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## Determinants of the green supplier selection

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### Abstract

Green consideration has been one of the most crucial issues for environmental protection due to increasing consumption level, and ill effect of the industrial developments, as well. For overcoming the negative impacts of the industrial processes, supplier selection can be seen as an important part of the green supply chain management concept due to its long term effects. On the other hand, many companies bestow a privilege on their partners if they have green consideration thanks to the positive perception of the customers. In this paper, a literature review is done for expressing what criteria effect the decision environment to build a better relationship with partners, and a criteria list for green supplier selection for textile industry is proposed in a hierarchic structure which is useful to integrate multi criteria decision analysis. The proposed criteria list is formed by eight main criteria and thirty one sub-criteria which consists green and also non-green criteria what are cost, delivery, quality, service, strategic alliance, pollution control, green product and environmental management.

*Keywords:* Green supplier selection, green logistics, green supply chain management, textile

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### 1. Introduction

In today's business world, a company cannot be competitive without working in close collaboration with external partners. The concept of Supply Chain Management (SCM) emerged in this direction and seeks to optimally manage the physical and information flows exchanged between all actors in a supply chain (Aguzzoul, 2012). In today's highly competitive era, effective supply chains gain more important to achieve competitive advantage. Moreover, this highly competitive environment is forcing the businesses establish a long-term effective collaboration with the efficient organizations. Thus, today the businesses in a supply chain pay particular attention to the identification and selection among alternative supply sources. As a result an effective supplier selection process is very important to the success of any business which needs effective suppliers (Chan, Kumar, Tiwari, Lau, & Choy, 2008).

Supplier selection has a critical effect on the competitiveness of the entire supply chain network. Research results indicate that the supplier selection process appears to be the most significant variable in deciding the success of the supply chain. Additionally, selection of suppliers is one of the most important aspects that firms must incorporate into

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their strategic processes. As organizations become more and more dependent on suppliers, the direct and indirect consequences of poor decision making in selecting the suppliers will become more critical (Chan et al., 2008). Apart from the common criteria such as cost and quality, this paper discusses the “green” issues which can play an important role in sourcing, and try to suggest critical environmental variables which can be used in supplier selection.

There are plenty source which focuses on the green supplier selection issues, and there are also different approaches based on categorical methods, data envelopment analysis, cluster analysis, case-based-reasoning systems, decision models for the final choice-phase, linear weighting models, total cost of ownership models, mathematical programming models, statistical models and artificial intelligence based models (Boer, Labro, & Morlacchi, 2001). All of the proposed methods are looking for the proper partner for collaboration in focused time terms. One of the most known and used approach is multiple criteria decision making for supplier selection processes thanks to its ability to compare tangible and intangible criteria (Büyükoçkan, 2012). The structure of the green supplier selection issues in multiple criteria approach can be classified in three category as follows; (i) application of the multi criteria decision making tools, (ii) focusing evaluation criteria, (iii) sensitivity analysis (Govindan, Rajendran, Sarkis, & Murugesan, 2013).

In this paper, we considered to create a criteria tree in hierarchic structure for textile industry’s selection process. The given structure is useful to integrate for one of the most used evaluation and selection technique which is analytic hierarchy process and also its fuzzy derivatives. The criteria consisted by eight main criteria and their thirty one sub-criteria. The proposed decision criteria do not rely on only green issues due to some of the problems applicability in traditionally working companies which are common in Brazil (Jabbour & Jabbour, 2009). For overcoming this problem, in the study, we concentrated on business issues as cost, delivery, quality, service, strategic alliance to create opportunity for long term collaboration with the suppliers. Green criteria which are pollution control, green product and environmental management also integrated to the selection criteria for better consideration of the supplier selection process.

In the following section, what criteria should be taken into consideration in green supplier selection processes is discussed. The third chapter has a brief discussion about green supplier selection concept, and it also compares different studies in the literature. Conclusion summarizes the study, and it also visualizes the proposed determinants of the green supplier selection concept in a figure.

## 2. Green Supplier Selection

In this study, eight criteria which are cost (e.g. Awasthi, Chauhan, & Royal, 2010; Celebi & Bayraktar, 2008; Chan, Kumar, Tiwari, Lau, & Choy, 2008), delivery (e.g. Celebi & Bayraktar, 2008; Kuo & Wang, 2010), quality (e.g. Lee, Kang,, Hsu, & Hung, 2009; Chan, Kumar, Tiwari, Lau, & Choy, 2008; Shaik & Abdul-Kader, 2011), service (e.g. Buyukozkan, 2012; Chan, Kumar, Tiwari, Lau, & Choy, 2008), strategic alliance (e.g. Jabbour, & Jabbour, 2009; Awasthi, Chauhan, & Royal, 2010), pollution control (e.g. Lee, Kang,, Hsu, & Hung, 2009; Jabbour, & Jabbour, 2009), green product (e.g. Lee, Kang,, Hsu, & Hung, 2009; Awasthi, Chauhan, & Royal, 2010) and environmental management (e.g. Kuo & Wang, 2010; Hsu & Hu, 2009) accepted as the main factors of the green supplier selection process according to the previous researches and their results are discussed. Therefore for an efficient and productive green supplier selection these criteria should be recognized.

The following section is devoted to describe the decision criteria with the source in the existing literature, and the hierarchic structure of the decision environment is illustrated in the Fig. 1.

### 2.1. Cost

For a decision making problem about the supplier selection, cost can be count as the most important factor. Selecting the right suppliers reduces the cost and provides the buyers better competencies in the market. Cost consists of purchasing, transportation, inventory, operation, maintenance, energy, inspection, delivery, security, ordering, holding etc. costs and can be expanded or subdivided in many other costs (Ghodsypour & O’Brien, 2001).

Environmentally friendly materials are the materials which protect the environment by using them severely. The friendly materials lower the pollution and save the natural resources. Recycling is well known method of generating friendly material and in that way the land used at dumpsites will be recovered. Between the consumer and buyer there is a significant behavior. The consumers tend to buy environmentally friendly products. They pay attention to use them and give special values to such products. There is a correlation between the attitude of the consumer and the environment (Laroche, Bergeron, & Barbaro-Forleo, 2001). Compliance with sectorial pricing strategy (CSP) is one of the strategic performance metrics related to the cost (Sarkis & Talluri, 2002). It shows us coherence between the supplier’s price level and the sectorial average (Celebi & Bayraktar, 2008).

Criteria	Cost	Delivery	Quality	Service	Strategic Alliance	Pollution Control	Green Product	Environmental Management
Sub-Criteria	Buying Friendly Materials	Order Frequency	Quality Assurance	Responsiveness	Willingness to Information Sharing	Solid wastes	Green Packaging	EUP
	Compliance with Sectorial Pricing Strategy	Order Fulfillment Rate	Process Improvement	Stock management	Capability of Sharing Benefits & Risks	Energy consumption	Recycle	ISO14001
	Price/Performance Value	Lead time	Quality related certificates	Design Capability	Capability of Understanding Ultimate Aims and Business Processes	Use of harmful material	Remanufacturing	ODC
	Transportation Cost		Quality management		Capability of Building Long-Term Relationships To Share Culture and Business Policies Ultimately		Reuse	RoHS  WEE

Fig.1. Determinants of the green supplier selection concept

To evaluate the supplier performance there are some methods to be used. One of the methods is the cost ratio namely price/performance value. This method is based on cost analysis and compared with the performance of the supplier. The performance is measured by the product quality, delivery and customer services which are the performance criteria of the supplier. There are also some drawbacks in that system, because all the units should be given in the same unit and there is complexity to develop a cost accounting system (Petroni & Braglia, 2000). The price/performance value is a measure of budgetary conformance of cost (price) of work (performance criteria) performed (Anbari, 2003).

Transportation is an important part of the logistics and can be implemented in various modes. Road, railroad, sea road and air road are the main roads of transportation. Transportation cost is a substantial part of the sum of the general expenses which is highly dependent to the modes. It includes the cost of fuel or lubricants, penalties, driver salaries, maintenance costs, failure of the vehicle costs (Ongkunaruk & Piyakarn, 2011; Sahin, Yilmaz, Ust, Guneri, & Gulsun, 2009).

2.2. Delivery

Order fulfillment is very important to achieve competitive advantage in today’s customer focus market place. In order to satisfy customer-driven market place, firms need to operate effective supply chain with the right supplier which supplies their needs at the right time, at the right place with the right conditions and the right service (Wisner, Tan, & Leong, 2009). That requires real time fulfillment solutions. Order fulfillment process consists of two phases. In the first phase customers give the order and in the final phase suppliers deliver the goods. The time between order receipt to product delivery is defined as order fulfillment cycle time (Lin & Shaw, 1998). The success of order fulfillment solutions depends on the successful integration of four key elements of order fulfillment capability: order fulfillment planning, product execution, distribution management and cross application integration. In recent study (Zehir & Acar, 2006) order fulfillment capability is represented and validated as a distinct organizational capability.

Firms use multiple channels to reach important customers. Nevertheless, customer needs and expectations change rapidly day by day. Therefore, an operation was replaced with order fulfillment to focus on delivery lead-time and volume flexibility - two critical areas for customers requiring just-in-time inventory for sometimes - erratic production schedules (Celuch, Kasouf, & Peruvemba, 2002). Besides that, it needs a strong information tie between customers and firms, to reach these rapid changeable customer expectations. Otherwise, all effort of firm shall be useless at the lack of this capability. Thus order fulfillment capability / rate is replaced as a sub-criterion of delivery dimension of supplier selection criteria.

Since Just in Time (JIT) has been successful, the importance of lead time reduction is become more obvious. Order preparation, order transit, supplier lead time, delivery time and set up time are the main components of lead time (Li, Xu, Zhao, Yeung, & Ye, 2012).

### 2.3. *Quality*

Management generally deals with quality control and assurance. Aiming to improve production; initiating, directing and controlling objective directed activities constitute management. Quality assurance meets customer demands in order to optimize utilization of resources and to coincide with the firm's policy (Manning, Baines, & Chadd, 2006).

“Business process reengineering (BRP)” and “Total quality management (TQM)” are the main elements of process organization, process control and process improvement. Assessment of the environmental impact of processes, incorporation of economic and quality aspects into an integrated performance assessment, and identification and implementation of improvement initiatives are the three principle steps of process improvement (Schiefer, 2002). Several performance criteria, certifications and awards have been applied by the companies who intend to benchmark and advance their performance. Total Quality Management (TQM), ISO 9000, EN 29000 and BS 5750 are the examples of performance certifications and improvement awards reflecting quality (Kardaras & Mentzas, 1997).

Quality management (QM) is characterized by its principles, practices, and techniques. Since the practices are observable facets of QM, and it is through them that the QM implementation is accomplished, QM should be conducted at the level of practices. The principles provide general guidelines, which are implemented through the practices that are themselves supported by multiple techniques (Zu, Fredendall, & Douglas, 2008).

### 2.4. *Service*

In the twenty-first century's competitive business environment, companies have to overcome the difficulty of satisfying the demand of customers for products of a high quality, but low price. Responsiveness, stock management and design capability are crucial components of service level. Satisfying each of these criteria will directly improve service level. Logistics also aims to help the organization achieve customer satisfaction. Firms can achieve this aim through some operational goals, such as fast deliveries, low costs, minimum wastage, quick response, high productivity, low stocks, no damage, few mistakes, high staff morale, and so on. As it can be seen on this short list, quick response is the most relevant variable of the operational goal of the logistics which constitute customer service. In order to meet customer's unique and rapidly changing needs, a firm need to be more responsive (Gunasekaran, Lai, & Cheng, 2008). In order to provide the customer with promised service level, stock management is accepted as a caution against uncertainty. Service level, on the other hand is the expected fraction of demand that the supply chain can satisfy within predefined allowable delivery time window. (Jung, Blau, Pekny, Reklaitis, & Eversdy, 2008) An organization's ability to perform design-related actions in various levels of activity is defined as design capability (Mutanen, 2008).

### 2.5. *Strategic Alliance*

Strategic alliances have become central to competitive success in the fast changing global markets. Today in Strategic alliance can be defined as an agreement between two or more independent organizations to cooperate in a specific business activity toward common objectives. Strategic alliances developed and disseminated as formalized inter-organizational relationships among companies (Isoraite, 2009).

Strategic alliance has to contribute to the successful implementation of the strategic plan; therefore, the alliance must be strategic in nature (Isoraite, 2009). Unlike in a joint venture, firms in a strategic alliance do not form a new entity to further their aims but collaborate while remaining apart and distinct (web\_1, 2013). Strategic alliances depend on benefiting from the other's strengths mutually in order to gain competitive advantage.

However there are main other important reasons, the main purpose of a strategic alliance is to improve their competitive positioning, gain entry to new markets, supplement critical skills, and share the risk and cost of major development projects (Isoraite, 2009). According to the literature majority of the buying firms are tending to perceive their long term suppliers as partners (Humphreys, Li, & Chan, 2004). Also companies in a strategic alliance called as partners. So the long term relationship between buyer and seller companies can be called as external partnership. In a recent study external relationship capability has been validated as a distinct organizational capability (Acar & Zehir, 2009). To build a strategic alliance has effects on the organization's capability to develop new skills through building external relations and development capability. Since organizations develop parts as a result of working with partners, external partnership is a critical capability ensuring that sellers create maximum value for customers (Celuch et al., 2002). Thus to build a healthy and effective strategic alliances both companies need to develop some capabilities. And while selecting a supplier as a strategic partner firms need to evaluate their capabilities in order to build external relationships, as well. According to the literature those are willingness to share information (Humphreys et al., 2004; Isoraite, 2009; J. N. Lee, 2001), to share benefits and risks in the process of business with partners (Isoraite, 2009; J. N. Lee, 2001), to understand business objectives and process of others (Humphreys et al., 2004; J. N. Lee, 2001), to share culture and policy in the process of business with partners (J. N. Lee, 2001), and to develop and sustain long-term relationship (Humphreys et al., 2004; Kaleka, 2002).

## 2.6. *Pollution Control*

Pollution control is an important parameter which should be accomplished to get priority selected as supplier. More and more companies want to deal with suppliers which have some special values. Supplier's attitude toward the pollution is determining for working together.

Solid wastes are the wastes disposed to the environment in solid form and cause pollution. Related to the negative effect of pollution the nations, municipalities, corporations and humans create the solid waste management systems. The incorrectly removal of the solid waste leads to the damage of the health, environment, resource, economy and aesthetic. Thereby, it is obligatory that the wastes should be controlled and regulated by particular programs and directives (Marshall & Farahbakhsh, 2013).

With the growing production rate in the world energy consumption grows quickly. By the production process the pollution is the byproduct of energy use. It has been known that the pollution costs both a great deal of money and also destroys the environment in an irreparable manner. Therefore pollution control programs that imply a proper usage of energy consumption are promulgated (Yanqing & Mingsheng, 2012).

To reduce the pollution, the use of harmful material has to be limited. Companies demand from their suppliers some checklists which prohibit using the harmful substances. The reduction of the use is on the priority list of these companies. Obviously, harmful materials are the great parts of the pollutants (Awasthi, Chauhan, & Royal, 2010).

## 2.7. *Green Product*

In the recent years there is a "green" competency between vendors and suppliers, which has a strategically value and stands high in companies favor. In addition to the traditional selection criteria like costs, flexibility, quality, lead time, and new factors are considered more precious. Green product is an unusual agent to be applied (A. H. I. Lee, Kang, Hsu, & Hung, 2009).

Green packaging is a type of packaging which aims to protect the environment by using environmental friendly material. Its main characteristic is to get dissolved or disappeared in nature rapidly without harming any damage. Green packaging can be attained in 4R1D way. 4R1D is the abbreviation of reduce, reuse, reclaim, recycle, degradable (Zhang & Zhao, 2012).

The used up product is reduced to its raw materials and new and different products are generated from them. So, raw materials are saved. Recycle can be implemented if the scrapped product couldn't be reused again. Recycle needs few process (extraction, separating, etc) which require energy consumptions and harm the environment (Ke, Zhang, Liu, & Li, 2011; Zhang & Zhao, 2012).

Reuse is the use of the product which has been at the end of his life again with little or no treatment. So the life usage of the product has been extended. Reuse can be shortly explained utilizing the material for a second or further time. No new values has been added and decomposed to its raw material. It is the simplest way of getting green product (Ke et al., 2011).

By remanufacturing a large quantity of the products restored to a new state. Faulty and damaged components are repaired but it doesn't ensure that the product wouldn't work as good as before. The manufacturers can add new values or features to the product. It can be seen similar to the recycling but it differs from it. Recycling is related with the raw materials but remanufacturing is interested in the original function(Ke et al., 2011; Zhang & Zhao, 2012).

### *2.8. Environment Management*

The environmental dimension has been added to the procurement processes recently. The developments in the Environmental Management Systems and the negative impacts of productions to the environment make the buyers aware of the environment. It influences the firms by decision making. Many buyers await from their supplier a good level of applying Environment Management Systems (Handfield, Walton, Sroufe, & Melnyk, 2002). Energy Using Product (EUP) is an international guideline which stands for regulating the environmental consequences of all energy using products. The scope of the directive is to assess the environmental impacts and to raise the awareness of eco-design for personal electronic products (Yung et al., 2009). Ozone Depleting Chemicals (ODC) are the substances which are responsible for the depletion of the ozone layer by human-made chemicals (Ravishankara, Daniel, & Portmann, 2009). The well-known ODC's are the -dominant deplorer- CFC (chlorofluorocarbon) that is released to the atmosphere and NOx's which known as catalytically ozone destroyer. Both destroy the stratosphere by the reaction with active chemicals found there after being emitted. Restriction of hazardous substance (RoHS) is another guideline which is used to reduce the causes of hazardous chemicals and to stop the generation of electronic products containing toxic and harmful materials. With this directive it has been aimed to protect the environment and the health of the human beings. Such companies carry out RoHS programs to provide a comparative advantage for the competency of supplier selection. It is so crucial that the companies demand from the suppliers products that meet the RoHS directive. To obey the directive arouses a strong green image to the company and attracts it for the supplier selection (Hsu & Hu, 2009). International Organization for Standardization (ISO 14001) is a certification requirement based on the identification of "environmental aspects" in the firm. To overcome these aspects the firm develops a program and tries to counter the "environmental impacts". It sets goals, targets to fulfill and actions that should be taken. The improvements are done and the goals are met. After completion, the nonconformities about the aspects should be precisely determined. The whole system is assessed and re-evaluations of all policies, regulations, goals and targets are made for the continuous improvement (Bansal & Bogner, 2002).

Waste electrical electronic equipment (WEEE) directive is enhanced for the environmental protection by restricting the waste of electrical and electronic devices. With the growing technology and rapid changing products the disposal of the electric and electronic waste is a big problem in the industry. To rise the challenge the state or sometimes stakeholders compels from the companies to comply with the regulations. In addition to the environmental protection WEEE also aims customers, manufacturers and suppliers to make aware of the waste (A. H. I. Lee et al., 2009).

### **3. Discussion**

Green supplier selection is been an interesting topic to researchers due to increasing awareness in environmental protection and its long term effect on business and marketing issues. There are different applications for evaluating the alternatives based on data envelopment analysis (Kumar, Jain, & Kumar, 2014), multi criteria approaches (Büyüközkan, 2012; A. H. I. Lee et al., 2009), artificial neural networks (Kuo, Wang, & Tien, 2010), and also based on integration of the different approaches. In addition to the variety of the evaluation and selection techniques, there

are also variety existed for the used evaluation criteria. It might say that there is no consensus on the decision criteria for green supplier selection. Some of the research papers based on solely green evaluation criteria (Lu, Wu, & Kuo, 2007), on the other hand, some of the studies integrated green and non-green criteria during selection process (Büyüközkan, 2012; Shaik & Abdul-Kader, 2011). Additionally to the differences between the decision criteria, the calculated priorities also show differences between the studies. (Büyüközkan, 2012) accepted four main criteria which are cost, quality, service performance and environmental performance for evaluating the supplier alternatives, and according to the paper, environmental factors are found as the most important decision criteria, and quality, service and cost criteria are followed to the environmental factors in sequence. According to (Lu et al., 2007)'s study, materials factor is found as the most and liquid residues are found as the second most important criteria within the green selection process.

Owing to the popularity of the green concept in marketing and academic platforms, we cannot say each company uses green criteria in their selection processes (Jabbour & Jabbour, 2009). Due to the possible negative impacts on the costs, small and medium sized enterprises can avoid importing green criteria in their selection processes. For overcoming this possibility, governments can propose an award system to support for a better environmental protection.

#### 4. Conclusion

The purpose of this paper is to investigate, what are the determinants of the supplier selection process with green consideration is researched for long term collaboration with the partners of the textile sector's supply chain. Due to the selection decision's environment in both traditional and global companies non-green criteria are also accepted as a part of the green supplier selection process. It is accepted for sustainable supplier selection process and long term collaboration, each determinant of the supplier selection should be found and evaluated during selection process. Within this context, previous studies in green supplier selection area are taken into consideration and both business and environmental criteria are gathered in a hierarchical criteria tree for supplier selection process. The proposed criteria tree is formed from eight main criteria what are cost, delivery, quality, service, strategic alliance, pollution control, green product, environmental management. Cost, delivery, quality, service and strategic alliance capabilities are accepted as business criteria and pollution control, green product and environmental management are accepted as green criteria in selection. The proposed criteria tree is illustrated in the Fig. 1.

There are different applications for green concept in a wide variety; thus each priority for components of the supplier selection process. Following studies might focus on evaluation of the determinants of the green supplier selection problem with multiple criteria decision making techniques. The proposed criteria tree shows concordance with AHP technique thanks to its hierarchical structure. On condition that building decision network and linking decision criteria in green selection process, the proposed criteria tree can be used for analytic network technique. During evaluation process, due to variety in the thoughts on green and other determinants of the decision environment the number of the experts should be abundant, and if it is possible fuzzy environment (Zadeh, 1965) should be integrated with the evaluation techniques (Mon, Cheng, & Lin, 1994).

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