EFFECTS OF COLLABORATION IN PROJECTS ON CONSTRUCTION PROJECT PERFORMANCE

Patrik Löfgren[1] and Per Erik Eriksson[2]

[1] *Division of Business Administration and Management, Luleå Univ. of Technology, SE-971 87 Luleå, Sweden*

[2] *Corresponding author: Division of Business Administration and Management, Luleå Univ. of Technology, SE-971 87 Luleå, Sweden*

Collaboration among project actors has been subjected to much attention in recent years within the field of construction management. Several case studies support the argument that collaboration has positive effects on project performance. There is however, a need for quantitative studies investigating statistical relationships between collaboration and performance. Joint activities and collaborative tools (e.g. workshops, joint objectives, and teambuilding activities) are commonly used in order to establish a collaborative spirit among project actors. The purpose of this research is to investigate how collaborative tools affect collaboration and further collaboration's effect on project performance. The empirical data was collected through a survey responded to by 106 Swedish construction clients. Results from hierarchical regression analyses show a positive relationship between collaborative tools and collaboration suggesting that joint activities are crucial for collaboration to emerge. A positive relationship was also found between collaboration and project performance. The statistical results support previous case study findings where collaboration is positively affected by joint activities and project performance is enhanced by collaboration.

Keywords: collaboration, partnering, project performance.

INTRODUCTION

The construction industry is a complex and high-risk multi-actor business that over a long period of time has received criticism for its relationships between contractor and client, where poor collaboration, ineffective communication, unbalanced risk allocation in contract provisions, limited trust, and lack of customer focus are cited amongst its shortcomings (Cheung *et al.*, 2003, Eriksson *et al.*, 2008). Partnering, a concept which provides a governance framework for the establishment of collaboration, can be beneficial for all parties involved if implemented successfully (Naoum, 2003, Eriksson, 2008). Case studies of construction partnering in Hong Kong (Chan *et al.*, 2003), Sweden (Eriksson and Nilsson, 2008), the US (Naoum, 2003) and the UK (Bresnen and Marshall, 2000) argue that partnering increases the possibility that projects are completed within budget, on time, with the least number of conflicts, claims and work defects, and with a good client-contractor relationship.

Even though the greater part of earlier studies has favourable conclusions about partnering these studies can be criticised of being limited in scope and heavily reliant on supportive case studies as well as anecdotal evidence (Bresnen, 2007). The

[2] pererik.eriksson@ltu.se

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limitation of scope of case studies illustrates the need for quantitative studies on partnering effects on project performance. One quantitative study, conducted by Larson (1995), supports that partnering projects achieve superior results in controlling costs, technical performance, and in satisfying customers compared to projects without partnering. Another more recent investigation, conducted by Nyström (2008), did not however find any clear differences in project performance when comparing the performances of ten partnering projects with ten similar non-partnering projects. Hence, there is a comprehensible need for similar quantitative studies on how partnering and collaboration affect project performance today.

Partnering encourages the relationship between contracted parties to become more cooperative and team-based, which promotes the achievement of mutually beneficial goals (Larson, 1995). Joint activities and collaborative tools, such as joint objectives, joint project office, workshops and team building activities, will effectuate trust-building and collaboration (Naoum, 2003, Bayliss *et al.*, 2004, Eriksson, 2008). Such collaborative tools may also be useful in dispute resolution, risk balancing, problem solving, decreasing the risk of opportunism and enhancing a "win-win" situation (Cheung *et al.*, 2003, Bayliss *et al.*, 2004). If implemented right collaborative tools will instill, foster and maintain a collaborative spirit among project actors (Bayliss *et al.*, 2004), for which reason they are argued to be a core component of partnering. The drawback with these activities is the cost associated with their implementation. To justify the use of collaborative tools it is therefore important that they really result in increased collaboration, as suggested in earlier case studies.

The purpose of this research is to investigate how collaborative tools affect collaboration and further collaboration's effect on project performance. First, a literature review was performed, ending up in the formulation of two testable hypotheses. Second, the hypotheses were empirically tested based on data collected through a large scale survey among Swedish construction clients.

COLLABORATIVE TOOLS' EFFECTS ON COLLABORATION

The concept of partnering overhauls the traditional adversarial relationships between contracted parties with a shift towards more collaborative and caring environments. To facilitate effective partnering a range of collaborative methods and joint activities with the purpose to enhance the collaborative spirit among contracted parties, collectively named collaborative tools, are required (Bayliss *et al.*, 2004). Examples of collaborative tools are: joint objectives, follow-up workshops, dispute resolution techniques, joint IT-database, joint project office, teambuilding activities, partnering facilitator, and joint risk management (Ng *et al.*, 2002, Eriksson and Laan, 2007, Eriksson, 2008). The usage of joint objectives enables the client and contractor to see the wider benefits and will give little room for those who are not committed to the project (Gil, 2009). Joint objectives will therefore enhance the possibility of a "win-win" situation between contracted parties. Follow-up workshops have been identified as one of the most effective tools to effectuate a collaborative spirit and together with pre-project meetings it helps the project members to focus on potential problem areas and creates a possibility for face-to-face discussion (Larson, 1997, Cheng *et al.*, 2001, Bayliss *et al.*, 2004, Olsen *et al.*, 2005). Dispute resolution techniques reduce the risk for litigations and claims that could harm the collaboration (Cheung and Suen, 2002). A joint IT-database, designed to reflect the projects strategic vision and environmental factors, is an effective tool to increase collaboration and information sharing among project actors due to its capability of providing available resources to users with

minimal cost and time (Cheng *et al.*, 2001). The establishment of joint project office has positive effects on developing a collaborative climate between contracted parties through the endorsement of openness in face-to-face meetings and identification with the project (Olsen *et al.*, 2005, Swan and Khalfan, 2007). Teambuilding activities are an essential part of modern project management designed to enhance teamwork, socialisation and collaboration among project members (Cheng *et al.*, 2001, Jha and Misra, 2007). A partnering facilitator is critical in the initial phase of a partnering project due to the facilitator's possibility to form the process towards higher collaboration (Cheng and Li, 2002). A joint risk management approach where economic losses or gains, due to market change, are shared generates a sense of mutual trust and commitment to the project (Gil, 2009).

In the construction of a Swedish pharmaceutical plant the client used different collaborative tools extensively which resulted in a high emphasis on trust and participants solved problems in a collaborative manner (Eriksson and Nilsson, 2008). Hence, high usage of collaborative tools indicates bilateral governance and cooperation, whereas no or low use indicates market relationships and competition (Eriksson, 2008). In accordance with the above presented line of reasoning the following hypothesis has been formulated:

Hypothesis 1: The higher the usage of collaborative tools, the better the collaboration among contracted parties in a construction project.

COLLABORATION'S EFFECT ON PROJECT PERFORMANCE

In a quantitative study, with the limited scope of 20 projects, comparing ten partnering projects with ten similar non-partnering projects, no general trend concerning the performance in terms of cost, construction time, quality, contract flexibility, or avoidance of disputes was found (Nyström, 2005). In contrast to these results there is nevertheless a common opinion that partnering has positive effects on project performance. A more collaborative spirit among project members have been found to improve cost performance, such as elimination of cost overruns, controlling overall costs, and reducing administration costs (Abudayyeh, 1994, Larson, 1995, Bresnen and Marshall, 2000, Naoum, 2003, Chen and Chen, 2007, Keil, 2007). Furthermore, construction projects with emphasis on collaboration rather than price and authority are more likely to eliminate time overruns (Larson, 1995, Naoum, 2003). Collaboration among project actors has also been found to improve quality by replacing the more traditional adversarial relationship with an atmosphere that fosters teamwork to achieve joint objectives (Chan *et al.*, 2003).

In Sweden, the project participants in a case study of the construction of a pharmaceutical plant considered that the project success and the timely completion of the project below budget were highly facilitated by the collaborative approach (Eriksson and Nilsson, 2008). Hence, in construction projects with great uncertainty high levels of trust and collaboration could lead to increased efficiency (Kadefors, 2004). In line with these arguments the following hypothesis has been formulated:

Hypothesis 2: the better the collaboration among contracted parties in a construction project, the better the project performance.

In Figure 1 below we propose a model in which collaboration works as a mediator between collaborative tools and project performance. A full mediating effect hypothesise that there is no direct relationship between collaborative tools and project performance.

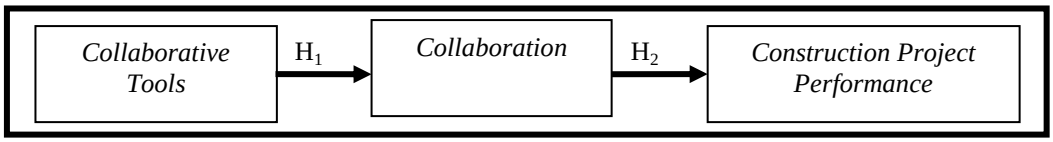

Figure 1: The proposed project performance model

METHODOLOGY

Sample

The empirical data were collected through a questionnaire to a population of 140 construction client organisations that are members of The Swedish Construction Client Forum (SCCF). The population consists of regional, national or international industrial and property companies, municipalities and regional authorities, and also government services and agencies. Hence, this population provides a suitable representation of Swedish construction clients. The organisations where initially approached by the CEO of SCCF through a letter describing the purpose of the investigation and its importance for SCCF and its members. In a second step the registered contact persons were telephoned, in order to inquire theirs or other more suitable person´s willingness to participate in the study. Consequently, it was up to the contact person to choose the most suitable respondent, given that the survey involved procurement, project management processes and project performance. At this stage six respondents declined participation due to lack of time. In a third stage, questionnaires were posted to the 134 potential respondents that had agreed to participate in the investigation. After two reminders a total of 111 responses were received. In a fourth stage respondents who had not answered all questions were telephoned and asked to respond to these questions. This resulted in minimisation of the amount of missing values. Nevertheless, in five responses there were a lot of missing values, for which reason they were discarded. Accordingly, from the population of 140 clients 106 usable responses were received, resulting in a response rate of 76%.

Measure: Collaborative tools, collaboration and project performance

In the questionnaire the respondents were asked to what extent they use different collaborative tools in their construction projects, and how satisfied they are with various aspects of project performance, including collaboration among project actors. The questions were measured using seven-point Likert scales anchored by 1 = very seldom/very dissatisfied and 7 = very often/very satisfied. The questions did not measure these aspects in a particular project but involved firm-level behaviour and project performances in the clients' portfolios of procured and finished projects. Furthermore, three control variables were measured through a nominal scale: if the organisation follows public procurement regulations or not, if the construction activities involve new construction/rebuilding projects or continuous maintenance work, and if the client is active on a local/regional or national/international market.

PRESENTATION AND ANALYSIS OF EMPIRICAL RESULTS

Usage of collaborative tools

The most commonly used collaborative tool is joint objectives (4.35) followed by joint IT-database (4.26). The least common used collaborative tools are partnering facilitator (2.46) and joint project office (2.46). The eight items of collaborative tools (joint objectives, follow-up workshops, arena for relationship discussion and dispute resolution, joint IT-database, joint project office, teambuilding activities, partnering

facilitator, and joint risk management) were subjected to principal component factor analysis (PCFA) with Oblimin rotation using the Statistical Package for the Social Sciences (SPSS) version 16. Oblimin rotation is justified when it is reasonable to expect correlation between perceptual dimensions (Hair, 1995). The Kaiser-Meyer-Oklin (KMO) value was 0.87, exceeding the recommended value of 0,6 and the Bartlett Test of Sphericity reached statistical significance (0.00). The analysis on collaborative tools resulted in a one-dimensional factor with factor loadings between 0.39 and 0.80. Hence, collaborative tools will be computed into a single factor in later analysis. The computed factor of collaborative tools have Cronbach alpha CA = 0.84 and factor mean value MV = 3.24. The relatively low mean value indicates that collaborative tools are not used to a high extent by Swedish construction clients.

Project performance

The respondents are satisfied with project performance: customer satisfaction (5.90) receives the highest score and time schedule minimised (4.70) the lowest, see Table 1.

Table 1. Principal component factor analysis of project performance

	Item Mean	Factor 1 Quality	Factor 2 Time	Factor 3 Cost	Factor 4 Collaboration
Function according to specification	5.75	0.91	0.04	0.13	-0.14
Expected quality is achieved	5.70	0.90	0.01	-0.03	0.03
High customer satisfaction	5.90	0.77	-0.04	-0.06	0.20
Time schedule is minimised	4.70	-0.09	0.92	-0.02	0.07
Within time schedule	5.61	0.25	0.60	0.30	-0.06
Within project budget	5.51	0.01	0.05	0.94	-0.07
Project cost is minimised	4.95	-0.06	0,14	0.77	0.16
Life cycle costs are minimised	4.87	0.32	-0,24	0.48	0.20
Negotiations don't end up in disputes	5.18	-0.10	-0,05	0.18	0.87
Good cooperation among project actors	5.41	0.30	0.19	-0.12	0.67
Percentage of variance		42.16	14.76	9.70	8.74
Cronbach alpha (CA)		0.87	0.60	0.73	0.59
Factor mean value (MV)		5.76	5.17	5.09	5.73

The ten items of project performance are theoretically related to the four aspects of cost, time, quality and collaboration. In order to investigate if the empirical data supports such a grouping of performances the ten items were subjected to a PCFA with Oblimin rotation, which was forced into four solutions. The Kaiser-Meyer-Oklin (KMO) value was 0.76 and the Bartlett Test of Sphericity reached statistical significance (0.00), supporting the expected four factor solution, explaining 42.2%, 14.8%, 9.7% and 8.7% of the variance respectively. The identified factors are; 1) Quality (CA = 0.87, MV = 5.76), 2) Time (CA = 0.60, MV = 5.17), 3) Cost (CA = 0.73, MV = 5.09) and 4) Collaboration (CA = 0.59, MV = 5.73). To be able to address H2 the collaboration factor is used as an independent variable potentially affecting the performance factors quality, time and cost.

Collaborative tools' effect on collaboration

Hierarchical multiple regression analysis was used to assess the ability of collaborative tools to predict levels of collaboration, after controlling for the influence of three control variables (if the organisation follows public procurement regulations or not, new construction/rebuilding projects or maintenance work, and local/regional or national/international market). Model 1 in Table 2 only consists of the control variables, explaining 2.4% of the variance in collaboration. In Model 2 collaborative tools were entered and the model as a whole explained 11.6% of the variance in collaboration. Hence, collaborative tools explained an additional 9.2% of the variance, which is a small but definite correlation (Hair *et al.*, 2006). The control variables are not statistically significant ($p > 0.05$) and can be rejected whereas Model 2 was statistically significant ($p < 0.05$). H1 is therefore confirmed with a small but definite positive relationship between the usage of collaborative tools and collaboration among project actors (R^2 change = 0.092).

Table 2. Hierarchical regression analysis testing Hypothesis 1

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	0.15	0.024	-0.01	1.07	0.024	0.83	3	102	0.48
2	0.34	0.116	0.08	0.98	0.092	10.49	1	101	0.02

Collaboration's effect on project performance

Project performance is divided into three dependent variables; quality, cost and time and the collaboration construct functions as an independent variable. A hierarchical multiple regression analysis was used to assess the ability of collaboration to affect the three factors of project performance, after controlling for the influence of four control factors (if the organisation follows public procurement regulations or not, new construction/rebuilding projects or maintenance work, local/regional or national/international market, and collaborative tools). Model 1 for each performance factor represents the results only from the control variables whereas Model 2 represents the results from control variables and collaboration, see Table 3.

The results from the three regression analyses show that none of the Model 1 solutions are statistically significant ($p > 0.05$). This indicates that the three original control variables together with collaborative tools do not affect project performance. To further verify this result bivariate regression analyses with collaborative tools as independent variable and the three performance factors as dependent variables were conducted. These analyses verify that there is no statistically significant relationship between collaborative tools and any of the three aspects of project outcome ($p > 0.05$).

Collaboration's effects are statistically significant ($p < 0.05$) on all three aspects of project performance. Collaboration accounts for 23.7 % of the variance in quality, 22.1 % of the variance in cost and 4.5% of the variance in time. For quality and cost collaboration accounts for significantly more than the control variables which is not the case for time where control variables accounts for 7.9% compared to collaboration 4.5%. The effects collaboration has on quality and cost are moderately strong and its

effect on time is small but definite (Hair, 1998). H2 is thus confirmed with a positive relationship between collaboration and all three aspects of project performance.

Table 3. Hierarchical regression analysis testing Hypothesis 2

	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df1	df2	Sig. F Change
Quality	1	0.17	0.029	-0.01	0.92	0.029	0.74	4	101	0.56
	2	0.52	0.265	0.23	0.80	0.237	32.20	1	100	0.00
Cost	1	0.25	0.061	0.02	1.09	0.061	1.65	4	101	0.17
	2	0.53	0.283	0.25	0.95	0.221	30.85	1	100	0.00
Time	1	0.28	0.079	0.04	0.91	0.079	2.15	4	101	0.08
	2	0.35	0.124	0.08	0.89	0.045	5.18	1	100	0.03

DISCUSSION

Even if the nature of collaborative tools is to instill, foster and maintain a collaborative spirit among project actors (Bayliss *et al.*, 2004) the study show only a small but definite relationship between the usage of collaborative tools and the achievement of collaboration (R^2 0.092). Even if H1 is confirmed it is not entirely in line with previous research which argues for a strong relationship between them. The difference in results could be explained by the difficulties in effective implementation of collaborative tools in a construction project. This study only investigates to what extent clients use collaborative tools and do not address questions of implementation, time of implementation nor which actors that participated in the joint activities. The difference in results could also be explained by the criticism previous research received arguing that the studies in some extent is limited in scope and based on evidence from successful projects in which strong collaboration was achieved. Hence, the effect of collaborative tools on collaboration may be exaggerated if the relationship is not investigated on an industry level, including both successful and failed partnering relationships.

If a true collaborative approach is to take place it involves client decisions during the entire buying process, such as collaborative tools, joint specification and incentive-based compensation (Eriksson and Laan, 2007). From a transaction cost economic perspective construction clients focus too much on price and authority in several decisions in the buying process (Eriksson and Laan, 2007). A client that uses collaborative tools to some extent but in other aspects has too much focus on price and authority is not likely to establish a collaborative sprit among the project actors. Hence, a higher focus on trust and collaboration is needed in all stages of the buying processes. It is probably hard to create a collaborative spirit in a more adversarial relationship only by the use of collaborative tools. Another explanation of the weak relationship between collaborative tools and collaboration is therefore that clients have to adopt a systemic and holistic view, implementing a whole range of cooperative procurement procedures in order to enhance collaboration.

The results from the factor analysis support previous research where project performance often is discussed in terms of time, cost, and quality. The positive

relationship between collaboration and the three aspects of project performance that confirms H2 support previous research, where adversarial relationships have shown inferior results compared to more collaborative approaches (Larson, 1995). There is, however, a distinctive difference in the strength of the relationships; both quality and cost are moderately strong affected by collaboration while the effect on time is small but definite. Collaboration's effect on quality and cost are in line with what could be predicted based on previous research, where quality and cost can be improved by parties working more closely together (Black *et al.*, 2000). Collaboration's smaller effect on time is harder to explain and more research on this relationship is needed. It is also noteworthy to mention that the bivariate regression analyses showed that collaborative tools do not have a significant direct effect on project performance. This suggests that collaborative tools are pointless if they do not result in increased collaboration.

CONCLUSIONS

This paper offers contributions that are important to the research on how project performance is affected by collaboration among project actors. The fact that there is only a small but definite relationship between collaborative tools and collaboration does not question the possible benefits of collaborative tools found in earlier research. There is an increasing recognition among practitioners that partnering is potentially beneficial to all parties involved. The problem lies in the traditional procurement methods where much focus is on price and authority. A move towards a more collaborative approach calls for a more or less complete change in procurement methods. A traditional procurement method is not likely to achieve collaboration even with the use of collaborative tools because of the underlying focus on price and authority.

This investigation shows a moderately strong relationship between collaboration and factors of project performance supporting the importance of a collaborative approach in procurement. The theoretical contributions of the investigation are that the result provides statistical support to previous case study findings of the positive relationship between collaboration and project performance. The statistically none existing effect that collaborative tools have on project performance leads to the conclusion that collaborative tools should not be seen as tools to enhance project performance but to instill, foster and maintain a collaborative spirit. For practitioners the statistically significant positive relationship between collaboration and project performance may decimate eventual scepticism of the benefits that could be achieved through the implementation of collaborative relationships in construction projects. An additional practical implication is that construction clients should put a considerate effort in the implementation of collaborative tools because if they are not implemented successfully they will cost time and money without doing any good. In this investigation, the aspects measuring project performance were limited to the aspects of time, cost, and quality. However, it is highly possible that collaboration also is related to more qualitative aspects, such as improved morale, job satisfaction, decision making, learning and innovation. Hence, future investigations should include a broader range of performance criteria.

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