Framework for Measuring Success of Construction Projects

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Framework For Measuring Success Of Construction Projects

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Abstract

The construction industry is dynamic in nature. The concept of project success has remained ambiguously defined in the construction industry. Project success means different things to different people. While some authors consider time, cost and quality as the predominant targets, others suggest that success is something more complex. The aim of this report is to develop a framework for measuring success of construction projects. A range of Key Performance Indicators (KPIs), measured both objectively and subjectively is developed. The identification of KPIs helps set a benchmark for measuring the performance of a construction project and provides significant insights into developing a general and comprehensive base for further research.

Keywords: Project success, assessment framework, and key performance indicators.

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Introduction

Almost every industry is dynamic in nature and the construction industry is no exception. Its environment has become more dynamic due to the increasing uncertainties in technology, budgets, and development processes. A building project is completed as a result of a combination of many events and interactions, planned or unplanned, over the life of a facility, with changing participants and processes in a constantly changing environment (Sanvido *et al.*, 1992). Temporary, fragmented and short-term are also significant characteristics inherent in the construction industry. Such characteristics greatly affect the effectiveness of project team, especially the project managers. The concept of project success is a means to improve the present situation. However, this concept has remained ambiguously defined in the minds of the construction professionals. Many project managers still attend to this topic in an intuitive and ad hoc fashion as they attempt to manage and allocate resources across various project areas (Freeman and Beale, 1992).

Although a number of researchers have explored this concept, no general agreement is achieved. Project success means different things to different people. And the criteria of project success are enriched as time goes by. Therefore, a systematic critique of the existing literature is needed in order to develop a framework for measuring construction success both quantitatively and qualitatively.

This report based on the earlier work by Chan et al (2002a; 2002b) and Chan (1996; 1997) aims to develop a conceptual framework for measuring construction success. The report is divided into five main parts. Firstly, the methodology adopted by the author is presented. Secondly, the general background of project success, including the definitions and related issues, are discussed. Thirdly, a critical review of project success articles from 1990 to 2000 is undertaken. Fourthly, a range of Key Performance Indicators measured both objectively and subjectively, are developed to assess the project performance. Finally, the significance of this report is presented.

Methodology

Project success is an abstract concept, and determining whether a project is a success or a failure is highly complex (Chan et al, 2002a). However, the concept of project success can be evaluated through performance measures that can be developed from research literature where various success criteria can be identified.

The research method used for this report was to make a comprehensive review of the literature over the past 10 years. The selection of literature was based mainly on the research findings of Chua (1997), including the following sources:

- Construction Management and Economics (UK),
- ASCE Journal of Construction Engineering and Management (US),
- Engineering, Construction and Architectural Management (UK),
- ASCE Journal of Management in Engineering (US),
- International Journal of Project Management (UK),
- Project Management Journal (US),
- Journal of Construction Procurement (UK).

To maintain the efficiency and effectiveness of the literature searching process, an on-line search was undertaken for the past 10 years. Search engines identified are CatchWord, Ebsco, and Science Direct, and keywords include project success, criteria, performance measures, evaluation, and key performance indicators. Some papers for the last 10 years may not have been put on line, especially those of Project Management Journal, and so manual search was done to catch any missing articles. Chan et al (2002a; 2002b) and Li et al (2000) adopted similar methodology in the study of design/build and partnering projects respectively.

Criteria Of Project Success

Munns & Bjeirmi (1996) consider a project as the achievement of a specified objective, which involves a series of activities and tasks that consume resources. From the Oxford Dictionary (1990), criterion is defined as standard of judgement or principle by which something is measured for value. Lim & Mohamed (1999) advocate a criterion as a principle or standard by which anything is or can be judged. The Oxford Dictionary further defines success as favourable outcome or the gaining of fame or prosperity. When combining these terms, criteria of project success can be defined as '*the set of principles or standards by which favourable outcomes can be completed within a set specification'*.

Project success means different things to different people. Each industry, project team or individual has a definition of success. Pariff and Sanvido (1993) consider success as an intangible perceptive feeling, a measuring criterion that varies with management expectations and varies among persons and with the phases of project. Actually, owners, designers, consultants, contractors, as well as sub-contractors have their own project objectives and criteria for measuring success. For example, architects may view aesthetics or functionality as the main criterion rather than building cost. However, the client may have different views. Moreover, even the same person's perception of success changes from project to project. Definitions on project success may change according to project type, size and sophistication, project participants and experience of owners, etc.

Changing Measures Of Project Performance Over Ten Years

Over the last ten years, a number of researchers have shown intense interest in this topic. Chan (1996; 1997) undertook a comprehensive review of measurement of project success in the late 80s and the early 90s. However, more literature has emerged since Chan's review. This report attempts to bridge the gap by providing a critical review of project success in the last decade.

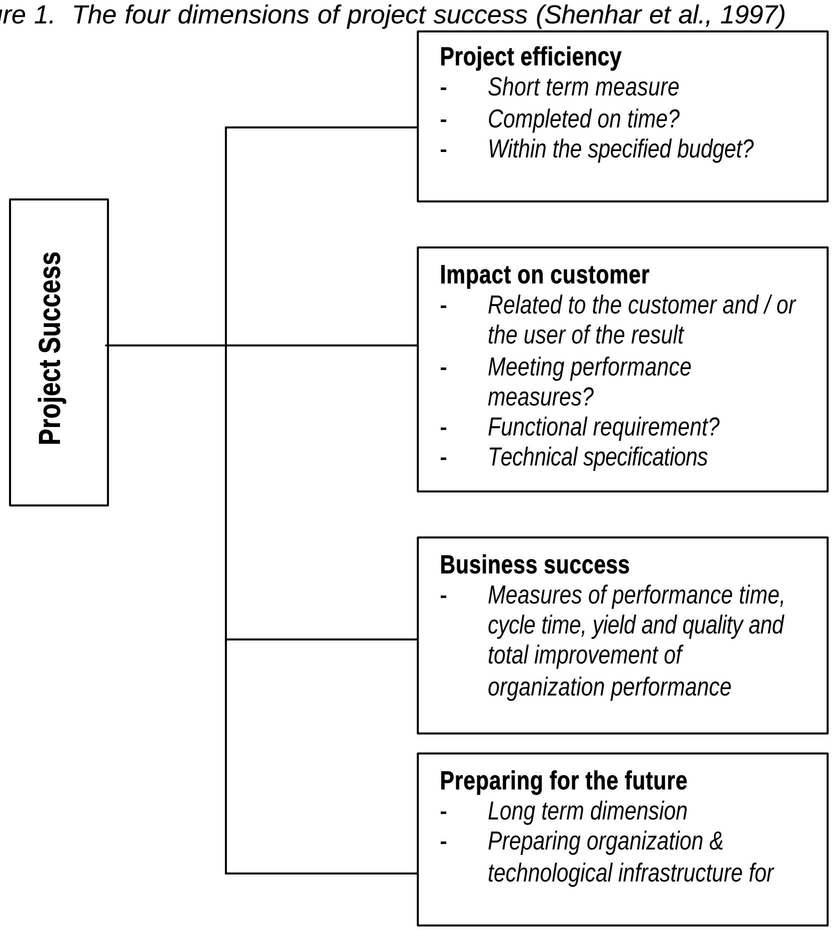
In the early 90s', project success was inherently tied to performance measures, which in turn were tied to project objectives. At project level, success was measured on the bases of time, monetary cost and project performance (Navarre and Schaan, 1990). Time, cost and quality are the basic criteria to project success, nearly every related article mentions these three and point out the importance of them in a construction project and in the views of project participants, such as Walker (1995; 1996), Belassi and Tukel (1996) and Hatush and Skitmore (1997). Atkinson (1999) identified these three criteria as the 'Iron Triangle'. He further suggests that while some different definitions about project management have been made, the criteria for success, namely cost, time and quality remain and are included in the actual description.

Apart from these three basic criteria, Pinto and Pinto (1991) advocated that measures for project success should also include project psychosocial outcomes - the satisfaction of interpersonal relations with project team members. Subjective measures such as participants' satisfaction level are known as the 'soft' measures. The inclusion of satisfaction as a success measure can be found earlier in the work of Wuellner (1990). Pocock *et al.* (1996) further noted this measure as having 'no legal claims' as an indicator of project success.

'Safety' is another issue the construction industry is very aware of. It is reasonable to expect that if accidents occur, both contractors and clients may be subject to legal claims, as well as financial loss and contract delay in the construction project. Kometa *et al.* (1995) used a comprehensive approach to assess project success. These criteria include: safety, economy (cost), running/maintenance cost, time and flexibility to users. Songer & Molenaar (1997) advocated that a project is successful if it is achieved on budget, on schedule, conforms to users expectations, meets specifications, quality workmanship and minimize construction aggravation. Kumaraswamy and Thorpe (1996) included a variety of criteria in their study of project evaluation. These include meeting budget, schedule, quality of workmanship, client and project manager's satisfaction, transfer of technology, friendliness of environment, health and safety.

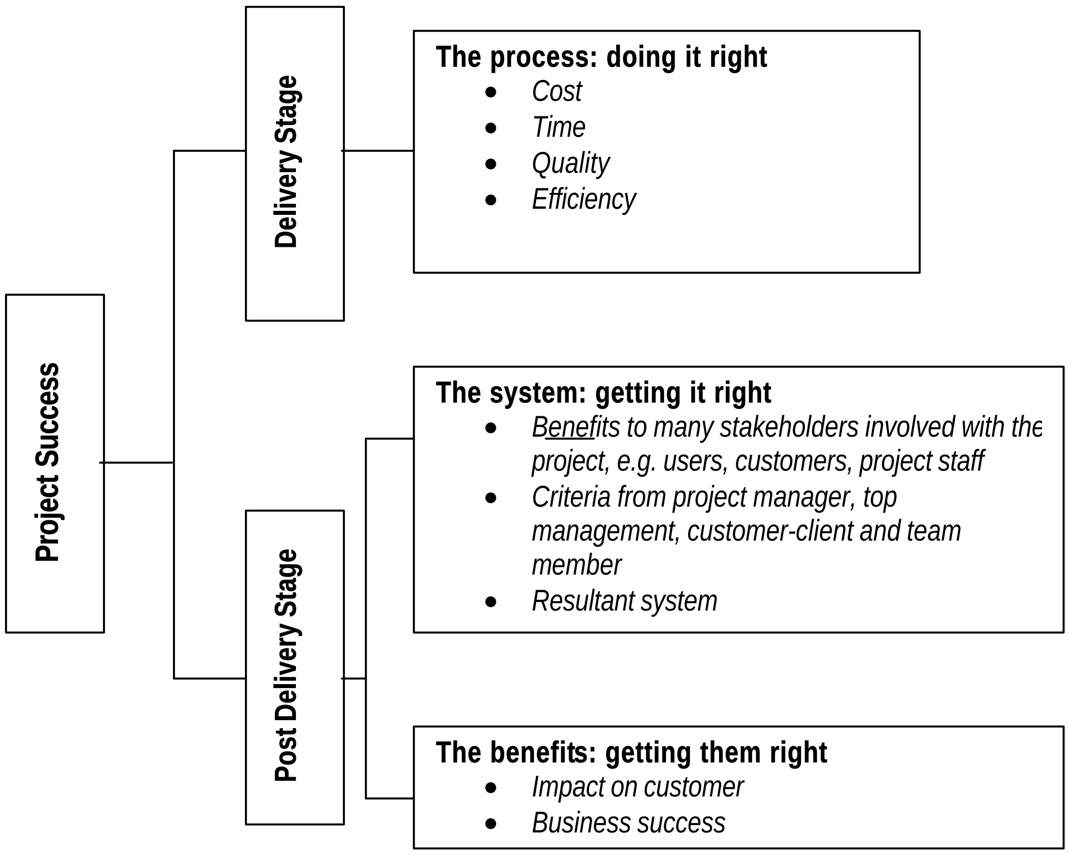
Shenhar *et al.* (1997) proposed that project success is divided into four dimensions. Figure 1 shows these four dimensions that are time-dependent. The first dimension is the period during project execution and right after project completion. The second dimension can be assessed after a short time, when the project has been delivered to the customer. The third dimension can be assessed after a significant level of sales has been achieved (one to two years). Finally the fourth dimension can only be assessed three to five years after project completion.

Figure 1. The four dimensions of project success (Shenhar et al., 1997)



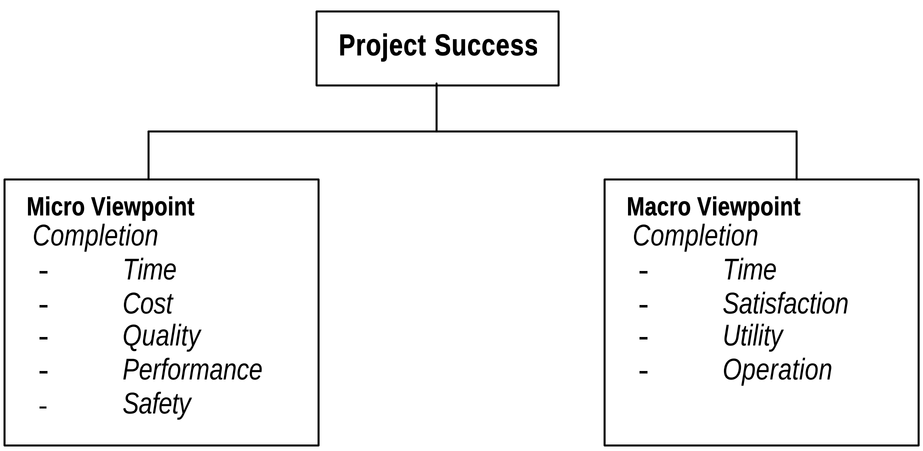
Atkinson (1999) in a similar pattern defined project success in three stages: the first stage is 'the delivery stage: the process: doing it right'; the second is 'post delivery stage: the system: getting it right' and the last stage is 'the post delivery stage: the benefits: getting them right'. Figure 2 is used to show Atkinson's model of measuring project success.

Figure 2. Atkinson's model of measuring project success (Atkinson, 1999)



Lim and Mohamed (1999) believed that project success should be viewed from different perspectives of the individual owner, developer, contractor, user, and the general public and so on. Two categories: the macro and micro viewpoints of project success were proposed. Figure 3 shows the micro and macro viewpoints of project success.

Figure 3. Micro and Macro Viewpoints of Project Success (Lim and Mohamed, 1999)



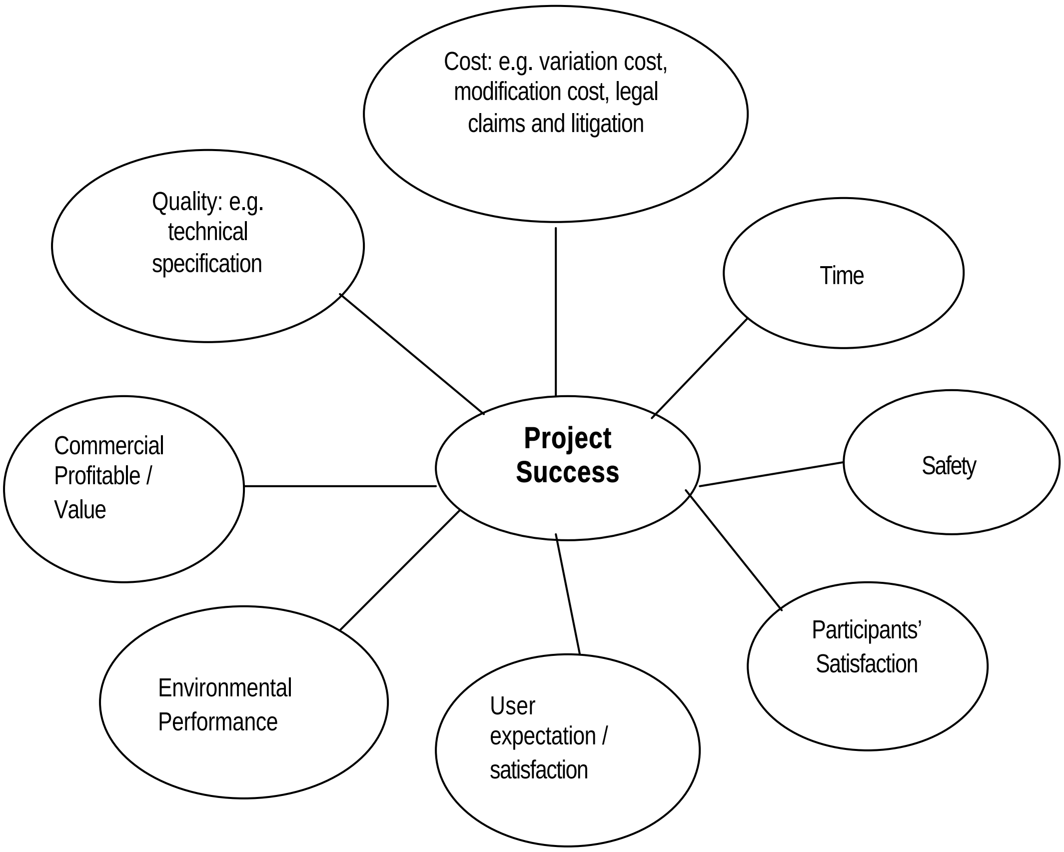
Sadeh *et al.* (2000) nevertheless divided project success into four separate dimensions. The first dimension is meeting design goals, it refers to the contract that was signed with the customer. The second dimension is the benefit to the end user; it refers to the benefit to the customers from the project end products. The third dimension is benefit to the developing organization; it refers to the benefit gained by the developing organization as a result of executing the project. The last dimension is the benefit to the national technological infrastructure, as well as to the technological infrastructure of the firm that was engaged in the development process. The combination of all these dimensions gives the overall assessment of project success. Table 1 shows the success dimensions and measures.

Table 1. Success Dimension and Measures (Sadeh et al., 2000)

Success Dimension	**Success Measures**
Meeting design goals	• Functional specifications • Technical specifications • Schedule goals • Budget goals
Benefit to the end user	• Meeting acquisition goals • Answering the operational need • Product entered service • Reached the end user on time • Product has a substantial time for use • Meaningful improvement of user operational level • User is satisfied with product
Benefit to the developing organization	• Had relatively high profit • Opened a new market • Created a new product line • Developed a new technological capability • Increased positive reputation
Benefit to the defence and national infrastructure	• Contributed to critical subjects • Maintained a flow of updated generations • Decreased dependence on outside sources • Contributed to other projects
Overall success	• A combined measure for project success

Reviewing of the relevant literature suggests that different criteria were hypothesized by different researchers. Appendix A presents the various measures that were developed by previous researchers. Figure 4 presents a consolidated framework for measuring success of construction projects.

Figure 4. Consolidated Framework for Measuring Project Success



Key Performance Indicators (KPIs)

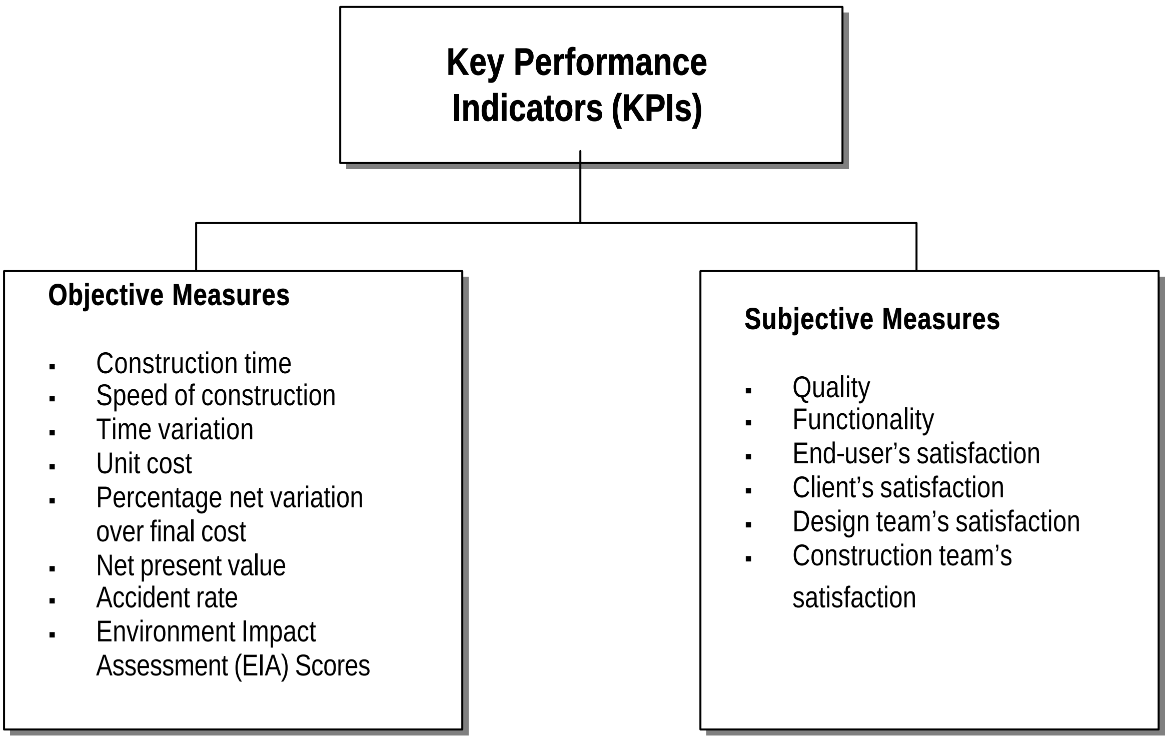
The purpose of the Key Performance Indicators (KPIs) is to enable measurement of project and organisational performance throughout the construction industry (KPI Working Group, 2000). Collin (2002) advocates that the process of developing KPIs involved the consideration of the following factors:

- *KPIs are general indicators of performance that focus on critical aspects of outputs or outcomes.*
- *Only a limited, manageable number of KPIs is maintainable for regular use. Having too many (and too complex) KPIs can be time and resource consuming.*
- *The systematic use of KPIs is essential as the value of KPIs is almost completely derived from their consistent use over a number of projects.*
- *Data collection must be made as simple as possible.*
- *A large sample size is required to reduce the impact project specific variables. Therefore KPIs should be designed to be used on every building project.*
- *For performance measurement to be effective, the measures or indicators must be accepted, understood and owned across the organisation.*

- *KPIs will need to evolve and it is likely that a set of KPIs will be subject to change and refinement.*
- *Graphic displays of KPIs need to be simple in design, easy to update and accessible.*

With these factors in mind, a range of KPIs to measure the performance of a construction project is developed, both objectively and subjectively. With reference made to Chan's (1996;1997) and Naoum's (1994) earlier research, each KPI will be discussed in detail and practical approaches to measure these KPIs will be introduced. The measures of the suggested KPIs are mainly divided into two groups. The first group is to use mathematical formula to measure the criteria quantitatively. Formula will be presented after the detail explanations of each KPI, such as time, cost, value, safety and environmental performance. The other group of criteria is based on subjective opinions and personal judgement. This group includes the satisfaction of clients, users and other key participants, the functionality of building and quality. A seven-point scale[2] scoring system is applied to measure these KPIs. Figure 5 provides a pictorial presentation of the KPIs.

Figure 5. Key Performance Indicators for Project Success



[2] *Seven point scale scoring system*

1	2	3	4	5	6	7
very dissatisfied	dissatisfied	slightly dissatisfied	neutral	slightly satisfied	satisfied	very satisfied

Time

Time is the duration for completing the project. It is scheduled to enable the building to be used by a date determined by the client's future plans (Hatush and Skitmore, 1997). Alarcon and Ashley (1996) raised 'effectiveness' as a success criterion. They defined effectiveness as a measure of how well the project was implemented or the degree to which targets of time and cost from the start-up phase to full production. Therefore, effectiveness will be measured under this category. From Naoum (1994) and Chan (1997), time can be measured in terms of construction time, speed of construction and time overrun.

Construction Time is the absolute time that is calculated as the number of days/weeks from start on site to practical completion of the project.
Construction time = Practical Completion Date – Project Commencement Date

Speed of Construction is the relative time, which is defined by gross floor area divided by the construction time.

$$\text{Speed of Construction} = \frac{\text{Gross Floor Area } (m^2)}{\text{Construction Time (days/weeks)}}$$

Time variation is measured by the percentage of increase or decrease in the estimated project in days/weeks, discounting the effect of Extension of Time (EOT) granted by the client.

$$\text{Time variation} = \frac{\text{Construction Time} - \text{Revised Contract Period}}{\text{Revised Contract Period}} \times 100\%$$

Where Revised Contract Period = Original Contract Period + EOT

Cost

Cost is another important measure. Cost is defined as the degree to which the general conditions promote the completion of a project within the estimated budget (Bubashait and Almohawis, 1994). Cost is not only confined to the tender sum only, it is the overall cost that a project incurs from inception to completion, so it includes any costs arise from variations, modification during construction period and the cost created by the legal claims, such as litigation and arbitration. The measure of cost can be in form of unit cost, percentage of net variation over final cost.

Unit cost is a measure of relative cost and is defined by the final contract sum divided by the gross floor area.

$$\text{Unit Cost} = \frac{\text{Final Contract Sum}}{\text{Gross Floor Area } (m^2)}$$

Percentage net variation over final cost (%NETVAR) is the ratio of net variations to final contract sum expressed in percentage term. It gives an indication of cost overrun or underrun. Yeong's (1994) approach in measuring this term is used:

$$\%NETVAR = \frac{\text{Net Value of Variations}}{\text{Final Contract Sum}} \times 100\%$$

Where Net Value of Variations = Final Contract Sum – Base
Base = Original Contract Sum + Final Rise and Fall – Contingency Allowance

Value and profit
Alarcon and Ashley (1996) defined the measure of value as evaluating the satisfaction of owner's needs in a global sense. It includes the realization for the owner of quantity produced, operational and maintenance costs, and flexibility. It might be considered as 'business benefit' derived from the completed project. Most projects are profit-oriented. The private clients, developers, as well as the public clients do not want to have a negative net profit after the construction. Therefore, value and profit is an important success criterion, especially in the handover stage. The most common measure of financial achievement is net present value (NPV).

$$NPV = \sum_{t=0}^{n} \frac{NCF_t}{(1+r)^t}$$

NPV is Net Present Value
NCF is Net Cash Flow
r is the rate of discount rate

Safety
Health and safety are defined as the degree to which the general conditions promote the completion of a project without major accidents of injuries (Bubshait and Almohawis, 1994). The issue of safety has been raised for a long time (Sanvido *et al.*, 1992; Parfitt & Sanvido, 1993 and Kometa *et al.*, 1995). Therefore, the importance of safety cannot be overlooked. The measurement of safety is mainly focused on the construction period as most accidents are happened during this stage. The methodology adopted by the Labour Department for calculating the annual accident rate on construction sites forms the base for calculating the accident rate in a specific project (Construction Industry Review Committee, 2001).

$$\text{Accident rate} = \frac{\text{Total no. of construction site accidents}}{\text{Total no. of workers employed on a specific project}} \times 1000$$

Environmental performance
Construction industry has been regarded as a major contributor to environmental impacts. Construction projects affect the environment in numerous ways across their life cycle (Shen *et al.,* 2000). For example, 14 million tonnages of waste have been put into landfill in Australia each year, 44 % of the waste is attributed to the construction/demolition industry (Songer and Molenaar, 1997). 62-86% domestic productions of non-metallic minerals, such as glass, cement, clay, and lime and so on in developing regions are for the construction industry (UNIDO, 1985). The Technical Committee (TC) was formed in January 1993 by the International Organization for Standardization (ISO) to develop a series of standards, which are known as ISO14000 series. It contains 21 standards and guidance documents on environmental management and provides a benchmark of a proper environmental management practice. Environmental issues are a global concern. The UN and some economics blocs such as the European Community and ASEAN have introduced environmental protection model laws or directives to member countries (Wong and Chan, 2000). Environmental Impact Assessment (EIA) Ordinance is now a widely accepted statutory framework for prediction and assessment of potentially adverse environmental impacts from development projects (Environmental Protection Department, 2000). The enforcement of EIA Ordinance provides a good measure for environmental

aspects. Therefore the EIA score can be used as an indicator to reflect the environmental performance of a given project.

Quality

Quality is another basic criterion that is heavily referred to by previous researchers. However, the assessment of quality is rather subjective. In the construction industry, quality is defined as the totality of features required by a product or services to satisfy a given need; fitness for purpose (Parfitt and Sanvido, 1993). Nowadays, quality is the guarantee of the products that convince the customers or the end-users to purchase or use. Specification is one of the criteria that were advocated by Songer *et al.* (1996) and Wateridge (1995). They defined it as the workmanship guidelines provided to contractors by clients or client's representative at the commencement of project execution. The measure of technical specification is to what extent the technical requirements specified can be achieved. Actually, technical specification is provided to ensure that buildings are built to good standard and by proper procedure. Freeman and Beale (1992) extended the definition of technical performance with scope and quality. So, meeting technical specification is grouped under the 'quality' category. The measurement of quality will be measured subjectively using the seven-point scale mentioned earlier.

Functionality

Kometa *et al.* (1995) opine that there would be no point in undertaking a project if it does not fulfil its intended function at the end of the day. The importance of functionality is highlighted. This indicator correlates with expectations of project participant and can best be measured by the degree of conformance to all technical performance specifications (Chan et al, 2002a). Quality, technical performance, and functionality are closely related and are considered important to the owner, designer, and contractor. A similar seven-point scale will be used to measure functionality.

User expectation and satisfaction

Users are those who actually work or live in the final products, they are the ones who spend most of time in the constructed facilities. Ensuring the completed projects to meet the users' expectation and satisfaction is essential. Liu and Walker (1998) consider satisfaction an attribute of success. Torbica and Stroh (2001) believe that if end-users are satisfied, the project can be considered successfully completed in the long run. This measure is placed in the second stage (maintenance period), as the users will normally be involved after the project is completed. Again a seven-point scale will be used to measure this criterion.

Participants' satisfaction

Participants' satisfaction has been promoted to be an important measure in the last decade (Sanvido *et al.*, 1992; Parfitt & Sanvido, 1993 and Cheung *et al.*, 2000). Key participants in a typical construction project include: client, design team leader and construction team leader. Their level of satisfaction can be taken as an indicator of project success and is measured by the seven-point scale discussed above.

Significance Of The Study

Success is always a debatable topic. In the construction industry, time, cost and quality have long been defined as the basic criteria of measuring success. However, different ideas have been emerged in the last decade. Therefore, a comprehensive review of Key Performance Indicators is essential.

Firstly, if one wants to have outstanding performance, one must know what is the definition of success in order to make correct measures to achieve this goal. Without a general agreement on success, project managers still manage their resources by their perceiving intuition. They cannot ensure whether the instrument is correct or not. The proposed framework can provide a clear and unambiguous definition for project performance. It can also enhance clients', contractors', as well as designers' understanding of running a successful project and set a base for them to improve the project performance. It is beneficial to project managers by providing helpful information that is necessary for the achievement of a successful construction project. Assessment of likely project outcomes can be ascertained during construction.

The current study also helps set a benchmark for measuring the performance of a project. It develops a general and comprehensive base for future research, especially in the determination of success factors. This report provides an overview of success measures that can be applicable either in a general construction project, or in a specified type of project, such as health-care or hotel projects.

Conclusion

Project success is a topic long-discussed in the construction management field over a period of time. The review of the eight leading journals on project success reveals that cost, time and quality are the three basic and most important performance indicators in construction projects. Other measures, such as safety, functionality and satisfaction, etc are attracting increasing attention. A consolidated framework that includes and re-groups all the identified performance indicators is developed in this report. A more systematic way of assessing project success is now made possible. It provides a benchmark for measuring project performance for future studies. It also furnishes project managers, clients and other project stakeholders useful information to implement a project successfully.

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Appendix A: Summary Table for project evaluation criteria by previous researchers

					Satisfaction													
	Authors	Cost	Time	Quality	Clients	Architect	Contractor	User	Project Manager/team members	Reduce modification changes	No legal claim	User expectation	Functionality	Meet technical specification	Commercial profitable	Safety	Effectiveness / Value	Environmental friendliness
Construction Management and Economics	Mohsini & Davidson (1992)	X	X	X														
	Walker (1995)	X	X	X														
	Hatush & Skitmore (1997)	X	X	X														
	Liu & Walker (1998)	X	X	X	X	X	X	X	X				X			X		X
	Cheung *et al.* (2000)	X	X	X	X	X	X		X									
Journal of Construction Engineering and Management	Jaselskis & Ashley (1991)	X	X															
	Sanvido *et al.* (1992)	X	X		X	X	X				X		X		X	X		
	Naoum (1994)	X	X		X													
	Pocock *et al.* (1996)	X	X								X				X			
	Alarcon & Ashley (1996)	X	X														X	
	Songer & Molenaar (1997)	X	X	X							X	X		X				
	Pocock *et al.* (1997)	X	X							X								
	Chua *et al.* (1999)	X	X	X														
Journal of Management in Engineering	Wuellner (1990)	X	X	X	X										X			
	Parfitt & Sanvido (1993)	X	X	X	X	X	X		X					X		X		
	Albanese (1994)	X	X	X												X		
	Kumaraswamy & Thorpe (1996)	X	X	X	X				X				X			X		X
	Pocock *et al.* (1997)	X	X					X		X	X				X			

Journal	Authors	Cost	Time	Quality	Satisfaction: Clients	Architect	Contractor	User	Project Manager/team members	Reduce modification changes	No legal claim	User expectation	Functionality	Meet technical specification	Commercial profitable	Safety	Effectiveness / Value	Environmental friendliness
Engineering, Construction and Architectural Management	Kometa *et al.* (1995	X	X	X									X		X	X		
	Liu (1999)	X	X	X	X		X							X				
	Dissanayaka & Kumaraswamy (1999)	X	X		X	X	X		X									
Journal of Construction Procurement	Walker (1996)	X	X	X														
	Songer *et al.* (1996	X	X									X		X				
International Journal of Project Management	Gray *et al.* (1990)	X	X	X														
	Munns (1995)	X	X	X	X													
	Wateridge (1995)	X	X	X	X	X	X	X	X			X	X	X	X			
	Munns & Bjeirmi (1996)	X	X	X														
	Belassi & Tukel (1996)	X	X	X														
	Belout (1998)	X	X	X	X			X	X						X		X	
	Jang & Lee (1998)	X	X		X													
	Atkinson (1999)	X	X	X	X	X	X	X	X							X		
	Lim & Mohamed (1999)	X	X	X	X	X	X	X	X							X		
	Brown & Adams (2000)	X	X	X														
	Gardiner & Stewart (2000)	X*	X*	X														

Note: X* refer to the best achievable NPV

	Authors	Cost	Time	Quality	Satisfaction: Clients	Satisfaction: Architect	Satisfaction: Contractor	Satisfaction: User	Satisfaction: Project Manager/team members	Reduce modification changes	No legal claim	User expectation	Functionality	Meet technical specification	Commercial profitable	Safety	Effectiveness / Value
Project Management Journal																	
	Navarre & Schaan (1990)	X	X	X													
	Pinto & Pinto (1991)	X	X		X	X	X		X								
	Beale & Freeman (1991)	X	X											X			
	Freeman & Beale (1992)	X	X											X			
	Paek (1995)	X	X	X													
	Tan (1996)	X	X	X	X	X	X	X	X								
	Shenhar *et al.* (1997)	X	X	X	X			X						X			X
	Chang & Ibbs (1998)	X	X	X	X							X					X
	Hayes (2000)	X	X	X									X		X		
	Sadeh *et al.* (2000)	X	X	X	X								X				