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PROJECT LIFECYCLE APPROACH TO THE PERCEIVED VALUE OF SUPPLIERS: A STUDY OF A FINNISH CONTRACTOR

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ABSTRACT

Systematic supplier evaluation, benchmarking, and development are parts of successful construction. However, there is a possible bias in supplier evaluations as in the early phase of projects, higher uncertainty about project success makes contractors potentially more critical of suppliers. We investigate whether contractors tend to favor suppliers of late project phases over suppliers in early phases. The analysis of 1,374 supplier evaluations revealed that in all 13 variables ranging from safety and schedule to quality the performance of the supplier was perceived lower among suppliers in the early phase compared to the late phase of the project. The evaluators recommended 92.8 % of the suppliers of late phases whereas they recommended only 86.1 % of the suppliers of early phases. When 12 other variables were taken into account, the contractor still tended to recommend more often suppliers that were active in the late phase ($p<0.01$). The paper contributes to the research on supplier management in projects by revealing novel insights about the effect of project phase on perceived value of suppliers. Contractors can utilize the findings by improving the objectivity of supplier evaluation systems. More research is needed to generalize the findings and to investigate the mechanisms behind the phenomenon.

KEYWORDS

Supply Chain Management, Supplier Evaluation, Perceived Value, Project Phase.

INTRODUCTION

Careful supplier selection has been recognized as a significant factor in maximizing customer value and eliminating waste in construction. As the competition usually occurs between project supply chains rather than between individual companies (Lambert et al. 1998), contractor's ability to develop its supplier network by evaluating suppliers' performance and selecting only best of them for the following projects is crucial in

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project-based business (Kumaraswamy et al. 2000). Existing research on supplier evaluation in construction has mainly focused on identifying characteristics of a good evaluation system. These characteristics include supplier categorization and comprehensive evaluation criteria (Biesek et al. 2008; Ho et al. 2007), proactive and periodic on-site evaluation (Maturana et al. 2004), combining evaluation to preferred supplier programs (Elfving and Ballard 2011) and to supplier development (Elfving and Ballard 2013), and use of appropriate analytics in the selection process (Bayazit et al. 2006).

From a contractor perspective, uncertainty about project costs, schedule and quality of the final product is highest in the early phase of a project (Chapman and Ward 1996). If suppliers have a remarkable role in the accomplishment of project's targets on time and on budget, it is logical to assume that uncertainty about the achievement of the overall targets of a project affects also contractor's perceptions of its suppliers: A contractor which is uncertain about the overall success of a project, may undervalue the performance of its supplier even if the supplier's performance has been objectively adequate. Construction project involves typically dozens of suppliers whose participation and activity in a project organization may concentrate on the specific stage of a project life cycle depending on whether their offerings are related e.g. to the planning phase, early execution phase or finalizing phase of a project. Therefore, evaluating suppliers at different times during project life cycle may unfairly favor suppliers whose activities take place in late phases (less uncertainty) compared to those who participate in the early phase (more uncertainty). Despite this possible bias in the evaluation systems of project suppliers, existing research about the topic is scarce.

This paper investigates the connection between the timing of a supplier evaluation during project life cycle and the perceived performance. More specifically we are interested in whether contractors tend to favor suppliers of late project phases over suppliers in early phases in their evaluations. In the next section we draw the hypothesis about the connection based on the existing research on project life cycle approach to supplier relationships. In the third section the method to test the hypothesis is presented. After results section, we conclude by discussing findings and their contribution on the existing research and practitioners. Finally, several avenues for further research are suggested.

PROJECT LIFE CYCLE APPROACH TO SUPPLIER RELATIONSHIPS

A construction project typically consists of several project phases which differ remarkably from each other both in their objectives and activities. Respectively, also critical success factors differ in each project phase. In execution phase, for example, project manager has to simultaneously manage several critical factors, such as mission, troubleshooting, schedule and plan, technical tasks, and client consultation (Pinto and Prescott 1988).

When the on-site execution is further divided into typical phases of building projects, such as foundations, structural work and interior construction, from project and supplier

management perspectives, these phases have remarkable differences: In early execution phase, project organization is typically small, and contractor can easily evaluate the specific contribution of each supplier as the number of dependencies between tasks and sub-products is smaller than in the later phases of execution. The early phases of the project (Earthworks, Foundations and Structure) have fewer hand-offs because they have fewer subcontractors. In addition, several studies report that the finishing stages of the project are less well managed and often have poor quality, schedule overruns and hurry (Brodetskaia et al. 2010; Sacks and Goldin 2007; Seppänen 2009; Vasconcelos et al. 2012). Therefore, although there are more production problems in the end, they are very difficult to assign to an individual actor of the process because they result from cascading delay chains and cumulating quality problems. It is much easier to know who to blame in early parts of the project when just a few subcontractors are on site.

On the other side, relationships between client or contractor and its suppliers in construction are typically acknowledged to be poor. Especially in traditional procurement practices, such as in design-bid-build (DBB) contracts, overemphasis of low price leads to misaligned objectives between buyer and supplier and lack of patience to build long-term relationships (Davis and Walker 2003). Research about value suggests that relationship and engagement between customer and supplier is essential in value co-creation (Payne et al. 2008). Vice versa, when a supplier is engaged with the customer at the moment when the customer perceives to gain value, it can be argued that this engagement improves the relationship between the parties. We apply this phenomenon about customer value and relationships to a late project phase, and suggest that site managers' attitude toward late suppliers might therefore turn out to be positive even though they participated in cascading delay chains: "Although the sub-contractors who started early screwed up, these later suppliers were able to work as a team and finally to finish with us on time".

In summary, due to the lower uncertainty about the final value in the end of the project and higher uncertainly about the single supplier's contribution (or lack of contribution) on that final value, it can be proposed that in construction, contractors tend to favor suppliers of late project phases over suppliers in early phases. Therefore, the following hypothesis is proposed:

- ***Hypothesis:*** *Contractors tend to favor suppliers of late project phases over suppliers in early phases in their evaluations.*

We further divide our main hypothesis into two research hypotheses:

- ***Hypothesis 1A:*** *Contractors give higher evaluation grades for suppliers of late project phases compared to suppliers in early project phases.*
- ***Hypothesis 1B:*** *When sub-measures for supplier performance, such as achievement of costs, schedule and quality targets, are taken into account, contractors tend to recommend more often the use of the suppliers of late project phases than the suppliers of early project phases.*

The first research hypothesis highlights the objective nature of evaluation by claiming that suppliers in the late phase receive higher grades in specific project-related sub-

measures, such as time, quality and cost. The second hypothesis, instead, underlines subjective issues in supplier evaluation and proposes that even when more objective performance measures are taken into account, alignment of the evaluation with customer's own value creation favors suppliers in late project phase.

METHOD

The hypotheses were tested by analyzing supplier evaluation database of a Finnish construction company. The company and its database were chosen for the study due to the company's long history in the development and use of systematic supplier evaluation, wide range of different construction projects in terms of their product, size and region, and easy access to data.

The supplier evaluation was made by project on-site superintendents. The evaluation system asked superintendent to fill an electronic evaluation form one week after the planned end of the delivery. The data included project-specific information (name, number, and region), basic information about the supplier (name, org id, and offering), and evaluation information (date, Likert scale grades (1-5) of 12 specific performance measures, and recommendation to use the supplier in future: true or false). The 12 specific performance dimensions included:

1. Supplier's attitude to occupational safety
2. Cleanliness, order, and consideration of environmental issues
3. Observance of safety regulations and guidelines
4. Activity in promoting safety
5. Supervision of work
6. Compliance with the agreed timetables
7. Additional claims in relation to the contract
8. Knowing the content of and compliance with the agreement
9. The quality of the product and service
10. Development activity
11. Billing and payment terms were timely and in accordance with the agreement
12. Response to possible comments and complaints

The original data consisted of 2,820 supplier evaluations made during the two-year period of 2014 and 2015 in 195 projects. For the analysis of this research, only projects in which the time period between the first and the last supplier evaluation was at least 30 days were selected. This also excluded potential projects in which all evaluations were made in the end of the project even if some suppliers' activity took place in earlier phases. After that the evaluations were categorized based on their timing during the project life cycle. As exact starting and ending times of the projects were not available, the categorization was made based on relative timing of the evaluation among all evaluations of the same project. The evaluations made during the first fifth of the time frame of all evaluations were categorized as '*early*' and the evaluations made during the last fifth as '*late*'. Evaluations made between these times were excluded. The final sample included 75 projects and 1,374 evaluations of which 577 (42.0%) were *early* evaluations and 797 (58.0%) *late* evaluations.

The hypothesis 1A was tested using ordinal regression analysis (Agresti 2010) in which a dichotomous variable about the project phase was used as an independent variable to explain each 12 performance dimensions and recommendation to use the supplier. The hypothesis 1B was tested using binomial logistic regression in which the project phase and all 12 performance dimensions were used as independent variables and binary variable about recommendation to use the supplier as a dependent variable. Spearman's rhos were first calculated to test the correlations between the independent variables. As the highest correlation coefficient was .778, all variables were included in the model.

RESULTS

The basic information about the projects and suppliers is presented in Table 1. The projects were very heterogenous both in their time span and number of suppliers. 44.9 % of the suppliers (n=167) were evaluated both in early and late phases depending on the project. On the other hand, 42.7 % of the suppliers (n=159) were evaluated only once, either in early or late phase.

Table 1: Basic information about the projects and suppliers

Variable	Value
No of projects	75
Time between first and last evaluations (days); mean (min; max)	204 (33; 693)
No of different evaluated suppliers	372
No of suppliers evaluated in the early phase	*262*
No of suppliers evaluated in the late phase	*277*
No of evaluated suppliers per project; mean (min; max)	18.3 (2; 130)
No of evaluations per supplier; mean (min; max)	3.8 (1; 39)

The results of testing the Hypothesis 1A are presented in Table 2. Share of non-recommended suppliers was 13.9 % in the early project phase and only 7.2 % in the late project phase, and that difference was statistically significant ($p<.001$). In nine of the 12 specific performance dimensions, grades given in the late phase were statistically significantly ($p<.05$) higher than grades given in the early project phase. The biggest difference in evaluations between the project phases existed in *timely and accordance billing and payment*.

Table 2: Comparison of evaluation grades between early and late project phase (significance evaluated using Ordinal regression analysis) (n=1,374 evaluations)

Performance dimension	Early phase (mean ± sd)	Late phase (mean ± sd)	Difference	Significance (p-value)
1. Supplier's attitude to occupational safety	3.53 ± 0.91	3.75 ± 0.90	0.22	<.001*
2. Cleanliness, order, and consideration of environmental issues	3.49 ± 0.88	3.74 ± 0.86	0.24	<.001*
3. Observance of safety regulations and guidelines	3.54 ± 0.91	3.77 ± 0.90	0.23	<.001*
4. Activity in promoting safety	3.21 ± 0.86	3.41 ± 0.95	0.20	.001*
5. Supervision of work	3.85 ± 0.95	3.92 ± 0.95	0.08	.150
6. Compliance with the agreed timetables	3.78 ± 1.09	3.91 ± 1.01	0.13	.061
7. Additional claims in relation to the contract	4.01 ± 0.96	4.20 ± 0.91	0.19	<.001*
8. Knowing the content of and compliance with the agreement	3.97 ± 0.84	4.13 ± 0.80	0.16	<.001*
9. The quality of the product and service	3.80 ± 0.93	3.95 ± 0.89	0.16	.001*
10. Development activity	3.55 ± 0.94	3.65 ± 0.93	0.10	.106
11. Billing and payment terms were timely and in accordance with the agreement	4.00 ± 0.91	4.34 ± 0.76	0.33	<.001*
12. Response to possible comments and complaints	4.01 ± 1.05	4.21 ± 0.96	0.21	<.001*
Recommendation to use the supplier in future (Share of recommended)	86.1 %	92.8 %	6.7 %	<.001*

*$p<0.05$

In testing of the Hypothesis 1B, the binomial logistic regression model was statistically significant, $\chi 2 = 496.42$, $p<.001$. The model explained 64.0% (Nagelkerke R2) of the variance in supplier recommendations and classified correctly 94.1% of the evaluations. When specific performance dimensions were taken into account, suppliers in late project phase were tended to be recommended more often ($p<0.01$) than in early project phase

(Table 3). The *quality of the product and service* had the strongest association with the supplier recommendation. Also *response to possible comments and complaints*, and *compliance with the agreed timetables* were statistically significantly ($p<0.05$) associated with supplier recommendation.

Table 3: The connections between variables and supplier recommendation (Binomial logistic regression) (n=1,374 evaluations)

Variable	B coefficient	Significance (p-value)	Exp(B)
Project phase (Early=0; Late=1)	.824	.003**	2.281
Supplier's attitude to occupational safety	.154	.549	1.166
Cleanliness, order, and consideration of environmental issues	.001	.997	1.001
Observance of safety regulations and guidelines	.195	.401	1.215
Activity in promoting safety	.108	.655	1.114
Supervision of work	.293	.090	1.341
Compliance with the agreed timetables	.452	.001**	1.571
Additional claims in relation to the contract	.254	.061	1.290
Knowing the content of and compliance with the agreement	.107	.580	1.113
The quality of the product and service	1.08	.000**	2.945
Development activity	.034	.862	1.035
Billing and payment terms were timely and in accordance with the agreement	.169	.320	1.184
Response to possible comments and complaints	.632	.000**	1.881
Constant	-9.980	.000**	0.00

*p<0.05; **p<0.01

The connections between supplier recommendation and product and service quality as well as compliance with timetables are illustrated in Figure 1. The figure shows that early suppliers received systematically lower recommendations than late suppliers with the same grades in quality and schedule.

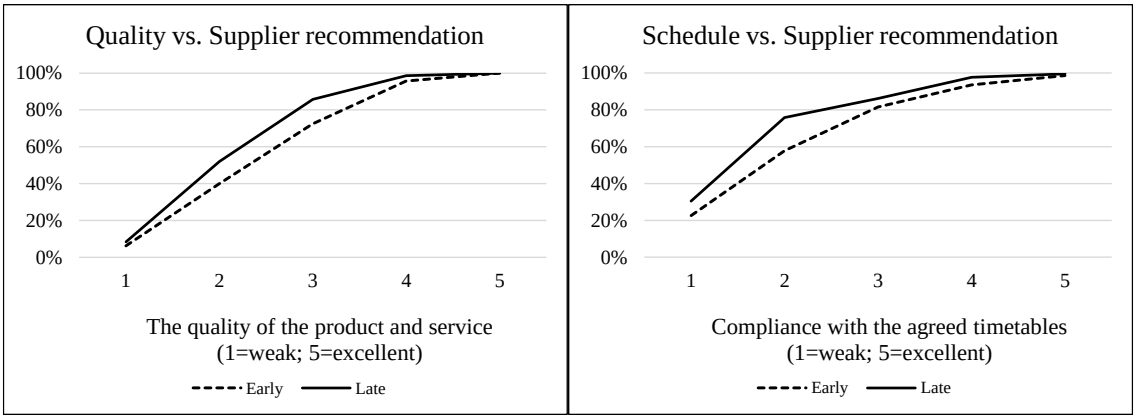

Figure 1: Share of recommenced suppliers compared to the grades of quality (left) and compliance with schedule (right) in early and late evaluations (n=1,374 evaluations)

As a summary of the results, the data confirmed the both hypotheses 1A and 1B and therefore also the main hypothesis. Based on the analysis contractors gave higher evaluation grades for suppliers of late project phases compared to suppliers in early project phases. That was confirmed as in 10 of the 13 performance dimensions the later evaluations were statistically significantly higher. In addition, when sub-measures of supplier performance were taken into account, the contractor tended to recommend more often the use of suppliers of late project phases than suppliers in early project phases. In conclusion, the contractor tended to favor suppliers of late project phases over suppliers in early phases in their evaluations.

DISCUSSION

The purpose of the study was to increase understanding about the connection between the timing of supplier's activity during project life cycle and the perceived performance.

The empirical analysis revealed that supplier recommendation was strongly connected with grades of typical project performance indicators, time and quality. Also response to comments and complaints was connected with recommendation. The findings indicate that contractors emphasize these dimensions in their evaluations. Therefore, minimum requirement for suitable supplier evaluation could be to incorporate three dimensions, schedule, quality, and treatment of complaints, into the system. Other dimensions, such as safety and supervision, may be important but not critical when recommending suppliers for further projects. The findings are mostly aligned with the existing research about critical dimensions (Biesek et al. 2008; Elfving and Ballard 2013), however, the role of cost was minor in this research. The reason might be that costs are rather fixed during the project but shedule and quality issues require more everyday attention from on-site superintendents.

The results supported the research hypotheses by indicating that in addition to time, quality, and treatment of complaints, also timing of supplier's activity and related evaluation impact on supplier recommendation: Superintendents tend to favor suppliers of the late project phase over suppliers in the early phase. The findings underline that supplier evaluation is highly subjective issue and that the perceived value cannot be fully

explained by objective submeasures. Also context-related issues, such as project life cycle, affect the evaluation. Contractors can utilize this knowledge by improving the objectivity of their supplier evaluation systems. That can be done either by increasing consciousness of the phenomenon among project superintendents or by taking it into account in supplier selection process. With more accurate and appropriate supplier evaluation systems, contractors can develop their project organizations in order to collectively eliminate waste and increase customer value.

The study findings contribute to existing literatures about lean construction, projects and supply chains. The study contributes on previous lean supplier research by arguing that subjectivity in evaluating the value of suppliers might affect preferred supplier programs. To project management literature, the study highlights the role of project life cycle on relationships between project organizations. Although the empirical study could not reveal the exact mechanism behind the connection between project phase and supplier recommendation, the results support the argument about dynamic nature of uncertainty and complexity in projects and related dynamism in attitudes toward project suppliers. The findings also contribute to supply chain management and supplier evaluation literature by indicating that not only the life cycle of supplier relationship, but also the life cycle of the specific context of the relationship, project, affects attitudes about the relationship. In summary, the research increases understanding about supplier relationships in project context. Projects are specific and complex contexts in which the development of relationships may be more cyclical than in manufacturing and other more continuous and less uncertain production contexts.

CONCLUSIONS

The study indicates that contractors tend to favor suppliers of late project phases over suppliers in early phases in their evaluations. Contractors are more willing to recommend further use of late suppliers than suppliers of the early phases of the project.

The study has several limitations which hinder the applicability of the results. First, the study was conducted in a specific setting using data of a Finnish contractor. It is possible that the specific regional context affected the findings due to e.g. lack of markets in some offerings. There might be also problems in data accuracy. The date of evaluation was used to define a project phase, which might differ from the actual activity of a supplier. We also did not have data about projects' overall success, complexity or uncertainty. Therefore, the proposed mechanisms behind the identified empirical phenomenon are rather theoretical and more research is needed to clarify and justify them. This would require either a qualitative approach or prospective data gathering in which also other variables, such as project complexity, uncertainty or value are taken into account. It would also be interesting to look at the objective measures of project success (for example actual vs. budgeted costs and actual flowline diagrams) and compare them to subjective evaluations.

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