PERFORMANCE EVALUATION MECHANISM FOR ENGINEERING CONSULTANTS– CASES STUDY ON TAIPEI RAPID TRANSIT SYSTEMS

Chien-Hui Sun[1]* and Nie-Jia Yau[2]

[1] *Ph.D. Student, Graduate Institute of Construction Engineering and Management, National Central University, Taiwan*
[2] *Professor, Graduate Institute of Construction Engineering and Management, National Central University, Taiwan*
**Corresponding author (983405003@cc.ncu.edu.tw)*

ABSTRACT: Engineering consultation is a knowledge intensive industry. It operates by providing design-related technical services. Although design cost is relatively far less than construction cost, the decisions made in the design phase have a significant impact on the project, especially for large public construction projects. Therefore, this research focuses on establishing a performance evaluation mechanism for the consulting firms that execute detailed design for the Taipei Rapid Transit Systems (TRTS). This research first established a set of indicators through literatures and expert interview. Then, those indicators were incorporated into the four aspects of balanced scorecard (BSC) to create the structure of performance evaluation. The weight of each indicator was calculated by analytic hierarchy process (AHP). Lastly, the performance of two TRTS design firms was evaluated using the developed model. Correspondence was found between the evaluation results and the actual performance of the sampled consulting firms. This shows the accuracy of the evaluation method and presents, objectively and explicitly, the performance of the consulting firms. The established mechanism of performance evaluation will be further extended for construction phase in the future.

***Keywords**: Performance Evaluation, Engineering Consultant, Taipei Rapid Transit Systems*

1. INTRODUCTION

Under the current economic circumstances where the fuel prices are sky-rocketing, the saturation of traffic flows within cities has become phenomenal. Fortunately, this was alleviated by the Taipei Rapid Transit Systems (TRTS) in the Greater Taipei Metropolitan Area. TRTS offers millions of daily commuters who live in the greater Taipei metropolitan area a means of safe, economic, comfortable, and convenient way to commute. Thus, it is crucial that construction of such system meet all its expectations throughout its construction lifespan starting from the initial designing stage. It is also vital to conduct performance evaluation right from the designing stage where early amendments can be made to avoid unnecessary changes derived from the construction stage.

2. LITERATURE REVIEW

This research collected related performance evaluation systems of domestic public engineering organizations in Taiwan（Taipei City Government [1], Construction and Planning Agency under the Ministry of the Interior [2], Taiwan Area National Expressway Engineering Bureau under the Ministry of Transportation Communication [3]）and literature of overseas performance evaluations [4, 5, 6, 7,8] for comparison. Finally, forty performance indicators of aforesaid perspectives were noted.

3. ESTABLISHING THE DESIGN PERFORMANCE EVALUATION MECHANISM

After sorting the forty preliminary established performance evaluation indicators for the consulting firms, one supervisor and two senior engineers responsible for management of the detail design contract execution in the organization were interviewed and asked to select

significant indicators based on their years of professional acquaintance. Evaluation indicators that were deemed as of "critical importance" by most professionals were then selected as the gradual performance evaluation indicators for the consulting firms.

Balanced Scorecard (BSC) has assisted organizations in the ability to perform tactics efficiently with the provision of systemized framework and methods, so that the organizations might be able to progress toward its planned goals. Therefore, this study applies the BSC concept to establish the framework of performance evaluation indicators for the consulting firms. Similar to BSC, this research establishes the framework from the aspect of customers, finance, internal processes, and creation and learning. Thus, twenty-four indictors, categorized into these four aspects of BSC, were finally selected by the experienced supervisors and senior engineers, as shown in Table 1.

In view of the objectivity of indicator weight, this study adopts the Analytical Hierarchy Process (AHP) to conduct expert questionnaires. Thirteen experts with more than 10 years of experience were interviewed to complete the questionnaire. Based on figures of investigating result, the weights of four aspects are 16.3% for client, 45.6% for finance, 22.0% for internal process, and 16.1% for creation and learning, respectively. Among them, the weight of aspect of finance, 45.6%, is the highest. It shows that owners have high expectation on achieving the goal of budget and creating effectiveness and benefit of result. Consulting firms shall take off quantity, estimate construction cost, and fulfill owners' requirements on function with minimum cost.

In addition, the weights of the finance aspect indicators, "F1-1, Accuracy of Quantity Calculation" (16.9%), "F2-1, Conformance of Function" (13.0%), and "F1-2, Construction Cost Estimate" (11.8%) are among the highest. They shall be managed with special cares during the design stage.

3.1 EVALUATING SCORE OF AN INDICATOR

The design performance evaluation form that established by this study is shown in Table 1. From the aforesaid evaluation sheet, "F1-2 Construction cost estimate," is chosen as an example to explicate the content of indicators and the 5-point scale for evaluating their scores. Construction cost estimate requires rational price inquiry. Accordingly, the total cost can be calculated based on selected construction methods, machinery facility, material specification and dimension measurement from drawings. All unit prices can be analyzed rationally through the trend of appraised unit prices of City Council, published unit prices of Construction Cost Indicator, market prices, announced cost indicator by Directorate-General of Budget, Accounting and Statistics. It then can be recognized as a basis of Department of Rapid Transit Systems (DORTS) construction budget planning. Therefore, its 5-point scale is designed as follows for fast evaluation:

(A) □Below 55 □60 Construction cost is not estimated based on published unit prices and reasonable market prices. No detailed quotation and estimation is available and cost estimation shows large variation from project budget.

(B) □65 □70 Most unit prices are estimated reasonably, but some item cost are deviating from market prices without reasonable supported quotations. The cost estimation shows little variation from project budget.

(C) □75 □80 Estimated unit prices are reasonable. Most items are analyzed. The result of estimation is attached for reference and meets project budget.

(D) □85 □90 Construction cost has been carefully quoted, estimated and analyzed. The result of careful quotation and estimation are attached for reference. The estimation meets project budget.

(E) □95 □100 Construction cost has been carefully quoted, estimated and analyzed. The result of quotation, risk analyses, market trend, past cost analyses are attached for reference. The estimation meets project budget.

Depending on the construction cost estimation provided by the consulting firm, the appraiser may evaluate and check on suitable grades. After all the 24 evaluation indicators are evaluated and checked, they are multiplied by the respective weights listed on Table 1 to attain the weighted scores for the evaluation of that consulting firm.

Table 1 Evaluation Sheet of Design Performance

Aspect	Strategy Objective	Indicator	Weight%	Score*	Weighted Score
Customer (16.3%)	C_1 Promote Service Performance	C_{1-1} Design Progress	2.1		
		C_{1-2} Question Solution Proposal	3.0		
	C_2 Promote Owner Satisfaction	C_{2-1} Owner Satisfaction	8.3		
		C_{2-2} Communicate Coordination	2.9		
Finance (45.6%)	F_1 Reach Budget	F_{1-1} Accuracy of Quantity Calculation	16.9		
		F_{1-2} Construction Cost Estimate	11.8		
	F_2 Create Result Efficiency	F_{2-1} Conformance of Function	13.0		
		F_{2-2} Value Engineering	3.9		
Internal Process (22.0%)	Q_1 Practice Project Management Strategy	Q_{1-1} Project Manage Method	1.2		
		Q_{1-2} HR Organization	1.0		
	Q_2 Strengthen Document Integration	Q_{2-1} Document Review and Reply	1.0		
		Q_{2-2} Document Management	0.8		
		Q_{2-3} Accuracy of Design Document	2.9		
	Q_3 Ensure Design Quality	Q_{3-1} Quality Assurance	1.5		
		Q_{3-2} Responsibility of Change Order	2.6		
		Q_{3-3} Impact of Environment & Ecosystem	2.4		
	Q_4 Completeness of Design Document	Q_{4-1} Basic Data Collection	1.5		
		Q_{4-2} Design Analysis	1.0		
		Q_{4-3} Constructability	3.4		
		Q_{4-4} Interface Integration	2.7		
Creation & Learning (16.1%)	S_1 Promote HR Effectiveness	S_{1-1} Degree & Certificates	1.4		
		S_{1-2} Expert Experience	5.2		
	S_2 Promote Member Professional Skill	S_{2-1} Training	7.2		
		S_{2-2} Research & Development	2.3		
Total			100.0	—	Sum**

*Score evaluation described in Section 3.1
**Total Weighted Score:
59 or less: Awful Performance
60 to 69: Poor Performance
70 to 79: Fair Performance
80 to 89: Better Performance
90 to 100: Excellent Performance

4. Case Analysis

This section depicts the applicability of the proposed evaluation scheme for performance by testing against two representative cases selected from numerous tendering cases originated from governmental agencies. It was required of the engaged agency officers to conduct performance evaluation utilizing the score card supplied by this research.

4.1 Case One

Case one is "The Luzhou Line DL13X Construction Detailed Design Service Contract." The evaluated design

service performance of the design firm from Case One was shown in Figure 1. The engineering consultant's design service performance had a total weighted score of 85.91 that lay in the ranking which indicated "Better Performance" (detailed allocation of rankings was shown in Figure 1). In referencing to Figure 1, these high scores indicated good performances from the said consultant where effectiveness in commanding controls in design progress, problem identification and resolution process, level of cooperation in task involvement, and communication and coordination were demonstrated.

In the aspects of finance, the consultant also demonstrated good performances where effectiveness in allocating budget plans, appeasing contractual requirements and exhausting exploration on alternative plans were executed, however only minor discrepancies encountered for the tabulation of quantity. The consultant had been notified of rectification on such discrepancies.

For the aspects of Internal Process, the consultant's team on technology service also demonstrated leveled effective mechanism in internal control and management of the team. The consultant made available single corresponding personnel for documentation while acting as reservoir of professional knowledge and technological know-how that ample sound advises were offered in such way that the designing quality was preserved. The only suggestion for improvement in this aspect was probably involved the promptness in replying technologic document reviews.

With regard to "Creation and Learning" aspect, the evaluation result indicated that the credentials and training of the consultant's team members were maintained in a satisfactory level where award system that promoted further trainings was emplaced.

In conclusion, the said design firm of case one had performed effectively and satisfactorily to the assigned designing tasks stipulated in the contractual terms. The only shortcoming was the discrepancy in quantity tabulation, of which was enlisted to be inclusive in the critical control tasks of construction stages when changes in designs were made. The design firm's overall performance could be rated as "Good Quality," the rightful agency in charge granted the said contractor with Good Quality Award in pursuant to relevant procedures. This tender case enrolled the contest held in 2000 for Public Construction Golden Award and won the price of Excellence for Quality Design. The evaluation outcome extrapolated by this research correlated with the contest evaluation outcome derived from the criteria of Public Construction Golden Award, and further, the precision and correctness in predicting the applicability of the design performance evaluation scheme was evidently proven.

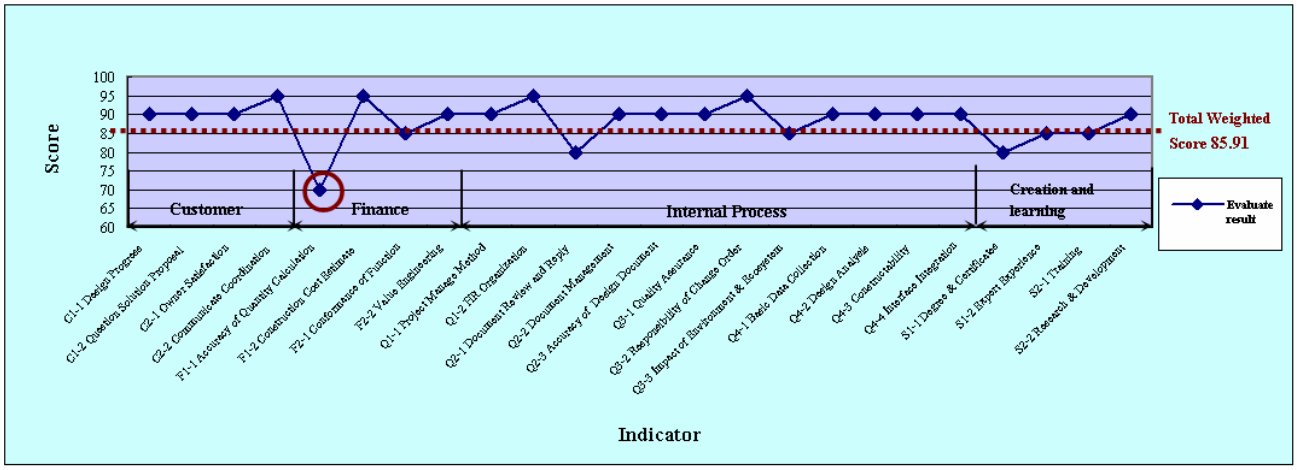

Fig. 1 Performance Review on Consultants of Case One Detail Design Contract at Design Stage

4.2 Case Two

Case Two is "The Songshan Line DG16X Construction Detailed Design Service Contract." The evaluated design service performances of the design service contractor from Case two were shown in Figure 2.

The engineering consultant's design service performance had a total weighted score of 79.45 that lay in the ranking which indicated "Fair Performance" (detailed allocation of rankings was shown in Figure 2). In referencing to Figure 2, this consultant firm performed satisfactorily in indicator that related to aspects concerned clients in particular the level of cooperation in task involvement, however with regard to communication and coordination, improvements were sought.

In the aspects of finance, improvements in the effectiveness and detailing of allocating budget plans were sought. In the aspect of executing internal control, the evaluation indicated for many improvements in specifics of harmonizing the coordination of interface management among teams where the quality of bringing the finished design outcome together needed many improvements. Moreover, in the duration of the project, there were many incidences of personnel changes which should be rectified accordingly so that such change would not influenced task progressions. With regard to "Innovation and Learning" aspect, the evaluation result indicated that the credentials and training of the consultant's team members were maintained in a satisfactory level where award system that promoted further trainings was emplaced.

In conclusion, the said design service contractor of case two had performed only satisfactorily where the coordination in internal control of the teams, the allocation of man power and budget plan, quality in the presented design charts and design conformity demonstrated in the finished design outcome had much room for improvement, the contractor was advised of improvements in these areas which will be enlisted to be inclusive in the critical control tasks of construction stages later in the future stages.

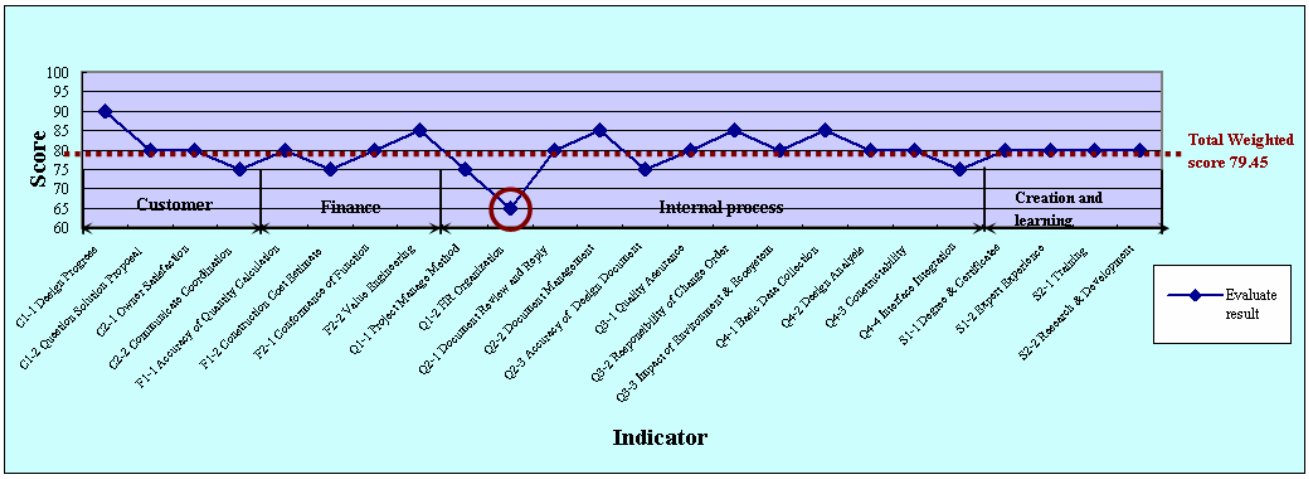

Fig. 2 Performance Review on Consultants of Case Two Detail Design Contract at Design Stage

5. CONCLUSION

This research collected performance evaluation indicators from literatures and expert interviews, total 24 items have been selected as the indicator to service performance evaluation at the design stage of MRT detail design contract. This research applies Balanced Scorecard (BSC) concept to create indicators' structure – customer, finance, internal process, creation and learning. Then, this research adopts AHP (Analytical Hierarchy Process) to set up each indicator's weight. The indicators were further divided using a 5-point scale that distinguishes the indicators and establishes the score-intervals between them. A complete evaluation model for consulting firms was then established. The testing of the two representative cases indicates that the score of each case indeed matches the actual contract-fulfillment by the consulting firms, whose individual

performance was also manifested by their scores in different indicators. The result can then be used to verify the accuracy and feasibility of the performance evaluation system established in this study.

The framework of performance evaluation, definition of evaluation indicators, indicator weight, evaluation results and evaluation processes in this study were provided as references for evaluating design firms in the design phase. Further study is now under process to apply such mechanism to evaluate the performance of consulting firms in the construction phase for a complete performance evaluation.

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