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A CONCEPTUAL FRAMEWORK FOR BUYER-SUPPLIER INTEGRATION STRATEGIES AND THEIR ASSOCIATION TO THE SUPPLIER SELECTION CRITERIA IN THE LIGHT OF SUSTAINABILITY

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ABSTRACT

In recent years, considering the evolution of consciousness about firms' and their partners' environmental and social responsibility, briefly sustainability, has become an important theme for enterprises. Henceforth, while evaluating the suppliers, not only economic performance, but also environmental and social dimensions of suppliers should be taken into account by the firms. On the other hand, firms often establish closer relationship with their suppliers in order to improve their competitiveness and to take advantage of complementary skills. In this paper, it is observed that too many integration strategies have been developed in the literature. However, to our knowledge, in almost all of these integration strategies, sustainability and association of strategy with supplier selection criteria have not been taken to the agenda. Therefore, the aim of this paper is twofold. First, we propose a classification for buyer-supplier integration strategies from buyers' perspectives; second, we put effort to associate integration strategies with supplier selection criteria. An existing fuzzy weightened method is shown for determining whether criterion is important or not for a specific integration level. An actual evaluation is performed in Turkish Electrical and Electronics Industry to guide firms about how they decide selection criteria according to integration level.

Keywords: *Integration Strategies, Sustainability, Supplier Selection Criteria.*

ALICI-TEDARİKÇİ ENTEGRASYON STARTEJİLERİ İÇİN KAVRAMSAL TASARIM GELİŞTİRİLMESİ VE SÜRDÜRÜLEBİLİRLİK ÇERÇEVESİNDE TEDARİKÇİ SEÇİM KRİTERLERİ İLE ENTEGRASYON STRATEJİLERİNİN İLİŞKİLENDİRİLMESİ

ÖZET

Son yıllarda firmaların ve ortaklarının çevresel ve sosyal sorumlulukları kapsamında göstermiş oldukları farkındalık, diğer bir değişle sürdürülebilirlik, işletmeler için son derece önemli bir konu haline gelmiştir. Artık firmalar tedarikçilerini değerlendiriken sadece ekonomik performansını değil, aynı zamanda tedarikçilerinin çevresel ve sosyal boyutlardaki göstermiş olduğu performanslarını da göz önünde bulundurmaktadır. Diğer yandan firmalar rekabet gücünü arttırmak ve tamamlayıcılık yetenekleri kazanmak amacıyla tedarikçileri ile yakın ilişkiler tesis etmek istemektedir. Bu makalede literatürde var olan pek çok entegrasyon stratejisi incelenmiştir. Ancak yapılan araştırma çerçevesinde, entegrasyon stratejilerinde hem sürdürülebilirliğin dikkate alındığı hem de entegrasyon stratejileri ile tedarikçi seçim kriterlerinin ilişkilendirildiği bir çalışma bulunamamıştır. Bu nedenle bu makalede iki çalışma alanı bulunmaktadır. İlk olarak, varolan literartüre dayanarak satın alıcının perspektifinden sürdürülebilirliğin gözetildiği alıcı-tedarikçi entegrasyon stratejileri geliştirilmiştir.Daha sonra geliştirilen stratejiler ile tedarikçi seçim kriterleri ilişkilendirilmiştir. Spesifik bir entegrasyon seviyesinde tedarikçi seçim kriterinin kullanım gerekliliğine karar vermek için varolan bir bulanık ağırlıklandırma metodu kullanılmıştır.Entegrasyon seviyesine gore seçim kriterlerine nasıl karar verileceği konusunda firmalara yol gösterici olması açısından Elektrik-Elektronik sektöründe uygulama yapılmıştır.

Anahtar Kelimeler: *Entegrasyon Stratejileri, Sürdürülebilirlik, Tedarikçi Seçim Kriterleri.*

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1. INTRODUCTION

Nowadays, companies focus on their core competencies and the non-core activities that support to main processes, such as raw material or component procurement, logistics, distribution, new product development etc., are being assigned and/or involved to the supply chain partners [1-3]. Firms that want to improve operational, environmental and social performances are seeking the ways to establish long term relationship with right suppliers. Partner selection and appropriate relationship formation are strategic problems for enterprises. It may affect an alliance performance and even decide the fate of an alliance [4]. However, the failure rate of strategic alliance was reported as high as 70% by the literature [1]. This input raises the suspicion about not determining the right Supplier Selection (SS) criteria and not establishing relationship type between firms. The integration of environment, economic and social performances to achieve sustainable development is a major business challenge for the new century [5].

Basically, two types of relation between the buyer and the supplier are described in the literature: a competitive relation and a collaborative relation [6]. While competitive relation has characteristics of tough negotiation, focus on price, short-term contracts and multiple sourcing; collaborative relation is based on cooperation, mutual benefit, trust driven and relational exchange [7]. Currently, cooperative buyer–supplier relationship is essential for a manufacturer to survive [8]. Companies may prefer to build up more collaborative relations, such as technological cooperation or strategic partnership, instead of conventional approaches with their suppliers to get cost reduction, to expand profits, to focus on core competency and to improve competitiveness.

The literature reports that the Supply Chain Integration includes customer/market integration, information integration, logistics and distribution integration, supplier integration, and purchasing integration [9]. Supplier integration is the focus of this paper. We define the buyer-supplier integration as an enterprise carrying out purchasing and manufacturing operations, is integrated with its supplier to the same goal via different integration applications. The span of the integration mechanism is specified as technological initiatives (electronic data exchange, Web based integration systems, ERP and supply chain optimization software applications) and relational capital development initiatives (cross functional involvement, supplier relations development, joint problem solving). Lee et al. [5] have specified stimulants of buyer-supplier integration as follows: sufficient material supply, reducing cost, shortening delivery time, reducing investment, acquiring core technology, and reducing purchasing operation time, repetitive processes and negotiation cost [8]. But, in today's highly competitive environment, just getting operational and capital advantages of supplier integration may not be enough. Companies that are willing to improve their environmental performance besides their operational performance are in search of the right suppliers to achieve a long term interaction [10]. Since demanding market and competitive forces induce to companies not only environmental but also social responsibilities, the importance of selection and collaboration with right suppliers have become ever grown for the firms.

Large and Thomsen [11] stated that the degree of green supplier assessment and the level of green collaboration exert direct influence on environmental performance. Additionally, Gimenez and Tachizawa [12] showed that both assessment and collaboration with suppliers have a positive impact on environmental performance and corporate social responsibility. Based on this finding, one can say that first of all right supplier should be selected and then right partnership type should be established. But assessment and collaboration are not independent and should interact with each other. The choice and the number of criteria to be included in the supplier selection process must be carefully determined to represent the competitive strategies of buying firm [13-15]. According to de Boer et al's [16] taxonomy, many decision models have been offered for supplier assessment. But along its main steps (problem definition, formulation of the criteria, prequalification of suppliers and final choice) no paper that suggests a solution to the stage of criteria formulation can be found [17]. The majority of supplier selection models in the existing literature ignore the fact that evaluation criteria must be aligned with firm strategy [18]. Additionally, if environmental and social concerns are added to the problem, it can be easily seen that no paper offers guidance to the companies.

Further motivation of this paper comes from seminal work of Ghodsypour and O'Brien [13], which stated that the important criteria for supplier selection should be selected according to integration level, the company's competitive situation and its corporate strategies. Even though the researches on various types of integrations between firms are abundant, the research that provides integration strategies from sustainable perspective cannot be found. With the intention to fill this gap, this paper focuses on buyer–supplier relationships in the light of sustainability and matching the Supplier Selection Criteria (SSC) with the Buyer-Supplier Integration Levels (BSILs). Section 2 reviews the existing the literature, advantages/disadvantages of integration and examines the existing integration strategies. Categorisation of integration strategies from buyers' perspective, called Buyer-Supplier Integration Levels (BSILs), is defined in the scale of sustainability in Section 3. Relating to associate Sustainable Supplier Selection Criteria

(SSSC) with BSILs, a basic and easy concept of fuzzy evaluation is abstracted in the Section 4 with the aim of providing help and guidance to firms. Section 5 presents a real case study concerning Turkish Electrical and Electronics Industry (TEEI). Some conclusions and directions for future research are provided in the sixth section.

2. BUYER-SUPPLIER INTEGRATION STRATEGIES ILLUSTRATED IN THE LITERATURE

Authors in the literature have mentioned many times that established integration between firms will elicit the individual and mutual benefit [1,8,9,19-22]. When these papers are being analyzed, one can say that cooperation with fewer suppliers will reduce operational, managerial, transaction and logistic costs through better inventory control, scale, and learning economies [9,23]. It can be clearly stated that integration with the right supplier will enable sharing information and goals, and this will improve the relationship and trust between institutions. Improved trust, communication and coordination will minimize the uncertainty and concerns of opportunism in the chain [7]. The benefits of a long term relationship that is established between buyer and supplier are reviewed by Perona and Saccani [23] as shown in Table 1.

Table 1. Potential advantages of long-term relationships for customers and suppliers [23].

Interface process	Advantages for customers	Advantages for suppliers
New product development	Increased innovation	Joint investments in R&D Operations
	Reduced time-to-market	
	Reduced cost of projects	
	Improved quality of projects	
	Reduced risk of projects	
	Joint investments in R&D	
Operations	Increased level of customer service	Reduced risk through long-term planning of production capacity, more reliable orders and forecasting
	Reduced financial cost of stocks	
	Increased overall quality	Reduced costs through better inventory control, scale and learning economies
	Increased flexibility	
Management and strategic planning	Reduced costs through reduced complexity	Reduced administrative costs through the focus on few key customers
	Increased supplier loyalty through mutual dependence	Reduced risks thanks to the certainty of consolidated customers
	Reduced time spent looking for new suppliers of stipulating contracts	Help in developing capabilities and support to growth
	Focus on core competencies	

Disadvantages of integration with suppliers have also been stated by the literature. Since high degree of dependency to supplier or buyer, 'captive position of dependence' [24] may lead some opportunistic approaches and buyer or supplier may expose to unfair demands. On the other hand, long-term commitment to a supplier may decrease the buyer's flexibility and responsiveness to changes in the supply or demand market [25]. Additionally, necessary investments for the integration (such as production equipment, software, hardware, and human resources, etc.) may reach serious levels. Besides, unexpected or tacit costs, such as cost of coordination/ loss of flexibility etc., may occur due to integration programs. Although a primary incentive for BSI is cost reduction, in some cases, supplier integration may become more costly than its savings [9]. Unless right relationship types are established with right suppliers, cost of integration would begin to exceed the savings obtained from it. To achieve this objective, defining the BSILs should be the first step. Moreover, while defining to BSILs, legal obligations pertaining to corporates' environmental and social responsibilities should be taken into consideration by the firms.

Portfolio models are used in various fields and disciplines and have their roots in financial investment in the early 1950s [2]. Portfolio management literature addresses the features of exchange contexts influencing the configuration of buyer–supplier relationships [25]. The first detailed portfolio approach relating to purchasing was done by Kraljic (1983) [26]. According to this study, the purchased components should be analyzed considering profit impact (purchased volume, percentage of total purchase cost, impact on product quality, business growth) and the supply risk (availability, number of suppliers, competitive demand, make-or-buy opportunities, and storage risks, and substitution possibilities). Then purchased components are classified as strategic, bottleneck, leverage and non-

critical. Also, purchasing strategies and supplier relationships depend on components' classification.

The two most used models in industry are those made by Kraljic (1983) and Bensaou (1999) [2], both focusing on optimising the buyer–supplier relations by assigning segmented solutions [2]. Bensaou (1999) used the level of buyer's and level of supplier's specific investments as scales for portfolio analyze in order to make the classification of relationships. Thus, four types of buyer-supplier relationships are identified as captive buyer, captive supplier, strategic partnerships, and market exchange relationships.

In accordance with Bensaou (1999) classification, Hvolby et al., (2007) [2] have also assigned suppliers to a convenient integration level by using portfolio. Standard suppliers, key suppliers, capacity suppliers, and system suppliers are classified depending on product breakdown which compose of standard product, complex product, customised product, and highly customised product. Under these conditions, suppliers are assigned to three types of integration levels. Extended enterprise type of collaboration containing integration systems and production process is appropriate for system suppliers and key suppliers. Supply chain type of collaboration can be applied in short and long term and it focuses on low costs, proper quality and short lead time. This type of collaboration can be applied on capacity suppliers and loose form of collaboration may be applied on standard suppliers. The third one is virtual enterprise type and it is similar to the extended enterprise type of collaboration. But the virtual enterprise can be short-term collaboration and requires flexible system integration options. This kind of collaboration can be established with system suppliers.

Ghodsypour and O'Brien (1998) [13] identified important criteria in supplier selection according to one of five levels of buyer-supplier integration and considered strategies include from no integration to business partnership, which are shown in Table 2. By this way, they claimed that the company's competitive situation and its corporate strategies can be reflected to supplier selection process. Based on this classification, Amin and Razmi (2009) [28] proposed a decision model to select suppliers for internet service provider. They also claimed that proposed methodology was on the basis of company's strategy for supplier management including supplier selection, evaluation, and development. Şen et al. (2008) [7] proposed a framework for defining supplier selection criteria by considering the buyer–supplier integration levels. Through the heuristic algorithms they proposed, 49 traditional SSC are assigned to integration levels which adapted from Ghodsypour and O'Brien (1998).

Table 2. Buyer–supplier integration levels and its prominent criteria [13].

Integration levels	**Prominent criteria for supplier selection**
1. No integration	Price and quality
2. Logistical integration	Besides the quality and price, the operational logistics elements such as reliability, flexibility, supply lots, lead time, and so on
3. Operational integration	Addition to previous levels, suppliers' process capability indexes such as set up time, lot size, lead time, etc.
4. Process and product integration	Addition to previous levels, supplier's human resource from several points of view such as design involvement, management ability, culture, etc.
5. Business partnership	Addition to previous levels, criteria related to technological and strategic directions of the suppliers

Perona and Saccani (2004) [23] explored the management of customer–supplier relationships through the adoption of a set of practices supporting integration in interface processes by using taxonomy of buyer–supplier relational styles adapted from Maggiore and De Maio (1992) [29]. Based on this taxonomy, four levels of the BSILs are identified: namely, traditional relationships, operational partnerships, technological partnerships and evolved partnerships. Traditional relationships are characterised by the absence of customer–supplier integration and specifications are determined through pure market mechanisms. Operational partnerships arise from the need for reducing the high physical or opportunity costs due to the exchange of high volumes of components. Logistical integration becomes a priority for this BSIL. Technological partnerships arise when there is a lack of technological expertise at the buyer's side. Evolved partnerships are characterised by integration over both logistic and technological aspects. Soon afterwards, this paper of Saccani and Perona (2007) [27] re-contextualized the issue from the dimensions of level of interaction between firms and level of cooperation between firms. They proposed a contingency model for shaping and managing buyer–supplier relationships in manufacturing contexts. Lee et al. (2009) [8] proposed a model for providing a guidance to select the most appropriate form of relationship between the manufacturer and its supplier. Three forms of buyer–supplier relationship had been taken into account according to ownership rights mechanism: acquisition, joint venture, and majority equity ownership, respectively.

Table 3. Review of some articles concerning buyer–supplier integration strategies.

Author(s)	**Dimensions of classification**	**Taxonomy**	**Focus/ Requirement**
Kraljic (1983) [26]	Profit impact Supply risk	1. Strategic items 2. Bottleneck items 3. Leverage items 4. Non-critical items	Analyzing the supply market according to classified items. Then developing strategies and action plans for suppliers
Bensaou (1999) [27]	Level of buyer's specific investments Level of supplier's specific investments	1. Market exchange 2. Captive buyer 3. Captive supplier 4. Strategic partnership	1. Standard product, competitive market, low switching costs 2. Complex product, core technology and bargaining power belongs to supplier 3. Complex product, bargaining power belongs to few qualified buyers 4.Balanced power with few buyers and suppliers, both specific investments are high, complex technology, high customisation, competitive and concentrated market
Hvolby et al. (2007) [2]	Requirement of integration of information systems Requirement of integration of production processes	1. Extended enterprise type of collaboration 2. Supply chain type of collaboration 3. Virtual enterprise type of collaboration	1. The most integrated form, information systems and production processes are integrated 2. Based on long-term collaboration, with no or limited system integration 3. Short-term collaboration between companies with flexible system integration options
Perona and Saccani (2004) [23]	Operational integration Technological integration	1. Traditional relationship 2. Operational partnership 3. Technological partnership 4. Evolved partnership	1. No integration, focus on service, product quality and prices 2. High level logistic integration 3. Lack of technological expertise at the buyer's side 4. Both logistic and technological integration
Saccani and Perona (2007) [25]	The level of interaction between firms The level of cooperation between firms	1. Traditional relationship 2. Operational relationship 3. Project-based partnership 4. Evolved partnership	1. Components with low operational impact and low criticality, no integration in logistics or in design activities, focus on low costs, product quality and customer service 2. Simple and standard component, alternative suppliers are available but flows (goods/ information) are high 3. High customisation and complexity, volumes and frequency are low or occasional,know-how might be exchanged 4. High complexity or criticality of the component, suppliers' technical skills and co-design capabilities are important
Lee et al.(2009) [8]	Not explicitly stated	1. Acquisition 2. Joint venture 3. Majority equity ownership	1. Manufacturer takes full control of the supplier's assets and coordinates actions by the ownership rights mechanism 2. Manufacturer and supplier create a jointly owned organization 3. Manufacturer holds majority equity of the supplier
Huang and Keskar (2007) [10]	Not explicitly stated	1. No integration 2. Operational integration 3. Strategic partnership	Not explicitly stated
Şen et al.(2008) [7] and Amin and Razmi (2009) [28]	This papers have adapted the taxonomy of Ghodsypour and O'Brien (1998)	As described in Table 2.	As described in Table 2.
Ghodsypour and O'Brien (1998) [13]	Company's competitive situation Corporate strategies		

Huang and Keskar (2007) [10] presented basic structure with seven categories for selecting the SSC based on the firms' strategy. 107 SSC have been marked according to product type, supplier type, and manufacture/supplier integration level. However, they didn't provide deep insight about what the means and scope of integration levels and neither environmental nor social SSC are classified according to integration level. Table 3 reviews some of the above-mentioned papers.

3. CATEGORISATION OF SUPPLIERS FROM BUYERS' PERSPECTIVE IN THE LIGHT OF SUSTAINABILITY

Since firms are increasingly becoming outsourcing-oriented [10,30], the expanding content of the Supply Chain Management (SCM) paradigm also should not be overlooked. Additionally, competition has shifted from firm level to supply chain level [22] and not only environmental but also social responsibilities dimension such as creation of productive employment, equality achievement [30], diversity, human rights, philanthropy, safety [31] should not be neglected in modern business environment. The concept of sustainability that composed of economic (traditional or business), environmental (green or natural) and social dimensions, briefly triple bottom line approach, has been mentioned by several studies [12,30,32-35]. Many companies have been sanctioned because of poor environmental and social performance of their SCM members. It is possible to find too many firms suffering from poor environmental and social performance of their suppliers as stated by several earlier studies [12,31,32,36]. As can be understood from the real-world examples in these papers, boundary of responsibility often extends beyond the reach of a corporation's ownership and solely internal improvements of companies may be not enough. Companies might be boycotted due to the reasons such environmental impact, child labour, inhuman working conditions, abuses, discrimination, etc. caused from firms' or suppliers' activities. In such cases, the focal or leading company of the chain's might be held responsible for poor environmental and social performances of their suppliers [11,32,37]. However, to the best of our knowledge, environmental and social competency of suppliers' has not been brought to the agenda by the integration literature. Due to these reasons, one dimension of classification is determined as 'potential of sustainable relationship'. On the other hand, to our viewpoint, dependence to supplier in order to survive or operate properly is so much comprehensive and important. In Section 2, subcomponents (parameters and/or factors) of dependence to supplier have been observed in almost all papers. There are so many subcomponents such as operational impact, level of specific investments, criticality of the component, and market for determining the level of dependency as shown in Table 4. Hence the matter in question is handled from buyers' perspective in this paper, other dimension of classification is determined as 'dependence to supplier' for proposed classification.

Table 4. Classification of integration levels from buyers' perspective.

Dimensions of classification	Parameters of dimensions	Focus of parameters (Factors/Determinants)	Proposed classification
Dependence to supplier	Operational impact	Exchanged volumes, exchange frequency, costs etc.	**Level-1:** Traditional relationship
	Criticality of the component	Complexity, customization, innovation degree, integrated technology etc. of the component Contribution to final product or profit	**Level-2:** Logistic partnership
	Level of specific investments	Cost of integration with the supplier	**Level-3:** Operational partnership
	Criticality of the market	Alternative suppliers in terms of number and competency Risks and uncertainties	**Level-4:** Strategic alliance
Potential of sustainable relationship	Expectations of scope of sustainability (legal compliance, ability to meet the specified common values of the chain, being in leader or driver position about sustainability), the density of processes and activities that require joint efforts, the density of reciprocal commitments and compliance of firms' strategies		**Level-5:** Sustainable collaboration

Hines (2004) [38] identified a range of relationships from arm's length transactions to vertical integration with cooperative relationships in between the two as shown in Figure 1. This classification system places relationships under a specific type based on how the transactions between parties are organized [1]. But we define buyer-supplier integration as an enterprise carrying out purchasing and manufacturing operations, which is integrated with its supplier for achieving the same goal via different integration applications.

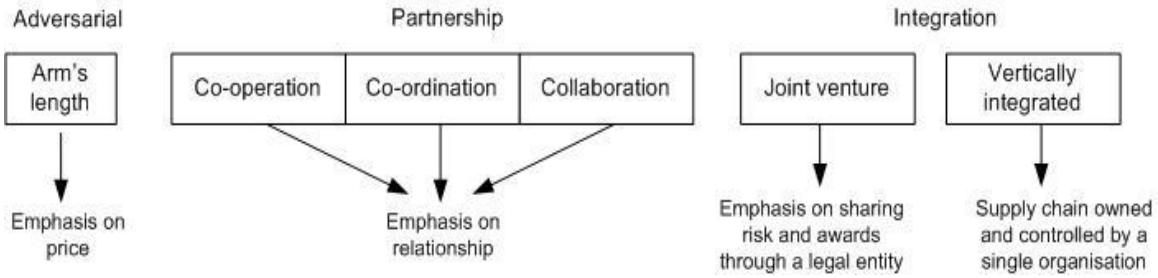

Figure 1. Types of relationship between buyer and supplier [38].

Since relational bounds are dealt with in this paper, it has been decided to revise and expand Ghodsypour and O'Brien's (1998) [13] classification via literature and concept of sustainability. BSILs defined as consecutive and inclusive in this paper as Ghodsypour and O'Brien (1998) [13]. Additional proposed BSILs are associated with SSSC within the subsequent section. Traditionally vendors focus on a ''technical'' output evaluation, in terms of quality, delivery speed and reliability, price offered, but when the relationship becomes closer and longer, the number of selection criteria increases, and vendors are selected on their global performances [39]. As the levels of buyer–supplier relationship affect the number of the criteria considered, the definitions of five different levels and their criteria are discussed as follows:

Level-1. Traditional relationship level also called different names (such as 'No Integration, Arm's Length Transaction, Market Governed, Market Exchange') with similar meaning in literature. Focus is on price and quality for this level. According to Perona and Saccani (2004) [23] and Saccani and Perona (2007) [25], service related criteria also should be taken into account. Within this scope;

While integration cannot be mentioned, only skin-deep criteria concerning price, quality, and service may be important at this level. Generally, considered criteria should be product related such that these products are easily accessible, technically simple and non-critical as Kraljic (1980) [26] stated. Social and environmental responsibilities of suppliers are not taken into consideration.

Level-2. Logistic partnership level is parallel to JIT relationship from Maggiore and De Maio (1992) [29] and Logistic integration from Ghodsypour and O'Brien (1998) [13]. Within this scope;

This type may be preferred when buyers intend to reduce the number of suppliers and build good relationship with them. While it is possible to shift supplier in terms of market, product/component and costs, since buyer wants to take advantages of integration, it is not appropriate for corporate strategies. If there are situations where it is necessary to contact with supplier in after-sale phase (such as maintenance, spare parts support), this level is the minimal BSIL to be established. More detailed criteria related to cost (such as support and maintenance costs, transportation and distribution costs) and quality (such as quality of support services, complaints, quality certifications) may be taken into consideration. Since low-level of integration can be mentioned, reliability and logistic performance of suppliers become important from the point of buyers' competitive position. Besides elaborated logistic metrics, additional criteria about reliability should be included to supplier assessment process. Information sharing is important but does not require high level of investment to keep low level of dependency to supplier. Environmental competencies of suppliers' concerning legal requirements (such as reverse logistic capabilities) should be considered. But, still depth of partnership is not enough to intervene in ethical and social responsibilities of suppliers.

Level-3. Operational partnership level includes the third and forth level of Ghodsypour and O'Brien (1998) [13] classification. More elaborated SSC than previous level and new criteria related to different main competencies of suppliers should be included. Within this scope;

Common view obtained from Kraljic (1983) [26], Bensaou (1999) [27] and Ghodsypour and O'Brien (1998) [13] states that availability of the component is getting more difficult at this level due to requirement of customization, market position, component complexity. Additionally, each supplier has been assumed as one of the members of the chain. So, continuous material and information flow gains more importance. Hence, applications such as ICT-Information Communication Technologies (i.e. Enterprise Resource Planning-ERP, Electronic Data Interchange-EDI, Advanced Planning Systems-APS, Customer Relationships Planning-CRP and Internet applications etc.), JIT, and TQM may be necessary, and SSC concerning technology of supplier might be taken into consideration. Since the integration is deeper than previous level, also more detailed SSC should be used. Operational factors that reinforce logistic performance of suppliers (such as process capabilities, manufacturing capabilities, service level, set up time, etc.) may be important at this level. More criteria related to reliability of suppliers (impression of supplier, risks of supplier, performance history and

references, etc.) should be considered. At this level, suppliers have an important impact on logistic and operational performance of the chain. If a supplier has a trouble in legal scope, due to its membership of the chain, there will be also disruptions in production phase. In this regard, environmentally and socially prudent suppliers can be selected by incorporating criteria, such as emissions and wastes in manufacturing processes, health and safety practices about employees into assessment process.

Level-4. Strategic alliance level is similar to business partnership level that identified by Ghodsypour and O'Brien (1998) [13]. Also, similar to evolved partnership level that identified by Saccani and Perona (2007) [25] and Perona and Saccani (2004) [23]. From the transactional based viewpoint [1], this level is close to vertical integration. Within this scope;

At this level, suppliers have been accepted as a powerful partner, such that alliances can be formed with them and cooperation can extend over a long period of time. Supplier has importance as much as buyer and mutual benefits should be looked after (win-win). Efforts related to improvements, R&D and innovative thinking concerning to outputs may be formed mutually. Since both sides work towards the same strategic goals, suppliers may be included to processes such as product design and decision making. Buyers may integrate products, technologies, manufacturing processes, and information and decision systems. So, in addition to the criteria that preferred previous levels, suppliers should be subjected to an extensive evaluation about human resources, reliability, and technology. However, even though supplier achieves high level of competency within logistic, operational, and technological and human resources contexts, they might be inadequate for this type of cooperation, unless strategic alignment is provided for both sides. Owing to the all devoted effort, cost of integration and dependency of supplier will be high degree. Also cost of shifting supplier will be relatively high. If environmental and social concerns are important for buyer or chain, candidate supplier should put forth high performance about environmental and social competency and eco-design capability. Besides satisfying common values of the chain (such as environmental image, brand value and employment practices), it is expected that the candidate supplier should be one step ahead of their rivals.

Level-5. Sustainable collaboration level can be established with the suppliers who are evaluated as 'excellent' for all dimensions of triple bottom line approach. While some buyers may prefer suppliers who are sufficient according to the present conditions, the others may prefer suppliers who can respond to the anticipated or forecasted requirements of future. Hence, stronger relational level ought to be added to proposed classification. Thus far, from the environmental and social perspectives, satisfying legal necessities or common values of the chain was enough. Legal necessities and common values of the chain are dynamic variables since firms' environmental and social responsibilities have been expanding each passing day. For this reason, available suppliers may not meet the updated expectations in the future. In other words, solely satisfying today's thresholds is a narrow-scoped viewpoint in order to form sustainable relationship. While evaluating the suppliers, not only in environmental and social scope but also in economic scope, more detailed SSC related to the future requirements should be added to evaluation process.

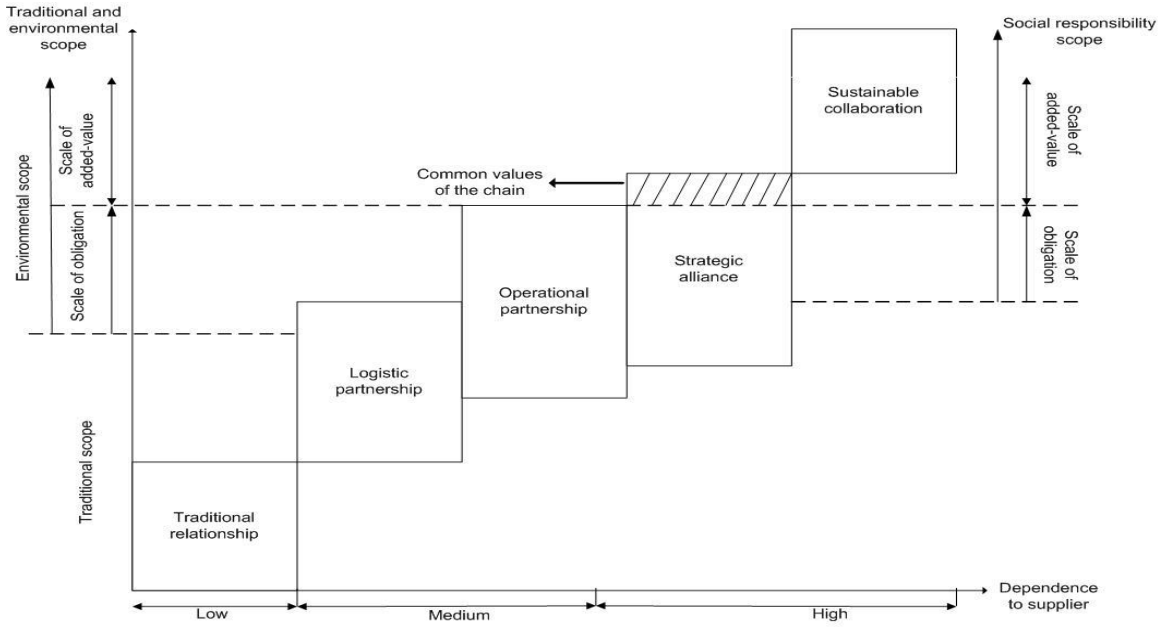

Figure 2. Summary model of dependency and triple bottom line based BSILs.

Figure 2 illustrates the overview of proposed classification. According to Lu et al. (2007) [40], the number of products produced entirely of recyclable materials will increase in the future, and organizations will need to make all supply chain decisions within the context of growing environmental issues, concerns and challenges. On this base, one can say that in the future it will more likely be necessary to evaluate the supplier from the standpoint of life cycle assessments, green logistic dimension, environmental certification, etc., and corporate's social responsibilities. In this direction, firms should follow and adapt the new concept. Unfortunately, many corporations around the world have been operating by ignoring the green and social dimensions. Due to these reasons, components of sustainability are presented separately in the model and the range of boundaries of BSILs is shown broadly in Figure 2.

Relationships are called by using different words with the intent to emphasize the power of integration. According to Daugherty (2011) [1], although the terms 'partnership' and 'alliance' seem to be used interchangeably, alliances are often considered the 'next step' beyond a partnership. Additionally, the new term 'collaboration' has supplanted the terms 'partnering' and 'alliances' in the literature on relationship. But in this paper, the term 'collaboration' is used to refer more powerful and deeper meaning of relationship.

4. ASSOCIATE SSSC WITH BSILS

According to Chan (2003) [41], depending on the different buyer–supplier integration strategies, different selection criteria are employed and different structures of criteria hierarchies are built. Since the quality of the final selection phase is largely dependent on the quality of the steps prior to that phase [7,16,17], especially criteria formulation, BSILs play a crucial role in supplier selection process. As Huang and Keskar (2007) [10] stated, as different manufacturers have different business strategies for different products, it is impossible to create a fixed set of criteria. Therefore, the prerequisite for supplier selection is to determine appropriate criteria based on BSILs. By this motivation, we present an integration level indices template that indicates whether each criterion is important or not for each BSILs. We aimed to guide firms about forming of criteria hierarchies according to their integration preference. Therefore, an actual evaluation was performed in the next section.

Table 5. Main criterion Cost and its subordinate criteria.

COST	Net price				
	Cost components	*Life cycle cost*	Design costs		
			Operating costs	Fixed costs	
				Variable costs	
			After sale service costs	Support and maintenance costs	
				Set up and assembly cost	
				Transportation and distribution cost	
			Reverse logistics costs	*Retrieval (Collection) costs*	
				Disposal and recycling (treatment) costs	*Disassembly costs*
					Reprocessing costs
					Landfill costs
				Transportation costs for disposal and recycling stage	
		Ordering cost			
		Order cancellation/ replacement costs			
		Holding cost			
		Cost of integration with supplier			
		Environmental costs	*Pollution treatment cost*		
			Env. Perf. improvement cost		
	Price/cost ratio				
	Price position within the sector				
	Quantity price breaks				
	Price increments				
	Export taxes				
	Foreign exchange rate				

For this reason, an extensive literature review is conducted (for details, see Seckin (2015) [42]) to form Comprehensive Criteria Hierarchy (CCH). In here, full integration of criteria, which belongs to green, social and traditional domains, are provided. Additionally, criteria hierarchies have been constructed in such a way that can be adapted and used by all manufacturing industries. To shorten the main text, only the main criterion Cost and its subordinate criteria are presented in Table 5 and the other main criteria are shown in Appendix A. In the Table 5, environmental criteria are shown by using italic font.

Hence an individual industry uses its own industrial-domain related decision attributes [43], Industry-oriented Criteria Hierarchy (ICH) for BSILs is extracted from CCH, thanks to group decision making techniques . To handle with the subjectivity due to the experts' judgements, a fuzzy evaluation has been performed to obtain the ICH. The methodology used here appeared in a recent paper by Sanayei et al. (2010) [44] where the authors applied linguistic values to assess the ratings and weights for the established criteria, and built a MCDM model to deal with the SS problems via fuzzy sets theory and VIKOR method. By the way, Importance Weights (IW) of each criterion are obtained and IW are used for determining whether criterion is important (1) or not (0) for each BSIL according to thresholds. For brevity, the methodology which is used here is mentioned briefly and only equations related to calculations are provided (for details, see Sanayei et al. (2010) [44]).

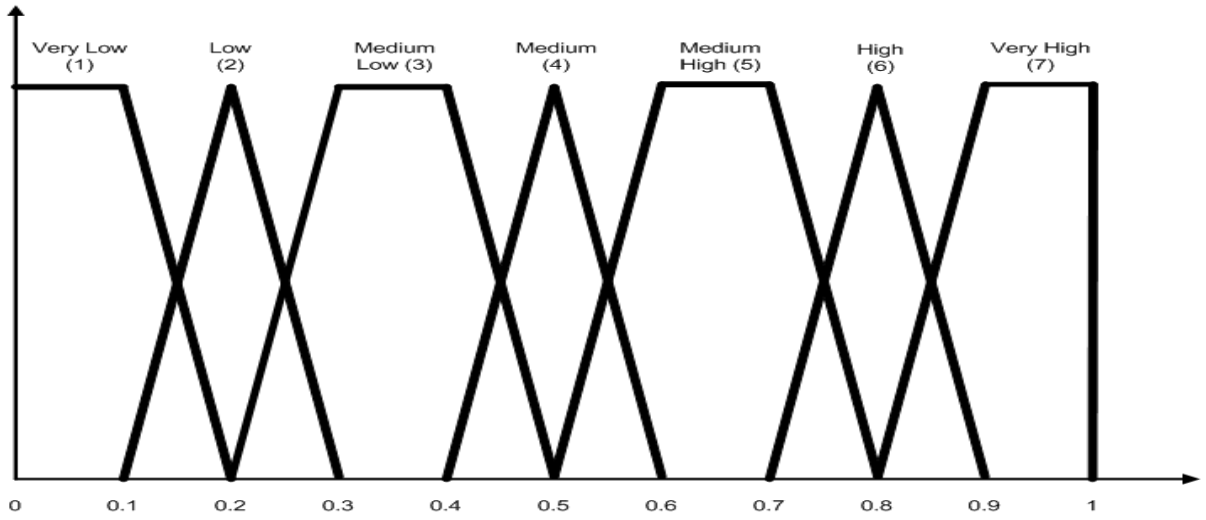

Figure 3. Linguistic variables for importance weight of each criteria.

Fuzzy number was proposed by Dubois and Parade (1980) [45]. A fuzzy set can be called as a fuzzy number when fuzzy set is convex, normalised and defined as real number [45] There are many types of fuzzy numbers according to its membership function. Trapezoidal fuzzy numbers and triangular fuzzy numbers are two most commonly used types [8]. Each linguistic judgement is associated with a fuzzy number. The determination of the number of conversion scales is generally intuitive. Too few conversion scales don't provide more help, while too many conversion scales may make the evaluation too complex [46]. The scale of seven plus or minus two generates the largest amount of information from a decision making regarding the objectives on the basis of absolute judgements [47]. For the reasons mentioned, seven scaled Trapezoidal Fuzzy Number (TFN) is preferred for this study and depicted in Figure 3.

A TFN can be defined as (a1; a2; a3; a4) and the membership function is defined as in Equation (1).

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x < a_1 \\ \frac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2 \\ 1, & a_2 \le x \le a_3 \\ \frac{x-a_4}{a_3-a_4} & a_3 \le x \le a_4 \\ 0, & a_4 < x \end{cases} \quad (1)$$

We try to assign importance weight (IW) of each criterion by using experts' opinions in the form of linguistic terms. Then, these linguistic terms are converted to TFN via Equation (1). Obtained fuzzy numbers also combined via Equation (2). Thereafter, combined set is converted to a crisp value through defuzzification. Defuzzification is the process of reducing a fuzzy set to a crisp single-valued quantity [48]. There are too many methods that can be used for defuzzification. Since it is the most used one [49], we chose the centroid method, which is also referred as the Center Of Gravity (COG) method. Each combined judgements (resultant fuzzy sets) are merged into a

final aggregated shape and then centroid of the aggregated shape can be computed.

Let the fuzzy IW of k[th] decision maker, with respect to criteria C_i=(1,2,...n), be $\widetilde{w}_{ik} = (\widetilde{w}_{ik1}, \widetilde{w}_{ik2}, \widetilde{w}_{ik3}, \widetilde{w}_{ik4})$ The aggregated fuzzy weights ($\widetilde{w}_i$) of each criterion can be calculated as:

$$\widetilde{w}_i = (w_{i1}, w_{i2}, w_{i3}, w_{i4})$$
$$w_{i1} = min_k\{w_{ik1}\} \qquad w_{i2} = \frac{1}{K}\sum_{k=1}^{K} w_{ik2}$$
$$w_{i3} = \frac{1}{K}\sum_{k=1}^{K} w_{ik3} \qquad w_{i4} = max_k\{w_{ik4}\} \tag{2}$$

After this phase we can obtain aggregated crisp weights (w_i) of each criteria, namely IW, by using Equation (3) where x represents combined TPF, $\tilde{A}$ represents the membership function, $\mu_{\tilde{A}}(x)$ indicates the membership value of x and $defuzz(\tilde{A})$ shows the COG of the space covered by membership function of $\tilde{A}$.

$$defuzz(\tilde{A}) = \frac{\int x\,\mu_{(x)}\,d_x}{\int \mu_{(x)} d_x} = \frac{\int_{a_1}^{a_2}\left(\frac{x-a_1}{a_2-a_1}\right)x d_x + \int_{a_2}^{a_3} x d_x + \int_{a_3}^{a_4}\left(\frac{a_4-x}{a_4-a_3}\right)x d_x}{\int_{a_1}^{a_2}\left(\frac{x-a_1}{a_2-a_1}\right)d_x + \int_{a_2}^{a_3} d_x + \int_{a_3}^{a_4}\left(\frac{a_4-x}{a_4-a_3}\right)d_x} \tag{3}$$

$$defuzz(\tilde{A}) = \frac{-a_1a_2+a_3a_4+\frac{1}{3}(a_4-a_3)^2+\frac{1}{3}(a_2-a_1)^2}{-a_1-a_2+a_3+a_4}$$

By the way, we can obtain all IW values belonging to criteria. In here, an exceptional condition is exists. Since BSILs are defined as consecutive and inclusive, also criteria hierarchies should be built according to this logic. For example, linguistic judgement 7 (Very high importance) can be assigned to '*Price*' criterion for *Logistic partnership* level. But, linguistic judgement 2 (Low importance) can be assigned to it for *Strategic alliance* level, since other criteria related to strategic dimensions gain importance. However, if a criterion is considered as important (1) for lower level in BSILs, it also should be considered as important (1) for upper level in BSILs. F_1 algorithm is presented to fill the templates. 'M' represents 'Maybe in the future' is used to provide the visibility of criterion which is thought as 'not important' in today's conditions.

F_1 algorithm:

IW_{ij}: Importance weight of i[th] criterion according to j[th] BSIL,
N_{ij}: Necessariness indicator of i[th] criterion according to j[th] BSIL, $N_{ij} = \begin{cases} 1, & important \\ 0, & not\ important \end{cases}$

j: Integration level, $1 \le j \le 5, j \in I$
i: Number of criterion, $1 \le i \le n, i \in I$
n: The lower layer of the CCH, $n \in I$

$$\begin{aligned} &N_{ij} = 1\ if\ IW_{ij} \ge \alpha, \\ &N_{ij} = 0\ if\ IW_{ij} < \alpha, \\ &0 \le k \le j\text{-}1 \text{ and } k \in I, \\ &IW_{ij} = max\{IW_{i(j-k)}\}, \quad \forall i, \forall j, \forall k \\ &N_{ij} = 1\ if\ IW_{ij} \ge \alpha \\ &N_{ij} = 0\ if\ IW_{ij} < \alpha \\ &N_{i5} = 'M'\ if\ N_{i5} = 0 \end{aligned} \tag{4}$$

5. AN ACTUAL EVALUATION

In 2003, the European Union declared two directives, WEEE (Waste Electric and Electronic Equipment) and RoHS (Reduction of Hazardous Substances), which have been two of the main driving forces of interest to this field and exerted great impacts on electrical and electronics industries. Consistent with these regulations, in CCH construction phase, it has been observed that papers related to GSS mainly focus on electrical and electronics industry. Therefore, evaluation is conducted in Turkish Electrical and Electronics Industry (TEEI). Evaluation template is addressed to 10 knowledgeable people, whose experience is more than 10 years pertaining to TEEI, in order to obtain the linguistic judgements of 142 criteria (the lower layer of the CCH). And we asked experts the threshold values which determines whether criterion should be considered or not at BSILs. Thereafter, conversion, aggregation, and defuzzification phases were performed by using Equation (1), (2), and (3), respectively. Also the threshold value α is calculated through the same process with the IWs. Then, assignments of criteria to BSILs have been done by using F_1 algorithm. By the way, ICH is extracted from CCH for TEEI.

BSILs indices template concerning to Cost and its subordinate criteria is shown in Table 6. The biggest IW of criteria is marked in the related column. Bold numbers belong to the prominent criteria related to each levels. Although some criteria have smaller IW than threshold values, marked with dashed line, '1' is assigned to them since they are assigned '1' at lower levels. Additionally, 'M' is assigned to some criteria which are assessed not important for all levels as required F_1 algorithm. Also, explained conditions are marked in Criteria Necessariness Indices column. The remaining parts of ICH are presented in Appendix B. Herein, only the numbers of advised criteria are summarized in Table 7.

Table 6. BSILs indices template concerning to Cost and its subordinate criteria.

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
COST	1	Net price	**0,8782**	0,7305	0,5795	0,4947	0,4411	1	1	1	**1**	**1**
	2	Quantity price breaks	**0,8782**	0,7679	0,6447	0,4888	0,4409	1	1	1	**1**	**1**
	3	Price increments	**0,7968**	0,7138	0,5696	0,4518	0,4309	1	1	1	**1**	**1**
	4	Design costs	0,1344	0,2858	0,4893	0,7574	**0,7743**	0	0	0	1	1
	5	Fixed costs	0,1282	0,2537	0,3764	0,5962	**0,6607**	0	0	0	1	1
	6	Variable costs	0,2155	0,3018	0,4841	0,6874	**0,7202**	0	0	0	1	1
	7	Support and maintenance costs	0,1282	0,7305	**0,7574**	0,5109	0,4624	0	1	1	1	**1**
	8	Set up and assembly cost	0,6982	0,7736	**0,7968**	0,4091	0,3336	1	1	1	**1**	**1**
	9	Transportation and distribution cost	0,2627	0,4637	0,5428	0,6878	**0,7035**	0	0	1	1	1
	10	*Retrieval (Collection) costs*	0,1151	0,2155	0,2426	0,4834	**0,5162**	0	0	0	0	1
	11	*Disassembly costs*	0,1218	0,1463	0,2426	0,3611	0,4945	0	0	0	0	**M**
	12	*Reprocessing costs*	0,1218	0,1463	0,1463	0,2594	0,4786	0	0	0	0	**M**
	13	*Landfill costs*	0,1218	0,2094	0,2205	0,5428	**0,6927**	0	0	0	1	1
	14	*Transportation costs for disposal and recycling stage*	0,1218	0,2205	0,2537	0,4891	**0,5396**	0	0	0	0	1
	15	Ordering cost	0,5162	**0,6983**	0,6392	0,3553	0,2910	1	1	1	**1**	**1**
	16	Order cancellation/replacement costs	**0,7197**	0,7035	0,5750	0,3342	0,2752	1	1	1	**1**	**1**
	17	Holding cost	0,2144	0,4145	0,4624	0,7519	**0,7685**	0	0	0	1	1
	18	Cost of integration with supplier	0,1151	0,3236	0,3708	0,7092	**0,7364**	0	0	0	1	1
	19	*Pollution treatment cost*	0,1218	0,2197	0,2695	0,4674	**0,6874**	0	0	0	0	1
	20	*Env. Perf. improvement cost*	0,1218	0,2356	0,2636	0,4676	**0,6229**	0	0	0	0	1
	21	Price/cost ratio	0,2083	0,3822	0,5000	0,6342	**0,6547**	0	0	1	1	1
	22	Price position within the sector	**0,7803**	0,7463	0,6342	0,4782	0,3556	1	1	1	**1**	**1**
	23	Export taxes	**0,5211**	0,5159	0,4518	0,3227	0,3122	1	1	**1**	**1**	**1**
	24	Foreign exchange rate	0,3453	0,4782	0,4848	0,6664	**0,7142**	0	0	0	1	1

Table 7. Summary of criteria according to all integration levels.

Main criterion	Types of sub-criteria	Number of sub-criteria	Buyer-Supplier Integration Levels				
			Level-1	Level-2	Level-3	Level-4	Level-5
Cost	Traditional	17	8	9	11	17	17
	Environmental	7	0	0	0	1	5
Quality	Traditional	15	2	8	10	11	11
	Environmental	6	1	1	1	3	4
Service	Traditional	20	3	14	17	20	20
	Environmental	14	1	1	1	2	12
Reliability	Traditional	24	3	12	18	24	24
	Environmental	9	0	0	0	1	8
Management and organisation	Traditional	8	0	2	6	7	7
	Environmental	5	0	0	0	0	0
	Social	4	0	0	0	2	2
Technology	Traditional	10	0	6	7	9	9
	Environmental	3	0	0	0	3	3
Total		142	18	53	71	100	122

6. SOME CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Partner selection and appropriate relationship formation are strategic problems for enterprises. It may affect an alliance performance and even decide the alliance's fate [4]. Also, Şen et al. (2008) [7] highlighted that the most important decision in the supplier selection process is the decision of determining the buyer-supplier integration level. Even though closer and longer relationship among firms has become a trend, Daugherty (2011) [1] has mentioned that close relationship is not always the answer. Closeness between firms should be detected correctly. Besides, sustainability has a vital role for the long term success of a supply chain and the purchasing process has become more complicated with environmental and social burdens in recent years. Now, many organizations have considered environmental, social, and economic concerns [34] and have initiated significant reforms of their entire SCM system [40]. In the case of new supplier addition to chain or replacement of an existing supplier with a new one, selection criteria which have been used before should be revised. Since the focal or leading company of the chain's might be held responsible for poor environmental and social performances of their suppliers, green and social criteria should also be integrated into firms' traditional SS criteria structures. By this way, firms can avoid undesirable situations stemming from government or public response.

Consequently, in order to overcome above-mentioned burdens, first of all, we have offered a conceptual framework for sustainable buyer-supplier integration strategies. Then, we have tried to associate them with the SSC by using already existing fuzzy weighting method to extract ICH from CCH. Although the ICH is formed for a specific industry in this paper, our proposed structure can be tailored and adapted to meet the special needs of buyer firms and can serve as guidance. There are no limitations in this sense. In this respect, the ICH can be an initial step for criteria formulation phase of the SS process.

As Huang and Keskar (2007) [10] stated, it is impossible to create a fixed set of criteria which suggests solution for all cases. ICH suggests an initial set of criteria and firms should take ICH one step further for finding the optimal set of criteria according to their products. Then optimal set of criteria can be compared with ICH to find whether a dichotomy is exists between theory and practice. On the other hand, ICH can be used for determining the integration level. Additionally, different analyzes such as diffusion level of sustainability to supplier SS process can be performed. For future research, these aspects will continue to be interesting topics.

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Appendix A. Comprehensive Criteria Hierarchy (CCH).

COST	Net price				
	Cost components	*Life cycle cost*	Design costs		
			Operating costs	Fixed costs	
				Variable costs	
			After sale service costs	Support and maintenance costs	
				Set up and assembly cost	
				Transportation and distribution cost	
			Reverse logistics costs	*Retrieval (Collection) costs*	
				Disposal and recycling (treatment) costs	*Disassembly costs*
					Reprocessing costs
					Landfill costs
				Transportation costs for disposal and recycling stage	
		Ordering cost			
		Order cancellation/ replacement costs			
		Holding cost			
		Cost of integration with supplier			
		Environmental costs	*Pollution treatment cost*		
			Env. Perf. improvement cost		
	Price/cost ratio				
	Price position within the sector				
	Quantity price breaks				
	Price increments				
	Export taxes				
	Foreign exchange rate				

QUALITY	*Legal compliance and received fines*		
	Product quality	Defects	
		Product durability and ease-of-use	
		Shelf life	
		Green/environmental product	*Availability and use of environmental friendly or clean materials*
			Eco label of products
	Quality of support services		
	Packaging quality		
	Process yield		
	Quality of distribution system		
	Capability of R&D	Design/process improvement	
		Green R&D	
	Response to claims and complaints	Customer complaints	
		Response to claims	
		Remedy for quality problems	
	Quality and *Environmental management systems* used by supplier	Quality accreditations and certifications	
		Environmental certifications	
		Awards	Quality awards
			Green quality awards
		Quality team visits	
		Operational controls	

SERVICE	Delivery	On-time delivery/JIT delivery capability	
		Delivery lateness rate	
		Order fulfilment (accuracy) rate	
		Set-up time	
		Order lead time	
	After sale services/supports	Repair service (Maintenance support)	
		Training aids	
		Warranties and claims	
		Spare parts availability	
		Technical and engineering support	
	Capabilities of supplier	Production facilities	
		Process capabilities	
		Cost reduction capabilities	
		Conflict resolution	
		Pollution control and treatment capabilities	
		Secondary market capability	
		Design capability	
		Green design capabilities	*Redesign*
			Recyclability
			Reusability
			Remanufacturability
			Disassemblability
			Consumption of resources
			Biodegradable
			Use of harmful materials
	Environmental/green competencies	*Green logistic dimension*	
		Eco-packaging	
		Reverse logistics dimension	
		Life cycle assessments	
	Production capacities		
	Product range		
	Service level		
	Payment and billing flexibilities/ terms		
	Having warehouse in free zone		

TECHNOLOGY	Supplier's technological system		
	Technology investments		
	Technical capacity	Having technically adequate employee	
		Having technically adequate equipment	
	Technological capabilities	Catalog technology	
		E-commerce capability	
		Measurement, calibration and test capability	
	Information and communication technologies		
	Online ordering and tracking		
	Appropriating of supplier's technology		
	Availability and use of clean technologies	*Reactive methods/ technologies*	
		Proactive methods/ technologies	*Environmental production and processes*
			Waste and hazardous substance management system

RELIABILITY	Response to changes	Process flexibility		
		Order frequency flexibility		
		Freight flexibilities		
		Emergency order processing		
		Production/ order volume flexibility		
	Impression of supplier	Strategic partnerships		
		Institutionality and age of organisation		
		Trademarks, patents, licenses		
		Amount of past business		
		Attitude of supplier		
		Performance history and referances		
		Supplier's expertise		
	Reputation and position in industry	*Green/environmental image*	*Environmental commitments, policies, practices and plans*	
			Green auditing	
			Green supplier (Second tier) assessment and procurement	
			Public disclosure of environmental record	
			Green market share	
			Emissions and waste/disposal	*Emissions*
				Solid waste
				Liquid waste
				Waste water
		Corporate image	Market share	
			Brand image/value	
			Customer loyalty	
			Documentation and audit	
		Financial position	Asset/liability ratio	
			Rate of Asset Debt	
			Gross profit margin	
			Total revenue	
	Labour relation record			
	Accessibility			
	Risks	Risks of supplier		
		Risks of geographical location		

MANAGEMENT AND ORGANISATION	Compatible management styles and organization cultures		
	Sustainable relationship potential		
	Quality and stability of management team		
	Protecting clients' intellectual property rights and security		
	Speed in development and desire for business		
	Clarity of communication channels		
	Environmental relationships and partnerships		
	Green organizational dimension	*Management support and competencies*	
		Environmental trainings	
		Environmental motivations	
		Environmental responsibility and volunteerism	
	Corporate Social Responsibilities	*Internal social responsibilities*	*Employment practices*
			Health and safety
		External social responsibilities	*Local communities influence*
			Stakeholders influence
	Capability to access new markets		
	Reciprocal arrangements		

Appendix B. BSILs indices template concerning to TEEI.

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
COST	1	Net price	**0,8782**	0,7305	0,5795	0,4947	0,4411	1	1	1	**1**	**1**
	2	Quantity price breaks	**0,8782**	0,7679	0,6447	0,4888	0,4409	1	1	1	**1**	**1**
	3	Price increments	**0,7968**	0,7138	0,5696	0,4518	0,4309	1	1	1	**1**	**1**
	4	Design costs	0,1344	0,2858	0,4893	0,7574	**0,7743**	0	0	0	1	1
	5	Fixed costs	0,1282	0,2537	0,3764	0,5962	**0,6607**	0	0	0	1	1
	6	Variable costs	0,2155	0,3018	0,4841	0,6874	**0,7202**	0	0	0	1	1
	7	Support and maintenance costs	0,1282	0,7305	**0,7574**	0,5109	0,4624	0	1	1	1	**1**
	8	Set up and assembly cost	0,6982	0,7736	**0,7968**	0,4091	0,3336	1	1	1	**1**	**1**
	9	Transportation and distribution cost	0,2627	0,4637	0,5428	0,6878	**0,7035**	0	0	1	1	1
	10	*Retrieval (Collection) costs*	0,1151	0,2155	0,2426	0,4834	**0,5162**	0	0	0	0	1
	11	*Disassembly costs*	0,1218	0,1463	0,2426	0,3611	0,4945	0	0	0	0	**M**
	12	*Reprocessing costs*	0,1218	0,1463	0,1463	0,2594	0,4786	0	0	0	0	**M**
	13	*Landfill costs*	0,1218	0,2094	0,2205	0,5428	**0,6927**	0	0	0	1	1
	14	*Transportation costs for disposal and recycling stage*	0,1218	0,2205	0,2537	0,4891	**0,5396**	0	0	0	0	1
	15	Ordering cost	0,5162	**0,6983**	0,6392	0,3553	0,2910	1	1	1	**1**	**1**
	16	Order cancellation/replacement costs	**0,7197**	0,7035	0,5750	0,3342	0,2752	1	1	1	**1**	**1**
	17	Holding cost	0,2144	0,4145	0,4624	0,7519	**0,7685**	0	0	0	1	1
	18	Cost of integration with supplier	0,1151	0,3236	0,3708	0,7092	**0,7364**	0	0	0	1	1
	19	*Pollution treatment cost*	0,1218	0,2197	0,2695	0,4674	**0,6874**	0	0	0	0	1
	20	*Env. Perf. improvement cost*	0,1218	0,2356	0,2636	0,4676	**0,6229**	0	0	0	0	1
	21	Price/cost ratio	0,2083	0,3822	0,5000	0,6342	**0,6547**	0	0	1	1	1
	22	Price position within the sector	**0,7803**	0,7463	0,6342	0,4782	0,3556	1	1	1	**1**	**1**
	23	Export taxes	**0,5211**	0,5159	0,4518	0,3227	0,3122	1	1	**1**	**1**	**1**
	24	Foreign exchange rate	0,3453	0,4782	0,4848	0,6664	**0,7142**	0	0	0	1	1

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
QUALITY	25	*Legal compliance and received fines*	0,5535	0,5535	0,5748	0,6384	**0,7255**	1	1	1	1	1
	26	Defects	0,2636	0,6400	**0,6713**	0,4946	0,4145	0	1	1	**1**	**1**
	27	Product durability and ease-of-use	**0,7090**	0,6982	0,6871	0,5860	0,5806	1	1	1	1	1
	28	Shelf life	0,2292	0,1905	0,1969	0,2032	0,2032	0	0	0	0	**M**
	29	*Availability and use of environmental friendly or clean materials*	0,3394	0,3616	0,3715	0,6336	**0,7305**	0	0	0	1	1
	30	*Eco label of products*	0,1218	0,1282	0,1969	0,3600	0,4517	0	0	0	0	**M**
	31	Quality of support services	0,2197	0,4465	**0,6071**	0,6056	0,6056	0	0	1	1	1
	32	Packaging quality	0,2257	0,2321	0,2537	0,2537	0,2910	0	0	0	0	**M**
	33	Process yield	0,1969	0,6874	**0,7423**	0,6982	0,6279	0	1	1	1	1
	34	Quality of distribution system	0,1969	0,5052	0,5748	0,6553	**0,7087**	0	1	1	1	1
	35	Design/process improvement	0,2094	0,2965	0,4781	0,7627	**0,7736**	0	0	0	1	1
	36	*Green R&D*	0,0778	0,1405	0,3382	0,4254	**0,6175**	0	0	0	0	1
	37	Customer complaints	**0,6927**	0,6555	0,7090	0,4570	0,3658	1	1	1	**1**	**1**
	38	Response to claims	0,2466	0,4359	0,5912	0,7036	**0,7519**	0	0	1	1	1
	39	Remedy for quality problems	0,2965	0,5106	0,6658	0,7313	**0,7413**	0	1	1	1	1
	40	Quality accreditations and certifications	0,4413	0,5482	0,6236	0,6393	**0,7087**	0	1	1	1	1
	41	*Environmental certifications*	0,2803	0,3715	0,3177	0,5052	**0,6444**	0	0	0	1	1
	42	Quality awards	0,2373	0,3447	0,3447	0,4776	0,4776	0	0	0	0	**M**
	43	*Green quality awards*	0,2515	0,2681	0,2894	0,3964	0,4182	0	0	0	0	**M**
	44	Quality team visits	0,2577	0,3453	0,3511	0,3665	0,3715	0	0	0	0	**M**
	45	Operational controls	0,2636	0,6393	**0,6983**	0,5054	0,5054	0	1	1	1	1

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
SERVICE	46	On-time/JIT delivery capability	0,2965	0,7197	**0,8031**	0,6982	0,6927	0	1	1	1	1
	47	Delivery lateness rate	0,2803	0,6553	**0,7248**	0,5802	0,5750	0	1	1	1	1
	48	Order fulfilment rate	0,4248	0,6764	**0,7968**	0,6234	0,5860	0	1	1	1	1
	49	Set-up time	0,2257	0,7519	**0,7968**	0,5377	0,5272	0	1	1	1	1
	50	Order lead time	0,5052	**0,6441**	0,6325	0,5054	0,5054	1	1	1	1	1
	51	Repair service (Maintenance support)	0,2032	0,6447	**0,7305**	0,5276	0,5218	0	1	1	1	1
	52	Training aids	0,2094	0,6447	**0,7305**	0,5276	0,5218	0	1	1	1	1
	53	Warranties and claims	**0,7142**	0,6871	0,6818	0,4409	0,4356	1	1	1	**1**	**1**
	54	Spare parts availability	0,2636	0,5752	**0,7856**	0,5952	0,5848	0	1	1	1	1
	55	Technical and engineering support	0,2315	0,5162	**0,7627**	0,6611	0,7092	0	1	1	1	1
	56	Production facilities	0,2745	0,4717	0,5000	0,7354	**0,7473**	0	0	1	1	1
	57	Process capabilities	0,2144	0,3393	0,4894	0,6874	**0,7090**	0	0	0	1	1
	58	Cost reduction capabilities	0,2197	0,4834	0,5696	0,8595	**0,8782**	0	0	1	1	1
	59	Conflict resolution	0,2094	0,4465	0,6285	0,7627	**0,7845**	0	0	1	1	1
	60	*Pollution control and treatment capabilities*	0,0778	0,1344	0,3444	0,5106	**0,6715**	0	0	0	1	1
	61	*Secondary market (for waste generated) capability*	0,1151	0,1282	0,2327	0,4300	0,4946	0	0	0	0	M
	62	Design capability	0,1218	0,3781	0,3672	0,8031	**0,8849**	0	0	0	1	1
	63	*Redesign*	0,1282	0,2032	0,2094	0,4838	**0,7255**	0	0	0	0	1
	64	*Recyclability*	0,1151	0,2577	0,2752	0,4093	**0,7685**	0	0	0	0	1
	65	*Reusability*	0,1151	0,2418	0,2687	0,3129	**0,6982**	0	0	0	0	1
	66	*Remanufacturability*	0,1282	0,3148	0,2803	0,4730	**0,7036**	0	0	0	0	1
	67	*Disassemblability*	0,1969	0,2020	0,2636	0,4198	**0,5696**	0	0	0	0	1
	68	*Consumption of resources*	0,1151	0,2032	0,2094	0,4309	**0,7202**	0	0	0	0	1
	69	*Biodegradable*	0,1282	0,1282	0,1344	0,2855	**0,6073**	0	0	0	0	1
	70	*Use of harmful materials*	0,6342	0,6342	0,6342	**0,6445**	0,6018	1	1	1	1	1
	71	*Green logistic dimension*	0,1218	0,2032	0,2083	0,2910	**0,5269**	0	0	0	0	1
	72	*Eco-packaging*	0,1218	0,1463	0,2214	0,2377	0,4834	0	0	0	0	**M**
	73	*Reverse logistics dimension*	0,0778	0,1282	0,2516	0,2855	**0,5535**	0	0	0	0	1
	74	*Life cycle assessments*	0,0778	0,1218	0,1218	0,3664	**0,6927**	0	0	0	0	1
	75	Production capacities	0,2373	0,5696	**0,7142**	0,5696	0,5589	0	1	1	1	1
	76	Product range	0,2197	0,2964	0,4036	0,5855	**0,6285**	0	0	0	1	1
	77	Service level	0,2257	0,7406	**0,8782**	0,7145	0,6982	0	1	1	1	1
	78	Payment and billing flexibilities/ terms	**0,7917**	0,7090	0,6500	0,4946	0,4464	1	1	1	**1**	**1**
	79	Having warehouse in free zone	0,2964	0,5109	0,6182	0,6983	**0,7035**	0	1	1	1	1

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
RELIABILITY	80	Process flexibility	0,1405	0,4091	0,5428	**0,6292**	0,5696	0	0	1	1	1
	81	Order frequency flexibility	0,2144	0,6389	**0,7255**	0,5430	0,5482	0	1	1	1	1
	82	Freight flexibilities	0,2466	0,5371	**0,6836**	0,5106	0,5430	0	1	1	1	1
	83	Emergency order processing	0,2083	0,6555	**0,8718**	0,7092	0,7092	0	1	1	1	1
	84	Production/ order volume flexibility	0,3447	0,7036	**0,7917**	0,6445	0,5700	0	1	1	1	1
	85	Strategic partnerships	0,2144	0,2855	0,4946	0,7145	**0,7313**	0	0	0	1	1
	86	Institutionality and age of organisation	0,4038	0,5483	0,6823	0,7856	**0,7968**	0	1	1	1	1
	87	Trademarks, patents, licenses	0,4948	0,5482	0,5868	0,7685	**0,7795**	0	1	1	1	1
	88	Amount of past business	0,4948	0,5535	0,6607	0,7297	**0,7460**	0	1	1	1	1
	89	Attitude of supplier	0,3393	0,5483	0,7036	0,7736	**0,7906**	0	1	1	1	1
	90	Performance history and referances	0,4356	0,5642	0,6229	0,7743	**0,7968**	0	1	1	1	1
	91	Supplier's expertise	0,5000	0,6285	0,6927	0,7736	**0,8031**	1	1	1	1	1
	92	*Environmental commitments, policies, practices and plans*	0,2020	0,2577	0,2745	0,4735	**0,5589**	0	0	0	0	1
	93	*Green auditing*	0,2466	0,2527	0,2858	0,4257	**0,6285**	0	0	0	0	1
	94	*Green supplier (Second tier) assessment and procurement*	0,3599	0,3781	0,3886	0,4948	**0,6983**	0	0	0	0	1
	95	*Public disclosure of environmental record*	0,2020	0,2083	0,2205	0,3550	0,4518	0	0	0	0	**M**
	96	*Green market share*	0,1218	0,1282	0,2577	0,4145	**0,6236**	0	0	0	0	1
	97	*Emissions (gases/ozone depleting chemicals/carbon footprinting etc)*	0,1151	0,1282	0,2369	0,5106	**0,6611**	0	0	0	1	1
	98	*Solid waste*	0,1151	0,1218	0,2197	0,4894	**0,6553**	0	0	0	0	1
	99	*Liquid waste*	0,1151	0,1218	0,2197	0,4088	**0,6555**	0	0	0	0	1
	100	*Waste water*	0,1151	0,1218	0,2197	0,3982	**0,5419**	0	0	0	0	1
	101	Market share	0,2745	0,4572	0,5589	0,7518	**0,7631**	0	0	1	1	1
	102	Brand image/value	0,5106	0,5644	0,5644	0,7729	**0,7845**	1	1	1	1	1
	103	Customer loyalty	0,2910	0,4300	0,6071	0,7803	**0,7917**	0	0	1	1	1
	104	Documentation and audit	0,2144	0,2745	0,4782	0,6982	**0,7090**	0	0	0	1	1
	105	Asset/liability ratio	0,1282	0,2636	0,2803	0,5644	**0,6073**	0	0	0	1	1
	106	Rate of Asset Debt	0,2020	0,2910	0,5000	0,7038	**0,7519**	0	0	1	1	1
	107	Gross profit margin	0,2020	0,2426	0,3611	0,6393	**0,6818**	0	0	0	1	1
	108	Total revenue	0,2020	0,3550	0,3755	0,6658	**0,7090**	0	0	0	1	1
	109	Labour relation record	0,2032	0,2315	0,4254	0,5000	**0,5428**	0	0	0	1	1
	110	Accessibility	0,6767	0,6982	0,7364	**0,7708**	**0,7708**	1	1	1	1	1
	111	Risks of supplier	0,2855	0,4891	0,5691	**0,6852**	**0,6852**	0	0	1	1	1
	112	Risks of geographical location	0,2426	0,4518	0,6396	**0,7917**	**0,7917**	0	0	1	1	1

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
MANAGEMENT AND ORGANISATION	113	Compatible management styles and organization cultures	0,2094	0,3611	0,5589	0,8656	**0,8718**	0	0	1	1	1
	114	Sustainable relationship potential	0,2404	0,4243	0,6709	0,7631	**0,7743**	0	0	1	1	1
	115	Quality and stability of management	0,2083	0,3611	0,6818	0,7795	**0,7906**	0	0	1	1	1
	116	Protecting clients' intellectual property rights and security	0,3447	0,5964	0,7202	0,8782	**0,8849**	0	1	1	1	1
	117	Speed in development and desire for business	0,2094	0,3126	0,5535	0,8656	**0,8849**	0	0	1	1	1
	118	Clarity of communication channels	0,3336	0,5000	0,6389	0,7906	**0,8782**	0	1	1	1	1
	119	*Environmental relationships and partnerships*	0,1218	0,2454	0,2752	0,4248	0,4736	0	0	0	0	**M**
	120	*Management support and competencies*	0,0778	0,1905	0,2032	0,2426	0,3658	0	0	0	0	**M**
	121	*Environmental trainings*	0,1218	0,1969	0,2032	0,2083	0,3766	0	0	0	0	**M**
	122	*Environmental motivations*	0,1151	0,1151	0,2032	0,2205	0,2910	0	0	0	0	**M**
	123	*Environmental responsibility and volunteerism*	0,1218	0,2020	0,1344	0,2424	0,4570	0	0	0	0	**M**
	124	*Employment practices*	0,1218	0,1969	0,2808	0,5804	**0,7463**	0	0	0	1	1
	125	*Health and safety*	0,1218	0,1969	0,3342	0,5000	**0,6500**	0	0	0	1	1
	126	*Local communities influence*	0,1218	0,1218	0,2032	0,2703	0,4724	0	0	0	0	**M**
	127	*Stakeholders influence*	0,1218	0,1218	0,1344	0,2646	0,4248	0	0	0	0	**M**
	128	Capability to access new markets	0,1956	0,3394	0,3930	0,5752	**0,7036**	0	0	0	1	1
	129	Reciprocal arrangements	0,3071	0,4309	0,4465	0,4894	0,4946	0	0	0	0	**M**

	No	Sub-criteria (The lower layer)	IW Values					Criteria Necessariness Indices (F_1)				
			Level-1	Level-2	Level-3	Level-4	Level-5	Level-1	Level-2	Level-3	Level-4	Level-5
TECHNOLOGY	130	Supplier's technological system	0,3069	0,5224	0,7145	0,8656	**0,8782**	0	1	1	1	1
	131	Technology investments	0,2155	0,3018	0,5587	0,7856	**0,8656**	0	0	1	1	1
	132	Having technically adequate employee	0,2205	0,5431	0,6982	0,7856	**0,8782**	0	1	1	1	1
	133	Having technically adequate equipment	0,2205	0,5431	0,6982	0,7856	**0,8782**	0	1	1	1	1
	134	Catalog technology	0,2032	0,2858	0,3071	0,3822	0,3822	0	0	0	0	**M**
	135	E-commerce capability	0,1282	0,3500	0,4845	0,5795	**0,5899**	0	0	0	1	1
	136	Measurement, calibration and test capability	0,2646	0,6018	**0,7364**	0,4838	0,4838	0	1	1	**1**	**1**
	137	Information and communication technologies	0,1218	0,3236	0,4196	0,7795	**0,7968**	0	0	0	1	1
	138	Online ordering and tracking	0,1344	0,6767	**0,7313**	0,5964	0,5964	0	1	1	1	1
	139	Appropriating of supplier's technology	0,2144	0,7534	0,8031	**0,8849**	**0,8849**	0	1	1	1	1
	140	**Reactive methods/ technologies**	0,1282	0,2205	0,3018	0,5000	**0,6393**	0	0	0	1	1
	141	**Environmental production and processes**	0,1282	0,2197	0,3018	0,5054	**0,7202**	0	0	0	1	1
	142	**Waste and hazardous substance management system**	0,1282	0,2426	0,4630	0,6335	**0,7423**	0	0	0	1	1