

*Article*

## How Do Contractors Select Suppliers for Greener Construction Projects? The Case of Three Swedish Companies

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*Received: 12 May 2014; in revised form: 12 June 2014 / Accepted: 16 June 2014 /*

*Published: 30 June 2014*

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**Abstract:** There are many studies of contractor selection based on clients and the selection of suppliers by contractors. However, supplier selection specifically related to green construction projects has been much less studied. Green construction differs from conventional construction because of differences in its underlying principles and use of environmentally-friendly materials and technologies. This paper studies how procurers in contractor companies in Sweden adopt green projects and how contractor perception of supplier mastery of green knowledge affects supplier selection. The investigation is based on a set of semi-structured interviews conducted among three large contractors in Sweden. A main finding is that the perceived differences between green and conventional projects do not change supplier selection dramatically. An implication is that “greener projects” is a more appropriate denotation than “green project”. Evidence shows that suppliers’ green knowledge is an important factor in supplier selection, as respondents rated suppliers’ knowledge of green projects as very important, and to fix this, there was a consensus among respondents about the need for close collaboration between contractors and suppliers. To ensure knowledge acquisition from suppliers and to increase their competitive advantage over rivals, contractors collaborate with their suppliers in a partnering setting. It is anticipated that the results of this study will be used to fill the gap in the literature on supplier selection in green projects and can also be used for construction firms contemplating getting involved in green projects.

**Keywords:** procurement; knowledge transfer; partnering; green construction; supplier selection

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## 1. Introduction

The construction industry consists of companies with different aims and specializations that work together on projects to deliver a final product. For most projects, the client selects the contractor, which then selects suppliers of goods and services. The successful implementation of a project requires selecting companies that contribute to the project objective. This selection should be tailored to match project objectives.

One objective for many construction projects is environmental sustainability, or green construction [1]. This has recently come into attention as a result of increased environmental awareness among policy-makers, stakeholders [2] and non-governmental organizations [3]. Consequently, construction companies have integrated green concepts into their construction plans to mitigate the impacts on the environment [4,5].

The construction industry consumes about 40 percent of the global material and produces almost 25 percent of the global waste for creating and operating buildings [6,7]. This shows the importance of materials and goods used in the construction process and the final product.

A shift from a disposable goods approach to a recycled goods approach [8] is required to become green. Manufacturers of goods and materials largely make such changes by means of product and process innovations [9]. As providers of green knowledge in construction [10], they are key drivers of technical innovation [11]. This is important, as green construction is an innovation in the industry [12], whose adoption requires green technology.

Green technologies may require new forms of knowledge and competencies [13], because green technologies often require complicated techniques and construction processes [14], and green buildings are often more sophisticated than conventional buildings [15]. For instance, the design of a green building generally takes longer than traditional design [16,17] and requires a more holistic and integrated approach [18].

A lack of knowledge about green technologies is a main barrier to considering green issues [19]. This knowledge can be acquired by inter-firm collaboration [20,21]. Although contractors in conventional construction use several procurement methods, see [22–24], none of these methods automatically results in the successful transfer of knowledge from suppliers. Arguably, purchasing methods that deliver knowledge to the contractor must be selected. This means that the role of suppliers in green construction projects (referred to as green projects) is two-fold: a provider of greener goods and materials; and a source of green knowledge for contractors.

Although the construction literature addresses contractors' selection of suppliers and subcontractors [25–32], no study has examined how green projects affect contractors' procurement processes, including their supplier selection methods.

Currently, the literature is ambiguous in terms of how green construction is different from conventional construction. Although the construction literature deals with different aspects of green projects (for example, in terms of underlying principles, economics and supply chains) and, to varying degrees, the differences between how green and conventional projects are portrayed, it is not so clear to what extent these two types of projects differ. There is no evidence showing how large the differences must be to justify a totally different purchasing process. Therefore, this paper attempts to analyze how supplier selection methods in green projects are influenced by contractors' potential for learning from suppliers.

I address two research questions:

RQ1: How does supplier selection for green construction projects differ from conventional construction projects?

RQ2: How does contractor perception of supplier mastery of green knowledge affect supplier selection?

It is anticipated that the results of this study will be used to fill the gap in the literature on contractor-supplier selection in green projects and can also be used for construction firms contemplating getting involved in green projects. The first part of this paper discusses purchasing in construction and green projects, followed by a literature review of the knowledge exchange in construction and green projects. Methods, results and a discussion are then presented. The analysis and conclusion are presented last.

## 2. Procurement Methods in Construction

Much is known about the purchasing process in different industries, and several studies address the issue of supplier selection, e.g., [33–36]. However, fewer studies focus on supplier selection issues in the context of environmental aspects in different industries, e.g., [37–41]. The same holds true for construction.

Construction procurement is defined as: “The framework within which construction is brought about, acquired or obtained” [42] and is a wider concept than purchasing. Contractors traditionally buy from many suppliers to maintain price competition [43]. At times, the number of suppliers can be up to thousands, which can lead to more supplier dependence [44]. However, contractors do not take full advantage of opportunities from the buyer-supplier cooperation [28], which suggests that smarter choices than purely the price-based selection of project participants are required [42].

Therefore, supplier-base reduction [45–47] or optimization [44] is required. Suppliers and subcontractors should be a firm’s long-term partners instead of the traditional win-lose relationship of business partners with different objectives [48]. Doing so requires changing the firm’s atmosphere and behavior to focus on longer-term relational exchanges based on close buyer-seller relationships [49] and changing elements of the traditional procurement procedures [50]. Several studies emphasize partnering to overcome problems, such as lack of communication, adversarial relations between players [51–53], and common problems in traditional procurement [54]. Partnering is not a contract, but an endeavor to establish non-adversarial working relationships among project participants by open communication and mutual commitment [55]. Effective partnering requires project participants to abandon litigation in favor of joint problem-solving [55–57] and charters [54] to set common objectives [54–56,58].

Barlow and Jashapara [59] distinguish between long-term partnering, which lasts the duration of several projects, and project partnering, which generally involves cooperative arrangements embracing the entire construction project or only the early design and planning stages. Although partnering is common between clients and contractors [60], it can also be found between contractors and their suppliers [30,46,56,61]. Partnering benefits include knowledge and information flow between partners, shared risks [54,58] and the lower costs of managing a few close relationships with suppliers [46].

Ellram [62] states that strategic fit and assessment of future manufacturing capabilities should be considered in addition to traditional selection criteria. When contractors adopt green projects, they may

need to keep suppliers' green capabilities in mind. Therefore, changes in contractors' purchasing methods may be expected.

### *Procurement Methods in Green Projects*

Over the last two decades, environmental considerations have gained importance in purchasing [3,63,64]. By integrating green preferences into the purchase of products, firms can improve both their and their suppliers' green performance, while also reducing environmental risks and saving money [64]. Procurement methods have significant influence on the success of construction project delivery [65], and choosing the right procurement method is one of the factors that can reduce overrun in green projects [5,66]. However, green purchasing is hindered by the lack of available, reliable knowledge [21,64,67–69] about green products, materials, systems, design [69], correct green specifications [13,19,70], assessing green requirements [64] and the availability of green suppliers [19,70,71]. Green requirements are important, since they affect the schedule of procurement, construction and commissioning [72,73]. Therefore, firms can benefit from suppliers' knowledge in solving unforeseen problems in green projects [74] by establishing cooperative innovation [20]. Albino and Berardi [75] show that contractors consider supplier knowledge and ability to “co-make” green projects.

Barlow and Jashapara [59] compared traditional hierarchical systems with partnering. The former limits the knowledge and adaptive capacity of firms and raises information costs, whereas the latter improves the company knowledge base and provides organizations with flexibility and opportunities for innovation and learning. Effective procurement (including purchasing) is required to enhance relational quality, knowledge distribution [11] and supplier integration for successful green product adoption [11,12,75,76].

Thus, a change in procurement methods towards a method that promotes partnering among different players is potentially beneficial in the exchange of knowledge in green projects. This is important, since in construction projects, traditionally, there is a lack of knowledge exchange among different companies.

### **3. Knowledge Transfer in Construction**

Knowledge acquired by inter-firm collaboration and exchange is well studied [77,78]. Firm knowledge combines individuals' competencies, the organizing principles structuring and coordinating the relationships among individuals and members of an industry network [79]. The firm's knowledge and capability is embedded in the various networks of people, tools and tasks [80]. The firm's knowledge, capability, scope, content (tacit or explicit) and social ties between transferor and recipient are important factors for knowledge transfer [81]. Since the core of knowledge sharing is interaction among individuals [82], knowledge sharing can be improved by exploiting the skills of network members by transferring knowledge within and across firms [83]. However, a potential risk related to knowledge sharing is a shift in dependency between partners, which can erode cooperation [84]. This risk can be alleviated by establishing trust through good relationships among partners [85], so that exchanged knowledge will not be exploited beyond its intended purpose [86].

Knowledge exchange, although beneficial for firms, can sometimes face problems. The fragmented nature of the construction industry [43] and the *ad hoc* nature of construction projects can be barriers to accumulating explicit knowledge [87], hinder learning and innovation [87,88] and reduce the contractor's interest in investing in innovation [89,90]. Nonetheless, as Edum-Fotwe *et al.* [91] claim, arrangements, such as partnering, facilitate sharing information that had previously been confidential and commercially sensitive. The pattern of knowledge exchange in green and conventional projects may be different. When a supplier delivers a greener, knowledge-based product, that knowledge may not have been exchanged, because it may be embodied in the product. Thus, the nature of the knowledge exchange is crucial.

### *Transfer in Green Projects*

Arguably, the greener the project, the more important new knowledge becomes. A radically new green project likely requires new techniques, methods or processes. Due to the evaluation of alternative materials and systems, green project design can be more complicated than conventional projects [4]. Competent specialists are needed to design, construct, manage and maintain specialized green facilities and services [15].

There are several barriers for contractors to considering green issues: a lack of understanding the effect of construction on the environment; a lack of alternative technologies and reliable information on the environment [21,71,92]; the poor dissemination of new knowledge; and the poor adaptation of new approaches [93]. Pinkse and Dommisse [10] indicate that the adoption of such technologies requires a built-up knowledge about where to acquire and how to adopt these technologies and integrate them into the project-based structure. Therefore, resistance to new technologies is the main barrier for implementing green projects [19]. Introducing new efficient processes, decision-making methods, tasks, actors, roles and ways of networking can resolve this problem. Proper coordination and sufficient information exchange among project players are necessary for greener practices [20,94]. Hwang and Leong [66] identified five factors causing a delay in green projects, where one of them is communication/coordination between key parties. According to Hwang, Leong and Huh [5], project members involved in green projects need to have appropriate knowledge and experience in green technologies, and to select right team members and to organize an optimized project team, rigorous selection procedures with a set of qualification criteria need to be developed and implemented, even if it takes more time.

In most industries, organizations and projects, the exchange of information and the development of the knowledge required for innovation are facilitated by loose horizontal communication structures [95]. However, loose coupling in construction can block the spread of learning and innovation. A tightly-coupled system is needed to overcome this problem [76]. Although the knowledge acquired from strong ties based on high levels of trust, extended timeframes and close relationships is unlikely to be innovative [82], these ties do facilitate innovation [81]. In the case of green projects, which require co-innovation and knowledge sharing between contractors and suppliers, partnering can be beneficial.

Partnering, in the construction literature, is often used for the relationship between client and contractor; thus, it is important to study how contractors consider partnering with their suppliers of goods and materials through the supplier-selection process.

#### 4. Method

There is a lack of project- and firm-level empirical evidence on how contractors select suppliers for green projects and how knowledge is transferred among firms involved in green projects. This research was based on a set of semi-structured interviews. A semi-structured process allows new ideas to emerge during the interview. Data was collected using a standardized semi-structured interview guide. These interviews were supplemented with reviews of the companies' websites, magazines and visits to production sites, in a few cases. The companies dominate the Swedish construction industry. The first company is internationally active in nine countries in Europe, North America and Latin America. The second company, although active internationally, is mainly focused on Scandinavia. The third company is also active in Scandinavia, but on a smaller scale than the other two. Interviewees were involved in procurement, environmental and project departments. They were knowledgeable about green, partnering and supplier-contractor relationships and also directly involved in projects (see Table 1).

**Table 1.** Interviewees in each company according to department.

	Company 1	Company 2	Company 3
Procurement	5	2	1
Environmental	4	1	1
Project	4	1	1

Most interviewees from the procurement department had several years of experience in working with suppliers and green projects. Except for a few interviewees in the environmental department who had a couple of years' experience with green projects, most others had limited work experience in green projects and dealing with suppliers. Since this research deals with supplier selection in green projects and the contractor's perception of suppliers' green knowledge, contractors were interviewed. The interview questions covered two main themes. The first theme dealt with factors that contractors considered in their procurement system for green projects when selecting suppliers. Interviewees were asked about supplier selection processes for green projects, objectives and important factors related to forming a supply-chain relationship, reasons for partnering in green projects and how they were established and the relative importance of partnering with clients and suppliers. The second theme of the interview questions focused on how suppliers' green-related knowledge was perceived by contractors in the selection process and factors inhibiting the formation of successful supply-chain relationships.

Twenty interviews, each lasting between 30 and 60 min, were conducted to investigate interviewees' experience with specific partnering relationships, supplier selection processes in green projects and perception about the importance of suppliers' green knowledge. Based on interviewee preferences, 18 interviews were conducted by telephone and two were face-to-face, and in one of the face-to-face interviews, two interviewees were interviewed. All interviews were conducted by one interviewer and recorded and transcribed for further analysis. Follow-up calls were made with the

majority of the respondents to clear up potential ambiguities. Since the interviews were in English, there was a risk of confusion due to different terminologies between in Swedish and English (such as the concept of partnering). Most follow-ups revolved around the partnering concept. The collected data was reviewed and coded based on the two research questions. Different answers for each interview question were compared. Similarities and differences were identified and analyzed to elicit any pattern(s).

## 5. Results

The objective of this study was to investigate how supplier selection methods in green projects are influenced by the potential for learning from suppliers, based on the two research questions of how supplier selection for green construction projects differs from conventional construction projects and of how contractor perception of supplier mastery of green knowledge affects supplier selection.

### 5.1. Supplier Selection for Green Projects

Respondents were asked how suppliers were selected for green projects and if selection differed from that for conventional construction projects. The responses indicated no substantial differences between supplier selection for conventional and green projects. Most respondents mentioned that green requirements added to the documents were the only differences. They did not recognize a substantial difference between supplier selection for green and conventional projects. According to most respondents, green requirements were a small part of the whole tender document, which meant that there was not much specificity about the green requirement. This led to a question as to whether or not including more green specifications in the tender documents made the supplier selection process substantially greener.

The interviewees were asked what is green to them. Respondents had a multidimensional view of greenness, so they defined green projects differently. For example, many green projects were considered only slightly green, while a few were considered radically green. However, if a similar project was undertaken at a later stage, it was downgraded from radically green to lightly green and from vanilla green (lightly green) to conventional construction. This led respondents to argue that the difference between green projects and conventional projects was small when it came to supplier selection.

There were differences in the responses from the environmental and procurement departments. The former group was keen to use particular green requirements as selection criteria, whereas the latter believed that suppliers can learn from contractors by doing. However, both groups of respondents stated that the green criteria that suppliers needed to meet were specified by clients.

The interviewees were asked about the importance of suppliers' green knowledge in the supplier selection process for green projects. The majority of respondents rated suppliers' knowledge of green projects as very important. The importance of supplier's green knowledge depended on the complexity of the job and the costs; the former had a direct relationship with supplier knowledge, while the latter had a reverse relationship. According to these respondents, contractors look for cheaper, probably less advanced solutions if cost is paramount for the client, which reduces the need for green knowledge. Only one respondent claimed that suppliers' prior green knowledge was not important for two reasons: green knowledge can be acquired through joint learning-by-doing between suppliers and contractors;

and contractors can dictate and codify suppliers' capabilities by green certification schemes, such as LEED (Leadership in Energy and Environmental Design) and other national, environmental-certification schemes (e.g., Svanen and Miljöbyggnad). However, there was a consensus among respondents about the need for close collaboration between contractors and suppliers.

Interviewees were asked about how their company knows which suppliers have the right green knowledge. Interviewees identified several ways to determine suppliers with green knowledge: Supplier records, supplier adherence to tender specifications, evaluations by the contractor's environmental and purchasing employees, negotiation and interviews. The least-frequently mentioned way to identify appropriate suppliers was checking their offers. According to two respondents, it was impossible to identify knowledgeable suppliers until they started doing the job. Traditional important criteria, such as cost, quality, dependability and delivery, were excluded from the answers given by many respondents. They believed that these criteria applied to all projects, including green ones. Overall, the negotiations involved in supplier selection for green projects may be somewhat more cumbersome, but was often handled by forming partnerships, as the next section shows.

### *5.2. Knowledge Transfer and Partnerships*

The interviewees were also asked about the most important factors for their company to consider when forming a supply chain relationship with a supplier for green project. Trust and commitment were the factors respondents most frequently mentioned in relation to forming a partnership with suppliers. The interviewees viewed trust as the confidence that suppliers will provide up-to-date green technologies. Trust was an important factor for assessing the appropriateness and level of suppliers' green knowledge in a partnering relationship. The other factors interviewees mentioned were common goals, good relationships with suppliers, common values and knowledge. Cost/price, long-term relationship and suppliers' openness were other factors, although only a few respondents mentioned these.

### *5.3. Objectives for Forming Relationships with Suppliers*

Respondent were asked about the most important objectives for their company in developing supply chain relationships with their suppliers. The most frequent objectives for forming relationships with suppliers included: getting better prices, higher profits, higher quality, greater efficiency in projects, cost reductions, knowledge- and risk-sharing. One respondent described situations where partnering was appropriate: "Usually, partnering is suitable for very specific situations or projects where more cooperation and risk sharing are required, since risk sharing for both parties in complex projects would become more important than focusing only on profit." Another respondent stated: "The main objective of partnering is to get the right price, high quality, on-time delivery and also environmentally-friendly solutions", whereas another saw it as the solution to several problems, such as: "Cost reduction, efficiency improvement and involvement of suppliers from the early stages of projects." According to one respondent, clients' demands play an important role in involving contractors in partnering if the client believes that it will produce cost reductions and the early involvement of suppliers, which translates into a more efficient project and cost reductions.

Several specific objectives related to forming supply-chain partnerships were identified and grouped into four main categories. First, almost half of the respondents mentioned reduced cost and

more collaborative, flexible, committed suppliers that can provide new solutions and adapt to contractors' needs through common goals and close relationships. Second, less than half of the respondents mentioned access to quality green products, the right suppliers and securely getting products at the right time. Third, nearly one-third of the respondents mentioned more competitiveness in the market, the ability to document and customer satisfaction. Fourth, one-third of respondents believed that economic benefits, cost reductions, greater efficiency and minimizing waste were objectives in forming partnerships with suppliers.

When the interviewees were asked if their company has any partnering agreement with suppliers, the majority mentioned that their companies were actively involved in partnering with suppliers. A few said that either their company had no plans for a partnering policy in the near future or their companies were indifferent to partnering. The most-favored partnering agreements were for multiple projects to build close relationships and facilitate knowledge sharing from one project to another. However, one respondent stated that a lower price offered by a different supplier was a barrier to partnering, as price was important to his company.

The interviewees were asked if their company prefers to form partnering with their clients or suppliers. To the majority of respondents, clients were more important for the partnership, as they assign the jobs to contractors, establish requirements and enable higher economic profits for contractors. Only two respondents believed that clients and suppliers were equally important. One interviewee mentioned that although clients were more important for partnering, it was hard to deliver a good offer to clients with bad cooperation in the supply chain. Rather surprisingly, none of the interviewees saw suppliers as more important than clients for partnerships.

When the interviewees were asked about the inhibiting factors in implementing efficient and successful supply chain collaboration in green projects, the following factors were identified: a lack of interest in, or assigning low importance to, green projects; resistance to change; traditional ways of thinking; lack of green knowledge manifested in design or products; and no green specifications. Other barriers included: clients that were sensitive to cost or unwilling to pay the costs of green construction; a lack of mutual understanding, common values and goals; a lack of trust; a lack of collaboration; difficulty finding green suppliers; a lack of commitment; inappropriate focus on green; and unrealistic green development efforts.

According to one respondent, price, immature green knowledge and non-continuous trending created problems in forming supplier partnerships for green projects. However, some respondents believed that barriers related to a lack of knowledge, old habits and traditional ways of thinking were diminishing as companies recognized the need for more collaboration and knowledge sharing among players involved in green developments. Several interviewees said that if the level of interest among suppliers was sufficiently high, problems related to cost would likely be resolved, especially in the context of long-term trust and ability to adapt.

## 6. Discussion

One important aspect that emerged from the interviews was that respondents were not clear about how to define a green project. Their differences were partly due to their uncertainty about the real consequences of the plethora of design and technology choices, which indicated uncertainty about

what a green project entailed. They tended to resort to green standards, such as LEED, to determine either what constituted a green project or what the client considered green. They then asked suppliers to comply. This problem may be based on environmental product policies, such as eco-labelling [96]. Interviewees equated the definition of green project with specified standards. In addition, some of the respondents' uncertainty stemmed from the idea that green is absolute, whereas it is actually relative. What might be considered a green project today may be viewed in the future as a conventional project. This suggests that a more relevant description might be greener project.

The minor differences between the selection of suppliers for conventional *versus* green projects can be attributed to a desire to retain knowledge accumulated in previous projects by using the same suppliers. Changes in purchasing methods might lead to selecting another supplier. Suppliers must comply with a small proportion of green specification in the tender document. Another explanation might be that the differences between green and non-green projects, such as in terms of materials selection, are not large enough to justify substantial changes in the supplier selection process. Yet, another reason might be attributed to clients' demands, which are reflected in contractors' specifications. This is consistent with previous literature emphasizing that clients can have a major influence on the selection of contractors, suppliers and subcontractors [97], since they raise the green requirement to the design and the construction procedures [98].

De Boer *et al.* [99] argue that many purchasing decisions are made, or influenced by, different actors who might have different views of reality. This makes the process even more complex. Therefore, different responses from the environmental and procurement departments can affect the final supplier selection. The differences in the responses can be because the procurement department is obliged to adhere to current business structures, whereas the environmental department adheres to the environmental agenda set by the client or contractor firm. This is supported by previous literature, that changes to routines might result in changes to the firm's business model, have major financial consequences, affect the firm's supplier network setup or affect how the firm profits from its innovations [100–102]. Procurement and environmental employees are likely to behave more conservatively compared to project employees. The latter tends to respond at the more operational/tactical level and is less concerned with the firm's business structure. This is consistent with Ball [103], who claims that employees in the lower hierarchy of firms have limited power to influence changes if top management is not committed to green issues. That is why firms aiming to improve their environmental performance by the adoption of contractors' green construction practices require having managers with knowledge and concern about environmental issues [104]. A lack of a holistic view of green knowledge can also explain the different opinions of respondents from different departments. There is probably little communication between departments. This means that every department within the case company owns the green knowledge to their own area of expertise.

It is reasonable to believe that the importance of suppliers' green knowledge is because there is a direct relation between their knowledge and their ability to produce greener goods and materials. However, there is a risk of green-washing, or claiming that the construction is green without any actual proof.

Previous studies show that in the procurement situation, it can be difficult to differentiate between companies that only produce nice documents and those that actually perform well [64]. That is probably why respondents stressed the role of trust in evaluating suppliers' green knowledge. Trust can affect

both the extent of knowledge exchanged in alliances and the efficiency with which it is exchanged. Therefore, with a high level of trust, information sharing and learning are facilitated, as decision-makers do not need to protect themselves from the other's opportunistic behavior. Without trust, due to the unwillingness of parties to take risks associated with sharing more valuable information, the information exchanged may not be highly accurate, comprehensive or timely [78]. Easterby-Smith *et al.* (2008) argue that the knowledge donor is often in a superior position to the knowledge receiver, so that there is a risk that the recipient will receive obsolete knowledge. This risk is partly alleviated by inter-organizational trust [86]. However, this is neither common nor widespread in the construction sector [105].

Settings, such as partnering relationships, that are characterized by trust and commitment can facilitate knowledge transfer between contractors and suppliers. Trust, followed by commitment, were the most frequently mentioned factors for forming a supply-chain partnership with suppliers. By developing collaborative relationships, firms can achieve lower costs as they enhance their capacity to continually improve system and operation effectiveness over time, as long as they maintain trust [46].

In addition to a formal written contract detailing green requirements and technical specs, respondents noted that there was a partnering charter outlining the general conditions of cooperation for multiple project partnering. Most interviewees mentioned multiple project partnering because it reduced negotiation costs [45] by managing a smaller supplier base [44,46] and keeping personnel from one project to the other in long-term partnering. This may provide learning benefits and innovation [59]. One interviewee mentioned lower price as a barrier to partnering due to the nature of market-based relationships that allow the firm to purchase products at a lower cost [46].

Our findings of greater emphasis on partnering with clients rather than with suppliers is consistent with Akintoye *et al.* [106], who studied the supply-chain relationship in the U.K. construction industry. They found that contractors were more favorable toward clients than their suppliers, because clients provide contractors' workload. Interestingly, the researchers found that almost 10 percent of their contractors had long-term partnerships with their suppliers. This contrasts with our findings that the majority of respondents acknowledged the long-term partnerships with their suppliers. This may mean that: the role of suppliers in the supply chain relationship became more important over the years; contractors recognized the benefits from partnering with suppliers in green projects; and it is difficult to deliver good service to clients without good relationships with suppliers.

A number of respondents told us that contractors might choose non-green materials, because of lower cost compared to green materials and clients' lower willingness to meet the higher costs. This is consistent with the most important barriers for adopting green construction: affordability and lack of clients' interest [92] and also the higher cost premium of green buildings [4,98]. Yet, another reason might be related to the effect that green requirements and materials can have on the project schedule. According to Hwang, Leong and Huh [5], green requirements can have a great influence on the construction phase, and contractors have to ensure that materials, equipment, devices and systems specific to green construction are delivered as planned, so as not to affect construction activities and the schedule.

Greener product availability can be partly explained by the tradeoff between product development and procurement processes when alternative solutions emphasize different aspects that should be balanced against each other [68].

However, van Hemel *et al.* [107] mention that in many cases, the integration of green aspects into product development leads to synergies with image improvement, new market opportunities and cost reductions. Varnäs, Balfors and Faith-Ell [64] found that difficulty in providing green products and their higher costs were barriers to the adoption of green procurement. They also mention a lack of pressure from stakeholders and NGOs and the lack of clear business benefits as reasons why firms usually do not include green criteria in purchasing decisions [64]. As a result, contractors may easily switch to non-green materials when there is no pressure from clients.

The objectives of this study identified for forming partnerships with suppliers are consistent with previous literature that highlights the benefits of partnering. Such benefits include greater risk-sharing, less project risk, the transfer of practices and processes to other projects, improved cooperation, mutual understanding, improving overall competitiveness and increased customer satisfaction [46]. Albino and Berardi [75] found that limiting risks was one of the reasons why contractors select suppliers for green projects. One of the objectives for partnering was the early involvement of suppliers. Early involvement enables suppliers to build a clearer vision of both client and contractor needs and to create value by more effectively meeting client needs. Suppliers should be engaged during the early stage of construction projects, due to their green knowledge [108] and the need to be more connected with designers [19].

## 7. Conclusions

This paper investigated how supplier selection methods in green projects are influenced by contractors' potential for learning from suppliers. The results of the analysis show that contractors generally select the same suppliers for conventional and green projects. The technical and business features of green projects are not so different as to dramatically change the supplier-selection process compared to conventional construction. Nonetheless, there was a lack of consensus on defining green projects between departments. This can be related either to the influence on interviewees from green certificate schemes or fragmentation between departments. In a few cases, joint learning-by-doing between suppliers, contractors and green certifications (e.g., LEED) were used in the face of an initial lack of supplier knowledge. Respondents regarded green as a relative concept that was defined based on the degree of greenness applied in the project. This suggests that, from the contractors' perspective, greener is a more appropriate expression. The supplier selection process was affected by client demands, business roles of people involved in supplier selection within the contractor companies and supplier knowledge. The importance of suppliers' green knowledge depended on the complexity of the job and the clients' willingness to pay the costs of being green. Contractors identified suppliers' knowledge using various methods, including: checking reference projects, suppliers' records, meeting tender specifications, evaluations by environmental and purchasing staff, negotiations, interviews and checking suppliers' offers.

Contractors often establish partnerships with suppliers, in which trust and commitment are considered particularly important to ensure the acquisition of knowledge from suppliers. Trust reduces the risk of obsolete or inappropriate knowledge from suppliers and adversarial relationships between contractors and suppliers, while commitment reduces the likelihood of green-washing by suppliers.

Contractors have four main objectives in developing supply-chain relationships with suppliers: Improving relationships with new suppliers; gaining access to high-quality green products and services; increased competitiveness and customer satisfaction; and more favorable financial aspects. Well-developed relationships with suppliers lead to easier knowledge exchange and discourage suppliers from hiding problems. The strong links between contractors and suppliers are advantageous in that they help contractors increase their competitive advantage over rivals. Client pressure is an important driver of contractor supply chains. Weak, or no, client demands reduces the motivation of the whole supply chain to pursue and apply green initiatives.

Although most contractors seem to favor partnerships with suppliers, they regard partnering with clients as more important. Clients are potential sources of financial profit for contractors, as well as barriers to partnering. Contractors also prefer multi-project partnering to forming stronger ties with clients. However, meeting clients' demands can be difficult in the absence of good partner relations with specific suppliers. The potential benefits of supplier-contractor partnerships include: knowledge transfer between companies; openness; friendly relations; and reductions in overall costs. The barriers to forming supply-chain relationships include: a lack of interest in, or low importance given to, being green; a lack of green knowledge; and the unwillingness of clients to pay the higher costs of being green.

This research contributes to the understanding of the differences between supplier selection in green and conventional projects. This research has a number of limitations. First, this study is based on the data collected from three large Swedish contractors. To generalize the results, it is suggested that research with more samples in a different context be conducted. Another limitation is that, though the importance of trust has been addressed in this paper, it could not be measured, giving a more subjective than an objective picture. In addition, the consequences of differences between the answers among people from different departments are not known, and further research is needed to investigate the consequences.

## Acknowledgments

This paper is based on a research project funded by the Development Fund of the Swedish Construction Industry (Svenska Byggbranschens Utvecklingsfond). The author would like to thank the sponsors for their support.

## Conflicts of Interest

The author declares no conflict of interest.

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