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# A Review on the Buyer–Supplier Dyad Relationships in Sustainable Procurement Context: Past, Present and Future

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Sustainable development is currently being applied in most fields of research. Procurement, focused on the buyer-supplier dyad, is one such discipline where sustainability is being widely applied. This paper provides a review of these research studies, conducting a systematic content analysis in order to present the state of the art in this domain. The paper carries out a detailed review of articles in international scientific journals and well-known international conferences related to green and sustainable supplier selection published between 2008 and 2014 inclusive. Seven designed research questions are proposed and answered based on this bibliography. Interesting results are reported in each section and gaps in the current body of literature are identified. The purpose of this review is to provide important future directions and limitations in this research topic.

**Keywords:** supply chain management; supply chain design; supplier selection; multi-criteria decision making; sustainable procurement.

## 1. Introduction

In 1992, the *Declaration on Environment and Development* and the *Agenda 21* statement were released as a result of the United Nations (UN) meeting in Rio de Janeiro which was held to discuss possible approaches to confront climate change. In recent years, firms' contributions and impacts on the environment, economy and the society have been increasingly important for scholars and practitioners. Governmental legislations and increasing environmental awareness are the two key factors why organizations and their suppliers have to take green initiatives into account if they want to be competitive in the global market (Büyüközkan and Çifçi, 2012). Nevertheless, minimizing environmental negative impacts can be in conflict with economic development. Besides, within the supplier management context, imbalances in society can be addressed by supplying goods from local SMEs and globally by sourcing products from companies in developing countries (Walker and Phillips, 2009; Brammer and Walker, 2011).

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The increasing prevalence of research on responsible purchasing, environmental and social performance of firms in their supply chains have transformed purchasing and supply to play a strategic role in sustainability (Meehan and Bryde 2011). Sustainable procurement has been defined by the UK Sustainable Procurement (SP) Task Force as:

…a process whereby organizations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organization, but also to society and the economy, whilst minimizing damage to the environment (DEFRA, 2006, p. 10).

SP can also be defined as:

…the efforts of an organization to achieve or simply improve performance of buying activities in three ways: environmentally, socially and economically (Oruezabala and Rico, 2012).

Walker et al. (2012) defined a framework that helps to illuminate pertinent sustainable procurement issues at different stages in the supply chain. The developed framework illustrates five levels of focus across the three dimensions of sustainability, namely individual focus, organizational focus, buyer-supplier dyad focus, supply chain focus, market/society/stakeholder/NGOS focus.

Most extant studies on sustainable procurement focus on indirectly stimulating social and environmental benefits through exerting pressure on suppliers to reduce their own impacts (Brammer and Walker, 2011). The abovementioned matter can be interpreted in more details by analyzing the level of interest of manufacturing organizations and their suppliers to participate in the sustainable procurement practices.

Buyer-supplier relationship has an enormous influence on the overall profitability of the whole supply chain (Hollos et al., 2012; Panahifar et al., 2013). A supplier as one of the constituting members of this relationship needs to have certain skills and capabilities in order to be selected as the appropriate partner (Govindan et al., 2013). Therefore, supplier evaluation and selection affect almost every subsequent decision to be made in the management of supply networks. Selecting the right suppliers reduces purchasing costs, improves competitiveness, and enhances end user satisfaction by eliminating waste, improving quality and flexibility to meet the requirements of the end users, and reducing lead-time at different stages of the network (Özgen et al., 2008). The on-going sustainability movement requires companies to extend their focus beyond traditional economic objectives to a triple bottom line (TBL) approach that simultaneously accounts for economic, ecological and social performance (Hollos et al., 2012). On one side, environmental management has

become important for manufacturers as they face intense inspections from diverse stakeholder groups, including end consumers, industrial customers, suppliers, and financial institutions (Vachon and Klassen, 2008). On the other side, social issues like human rights, and workers health and safety issues are being acknowledged by manufacturing organizations and need to be considered in their organizations' agenda as well as environmental criteria (Bai, and Sarkis, 2010a).

The vast majority of papers in supplier selection literature have paid considerable amount of attentions to develop decision-making mathematical models (Ho et al., 2010; Wu and Barnes, 2011) and to formulate the appropriate criteria in selecting and evaluating supply partners (Weber et al., 1991). Recently, noteworthy literature review papers have been published in the area of green supplier selection. The contributions of each of these reviews are discussed in Section 2. Accordingly, the insights observed from these literature review papers were our motivation to conduct the current literature review paper which sheds light on the current status of the relationships of buyer-supplier dyad in the sustainable procurement research domain and also identifying research gaps and issues for both researchers and practitioners.

## 2. Previously published literature reviews

Former reviews of scientific literature on sustainable supplier selection and sustainable procurement focusing on buyer-supplier dyad are summarized. The purpose of this examination of previous literature reviews is to help derive relevant structures, identify research questions and understand the state-of-the-art contributions for the current study.

Igarashi et al. (2013) conducted a literature review considering papers focusing on the stages of the supplier selection process and criteria. Govindan et al. (2013) reviewed papers related to the green supplier selection research domain in order to have more clarification on the tools and techniques that have been used by researchers to evaluate and select the most appropriate suppliers. Genovese et al. (2013) provided a review of the literature in the area of green supplier selection reviewing deployed methodologies in selecting the best supply candidate. In addition their research investigated whether the environmental and green criteria had penetrated into the actual practice in the top 100 UK manufacturing companies.

Table 1 overviews these three recent reviews regarding their time horizon, number of reviewed papers, sustainability aspects covered in the review, research questions answered and the taxonomy pursued in their reviews.

In two of these reviews only papers published up to year 2011 were considered. In contrast, our review updates the time horizon until 2014 with the total number of 61 papers gathered and through a rigorous literature analysis methodology (explained in Section 4) applied.

Table 1. Overview of the recent reviews.

| Author(s) & year | Time horizon | Number of reviewed papers | Sustainability aspect | Research questions | Taxonomy |
|---|---|---|---|---|---|
| Genovese et al. (2013) | n.a | 28 | environmental | (i) is the growing academic literature interest in green supply chain management and greener supplier selection linked to a growing awareness among real-world firms of these issues?<br>(ii) to what extent are firms incorporating greener supplier selection criteria into their supplier selection practices?<br>(iii) what are the barriers preventing firms from incorporating green supplier selection criteria into their supplier selection practices? | (a) proposed application<br>(b) environmental criteria<br>(c) employed methodology |
| Govindan et al. (2013) | 1997-2011 | 33 | environmental | (i) which selection approaches are commonly applied?<br>(ii) what environmental and other selection criteria for green supplier management are popular?<br>(iii) what limitations exist? | a) decision making methodology base<br>b) criteria selection base |
| Igarashi et al. (2013) | 1991-2011 | 60 | environmental | (i) what characterizes the existing studies on green supplier selection?<br>(ii) what are the unaddressed or overlooked areas within green supplier selection research?<br>(iii) what could be the future directions of research into green supplier selection? | (a) type of research and theoretical viewpoint<br>(b) supply chain position<br>(c) stages of the supplier selection process<br>(d) the perspective taken on environmental criteria |

The three review papers did not investigate the social sustainability dimension criteria and its effect on the evaluation and selection process. Therefore, there is a clear need to assess and analyse the literature on sustainable supplier selection apart from a more detailed investigation into the green supplier selection criteria addressed in the literature. One of the

aims and contributions of this article is to present a comprehensive and complete categorization of criteria utilized in the domain of green/sustainable supplier evaluation and selection that can be considered as a proper reference for researchers and practitioners to select the most suitable ones among them for their use. Apart from this, a detailed investigation has been carried out regarding the merits and drawbacks of the developed tools in the domain of sustainable procurement which has not been comprehensively addressed in the literature.

The reminder of this paper starts with Section 3 where the research questions are stated. This is followed by Section 4 where the research methodology of the literature review is presented including a descriptive and content analysis of the reviewed papers. In Section 5, a detailed discussion to the research questions are presented based on the insights obtained from Section 4. Lastly, final remarks are concluded in Section 6.

## 3. Research questions

Using the insights gathered from previous literature review studies, we carefully selected part of our research questions in order to update the status of previously addressed issues in this research domain. This decision was made in order to present our work in line with these review studies. All of the previously done papers were looking at green aspects and did not consider the TBL context (environmental, economic and social). Therefore, we added the TBL context to the previously identified questions from those three review papers. Apart from this, we also added more dimensions to our analysis where we considered the role of the supplier selection activities in the sustainable procurement context. Therefore, questions five and six were designed to address these new dimensions. Basically, we would like to highlight that the final structure of the questions was a result of an iterative process where we changed them many times while analysing and reviewing the related papers.

We ask the following research questions:

1. What are the criteria/dimensions that constitute green/sustainable supplier selection implementation?
2. Can these criteria be further categorized?
3. Which models and tools are employed in green/sustainable supplier selection research?
4. To what extent are firms incorporating sustainability principles into their supply chain regarding buyer-supplier dyad and how this is affecting their performance?
5. What are the key factors for effective supplier evaluation and selection?

6. How green/sustainable supplier selection research domain is combined with procurement and purchasing activities or other research domains in the literature?
7. What future research directions and limitations can be drawn out of the content analysis of this literature review?

## 4. Research methodology

In order to conduct a useful literature review that can yield reliable results, it is important to delimitate the research using appropriate boundaries. For the current review paper, it is worth to note that:

1. Only the relationship between suppliers and buyer was studied and analysed and the studies regarding green/sustainable supply chain management were excluded as there are already published reviews addressing those aspects.

2. Published papers in sustainable and green public procurement research were not targeted in this review as the focus of this paper is looking at the relationships of buyers and suppliers and their contribution into procurement operations and purchasing activities. Research in sustainable and green public procurement is concerned with developing methodologies and policies on efficiently spending taxpayer's money on goods and services in order to move towards sustainable development (Brammer and Walker, 2011).

3. Most of the considered papers are related to forward supply chains. However, there were a few papers that looked at buyer-supplier relationship as a part of reverse logistics. These papers were also considered in the current review to make the suggested criteria categorization more detailed and comprehensive.

Besides, the relevant references cited in the three review papers mentioned in Table 1 were also considered in this paper in order to emphasize the fact that all of the relevant papers were gathered and included in the analysis which can be taken as an indication of the validity of the research. A total of 61 articles were identified after taking the delimitations into account.

### 4.1. *Descriptive analysis*

The current review paper considers the paper published between 2008 and 2014 inclusive. The related papers published before 2008 were excluded from both descriptive and content analysis and the readers can refer to Govindan et al. (2013), Genovese et al. (2013) and

Igarashi et al. (2013) for the excluded content. It can be perceived from the results of these papers that the number of published publications from 2008 to 2011 has substantially grown. Therefore, it was decided to consider the publications published from 2008 onwards to perform a more comprehensive content analysis.

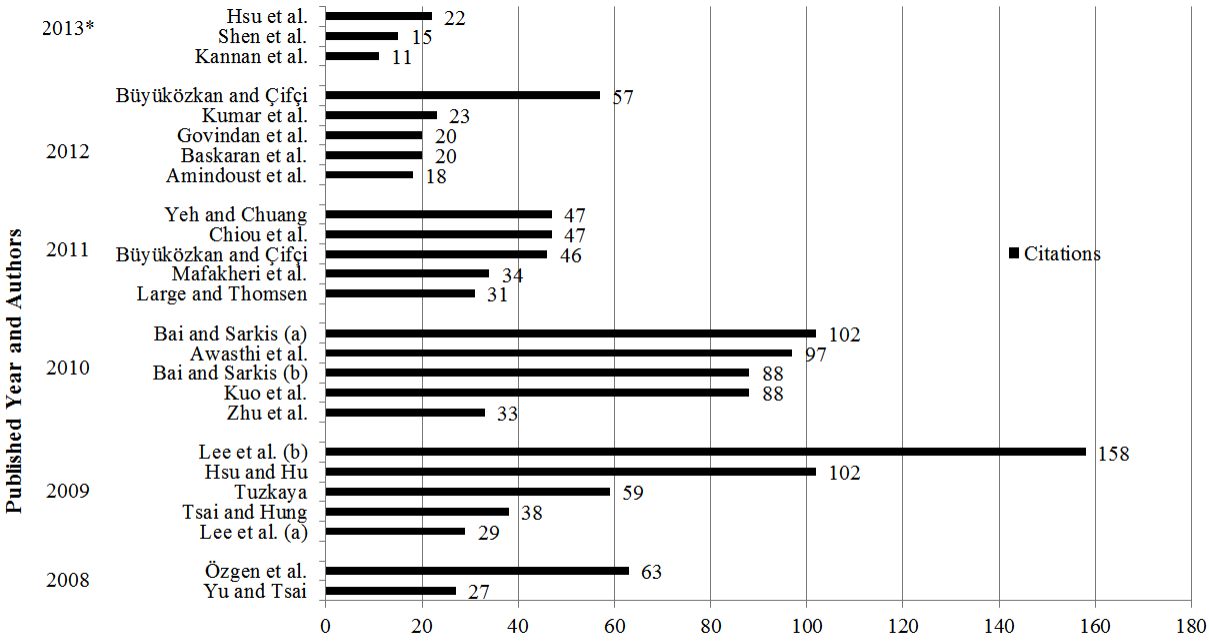
#### 4.1.1. Top cited research papers across the time

In this classification, the top papers were ranked based on their citation records for each year (see Figure 1).

Lee et al. (2009b) seems to be the top cited and a well-known paper among academia. The authors in this publication discussed environmental management systems and how to incorporate them into the supplier selection process. They investigated the process using a real-world case study, a high-tech industry, which gained lots of attention among researchers as it is well presented.

The work done by Büyüközkan and Çifçi (2012) also attracted many citations among scholars being cited 57 times. Although this was published in 2012, comparing to other articles published in the same year or some others published in previous years, it can be considered as one of the highly cited papers in the green/sustainable supplier selection research domain. One of the strengths of this paper is the presentation of the criteria selection procedure. They carefully tried to select the best criteria for environmental and economic sustainability dimensions in order to implement a proper evaluation.

As mentioned in Section 2, one of the contributions of this paper is that it tried to carefully categorize all the sample papers with regards to the possible criteria utilized for each dimension of sustainability as a reference model, with highly cited papers introduced in Figure 1 considered as the basis of the suggested categorization.




***Note:** 1. 2014 citation reports were excluded from this categorization.
2. Google Scholar is used as the source of the citation counts.

Figure 1. Top papers ranking based on their citation records in each year.

### 4.2. *Dimensions applied in the content analysis*

We identified seven dimensions of classification including:

(a) Sustainable/green supplier evaluation and selection;

(b) Environmental sustainability evaluation criteria;

(c) Social sustainability evaluation criteria;

(d) Research methodology approaches;

(e) Illustrations/application types;

(f) Industries addressed;

(g) Combined research domains.

Regarding classification of the three sustainability dimensions of the supplier selection criteria, it is worth to mention that none of these sustainability criteria and sub-criteria had explicitly been used in real world applications. However, we felt that useful starting points can be introduced to tackle the complexities of the decision processes facing organizations that are trying to balance sustainability issues and integrate these attributes into the supplier selection decision as well as other organizational management decisions.

#### 4.2.1. Sustainable/green supplier evaluation and selection

The articles are differentiated into two categories in relation to their sustainability approach either as green supplier selection articles or sustainable supplier selection articles. The former articles were defined as:

…a classical supplier selection problem in which, among the others, environmental criteria are also taken into account in order to select and monitor suppliers' performances (Genovese et al., 2013, p. 2871).

The later articles were described as:

…a process that requires consideration of environmental and social issues as well as economic ones by buyer's organization while evaluating its suppliers (Bai and Sarkis, 2010b, p. 253).

An interesting point that needs to be mentioned is the considerable amount of research activities that have been conducted regarding green supplier selection. This can be interpreted as a result of the approval of more restrictive environmental regulations (e.g. Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) in the European Union) aimed at making manufacturers, wholesalers, and final distributors fully responsible for the environmental impact of their products (Lee et al. 2009b). These types of regulations introduced by authorities and also collaborations among product designers (manufacturers) and suppliers has been identified as an important driver in reducing and eliminating product environmental hazardous impacts (Diabat and Govindan, 2011).

However, TBL attributes (environmental, economic and social) has not been adequately addressed in the process of supplier evaluation and selection in the literature. Bai and Sarkis (2010b) proposed a generic framework to evaluate suppliers on the basis of using sustainability factors in the evaluation process. They concluded that organizations that do not use the full complement of attributes to select suppliers or for outsourcing in a world where sustainability has gained significant importance by governments, communities, industry, customers, and markets, may be a disadvantage competitively. One of the important reasons for this may be due to the inadequacy of legislation in order to make manufacturing organizations obligated towards implementing social sustainability principles. Welford and Frost (2006) interviewed a number of Corporate Social Responsibility (CSR) experts and managers in developing countries and found one of the most commonly articulated complaints from CSR managers is the lack of local government involvement in enforcing local law. Genovese et al. (2013) stated that companies have started to enhance their overall sustainability profile as a result of stakeholders' demand, market pressure and more legislation toward complying with environmental principals.

4.2.2. Environmental sustainability evaluation criteria

Environmental issues cannot be neglected by firms anymore as nowadays they need to follow governmental legislation in order to remain in business. Moreover, people as the end users are gaining more awareness about environmental issues everyday through media advertisements, social networks and governments' environmental reports. This means that environmental pollution issues need to be considered in any organization's supply chain management activities such as supplier evaluation and selection; as sustainable procurement operations leads to the emerging concept of green supply chain management (GSCM) (Hsu and Hu, 2009; Diabat and Kannan, 2011; Ghadimi et al., 2013).

Academic literature regarding the evaluation and selection of suppliers while taking into account environmental issues are growing. Stakeholders are interested in investing in companies that are producing more sustainable products rather than investing in only lean and JIT manufacturing (Ghadimi et al., 2012). Similarly, customers are attracted to green/sustainable products that are manufactured in green/sustainable manufacturing organizations.

Consequently, manufacturing companies want to source their raw materials or needed components from suppliers that integrate sustainability into their manufacturing and production operations using the TBL attributes. Hence, a proper assessment of suppliers that consider sustainability issues is required. This evaluation is only possible through selection of proper assessment criteria. Dickson (1966) identified quality, delivery, and performance history as the important criteria. This study was later followed by Weber et al. (1991) with price, delivery, quality, facilities and capacity, geographic location, and technology capability to be the most important criteria for supplier selection. Ho et al. (2010) reconfirmed the previous works results by identifying quality, delivery, price/cost to be the most important factors together with manufacturing capability, service, management, and technology. However, all of these well-known research activities are conducted without considering sustainability issues.

Many researchers proposed and applied various environmental and economic criteria and sub criteria in the process of supplier assessment. Upon reviewing these research articles, an inconsistency can be observed in the criteria and sub criteria categorization done by various researchers. Obviously, ambiguity and subjectivity in categorizing especially environmental and social criteria and sub criteria has been observed. Although there are few categorizations out there that might be useful for practitioners to choose suitable criteria from, such as

GreenSCOR (Cash and Wilkerson 2003), a comprehensive classification of criteria and sub criteria is needed.

In this paper, a comprehensive and unified categorization by taking into account the most distinguished research articles (Figure 1) in this research domain (Büyüközkan and Çifçi., 2012; Bai and Sarkis 2010 a, b) is suggested.

Regarding the environmental sustainability dimension categorization, five main criteria has been identified according to the literature (Shaik, and Abdul-Kader 2011), environmental performance, green image, pollution control, green competencies and green design. Each of these criteria has a set of sub criteria that can be utilized qualitatively/quantitatively in the process of evaluation. It should be noted that a very large set of criteria and sub criteria has been utilized in various works. The complete sets of the defined categorization for environmental sustainability dimension are tabulated in Table 2 together with a brief description of the main five criteria (Shaik and Abdul-Kader, 2011).

Environmental performance and pollution control are the most widely used criteria among researchers. These two major criteria are followed by green design, green competencies and green image. Statistically, 43 articles incorporated environmental performance as the main criteria in their assessment.

Table 2. Environmental sustainability criteria.

| Criteria | Description | Sub-criteria | Source |
|---|---|---|---|
| Environmental performance | Supplier's performance towards implementing environmental policies, adapting environmental certificates and regular environmental quality audits is measured. | Environment-related certificates<br>Internal control process<br>Green process planning<br>Continuous monitoring and regulatory compliance<br>Environmental protection plans<br>Environmental protection policies | Büyüközkan and Feyzioğlu (2008); Çifçi and Büyüközkan (2011); Özgen et al. (2008); Yu and Tsai (2008); Lee et al. (2009a); Tuzkaya et al. (2009); Grisi et al. (2010); Wen and Chi (2010); Zhu et al. (2010); Chiouy et al. (2011); Large and Thomsen (2011); Mafakheri et al. (2011); Wang et al. (2012); Dou et al. (2014); Lima Junior et al. (2013); Sun et al. (2013); Tuzkaya (2013); Kannan et al. (2014a); Kannan et al. (2014b); Tsai and Hung (2009); Lee et al. (2009b); Awasthi et al. (2010); Çifçi and Büyüközkan (2011); Lee et al. (2011); Akman and Pışkın (2013); Büyüközkan (2012); Bai and Sarkis (2010a); Kuo and Lin (2012); Kuo et al. (2010); Hsu and Hu (2009); Yeh and Chuang (2011); Fu et al. (2012); Shen et al. (2013); Wittstruck and Teuteberg (2012); Buyukozkan and Cifci (2011); Bai, and Sarkis (2010b); Azadnia et al. (2013); Amindoust et al. (2012); Azadnia et al. (2012); Kannan et al. (2013); Govindan et al. (2013); Yu and Wong (2014); Azadnia et al. (2014) |
| Green image | The criterion reflects supplier's efforts toward establishing itself as an environmental friendly manufacturer among various stakeholders and customers. | Market reputation<br>Market share<br>Customer retention<br>Stakeholders' relationships<br>Staff environmental training | Özgen et al. (2008); Li and Zhao (2009); Tuzkaya et al. (2009); Grisi et al. (2010); Wen and Chi (2010); Large and Thomsen (2011); Mafakheri et al. (2011); Wang et al. (2012); Bali et al. (2013); Sun et al. (2013); Tuzkaya (2013); Kannan et al. (2014a); Kannan et al. (2014b); Lee et al. (2009b); Lee et al. (2011); Lee et al. (2013); Kuo and Lin (2012); Yeh and Chuang (2011); Fu et al. (2012); Shen et al. (2013); Shaik and Abdul-Kader (2011); Parthiban et al. (2013); Ghadimi and Heavey (2014a) |
| Pollution control | It provides measures to control supplier's pollution level, green house and $Co_2$ | Air emissions<br>Waste water | Yu and Tsai (2008); Tuzkaya et al. (2009); Yan (2009); Grisi et al. (2010); Zhu et al. (2010); |

| | | | |
|---|---|---|---|
| | emissions and check their compliance toward local and global legislation and manufacturer company's requirements. | Solid wastes<br>Resource consumption<br>Use of harmful materials<br>Carbon footprint | Chiouy et al. (2011); Large and Thomsen (2011); Mafakheri et al. (2011); Wang et al. (2012); Bali et al. (2013); Dou et al. (2014); Hashemi et al. (2013); Hsu et al. (2013a); Sun et al. (2013); Tuzkaya (2013); Kannan et al. (2014a); Kannan et al. (2014b); Theißen and Spinler (2014); Lee et al. (2009b); Awasthi et al. (2010); Lee et al. (2011); Akman and Pışkın (2013); Lee et al. (2013); Kuo et al. (2010); Hsu and Hu (2009); Yeh and Chuang (2011); Fu et al. (2012); Shen et al. (2013); Bai, and Sarkis (2010b); Azadnia et al. (2013); Amindoust et al. (2012); Azadnia et al. (2012); Kannan et al. (2013); Govindan et al. (2013); Baskaran et al. (2012); Shaik and Abdul-Kader (2011); Zhang et al. (2012); Kumar et al. (2014); Hsu et al. (2013b); Shaw et al. (2013); Azadnia et al. (2014); Ghadimi and Heavey (2014a) |
| Green competencies | Suppliers' competencies in utilizing greener production and packaging processes and materials in order to decrease environmental effects can be measured using these criteria. | Use of environmental friendly materials<br>Flexibility<br>Responsiveness<br>Green packaging<br>Recycling capability<br>Green technology | Özgen et al. (2008); Yu and Tsai (2008); Tuzkaya et al. (2009); Grisi et al. (2010); Large and Thomsen (2011); Mafakheri et al. (2011); Wang et al. (2012); Kannan et al. (2014a); Kannan et al. (2014b); Lee et al. (2009b); Awasthi et al. (2010); Çifçi and Büyüközkan (2011); Akman and Pışkın (2013); Büyüközkan (2012); Kuo and Lin (2012); Hsu and Hu (2009); Yeh and Chuang (2011); Shen et al. (2013); Wittstruck and Teuteberg (2012); Amindoust et al. (2012); Shaik and Abdul-Kader (2011); Büyüközkan and Çifçi (2012); Dai and Blackhurst (2012); Ghadimi and Heavey (2014a) |
| Green design | The design for environment which includes checking the supplier's design for environment capability so that the product becomes more environmental friendly. | Recycle<br>Reuse<br>Refurbish<br>Remanufacture<br>Disassembly<br>Disposal | Tuzkaya et al. (2009); Chiouy et al. (2011); Mafakheri et al. (2011); Wang et al. (2012); Wang et al. (2012); Bali et al. (2013); Sun et al. (2013); Tuzkaya (2013); Kannan et al. (2014a); Kannan et al. (2014b); Çifçi and Büyüközkan (2011); Lee et al. (2011); Akman and Pışkın (2013); Büyüközkan (2012); Bai and Sarkis (2010a); Yeh and Chuang (2011); Shen et al. (2013); |

| | | |
|---|---|---|
| | | Amindoust et al. (2012); Azadnia et al. (2012); Kannan et al. (2013); Govindan et al. (2013); Shaik and Abdul-Kader (2011); Büyüközkan and Çifçi (2012); |

4.2.3. Social sustainability evaluation criteria

Sustainable development and sustainability is frequently interpreted as a synthesis of economic, environmental and social development, a TBL approach (Seuring and Müller, 2008). Other than green supplier selection decisions, a more practical attachment of other sustainability factors to the traditional supplier selection problem is needed. In other words, Social dimension criteria, e.g., human rights abuses, child labour, and irresponsible investment need to be incorporated into traditional/green supplier selection in order to have a TBL consideration of sustainability. Globally, social issues like human rights, workers health and safety issues are being increasingly acknowledged by manufacturing organizations and need to be considered in their organizations' metrics in combination with environmental criteria (Bai, and Sarkis, 2010b).

CSR is one of the important concepts when practising social supply chain management which encompasses sustainable procurement operations and sustainable supplier selection and order allocation. In 2001, CSR was defined by the Commission of the European Communities as "the voluntary integration, by organizations, of social and environmental concerns in their commercial operations and in their relationships with interested parties". Cruz (2013) stated that CSR is not only a prominent research theme but it can also be found in corporate missions and value statements. In a socially responsible supply chain, not considering social factors can affect an organization's reputation and long term success. This is because organizations are held responsible for paying constant attention to their workers' health and safety issues together with some other important social criteria such as stakeholder engagement e.g. manufacturers, distributors, and/or retailers (Cruz and Wakolbinger, 2008). Table 3 summarizes a number of factors and measures regarding social dimension of sustainability.

Table 3. Social sustainability criteria.

| Criteria | Description | Sub criteria | Source |
|---|---|---|---|
| Health and safety | Measuring a potential supplier's considerations in terms of health and safety practices. | Standardized health and safety conditions<br>Health and safety incidents<br>Health and safety practices<br>Occupational Health and Safety Management (OHSAS) 18001 | Chiouy et al. (2011); Lee et al. (2013); Wittstruck and Teuteberg (2012); Bai, and Sarkis (2010b); Azadnia et al. (2012); Amindoust et al. (2012); Azadnia et al. (2013); Govindan et al. (2013); Dai and Blackhurst (2012); Thornton et al. (2013); Azadnia et al. (2014); Ghadimi and Heavey (2014a) |
| Employment practices | The influences that an employer can have on its employees. | Disciplinary and security practices<br>The interests and rights of | Chiouy et al. (2011); Lee et al. (2013); Buyukozkan and Cifci (2011); Bai, and Sarkis (2010b); |

| | | | |
|---|---|---|---|
| | | employee<br>Employee contracts<br>Equity labor sources<br>Diversity<br>Discrimination<br>Flexible working arrangements<br>Job opportunities<br>Employment compensation<br>Research and development<br>Career development<br>Employee welfare<br>Child labor | Azadnia et al. (2012); Amindoust et al. (2012); Azadnia et al. (2013); Govindan et al. (2013); Baskaran et al. (2012); Dai and Blackhurst (2012); Thornton et al. (2013); Azadnia et al. (2014); Ghadimi and Heavey (2014a) |
| Local communities influence | Social influences that a potential supplier can make to its surroundings. | Health<br>Education<br>Housing<br>Service infrastructure<br>Mobility infrastructure<br>Regulatory and public services<br>Supporting educational institutions<br>Security<br>Economic welfare and growth<br>Social cohesion<br>Grants and donations<br>Supporting community projects | Bai, and Sarkis (2010b); Govindan et al. (2013); Baskaran et al. (2012); Dai and Blackhurst (2012); Thornton et al. (2013) |
| Contractual stakeholders influence | Measuring the level of attentions that a potential supplier pays to get its stakeholders to be involved in its activities and operations. | Procurement standard<br>Partnership screens and standards<br>Consumers education<br>Decision influence potential<br>Stakeholder empowerment<br>Stakeholder engagement<br>Information disclosures | Chiouy et al. (2011); Bai, and Sarkis (2010b); Govindan et al. (2013); Thornton et al. (2013) |

4.2.4. Research methodology techniques

In this section, we look at the various tools and methodologies that have been employed to conduct the supplier evaluation and selection process. The purpose here is to find out what tools/methodologies are the most popular and widely used among researchers in the area of sustainable/green supplier selection.

Table 4 categorizes the tools employed and also the number of papers that any specific tool was utilized by researchers. From a high level view, the papers were categorized into two separate steps i.e. single approach models where only one type of tool is utilized to conduct the assessment such as Multi-Criteria Decision Making (MCDM) and combined approach models where various techniques and tools such as fuzzy approach and MCDM methods are combined to form an integrated methodology. In Table 5, the individual utilized

approaches for all of the developed tools that are presented in Table 4 are analysed with regard to their advantages and disadvantages. The analysis of the merit and drawbacks of hybrid and fuzzy tools are not presented as they are a combination of the presented approaches in Table 5.

Table 4. Categorization of the tools employed.

| Proposed approach type | Tool | Authors |
|---|---|---|
| *Single approach models – MCDM* | Multiple-Attribute Utility Theory (MAUT) | Shaik and Abdul-Kader (2011) |
| | Data Envelopment Analysis (DEA) | Sun et al. (2013), Kumar et al. (2014) |
| | Decision Making Trial and Evaluation Laboratory (DEMATEL) | Hsu et al. (2013a) |
| | Analytical Network Process (ANP) | Hsu and Hu (2009), Zhu et al. (2010), Theißen and Spinler (2014) |
| | AHP | Özgen et al. (2008), Yu and Tsai (2008), Li and Zhao (2009), Mafakheri et al. (2011), Lee et al. (2013), Shaw et al. (2013) |
| *Single approach models – Mathematical programming* | Goal programming | Tsai and Hung (2009) |
| | Multi-objective programming | Lee et al. (2009a), Yeh and Chuang (2011), Zhang et al. (2012) |
| *Single approach models – Other approaches* | Survey/questionnaire | Large and Thomsen (2011), Thornton et al. (2013) |
| | Rough set theory | Bai, and Sarkis (2010a, b) |
| | Grey system approach | Baskaran et al. (2012) |
| | Fuzzy Inference System (FIS) | Amindoust et al. (2012), Lima Junior et al. (2013); Ghadimi and Heavey (2014a) |
| | Fuzzy Axiomatic Design (AD) | Kannan et al. (2014b) |
| *Combined approach models – Integrated Fuzzy approach* | Fuzzy Analytical Hierarchy Process (FAHP) | Grisi et al. (2010), Lee et al. (2011), Chiouy et al. (2011), Çifçi and Büyüközkan (2011) |
| | FAHP-Delphi | Lee et al. (2009b) |
| | Fuzzy-SWOT-DEA | Parthiban et al. (2013) |
| | FAHP-FuzzyAD | Büyüközkan (2012) |
| | Fuzzy-DEMATEL-ANP-TOPSIS | Büyüközkan and Çifçi (2012) |
| | Fuzzy-VIKOR | Büyüközkan and Feyzioğlu (2008) |
| | Fuzzy-TOPSIS | Awasthi et al. (2010), Shen et al. (2013), Govindan et al. (2013), Kannan et al. (2014a); Yu and Wong (2014) |
| | Fuzzy-AHP-TOPSIS | Wittstruck and Teuteberg (2012), Azadnia et al. (2012), Kannan et al. (2013), Wittstruck and Teuteberg (2012) |
| | FANP | Buyukozkan and Cifci (2011) |
| | FAHP and FIS | Azadnia et al. (2013); Azadnia et al. (2014) |
| | Fuzzy-Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE)-FANP | Tuzkaya et al. (2009) |
| | Fuzzy-case-based reasoning (CBR) | Wang et al. (2012) |
| | Fuzzy-grey relational analysis | Bali et al. (2013), Hashemi et al. (2013) |

| | | |
|---|---|---|
| | (GRA) | |
| | Fuzzy-Choquet integral operator | Tuzkaya (2013) |
| *Combined approach models – Integrated mixed approach* | Genetic Algorithm-AHP | Yan (2009) |
| | AHP-DEA | Wen and Chi (2010) |
| | ANN-DEA-ANP | Kuo et al. (2010) |
| | Grey System Theory and DEMATEL | Fu et al. (2012) |
| | ANP-DEA | Kuo and Lin (2012) |
| | ANP-TOPSIS | Akman and Pışkın (2013) |
| | ANP-VIKOR | Hsu et al. (2013b) |
| | ANP-DEMATEL | Lee et al. (2013) |
| | Grey System Theory and ANP | Dou et al. (2014) |

Table 5. Advantages and disadvantages of the tools employed.

| Tool | Advantages | Disadvantages |
|---|---|---|
| MAUT | • ability to help decision makers gain further knowledge and understanding of the problem.<br>• flexible and quantitative decision analysis tool.<br>• capability to select the best alternative under dynamically changing situations | • rather complex method.<br>• procedure for determining work is not convenient considering the complicated framework. |
| DEA | • multiple inputs and outputs can be considered. | • needs to assume that all data are exactly and percisely known. |
| DEMATEL | • ability to deal with the interrelationship among criteria.<br>• it can calculate and quantify efficiency | • inability to consider the ambiguities of human assessments given the crisp value of the inputs.<br>• Existance of vagueness in the integrated mechanism of expert opinion. |
| ANP | • independence among elements is included.<br>• feedback mechanism improves the priorities resulting in more accurate prediction.<br>• Decision making process is not biased due to considering interdependencies. | • time consuming<br>• uncertainty is not supported |
| AHP | • ability to handle problems that cannot be handled by mathematical models.<br>• can handle both quantitative and qualitative judgements<br>• calculating inconsistency index as a ratio of the decision maker's inconsistency | • requires high level of management involvement.<br>• not able to evaluate under uncertain environment.<br>• number of pairwise comparisons for complex processes.<br>• criticised for its reliability based on the decision makers' beliefs and preferences.<br>• has limitation in the use of 9-point scales. |
| Goal programming/ Multi-objective programming | • has the capacity to handle large-scale problems<br>• unlimited alternatives can be produced | • inability to weight coefficient.<br>• needs to be combined with weigting approachses. |

| | | |
|---|---|---|
| Survey/questionnaire | • easy to analyze the results | • imprecise results if small sample size |
| Rough set theory | • provides appropriate tools for uncover the underlying patterns about available data.<br>• ideal for explanatory analysis applications. | • dependence on availability of comprehensive information with known object values (data-driven).<br>• the utilized approximation boundaries may not always reflect the real case situations.<br>• the possibility of large number of rules while dealing with big data. |
| FIS | • reduces subjectivity in decision makers opinion.<br>• large number of alternatives can be taken into account. | • constructing the if-then rules can be complex while dealing with more than four criteria.<br>• the number of rules increases in great extent in case of having large number of criteria and sub-criteria |
| VIKOR | • handling conflicting and noncommensurable criteria<br>• provides optimum level for decision making by maximizing utility group and minimizing regret group. | • crisp performance rating values might be inadequate for handling real life supplier selection problems. |
| TOPSIS | • easy to implement<br>• easy to visualize all the performance measures.<br>• the ability to identify the best alternative quickly | • less accurate in case of so many criteria. |
| PROMETHEE | • easy to use.<br>• less inputs are needed regarding evaluation elicitation. | • does not provide a clear method by which to assign weights.<br>• not providing hierarchal structure to break down the problem.<br>• no specific guidelines are given to determine the weights. |
| CBR | • ability to learn from past cases to come up with better ranking solutions.<br>• ill-structured selection problems can be handled<br>• can handle missing input values by measuring the similarities of preexisted cases. | • deficiency to reason based on insufficient knowledge/cases about suppliers.<br>• old case might bias the reasoner for new situations. |
| GRA | • ability to deal with limited data.<br>• ability to handle quantitative data. | • has difficulty to adopt linguistic variables.<br>• not able to evaluate qualitative data. |

As listed in Table 4, tools such as AHP, Delphi, DEA, TOPSIS, VIKOR have been combined with a fuzzy logic approach forming a hybrid fuzzy approach to address the uncertain environment in decision making processes (Büyüközkan and Feyzioğlu, 2008; Çifçi and Büyüközkan, 2011; Govindan et al., 2013).

4.2.5. Illustrations types

As shown in Table 6, four approaches for model validations are used in the literature. There are many papers that "generated numerical tests" used to illustrate the efficiency and effectiveness of the proposed methodology or approach (28 papers in total).

Two papers have been identified among the reviewed papers that are purely theoretical. The authors of these papers proposed a methodology, but did not apply them on any numerical example or real case study. Authors in four papers used statistical data to conduct their research. These articles mostly applied questionnaire/survey-based approaches to gather their required data and information.

In 27 research articles case studies were used where the efficiency of the developed tools were examined. Although using numerical examples to verify the developed method merits can be useful (Amindoust et al., 2012), applying the developed method on a real-life example with real data can shed light on the actual implementation challenges of the developed approach (Azadnia et al., 2014). Kumar et al. (2012) also mentioned that offering such approaches and applying them on a real world application provides insights that are more realistic in finding out the actual willingness of companies towards integrating sustainability into their supply chain practices. This significant aspect would not be considered in papers where the methodologies have not been applied to a real-life example.

Table 6. Validation approaches.

| Types | No. of articles (N = 61) |
|---|---|
| Generated numerical examples | Özgen et al. (2008); Tsai and Hung (2009); Hsu and Hu (2009); Lee et al. (2009a); Li and Zhao (2009); Yan (2009); Bai and Sarkis (2010a); Awasthi et al. (2010); Wen and Chi (2010); Zhu et al. (2010); Bai and Sarkis (2010b); Shaik and Abdul-Kader (2011); Mafakheri et al. (2011); Kuo and Lin (2012); Wang et al. (2012); Amindoust et al. (2012); Azadnia et al. (2012); Dai and Blackhurst (2012); Bali et al. (2013); Hashemi et al. (2013); Lima Junior et al. (2013); Sun et al. (2013); Tuzkaya (2013); Kannan et al. (2013); Parthiban et al. (2013); Shen et al. (2013); Govindan et al. (2013); Yu and Wong (2014) |
| Statistical data | Large and Thomsen (2011); Thornton et al. (2013) |
| Real-world applications/case studies | Büyüközkan and Feyzioğlu (2008); Yu and Tsai (2008); Tuzkaya et al. (2009); Lee et al. (2009b); Kuo et al. (2010); Buyukozkan and Cifci (2011); Çifçi and Büyüközkan (2011); Chiouy et al. (2011); Yeh and Chuang (2011); Wittstruck and Teuteberg (2012); Büyüközkan (2012); Büyüközkan and Çifçi (2012); Fu et al. (2012); Baskaran et al. (2012); Shaw et al. (2013); Akman and Pışkın (2013); Hsu et al. (2013b); Azadnia et al. (2013); Hsu et al. (2013a); Kannan et al. (2014a); Kannan et al. (2014b); Kumar et al. |

| | |
|---|---|
| | (2014); Theißen and Spinler (2014); Dou et al. (2014); Azadnia et al. (2014); Ghadimi and Heavey (2014a) |
| Theoretical approach | Grisi et al. (2010); Lee et al. (2011); Zhang et al. (2012); lee et al. (2013) |

4.2.6. Industries addressed

From publications in which real-world data have been utilized, we can conclude that there are three main industries involved in the sustainable procurement and supplier selection process. In Table 7, ten research articles address supplier management problems in the automotive industry. This is followed by electrical/electronic industry for which nine research activities were reported. White goods manufacturing industry is the third most addressed industry among researchers with four research publications during 2008 to 2014.

Table 7. Classification based on industries addressed.

| Industry | Reference |
|---|---|
| Automotive manufacturing | Li and Zhao (2009); Çifçi and Büyüközkan (2011); Büyüközkan (2012); Büyüközkan and Çifçi (2012); Akman and Pışkın (2013); Kannan et al. (2013); Parthiban et al. (2013); Kumar et al. (2014); Azadnia et al. (2013); Kannan et al. (2014b) |
| Electrical/Electronic | Chiouy et al. (2011); Hsu et al. (2013a); Kannan et al. (2014a); Tsai and Hung (2009); Hsu and Hu (2009); Yeh and Chuang (2011); Hsu et al. (2013b); Kuo et al. (2010); Wittstruck and Teuteberg (2012); |
| White goods manufacturing | Tuzkaya et al. (2009); Lima Junior et al. (2013); Buyukozkan and Cifci (2011); Lee et al. (2009a) |
| Semiconductor industry | Yu and Tsai (2008); Lee et al. (2009b) |
| Garment manufacturing | Shaw et al. (2013); Baskaran et al. (2012) |
| Pivot irrigation equipment | Dou et al. (2014); |
| Hand tool manufacturing | Lee et al. (2011) |
| Pipe clamps and hanging systems | Özgen et al. (2008) |
| Telecommunication equipment provider | Fu et al. (2012) |
| Fast-moving consumer goods (FMCGs) | Theißen and Spinler (2014) |
| Packaging industry | Azadnia et al. (2014) |
| Medical device | Ghadimi and Heavey (2014a) |

4.2.7. Combined research domains

In almost all of the research activities already cited in this review paper, the problem of supplier selection solely examined identifying the best suppliers with regards to sustainable/green issues and practices. There are only a few research activities conducted with respect to integrating the sustainable/green supplier selection problem with other problems. Three other research problems have been considered simultaneously with the sustainable/green supplier evaluation and selection problem, they are as follows:

(1) order allocation;

(2) distributed, real-time assignment and control;

(3) clustering techniques.

Order allocation is made where selected supply partners are identified using a ranking methodology and then optimal order quantities are allocated to them based on their production limitations and constraints (Özgen et al., 2008;Yu and Tsai, 2008;Mafakheri et al., 2011;Shaw et al., 2013;Yeh and Chuang, 2011; Kannan et al., 2013; Azadnia et al., 2014).

The distributed real-time assignment and control via Multi-Agent Systems (MAS) where agent technology is integrated with the supplier selection process mostly for negotiation-based selection where a network of agents communicate with each other to come up with the best proposal and consequently the best supplier (Ghadimi and Heavey, 2014b; Wang et al., 2012; Lee et al., 2009a). Also, there are publications where clustering techniques are used as a step before the evaluation and selection process where suppliers are clustered from the top performance cluster to the lowest performance cluster for further evaluation and investigation and final shortlisting (Bai, and Sarkis, 2010b; Azadnia et al., 2012).

## 5. Discussion

In the following sub-sections, we present findings and insights in order to answer the research questions presented in Section 3.

### 5.1. *Sustainable/green supplier selection implementation widely used criteria/dimensions*

It has been observed that 70.5% of the reviewed papers incorporated environmental performance as the main criteria in their assessment. Regarding the inclusion of the social aspects of sustainability into the process of supplier selection, employment practices is the most popular main criteria among researchers as it is considered in 13 papers (21.3%). Based on content analysis, the most important sub criteria used are *disciplinary and security practices* and *employee training*.

In the current review paper, a categorization of the main sustainability criteria and their sub criteria were suggested. The defined categorization can be used as a comprehensive repository of almost all of the utilized influencing factors in the related literature. This categorization was provided based on well-known papers identified through this review study and is intended to provide an insight for practitioners in various type of industries. However, the decision-makers in organizations need to take proper deliberations and justifications in choosing the appropriate main and sub-criteria as some sets of sub-criteria might not be suitable for a specific type of industry.

As mentioned above, the influencing factors presented in Tables 2 and 3 were gathered and categorized based on their utilization in the reviewed papers. It is worth mentioning that these influencing factors act as input data for the developed approaches. However, there is no research activity that has addressed clearly how to calculate the value of these influencing factors. Therefore, additional emprical research would be required to address this gap especially for the influencing factors related to environmental and social sustainability. Conducting such research requires a large participation of practitioners mostly from the top three industries that are pointed out in Section 4.3.6 i.e. electrical/electronics, automotive manufacturing, and white goods manufacturing.

### 5.2. *Widely applied tools and approaches in green/sustainable supplier selection research*

Many tools and approaches have been proposed and applied to the process of sustainable and green supplier selection. One interesting characteristic is the dominance of fuzzy analysis. Interestingly, researchers in twenty six papers (42.6%) combined fuzzy set theory with other tools such as AHP, ANP, TOPSIS and DEMATEL. The reason for the use of fuzzy analysis lies behind the natural uncertainty, ambiguity and intangibility involved in the decision-making process in this domain. Another reason is the underling vagueness and uncertainty involved in the sustainability attributes as well. Twenty six papers (42.6%) of the identified papers utilized a single approach in their analysis which is most probably due to the easiness involved in using just one tool which of course requires relaxing some complexities in the analysis. In a literature review done by Kannan et al. (2013), considering publications during 1997 to 2011, 77.77% of the identified papers considered a single approach in their analysis. Comparing this result with the 42.6% obtained in this current review, it can be perceived that researchers are more willing to use integrated approaches where the complexities of the real-world decision process are more realistically taken into account. As mentioned in Table 5, the single approach tools might be easier to implement in industry but all of them have some drawbacks that can be tackled by combining them with other approaches to form a hybrid tool.

The most popular MCDM approach that was utilized solely or integrated with other approaches is AHP. Surprisingly, AHP was involved in the developed tools in nineteen papers (31.14%). AHP helps to include both qualitative and quantitative attributes in a partner selection process. AHP can be easily implemented by practitioners in industry if they want to adopt it for measuring the performance of a supplier and it allows them to directly participate in the decision process. Despite the many benefits that come with applying AHP

in the decision-making process, there are some drawbacks worth mentioned. The AHP process can be time consuming and complex when we are dealing with a great number of criteria and sub criteria. This complexity would occur in the pairwise comparisons required by the AHP process. To avoid this type of complexity, it is recommended to group the attributes into more specific sub criteria in order to shorten the number of factors considered in each sub criteria. Besides, some of the sub-criteria are forced to be considered as qualitative although they are naturally quantitative such as several types of cost. Integrating AHP with fuzzy set theory seems to be advantageous for some certain situations and applications but not all the time. Kannan et al. (2013) pointed out that in some studies fuzzy AHP does not contribute to the final results but at the same time causes difficulties for practitioners as more computational efforts are required.

Regardless of many proposed mathematical and decision support systems whether integrated or a single approach, it is always difficult for practitioners to implement them due to the embedded complexity involved. Therefore, some approaches that can reduce unnecessary human interactions while implementing the tools have to be developed. This matter is discussed in Section 5.6 in more details.

### 5.3. *Firms' sustainability awareness and their performance*

Genovese et al. (2013) stated that difficulties in measuring environmental variables act as an obstacle to implement proposed methodologies in the academic literature. Therefore, it can cause a gap in penetrating sustainability concepts in an organization's corporate agenda. This was also confirmed by Tsoulfas and Pappis (2008) who highlighted that this issue occurs due to the qualitative and intangible nature of many of the indicators. Our analysis seems to indicate a trend towards more and more application of the proposed models on real world cases.

Almost 59% of the reviewed papers conducted their research using real-world data which illuminate that the gap reported by Genovese et al. (2013) is narrowing but still not completely closed. Towards engaging suppliers into the TBL practices, it was reported by Dou et al. (2014) that suppliers that intend to participate in green/sustainable supplier development programs will gain more profit margins and returns out of their investments in these types of programs. Besides, Çifçi, G. Büyüközkan (2011) pointed out that a good green supplier selection model in the competitive environment can help lessen the environmental and legal risks and increase the competitiveness of a firm. However, Kannan et al. (2014) stated that although their work was applied on a real case company together with its suppliers

in Brazil, it does not indicate that the suppliers are aligned with the TBL principles. Therefore, continuous improvement toward increasing suppliers' awareness toward the TBL context should always be pursued such as training the suppliers to modify their product design toward the TBL attributes and also to have proactive commitments toward environmental management practices.

Using the results presented in Section 4.2.7, combining supplier selection with other research problems and techniques such as order allocation can yield interesting results regarding illuminating the role of sustainability in suppliers' performance and finally their total profitability considering many constraints such as production capacity, delivery lead time and so forth. It can be perceived that suppliers which are committing to the manufacturer's sustainable development programs and trying to incorporate sustainability into their corporate agenda would be allocated more orders and as a result would gain more competitive advantages (Kannan et al. 2013). Despite the fact mentioned by Kannan et al. (2013), Hollos et al. (2012) pointed out that social practices do not yield tangible impact of reducing costs which can be interpreted as a reason why companies are not that willing to invest in social practices.

Additional research has to be done taking SMEs into account as they constitute a great portion of suppliers for large organizations reviewed in the current literature such as Intel, Coca Cola and Ford. To our knowledge, there is no research conducted considering a holistic view of second and third tier suppliers.

### 5.4. *Effective supplier evaluation and selection key factors*

Most of the published papers conducted their research activities in Asia and the middle-east where sustainability and environmental practices are evolving. One of the important barriers is the lack of effective legislation to make it an obligation for manufacturers to actually evaluate their supplier using a TBL measure in these regions. Also, Tsai and Hung (2009) reported that cost problems are also critical barriers for enterprises to implement environmental aware procurement operations.

However, legislation in some other regions, such as the EU, acts as enablers for green/sustainable practices in procurement and purchasing activities (Walker et al., 2008). In the sustainable procurement context, customers can act as drivers. Customers can be divided into two types: large customers that are actually the manufacturers themselves. They drive smaller suppliers to improve their performance regarding sustainability issues as they are

requested by a second type of costumers that are end-costumers and stakeholders to manufacture green/sustainable products or the implementation of environmentally friendly practices (Walker et al., 2008; Blome et al., 2013). Apart from these, gaining competitive advantage can act as another key factor for effective supplier evaluation. End-customers and other stakeholders ask for sustainable products or components, seeking for companies that can provide such products. Small manufacturing companies try to improve their competitive advantage by increasing their commitment in being environmentally and socially responsible, increasing their chance to be selected as a supply partner for large manufacturing organizations.

### 5.5. *Contribution of sustainable/green supplier selection to sustainable procurement and purchasing activities*

Hollos et al. (2012) clarified that incorporating green attributes in an organization's procurement operations can have positive impacts on its costs and operational performance. Krause et al. (2009) pointed out that companies who practice sustainable procurement activities need to be located in a supply chain where all partners have commitments to the TBL. The buyer-supplier dyad as one part of the procurement and purchasing activities plays an important role in these commitments. In order to do so, manufacturers (OEM) should systemically analyse the supplier's environmental performance with various elements, such as business policy, modes of transportation, products and processes which must be environmentally compliant. They should also note that the selected supplier has the capacity to deal with the growing demand for improvements in environmental performance, by expressing it through environmental and social clauses in supply contracts (Shaik and Abdul-Kader, 2011). Blome et al. (2013) defined a relationship between green supplier development and green procurement activities by explaining that green supplier development can be affected in a positive manner whenever there is more focus on waste reduction and green packaging through green procurement initiatives. In addition, based on Section 4.2.7, sustainable/green supplier selection has been combined with other problems for instance, order allocation. This particular integration can be seen as an important step towards integrating the supplier selection process with procurement and purchasing activities.

### 5.6. *Future research directions, limitations and managerial implications*

It can be pointed out from the result of this review that many researchers tried to model the supplier selection problem by various types of modelling approaches such as MCDM,

integrated fuzzy techniques, survey-based approaches and multi-objective programming. The main issue in almost all of these studies is that the evaluation and selection process in most cases is done just once which lacks the consideration of market uncertainty and dynamic changes in the suppliers' behaviours. As highlighted in Section 4.2.7, Lee et al. (2009a) and Wang et al. (2012) applied a MAS approach on the supplier evaluation and selection problem in order to make the whole process automated. Additional research has to be conducted to expand their attempts by applying an Agent-based Simulation and Modelling (MASM) approach combined with order allocation processes which can capture the uncertainty involved. Such a model can be an interesting subject for future investigation. Combining the order allocation models into the supplier selection model would make the MAS model more challenging and more practical.

An interesting point that can be perceived from the current body of literature is the lack of a further stage named "application feedback" that was initially proposed by Wu and Barnes (2009) and Luo et al. (2009) to be added to the process of supplier selection. It was argued that today's highly competitive environment where selecting the right supplier at the right time would require such an additional step. This step can contribute to the concept of continuous improvement as it can be designed so that the process of a supplier selection process in SCs can be continuously improved. This aspect can be also addressed as a future research topic.

We also observed that huge advancements among practitioners and academia are needed to come up with a reference or at least a standard model to calculate the intangible and sometimes tangible influencing factors especially related to environmental and social sustainability. On a different note, sensitivity analysis is not also included in most of the research activities. Most of the researchers tried to adjust the impact of each sustainability criterion through the weights that are assigned to them based on the decision makers opinion which can be highly subjective. As also mentioned by Kannan et al. (2013), using sensitivity analysis the impacts of criteria weights on the selection of a supplier with the best sustainable/green performance can be obtained by changing the weights of the criteria for several experiments. Moreover, future research works can focus on considering a holistic view of second and third tier suppliers as they constitute a great portion of suppliers for large organizations.

An important limitation that was mentioned by some researchers is poor supplier commitment especially by smaller companies to disclose their information. Walker et al. (2008) also mentioned that this limitation exists and is an industry specific barrier. Industries

that are more related to the health care market segment are controlled by the US Food and Drug Administration (FDA) regulations and are not willing to expose their information regarding the supplier selection and purchasing and manufacturing activities. One more limitation that might occur while conducting research in this area is related to convincing the managers and CEOs inside some companies, specially SMEs, that social sustainability can be advantageous for their business. As mentioned earlier, considering social sustainability might not have direct impact on increasing the profitability of their operations (Hollos et al., 2012) but it has been proven in a few works that it can eventually be a driver for widening a company's profit margin (Thornton et al. 2013). Unfortunately most SMEs are more willing to be forced to comply with environmental regulations and laws and skip social practices.

## 6. Conclusion

A systematic review of supplier evaluation and selection problems and their relationship with sustainable procurement and purchasing activities has been conducted. It initially specified the concept of sustainable and green supplier selection and briefly described its role in sustainable procurement. The paper then employed a methodology to conduct a systematic and comprehensive content analysis. A seven dimensions taxonomy was designed for this review: (a) sustainable/green supplier evaluation and selection; (b) environmental sustainability evaluation criteria; (c) social sustainability evaluation criteria (d) research methodology approaches; (e) illustrations/application types; (f) industries addressed; (g) combined research domains. The main contribution of this current review is providing a state-of-the-art using these seven dimensions to carry out a content analysis of papers published during 2008 to 2014. Besides, a comprehensive sustainable supplier selection criteria categorization is suggested to be utilized by practitioners and researchers who want to conduct research in this area. To our knowledge, this is the first review paper that considers the TBL measure.

This paper found that the most popular evaluation tool identified was AHP, which was utilized solely or integrated with other approaches, confirming the results obtained by Kannan et al. (2013). The main evaluation criteria applied was "environmental performance" and "pollution control". Regarding social sustainability evaluation criteria, "employment practices" appears to be the most popular main criteria among researchers. Moreover, real-world applications seems to be increasing in the research activities conducted in this area, giving the impression that the extent of firms' awareness of incorporating sustainability into

their procurement and supplier evaluation activities has increased compared with previous results presented by other review papers in this area (Section 2). Additionally, the top three active industries in supplier management activities have been identified together with highlighting the links between sustainable procurement and other activities in the buyer-supplier relationship. Finally, some future directions have been introduced for research.

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