	0.3	0.5	0.0	0.1	0.3	0.0	0.1	0.3	0.7	0.9	1.0	0.0	0.1	0.3	……												
C21	0.7	0.9	1.0	0.3	0.5	0.7	0.1	0.3	0.5	0.3	0.5	0.7	0.3	0.5	0.7	……												
C22	0.3	0.5	0.7	0.1	0.3	0.5	0.5	0.7	0.9	0.1	0.3	0.5	0.1	0.3	0.5	……												
C23	0.7	0.9	1.0	0.0	0.1	0.3	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	……												
C24	0.7	0.9	1.0	0.0	0.1	0.3	0.0	0.1	0.3	0.7	0.9	1.0	0.5	0.7	0.9	……												
C25	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1.0	0.3	0.5	0.7	0.0	0.1	0.3	……												
C26	0.7	0.9	1.0	0.3	0.5	0.7	0.5	0.7	0.9	0.1	0.3	0.5	0.1	0.3	0.5	……												
C27	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1.0	0.7	0.9	1.0	0.1	0.3	0.5	……												
C28	0.7	0.9	1.0	0.7	0.9	1.0	0.0	0.1	0.3	0.0	0.1	0.3	0.1	0.3	0.5	……												
C29	0.5	0.7	0.9	0.7	0.9	1.0	0.1	0.3	0.5	0.3	0.5	0.7	0.3	0.5	0.7	……												
C30	0.0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1.0	0.1	0.3	0.5	0.3	0.5	0.7	……	1.0	1.0	1.0									
C31	0.0	0.1	0.3	0.0	0.1	0.3	0.3	0.5	0.7	0.7	0.9	1.0	0.7	0.9	1.0	……	0.1	0.3	0.5	1.0	1.0	1.0						
C32	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.0	0.1	0.3	0.3	0.5	0.7	……	0.3	0.5	0.7	0.7	0.9	1.0	1.0	1.0	1.0			
C33	0.5	0.7	0.9	0.0	0.1	0.3	0.1	0.3	0.5	0.7	0.9	1.0	0.7	0.9	1.0	……	0.7	0.9	1.0	0.3	0.5	0.7	0.5	0.7	0.9	1.0	1.0	1.0

$d(d_{21}-d_{31}) = \sqrt{\frac{(\frac{0.65}{0.65})}{8}} \times \sqrt{(0.214-0.165)^2} = 0.354 \times 0.049 = 0.017$. Similarly, if $\sigma = 0$, $\mu_{24} = 0.55$ and $\mu_{34} = 0.65$, then $(d_{24} - d_{34}) < 0$ (indicating a cost) and $\tau_4(C_2, C_3) = (\frac{-1}{\sigma})\sqrt{\frac{(\sum_{y=1}^{a}\mu)}{\mu}} \times d(d_{24}-d_{34}) = (\frac{-1}{1})\sqrt{\frac{8}{(\frac{0.55}{0.65})}} \times \sqrt{(0.114-0.219)^2} = -1 \times 3.075 \times 0.105 = -0.323$

Step 6: Global values

The global value of the aspects is calculated using Eq. (16) to normalize the corresponding measurements. The ranking of each variant is determined by setting the corresponding values of the aspects. Global measures are calculated by using a complete ranking order of all the aspects. A sensitivity analysis is then used to verify the accuracy of the results based on the preferences of the decision maker. The results are presented in Table 10.

$$\rho_\alpha = \frac{\sum \rho(\alpha, \beta) - min \sum \rho(\alpha, \beta)}{max \sum \rho(\alpha, \beta) - min \sum \rho(\alpha, \beta)} = \frac{[0.2714 - (-0.2780)]}{[0.2863 - (-0.2780)]} = 0.974$$

This analysis is done by altering the σ value, the attribute that indicates a decline in the cost. In the first implementation, θ is set to 1. For the sensitivity analysis, σ was altered to 2.25. The change in the value of the decline in benefits and costs only reverses the order of AS2 and AS3 in the order of the aspects. In this specific application, the decision makers argued that there should be a broad sensitivity analysis on the weight of the reference criterion and the value of θ. The comparative analysis shows the effect of applying two different values for benefits and costs ($\sigma = 0.88$ and 2.25) on the corresponding correlations. The preferences remain constant for varying degrees of aversion, even for increased antipathy. Segments of the value function are in the positive and negative angles of $\sigma = 2.25$. Consequently, both values of θ describe the benefits and costs of the value for the same good. However, $\sigma = 1$ indicates that the cost function is the appropriate choice.

Table 11 shows the TODIM rankings obtained by the fuzzy TODIM method ($\sigma = 0.88$) compared to the classical evaluation method used by the firms. Only SD rating criteria are considered in the information obtained from the firms. For the classic TODIM, the significant weighting of the life-cycle assessment is thought to be an important reversal of positioning efficiency compared to the fuzzy TODIM method, which is used for aspects 2 and 3. The comparison of rank order aspects (AS2 and AS3) obtained from the fuzzy TODIM and the classic TODIM for decision making show that there are significant changes in the ranking of these two aspects. Specifically, AS2 was ranked 4th by the classic TODIM but second by the fuzzy TODIM ($\sigma = 0.88$) for the cost function, and AS3 was ranked second by the classic TODIM and 4th by the fuzzy TODIM ($\sigma = 0.88$) for the cost function. This rank order change is due to the life-cycle assessment. However, the fuzzy TODIM ($\sigma = 2.25$) for the benefits and costs function produced a ranking similar to that using the classic TODIM. AS1 (SCF collaboration value innovation) is the first choice among the different approaches. This result indicates that a product is highly likely to be considered as waste or as a secondary resource after use. The results were verified by ranking the SSCF attributes. C2 (synchronization of financial-related decisions) is ranked highest.

5. Implications

This section presents the theoretical and managerial contributions related to SSCF and suggestions to improve the benefits and reduce costs.

Table 6
Crisp values for expert 1.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33
C1	1.00																																
C2	0.00	1.00																															
C3	0.58	0.38	1.00																														
C4	0.76	0.19	0.38	1.00																													
C5	0.19	0.00	0.00	0.19	1.00																												
C6	0.38	0.58	0.38	0.19	0.38	1.00																											
C7	0.58	0.58	0.38	0.76	0.00	0.58	1.00																										
C8	0.38	0.19	0.19	0.00	0.58	0.58	0.38	1.00																									
C9	0.00	0.58	0.58	0.38	0.58	0.38	0.38	0.19	1.00																								
C10	0.76	0.76	0.58	0.38	0.38	0.38	0.58	0.76	0.19	1.00																							
C11	0.38	0.76	0.19	0.38	0.76	0.00	0.19	0.00	0.19	0.19	1.00																						
C12	0.58	0.00	0.19	0.76	0.00	0.00	0.76	0.38	0.38	0.00	0.76	1.00																					
C13	0.19	0.76	0.58	0.58	0.00	0.38	0.19	0.58	0.76	0.38	0.76	0.76	1.00																				
C14	0.00	0.58	0.00	0.76	0.00	0.38	0.19	0.00	0.19	0.00	0.58	0.76	0.76	1.00																			
C15	0.76	0.38	0.00	0.76	0.00	0.00	0.38	0.76	0.00	0.00	0.38	0.19	0.58	0.58	1.00																		
C16	0.38	0.58	0.00	0.58	0.38	0.76	0.00	0.19	0.00	0.58	0.38	0.76	0.38	0.00	0.19	1.00																	
C17	0.38	0.19	0.00	0.58	0.58	0.76	0.19	0.00	0.38	0.38	0.76	0.38	0.38	0.76	0.38	0.76	1.00																
C18	0.19	0.00	0.76	0.38	0.38	0.76	0.76	0.00	0.76	0.76	0.76	0.76	0.00	0.38	0.76	0.38	0.76	1.00															
C19	0.19	0.76	0.00	0.58	0.76	0.76	0.19	0.19	0.76	0.76	0.38	0.58	0.00	0.38	0.19	0.19	0.00	0.76	1.00														
C20	0.19	0.00	0.00	0.76	0.00	0.38	0.58	0.00	0.38	0.19	0.38	0.76	0.00	0.76	0.76	0.76	0.19	0.38	0.76	1.00													
C21	0.76	0.38	0.19	0.38	0.38	0.76	0.19	0.58	0.58	0.76	0.19	0.76	0.19	0.00	0.19	0.19	0.76	0.00	0.38	0.38	1.00												
C22	0.38	0.19	0.58	0.19	0.19	0.76	0.19	0.38	0.19	0.00	0.38	0.76	0.00	0.00	0.00	0.00	0.38	0.58	0.00	0.00	0.38	1.00											
C23	0.76	0.00	0.58	0.58	0.58	0.19	0.58	0.58	0.58	0.38	0.00	0.19	0.19	0.00	0.76	0.38	0.38	0.76	0.76	0.76	0.38	0.58	1.00										
C24	0.76	0.00	0.00	0.76	0.58	0.00	0.19	0.58	0.00	0.00	0.19	0.00	0.58	0.19	0.00	0.38	0.00	0.38	0.58	0.19	0.00	0.00	0.19	1.00									
C25	0.38	0.38	0.76	0.38	0.00	0.76	0.38	0.38	0.19	0.38	0.58	0.00	0.19	0.76	0.76	0.00	0.38	0.76	0.76	0.58	0.76	0.58	0.58	0.00	1.00								
C26	0.76	0.38	0.58	0.19	0.19	0.58	0.58	0.19	0.58	0.76	0.00	0.00	0.76	0.76	0.19	0.76	0.58	0.76	0.76	0.38	0.38	0.76	0.00	0.76	0.44	1.00							
C27	0.38	0.38	0.76	0.76	0.19	0.76	0.76	0.38	0.19	0.58	0.38	0.38	0.58	0.38	0.38	0.00	0.58	0.19	0.19	0.58	0.19	0.76	0.00	0.38	0.00	0.19	1.00						
C28	0.76	0.76	0.00	0.00	0.19	0.00	0.19	0.00	0.38	0.19	0.19	0.00	0.58	0.58	0.38	0.19	0.58	0.19	0.00	0.19	0.38	0.58	0.00	0.38	0.00	0.76	0.58	1.00					
C29	0.58	0.76	0.19	0.38	0.38	0.76	0.38	0.38	0.76	0.58	0.19	0.58	0.19	0.19	0.00	0.19	0.38	0.76	0.00	0.76	0.58	0.00	0.76	0.58	0.44	0.58	0.76	0.64	1.00				
C30	0.00	0.58	0.76	0.19	0.38	0.76	0.00	0.58	0.38	0.58	0.58	0.58	0.76	0.38	0.76	0.76	0.58	0.19	0.00	0.38	0.38	0.76	0.76	0.00	0.64	0.19	0.00	0.64	0.25	1.00			
C31	0.00	0.00	0.38	0.76	0.76	0.00	0.19	0.58	0.58	0.58	0.58	0.38	0.38	0.00	0.19	0.76	0.38	0.19	0.58	0.38	0.76	0.76	0.00	0.19	0.44	0.76	0.00	0.64	0.50	0.00	1.00		
C32	0.58	0.58	0.38	0.00	0.38	0.19	0.58	0.19	0.38	0.19	0.76	0.19	0.58	0.76	0.58	0.19	0.19	0.38	0.58	0.19	0.00	0.00	0.76	0.19	0.00	0.58	0.38	0.64	0.00	0.22	0.53	1.00	
C33	0.58	0.00	0.19	0.76	0.76	0.19	0.19	0.00	0.00	0.76	0.76	0.00	0.19	0.38	0.76	0.19	0.58	0.19	0.58	0.19	0.38	0.38	0.76	0.19	0.00	0.00	0.76	0.00	0.25	0.64	0.00	0.00	1.00

Table 7
Aggregated matrix.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1	1.000															
C2	0.182	1.000														
C3	0.316	0.311	1.000													
C4	0.577	0.531	0.236	1.000												
C5	0.390	0.397	0.364	0.423	1.000											
C6	0.340	0.393	0.314	0.309	0.366	1.000										
C7	0.446	0.479	0.314	0.392	0.416	0.536	1.000									
C8	0.392	0.395	0.364	0.368	0.472	0.505	0.314	1.000								
C9	0.000	0.576	0.576	0.378	0.576	0.378	0.378	0.185	1.000							
C10	0.765	0.765	0.576	0.378	0.378	0.378	0.576	0.765	0.185	1.000						
C11	0.378	0.765	0.185	0.378	0.765	0.000	0.185	0.000	0.185	0.185	1.000					
C12	0.939	0.000	0.185	0.765	0.000	0.000	0.765	0.378	0.378	0.000	0.765	1.000				
C13	0.378	0.966	0.576	0.576	0.000	0.378	0.185	0.576	0.765	0.378	0.765	0.765	1.000			
C14	0.326	0.383	0.857	0.765	0.000	0.378	0.185	0.000	0.185	0.000	0.576	0.765	0.765	1.000		
C15	0.435	0.271	0.381	0.966	0.000	0.000	0.378	0.765	0.000	0.000	0.378	0.185	0.576	0.576	1.000	
C16	0.406	0.464	0.272	0.409	0.911	0.765	0.000	0.185	0.000	0.576	0.378	0.765	0.378	0.000	0.185	1.000
C17	0.407	0.381	0.466	0.218	0.353	0.966	0.185	0.000	0.378	0.378	0.765	0.378	0.378	0.765	0.378	0.765
C18	0.406	0.243	0.461	0.408	0.462	0.382	0.966	0.000	0.765	0.765	0.765	0.765	0.000	0.378	0.765	0.378
C19	0.299	0.436	0.326	0.629	0.405	0.518	0.381	0.884	0.765	0.765	0.378	0.576	0.000	0.378	0.185	0.185
C20	0.383	0.354	0.328	0.353	0.383	0.462	0.545	0.380	0.911	0.185	0.378	0.765	0.000	0.765	0.765	0.765
C21	0.325	0.381	0.242	0.463	0.379	0.352	0.324	0.437	0.327	0.966	0.185	0.765	0.185	0.000	0.185	0.185
C22	0.490	0.162	0.382	0.272	0.218	0.407	0.327	0.462	0.434	0.298	0.911	0.765	0.000	0.000	0.000	0.000
C23	0.380	0.299	0.352	0.301	0.464	0.189	0.435	0.602	0.327	0.462	0.300	0.884	0.185	0.000	0.765	0.378
C24	0.517	0.300	0.271	0.656	0.352	0.189	0.378	0.188	0.271	0.219	0.327	0.245	0.939	0.185	0.000	0.378
C25	0.409	0.325	0.381	0.464	0.163	0.516	0.408	0.326	0.327	0.355	0.463	0.270	0.437	0.966	0.765	0.000
C26	0.299	0.355	0.545	0.436	0.407	0.380	0.327	0.380	0.602	0.407	0.216	0.491	0.491	0.381	0.884	0.765
C27	0.161	0.298	0.546	0.601	0.354	0.381	0.434	0.410	0.379	0.410	0.380	0.351	0.474	0.354	0.520	0.857
C28	0.573	0.352	0.269	0.354	0.545	0.328	0.245	0.380	0.379	0.297	0.272	0.272	0.331	0.492	0.408	0.135
C29	0.491	0.571	0.463	0.463	0.462	0.435	0.163	0.299	0.435	0.354	0.243	0.300	0.300	0.546	0.189	0.410
C30	0.298	0.381	0.437	0.270	0.354	0.408	0.383	0.493	0.407	0.383	0.408	0.544	0.387	0.353	0.491	0.217
C31	0.352	0.410	0.489	0.545	0.408	0.272	0.213	0.327	0.298	0.436	0.354	0.297	0.217	0.299	0.491	0.407
C32	0.382	0.410	0.435	0.355	0.408	0.379	0.435	0.325	0.434	0.436	0.433	0.435	0.253	0.162	0.246	0.272
C33	0.326	0.270	0.462	0.299	0.410	0.271	0.406	0.327	0.410	0.435	0.325	0.353	0.245	0.354	0.327	0.324

	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33
C1																	
C2																	
C3																	
C4																	
C5																	
C6																	
C7																	
C8																	
C9																	
C10																	
C11																	
C12																	
C13																	
C14																	
C15																	
C16																	
C17	1.000																

(continued on next page)

Table 7 (*continued*)

	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33
C18	0.765	1.000															
C19	0.000	0.765	1.000														
C20	0.185	0.378	0.765	1.000													
C21	0.765	0.000	0.378	0.378	1.000												
C22	0.378	0.576	0.000	0.000	0.378	1.000											
C23	0.378	0.765	0.765	0.765	0.378	0.576	1.000										
C24	0.000	0.378	0.576	0.185	0.000	0.000	0.185	1.000									
C25	0.378	0.765	0.765	0.576	0.765	0.576	0.576	0.000	1.000								
C26	0.576	0.765	0.765	0.378	0.378	0.765	0.000	0.765	0.444	1.000							
C27	0.576	0.185	0.185	0.576	0.185	0.765	0.000	0.378	0.000	0.185	1.000						
C28	0.939	0.185	0.000	0.185	0.378	0.576	0.000	0.378	0.000	0.765	0.576	1.000					
C29	0.351	0.966	0.000	0.765	0.576	0.000	0.765	0.576	0.444	0.576	0.765	0.642	1.000				
C30	0.491	0.518	0.857	0.378	0.378	0.765	0.765	0.000	0.639	0.185	0.000	0.642	0.250	1.000			
C31	0.408	0.519	0.491	0.911	0.765	0.765	0.000	0.185	0.444	0.765	0.000	0.642	0.500	0.000	1.000		
C32	0.298	0.352	0.666	0.572	0.857	0.000	0.765	0.185	0.000	0.576	0.378	0.642	0.000	0.222	0.533	1.000	
C33	0.406	0.406	0.419	0.353	0.391	0.911	0.765	0.185	0.000	0.000	0.765	0.000	0.250	0.639	0.000	0.000	1.000

5.1. Theoretical implications

This study fills a gap in the prior literature by exploring the important SSCF attributes (More and Basu, 2013; Arani and Torabi, 2018). The results provide evidence that SCF collaboration value innovation (AS1), strategic competitive advantage (AS3) and financial attributes (AS5) are the important attributes of SSCF. The results reveal that SCF collaboration value innovation (AS1) is most important attribute for achieving SSCF. SCF collaboration value innovation provides access to new knowledge. Enhancing innovation ability and the ability to make financial-related decisions is the basis for SD in a supply chain. In addition, SCF collaboration value innovation helps firms control their supply raw materials, enhance their inventory management system, optimize product manufacturing, and even reduce product costs. Therefore, SCF collaboration value innovation has become increasingly important to enhance SSCF.

Through strategic competitive advantage, firms create unique competitive advantages in terms of sales, market share, and new market opportunities. SCF focuses on all aspects of a firm's extended value chain including marketing, sales, logistics, and manufacturing. Firms that incorporate the optimal strategy for SCF obtain more benefits by reducing both prices and costs. Product innovation can create relative advantages in market share, profit, and long-term competitive advantage (Liu, 2013; Liao et al., 2017). When a firm is faced with a highly competitive environment, SCF needs to be more disciplined and has to consider new strategies to achieve financial and commercial goals. Sustainable competitive advantage contributes to fulfilling the SD requirements. Therefore, strategic competitive advantage is considered indispensable for SSCF.

Financial aspects (AS5) plays a significant role in SSCF. The complexity of and challenges related to SCF create a number of constraints for managing cash flows, which leads to supply chain disruption (More and Basu, 2013). The financial aspects emphasize supplier integration, interdepartmental collaboration, plans and the management of cash flows, which can help firms share operational information, improve the working capital of the upstream supply chain, and reduce risks related to SCF. Because of their strong credit rating, firms are able to provide their suppliers with cheaper access to capital and reduce the total costs of their supply chain, which also has benefits for the buying firm (Wuttke et al., 2013). In addition, the financial aspects are the basis for facilitating communication among supply chain partners, and the underlying interrelations between physical, informational, and financial flows. Hence, enhancing the financial aspects is viewed as an important way to achieve SSCF. To summarize, SSCF as a strategy consists of building the strategic competitive advantage, improving the financial aspects and achieving collaboration value innovation to improve long-term firm performance and obtain sustainable competitive advantage. Moreover, firms should place more focus on three important aspects, collaboration value innovation, strategic competitive advantage and the financial attributes to achieve SSCF.

5.2. Managerial implications

This study addresses the lack of analyses on SSCF in the textile industry and provides suggestions for firms to improve performance in this context. Prior studies have not identified the attributes for measuring SSCF and its impact on firm performance. This study identifies the top 5 criteria that are most important and have a strong relationship with SSCF: the synchronization of financial-related decisions (C2), price and cost information (C11), product and service quality (C12), the dispersion of dependence (C27), and interdepartmental interactions (C29). These five criteria are the most important attributes for developing SSCF in the textile industry and should be regarded as focal points and be applied to operational capability to improve performance. The result from ISM is presented the textile industry practical steps on these criteria (1) interdepartmental interactions (C29); (2) product and

Table 8
Criteria under aspect 1.

AS1	Expert 1			Expert 2			Expert 3			Expert 4			Expert 5			Expert 6			Expert 7		
C1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9
C2	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C3	0.7	0.9	1	0.1	0.3	0.5	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1
C4	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C5	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C6	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9
C7	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C8	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
C10	0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7
C11	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C12	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C13	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9
C14	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.1	0.3	0.5	0.1	0.3	0.5
C15	0.5	0.7	0.9	0.3	0.5	0.7	0.1	0.3	0.5	0.7	0.9	1	0	0.1	0.3	0.1	0.3	0.5	0.1	0.3	0.5
C16	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.1	0.3	0.5
C17	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.1	0.3	0.5	0.5	0.7	0.9	0.7	0.9	1
C18	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1
C19	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C20	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9
C21	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C22	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C23	0.7	0.9	1	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
C24	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
C25	0.7	0.9	1	0.1	0.3	0.5	0.1	0.3	0.5	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7
C26	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7
C27	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C28	0.5	0.7	0.9	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.5	0.7	0.9
C29	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
C30	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.1	0.3	0.5	0	0.1	0.3	0.3	0.5	0.7
C31	0.1	0.3	0.5	0.7	0.9	1	0.5	0.7	0.9	0	0.1	0.3	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1
C32	0.1	0.3	0.5	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1
C33	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.1	0.3	0.5	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1

Table 9
TFN deffuzzifaction.
Step 5: Determining the ranking of each criterion

	As1	As2	As3	As4	As5
C1	0.819	0.840	0.827	0.792	0.809
C2	0.867	0.888	0.875	0.838	0.856
C3	0.686	0.703	0.692	0.663	0.677
C4	0.867	0.888	0.875	0.838	0.856
C5	0.743	0.761	0.750	0.718	0.734
C6	0.795	0.815	0.803	0.769	0.785
C7	0.843	0.864	0.851	0.815	0.832
C8	0.867	0.888	0.875	0.838	0.856
C9	0.700	0.718	0.707	0.677	0.691
C10	0.657	0.674	0.663	0.635	0.649
C11	0.867	0.888	0.875	0.838	0.856
C12	0.867	0.888	0.875	0.838	0.856
C13	0.690	0.708	0.697	0.668	0.682
C14	0.605	0.620	0.611	0.585	0.597
C15	0.443	0.454	0.447	0.428	0.437
C16	0.786	0.805	0.793	0.760	0.776
C17	0.610	0.625	0.615	0.589	0.602
C18	0.662	0.678	0.668	0.640	0.654
C19	0.867	0.888	0.875	0.838	0.856
C20	0.767	0.786	0.774	0.741	0.757
C21	0.867	0.888	0.875	0.838	0.856
C22	0.867	0.888	0.875	0.838	0.856
C23	0.724	0.742	0.731	0.700	0.715
C24	0.500	0.513	0.505	0.484	0.494
C25	0.524	0.537	0.529	0.507	0.517
C26	0.714	0.732	0.721	0.691	0.705
C27	0.867	0.888	0.875	0.838	0.856
C28	0.743	0.761	0.750	0.718	0.734
C29	0.867	0.888	0.875	0.838	0.856
C30	0.629	0.644	0.635	0.608	0.621
C31	0.605	0.620	0.611	0.585	0.597
C32	0.633	0.649	0.639	0.612	0.625
C33	0.710	0.727	0.716	0.686	0.701

Table 10
Criteria weights and ranking.
Step 6: Comparative analysis of the aspects

	Weight	Global Weight	Ranking
C1	**0.974**	0.0338	12
C2	1.031	0.0357	1
C3	0.816	0.0283	23
C4	1.031	0.0357	1
C5	0.883	0.0306	16
C6	0.946	0.0328	13
C7	1.002	0.0348	11
C8	1.031	0.0357	1
C9	0.833	0.0289	21
C10	0.782	0.0271	25
C11	1.031	0.0357	1
C12	1.031	0.0357	1
C13	0.821	0.0285	22
C14	0.719	0.0249	29
C15	0.527	0.0183	33
C16	0.934	0.0324	14
C17	0.725	0.0251	28
C18	0.787	0.0273	24
C19	1.031	0.0357	1
C20	0.912	0.0316	15
C21	1.031	0.0357	1
C22	1.031	0.0357	1
C23	0.861	0.0298	18
C24	0.595	0.0206	32
C25	0.623	0.0216	31
C26	0.850	0.0295	19
C27	1.031	0.0357	1
C28	0.883	0.0306	16
C29	1.031	0.0357	1
C30	0.748	0.0259	27
C31	0.719	0.0249	29
C32	0.753	0.0261	26
C33	0.844	0.0293	20

Table 11
Sensitivity analysis of the aspects.

	TODIM	Fuzzy TODIM	Fuzzy TODIM
		$\sigma = 0.88$	$\sigma = 2.25$
AS1	1	1	1
AS2	5	5	5
AS3	2	3	4
AS4	4	4	3
AS5	3	2	2

service quality (C12) and the dispersion of dependence (C27); (3) the synchronization of financial-related decisions (C2); (4) price and cost information (C11). Hence, the practical implication as follows.

The synchronization of financial-related decisions (C2) enhances the ability of the members of the supply chain to understand operations such as finance activities. Synchronization is the process of coordinating or combining two or more activities, equipment or processes over time. To improve firm performance, managers should synchronize financial-related decisions with the collection of important information. If information flows through the firm effectively, the firm avoids wasting time and making mistakes in the process of finding the right information. In addition, employees and senior managers can facilitate the synchronization of financial-related decisions made by the firm. Firm management can better understand employee development and more rapidly engage in SSCF. SSCF should be considered and widely applied to enhance performance.

Price and cost information (C11) is equally important and directly relates to the benefits and costs of SSCF. Firms confirm their pricing decisions by educating their customers about the process of bringing their products to market. Costs usually include labor costs, raw material, marketing and design costs. Asia pacific textile industry is a country that focuses on processes; therefore, this study focused on costs related to labor, factories and materials. In addition, prices are usually determined by importers. These criteria improve firms' minimize costs and optimize profit. Firms should focus on product and service quality (C12) because it is directly related to its performance and determines whether the firm obtains the benefits or incur costs. For instance, product and service quality control is the most important function of firms. One key aspect of product and service quality control is the establishment of clearly defined controls. These controls standardize the product or service and the response of the firm to quality problems. The spatial limitation for defects refers to the ability to determine whether the finance activities of the firm have been completed, which reduces the chance that employees involved in tasks have not had adequate training. Firm should also pay attention to product and service quality issues that may affect long-term SSCF.

Firms needs to avoid dependence on a few suppliers or certain customers. Dispersion of dependence (C27) indicates that a firm retains its independence regarding its operational activities. A firm that collaborates produces great products because their suppliers are cheap, on time, provide high-quality materials, etc. However, a firm's reputation will be adversely affected if the supplier is late for some reason or goes out of business. An independent firm finds a few suppliers that is quickly used if necessary or if the current supplier increases its prices. If all of the customers are on postpaid or deferred terms, rules must be developed for them. Independent business owners have their own terms of payment and charge late fees to non-paying customers. This process ensures a consistent cash flow and helps to avoid problems related to receivables. The cycle of return is one of the most importance aspects of SSCF. If firms ensure that there is a dispersion of dependence in the business, their benefits may increase and its costs may decrease.

Interdepartmental interaction (C29) directly affects SSCF and the costs and benefits of a firm. Firms' policies should facilitate departmental collaboration by holding meetings and ensuring that information is exchanged. Certain levels of interaction are necessary during product development, but such interactions do not lead to success. Collaboration can be the difference between success and failure and can be used to develop and implement an action plan to improve interdepartmental coordination. Management should first assess the level of collaboration and interactions between the different areas of the corporation to best manage interdepartmental connectivity. A firm that focuses on ongoing interactions may be able to reduce the number of meetings or the number of studies flowing between departments.

6. Conclusions

This study contributes to the literature by providing insights into SSCF and provides new and useful information by identifying the aspects and developing a criteria system to measure the aspects of SSCF. This study employed fuzzy TODIM to define SSCF criteria in the textile industry based on experts' experiences and knowledge obtained from practice to develop a complex system with multiple attributes. In addition, FISM was used to construct a hierarchical structure and practical sequences. Collaboration value innovation, operational capability, strategic competitive advantage, financial practices and financial aspects are the five attributes of SSCF. Thirty-three criteria are included in the hierarchical structure. This study explored how each attribute improves the performance of a firm and its ability to achieve SSCF. This study finds that firms can improve their competitive advantages by enhancing their performance through SSCF.

The results implied that firms should prioritize collaboration value innovation, strategic competitive advantage, and financial aspects over other aspects of their decision-making process. SSCF is complex and needs to be supported by collaboration value innovation to control the supply of raw materials, enhance inventory management systems, optimize product manufacturing and even reduce product costs. Strategic competitive advantage contributes to the ability of firms to create unique competitive advantages in terms of sales, market share, and new market opportunities. Firms provide their suppliers with cheaper access to capital and reduce the total costs of their supply chain through the financial aspects of SSCF.

This study finds that firms can improve benefits and costs by detecting the important aspects and developing a criteria system. This study indicated that collaboration value innovation and strategic competitive advantage are two basic aspects that can improve the costs and benefits of SSCF. The management of SSCF is encouraged to determine the direction of the textile industry. Financial-related decision synchronization, price and cost information, and product and service quality can facilitate effective cash flow control, reduce the return cycle and increase information sharing. These attributes minimize the costs and maximize benefits for the firms. Dispersion of dependence and interdepartmental interactions can help a firm to optimize its management, which will save time and reduce costs.

This study includes limitations. First, this study relied on prior studies on SD and SCF to explore the interrelationships among the relevant SSCF attributes. The set of attributes may not be comprehensive and complete. Future studies need to include more attributes of SSCF. Second, the sample includes only firms operating in the textile industry; therefore, the ability to generalize is limited. Hence, future studies need to focus on multiple countries or industries to overcome this limitation. Finally, this study applied FISM and TODIM; perhaps, future studies should apply other methods to provide more meaningful results. Moreover, it is necessary to identify potential attributes to increase the accuracy of future studies.

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