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Identifying the Key Process Factors Affecting Project Performance

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Abstract

Purpose: A construction project traditionally involves a variety of participants. Owners, consultants and contractors all have diverse opinions and interests, but they all seek to ensure project success. Success is habitually measured as performance output regarding cost, time, and quality. Despite previous research mapping the success and failure factors, construction managers seem to have difficulty in attaining success. To provide clearer guidance on how to fulfill success criteria, this research aims to identify the underlying factors that affect performance and thus project success in construction processes.

Design/methodology/approach: A questionnaire survey based on a literature review provided 25 key process factors divided into five key categories. On the basis of the responses from commonly involved construction parties (owners, consultants, and contractors), the factors were ranked and tested for significant differences between the parties.

Findings: The top five most important process factors were found to relate to the sharing of knowledge and communication. Moreover, testing the ranking for significant differences between owners, consultants, and contractors revealed five differences. The differences related to the interpretation and importance of trust, shared objectives, project coordination and alternative forms of coordination.

Originality/value: All respondents identify improved knowledge sharing and communication as the key to improved cost, time, and quality performance and are therefore the areas where construction managers need to focus their resources. Thus, improved experience sharing and communication will increase the likelihood of project success by improving competences, commitment and coordination.

Keywords: Communication; Success Factors; Failure Factors; Knowledge Management; Performance; Productivity.

1. Introduction

The construction industry experiences a high number of unsuccessful projects (Zwikael and Globerson, 2004), even though several studies have documented the factors that affect project success, often called the critical success factors. According to Zwikael and Globerson (2006), one explanation can be found in the very general formulations of critical success factors, and Murphy et al. (1974) found a direct relation between success and clarity on the one hand and consensus regarding success criteria on the other. It follows that site managers need more specific guidance to fulfill the criteria and thus to achieve successful projects (Zwikael and Globerson, 2006).

To ensure more concrete guidance, this study focused on the underlying processes that ensure high performance (Cheng and Tsai, 2003) and their relative importance. Improving the construction

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processes will indirectly lead to increased performance and project success (Kivrak et al., 2008). Thus, looking at how the conditions under which a process is completed affect project success constitutes an attempt to dig one level deeper into the issue. The result is list of process factors ranked in relation to their importance and their effect on success. Construction managers can use the importance ranking to determine how to allocate limited resources to fulfill the criteria and thus obtain project success (Chua et al., 1999).

To ensure project success, the first step is to identify what project success is and how it is measured. Several studies have come up with a variety of definitions. Most define project success as the fulfilment of project requirement, for example Tuman (1986), and most researchers agree that project success can be identified by measuring the three key performance parameters: cost, time and quality (Ashley et al., 1987; Liu and Walker, 1998; Wuellner, 1990). Ashley et al. (1987) defined project success in terms of five key criteria: *"Results are better than expected or normally observed in terms of cost, schedule, quality, safety, and participant satisfaction".*

While cost, time, and quality are known as the "iron triangle", several attempts have been made to expand the concept by adding additional parameters such as environmental sustainability, market entry, safety and organizational and stakeholder benefits (Atkinson, 1999; Chua et al., 1999; Liu and Walker, 1998). The added parameters tend to have a long-term focus that goes beyond the success of the individual project or to be somehow included in one of the original parameters.

To evaluate the performance of construction projects, numerous studies have measured cost, time and quality, but most of the studies produced disappointing results. The majority of construction projects seem to suffer from cost overruns, time overruns and poor quality.

For instance, Love et al. (2005) looked into the cost and time performance of 161 Australian construction projects and found the average overruns to be 12.6% with regard to cost and 20.7% with regard to time. Barber et al. (2000) measured the costs of quality failures in two major road projects and found the direct cost to be between 3.6% and 6.6 % of the total contract sum. By adding the cost of delay, such as site costs, general overheads, liquidation damages and cost of work acceleration, Barber et al. (2000) calculated the total cost of delay to be between 16 and 23 % of the total project costs. The size of the indirect cost is in accordance with the claim of Burati et al. (1992) that the direct measureable cost is "only the tip of the iceberg".

Literature survey

Cost and time are directly measurable, unlike quality or beauty, which exist in the eye of the beholder and are therefore complex to measure. Definitions of quality include "meeting customer requirements" (Chase, 1998) or "reduced defects and rework" (McKim and Kiani, 1995), and quality has even been related to cost and time and defined as "completion on time and budget" (Hoonakker et al., 2010). Quality can also be divided into internal quality, emphasising requirements (Voss and Blackmon, 1994), and external quality, emphasising customer satisfaction (Fynes and De Burca, 2005).

Numerous studies have looked into the factors that create success or failure, often referred to as critical success factors (Chua et al., 1999) or critical failure factors (Jha and Iyer, 2006). Ensuring success can be seen in two ways: the factors creating failure should be avoided while the factors creating success should be achieved.

Some variation can be expected in both the success and the failure factors of different projects, so it is impossible to find a universal list of success or failure factors (Toor and Ogunlana 2009). Nevertheless, a number of studies have tried to identify some general tendencies. Below is a literature review of previous research studies. The studies are divided in four groups, each of which contains a research study of failure factors and success factors. The four groups are (1) cost, (2) time, (3) quality and (4) the combination of cost, time and quality.

Factors affecting cost performance:

The success factors for cost performance were identified by Iyer and Jha (2005) using a questionnaire study that involved 112 respondents and included 55 factors to reveal the high impact factors affecting cost performance in construction projects in India. On the basis of their study, Iyer and Jha (2005) found that the top three success factors were (*1) the project manager's competences, (2) top management support, and (3)the project manager's coordinating and leadership skill.*

In a questionnaire study based on 31 factors and 109 respondents, Elinwa and Buba (1993) identified the failure factors for the cost performance of construction projects in Nigeria. The study revealed that the top three failure factors were *(1) the cost of materials, (2) price fluctuations, and (3) financing and payments for completed work.*

Factors affecting time performance:

The success factors for time performance were examined in a questionnaire study conducted by Jha and Iyer (2006). The study included 112 participants who ranked 55 factors. The findings revealed the top three factors to be (1) project manager's competences, (2) supportive owners and top management, and (3) monitoring, feedback, and coordination.

Chan and Kumaraswamy (1997) looked into failure factors for time performance in Hong Kong construction projects by conducting a questionnaire survey involving 148 respondents and including 83 factors categorized into eight key categories. They found the most important categories to be contractor-related, design team-related and labour-related. Moreover, the top three factors that influenced time were found to be (*1) poor site management and supervision, 2) unforeseen ground conditions,* and *3) low speed of decision-making.*

Factors affecting quality performance

Hoonakker et al. (2010) looked into success factors by conducting a mixed research study, they used nine interviews with different contractors to identify critical factors and followed this up with a questionnaire distributed to 148 contractors. Their study identified both indicators and influencers of quality. The top three indicators were (*1) overall customer satisfaction, (2) management commitment to quality, and (3) requests to come back and do more work.* The top three influencers were *(1) employee involvement and collaboration, (2) management commitment, and (3) skilled workforce.*

Jha and Iyer (2006) looked into the failure factors affecting quality. They based their study on a questionnaire survey with 112 participants who were asked to rank 55 identified failure factors. From the survey, Jha and Iyer (2006) found that the top three failure factors were (*1) conflict among project participants, (2) hostile socio-economic environment, and (3) harsh climatic conditions.*

Investigating the factors which affect cost, time and quality performance

In a questionnaire study involving 20 senior managers, Chua et al. (1999) identified the relative importance of 67 success factors with respect to time, cost, quality, and overall project success. They found the most important factors to be (*1) adequacy of plans and specifications, and (2) constructability*.

Toor and Ogunlana (2009), performed a combined study including 35 interviews and a questionnaire study with 76 participants. They found that the top critical success factors were related to (*1) project planning and control, (2) personnel, and (3) client involvement*.

Larsen et al. (In Press) have conducted a questionnaire survey which focuses on the failure factors for cost time and quality performance. The study included 26 factors and a total of 56 respondents completed the survey. The top three negative factors were (1) unsettled planning or lack of project planning, (2) errors or omissions in construction work, and (3) errors or omissions in consultant materials.

To summarize the literature study, the top five critical success factors from the identified studies are presented in Table 1.

Placement of Table 1

Project success is not identical with the success of individual project participants as they all have their own perception of project success. The most common ones relate to cost and time (Sanvido et al. 1992). The owner, consultant, and contractor experience success differently, so when measuring success it is important to underline ‘for whom’. Consequently, this study looks into similarities and differences between the perceptions of owners, consultants and contractors.

2. Research method

According to Rossi et al. (1983), the purpose of doing research using a questionnaire survey is to gather information and explore underlying structures in a social context or in relation to individuals in that context. A questionnaire survey is appropriate for our study because the research objective is to collect data from individuals within the construction industry, focusing on factors affecting internal process performance. The questionnaire is based on the literature review presented in the introduction section, where 25 factors were identified and was in relation to the context divided into five topic related categories: (1) project coordination, (2) communication, (3) trust and shared objectives, (4) alternative forms of cooperation, and (5) sharing of experience (see Table 2). The generated categories were an outcome of the context in which the factors were identified. To measure the impact of the factors, an ordinal five point Likert scale was used (1 = agree, 2 = partially agree, 3 = neither nor, 4 = partially disagree and 5 = disagree).

In accordance with Forza´s (2002) suggestion, the factors and questions were based on earlier published studies and factor descriptions. Moreover, the individual questions were subjected to a

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quality check to ensure concise and consistent wording and to ensure that questions were understandable, as recommended by Sekaran (1992).

The questionnaire and data collection were conducted using SurveyXact and sent to the selected population by e-mail. The survey population was chosen on the basis of three criteria: (1) the participants were all to be located in the region of North Jutland (one of five regions in Denmark, taken to be representative of all five regions); (2) all participants had to be involved in publicly financed construction projects; and (3) the level of management responsibility had to be either project or construction management.

Placement of Table 2

To ensure the reliability of the data set, a Cronbach alpha test was conducted, where .7 was used as acceptance level in accordance with recommendations made by Kline (2013). Factors were ranked by applying the Relative Importance Index (RII) with a range from 0.0 to 1.0, see equation (1) below.

(1) Relative Importance Index (RII) = $\frac{\sum_{i=1}^{5} W_i}{A*N}$

W_i Weight given to each factor by respondents: 1 agree, 2 partially agree, 3 neither nor, 4 partially disagree, 5 disagree

A Highest weight in this study; [5 disagree]

N Total number of respondents at each variable

The Relative Importance Index was followed by a Kruskal-Wallis test to investigate significant ranking differences for the 25 factors between the independent respondent groups (owners, consultants, and contractors). The Kruskal-Wallis test is applicable because data was measured on an ordinal scale and because the sample contains three independent respondents. Due to the relatively small dataset, a Monte Carlo simulation with 10,000 simulations was used to ensure a reliable level of significance (Field, 2009). All Kruskal-Wallis tests were conducted with a significance level of $p = .05$ in accordance with the recommendations of Fellows and Liu (2009).

Finally, tests revealing a significant difference were further analyzed using a Mann–Whitney test. This test is similar to the Kruskal-Wallis test, but it only tests for the significant difference between two independent datasets or respondent groups; thus, it locates the groups between which the difference is located. To reduce the number of post-hoc tests and Type I errors, the Bonferroni correction was used, only accepting something as significant if p was less than .017 (significant level dived by the number of comparisons) Field (2009). Like the Kruskal-Wallis tests, the post-hoc Mann-Whitney tests were supported using a Monte Carlo simulation with 10,000 simulations.

3. Results

The survey was sent to 190 potential respondents distributed between the three respondent groups (owners, consultants, and contractors). Table 3 presents the response frequency. 87 of the respondents completed the survey, giving a respondent rate of 45.8 %, which is just below the 50.0 % acceptance rate suggested by Flynn et al. (1990) but far above the 20 % limit set by Malhotra and Grover (1998). Even though a respondent rate above 50.0 % would have been optimal, the rate of 45.8 % is considered sufficient. To ensure the high quality of data, outliers were removed before the data analysis was started. In total, four variables had one outlier, and all four outliers were removed.

Placement of Table 3

To review the data reliability, the five survey categories were tested in accordance with the type of respondent (owner, consultant or contractor), as reported in Table 4. The results reveal that only two out of 15 tests have an acceptable Cronbach alpha value above the .7 cut-off point identified by Kline (2013). However, the Cronbach alpha values of the total sample are all above the acceptance threshold (Table 4).

Due to the low alpha values for the five categories, the conclusions drawn from analyzing the subcategories have a low reliability.

Placement of Table 4

3.1Ranking of factors

Table 5 shows the ranking [R] of the 25 factors, where R = 1 represents the most important factor. The ranking is divided into three groups representing the importance to owners, consultants, and contractors.

The top five factors affecting owners were found to be as follows: (1) CO5 (*Communication inconsistencies and conflicts are rarely caused by errors or defects in the project documents*); (2) SE2 (*There is always an external accumulation of experience and sharing of knowledge with the other parties after project completion*); (3) SE3 (*Experience gathering takes place using a set procedure*); (4) SE4 (*Sharing of knowledge is used adequately*) and 5) CO4 (*I rarely experience conflicts and disputes between project parties resulting from lack of communication*). The complete list of factors affecting the owners appears in Table 5, together with the related RII values. All top five factors belong to either the communication or the sharing experience category, both of which also have the highest average RII values. Thus, these areas are of particular importance to owners. Lack of communication and sharing of experience inside the project organization reveal an internal dysfunction of communicates and share project experience. With poor communication, changes will cause conflicts, and changes are likely to occur during construction due to the resulting complexity and unpredictability. These may include changes caused by errors in project material, in plans and in schedules or by the constant ad-hoc planning which occurs on-site (Lindhard and Wandahl, 2014).

The top five factors affecting consultants were found to be (1) SE2 (*There is always an external accumulation of experience and sharing of knowledge with the other parties after project completion*); (2) CO4 (*I rarely experience conflicts and disputes between project parties resulting from lack of communication*); (3) CO5 (*Communication inconsistencies and conflicts are rarely caused by errors or defects in the project documents*); (4) SE4 (*Sharing of knowledge is used adequately*); and (5) SE5 (*I only share my knowledge and experience if it is demanded*). Once again, all top five factors affecting the consultants are related to communication and the sharing of experience, but the specific factors differ. In the top five, the only new factor is SE5, which replaces SE3. The importance of SE5 supports the previous statement that construction projects face internal organizational complication, resulting in a lack of communication and knowledge sharing; as SE5 puts it, knowledge is only shared when it is demanded.

Placement of Table 5

The top five factors affecting the contractors are (1) CO5 (*Communication inconsistencies and conflicts are rarely caused by errors or defects in the project documents*); (2) SE2 (*There is always an external accumulation of experience and sharing of knowledge with the other parties after project completion*); (3) CO4 (*I rarely experience conflicts and disputes between project parties resulting from lack of communication*); (4) PC4 (*Tender documents are formulated clearly*) and (5) SE3 (*Experience gathering takes place using a set procedure*). An overall comparison between the factors affecting owners, consultants, and contractors reveals that the two most important categories are sharing of experience and communication respectively, with only minor variations in the ranking of the individual factors. The only exception in the top five factors is PC4, which the contractors rank fourth. Tender material is important to contractors, who rely on the quality of these documents in the bidding process and use them as guidelines in the construction process; unclear and inadequate project material creates misunderstandings and conflicts between contractors and consultants.

3.2Kruskal-Wallis test

The Kruskal-Wallis test tested for significant differences between the factors affecting owners, consultants, and contractors. A Kruskal-Wallis test is necessary because the relative importance index calculated above does not indicate whether or not the differences in rankings among project participants (owner, consultant, and contractor) are significant. The completed Kruskal-Wallis test is based on 86 registrations, which is far above Fahoome´s (2002) minimum requirement of 11 registrations with an $\alpha = .05$. The results from the Kruskal-Wallis test appear in Table 6.

Placement of Table 6

All factors were tested; 25 tests were conducted in total, revealing four factors with a significant difference: factors PC4, TO1, TO3 and AC4. The vast majority of the tests revealed that owners, consultants, and contractors agreed on the importance and impact of the examined factors, as was the case with the relative importance index. Where a significant difference was found in the four factors, further analysis is needed to reveal who disagrees with who (owner, consultant, and contractor). This need is addressed in the post-hoc analysis below.

3.3Post-hoc analysis

The Post-hoc analysis is based on the Mann-Whitney test. It compares the three groups pairwise to determine where the differences are located. Thus, for every one of the four factors identified by the Kruskal-Wallis test, three tests are necessary. The three tests are as follows: (1) owners compared to consultants, (2) owners compared to contractors, and (3) consultants compared to contractors.

The completed Mann-Whitney tests are based on 56 registrations, which is above the minimum of 20 registrations with an p reduced to .017 according to the Bonferroni correction (Deshpande et al., 1995; Field, 2009; Sprent, 1989). The test results appear in Table 7.

Placement of Table 7

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In total, the Mann-Whitney test was completed 12 times, revealing five significant differences between the respondents. The five tests revealing significant differences were distributed as follows: one showed a difference among owners and consultants (TO1), two among owners and contractors (TO1 and TO3) and two among consultants and contractors (PC4 and AC4). In short:

- Owners have a lower level of trust in the other project participants (TO1) than the level of trust shown by consultants and the contractors.
- To a greater extent than the contractors, owners feel that their role in the project is understood (TO3).
- Contractors experience more problems with tender documents (PC4) than consultants do.
- Consultants profit more from using alternative forms of cooperation (AC4) than contractors do.

4. Discussion of findings

Success in a construction project requires the consideration of a number of underlying process factors which affect performance (Kivrak et al. 2008). This enables construction managers to carefully consider and allocate limited resources. The ranking of process factors has been calculated and is shown in Table 5. Because success is experienced differently by the various project participants (Sanvido et al. 1992), the ranking is divided into three groups: owners, consultants, and contractors.

Despite the diversity, testing for significant differences also revealed a number of common conceptions. All respondents (owners, consultants, and contractors) identify knowledge sharing and communication as the key to improved processes in construction and thus as the most important factors in achieving project success.

Of the three times five key success factors identified, only one factor identified by the contractor was not related either to knowledge sharing or communication.

Specifically, the contractors identified tender documents as the fourth most important factor in ensuring success. The quality of the tender document is especially important to contractors because contractors get work primarily by winning tenders and because estimates and bids are based on information derived from tender documents (Mak 2001).

Table 8 presents the average top five process factors compared to the findings from the previous studies identified in the literature review.

<u>Placement of Table 8</u>

A comparison of the success factors across the studies shows that the most important factors in achieving success are endeavors and competences (7/20), commitment, support and involvement (5/20) and coordination (3/20).

A comparison of the failure factors across the parties reveals the most important factors to be deficiencies (5/20), endeavors and competences (3/20) and collaboration (2/20)

The key process factors relate to sharing of experience (3/5) and communication (2/5). The findings show that communication and sharing of knowledge are vital in any organization. Thus, these factors are the key to improving the underlying processes and thus to avoiding failure and achieving success.

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Improved experience sharing and communication will reduce the risk of failure by reducing the risk of deficiencies and by improving competences and collaboration. Moreover, improved experience sharing and communication will increase the likelihood of success by improving competences, commitment and coordination.

It follows that managers should focus resources on ensuring well-functioning communication and knowledge management; this is because it improves the performance of the underlying processes (Kivrak et al. 2008) and has the potential to improve all three key performance parameters of time, cost, and quality (Emmitt and Christopher, 2003; Shelbourn et al., 2006).

Communication and knowledge sharing are related to one another. In this study, communication refers to the sharing of project information and takes place *during* the project, while knowledge sharing refers to the sharing of experiences and tacit knowledge *after* project completion.

Despite the importance of communication and knowledge sharing, the statistical test reveals that poor communication and knowledge sharing occur in all parts of the project organization. These communication problems are compounded by the complex organizational structure with temporary organizations consisting of several different competing companies (Cheung et al. 2013). This complex organizational structure increases the need for well-functioning communication; for instance, complex structure enhances the impact of unclear contracts, misleading drawings, or inadequate project material. Moreover, complexity intensifies the need for structured knowledge sharing to collect experiences from the various companies. To improve both communication and knowledge sharing, greater attention must be paid to the information transferred between the project participants from the various companies. Besides increasing the quality of the project material, IT software can help to remove the physical boundaries caused by physical distances. It can do this by improving and simplifying information sharing and information speed (Hendriks 1999), but success still depends on the increased prioritization of communication and knowledge sharing.

5. Conclusion

In order to help construction managers to allocate effort and resources, the key process factors to ensure high performance have been ranked using the Relative Importance Index. The study was designed as a questionnaire survey and included 25 factors divided into five key areas: project coordination, communication, trust and shared objectives, alternative forms of cooperation, and sharing of experience. The respondents to the questionnaire survey were divided into three groups: owners, consultants and contractors. The creation of a ranked list of process factors has revealed that project managers need to focus on knowledge sharing and communication to improve cost, time, and quality performance. Owners, consultants and contractors alike identified knowledge sharing and communication as the most important focus areas. Improved communication and knowledge sharing will reduce the risk of project failure and increase the likelihood of project success.

The relative importance index revealed that the owners ranked the following factors as the five most important ones: (1) CO5, consistent and correct project documents; (2) SE2, external accumulation and sharing of experience; (3) SE3, procedure for experience gathering; (4) SE4: adequate use of knowledge sharing; and (5) CO4, well-functioning communication.

The consultants ranked the following factors as the five most important: (1) SE2, external accumulation and sharing of experience; (2) CO4, well-functioning communication; (3) CO5, consistent and correct project documents; (4) SE4, adequate use of knowledge sharing; and (5) SE5, sharing of knowledge when demanded.

The contractors ranked the following factors as the five most important ones: (1) CO5, consistent and correct project documents; (2) SE2, external accumulation and sharing of experience; (3) CO4, well-functioning communication; (4) PC4, clear and consistent tender documents; and (5) SE3, procedure for experience gathering.

In addition, the research contributed to the understanding of differences between project participants. Application of the Kruskal-Wallis test and the Mann–Whitney test revealed the following significant differences between the ranking of the owners, consultants, and contractors:

- Owners have a lower level of trust in the other project participants (TO1) than do consultants and contractors
- To a higher degree than the contractors, owners feel that their role in the project is understood (TO3).
- Contractors experience more problems with the tender documents (PC4) than consultants do.
- Consultants have a greater increase in profit than contractors when using alternative cooperation forms (AC4).

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