SUPPLIER DEVELOPMENT INITIATIVES AND THEIR IMPACT ON THE CONSISTENCY OF PROJECT PERFORMANCE

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Many empirical studies exploring the impact of supply chain management on performance metrics have been undertaken in the manufacturing and retail sectors, espousing the positive outcomes attainable. Due to a range of industry characteristics, some have questioned the effectiveness of such initiatives in the construction sector, and it has been noted that there is a lack of longitudinal empirical data in this setting. Exploiting a unique performance dataset gathered from a global construction company's archival records (1990-2013), the following question is addressed: 'what is the impact of supplier development initiatives on key performance indicators (KPIs) in a construction supply chain'? Mobilising established frameworks on relationship types and supplier development initiatives, suppliers are organised into relational categories, including 'strategic partners', 'preferred' and 'approved' suppliers. A combination of descriptive statistics, ANOVA and Levene's tests were used to analyse the data. The findings report a significant difference between the volatility of performance between different groups. The higher the level of partnership in the relational category, the more consistency there will be in performance. Suppliers in the approved category perform less well on the 'close out' KPI, suggesting a need for initiatives with this category to help raise performance on close out issues.

Keywords: supplier development, longitudinal study, performance management, relationships, supply chain management.

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INTRODUCTION

The idea that supply chains compete against each other, rather than individual firms or brands, has been written about extensively (Christopher 2005). In their seminal paper, Lambert and Cooper (2000) argue that for most companies the supply chain resembles an uprooted tree where the branches and roots are the extensive network. This prompts questions such as how many of these branches and roots need to be managed, and how close should those managed relationships be? The extent to which these roots and branches can be managed effectively through partnerships arrangements, and the impact of these efforts, is still an ongoing debate. For example, O'Brian et al. (2009) consider construction supply chain management as an emerging, promising, yet immature area of practice, whereas Fernie and Tennant (2013) question some of the assumptions made about the relevance of supply chain management in construction. Within the construction management literature, a range of barriers have been discussed in relation to the attainment and effectiveness of close partnership arrangements, such as the high levels of supply chain partners required (Briscoe and Dainty 2005), customisation requirements and 'uniqueness' for different projects (Gosling and Naim 2009), and lack of top management commitment (Akintoye, Mcintosh and Fitzgerald 2000).

Many large scale empirical studies on the impact of supply chain management and supplier development on performance have been undertaken in the manufacturing and retail sectors. Through regression analysis of a survey, Tan et al. (1999) found a positive impact on corporate performance, especially for those firms committed to evaluating performance throughout the supply chain. Analysis of a further large scale cross industry sample concluded that strategically managed long-term relationships with key suppliers has a positive impact on the firm's financial performance (Carr and Pearson 1999) . Such studies typically suggest number of advantages accrue to firms that address the issue of supply chain integration through supplier development practices (Danese 2013). Japanese approaches have had a large impact on how many firms consider the role of suppliers. This includes the rationalisation of the supply base to focus on a number of closer partnerships (Liker and Wu 2000), and a movement away from price-based criteria to other performance criteria (Van Weele 2010), and a focus on active development of suppliers (Krause, Handfield and Tyler 2007, Modi and Mabert 2007). The construction sector, however, has proceeded with bouts of enthusiasm and caution in relation to these issues.

Autry and Golicic (2010) observe that most empirical studies in the area of supply chain relationships offer only cross sectional snapshots of relationship strength/performance dynamics. They utilise an extensive longitudinal dataset from within the construction sector (from 1991-2000) to develop a relationship strength performance spiral model, and find that buyer–supplier relationships take time to develop, and the association between relationship strength and performance is cyclical over time. They do find support for existence of 'positive performance cycles'. We also note the lack of longitudinal data, and the complexity of partnership arrangement, that emerges from this study, and seek to add to the body of knowledge concerning longitudinal datasets. This also supports more general calls for more longitudinal research in supply chain management research (Boyer and Swink 2008)

In addition to the aforementioned complexity of relationship dynamics over time (2010), the need for 'fit for purpose' relationships has also been observed (Cox and Thompson 1997). Within the construction industry, this spread of relationships has

often been characterised via the use of preferred supplier arrangements, framework agreements and approved lists (Thorpe, Dainty and Hatfield 2003, Gosling, Purvis and Naim 2010). It is likely that a healthy balance across these relationship categories is needed for different project requirements (Gosling, Naim and Towill 2013). This paper builds on relationship categories to better understand their impact on performance metrics. In order to rationalise supplier development initiatives, a well-developed research framework, which has been extensively investigated through empirical research, is mobilised to help inform the analysis (Krause 1999, Krause, Scannell and Calantone 2000, Krause and Scannell 2002, Krause, Handfield and Tyler 2007, Modi and Mabert 2007). It categorises supplier development initiatives into those that relate to competitive pressures, evaluation and certification, incentives and direct involvement.

This paper addresses the question 'what is the impact of supplier development initiatives on key performance indicators in a construction supply chain'? Since such supplier development programmes are normally introduced by a procuring or buying firm, we adopt this perspective throughout. Further, we are primarily concerned with the task of managing and developing the network of material suppliers and subcontractors that undertake site work, rather than studying the dynamics of client-contractor alliances and partnership (e.g. Bresnen and Marshall 2000b). In answering the research question, we mobilise and integrate research frameworks from Gosling et al. (Gosling, Purvis and Naim 2010, Gosling, Naim and Towill 2013) and Krause et al. (Krause 1999, Krause, Scannell and Calantone 2000, Krause and Scannell 2002, Krause, Handfield and Tyler 2007). A unique and interesting dataset obtained from the archival records of a construction company is interrogated to give insight into the potential impact of development initiatives. The paper begins by reviewing different streams of literature to inform the theoretical elements of the study. Models for supplier development and relational categories are integrated to form the research framework. This is followed by the research design, which highlights the case context, as well as giving an explanation of the dataset and data analysis. The findings are then presented, which focus on the impact of different relationship categories and development initiatives within the dataset. The paper closes with discussion and conclusions.

LITERATURE REVIEW

Supply Chain Management and Relationship Models

Within supply chain management and purchasing literature, the area of partnerships has attracted considerable interest. An underlying assumption is that partnership activity has the potential to minimize the destructive potential of conflict, and leverage the respective strengths of the partners (Spekman 1988). However, as noted by Lambert and Cooper (2000), there is a need to establish the most appropriate relationship that best fits the set of circumstances. Further, the movement to develop and maintain strategic partnerships is not without critique, and it has been noted that many companies mishandle them, and do not have the strategic thinking and management capabilities to make them work (Wagner and Boutellier 2002, Van Weele 2010). van Weele (2010) refers to 'the myth of partnership' and argues that successful partnerships are quite rare and are often the result of "muddling through, disappointments and perseverance" (Van Weele 2010: p 222).

These struggles are echoed, and likely amplified, in the construction sector, due to structural issues and project based environments. Bresnan and Marshall (2000a)

present a thorough review of the complexities of partnering in the construction sector, and offer a reminder that the there is no guarantee that they will result in the desired outputs. A range of studies have bemoaned the lack of progress with respect to partnering and supply chain management in the construction industry context. In a large scale survey Akintoye et al. (2000) concluded that supply chain management was still in its infancy, and called for more training and education to overcome barriers. Barker and Naim (2008) also highlighted a lack of awareness of such practices in the housebuilding sector, and a recent article suggests that the diffusion of supply chain management can at best be described as 'non adoption' (Fernie and Tennant 2013).

In practice, it is likely that a spread of relationship types exist (Wagner and Johnson 2004). Portfolio management models have been proposed in purchasing literature to account for these different relationships. Most describe a scale of relationships spanning from loose 'arms-length' relationships to close partnerships. This links with notions of discrete and relational exchanges in relational contracting theory, whereby one time spot interactions are treated very differently to ongoing interactions (Cox 1996). Table 1 offers an overview of a selection of categorisation for relationship types. Cox (1996) offers a wide range of relational categories, spanning from mergers and acquisitions to adversarial. The categories proposed by Lysons and Farrington (2012) and Wagner and Boutellier (2002) offer broad sector interpretation, whereas Gosling et al. (2010) develop their categorisation within the context of the construction sector.

Table 1: Comparison of relationship types from different sources

Cox (1996)	Lysons and Farrington (adapted from Johnson 1997)	Wagner and Boutellier 2002	Gosling et al. 2010
Adversarial	Competitive Leverage	Arm's length	
			Approved
Preferred	Preferred Suppliers		Preferred
Single Sourcing	Performance Partnerships	Partnership	
Network Sourcing			
Strategic Alliances	Strategic Alliances	Strategic Partnership	Strategic Partnerships
Internal, mergers, acquisitions	Co-business Integration		

Gosling et al (2010) define ‘approved’ status as applied to suppliers and subcontractors that have met health and safety standards and have been successfully vetted with references. ‘Preferred’ status is granted when an organisation successfully completes a number of projects and delivers consistently on key performance indicators (KPIs). Finally, ‘Strategic partnership’ is a formal recognition of a partnership and includes agreements centred on tender assistance services, resource management and availability, environmental performance, collaborative working and conduct and performance measurement and review. A healthy balance across these partnerships categories should allow main contractors and construction management organisations to effectively configure their supply chain for different project

requirements. This particular framework is adopted for a number of reasons. Firstly, the categorisation has been developed drawing on extensive practices from empirical data (Gosling, Purvis and Naim 2010, Gosling, Naim and Towill 2013). Secondly, the three categories offer terms that are recognised and coherent within the construction management literature, as well as with practitioners working in the case company which forms the basis for the empirical elements of the paper.

Supplier Development Initiatives

Recognition that suppliers can be actively managed and improved has a long history (Leenders 1966). Efforts in this area are often termed 'supplier development', and refer to efforts by an industrial buying firm to improve the performance or capability of its suppliers (Krause 1999). Many studies in this area focus on the efforts of buying organisations within the context of the development of strategic partnerships. This normally assumes that a buying organisation has rationalised its supply base and has focused its supplier development efforts on a few select suppliers (Humphreys, Li and Chan 2004, Prahinski and Benton 2004). Aspects of supplier development that are popular in the literature include training, technological support and investment, evaluation of performance and recognition of performance in the form of awards (Prahinski and Benton 2004).

In the manufacturing sector, Danese's (2013) large scale survey found that supplier integration practices have a markedly positive effect on performance goals, such as schedule attainments, but also show that the 'structure' of the supply chain must be considered at the same time. In the construction sector, results have been more mixed. Barriers to such integration include scepticism over the motives behind supply chain management practices by SMEs (Dainty, Briscoe and Millett 2001), fragmentation and structural issues within the construction industry (Dubois and Gadde 2002), power relationships and regimes (Fernie and Tennant 2013), as well as the nature and regularity of demand patterns (Ireland 2004, Gosling and Naim 2009). It is likely that a range of structural and cultural problems make the direct application of such approaches difficult (Dubois and Gadde 2002).

There appears to be a lack of specific guidance on the anatomy of a supplier development programme in the context of the construction industry, as well as the role of direct involvement. An established framework, guided by wide ranging empirical evidence, is yet to emerge. A mature research framework from the operations and supply management literature is offered in the four supplier development strategies articulated in Krause (1999), and further advocated in Krause et al. (2000) and Krause and Scannell (2002). The framework has been empirically justified through large scale surveys by Krause et al (2007) and Modi and Mabert (2007). Hence we mobilise this framework in order to better understand and classify supplier development initiatives in the construction sector.

The first strategy proposed by Krause et al. (2000) is the use of Competitive Pressures. This strategy makes use of market forces and benchmarking to raise performance levels of suppliers. This strategy typically involves applying pressure through market forces and comparisons with other sources. Hence multiple sourcing approaches, short term contracts and the competitive tendering system common in the construction sector would be characteristic of initiatives in this category. The second strategy is Evaluation and Certification Systems. This involves the management of the current and expected performance through evaluation and feedback systems, such as balanced scorecards. Such evaluation might relate to supplier’s quality, cost, technical and

managerial capabilities (Krause and Scannell 2002). Supplier certification systems to establish expected standards, for instance on health and safety or financial risk exposure. The third strategy is incentives, whereby desired performance is motivated through incentive schemes. A popular example would include supplier awards.

The final strategy is 'Direct Involvement', which has attracted a lot of attention by researchers. Typically, such initiatives would include proactive approaches achieved through direct means. Modi and Mabert (2007) suggest that such initiatives could be capital and equipment investments, financial investment and partial ownership, and provision of human and organisational resource. They focus on operational knowledge transfer activities, and find that evaluation and certification is an important pre-requisite for such activities to be successful. Krause et al. (2007) extend the idea of direct investment to include relation specific assets, knowledge exchange activities, as well as combined resources and governance mechanisms. They find that different dimensions of knowledge have different effects on performance goals, but their findings do emphasize the importance of direct involvement in facilitating learning and knowledge exchange. In order to move towards such long term collaborative relationships, Spekman and Carraway (2006) argue that three decision categories need to be developed: capabilities, such as skillsets and processes, drivers, such as systems thinking and performance metrics, and enablers, such as trust.

Bringing the aforementioned streams of the literature review together, concepts developed in the operations and supply chain management literature are integrated with those with origins in the construction sector as the basis for our research framework. Table 2 integrates the aforementioned relational framework of Gosling et al. (Gosling, Purvis and Naim 2010, Gosling, Naim and Towill 2013) and the supplier development framework developed by Krause et al. (Krause 1999, Krause, Scannell and Calantone 2000, Krause and Scannell 2002, Krause, Handfield and Tyler 2007). The important message flowing from this integration is that supplier initiatives should be aligned with partnership category. They should not be seen as a ‘one-size-fits-all’ approach to supply chain management, as many of the initiatives require significant investment and cost, but should be deployed according to the particular situation. Approved partnerships with little investment should not be developed through high levels of direct involvement and investment. This is much more fitting for a strategic partnership. This table will be revisited with construction sector initiatives later in the paper.

Table 2: Aligning partnership categories with supplier development initiatives

Partnership Category (Gosling, Naim and Towill 2013)	Focus	Type of Initiatives (Krause, Scannell and Calantone 2000)	Example Initiatives
Approved	Little investment of resources in the partnership	Competitive Pressures	Comparison of Performance Measures and Multiple Sourcing
Preferred	Moderate investment of resources in the partnership	Evaluation and Certification, as well as Incentives	Supplier Awards
Strategic Partnerships	Invest significant resources in the partnership	Direct Involvement	Training and Technological Investment

Determining the impact on Key Performance Indicators

Construction companies have, typically, focused on measuring client objectives on cost, time and quality for individual projects (Ward, Curtis and Chapman 1991), but more comprehensive systems for project performance measurement have also been reported in the literature. For instance, Cheung et al. (2004) document a web based performance measurement and reporting system that includes time, quality, health and safety, environment, client satisfaction, and communications performance categories. An organisational perspective on performance measures is given in Bassioni et al. (2005). They propose a wide range of measurement categories. For instance, partnership and supplier measures are considered under a 'functions and programme' management category. Supplier and partnership results are considered to affect project results, not vice versa.

The foregoing discussion raises the possibility that there are different levels of measures that must be considered. Wegelius-Lehtonen (2001) argued that the focus of measurement for construction companies could be at three levels. The first relates to the general environment and their own performance at company level, the second level relates to individual project performance, and the third is concerned with subcontractors and suppliers. The complicated links between 'project' and 'supplier' perspectives on performance measures are also highlighted in the Kagioglou et al (2001). This raises the issue of the extent to which the goal is to measure the performance of a supplier, or a specific project, or of business or organizational metrics, as well as how they are interlinked. There are no doubt complex interactions and overlaps between these different levels and perspectives. We focus on the subcontractor and supplier level of measurement within the construction industry, and find a lack of guiding research for this particular issue.

There are numerous guidelines for supplier performance measurement within the wider supply chain management literature. Tan et al. (1999) indicate that regular assessment of suppliers is positively related to a range of competitive dimensions. Despite this, Simpson et al. (2002) found that a surprising 45% of firms, across a range of industries, had no formal method in place for evaluating suppliers. Carter (1995) outlines the seven C's as a guide to supplier evaluation, which are competency, capacity, commitment, control systems, cash resources, cost and consistency. Popular

purchasing textbooks give further suggestions about what might be measured in (Van Weele 2010, Lysons and Farrington 2012), but there appears to be no agreed standard protocol as to what to measure, and the ideal frequency of measurement.

Retailers such as Tesco, Walmart and Amazon are often cited as pioneers of 'analytics', whereby they collect and analyse masses of data from customers and suppliers in order to learn more about their markets and manage their operations more effectively (Davenport and Harris 2013). We contend that construction organisations can also learn from 'mining' their own performance data. Weaving the different threads of the literature review together, concepts from the areas of relationship models and supplier development initiatives are mobilised to inform the empirical elements of the paper.

RESEARCH DESIGN

Case context

This paper interrogates a comprehensive data set gathered from a global construction company's archival records and reports the analysis of historical performance data of the case company's supply base. The archive includes supplier performance data from 1990 to the present. The company was formed in 1990, and has maintained growth, even during the recession, and has won a range of awards relating to its supply chain practices. The company operates in a range of sectors, but has been particularly successful in managing the construction of iconic and headquarter commercial offices. The data relates specifically to this sector. For some projects, the company undertakes full delivery of construction work, where work packages are let out to subcontractors. In other cases, the company provides consultancy services, or will commission main contractors under Construction Management contractual arrangements. Projects in the United Kingdom (UK) are primarily undertaken using the former mechanism, that is, full delivery of construction work, and it is within this context that the performance data has been collected. Hence, while the company operates globally, with interests in over 65 countries, the dataset addressed in this study relates specifically to the UK.

Before the dataset is described and analysed in more detail, it is important to outline how performance of suppliers is undertaken at the case company. Project teams assign measurement scores across a number of different KPIs when a supplier has completed their contribution to a particular project, which is written up as a report allowing space for qualitative commentary. Performance may be graded 0, 1, 2 or 3 where the latter represents the highest score. Once reports are received by the project team, they are uploaded to a bespoke system and expressed as a percentage score. Suppliers are then able to log on to the system and observe performance figures and trends for all projects that they have contributed to.

The different KPIs are as follows:

- Health and Safety - Based on adherence to documentation and work place standards, communication standards and accident records
- Programme - Based on reliability and presentation of programmes, as well as achieving programme goals.
- Financial - Based on attitude towards change instructions, presentation of accounts and timeliness for settling accounts

- Quality - Based on workmanship, defects and snagging records
- Design - Based on completeness in relation to programme, buildability, interface management and change management.
- Management - Based on organisation/supervision on site, communication and exchange of information, proactive motivation and attitude, as well as progress reports.
- Close out - Timely completion of work, management of final accounts, management of issues raised at completion.

Supplier development initiatives at the case company can be related to the integrated framework developed in table 3, which argues for an alignment of initiatives and partnership categories. Hence, we show an updated version of the table mapping example initiatives put into place by the case company since 1990. Strategic partners receive training of various types, benefit from consulting expertise and may be offered co-location opportunities. Approved suppliers are much more likely to experience pressures of competitive bidding and rigorous benchmarking and comparison.

Table 3: Supplier development initiatives at the case company

Partnership Category	Emphasis of Initiatives	Example Initiatives at Case Company
Approved	Competitive Pressures	Comparison of Lead Times and Performance Measures across work packages, Multiple Sourcing, Standard competitive bidding procedures
Preferred	Evaluation and Certification, as well as Incentives	Monitoring of Performance with Structured Improvement Plans, Early Project Involvement, Supplier Awards, Access to Web Based Systems, Risk Analysis including financial Indicators, Early visibility of new and potential projects, Cluster Management Initiatives
Strategic Partnerships	Direct Involvement	Consulting, Supplier Training Programme, Executive Briefings, Shared Technology, Project Colocation Initiatives, Assured Level of Work

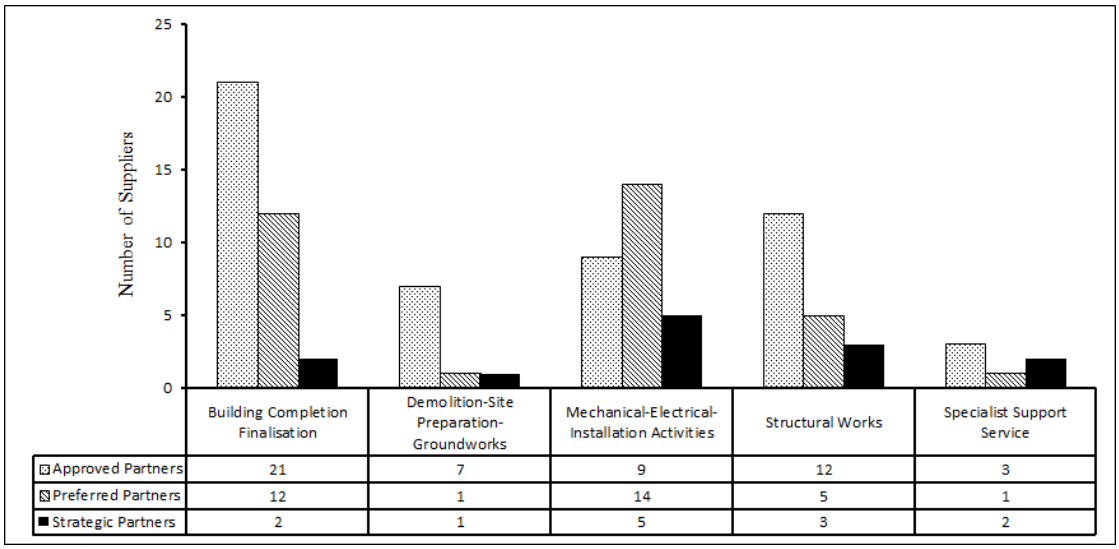
Categorising and analysing the performance dataset

In total, there are 98 suppliers included in the database and, since 1990, these suppliers have made 1334 contributions to various projects. In order to explore the impact of supplier development initiatives, suppliers were categorised into three partnership categories outlined in Gosling et al. (Gosling, Purvis and Naim 2010, Gosling, Naim and Towill 2013) of strategic partner, preferred supplier and approved supplier. For the purpose of analysing the dataset, these categories had to be further 'operationalized' to give more clarity. Establishing a strategic partnership is challenging since the realities of partnering are very often complicated, especially in a longitudinal setting where suppliers can float in and out of different relationship categories at different points, and can result in 'relationship strength–performance spirals' (Autry and Golicic 2010). The case company retains a list of supplier it considers as strategic partners and in order to achieve 'strategic partner' status in our

analysis, suppliers must have been identified in this list for over 5 years. This qualified the supplier as a long term strategic partner with established strategic ties to the case company. For those suppliers that were listed as a strategic supplier at some point within the history of the dataset, but not over 5 years, we deemed as ‘preferred’ suppliers. This was integrated with a further list of preferred suppliers to identify a coherent body of preferred suppliers. All other suppliers were considered ‘approved’ suppliers.

Figure 1 illustrates the breakdown of partnership percentages across five sectors of suppliers within the database. The sectors were adapted from Standard Industry Codes (SIC). Most of the suppliers in the database are in the Building Completion and Finalisation market, representing 35 of the 98 suppliers. Within this market sector, approved suppliers are most numerous representing 40.4 % of the suppliers in this area. The least represented sector was the business of specialist support service. Only 6 suppliers in the database related to this area. Most strategic partners were concentrated in the mechanical and electrical sector with a total of 5. Only 1 strategic partner was situated in the area of demolition and site preparation. Preferred suppliers were most represented in the building completion and finalisation (12) and mechanical and electrical industries (14). In terms of the geographical locations of the 98 suppliers, 66 are UK based and primarily serve the UK market, 22 are UK based companies that also have substantial international interests and locations, nine are UK subsidiaries of larger global groups, and one was registered as an Italian supplier with no UK bases.

Figure 1: Industry sector and partnership breakdown of suppliers in the database



Data was analysed using one way ANOVA and Levene's tests. The one-way analysis of variance (ANOVA) is used to determine whether there are any significant differences between the means of the three partnership groups. Furthermore, Levene (1960) test of homogeneity of variances is carried out in this study to examine the consistency of KPIs. It is more desirable for a KPI to achieve a higher score and have a lower level of variation. Hence we refer to stability of a KPI, where a more stable KPI score is represented by a higher mean with a lower level of variation (determined by the standard deviation). The stability of KPIs are, therefore, based on the combined

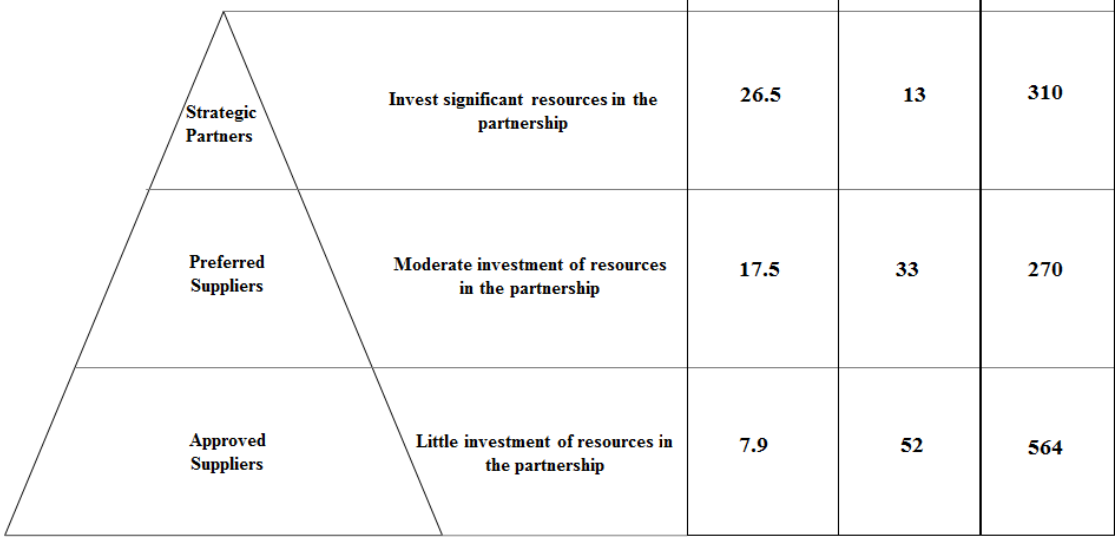
values of their means and standard deviations. The importance and ranking of a KPI is based on its level of stability, so that a KPI may be classified as having high stability if it is has a high mean value and low variation.

First, means and standard deviations are estimated for overall KPIs and are referred to in this paper as unconditional KPIs. They are unconditional as they represent the overall dataset, rather than analyses by specific conditions. The latter are represented by relationship categories. Second, means and standard deviations are estimated for KPIs within different relationship-types and are referred to in this paper as conditional KPIs. One-way ANOVA test results are reported for differences between partnership type KPI means. Levene's test results of homogeneity of variance across different partnership types are reported based on both mean and median. We report the mean and standard deviation of the different KPIs under investigation along with their significance test results.

FINDINGS

Figure 2 reports the number of suppliers for the different partnership categories, as well as the average number of projects completed by each supplier. As would be expected from the foregoing literature review, strategic partners completed on average, many more projects than other partnership categories with an average of 26.5 projects. This is consistent with the principle of awarding more work to companies with strategic relationships, and 13 suppliers qualified for this category. Suppliers in the approved category completed an average of just under 8 projects, but a total of 52 suppliers were accounted for. The 'approved' category had the highest average number of employees at 564, while 'preferred' suppliers average 270 employees and 'strategic' partners average 310 employees.

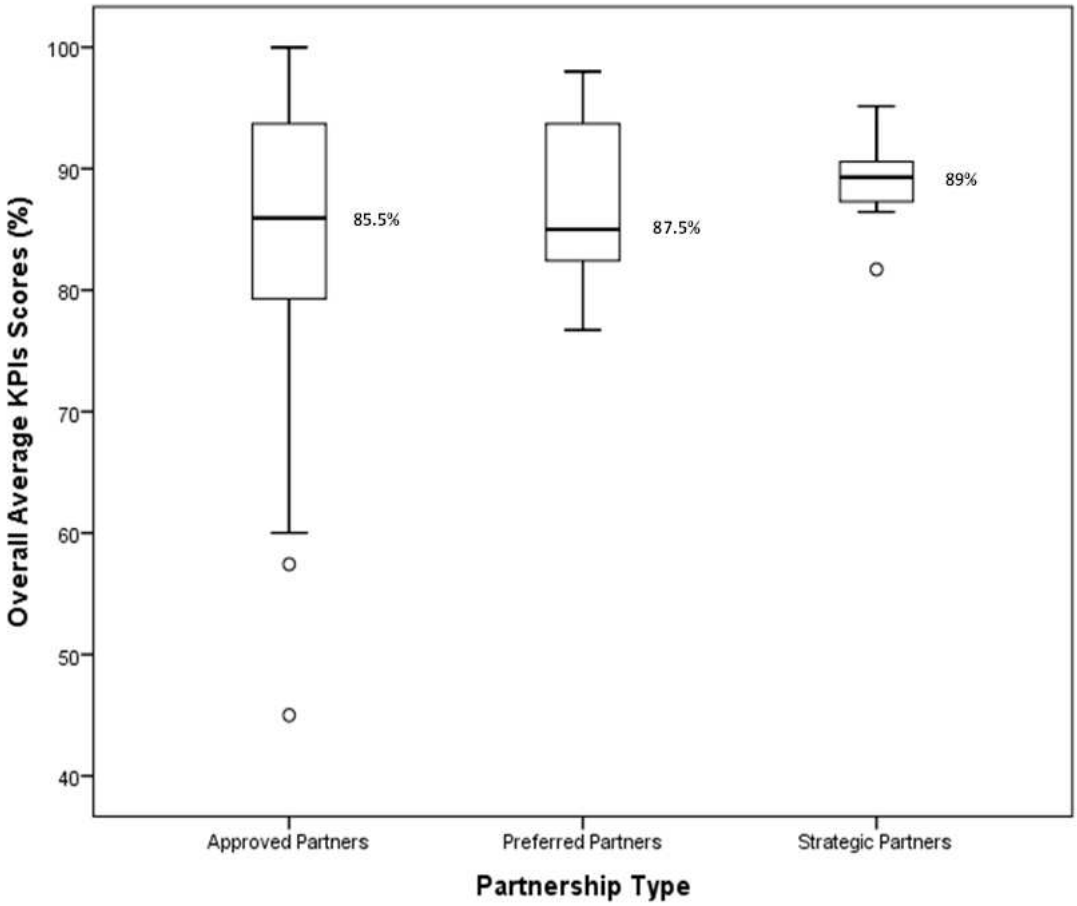
Figure 2: Relationship categories and the dataset



		Average Number of Projects Completed per Supplier	Number of Suppliers	Average size of supplier (No of Employees)
Strategic Partners	Invest significant resources in the partnership	26.5	13	310
Preferred Suppliers	Moderate investment of resources in the partnership	17.5	33	270
Approved Suppliers	Little investment of resources in the partnership	7.9	52	564

Based on studies outlined in the literature review (Carr and Pearson 1999, Tan *et al.* 1999), we would expect a higher average, and more consistent performance as the tighter the partnership becomes. The analysis begins with an overview of the total mean performance, giving a single figure for each supplier across all projects and metrics. A box plot for this is shown in Figure 3, where the mean score for each partnership types is indicated via the red line. The box plot shows that group 3, long term strategic partners, are more consistent in terms of the range of performance measures, whereas approved suppliers have a much greater range of performance. Strategic partners median and mean are slightly higher than the other groups.

Figure 3: Box plot comparison for the three different relationship types



While figure 3 gives a visual sense of the difference in overall scores between different partnership categories, it does not tell us how significant any differences are. In order to give further insight we undertook statistical testing to establish significance levels. Table 4 reports the results of these tests. It shows the averages and the spread of supplier KPIs for different partnership types. Means and standard deviations for KPIs are reported under KPIs dynamics and relationship types columns. ANOVA column reports F-Test results for joint significance to test the null hypothesis of similar means across the three partnership types for each supplier sector.

Results indicate that there is no significant difference between the means of the three relationship types apart for the closeout KPI, where test results indicate that means value across different relationship types differ and are significant at the 10% significance level. The Levene's tests are reported based on the absolute deviations from both the mean and median. This is to test the homogeneity of variances across the three relationship types for the five supplier sectors. Results clearly indicate that the null hypothesis of homogeneity of variances across the three relationship types is rejected, meaning that variances are heterogeneous. In summary, results confirm that even though there is no significant difference between the means of the different relationship types across KPIs, the variation, or stability levels, of these relationship types across KPIs is significantly different. The closer the relationship type, the more consistent KPIs will be. Table 4 also shows that there are no significant differences in the means of size related factors, including turnover and number of employees. However, the number of projects completed between different relational groups is significant, suggesting that learning from project to project may have an impact.

Table 4: The impact of relationship type on supplier KPI means and standard deviation

	KPIs Dynamics Vs. Partnership Types								**ANOVA**	**Levene's Test**	
	Full Sample		Approved		Preferred		Strategic				
	Avg	SD	Avg	SD	Avg	SD	Avg	SD	F-Test	Based on Mean	Based on Median
Turnover (£)	75.0	151.8	90.8	197.9	54,6	70.2	63.9	66.1	0.609	3.023* [0.053]	
Employees	431.2	907.9	563.9	1168.7	270.0	467.1	309.6	335.7	1.197	4.257† [0.017]	
Projects	13.6	13.0	7.9	7.0	17.5	16.7	**26.5**	**13.1**	**15.49‡**	11.627‡[0.000]	
ealth & Safety	**90%**	**8.5%**	**89%**	**9.7%**	90%	7.8%	**91%**	**3.5%**	0.389	6.001‡ [0.003]	5.869‡ [0.004]
Programme	86%	11.8%	86%	13.3%	**85%**	**11.1%**	88%	6.1%	0.261	3.344† [0.039]	3.056* [0.052]
Financial	84%	10.9%	84%	12.9%	85%	8.0%	**85%**	**6.7%**	0.357	6.330‡ [0.003]	5.788‡ [0.004]
Quality	88%	10.8%	88%	13.5%	88%	**7.1%**	90%	4.2%	0.184	6.528‡ [0.002]	4.140† [0.019]
Design	88%	13.9%	88%	17.4%	88%	9.4%	89%	4.1%	0.076	3.169† [0.047]	2.386* [0.098]
Management	87%	11.3%	87%	13.5%	87%	8.9%	90%	4.4%	0.393	4.149† [0.019]	3.635† [0.030]
Closeout	**83%**	**22.6%**	**77%**	**29.2%**	89%	8.4%	88%	5.4%	**3.08***	11.375‡[0.000]	7.328‡ [0.001]
Overall KPI	87%	9.1%	86%	11.1%	87%	6.5%	89%	3.1%	0.969	6.526‡ [0.002]	6.116‡ [0.003]

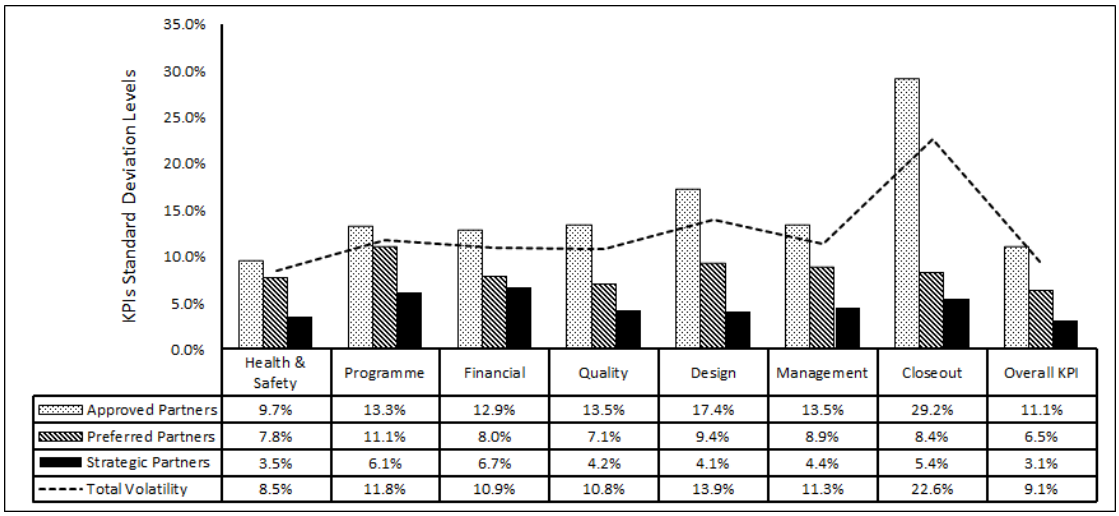
Values in [ ] are p-values. Characters ‡, † and * denote significance at 1%, 5% and 10% respectively.
Values in bold are highlighted to be discussed in the text.

As discussed in the data analysis section, the ranking importance of KPI is based on their means and standard deviations, and hence their stability. Therefore, ranking of unconditional KPIs indicates that Health and Safety is the most stable KPI, while Closeout is the least stable KPI. Ranking of conditional KPIs indicates that Health and Safety again is the most stable KPI for approved and strategic partnership-types, while programme is the most stable for some partnership-type. Furthermore, Closeout, Quality and Financial measures are the least stable KPIs for approved, preferred and strategic, respectively.

Figure 4 provides a visual representation of the changes in suppliers KPIs standard deviations across different partnership types, which is a further insight into our earlier finding of heterogeneity of the unconditional KPIs. Figure 4 clearly shows that standard deviation in KPI scores decrease as we move from approved to preferred to

strategic partnerships. In other words, strategic partnership is the most stable out of the three and that approved partnership type is the least stable.

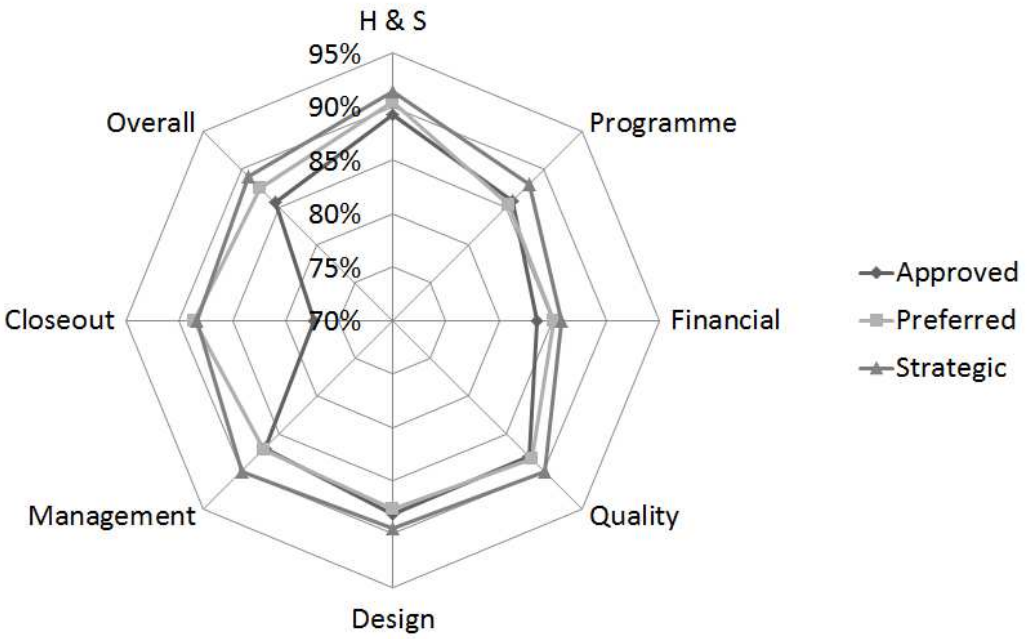
Figure 4: The volatility of supplier KPIs in different relationship categories



	Health & Safety	Programme	Financial	Quality	Design	Management	Closeout	Overall KPI
Approved Partners	9.7%	13.3%	12.9%	13.5%	17.4%	13.5%	29.2%	11.1%
Preferred Partners	7.8%	11.1%	8.0%	7.1%	9.4%	8.9%	8.4%	6.5%
Strategic Partners	3.5%	6.1%	6.7%	4.2%	4.1%	4.4%	5.4%	3.1%
Total Volatility	8.5%	11.8%	10.9%	10.8%	13.9%	11.3%	22.6%	9.1%

Figure 5 presents a radar plot for mean scores of the different partnership types across each of the different individual KPIs. It shows that strategic partners outperform on all individual KPIs apart from close out, where they are equal with type 2 suppliers. This difference is also highlighted in the statistical testing in table 4, where the F-test was highest for the comparison of close out means (significant at 10% level). Approved suppliers perform slightly worse than preferred suppliers on financial and much worse on close out.

Figure 5: Radar plot to show performance for specific KPIs



DISCUSSION

An important discussion point flowing from the findings is that while there is a difference in the overall KPI performance of means between different relationship categories, there is no significant difference. This is the case for overall KPI score, and for individual KPI metrics. The only exception was close out, significant at the 10% level. The poor performance of approved suppliers on the close out measure could be the result of a lack of understanding of processes and standards creating a build-up of snags and outstanding issues creating difficulties during the final stages. Furthermore, if there is no loyalty or certainty of future work between parties, there may be less incentive and leverage to ensure issues are 'closed out' effectively. This suggests that a focus for supplier development initiatives for the approved relationship category should be on raising the performance of 'close out'.

While differences in the means were mostly found to be not significant, the findings report that range of performance for different relationship categories was. The performance profiles are more consistent the higher the partnership level across all KPIs. The top performing supplier is a fit out and finishing subcontractor specialising in decorative and protective coatings services including general decoration, spray applied finishes, protective and hygienic coatings and special paint effects. The supplier averages 95.14% across the range of KPIs, and has contributed to 37 different projects. The supplier has also undertaken various continuous training initiatives with the case company, and joint investment has been made in new paint systems and technologies. While not appropriate in all situations, our findings suggest that this type of long term supportive business relationship is the type that leads to consistency of performance from one project to the next.

Despite these promising results, it is important to critique some of the characteristics of the dataset analysed. Firstly, the timing and frequency of measurement where Simpson et al. (2002) report a wide range of practice in this respect. They note that some buying organisations measure suppliers regularly while others only do so on an annual basis. In our construction case, suppliers are evaluated after their input on a particular project. In should be noted that this approach has been criticised as being a 'lagging' measure (Kagioglou, Cooper and Aouad 2001), which has limited ability to feed-forward into project improvements. The case company does operate monthly KPI figures with strategic partners in order to complement project measures, which is an area for investigation in the future.

A further area for discussion is the relative importance of different KPIs. In the analysis presented the measures are considered as equally important. The case company has considered at length the possibility that individual KPIs may have different significance to the overall performance of a project. They concluded that projects present many different scenarios, potentially requiring different weightings for the range of KPIs. This brings to the fore the difficulties of a one size fits all model for constructions projects. Simpson et al. (2002) found that the majority of buying companies considered quality to be the most important of the measures. Another important issue that has been highlighted in the literature is the level of inclusion of different parties within the supplier measurement process. It is possible that the buying organisation may undertake evaluations alone, the supplier may undertake the evaluation alone, or that it may be done jointly. Simpson et al. (2002) reported that only 19% of companies in the sample included both parties (buyer and supplier) in the measurement process. In this case, rankings were assigned by project teams without supplier involvement, although feedback meetings are intended to be collaborative, and suppliers have access to the performance data through a web system. This also raises the issue of consistency between project teams when performing ratings.

As stated in the introduction, we have investigated the impact of supplier development initiatives and partnership categories from the perspective of a larger buying organisation. In doing so, we are aware that we that the ideas, frameworks and programmes researched may be perceived differently from 'the supplier perspective'. Previous studies have raised awareness of this issue (Thorpe, Dainty and Hatfield 2003, Nagati and Rebolledo 2013), and we welcome further research in this area. However, we do take the position that this study supports the idea of active management of the supply chain, where an organisation makes proactive, sustained and structured effort to drive improvements throughout the supply chain. The KPI system was originally set up so that the company could provide evidence to clients on the performance of its supply chain, but it has subsequently become a source of learning and continuous improvements in the way that the company is working with it's suppliers and subcontractors. While there are many hurdles to doing so in the construction industry, this study gives some hope that performance can be more consistent and stable over time, hence, helping to manage and reduce risks.

CONCLUSION

The question 'what is the impact of supplier development initiatives on key performance indicators in a construction supply chain?' has been addressed. The overall finding is that the closer the relationship type, including the use of direct involvement supplier development activities, the more consistent KPIs will be. To

answer the above question, we integrated an established framework for supplier initiatives and a further framework for relationship categories. In doing so, we argued that supplier development initiatives should be aligned with relationship categories.

The empirical elements of the study focused on the archival records of a case company in the commercial buildings sector. The dataset includes performance data for 98 suppliers and, since 1990, these suppliers have made 1334 contributions to various projects. A combination of descriptive statistics, ANOVA and Levene's tests were used to analyse the data. While the findings suggest that groups of suppliers in closer relationship groups have higher mean performance scores, the statistical testing reports no significant different between the mean KPI scores of different relational categories. However, they do report a significant difference between the volatility of performance between different groups. The higher the level of partnership in the relational category, the more consistency there will be in performance. We also conclude that suppliers in the approved category perform less well on the 'close out' KPI. Hence, there is a need for buying companies to consider initiatives with approved suppliers to help raise performance on close out issues.

Through the analysis and exploration of a longitudinal dataset, the paper supports literature linking supplier development initiatives with improved performance, and offers some encouragement for other construction organizations embarking on their own supplier development programmes. However, the paper does not support a indiscriminate endorsement of strategic partnering. We argue that the paper is more supportive of the 'fit for purpose' approach to partnering, where different relationship types are required for different circumstances. The integrated model developed offers a route to more tailored supplier development efforts, whereby relational categories receive different focus and levels of resource. Direct involvement initiatives that consume a large amount of time and resource should be reserved for strategic partners.

A critique of the performance measurement system analysed was also presented. This gives insight into some of the challenges of collecting data for, and managing, such a system. These findings add to the debate in relation to the use of strategic partnerships and supply chain management in the construction industry, helping to refine existing models (e.g. Gosling et al and Krause et al), as well as addressing the lack of longitudinal 'big data' in the construction industry. It is unclear if supplier development initiatives are effective beyond the boundaries of the case and sector in question. Hence, we encourage other researchers to seek insight through the analysis of big data collected from further empirical settings. Further research is also needed to establish the extent to which the initiatives described herein have the same impact across different international contexts and construction market sectors, as well as to investigate the potential for learning curve models to be applied

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