Project Management Institute.
Kingdom of Saudi Arabia

Digital Insights:

The Way to Project Success

By: Ameer H. Al Abdullah

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ABSTRACT

This paper is concentrating on the success of construction projects and the critical success factors that contributing to achieve the project successfully and provided summary and end results of several studies and articles pertaining to success measurement and critical success factors for construction projects. There are several definitions for success that provided by researchers and subject experts. Measurement of project performance is not united for all organizations. One generic measurement system and practical performance system were discussed in this paper. Many of critical success factors from different aspects and different experts were summarized in this paper. It is recommended that project owner with other stockholders to provide the definition and goals for that organization's projects which will be the point of success. The result from the mentioned information is that human and management factors are playing critical role in project success. Moreover, the trained, committed and competent participants are influencing positively in the project success (Tabish & Jha 2012). They concluded those four factors; project manager competence, commitment of project participants, owners' competence and coordination between project participants are increasing the level of project success in parameters of schedule, quality and cost (Jha & Iyer 2007). Finally, researchers came up with that there is strong relationship between complexity and success of the project.

1. INTRODUCTION

The successful is the main objective for everybody in everything in the life. However, it is too rarely that someone will succeed in something if he doesn't have enough knowledge about it. Moreover, he should know the way to achieve that target he wants to do or requested to archive. That is needed to be done for personal goals as well as business goals. Delivering the project successfully with getting the outcomes are main goals for the project manager using project management skills. Due to the repeatable of project success, the researchers gave special attention to factors are contributing in project success. They proposed what they call it iron triangle of success containing schedule, cost & quality (Tabish & Jha 2012). This paper is concentrating on the success of construction projects and the critical success factors that contributing to achieve the project successfully.

2. DEFINITION OF PROJECT SUCCESS

The definition of the project success is not standard for all organizations around the world. There is no universal agreement on the success definition for construction projects (Jha & Iyer 2007). However, the project success was defined by researchers as following;

- Tuman (1986) defined project success as "having everything turned out as hoped...anticipating all project requirements and having sufficient resources to meet needs in a timely manner."
- De Wit (1986) considered the project success if the concerned parties; owner, project team and others are fully satisfied for the overall outcomes.
- Ashley et al. (1987) considered the project success when the final results are better than the planned or expected in form the aspects of quality, schedule, safety and cost.

- Wuellner (1990) defined the project success as completion on time within the budget plus profit margin with client satisfaction. (Hwang & Lim 2013).

- In some researches, it was defined as "The extent to which budget schedule, and quality milestones are achieved as perceived by project participants in the capacity of contractors, construction managers, and designers" (Inayat, Melhem, & Esmaeily 2015).

The definition of project success is not clear and it is defined in the mind of construction professionals (Chan, Scott, & Chan 2004). As result, the one definition for project success is not needed since it is too wide and contains effect during the execution and after project completion. Also, it involves many project concerned parties and stakeholders (Luo, He, Xie, Yang, & Wu 2017). It is recommended that project owner with other stockholders to provide the definition and goals for that organization's projects which will be the point of success.

3. THE MEASUREMENT OF PROJECT SUCCESS

Organizations & project managers are measuring the project performance during the construction and after completion. They always use the results as indicators for the project success. However, measuring the performance is not identical for all firms around the world and there are no agreed criteria to be used in all projects. Most of the project organization used the iron triangle criteria which are schedule, cost and quality to measure the performance (Jha & Iyer 2007).

3.1 PRACTICAL PERFORMANCE MEASUREMENT

The measurement criteria can be divided generally into categories;

A. Objective & measurable criteria which include schedule, cost, quality safety and dispute.
B. Subjective criteria & intangible which include client satisfaction, contractor satisfaction and project management satisfaction (Jha & Iyer 2007).

Mostly, the projects are evaluated on the personal experience without procedure which giving different evaluation scores for the same project if it is evaluated by two managers using the same data. The projects became more complex, so the performance measurement shall be expanded and unified. Nassar and AbouRizk (2014) proposed a framework that organizes and integrates the performance process through eight key indicators: cost, schedule, billing, profitability, quality, safety, project team satisfaction, and client satisfaction.
They defined the performance as achieving all related project objectives effectively and efficiently covering both quantity and human-related goals (Nassar & Abourizk 2014). The proposed model in Fig.1 is presenting the mentioned eight indexes with their sub-indexes. The table 1 is showing the calculation of the indexes and Table 2 is providing ratings, normalizations, and sample ranges for the performance indexes.

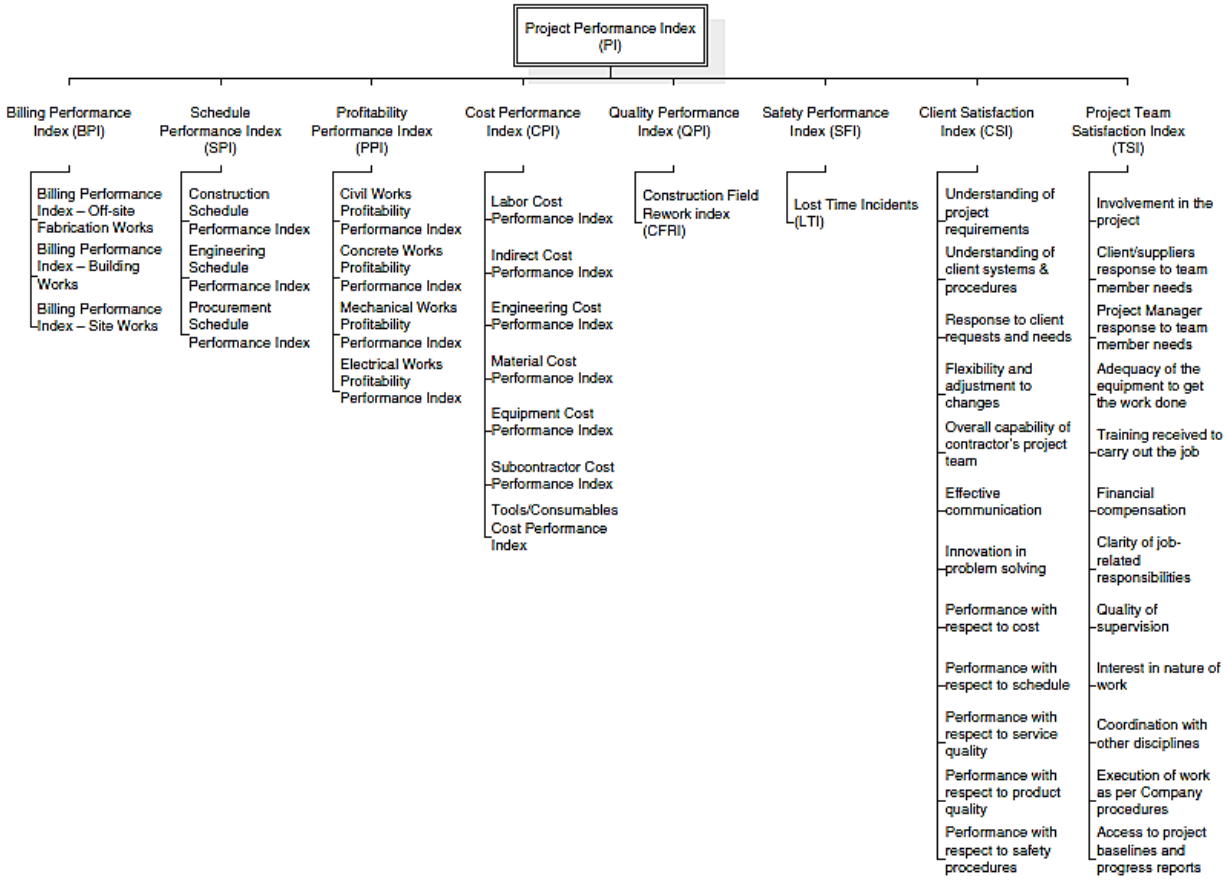

Fig. 1. Hierarchy design for the project performance model

Table 1. Calculation of the Project Performance Indexes

Index	Description	Calculation
Cost performance index (CPI)	Cost efficiency of the project	CPI = BCWP/ACWP
Schedule performance index (SPI)	Schedule efficiency of the project	SPI = BCWP/BCWS
Billing performance index (BPI)	Efficiency of invoicing the client for earned work; determines cash flow	BPI = BRWP/ERWP
Profitability performance index (PPI)	Profitability of project to date	PPI = ERWP/ACWP
Safety performance index (SFI)	Safety of project to date	SFI = LTI × C/M
Quality performance index (QPI)	Consistency in application of project standards and procedures	QPI = CFRI
Team satisfaction index (TSI)	Satisfaction of the project team	TSI = $\sum_{i=1}^{12} W_i R_i$
Client satisfaction index	Satisfaction of the client	CSI = $\sum_{i=1}^{12} W_i R_i$

Table 2. Ratings, Normalizations, and Sample Index Ranges for the Performance Indexes

			Index ranges					
Condition	Rating	Normalized range	CPI, SPI	BPI	PPI	SFI[a]	QPI	TSI, CSI
A	Outstanding performance	>1.15	>1.15	>0.98	>1.30	0.00	≤0.50	>9.51
B	Exceeds target	1.05–1.14	1.05–1.14	0.95–0.97	1.20–1.29	0.00–0.10	0.51–1.00	9.01–9.50
C	Within target	0.95–1.04	0.95–1.04	0.90–0.94	1.05–1.19	0.11–0.30	1.01–2.00	8.01–9.00
D	Below target	0.85–0.94	0.85–0.94	0.85–0.89	0.90–1.04	0.31–1.00	2.01–4.00	6.00–8.00
F	Poor performance	≤0.84	≤0.84	≤0.84	≤0.89	>1.01	>4.01	≤5.90

[a]Target one LTI every 1 million work hours.

BCWP = Budgeted cost of work performed: the cumulative budgeted cost for work
completed to date, or the cost allowed (based on budget) to be spent for the actual work
done;
ACWP = Actual cost of work performed: the cumulative cost incurred to complete the
accomplished work to date;
BCWS = Budgeted cost of work scheduled: the budgeted cost for work scheduled (as
per budget) to date;
BRWP = Billed revenue of work performed, or the cumulative amount of invoices;
ERWP = Earned revenue of work performed, or the cumulative revenue earned for the
actual work accomplished to date;
LTI = Number of lost time incidents to date;
C = a constant (200,000), which represents 100 employees working for a full year (100
× 000 ;2);
M = Total work hours expended to date;
CFRI = Construction field rework index: the total direct and indirect cost of rework
performed in the field/total field construction phase cost (Nassar & Abourizk 2014).

The project performance index (PI) can be calculated using the eight indexes as
shown in below equation;
PI= w1CPI + w2SPI + w3BPI + w4PPI + w5SFI + w6QPI + w7TSI + w8CSI
Where $\sum_{i=1}^{8} w_i = 1$ which are priority weights for each index with total equal 1
and it may change with the time due to changing the scope or human nature.

Performing the measurement shall be done regularly such as monthly, however it is recommended to be done weekly especially for the projects with short time or accelerated projects.

Both indexes team and client satisfaction (TSI &CSI) can't be done weekly and it is more practical to be done quarterly (Nassar & Abourizk 2014).

It is contractor responsibility to check the applicability of aforementioned framework for the project since each project has its unique specification.

Moreover, the accuracy of framework's results is depending on people who are involved to distribute the weights and the quality of data obtained from the project (Nassar & Abourizk 2014).

3.2 PROPOSED GENERIC SYSTEM FOR MEASURING PROJECT PERFORMANCE

Due to the limitation for the most of project management systems (PMS) by the time after completion and specific organizational level, many researchers proposed a new PMS model which is more generic (Haponava & Al-Jibouri 2012).

Haponava & Al-Jibouri collected all Performance Measurement Systems and they did analysis and provided some improvement area (Haponava & Al-Jibouri 2012).

They came up with a new proposed system which based on two main aspects: process completeness and process quality. The generic system requires answering a series questions pertaining to completeness of critical output within each sub process.

The process in the system can be evaluated in the scale from 0 to %100 where 0 means no thing done and %100 means excellent done.

The structure of the generic system is shown in Fig.3. The figure. 3 showing that if the completeness question answered with

NO", then the system will skip measuring the process since it is not applicable in this case (Haponava & Al-Jibouri 2012).

Fig. 5 is showing an example how to assess the completeness within sub process which understands client requirements. If the completeness questions answered with "YES" then can do the evaluation of quality by using "How" questions depending on the identified aspects (Haponava & Al-Jibouri 2012).

The proposed system is expected to produce accurate measurement, but to provide guidelines for the management on how to monitor and control the performance by concentrating on the critical issues the way that carried out (Haponava & Al-Jibouri 2012).

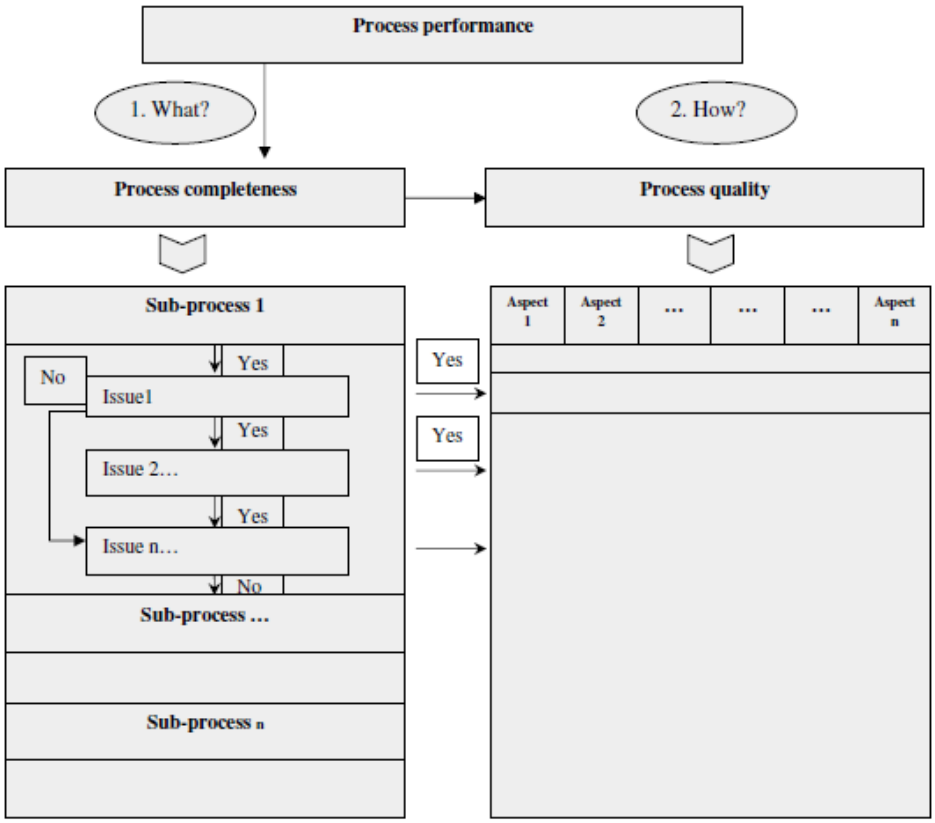

Fig. 3. Proposed measurement system for assessing process performance (of the identified KPIs)

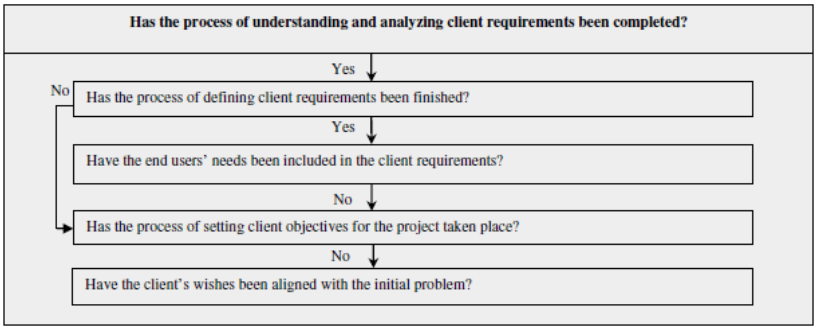

Fig. 5. Example of the measurement of the completeness of the subprocess of "understanding client requirements" within the "Management of client requirements" KPI

4. FACTORS OF PROJECT SUCCESS

After exploring the studies and researches regarding the critical success factors of the project, the result is not identical answer for the factors. Some researchers identified and discussed the success factors from the human side while other researchers discussed the subject from the organizational side. Other researchers collected the factors based on the majority of project management team and some authors discussed the relationship between the factors.
Moreover, someresearcher's concentrates on factors that related to briefing the scope. This part of paper will
provide summary and conclusion of some articles that discussed the critical success factors (CSFs) of construction projects.

4.1 SUCCESS FACTORS RELATED TO HUMAN ACTIONS

Successfully completing a project demands contributions and efforts from various stakeholders, including the client, project team, parent organization, procedures, and end users. The human factors that play a critical role in this process include the project manager's competence, the commitment of all participants, the owner's expertise, positive relationships among project stakeholders, and the availability of trained resources. These factors, which form a second-order construct comprising human factors and management actions, were assessed based on their impact on schedule, quality, and cost performance. (Tabish & Jha 2012).

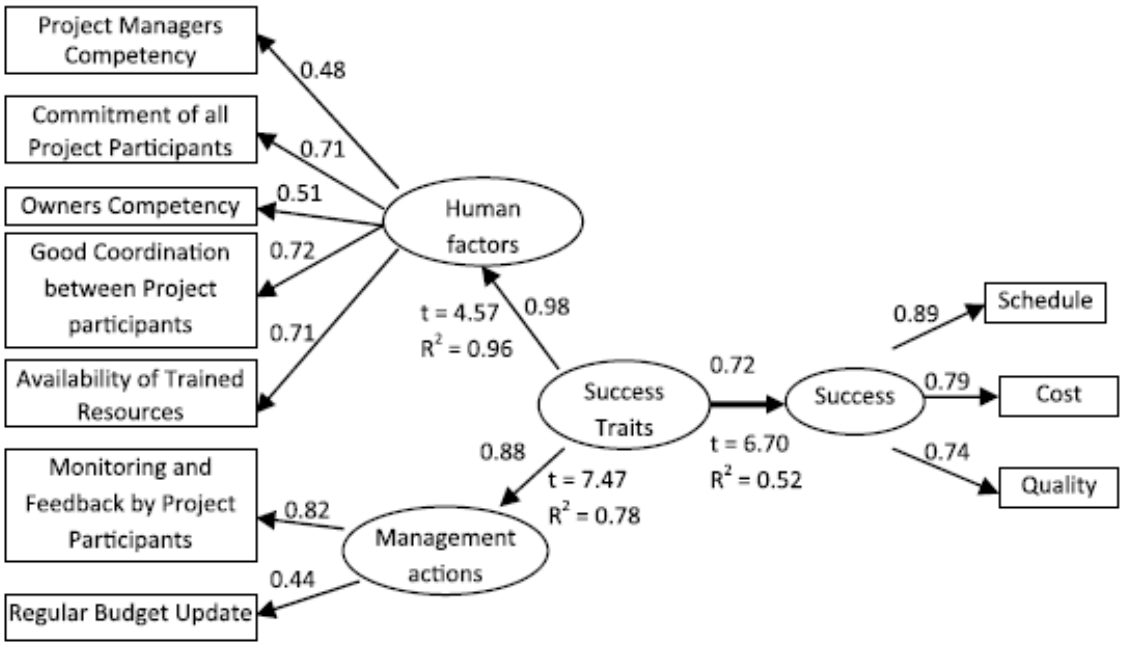

Fig. 3. Structural equation modeling results of linkage between success traits and project success

The results from the structural equation model (SEM) are showings that human factors and management actions have significant correlation with mentioned second order traits as shown in Fig.3 (Tabish & Jha 2012). The result from the mentioned information is that human and management factors are playing critical role in project success. Moreover, the trained, committed and competent participants are influencing positively in the project success (Tabish & Jha 2012).

4.2 CRITICAL SUCCESS FACTORS BASED ON ORGANIZATIONAL BACKGROUNDS

Construction professionals from different organizations were asked to rate 53 proposed potential factors (Inayat, Melhem, & Esmaeily 2015). Table 4 presents the top ten critical success factors (CSFs) for contractors, personnel, managers, and designers. based on the average priority values. In terms of overall project performance, both managers and contractor personnel identified six common CSFs: technical approval authorities, adequate funding. clear

objectives and realistic obligations, comprehensive plans and specifications, skilled labor availability, and site inspections. Similarly, for overall project performance, managers and designers agreed on five shared CSFs: project manager (PM) competency, the capability of key contractor personnel, a functional plan, design completion at the start of construction, and the level of skilled labor. However, the only CSF that was common between contractor personnel and designers was the availability of skilled labor. (Inayat, Melhem, & Esmaeily 2015).

Table 4. CSFs for Overall Project Success

Critical success factor	Contractor personnel	Managers	Designers
Technical approval authorities	4	9	—
Adequacy of funding	2	8	—
Site access limitation	6	—	—
Project size	5	—	—
Realistic obligations/clear objectives	9	5	—
Adequacy of plans and specifications	10	7	—
PM competency	—	4	6
Capability of contractor key personnel	—	10	5
Competency of contractor proposed team	—	—	4
Capability of consultant key personnel	—	—	10
Competency of consultant proposed team	—	—	1
Functional plan	—	1	2
Design complete at construction start	—	3	3
Level of modularization	—	—	8
Level of skilled labor	3	6	9
Design control meetings	—	—	7
Construction control meetings	8	—	—
Site inspections	7	2	—
Transparency in awarding of work	1	—	—

4.3 CRITICAL SUCCESS FACTORS BASED ON ORGANIZATIONAL BACKGROUNDS

Total of 27 experts in construction were asked identify the top ten success factors for the schedule, cost and quality performance from the side of architectural works (Arch), civil and structural works (C&S) and mechanical & electrical engineering works (M&E) (Kog & Loh 2012). The differentiation is important because of covering the stages of project; C&S is placing in the early stage of construction while M&E are placing in the later stages of projects (Kog & Loh 2012).

Table 12 presents the ranking of critical success factors (CSFs) for overall performance across architectural, C&S engineering, and M&E engineering works. Four factors are consistently identified as among the top 10 CSFs influencing overall performance across all three types of work: constructability, adequacy of plans and specifications, project manager competency, and clear objectives/realistic obligations.

Project manager commitment and involvement, along with contractual motivation and incentives, are considered top CSFs for the overall performance of C&S and M&E engineering works, but not for architectural works. Additionally, constructability programs and modularization rank among the top 10 CSFs for M&E engineering works.

Four factors are specific to architectural works, including the capability of consultant key personnel, consultant team competency, consultant team turnover rate, and client top management support. (Kog & Loh 2012).

Table 12. Ranking of CSFs for Overall Project Performance

	C&S engineers	M&E engineers	Quantity surveyors	Architects	Professions that have ranked this factor within top 10 CSFs
Constructability	1	3	1	9	C&S, M&E, QS, Arch
Adequacy of plans and specifications	2	1	2	1	C&S, M&E, QS, Arch
Project manager competency	3	2	5	2	C&S, M&E, QS, Arch
Realistic obligations	4	4	4	4	C&S, M&E, QS, Arch
Project manager commitment and involvement	7	7	3	6	C&S, M&E, QS, Arch
Contractual motivation/incentives	8	5	9	12	C&S, M&E, QS
Adequacy of funding	22	8	10	5	M&E, QS, Arch
Economic risks	5	18	7	14	C&S, QS
Construction control meeting	6	10	16	28	C&S, M&E
Technical approval authorities	10	9	21	24	C&S, M&E
Project manager authority	16	25	6	7	QS, Arch
Pioneering status	9	22	13	13	C&S
Project size	28	6	14	29	M&E
Site limitation and location	11	12	8	23	QS
Client top management support	14	40	20	3	Arch
Contractor key personnel capability	29	20	38	8	Arch
Contractor team competency	32	26	23	10	Arch

The mentioned results assuring that adequacy of plans and specifications and project manager competency are two critical factors part of the top 10 CSFs related to schedule, cost and quality for architectural works (Arch), civil and structural works (C&S) and mechanical & electrical engineering works (M&E) (Kog & Loh 2012).

Other researchers (Jha & Iyer 2007) concluded from their study what supporting the abovementioned results. They concluded those four factors; project manager competence, commitment of project participants, owners' competence and coordination between project participants are increasing the level of project success in parameters of schedule, quality and cost (Jha & Iyer 2007).

4.4 INTERRELATIONSHIPS BETWEEN CRITICAL SUCCESS FACTORS

In the 1990s, Chan et al. (2004) reviewed research on critical success factors (CSFs) and classified 44 identified factors into five categories: project-related factors, project procedures, project management actions, human-related factors, and the external environment. (Chen, Zhang, Liu, & Mo 2012). The structural equation model (SEM) is a technique that used to measure the relationships between CSFs (Chen, Zhang, Liu, & Mo 2012). Chen, Zhang, Liu, and Mo (2012) confirmed five key relationships in their study. They found that the "owner's ability," "economic environment," and "political environment" directly influence the "owner's expectations," while the "natural environment" and "economic environment" directly affect the "owner's preferences." Additionally, the authors identified several other relationships among the latent variables. Specifically, "owner's ability" positively impacts "contractor's characteristics," suggesting that more capable owners are better positioned to select qualified contractors. "Owner's expectations" were found to positively influence "subcontractors' characteristics," which is often the case when the owner directly appoints subcontractors. The study also reveals that the "natural environment" has a positive effect on the "owner's preferences," indicating that a deteriorating natural environment tends to increase the owner's risk appetite—though this relationship requires further validation. Furthermore, "political environment," "economic environment," and "natural environment" are positively correlated with each other, suggesting that a negative natural environment may contribute to political and economic instability. However, a stable political and economic environment may mitigate the negative impacts of a poor natural environment, fostering a virtuous cycle. Finally, "project characteristics" and "owner's ability" are positively correlated, as the nature of the project is typically defined when the owner makes the project selection. Thus, the owner's experience and capability with similar projects are often predetermined. It's important to note that the correlation here differs from a causal relationship, as a change in one variable does not necessarily cause a change in the other. (Chen, Zhang, Liu, & Mo 2012).

4.5 ADDITIONAL CSFS AND MORE RELATIONSHIP

Poor identified scope of work for the project is impacting the implementation in quality, cost and time which influencing the project success (Yu & Shen 2015). Seven critical factors were identified as influencing the success of the briefing process:

1. The client's business characteristics, organizational structure, and project requirements must be clearly defined in the brief.

2. The requirements of all stakeholders must be well-defined and understood.

3. The knowledge, experience, and cultural backgrounds of stakeholders involved in the briefing process should be appropriate.

4. Senior project managers must possess sufficient decision-making and management skills.

5. A competent design team is essential.

6. The interests of all stakeholders must be considered fairly and balanced.

7. The process of developing the brief must be transparent to all involved and rigorously followed (Yu & Shen 2015).

Finally, researchers came up with that there is strong relationship between complexity and success of the project. The project manager shall maintain the project goals and review the objectives periodically to check the applicability with the project environment (Luo, He, Xie, Yang, & Wu 2017).

5. CONCLUSION

This paper provided summary and end results of several studies and articles pertaining to success measurement and critical success factors for construction projects. There are several definitions for success that provided by researchers and subject experts. Measurement of project performance is not united for all organizations. One generic measurement system and practical performance system were discussed in this paper. Many of critical success factors from different aspects and different experts were summarized in this paper. It is recommended that project manager in the early stage of the project to prepare and identify the critical factors that may affect the project success and the measurement system will use for performance. This critical information shall be presented to all project team and stakeholders to work together for the successful. Moreover, project manager should be on top for the new researches discussing the factors and measurement of success to be able managing the project and team more efficiently and effectively.

5. CONCLUSION

1. Chan, Albert P. C., David Scott, and Ada P. L. Chan. "Factors Affecting the Success of a Construction Project." Journal of Construction Engineering and Management 55-153 :(2004) 130.1. Web.

2. Chen, Yong Qiang, Yang Bing Zhang, Jun Ying Liu, and Peng Mo. "Interrelationships among Critical Success Factors of Construction Projects Based on the Structural Equation Model." Journal of Management in Engineering 51-243 :(2012) 28.3. Web.

3. Haponava, Tatsiana, and Saad Al-Jibouri. "Proposed System for Measuring Project Performance Using Process-Based Key Performance Indicators." Journal of Management in Engineering 28, no. :(2012) 2 49-140. doi:10.1061/(asce)me.5479.0000078-1943.

4. Hwang, Bon-Gang, and E-Sin Janicia Lim. "Critical Success Factors for Key Project Players and Objectives: Case Study of Singapore." Journal of Construction Engineering and Management 15-204 :(2013) 139.2. Web.

5. Inayat, Asfandyar, Hani Melhem, and Asad Esmaeily. "Critical Success Factors in an Agency Construction Management Environment." Journal of Construction Engineering and Management 141, no. :(2015) 1 06014010. doi:10.1061/(asce)co.7862.0000921-1943.

6. Jha, K.n., and K.c. Iyer. "Commitment, coordination, competence and the iron triangle." International Journal of Project Management 25.5 40-527 :(2007). Web.

7. Kog, Yue Choong, and Ping Kit Loh. "Critical Success Factors for Different Components of Construction Projects." Journal of Construction Engineering and Management 28-520 :(2012) 138.4. Web. Journal of Management in Engineering 04014027 :(2014) 30.6. Web.

8. Luo, Lan, Qinghua He, Jianxun Xie, Delei Yang, and Guangdong Wu. "Investigating the Relationship between Project Complexity and Success in Complex Construction Projects." Journal of Management in Engineering 04016036 :(2017) 33.2. Web.

9. Nassar, Nadim, and Simaan Abourizk. "Practical Application for Integrated Performance Measurement of Construction Projects." Journal of Management in Engineering 04014027 :(2014) 30.6. Web.

10. Tabish, Syed Zafar Shahid, and Kumar Neeraj Jha. "Success Traits for a Construction Project." Journal of Construction Engineering and Management 138, no. 138-1131 :(2012) 10. doi:10.1061/(asce)co.7862.0000538-1943.

11. Yu, Ann T. W., and Geoffrey Q. P. Shen. "Critical Success Factors of the Briefing Process for Construction Projects." Journal of Management in Engineering 31, no. 04014045 :(2015) 3. doi:10.1061/(asce)me.5479.0000242-1943.