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A Success Measurement Model for Construction Projects

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Abstract. The purpose of this paper is to develop a success measurement model for construction projects to fulfill two main objectives: to provide a project success index for every finished projects in order to compare them with each other and to establish a benchmark for future improvement in success of construction project execution. The model's output is a project success index which is calculated based on five project success criteria. The methodology adopted in this paper was, first, to undertake a literature survey of the area. Then a two-round Delphi questionnaire survey and a questionnaire survey were employed for data gathering and finalizing project success criteria.

Keywords: Project success criteria, success factor, construction project, project success index.

1. Introduction

There is still a disagreement between project management researchers as to what constitute project success and how it is to be measured [1]. De Wit [2] and Pinto and Slevin [3] mentioned that it is still not clear how to measure project success since project stakeholders perceive success or failure factors differently. Lim and Mohamed [4] believed that project success should be viewed from different perspectives of the individual owner, developer, contractor, user, and the general public and so on.

This paper aims to provide a basis for measurement of construction project success in Mapna Special Projects Construction & Development Co (MD-3). MD-3 is a project-based company which mostly operates in the field of power plant, utility and cogeneration construction industries. The survey focused on developing a project success measurement model leading to one stand-alone measure for the MD-3 projects. By applying this model the organization is able to generally compare the finished projects and establish a benchmark for the current and future projects. In addition the model developed in this paper can be used as a guideline for other project-based organizations to initiate their own model.

The paper is organized as it follows. First, in definition and related concepts section, a clarification of project success and project success model is presented. The research methodology is explained in the next section followed by research findings. The model is presented in the next section. Finally, in conclusion, the paper concludes with a brief summary of findings, implications, and some recommendations for the future researches.

2. Definitions and related concepts

In his book, In Search of Excellence in Project Management, Kerzner [5] discusses definitions of Project success, and provides a list of critical success factors that can affect project performance at different stages of a project life cycle. As he mentioned, the definition of project success has changed over the years. In the 1960s, project success was measured entirely in technical terms: either the product worked or it did not. In the 1980s, the following definition for project success was offered [5]: project success is stated in terms of meeting three objectives: 1) completed on time, 2) completed within budget, and 3) completed at the desired level of quality. The quality of a project was commonly defined as meeting technical specifications. Note

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that all three of these measures are internal to a project, and do not necessarily indicate the preferences of the end user or the customer. In the late 1980s, after the introduction of TQM, a project was considered to be a success by not only meeting the internal performance measures of time, cost and technical specifications but also making sure that the project is accepted by the customer; and resulted in customers allowing the contractor to use them as a reference.

Based on the literature review there are some different project success models which are briefly explained here. Atkinson [6] separates success criteria into delivery and post-delivery stages and provides a "square route" to understanding success criteria: iron triangle, information system, benefit (organizational) and benefit (stakeholder community). The 'iron triangle', has cost, time and quality as its criteria (for the delivery stage). The post delivery stages comprise: (i) the information system, with such criteria as maintainability, reliability, validity, information quality use; (ii) benefit (organizational): improved efficiency, improved effectiveness, increased profits, strategic goals, organizational learning and reduced waste; (iii) benefit (stakeholder community): satisfied users, social and environmental impact, personal development, professional learning, contractors profits, capital suppliers, content project team and economic impact to surrounding community. This model takes into consideration the entire project life cycle and even beyond. It thus lends itself for continuous assessment. Lim and Mohamed [4], as reviewed by Chan and Chan [7], modelled project success measurement into 'micro viewpoint: completion time, completion cost, completion quality, completion performance, completion safety; and macro-view points: completion time, completion satisfaction, completion utility, completion operation. A key feature of this model is that it proposes only lagging indicators and gives no room for continuous assessment and monitoring. Patanakul and Milosevic [8] grouped their measurement criteria into three: (i) criteria from organizational perspective: resource productivity, organizational learning (ii) criteria from project perspective: time-to-market, customer satisfaction and (iii) criteria from personal perspective: personal growth, personal satisfaction. Chua et al. [9] proposed a hierarchal model for construction project success. In this model the objectives of budget, schedule, and quality are key measures that contribute to the goal of "construction project success". Sadeh et al. [10] divided project success into four dimensions: 1) meeting design goals, which applies to contract that is signed by the customer, 2) the benefit to the end user, which refers to the benefit to the customers from the end products, 3) benefit to the developing organization, which refers to the benefit gained by the developing organization as a result of executing the project, and 4) the benefit to the technological infrastructure of the country and of firms involved in the development process.

3. Research Methodology

In this paper a success measurement model for construction projects is developed to find out how much the projects were successful after the closing phase. This model has two applications; first it provides just one stand-alone measure as a basis which is comparable among finished projects and second it establishes a benchmark for improving the project success. The model is based on project success criteria. As Yeung et al. [11] developed A Partnering Performance Index (PPI), which is composed of seven weighted Key Performance Indicators (KPIs), to measure, monitor, improve, and benchmark the partnering performance of construction projects in Hong Kong, a weighting system applied for the project success criteria in order to consolidate different success measures to just one stand-alone measure for general comparison of the projects.

A two-round Delphi questionnaire survey and a questionnaire survey were applied in this research. Based on literature review and organizational experience in executing construction projects, a Delphi questionnaire consisting of two main parts was designed. In the first part of the questionnaire, 10 project success criteria and their definitions were listed and three questions were posed. In first question the respondents were asked whether they have any comments on the project success criteria regarding the modification of any of them. In second question the respondents were asked to propose any other project success criteria which they believe that they are missed, to the end of the list. Finally the respondents were asked to what extent they agreed to project success criteria on a five-point Likert scale where 1: totally disagree, 2: partially disagree, 3: indifferent, 4: partially agree and 5: totally agree.

The questionnaire survey conducted in order to assign a weight factor for the selected project success criteria. In this questionnaire, the respondents were asked to identify a significant degree of the selected project success criteria on a scale of 0 (not important) to 10 (very important).

4. Research Findings

21 persons who have had long-term experiences in execution of construction projects ranging from the middle managers to the project managers were selected as the panel of experts. A total of 20 respondents returned the questionnaires for the first round, giving a response rate of 95%. After the first round, 6 project success criteria were suggested by the panel of experts. For the second round a new questionnaire was designed where the average score for the initial project success criteria were provided next to the respondents' first round score. In this part, considering the average score, the respondents were asked whether they would like to reassess their first score. In addition, they once again were asked to what extent they agreed to the new project success criteria and input factors on the same five-point Likert scale. After the second round, the reassessed scores considered for the calculation of final average score for all project success criteria.

Project success criteria were sorted by their average score. The ones having the average score equal or less than 4 were deleted. By using Statistical Package for the Social Sciences (SPSS) software, the Mean Rank method was applied for the rest of them in order to select top five of project success criteria to be used for the model. The final results are summarized in Table 1.

Project Success Criteria	Average Score	Mean Rank	Rank	Description	Result
Time Performance	4.94	13.72	1	Meeting time objectives for key milestones	Selected
Cost Performance	4.67	11.94	3	Meeting cost objectives for the project	Selected
Quality Performance	4.61	12.13	2	Meeting quality objectives for the project	Selected
HSE	4.44	10.77	4	Health, safety & environment of the project	Selected
Client Satisfaction	4.28	9.58	5	Client's overall satisfaction of the project	Selected

Table 1: Project success criteria

To determine whether there is degree of agreement among the panel of experts with respect to their rankings of the project success criteria, Kendall's Coefficient of Concordance was used. The Kendall's Coefficient of Concordance says that the degree of agreement on a zero to one scale is:

$$W = \frac{12U - 3n(n-1)^2m^2}{n(n-1)^2m^2} \qquad (1)$$

where:

$$U = \sum_{j=1}^{n} \left(\sum_{i=1}^{m} R_{ij}\right)^2 \qquad (2)$$

n = number of project success criteria
m = number of experts
R_{ij} = significant degree allocated for i^{th} project success criteria by j^{th} expert
W = Kendall's Coefficient of Concordance

The calculated Kendall's Coefficient of concordance for project success criteria W = 0.3910. In order to know whether there is disagreement or agreement among the panel of experts on ranking the project success criteria, a test of hypothesis is needed.

- Null hypothesis: H_0: There is no agreement in ranking of project success criteria among the panel of experts.
- Alternative hypothesis: H_1: There is an agreement in ranking of project success criteria among the panel of experts.

Since $n = 16$ is too large for the table of critical values of Kendall's, chi-square approximation of the sampling distribution of W is computed with the following equation:

$$\chi^2 = m(n-1)W \qquad (3)$$

Therefore, $\chi^2 = 105.59$ and using a χ^2 critical table for $n = 16$ and $\alpha = 0.05$, the $\chi^{2(n-1)}_{0.05} = \chi^{2(15)}_{0.05} = 15.00$. Since computed value χ^2 is greater than critical table $\chi^{2(15)}_{0.05}$ null hypothesis H_0 is rejected and alternative hypothesis H_1 is accepted. Therefore, concluded that there is a significant degree of agreement among the panel of experts with respect to how they ranked the project success criteria.

To define a weight factor for the final project success criteria, a new questionnaire developed and distributed to the 105 people ranging from discipline engineers to project managers. A total of 74 respondents returned the questionnaires, giving a response rate of 70%. The respondents were supposed to represent the degree of significant of each project success criteria in our project success measurement model by giving a number between 0 (not important) to 10 (very important). By using SPSS software, the Mean Rank method was applied for the weighting for each of the project success criteria. The corresponding weight factor for each of project success criteria are shown in Table 2. Correlation matrix is shown in Table 3.

	Project Success Criteria	Mean Rank	Corresponding Weighting
1	Time Performance	3.141	0.209
2	Cost Performance	3.5	0.233
3	Quality Performance	2.986	0.199
4	HSE	2.587	0.173
5	Client Satisfaction	2.783	0.186
	Number	74	

Table 2: Weight factors for the final project success criteria

	Correlation Coefficient	Time Performance	Cost Performance	Quality Performance	HSE	Client Satisfaction
1	Time Performance	1	0.414	0.273	0.129	0.075
2	Cost Performance		1	0.205*	0.238*	0.075
3	Quality Performance			1	0.358	0.170
4	HSE				1	0.154
5	Client Satisfaction					1

* Correlation is significant at the 0.05 level (2-tailed).

Table 3: Correlation matrix amongst the five weighted project success criteria

The Table 3 reveals that five project success criteria are not highly correlated with each other at 5% significance level.

5. Proposed project success measurement model

The project success index will be calculated by using the following equation:

$$PSI = 0.209PTP + 0.233PCP + 0.199PQP + 0.173PHP + 0.186PCS \qquad (4)$$

Where:

PSI: Project Success Index

PTP: Project time performance

PCP: Project cost performance

PQP: Project quality performance

PHP: Project HSE performance

PCS: Project Client's Satisfaction

All five success criteria should be measured based on an approach applied by each project-based organizations.

6. Conclusion

This paper presented a success measurement model for construction projects. The model used five project success criteria for measuring success of construction projects. As core competency of project-based organizations is to execute projects in an effective and efficient way, measuring how much a project was successful can play a key role to improve project management competency. In summary, there are two significant applications of the results we have obtained. First, we proposed one overall measure for success of the construction projects which can be applied for comparing construction projects. Second the paper presents a practical success measurement model which can be simply applied or partially applied in construction projects and even more be customized in other kind of projects. The model presented here was from performing organization point of view and it could be developed for other project stakeholders' points of view for future studies. Another suggestion could be developing a project success model for other projects in different industries based on the model proposed in this paper.

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