LIST OF INDICATORS AND CRITERIA FOR EVALUATING CONSTRUCTION PROJECT SUCCESS AND THEIR WEIGHT ASSIGNMENT

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Abstract

This paper describes a process for developing an evaluation system for construction projects. It includes a list of indicators and criteria representative of project success and their weighted significance. The list of these indicators and criteria is the result of both academic and practical points of view. The weight assignments and rankings of these indicators are achieved by the application of descriptive analysis. The final index system contained 11 indicators and 46 criteria which were used in the survey of construction projects. In the survey, 266 completed questionnaires were used for analysis. Results show the importance of indicators ranking respectively as follows: Quality, Cost, Time, Safety, Technical performance, Functionality, Stakeholders' satisfaction, Environment, Communication, Productivity, and Dispute/Litigation. It is anticipated that these results can serve as a means to evaluate the current status for construction industry in developing countries. In practice, it is hoped that these results will contribute to the improvement of project success rate and be of benefit to all parties. Evaluating project success is a useful tool for the construction industry in efforts to manage, control, and improve policies, and to anticipate future project success.

Keywords: Project Evaluation, Weight Assignment, Construction Project Evaluation Indexes, Project Success

1. INTRODUCTION

Project success is a difficult concept because of projects are complex and dynamic. Until now, there has been no universal definition of project success accepted by all interested parties. The definition of project success may vary depending on the particular industry, project team, or individual point of view (Parfitt and Sanvido, 1993). It is different among participants, scope of services, project size, and time-dependent (Shenhar and Levy, 1997). "An architect may consider success in terms of aesthetic appearance, an engineer in terms of

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technical competence, an accountant in terms of dollars spent under budget, a human resources manager in terms of employee satisfaction, and chief executive officers rate their success in the stock market" (Freeman and Beale 1992 cited in Shenhar and Levy (1997)). However, according to Parfitt and Sanvido (1993), the definition of project success is different for each participant, but it is based on the basic concept of overall achievement of project goals and expectations. These goals and expectations include technical, financial, education, social, and professional issues.

It is necessary to develop a measurement for project success. . A project manager cannot manage, control, or improve if he cannot measure a project's success. This is a difficult concept and has been studied over long periods by many researchers. Although there is no universal definition of project success, no one can deny the importance of evaluating project success, particularly in construction. Project success is the foundation for managing and controlling current projects, and for planning and orienting future projects.

In fact, it is difficult to evaluate project success in the construction field, especially in developing countries. The reasons are numerous. Customarily, project participants (owners, contractors, and consultants or project managers) have never evaluated a project upon completion. Until now, there has been no reliable tool to perform this evaluation. An appropriate model to evaluate project success is necessary to develop a past performance database.

A distinction should be made between *project success* and *project management success*. They are often confused, but they are not the same. de Wit (1988) showed many examples from their research conducted in the USA on some 650 completed projects and concluded that "a project can be a success despite poor project management performance and vice versa". They stressed that "good project management can contribute towards project success but is unlikely to be able to prevent project failure" (de Wit, 1988). Project management plays an important role in project success, but project success may be affected by many other factors outside the direct control of project management. Project management is considered successful if it satisfies the following requirements: good planning to complete the project, careful appointment of a skilled project manager, allocating sufficient time to define the project adequately, correctly planning, ensuring correct and adequate information flow, changing activities to accommodate frequent changes in reaction to project dynamics, accommodating employees' personal goals with performance and rewards, and making a fresh start when mistakes in implementation have been identified (Munns and Bjeirmi, 1996). From this narrow definition of successful project management, it is believed that the concept of project success is much broader than project management success, and they do not directly correlate.

From a review of literature on the subject, there are a great number of researchers interested in studying the factors which influence project success and in the criteria used to measure project success. In order to reduce misunderstanding, a distinction should be made between *project success factors* and *project success criteria*. According to Oxford Advanced Learner's Dictionary, criterion means "a standard or principle by which something is judged, or with the help of which a decision is made"; whereas a factor is "one or several things that cause or influence something". So, the concepts of "project success criteria" and "project success factor" are totally different but sometimes misunderstood. From this definition, a set of criteria for project success forms the basis of judging a project's success. It includes a set of standards or principles to judge the project. On the other hand, project success factors are a set of several things that cause or influence the project outcomes. They contribute to the success or failure of project. Up to this time, the majority of the studies conducted have focused on project success factors. These published articles include (Chan, et al., 2001; Chan, et al., 2010; Chan, et al., 2004; Chu, et al., 2004; Hatush and Skitmore, 1997; Nguyen, et al., 2004; Parfitt and Sanvido, 1993; Salminen, 2005; Sanvido, et al., 1992; Tabish and Jha, 2011; Terry, 2002).

It is important to stress that the concept used in this research is project success criteria. This research will not focus on what factors influence or contribute to project success or failure; it completely concentrates on the principles or standards by which a project is judged.

2. A LITERATURE REVIEW OF PROJECT SUCCESS CRITERIA

The problem of whether the project success can be measured or not has been addressed by many researchers. According to de Wit (1988), measuring success is complex because it depends on the stakeholders' points of view, and it is time dependent. One party may acknowledge project as successful, but another may take the opposite view. A project may be successful today but may fail tomorrow. de Wit (1988) believed that it is an illusion to measure a project's success objectively. However, he pointed out that it is possible and valuable to evaluate a project at its post-completion stage. He also provided evidence at the Project Management Institute conference held in Montreal in 1986 demonstrating the possibility of success measurement. This conference discussed the importance of a measurement index system to evaluate project success. It reviewed the earlier versions of papers related to "measuring success", and it implied that project success is possible to be determined.

This section will consider previous research about project success criteria and their weight assignments.

Many researches created a solid foundation for this study by describing the whole picture of project success measurement indexes. They were de Wit (1988), Songer et al. (1997), Liu et al. (1998), Crane et al. (1999), Liu et al. (1999), Tukel et al. (2001), White et al. (2002), Bryde et al. (2005), Ahadzie et al. (2008), and Al-Tmeemy et al. (2011). They collected the indexes from previous research or industry and then asked the perception of respondents. Most of them were based on the important scale to evaluate the important level of each. These researches provided a valuable reference for this research.

Project goals were the most appropriate criteria for project success assessment. They were based on the level of these objectives being met. In almost all previous researches, triangle project objectives, which included cost, time, and quality, were the main components in the evaluation system. de Wit (1988) discussed the results from a pilot study about construction project success at Texas University. He suggested an evaluation index system which contained six criteria. These were budget performance, schedule performance, functionality of project, satisfaction of client, contractor, and project manager.

Another list of six success criteria was developed from Songer et al. (1997). Similar to de Wit (1988), Songer et al. (1997) also stressed the importance of budget and schedule achievement in evaluating project success. They were measured by the variation of budget and schedule between initial plan and practice. Songer et al. (1997) mentioned quality of project by adding criteria about specifications and quality of workmanship to the model. He also focused on the satisfaction of users compared with their expectations, and the aggravation in the project. This indexing system was compatible with construction industry at that period.

Over ten years, from 1990 to 2000, more than twenty studies were carried out to establish project success criteria (Chan, et al., 2002). They were separated into objective measures and subjective measures. Related to objective measures, four criteria in most all of the studies were Cost, Time, Health and Safety, and Quality. Five other measures were Technical performance/Meeting specifications, Functionality, Productivity, and Profitability, rarely appeared. In the subjective measures group, only one criterion, stakeholders' satisfaction, was predominant in almost all studies. Seven other criteria were only mentioned in one or two studies. They are Expectation/Aspiration, Dispute/Conflict management, Claim management, Professional image, Aesthetics, Educational/social/ professional aspects, and Environmental sustainability.

A group of studies concentrated on exploring the important weight and methodology to combine all indexes. They were Griffith et al. (1999); Chua et al. (1999); Shawn et al. (2004); Menches and Hanna (2006); and Shahrzad Khosravi (2011). Although some limitations made them difficult to apply in developing countries, these studies were very important in developing this research framework.

A success indexes equation was developed by Griffith et al. (1999). Their equation considered four main criteria with their careful definition. The first criterion was Budget Achievement, which kept the highest proportion, weighted at 33% in evaluating project success. It was measured by the percent of deviation between authorized budget and the actual budget expended at the time of completion. The second criterion was Schedule Achievement. It was weighted at 27% in project evaluation and was measured by the difference between the authorized schedule and schedule of actual completion. Two other criteria were Design Capacity and Plant Utilization. They were weighted at 12% and 28%, respectively, and were measured by authorized and actual attainment after six months of operation. Their relative weights were calculated by summing up all responses in important scale. This framework was developed specifically for facility projects. Therefore, it required more indicators and modifications to apply in construction building.

After two years, another group of researchers, Shawn et al. (2004), developed a Construction Project Success Survey (CPSS) instrument. Their instrument included classic objective measures such as cost, schedule, quality, performance, safety, and operating environment. They used the seven point Likert system to assess each criterion. In their instrument, respondents' perceptions about the importance of each issue was calculated. The instrument included thirty two issues related to six groups of criteria as mentioned above with the seven scale of answering. It made the instrument difficult and confusing for respondents. The result was still subjective because it depended on the perceptions of respondents.

A quantitative measurement method of successful performance was developed by Menches and Hanna (2006). They provided a quantitative methodology to measure the success from the qualitative evaluation. This method was the nearest basis for conducting the project success frame in this research. In the end, six factors were selected for the measurement. They were Project profit, Schedule achievement, Amount of time to perform the project, Communication among project participants, Cost achievement, and Change in work time. This method was suitable from a contractor's point of view. From the owner's standpoint, these criteria were not enough to cover their entire objective to evaluate project success. However, this research provided an effective method to convert a qualitative parameter to quantitative and the concept of the probability of successful performance.

The summary list of indicators and criteria from previous studies is described in Appendix 1 below. It explains the evaluation methodology that previous researchers suggested for each indicator and criterion. The main objective of this study was to develop a list of indicators and criteria to evaluate project success and assigning their weighted importance.

4. Research Methodology

4.1 Questionnaire Design

A list of original indicators, which expected representation of project success, has been established. This list is gathered from literature review and interviews with five experts in the construction field. They have more than ten years' experience working in the construction industry and have participated in more than five completed projects. A preliminary survey is performed to achieve the proposal list of indicators and criteria. There are three criteria for making decisions about which indicators should be used for evaluating project success. First, indicators having a high probability to collect information, namely the probability of successful collection of information should be higher than 60%. Second, indicators are important from a respondent's perception, meaning the importance level is significantly higher than three. Third, an applicable indicator with mean value should also be higher than three. The results of preliminary survey from sixty-five completed questionnaires indicated a list of eleven indicators and forty-six criteria, shown in Figure 1.

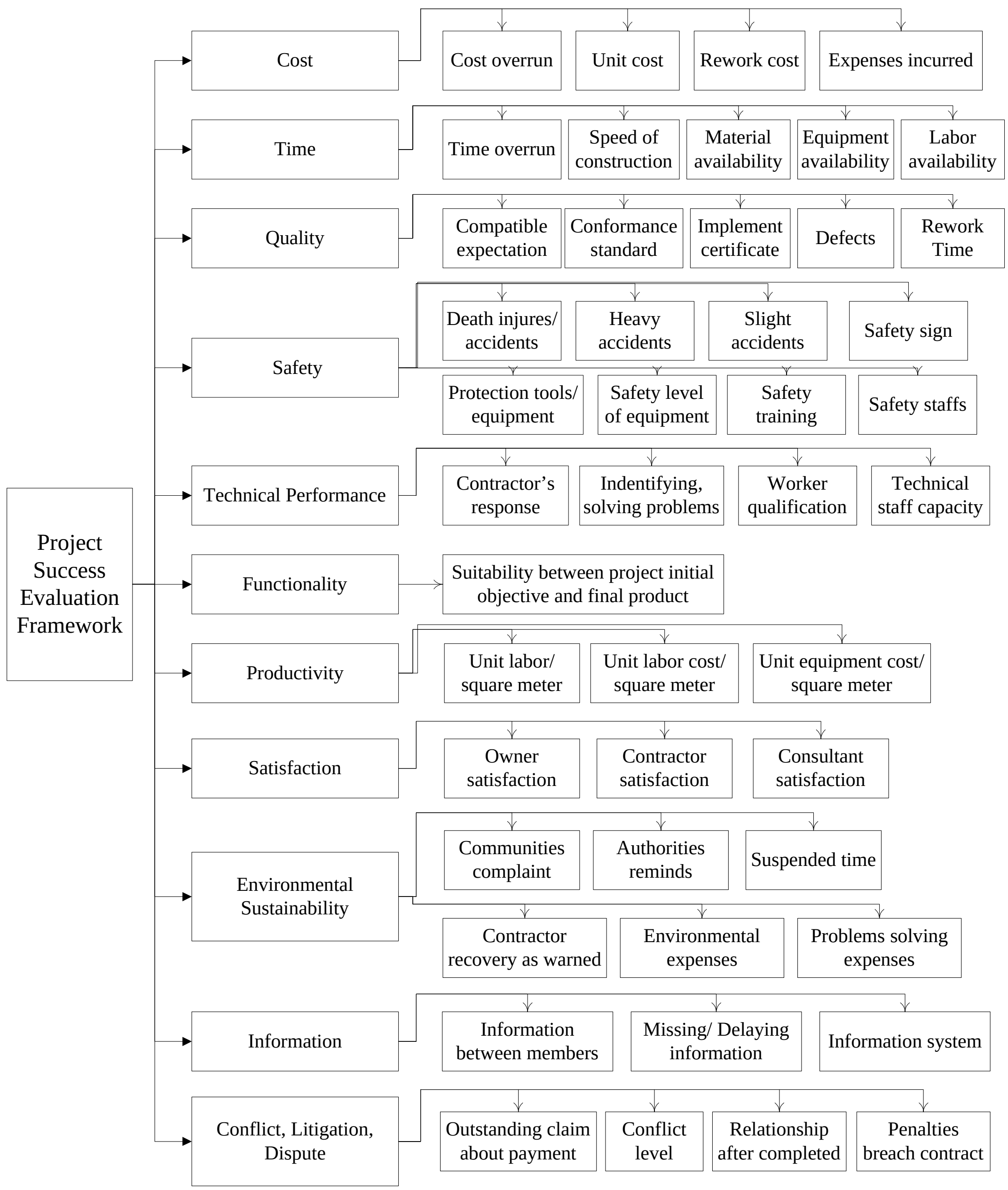

Figure 1. Proposed project success evaluation framework

A list of eleven indicators and forty-six criteria, shown in Figure 1 above, was used to develop a questionnaire for the main survey. The questionnaire contained two main sections including general information and evaluation of the importance of proposed indicators and criteria. First, respondents were asked their opinion about the importance of an evaluation system. Then, respondents expressed their opinion of the importance level of each indicator and criterion in five point Likert scale:

Not important at all	: rate “1”
Little important	: rate “2”
Moderately important	: rate “3”
Very important	: rate “4”
Extremely important	: rate “5”

Finally, open questions were given to collect respondents’ opinions about indicators that could be important but were not mentioned in the proposed list above.

4.2 Data Collection

The survey was carried out from July to September 2012 in Vietnam. From the survey, 600 questionnaires were prepared and distributed to twenty-five construction companies. The interviews took approximately thirty to forty five minutes. Finally, only 381 questionnaires were collected, representing an average response rate of 63.50%. In the 381 questionnaires that were collected, 115 questionnaires were eliminated because they missed too much information, so the total of final valuable questionnaires was 266; the adjusted response ratio was 44.33%.

4.3 Data Analysis and Reliability Analysis of Scale

Prior to analyzing the usable sample, it was important to check for mistakes initially. Data were screened using the complete sample (N = 266) prior to the main analysis to examine accuracy of data entry, missing values, and fit between distributions and the assumptions of necessary analysis tools. The Frequencies and Descriptive statistic command in SPSS Version 16 was used to detect any out of range values. None were found.

The construction project success is measured by eleven indicators and forty-six criteria. It is necessary to ensure that these items are comprised of a reliable measured scale. Cronbach’s alpha coefficient of internal consistency was calculated for scale. The results are shown in Table 1 below. In respect to the scale’s reliability, this scale was also found to be reliable with a high value of Cronbach’s alpha 0.767 and above the acceptable measure of 0.60 (Hair, et al., 2010). Values from the column “Alpha if item deleted” in Table 1 suggested that all of these eleven indicators provided the most reliability scale for measuring construction project success. Therefore, we should not remove any items from this scale for further analysis.

Table 1. Cronbach's alpha for construction project success evaluation scale (N = 266)

Cronbach's Alpha = 0.767 N of Items = 11	Cronbach's Alpha if Item Deleted
COST in evaluating project success	.763
TIME in evaluating project success	.753
QUALITY in evaluating project success	.750
HEALTH & SAFETY in evaluating project success	.739
TECHNICAL PERFORMANCE in evaluating project success	.745
FUNCTIONALITY in evaluating project success	.756
PRODUCTIVITY in evaluating project success	.749
SATISFACTION in evaluating project success	.765
ENVIRONMENT in evaluating project success	.734
COMMUNICATION in evaluating project success	.742
DISPUTE & LITIGATION in evaluating project success	.746

To ensure that the items comprising the indicators produced reliable scales, Cronbach's alpha coefficient of internal consistency was calculated for each scale. The results are shown in Table 2 below. The Cronbach's alpha ranged from 0.688 to 0.852, which are higher than standard value of 0.600, indicating adequate internal consistency (Hair, et al., 2010; Pallant, 2004). The reliability results provide significant confidence in the scales and demonstrate it is possible to conduct further analysis.

Table 2. Cronbach's alpha for construction project success evaluation scale (N = 266)

Items of Scale	Cronbach's Alpha	Cronbach's Alpha if Item Deleted
Indicator 1. Cost (N of Items =4)	0.688	
Cost variation		.688
Unit cost		.634
Rework costs		.579
Expenses incurred		.575
Indicator 2. Time (N of Items =5)	0.796	
Time variation		.727
Speed of construction		.711

Items of Scale	Cronbach's Alpha	Cronbach's Alpha if Item Deleted
Material availability		.715
Equipment availability		.697
Labor availability		.709
Indicator 3. Quality (N of Items =5)	0.689	
Conformity with expectations		.672
Conformity with predetermined standard		.647
Implement the "Evaluate the suitability project quality certificate" in the project		.670
Number of defects need to rework when take over the project		.590
Time to rework under-quality works		.609
Indicator 4. Health & Safety (N of Items =8)	0.844	
Number of death injures or accident		.840
Number of heavy accidents		.834
Number of slightly accidents		.829
Evaluation of safety signs		.825
Evaluation of providing safety tools and protection equipment		.820
Evaluation safety level of equipment used in construction		.817
Evaluation of safety training		.815
Evaluation of safety responsibility staffs		.816
Indicator 5. Technical Requirement (N of Items =4)	0.805	
Evaluation of the contractor's response to the technical requirements of project		.760
Evaluation of technical problem identification and solution		.729
Overall assessment qualifications of workers in the project		.783
Evaluation of the possibility of problem solving of technical staff		.749
Indicator 6. Functionality (N of Items =1)	-	
Degree of conformance to all technical performance specifications.		-

Items of Scale	Cronbach's Alpha	Cronbach's Alpha if Item Deleted
Indicator 7. Productivity (N of Items =3)	0.852	
Unit labor per square meter		.843
Unit labor cost per square meter		.751
Unit equipment cost per square meter		.759
Indicator 8. Satisfaction (N of Items =3)	0.776	
Owner satisfaction		.731
Contractor satisfaction		.630
Consultant satisfaction		.593
Indicator 9. Environment (N of Items =6)	0.881	
Frequency of complaints from the environment and communities around the construction site		.854
Frequency of time reminded about sanitation from the authorities		.851
The number of time and duration suspended from the authorities		.873
Assessing the recovery of the contractor when warned		.862
Expenses for ensure environmental sustainability		.859
Expenses of overcoming the problems of environmental sanitation		.864
Indicator 10. Communication (N of Items =3)	0.792	
Evaluation the communication in project		.677
The frequency of misinformation or delays affecting the project		.773
Information systems used in project		.701
Indicator 11. Dispute & Litigation (N of Items =4)	0.819	
Outstanding claim among parties about payment		.749
Evaluation of conflict level among parties in check and take over the project		.740
Evaluation of relationship between contractor and owner after project completed		.727
Information about penalties for breach of contract		.765

5. Results

5.1 Respondent Profiles

Of the respondents, the average age was 30.34 years and ranged from 23 to 57 years old. All of them had experience from 1 to 29 years, average 6.46 years. The level of a respondent's academic background was one factor that influenced their opinion about construction project success. In this study, respondent's backgrounds were classified into three groups. The data showed that 6.69% of the respondents had high school background, 78.74% had undergraduate qualification, and 14.57% had postgraduate education. Almost all respondents had acceptable education backgrounds, so they could serve as representative of the population.

Because of the purpose of this research, the number of completed projects is more important than the number of years a respondent has worked. Figure 2 below separated respondents' experience in completed projects into three groups. The first group is respondents who have taken part in less than three completed projects, which make up more than 30%. The second group, which was 27.38%, was the respondents who had finished from three to five projects. The last group of respondents, who had more than five projects completed, appropriated a high percentage of 42.46%.

Before conducting further analysis, respondents were asked how important a framework was in evaluating construction project success. Figure 3 below summarizes their opinions. Among 260 valid responses, 125 people believed that the proposed system is extremely important; 94 people thought that it is very important, and they comprised more than 84% of the responses. The remaining 16% of the respondents did not highly appreciate the importance of a project success evaluation framework. This result implies that the proposed framework is significant, and should be studied. Further analysis should be conducted.

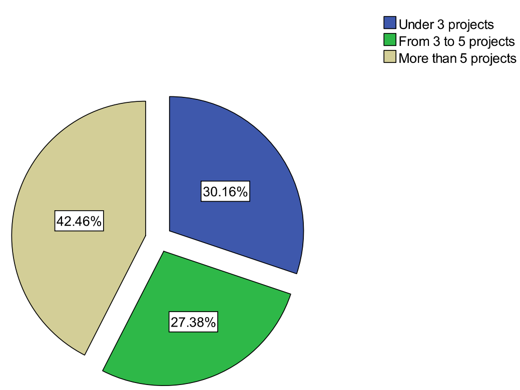

Figure 2. Respondents' experience

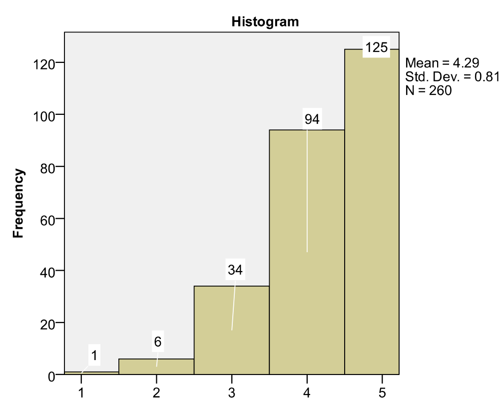

Figure 3. Respondents' opinion about the importance of evaluating project success

5.2 Descriptive of indicators, criteria, and their relative weight

The following Table 3 below is the summary of mean value of all indicators and criteria in construction project success evaluation system. Indicator weight is assigned by division between its mean and summing up mean of all indicators. In this study, the result of summing up all indicators is 43.274 (4.36+4.27+4.59+4.27+4.07+3.81+3.55+3.72+3.65+3.61+3.37). Therefore, the relative weight of Project Cost Indicator equals 4.36/32.274 = 0.101. Other indicators relative weights are described in the Table 3 below.

The relative weight of each criterion is calculated by summing up all mean value of criteria in the same indicator. The relative weight of each criterion in the indicator is the result of division between its mean and sum value. And then, the relative weight of criterion in project success equal this value multiply the weight of indicator.

Table 3. Mean, weight of importance and ranking of indicators and criteria (N=266)

Variable Name	Mean	Mean	Weight/Indicator	Weight/Project	Rank
Project Cost	**4.36**		**Sum=14.857**	**4.36/43.27=0.101**	**II**
Cost Variation		4.17	4.17/14.857=0.280	0.280x0.101=0.028	1
Unit Cost		3.82	0.257	0.026	2
Rework costs		3.59	0.241	0.024	3
Expenses incurred		3.29	0.221	0.022	4
Project Time	**4.27**		**Sum=20.120**	**0.099**	**III**
Time Variation		4.18	4.18/20.120=0.208	0.021	1
Speed of Construction		3.89	0.193	0.019	5
Material availability		4.08	0.203	0.020	2
Equipment availability		3.98	0.198	0.020	4
Labor availability		4.00	0.199	0.020	3
Quality	**4.59**		**Sum=19.906**	**0.106**	**I**
Conformity with expectation		4.32	4.32/19.906=0.217	0.023	1
Conformity with predetermined standard		4.28	0.215	0.023	2
Evaluate the suitability project quality certificate		3.89	0.195	0.021	3
Defects need to rework		3.77	0.189	0.020	4

Variable Name	Mean	Mean	Weight/Indicator	Weight/Project	Rank
Time to rework under-quality works		3.65	0.183	0.019	5
Project Safety	**4.27**		**Sum=33.586**	**0.099**	**IV**
Death injures		4.55	4.55/33.586=0.135	0.013	1
Heavy accidents		4.25	0.127	0.013	4
Slight accidents		3.55	0.106	0.010	8
Safety Signs		4.12	0.123	0.012	6
Providing safety tools and protection equipment		4.46	0.133	0.013	2
Safety level of equipment		4.32	0.129	0.013	3
Safety training		4.24	0.126	0.012	5
Safety responsibility staffs		4.09	0.122	0.012	7
Meeting specifications	**4.07**		**Sum=16.880**	**0.094**	**V**
Contractor’s response		4.40	4.40/16.880=0.261	0.025	1
Technical problem identification and solution		4.21	0.249	0.023	3
Qualifications of workers		3.92	0.232	0.022	4
Technical staff		4.35	0.258	0.024	2
Functionality	**3.81**		**0.088**	**0.088**	**VI**
Conformance to specifications		-		-	
Productivity	**3.55**		**Sum=11.192**	**0.082**	**X**
Unit labor		3.65	3.65/11.192=0.326	0.027	3
Unit labor cost		3.81	0.341	0.028	1
Unit equipment cot		3.73	0.334	0.027	2

Variable Name	Mean	Mean	Weight/Indicator	Weight/Project	Rank
Project stakeholder satisfaction	**3.72**		**Sum=11.914**	**0.086**	**7**
Owner satisfaction		4.39	4.39/11.914=0.369	0.032	1
Contractor satisfaction		3.79	0.318	0.027	2
Consultant satisfaction		3.73	0.313	0.027	3
Environment	**3.65**		**Sum=22.361**	**0.084**	**VIII**
Environment and communities		3.76	3.76/22/361=0.168	0.014	3
Reminded from the authorities		3.63	0.162	0.014	4
Time and duration suspended from the authorities		3.99	0.179	0.015	1
Contractor response		3.80	0.170	0.014	2
Environmental expenses		3.60	0.161	0.014	5
Overcoming problems expenses		3.59	0.161	0.014	6
Project communication	**3.61**		**Sum=11.639**	**0.083**	**IX**
Communication in project		3.86	3.86/11.639=0.331	0.028	2
Misinformation/ delays		3.94	0.339	0.112	1
Information systems		3.84	0.330	0.112	3
Litigation	**3.37**		**Sum=15.192**	**0.078**	**XI**
Outstanding claim		3.84	3.84/15.192=0.253	0.020	1
Check and take over conflict		3.79	0.249	0.019	3
Relationship		3.83	0.252	0.020	2
Breach of contract		3.74	0.246	0.019	4

In traditional opinion, as summarized in the literature reviewed, original project objectives such as cost, time, and quality are considered as the most important criteria in the evaluation of project success. The results from this study contribute one more convincing evidence for the importance of quality, cost, time and safety in construction success evaluation. Related to quality indicator, conformity with the expectation is considered the most important. Cost and time variations between actual achievement and original plan keep the first position in the cost and time indicator. Consideration for the overall project evaluation system, the first five criteria occupy the most important role are: Owner satisfaction (0.0317), Cost variation (0.0282), Unit labor cost (0.0279), Communication system in project (0.0277), and Contractor satisfaction (0.0274).

5. Conclusion

This paper presents a practical list of indicators and criteria for a construction project evaluation system. The expected advantage of this framework is overcoming the limitation from previous studies in practical evaluation. This framework is a result of the combination between practical construction industry and academic and experts' points of view. Eleven indicators, which are detailed by forty six criteria, will be used to evaluate project success. In this system, the importance of criteria related to Quality, Cost, and Time was stressed. They rank in the top of the project evaluation model. This implies a tendency in respondents' opinions about the importance level of these issues. Up to now, a complete system included both list of indexes and how the weighted importance of them was achieved. So, project success can be quantitatively evaluated. However, this system should be applied in a real construction project and feedback obtained to optimize the system; this is a part of our future mission.

APPENDIX

Appendix 1. Summaries List of Indicators and Methodology to Evaluate Project Success

Researchers	List of Indicators and Evaluation Method	Weight Assignment Methods
Tabish and Jha (2011)	Overall success : Nine-point scale Anti-corruption norms: Nine-point scale Financial norms: Nine-point scale	Not mentioned
Shahrzad Khosravi (2011)	Time Performance Cost Performance Quality Performance HSE Client Satisfaction	Mean Rank method from 0 (not important) to 10 (very important)

Researchers	List of Indicators and Evaluation Method	Weight Assignment Methods
Al-Tmeemy et al. (2011)	Quality Targets Schedule Budget achievement Satisfaction of customer Functionality Meeting specification Profit achievement Market development Reputation Competitive Improvement	Not mentioned
Ahadzie et al. (2008)	Project Cost Project Duration Project Quality Customer Satisfaction Environmental impact	Not mentioned
Menches and Hanna (2006)	Profit (0.583) Schedule achievement (0.117): Percent time variation over/underrun Realistic schedule (0.033): How realistic: 1-5 Communication (0.133): Rate how good: 1-5 Achieved budget cost (0.083): Exceed or not: Y/N Work hours (0.05): Percent change in work hours	Summing up all responses for six variables
Bryde and Robinson (2005)	Project Cost (*) Project Duration (*) Technical specification Customer Satisfaction Stakeholders Satisfaction (*)	Not mentioned
Chan and Chan (2004)	Time: Construction duration, Construction speed, Schedule variation Project cost: unit Profit: net present value Safety: Accident rate, EIA or ISO 14000 Environmental performance: Number of complaints	Not mentioned

Researchers	List of Indicators and Evaluation Method	Weight Assignment Methods
	Quality: Seven-point scale Functionality: Seven-point scale Satisfaction: Seven-point scale	
Shawn et al. (2004)	Cost: Seven-point scale Schedule: Seven-point scale Quality: Seven-point scale Performance: Seven-point scale Safety: Seven-point scale Operating Environment: Seven-point scale	Relative important weight assigned by respondents
Chan et al. (2002)	Time: Time overrun, Construction duration, Construction speed Cost: Unit cost, Cost overrun Health and Safety: Accident rate per 1,000 Profitability: Total net revenue over total costs Quality Technical Performance Functionality Productivity Satisfaction Environmental Sustainability	Not mentioned
White and Fortune (2002) (General Project)	Project Cost Project Duration Meets client's requirements Organizational objectives Business benefits Quality and Safety requirement	Not mentioned
Tukel and Rom (2001) (General Project)	Project Cost Project Duration Technical specification Customer Satisfaction Rework	Not mentioned
Chua et al. (1999)	Achieve budget target (0.314) Achieve schedule target (0.360) Achieve quality target (0.325)	AHP Technique

Researchers	List of Indicators and Evaluation Method	Weight Assignment Methods
Lim and Mohamed (1999)	Time Cost Quality Performance Safety Satisfaction	Not mentioned
Crane et al. (1999)	Cost Schedule Safety Quality Litigation	Not mentioned
Griffith et al. (1999) (Facility projects)	Budget achievement (0.33): Percent deviation Schedule achievement (0.27): Percent deviation Plant utilization (0.12): Percent of planned utilization and actual attainted after 6 months Design capacity (0.28): Percent of planned utilization and actual attainted after 6 months	Weighting by summing up all responses for four variables
Liu and Walker (1998)	Project goals (1st level): Time, budget, functionality/ quality/ technical specification, safety, environmental sustainability. Satisfaction of the claimant (2nd level) Perception and awareness of different claimant.	Not mentioned
Shenhar and Levy (1997) (General Project)	Budget and Schedule: Seven-point scale Customer Satisfaction Business benefits Potential Competition: extend market, new products, and new technology.	Not mentioned
Songer et al. (1997)	Budget variation, Schedule variation, Conformity to expectations	Not mentioned

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