 ISBN: 9789052693958

USING 'WHOLE LIFE CYCLE VALUE' TO EVALUATE INFRASTRUCTURE MEGAPROJECTS

BRENDA HONGBO XIE
Department of Civil Engineering, The University of Hong Kong
Hong Kong
H0995075@hku.hk

MOHAN M KUMARASWAMY
Department of Civil Engineering, The University of Hong Kong
Hong Kong
mohan@hkucc.hku.hk

JACKY K.H. CHUNG
Department of Civil Engineering, The University of Hong Kong
Hong Kong
jackychung@hku.hk

Abstract

Project evaluation is an effective tool in project management as it provides stakeholders with a management process through which they can learn from the past and perform better in the future. Although various project monitoring and evaluation methods have been used in the construction industry, most of these traditional evaluation approaches emphasize the three basic success criteria of time, budget and quality. However, recent research emphasizes the importance of 'satisfyting' key stakeholders. It is therefore necessary to develop a more holistic evaluation tool to evaluate projects from perspectives of all key stakeholders. However, it appears that no systematic project evaluation approach focusing on project stakeholder perspectives, has been developed.

This paper aims to develop a systematic evaluation model, based on the concept of whole life cycle value (WLCV), which integrates all the key stakeholders' value objectives and can be used to evaluate an infrastructure megaproject more holistically and comprehensively.

Projects aim to deliver value, including cost savings for client, desired functions for all end-users and other stakeholders over the whole life. It is therefore important to be able to identify, analyze and deal with the expectations of each group of stakeholders over the entire project life time, i.e. from client requirements formulation stage to demolition / re-use stage. In order to measure WLCV, we must identify its essential components, namely: significant criteria for measuring project WLCV, as well as related indicators which will help evaluate specific dimensions of the parent criteria. To be holistic as intended, both criteria and indicators should together reflect the value objectvies of all stakeholders including the client.

Based on a comprehensive literature review in evaluation and value studies, several semi-structured interviews with experts in academia and industry, and findings from the first stage of a relevant case study, this paper proposes a preliminary WLCV model for infrastructure megaprojects. A preliminary WLCV framework will be formulated in the next stage of this research, based on the findings of a planned questionnaire survey. This paper concludes with a discussion of some of the major difficulties in identifying, balancing and formulating WLCV criteria and some useful directions and opportunities for further research in this field.

Keywords: project evaluation, whole life cycle value, stakeholders

INTRODUCTION

A megaproject is described as a remarkably complex, large-scale project that has considerable influence on the economy, society and environment. The contract sum of a megaproject is usually very large, normally exceeding $ 1 billion in Hong Kong (Works Bureau, 2002).

In the past decades, while many countries planned and undertook more and bigger infrastructure megaprojects, many shortfalls have emerged in their delivery, such as poor performance in term of cost overruns, schedule delays, and shortfalls in expected benefits. This has been the case for many years and existing data show no immediate end to this situation. This megaproject paradox and shortfall was demonstrated in a seminal book (Flyvbjerg et al., 2003).

However, the rapid economic growth and the growing public expectations from public projects reveal the emerging concept that better value is more importance than the lowest cost. Saxon (2005), ASCE (2007), Levitt (2007) advocated that the construction industry should compete on the foundation of 'added value' rather than only on cost efficiency.

Due to the strong economical and social impact of infrastructure megaprojects, it is suggested that their performance should be measured from a broader aspect – value instead of a cost perspective only. Based on this assumption, this paper presents the preliminary findings of an on-going research project titled 'Integrated whole life cycle value framework for infrastructure megaprojects' which focuses on evaluation & monitoring project whole life cycle value (WLCV). The paper delves into the current infrastructure project evaluation situation in Hong Kong and brings out the need of a WLCV evaluation approach. The development of this WLCV model integrates all the key stakeholders' expectations into the client value system. This provides all the stakeholders a sense of 'fairness' and 'ownership' which encourages them to co-operate with common value objectives.

THE NATURE OF PROJECT EVALUATION

Project evaluation is an effective tool in project management which requires appropriate measurement of performance levels. It is a systematic analytical method, which is conducted aperiodically to measure and explain project performance issues (Samset, 2003). Figure 1 is derived from a relevant research conducted by Samset (2003) who presented three levels of evaluation.

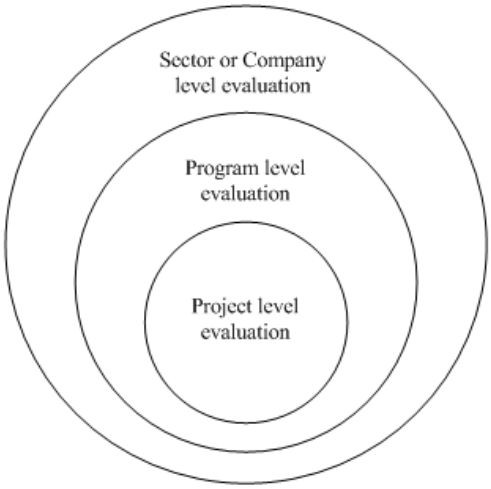

Figure 1: *Three levels of project evaluation (Samset, 2003)*

The single project evaluation can be divided into three stages – ex-ante evaluation, interim evaluation and ex-post evaluation. Nowadays, for single project, the emphasis of evaluation are put on the ex-post and interim stages and limited to the cost and quality dimensions.

It is critical to evaluate a project before commencement, as this can help determine whether the right decision is made at the start. It does not matter whether you implement a project extremely well or extremely poorly, if you are working on the wrong project.

It is also importance to involve all the relevant stakeholders from the start. As stated by Samset (2003) there will be several key stakeholders whose interests need to be considered in the process of any evaluation. In order to satisfy their needs, their preferences and attitudes should be ascertained carefully. Moreover, the earlier stakeholders are involved in the project, the better it is for effective and efficient project delivery.

In order to resolve the issues in infrastructure megaprojects, the evaluation emphasis should be on value. Also the evaluation stages should be more comprehensive. These aspirations need to be recognized in future megaproject formulation and implementation. Although, the requirement of evaluating project value during a project whole life cycle has been recognized, few studies have been conducted in this area.

THE PRACTICE OF PROJECT EVALUATION IN HONG KONG

The project evaluation & monitoring of local industry has its own uniqueness and requirements. In order to understand the current evaluation situation and identify whether it is necessary to develop a value evaluation approach, a good start would be by conducting interviews with relevant experts from both public and private sectors.

From early June, 2010 to early January, 2011, 11 semi-structured interviews were conducted with interviewees from academia, Architectural Services Department (ASD), MTR Corporation Limited (MTRC), EC Harris, AECOM and Hong Kong International Airport. Through these interviews, general opinions on the current practices of project evaluation were obtained from major clients in the local construction industry.

Based on the interviews conducted with the experts, it was observed that there has been no systematic project evaluation based on project value throughout the infrastructure projects in ether public or private sectors. Although, many major Hong Kong project clients including the ASD and the MTRC have introduced the whole life cycle concept into their evaluation, their evaluation still mainly based on the LCC not WLCV. However, the consensus now is that value is more important than only cost.

The majority of interviewees believe that a framework to guide the project WLCV evaluation process is needed to improve the overall project whole life performance, provided that it is comprehensive enough to be applicable to different types of projects, offers a sufficient degree of flexibility in different situations and will be easy to use in practice.

Another finding was that obtaining the stakeholders point of views are critical, for which stakeholder engagement is already conducted in ASD, MTRC and the Hong Kong International Airport.

THE USE OF PROJECT WHOLE LIFE CYCLE VALUE IN PROJECT EVALUATION

A review of common tools in project evaluation

Life Cycle Cost

The project life cycle cost (LCC) concept, which emerged since the 1960s, is an economic assessment indicator based on the relevant significant cost of ownership during the economic life of an item, area, system, or facility, expressed in terms of equivalent dollars (Dell`Isola 1982).

Although the LCC approach purports to include non-economic costs including those related to safety, environment, customer satisfaction etc, these factors are often only used to temper the result rather than incorporate in the final calculation. The fundamental consideration in LCC is cost which is so dominant, that it can lead to omitting, if not neglecting, these non-economic factors. Therefore, it is often likely that 'cost' is the only consideration in the process of comparing alternatives. Furthermore, emphasis on lowest cost may lead to some significant problems. The lower cost may be obtained by mean of compromising project quality or environment. Nowadays with the increasing emphasis on sustainability both at project construction, operation and maintenance stages, these non-economic factor become more and more critical. Furthermore, LCC approach is usually based on the client point of view without considering 'costs' of other stakeholders such as all end-users, contractors, suppliers etc, who also play an important role in the project.

Key Performance Indicators

Many previous performance measurement criteria such as Key Performance Indicators (KPIs), involve identifying all the critical indicators and providing a suitable guideline on how to measure them to evaluate project and organizational performance throughout the construction industry. For example, seven main groups including: time, cost, quality, client satisfaction, client changes, business performance and health and safety were recommended in the KPI report for the minister for construction in UK (The KPI working group, 2000). The

information obtained from the aforementioned set of KPI is used for benchmarking and helps organizations to achieve best practices. Lueng and Edum-Fotwe (2005) stated that critical performance indicators can and should be applicable to evaluate projects. However, there are limitations in applying this approach to existing project management practices. For example:

- Limitation 1: It has been noted that there should be connections amongst the indicators. The current KPIs system are used to evaluate projects typically by providing parallel comparison existing factors of time, cost, quality and client satisfaction etc (Lueng and Edum-Fotwe, 2005). Kumaraswamy and Thorpe (1996) stated that the interactions between indicators can be expressed through linkage factors / indicators. However, in most KPIs systems this kind of relationship is not presented appropriately.

- Limitation 2: The approach of the KPIs is by and large based on evaluation by client, contractor, designer and other organizations which have contractual / legal relationships with the project. Considerations of the other stakeholders such as the end-users, green groups etc are not included. According to Ward and Chapman (2008), most projects especially infrastructure megaprojects have a large number of stakeholders who contribute important components of uncertainty that can have a greater or lesser extent of impact on the project delivery process. So their opinions should be addressed appropriately. Furthermore a system value can only be measured from the stakeholders' point of views, as the purpose of the system is to provide service to them.

- Limitation 3: Inadequate contribution to the value objectives as described in the previous sections from all the stakeholders, albeit to differing extents and priorities.

Introduction to Whole Life Cycle Value

Historical development

Over the last several decades, a number of studies have focused on value such as that of Burt (1975), who stated that value includes two dimensions that are quality and cost in the construction field; Best and De Valance (1999) pointed to quality, cost and time. These previous studies mostly focus on value in a narrow sense. However, presently with the increasing injection of sustainable development criteria and concerns in construction industry planning and operations, industry and project stakeholders are widening their interpretation of value and reconsidering and redefining value by adding other factors, such as those related to the environment and society (Thomson et al. 2003a and 2003b, Abidin and Pasquire 2007). Furthermore, the value outcomes could be influenced by many factors during the project whole life cycle and the interactions between the various factors may lead to inefficiencies and ineffectiveness in the processes of delivering projects. It is thereby concluded to be necessary to research value in a broader sense that is Whole Life Cycle Value (WLCV).

In previous studies on WLCV, different researchers have chosen different definitions. Browning and Honour (2008) stated that "Whole life value is the system's attribution (which includes benefits and sacrifices)." This definition was developed in the context of system engineering and not in infrastructure megaprojects. Kerzner and Saladis (2009) developed anther definition: "The value of a product or service within the context of project management refers to the relationship between the customer's expectations of product quality and product usefulness, short and long term, to the actual amount paid for it." This definition focuses on the customers' points of view. Kelly (2009) suggested that "Whole life value is the benefit

given less the sacrifices required, related to the renewable and non-renewable resources used in the construction or manufacture and maintenance stages over a number of time periods in a given length of time, less the residual value at the end of the project."

Proposed WLCV concept

However, all above definitions were developed in special context for the purpose of those particular studies. None of them can fulfill the current needs as identified in this research. Through combining the previous definitions and injecting the findings from the current study, the following definition was developed: the project value is the sum total of the expectations (expectations here meaning: what they want to obtain from the given project and what they are ready to give up in return, including positive perspectives-benefits and negative perspectives-sacrifices) of different stakeholders for a given project. Project WLCV is the aggregated expectations of all the stakeholders for a given project over its life cycle. The client's expectations form the primary / high priority part and the other stakeholders' expectations contribute to the secondary / lower priority part. This definition is conceptualized in Figure 2.

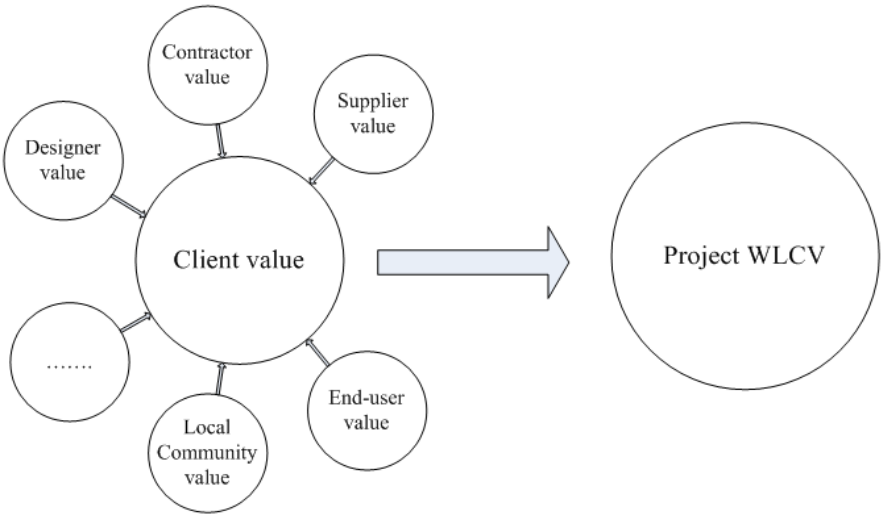

Figure 2: *The concept of project WLCV*

Characteristics of the proposed WLCV concept

The proposed WLCV concept is framed from three perspectives: multi-stakeholders, multi-stages and the dynamic nature of value. These perspectives are described as follows:

Multi-stages

In the context of the construction industry, there are many interpretations concerning the taxonomy of a project whole life cycle. For example, John et al. (2003) classified five stages: typically these are client requirements and briefing, design, installation, operations and maintenance, and disposal / reusing / recycling phases; Evans et al. (1998) divided the life cycle into three stages: design and construction, operational period, and demolition/recycling; Bennett (2003) stated that project whole life includes pre-project phase, planning and design phase, contractor selection phase, project mobilization phase, project operation phase, project closeout and termination phase.

In the current research, the project whole life cycle refers to client requirements stage i.e. formulation & briefing; design & construction stage; operation stage; demolition / re-use stage.

Multi-stakeholders

Many researchers presented different definitions of stakeholders. From the perspective of Freeman (1984) stakeholders are any groups or individuals who can affect or be affected by achievement of a corporation's purpose. Phillips (2003) presented two definitions: (1) "Those who have any input in decision making" and (2) "Those who benefit from the outcomes of a decision". Newcombe (2003) stated that stakeholders are groups or individuals who have a stake in, or expectations of a project's performance. According to Donaldson and Preston (1995) stakeholders are those who experience or anticipate experiencing potential benefits or dis-benefits as a result of the organization's actions. Despite the many definitions, most are within the context of an organization, with few focusing on project stakeholders.

In this paper, project stakeholders refer to groups or individuals who have special expectations from and vested interests in a given project; and can positively or negatively influence or be influenced by project performance. Chung (2010) developed a figure shown in Figure 3 which can assist to identify stakeholders in the current research.

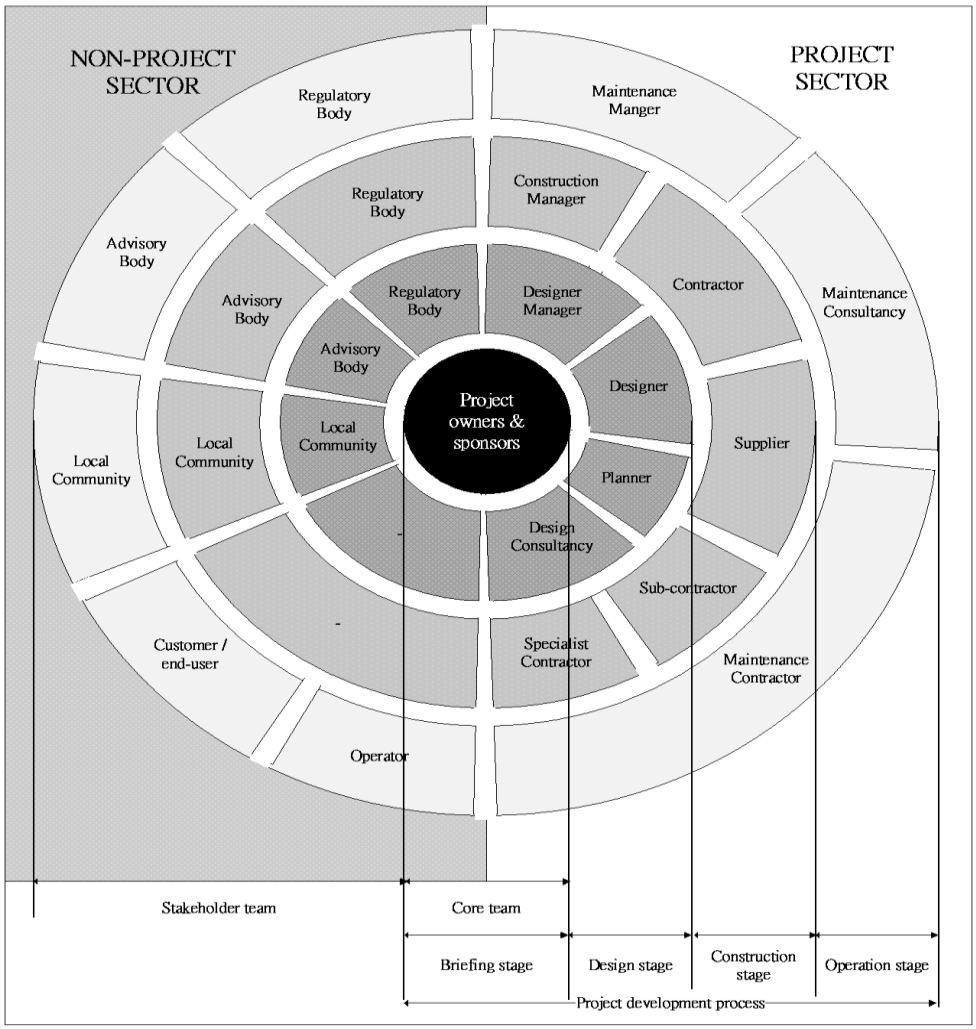

Figure 3: *Project stakeholders (Chung, 2010)*

The traditional view of the client as a single entity, who should make most of the important decisions about a given project has already obsolesced. The clients' views can not reflect the reality expectations of the other stakeholders. The importance of other stakeholders is widely recognized, as they can have positive or negative influence on the project performance. Newcombe (2003) applied an innovative technique to conduct stakeholder mapping in the context of a large construction project, demonstrating the importance for project managers to analyze the power, predictability and interest of key project stakeholders.

Despite many studies conducted about stakeholder management, scant attention has been received to joint stakeholder management for enhanced project value, leave along project WLCV. It is critical to consider stakeholders expectations from the project whole life cycle perspective, as the life cycle thinking applied during the decision making can provide a holistic view about the project to the key stakeholders (Thabrew et. al 2009).

The concept of combined multi-stakeholders and multi-stages is shown in Figure 4.

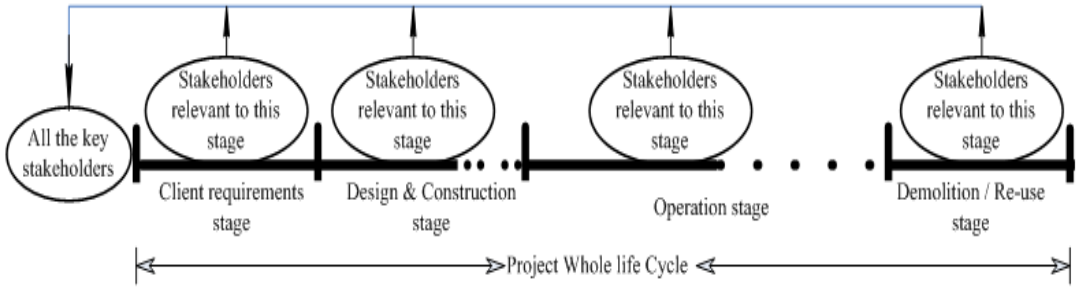

Figure 4: *The Concept of Multi-stakeholders and Multi-stages*

The dynamic nature of value

Kerzner and Saladis (2009) argued that sometimes project value can also change over time, but a project manager may not appreciate these emerging and dynamic needs. They also stated that factors, such as market-demanded changes, changing constraints and assumptions and technology advances were either not available or resources lacked the necessary skills etc, can lead to appropriate value expectations not being established, and hence trigger value shortfalls in the delivered project. So it is necessary to evaluate a project over time to detect if there are any changes that will influence the project value, and then take the necessary 'compensatory' actions, e.g. to change the plan or even abort the project.

Based on previous discussions, the conclusion is that it is necessary to apply the WLCV concept to evaluate the project over the whole life time. WLCV is a more holistic approach, which considers cost, quality, time and all other relevant performance factors and treats them impartially, compared with the LCC. The WLCV approach can make up for some of the disadvantages of LCC. Hence, it is possible and reasonable to introduce WLCV considerations to the process of evaluation & monitoring infrastructure megaprojects.

Feedback from industry professionals and a mini case study

Other findings from aforementioned 11 interviews with industry experts in the previous section are presented as follows:

It is very difficult to measure some qualitative factors, such as environmental protection and influence on regional economies etc.

It is also clear that we could face great difficulties in introducing a single set of value evaluation criteria for various types of infrastructure megaprojects, as each project is unique, so developing a project-specific WLCV criteria system is necessary. A more flexible model is required for project teams to formulate the most suitable evaluation system according to the specific nature of various projects. However, the new project value evaluation model should serve another objective, i.e. to provide a mechanism for the industry to benchmark project WLCV. Therefore, we should try to balance the two requirements in developing the new project value evaluation model.

After identifying the need for developing a WLCV evaluation system during the interview sections, the next step was to verify the possibility and benefits to conducting stakeholder engagement over the whole life of a project.

An on-going mini case study is being conducted in Hong Kong since October 2010. Data collection methods of the case study involve study of project documentation, interviews and observation of project meetings. This mini case study focused on the public engagement during this research stage. The project was to deck the existing Nullah and to construct an urban park on the decked Nullah. It would also expand the adjoin Road Roundabout. The project construction was commenced at the end of December 2009 and the decking work has been completed.

The preliminary findings from this case study prove that it is helpful to conduct stakeholder engagement at the beginning of the project. The public engagement in this project includes distributing leaflet to the community, liaising with Police, and DC member etc. After obtaining their viewpoints, the managers devised several strategies such as installation of Trash Net, guiding pedestrians and installing a sedimentation tank.

The key observation in terms of inefficiencies in value creation and value capture for the stakeholders in this case study are: (1) there are many different kinds of views from public and it is very difficult to get a consensus and satisfy everyone; (2) some factors can not be quantified so it is difficult to incorporate them into the decision making process, as well as to measure them.

On the positive side, the early informing of the community and relevant government departments helped the client to proceed the project with fewer complain and more co-operation. As the stakeholders had already expressed their opinions and learnt about the project progress, they felt a kind of ‘fairplay’ and ‘ownership’ which were incentives for them to support, or at least not oppose the project. The efficient management of the approval process for stakeholder engagement assisted in managing the issues and stopping them from flaring up into disputes.

THE PROPOSED WLCV BASED PROJECT VALUATION MODEL

Conceptual design of the model

The basic concept of this model will be illustrated in this section. This model can help the client to consider all the stakeholders' expectations for a given project.

Elements

An appropriate optimization mechanism will be chosen and used, along with statistical analysis to improve the WLCV model. Some information collecting methods are borrowed from a relevant research project completed in Loughborough University (IMCRC, 2005). The proposed model covers three stages: information stage, evaluation stage and re-analysis stage. The function of each stage and the database are presented in Table 1. Within the information stage, four kinds of data will be collected including: all the stakeholders of a given project; all the stakeholders' value objectives; weights of different groups of stakeholder; and weights of the value objectives.

Table 1: *Elements of the WLCV model*

Item	Function
Database	Providing generic data and benchmarks for comparison
Information stage	Collecting the four kinds of data for evaluation
Evaluation stage	Assessing whether the project WLCV within a reasonable range
Re-analysis stage	Re-analyzing the four kinds of data to identify the reason why the project WLCV can not live up to the client's expectations and what can be done to improve it.

Structure

The structure of the WLCV model is presented in Figure 5.

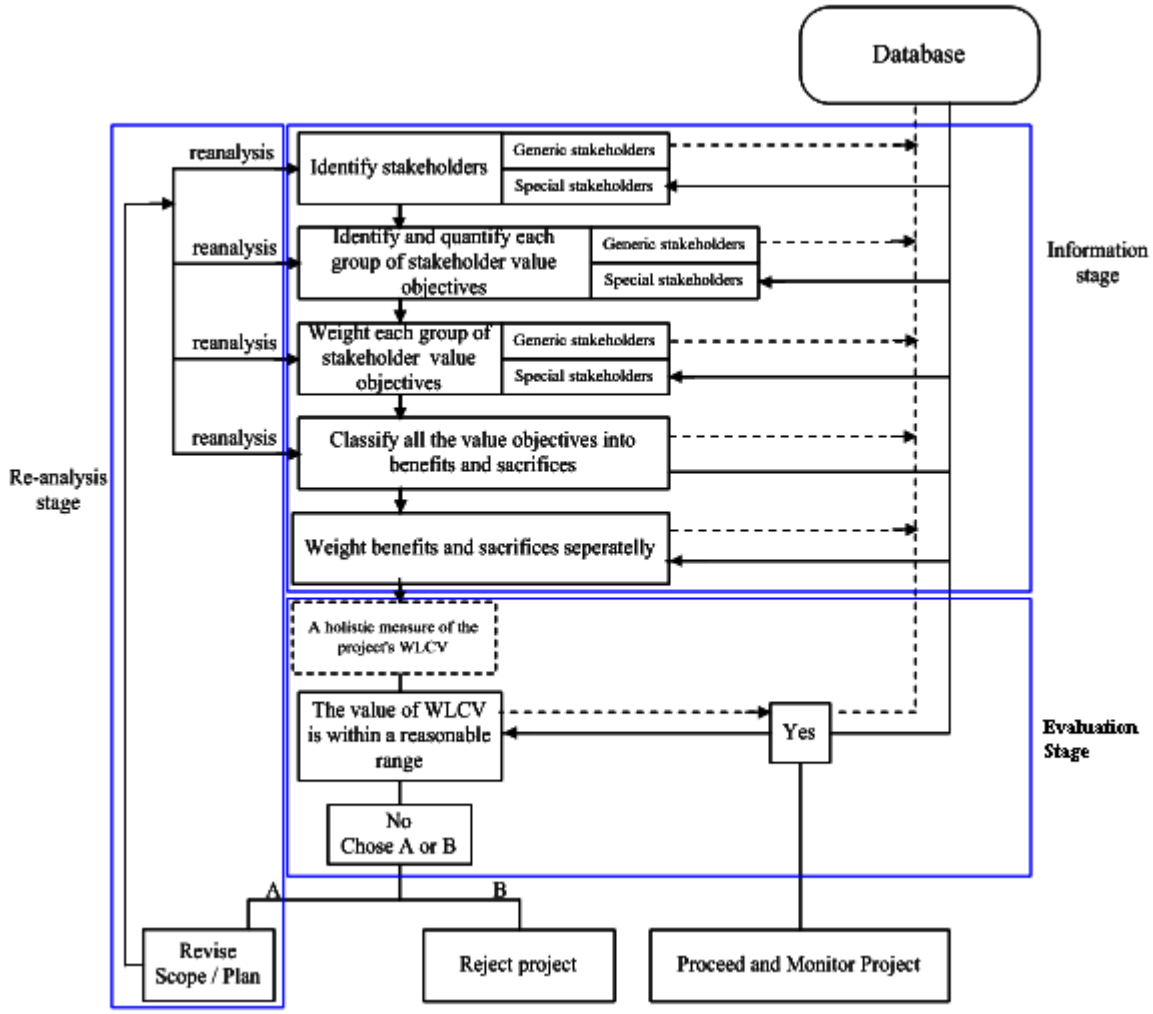

Figure 5: *Structure of the WLCV model*

These stakeholders will be divided into two kinds — project sector stakeholders who have contractual/legal relationships with the client and non-project sector stakeholders who do not have contractual/legal relationships with the client as shown in Figure 3. In operationalising the model, all the stakeholders will be identified during the whole life cycle of a project employing the aforementioned method. Next various value based decision making concepts such as lean approach, fuzzy theory etc will be evaluated for applicability and an appropriate method will be chosen. Furthermore, some experiences will be draw on from previous research work such as on 'network value' (Kumaraswamy et. al., 2009), stakeholder management (CICID, 2007), project briefing (Chung et. al., 2009) etc and with a supplemental literature review to incorporate into the value dimensions and design of the evaluation criteria system.

Criteria system

As project value is too abstract to measure as one item, a multiple level criteria system is proposed. The strategy behind this approach is to divide project value into several sections which are much easier to evaluate & monitor. The concept proposed is as shown in Figure 6. The six levels are Project WLCV, Value Objectives (VO), Value Criteria (VC), Primary Indicators (PI), Secondary Indicators (SI), and Tertiary Indicators (TI).

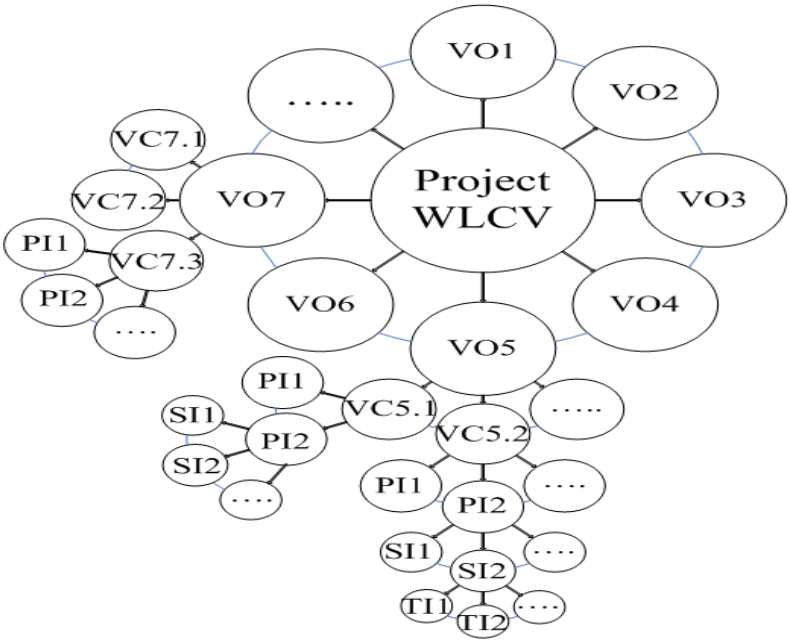

Figure 6: *Project WLCV Criteria System*

These value objectives can be divided into three categories which are the economic value objectives, the social value objectives and the environmental value objectives. This categorized approach integrates the sustainability concept into the WLCV. Also, the value objectives within each category include quantitative and qualitative types. It is much easier to quantify the former type. However, for qualitative value objectives, we can usually only obtain linguistic descriptions. Appropriate approaches (such as from fuzzy theory) will be identified to translate these descriptions into quantitative data.

The linkage factors/indicator will be introduced into this model after certain understandings of the factors interactions obtained. Thus the relationships among all the criteria and indicators can be expressed more realistically. The overall measure of the project value performance can then be more credible.

Limitations of the model

The preliminary model presented here is derived from the initial background work for a research project on 'Integrated whole life cycle value framework for infrastructure megaprojects'. This model is thus still short of a fully researched, well structured and tested framework. It needs to be developed and adjusted with further practical data inputs and validation. Moreover, a well populated database is needed to be formulated to support this model and the formulation of a detailed guideline is indispensible. Many of these limitations will be addressed as the research project progresses as described below. However, some of them will remain beyond the scope of this research.

ROADMAP FOR FUTURE RESEARCH

An in-depth investigation on evaluating project value will soon be launched with an aim to unveil and incorporate other 'value' factors to be considered into the detailed guidelines while evaluating & monitoring project WLCV, as well as unearth barriers to maximize project

WLCV with specific reference to Hong Kong. This will be approached through questionnaires and in-depth case studies. Further, strategies to overcome these barriers will be derived from best practices elsewhere and from experts' inputs. The model will be refined to reflect these limitations and accommodate the developed strategies; and will be validated by means of focus group meetings at appropriate research stages.

The findings of this particular research together with the findings for a framework of infrastructure project evaluation & monitoring, which forms the other part of this research will be the final output of the 'Integrated whole life cycle value framework for infrastructure megaprojects' research project.

CONCLUSION

The research introduces an innovative idea of using a project WLCV to evaluate projects over their whole lifetime, while addressing the conflicting value objectives among stakeholders. The final purpose is to evaluate & monitor project WLCV realistically.

The model is based on the premise that the value of a megaproject is impacted by the relative importance attributed to different dimensions by all stakeholders rather than only some stakeholders such as client, contractor etc. This model can assist the client to consider the involvement of various types of stakeholders (multi-dimension), such as all end-users, neighbors, suppliers and contractors, and different levels of stakeholders (multi-level), such as senior project manager and frontline staff. Moreover, involving stakeholders as early as possible, which can keeping potential problems from pushing stakeholders into adversarial posturing and consequential disputes, helps clients to achieve better project value.

Monitoring WLCV will also contribute to reduction of waste and environmental friendliness during the construction, operation, and reuse / demolition stages. In this regard, the need for an evaluation model of project WLCV has been proposed, especially for infrastructure megaprojects which have critical influence on the economy, society and environment. Also, this approach is seen to be capable of dovetailing well into current sceneries in the Hong Kong construction industry and in the long run will help improve infrastructure megaproject WLCV management.

The proposed evaluation system is expected to provide a sound approach to measure infrastructure megaproject WLCV in the context of Hong Kong, but can be modified and applied generally to other countries. However, the key is how to measure qualitative value objectives as well. How well the connections between the criteria / indicators can be defined and modeled will also pose a major challenge.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the CIDCA project HKU713209E and the co-operation of the interviewees who contributed to the study as well as for the kind assistance received from the personnel of the project during the case study data collection phase.

REFERENCES

Abidin, N.Z. and Pasquire, C. L., 2007, *Revolutionize value management: A mode towards sustainability*, International Journal of Project Management, 25, 275-282.

ASCE, 2007, *The vision for civil engineering in 2025*, American Society of Civil Engineers, Reston, USA.

Bennett, L.F., 2003, *The management of construction-a project life cycle approach*, Butterworth Heinemann, Burlington MA.

Best, R. and De Valence, G. (eds.), 1999, *Building in value: pre-design issues*, Arnold, London.

Browning, T.R. and Honour, E. C., 2008, *Measuring the life-cycle value of enduring systems*, Systems Engineering, 11(3), 187-202.

Burt, M.E., 1975, *A Survey of Quality and Value in Building*, Building Research Establishment, UK.

Chung, J.K.H., 2010, *Development of A Collaborative Briefing Approach for Infrastructure Projects in Hong Kong*, Ph.D. Thesis, The University of Hong Kong, Hong Kong.

Chung, J.K.H., Kumaraswamy, M.M. and Palaneeswaran, E., 2009, *Improving Megaproject Briefing through enhanced Collaboration with ICT*, Automation in Construction, Elsevier, 18, 966-974.

CICID, 2007, *Workshop Summary, 'Enhancing performance & overall value through Relationally Integrated Value Networks (RIVANS)'* [Online], Centre for Infrastructure and Construction Industry Development, Hong Kong. http://www.hku.hk/cicid/s_events.htm, [Accessed 5, January, 2011].

Dell'Isola, A.J., 1982, *Value engineering in the construction industry*, Van Nostrand Reinhold Company Inc., New York.

Donaldson, T. and Preston, L., 1995, *The stakeholder theory of the corporation: concepts, evidence, and implications*, Academy of Management Review, 20(1), 65-91.

Evans, R., Haryott, N., Haste, N. and Jones, A., 1998, *The Long-Term Costs of Owning and Using Buildings*, The Royal Academy of Engineering, London.

Flyvbjerg, B., Bruzelius, N. and Rothengatter, W., 2003, *Megaproject and Risk: An anatomy of ambition*, Cambridge University Press, Cambridge, UK.

Freeman, R.E., 1984, *Strategic management: a stakeholder approach*, Pitman Publishing Inc, Marshfield, MA.

IMCRC, 2005, *Value in Design (VALiD) project* [Online], Innovative Manufacturing and Construction Research Centre, Loughborough University: Publications, 2008,

http://www.valueindesign.com/downloads/VALiD_Implementation_Strategy.pdf [Accessed 20, July, 2010].

John, G., Loy, H., Clements-croome, D., Fairey, V. and Neale, K., 2003, *Through life support for building services systems,* Worldwide CIBSE/ASHRAE Gathering of the Building Services Industry, Florence.

Kelly, J.R., 2009, *A sustainable whole life cycle value agenda*, The value management, Hong Kong Institute of Value Management, 15(2), 2-7.

Kerzner, H. and Saladis, F.P., 2009, *Value-Driven Project Management*, John Wiley & Sons, Inc., Hoboken, New Jersey.

Kumaraswamy, M.M., Anvuur, A.M. and Smyth, H.J., 2009, *Super-charging supply chains - through 'Relational Integration' for 'Overall Value'*, Changing Roles: New Roles New Challenges, Rotterdam, The Netherlands, 397-408.

Kumaraswamy, M. M. and Thorpe, A., 1996, *Construction Project Evaluation Using Appropriate Indicators*, Advances in engineering software, 25, 197-206.

Levitt, R.E., 2007, *CEM research for the next 50 years: maximizing economic, environmental, and social value of the built environment*, Journal of Construction Engineering and Management, 133(9), 619-628.

Lueng, T. S. and Edum-Fotwe, F. T., 2005, *A survey of the use of KPI to augment current evaluation criteria of projects,* Third International Conference on Construction in the 21st century, Athens, 446-453.

Newcombe, R., 2003, *From Client to Project Stakeholders: a stakeholder mapping approach*, Construction Management and Economics, 21, 841-848.

Phillips, R., 2003, *Stakeholder theory and organizational ethics*, Berrett-Koehler Publishers Inc., San Francisco, CA.

Samset, K., 2003, *Project Evaluation - Making investments succeed*, Tapir Academic Press, Trondheim, Norway.

Saxon, R., 2005, *Be valuable: A guide to value in the building environment*, Construction excellence, London.

Thabrew, L., Wiek, A. and Ries, R., 2009, *Environmental decision making in multi-stakeholder contexts: applicability of life cycle thinking in development planning and implementation*, Journal of Cleaner Production, 17, 67-76.

The KPI Working Group, 2000, *KPI report for the minister for construction*, Department of the Environment, Transport and the Regions, London.

Thomson, D.S., Austin, S.A., Devine-Wright, H. and Mills, G.R., 2003a, *Managing value and quality in design*, Build Res Inform, 31(5), 334-345.

Thomson, D.S., Austin, S.A., Mills, G.R. and Devine-Wright, H., 2003b, *Addressing the subjective view of value delivery*, Proc Cobra' 03 Conference, Telford, UK, 197-213.

Ward, S. and Chapman, C., 2008, *Stakeholders and Uncertainty Management in Projects*, Construction Management and Economics, 26, 563-577.

Works Bureau, 2002, *Technical Circular*, The Government of the Hong Kong Special Administration Region, Hong Kong.