

# Development of a customer satisfaction evaluation model for construction project management

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## Abstract

Construction project management (CPM) is a technical-oriented service for construction project clients. Evaluating the performance of service providers is beneficial both to purchasers, enabling them to appraise the services received, and to providers, helping them to improve their services. However, no appraisal system for such services exists. This study developed a novel customer satisfaction evaluation model for CPM services that was developed using a questionnaire-based survey and statistical analysis. Test results show that the developed model is a feasible system. Research using this model reveals that CPM services in Taiwan are satisfactory with acceptable performance for clients. The developed model is a good reference for evaluating and assessing CPM performance.

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## 1. Introduction

With the ISO 9000 standard gaining popularity worldwide, total quality management (TQM) has become a strategic and survival approach for most firms in every industry. TQM is a complete management philosophy that emphasizes overall satisfaction through the continuous improvements to products and processes. Notably, TQM is concerned with customer satisfaction and is not merely a slogan [1]. Since 1988, TQM has been codified in a national award (the Malcolm Baldrige National Quality Award) in the United States, “customer satisfaction,” once the most criteria in TQM evaluation, has been transformed into “customer relationships and satisfaction” in the category of customer and market focus [2]. Obviously, customer satisfaction is a key factor in achieving quality improvement. The construction industry has many characteristics common to manufacturing and service industries. In the construction industry, customer satisfaction demands on contractor’s performance are in accordance with contractual duties, obligations and responsibilities. Total customer

satisfaction has never been a goal for designers, construction managers, subcontractors and material suppliers [3]. It is hard to achieve higher satisfaction level by any single project participant. However, there is no doubt that making customer (client) as satisfied as possible is an essential task for any firm in the construction industry regardless of the construction-related products or services they provide.

The application of professional construction management (PCM) has increased rapidly since it was first introduced and promoted in the early 1960s [4–7]. In a narrow sense, PCM forms a three-party team, including the owner, the architect/engineer (A/E) and the project manager, to accomplish the owner’s authorized tasks [5]. On the contrary, from a broad perspective, PCM is an effective means of satisfying an owner’s construction needs [4]. Functional PCM tasks consist of the following phases of construction projects: conceptual planning; conceptual design; detailed design; construction; closeout; and, start-up. PCM is now regarded as a professional team for serving all owner needs in a construction project.

In Taiwan, the Government Procurement Law (GPL), promulgated on May 27, 1998, allows several innovative concepts and regulations, including the PCM (the official

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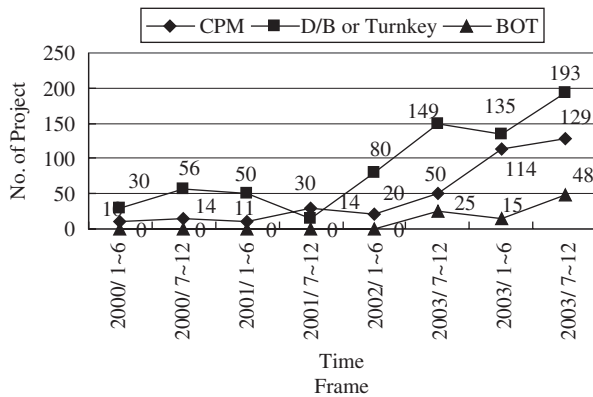


Fig. 1. Trend of new project delivery methods in Taiwan.

term in GPL is project management, therefore, construction project management (CPM is used hereinafter replacing the PCM term) approach and the most advantageous tendering approach [8] for construction projects and procurement entities. As stated in Article 39 of GPL—“*In conducting a procurement, an entity may entrust a supplier, according to this Act, with the project management related to planning, design, supply, or contract performance*”, a construction project can have a CPM contract to serve the consultative and administrative needs [9]. After the GPL of Taiwan went into effect, the number of construction projects with CPM contracts issued has been increasing (see Fig. 1). With CPM stepping into its flourishing phase in Taiwan, it is necessary to appraise the performance of CPM services. This study focuses on developing a customer satisfaction evaluation model for evaluating CPM services and examines its applicability in Taiwan.

## 2. Customer satisfaction

There has been a quite obvious increase in the emphasis on a firm's ability to produce high-quality products and/or provide high-quality services. Identification of high-quality products or services can be achieved by measuring customer satisfaction with these products or services. The concept of customer satisfaction transforms all industries from production centralized to customer based. Several evaluation models or indices exist for assessing customer satisfaction in various industries. To achieve a highly reliable and stable index of satisfaction, the American Customer Satisfaction Index (ACSI) [10] defines the satisfaction as a weighted average of three survey ratings: perceived quality, perceived value, and customer expectations. The ACSI index has been used to measure the satisfaction in the manufacturing/nondurables, manufacturing/durables, transportation, communications and utilities, retails, finance and insurance, services, public administration, and government. Although the ACSI index has an accepted satisfaction evaluation methodology, it is not designed for the construction industry. Generally, the evaluation result for customer satisfaction is highest for competitive products, lower for competitive services and

retailers, and lowest for government and public agencies [11]. The ACSI system criteria cannot be adapted to the construction industry, a new evaluation model must be developed not only for the construction industry, but also for CPM services.

## 3. Related research

Construction projects involve numerous stakeholders that are closely related and interacted during a given project. The level of a stakeholder satisfaction directly influences the current project and subsequent projects and the level of satisfaction experienced by other stakeholders. For contractors, completing a project in accordance with the plans and specifications within budget and on time satisfies owner needs and generates profit. Ahmed and Kangari [12] used six client-satisfaction factors, including time, cost, quality, client orientation, communication skills and response to complaints, to conduct a survey for analyzing the client-satisfaction factors in the construction industry. They concluded that these six factors are equally important when evaluating client satisfaction. Maloney argued that the physical product and service delivery must be considered when assessing customer satisfaction in the construction industry. For electrical construction projects, Maloney proposed a dual-influence model using five dimensions—contractor/customer relationship, project management, safety, prepared/skilled workforce and cost—to evaluate customer satisfaction and for contractor selection decisions [13]. Furthermore, Maloney claimed that labor-management activities at levels of contractor–workforce, contractor–local union and contractor association–local union influence customer satisfaction [14]. Contractors need to establish partnerships with labors to enhance customer satisfaction.

To measure home-buyer satisfaction, Torbica and Stroh [15–17] developed a model, called HOMBSAT, with three distinct dimensions of house design, house and services. The indicators of house design and house are used to rate the product quality of a transaction, whereas indicator of services is used to rate the service quality. The HOMBSAT can provide a total home-buyer satisfaction across three dimensions to the home builders to track the overall quality of their services. Moreover, Torbica and Stroh also confirmed that a home builder can increase home-buyer satisfaction by implementing TQM [18]. In 2002 and 2003, J.D. Power and Associates reported that the quality of workmanship/materials and customer services account for 50% of overall customer satisfaction among buyers of new homes, and the levels of customer satisfaction increased significantly in the highly competitive home-builder industry [19]. Liu, who surveyed residential satisfaction of housing estates in Hong Kong, utilized questionnaires comprising nine categories with a total of 51 questions [20]. That study developed a well-structured post-occupancy evaluation method for measuring customer satisfaction.

Tang et al. [21] investigated the client satisfaction of engineering consulting firms in Hong Kong using a questionnaire-based survey. Their study used the following eight factors (expressed in 29 indicators) to evaluate overall client satisfaction: professionalism of service; competitiveness of service; timeliness of service; quality of design; degree of innovation; completeness of other considerations; availability of support for client; and, supervision at implementation. Tang et al. concluded that the quality of engineering consulting services in Hong Kong was slightly higher (mean score is 3.122) than neutral (default score is 3) [21]. Leung et al. [22] measured participant satisfaction in the construction management process. Through 15 established and verified hypotheses, the study showed that management mechanisms (e.g., communication, participation and commitment) rather than particular project goals (e.g., time, cost and quality) influence directly participant satisfaction.

#### 4. Research approach

This study developed a customer satisfaction evaluation model for CPM services through the following processes. (1) Set an evaluation framework and related factors. This study used eight practical cases, Taiwan's GPL regulations and several studies to identify the evaluation hierarchy and associated factors. (2) Develop a usable questionnaire. Each question was based on each factor generated by the preceding process. A pilot survey was conducted to validate the questionnaire. After the pretest, the questionnaire was refined. (3) Collect field data. This study conducted an official survey to obtain raw research data for further analysis. The questionnaire was sent to 57 project clients; of the 24 replies, 22 were valid for analysis. (4) Analyze collected data. All responses were analyzed by the methods of descriptive statistics and inferential statistics to improve survey reliability. (5) Develop a formal evaluation model. The proposed evaluation model was developed according to antecedent statistical results and tested using several practical CPM cases in Taiwan. The five steps can be classified into three stages, i.e., questionnaire survey, model evaluation and formal model development, as discussed in Sections 5, 6 and 7, respectively.

#### 5. Questionnaire survey

Owing to the nature of data outsourcing of questionnaire-based survey, the development of a questionnaire plays the key role in customer satisfaction research. A well-structured questionnaire magnifies desired achievements of a research. Hayes [23] suggested a three-stage model for developing a practical questionnaire for customer satisfaction evaluation, namely determine customer requirements, develop and evaluate the questionnaire, and finally, apply the questionnaire. This study transformed Hayes' model into a comprehensive model with five stages

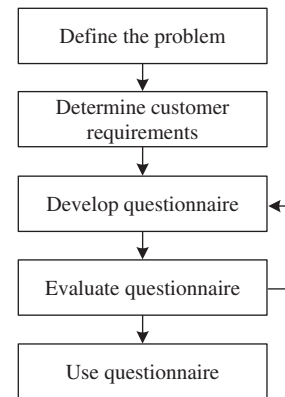


Fig. 2. Processes of questionnaire development for customer satisfaction.

that are as follows. Fig. 2 shows the questionnaire development process.

##### 5.1. Defining customer satisfaction

In addition to construction products, a contractor also provides a set of construction services that range from meeting periodically with owner representatives to a product of services that is provided by subcontractor or other material vendors. For CPM services, a client must find a service provider to do all construction-related works. However, clients with CPM service usually are nonprofessionals in the construction industry. As such, they are unfamiliar with construction-related works, which is why they require professional services. Thus, customer satisfaction in CPM services is defined as the degree to which client requirements are satisfied in construction-related works.

##### 5.2. Determining customer requirements

The Procurement and Public Construction Commission of Taiwan has promulgated several procurement regulations. One regulation regarding how to select a supplier and the formulas for calculating service fees of technical services has an article stipulating the kinds of construction works that an entity can entrust to suppliers. An entity who entrusts any CPM service should comply with these regulations. Fig. 3 shows the working areas of CPM service provided in Taiwan. Detailed legal services are listed on the web <<http://www.pcc.gov.tw>>. To identify the customer requirements for CPM services, this study collected work items from eight real CPM cases and compared these items with regulations to extract general customer requirements. Unique items added to the contract of any real case are pruned off. In summary, there are 82 work items utilized in the proposed model.

##### 5.3. Developing the questionnaire

Performance of CPM services was evaluated using a hybrid approach that monitors ongoing and completed services. This evaluation approach consists of two stages:

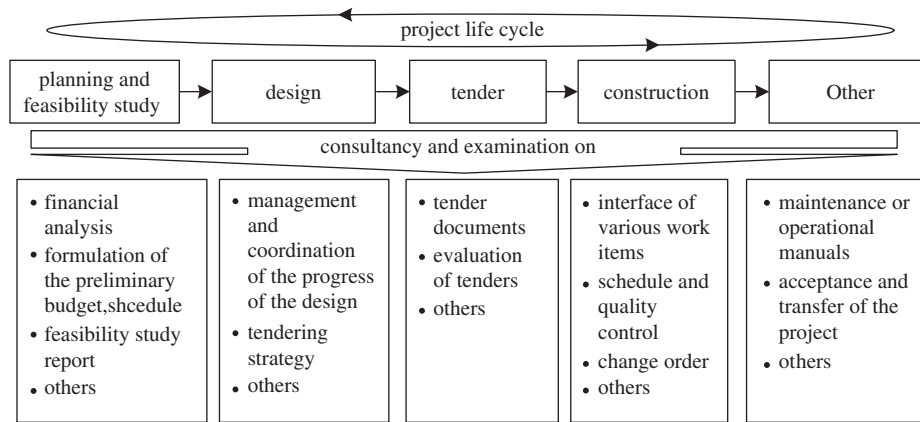


Fig. 3. Service areas of CPM in Taiwan.

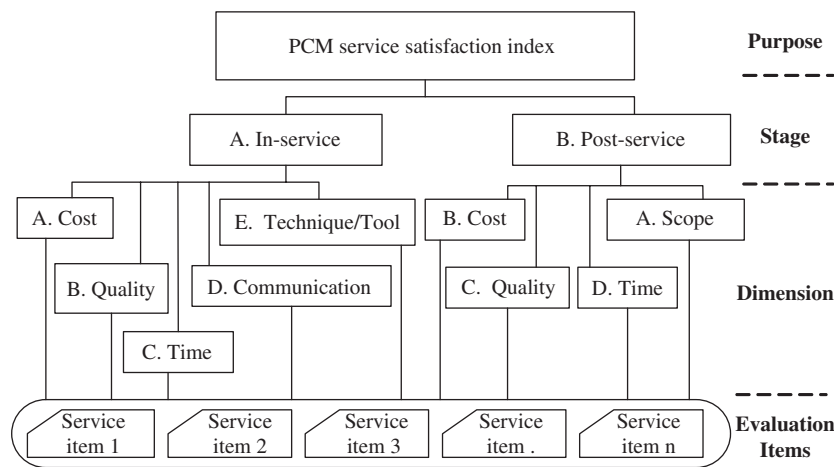


Fig. 4. Evaluation framework of CPM service.

in-service and post-service stages. To ensure the integrity of this CPM service evaluation, knowledge areas in the Project Management Institute’s publication, *A Guide to Project Management Body of Knowledge (PMBOK)* [24], was utilized to establish the evaluation dimension. Although nine knowledge areas exist in PMBOK, not all are suitable for this study. Discussion with several domain experts concluded that the appropriate dimensions for the in-service stage are cost, quality, time, communication and technique/tool; whereas those for the post-service stage are cost, quality, time and scope. Fig. 4 presents a detailed evaluation framework. There are 51 and 31 questions in the in-service and post-service stages, respectively. In the evaluation framework, all identified work items are classified according to the previous dimensions. To form a questionnaire, all evaluation items are re-written into the question type as shown in Fig. 5. The formal questionnaire is in Chinese.

The questionnaire consists of four sections. In the first and second sections, respondents were asked to choose one of five choices (very unimportant, unimportant, neutral, important and very important for the importance issues, and very dissatisfied, dissatisfied, neutral, satisfied and very satisfied for the satisfaction issues) for all questions in the

in-service and post-service stages, respectively. The third section probed respondent general impressions of services in the dimensions and asked respondents to grade overall satisfaction on a scale (very dissatisfied, dissatisfied, neutral, satisfied and very satisfied). The grades obtained were then used to calculate the value of total satisfaction for project management (TSPM). The fourth section collected basic information, such as the scale of a project in money, of involved CPM cases.

#### 5.4. Questionnaire evaluation

A pretest was conducted to assess a draft of the questionnaire. Five employees of CPM clients were invited to examine the questionnaire. The main concerns raised were as follows: (1) the meaning of some questions is unclear; (2) the default options for some questions are unsuitable; and, (3) some questions are hard to answer because the questions (the work items) are not applicable to respondent experience. All concerns were addressed and the questionnaire was modified according to the following principles: (1) questions are rewritten to improve clarity for respondents and default options are also adjusted; (2) the answer “not applicable” is added to each question.

Evaluation Item	Applicable		Importance					Satisfaction				
	Yes	No	VU	U	N	I	VI	VD	D	N	S	VS
Financial analysis and recommendation on the sources of finance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Note: VU for very unimportant; U for unimportant; N for neutral; I for important; and VI for very important. VD for very dissatisfied; D for dissatisfied; N for neutral; S for satisfied; and VS for very satisfied.

Fig. 5. Part of research questionnaire.

5.5. Using questionnaire

When analyzing the status of CPM services in Taiwan, the entities who issued CPM projects between January 31, 2000 and December 31, 2002 were considered. The original data is extracted from the Electronic Procurement System of Taiwan Government <<http://web.pcc.gov.tw>>. In this period, 115 CPM projects were launched: 47 central government projects; 62 local government projects and 6 school projects. Among them, 28 projects whose anticipated procurement budgets were below 1 million New Taiwan dollars (NT dollars) were excluded. Only 31 entities were contacted by the research team. Of the 57 questionnaires sent, 24 replies were received, 22 of which were valid. Figs. 6 and 7 present the distribution of questionnaires sent and responses received from service clients and providers, respectively. In general, the responses received cover all client and provider types. Thus, the analysis result will be representative of CPM services in Taiwan.

6. Model evaluation

6.1. Descriptive statistics test—reliability and validity test

This study used descriptive statistical method to analyze important characteristics and summarize survey results. Reliability is a prerequisite for measuring validity. Cronbach’s alpha coefficient was used as an index to test survey reliability. In general, the closer the Cronbach’s alpha coefficient is to 1.0, the more reliable the test is. As stated in the literature [25], an alpha equal to or greater than 0.70 is considered satisfactory. Reliability estimates below 0.60 are usually regarded as unacceptably low. Table 1 listed the detailed values of Cronbach’s alpha coefficient for each dimension. In summary, the reliabilities of each dimension are acceptable (greater than 0.60).

Test validity is difficult to establish since no accepted standard exists for comparison. Nevertheless, attempts can be made to establish validity using respondent subjective

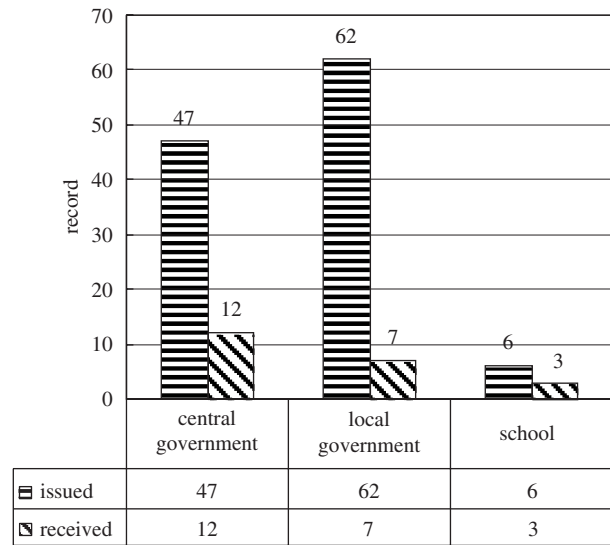


Fig. 6. Distribution of questionnaire in different service clients.

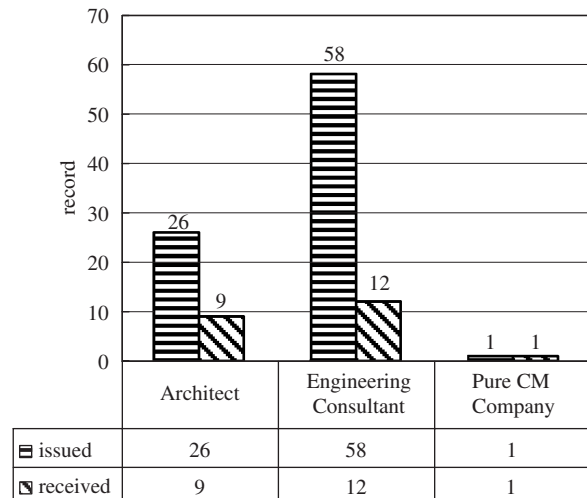


Fig. 7. Distribution of questionnaire in different service providers.

Table 1  
Reliability analysis results for original evaluation framework

Stage	Dimension	Reliability (alpha coefficient)	
		Importance	Satisfaction
In-service	Cost	0.9548	0.9354
	Quality	0.8900	0.8661
	Time	0.9086	0.8681
	Communication	0.9464	0.9410
	Technique/Tool	0.7285	0.8899
Post-service	Scope	0.6588	0.6196
	Cost	0.9471	0.9046
	Quality	0.9520	0.9261
	Time	0.9484	0.9598

Table 2  
Mean scores of respondents

Stage	Dimension	Importance	Satisfaction
In-service	Cost	7.68	6.77
	Quality	7.24	6.98
	Time	7.39	6.97
	Communication	7.95	7.18
	Technique/Tool	7.60	7.05
Post-service	Scope	7.00	6.59
	Cost	7.79	7.51
	Quality	7.30	6.92
	Time	7.52	6.55

Note: for the importance issue, average value: 7.50, variance: 0.087, stand deviation: 0.295.

judgments based on experience and empirical indicators. To be valid, a test must be reliable; but reliability does not guarantee validity, i.e., it is possible a meaningless (invalid) test can have a higher reliability. In general, the questionnaire used in this study is based on literature reviews, domain expert interviews and a pretest; thus questionnaire validity can be acceptable when reliability is acceptable.

6.2. Descriptive statistics test—mean value analysis

All questions have default options with corresponding scores (2 for very unimportant; 4 for unimportant; 6 for neutral; 8 for important; and, 10 for very important) for subsequent analysis. This study used the threshold of one sigma (one standard deviation) of respondent scores for the importance issue to erase unimportant questions. Table 2 shows detailed values of variation in the importance issue. With a threshold value of 7.205 for the importance score, 12 and 10 questions were erased from the in-service and post-service stages, respectively. Notably, the importance score for questions in the scope dimension is below the threshold; therefore, the dimension of scope is erased. Finally, there are 39 and 21 questions in the in-service and post-service stages, respectively.

6.3. Inferential statistics—importance-satisfaction matrix analysis

Importance-satisfaction matrix analysis [26], which is a means of combining satisfaction and importance measures to obtain a clear indication of which areas should be addressed and which should be maintained, is a standard method of analyzing customer satisfaction. The method forms a quadrant matrix that has four different meanings for interpretation and adoption. The top left-hand quadrant of the matrix shows items that are “high” in importance and “low” in satisfaction, and therefore they have been labeled as “more work needed to improve performance.” The lower left-hand corner contains items that have been rated “low” in both importance and satisfaction. Items in this quadrant have been labeled as “second priority for improvement”. The top right-hand corner of the figure contains items that are rated “high” in both importance and satisfaction and the items here have been labeled as “works are excellent and should be maintained”. Finally, the lower right-hand corner shows items that are “high” in satisfaction and “low” in importance. These items have been labeled as “second priority to maintain”. Results of evaluating customer satisfaction in the matrix can be a clear indication of the level of satisfaction and the strategy to be adopted for improving satisfaction.

As designated in the questionnaire, each question has a five-point scale to indicate relative importance and satisfaction. The importance scores are rated on the following scale: 2, very unimportant; 4, unimportant; 6, neutral; 8, important; and, 10, very important. Similarly, the satisfaction scores are rated on the following scale: 2, very dissatisfied; 4, dissatisfied; 6, neutral; 8, satisfied; and, 10, very satisfied. Mean scores (see Table 2) for the dimensions of importance and satisfaction were used to plot the matrix. Figs. 8 and 9 show the quadrant matrix of the two stages where the mean importance is plotted against the vertical axis and the mean satisfaction against the horizontal axis. The average values of all responses for in-service and post-service are in the high importance and satisfied quadrant, meaning that the works are excellent

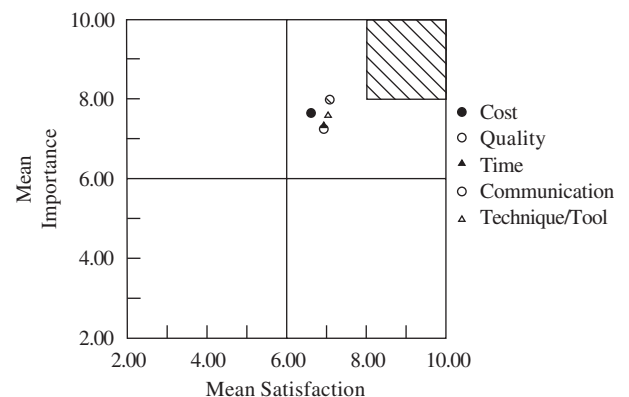


Fig. 8. Importance–performance relationship of in-service stage.

and should be maintained. In these CPM cases, the analysis results are not located in the very importance and very satisfied areas, the shadow areas in Figs. 8 and 9 that are the optimum areas. It implies that service performance still has some room for improvement. In summary, the CPM services in Taiwan are in general satisfactory.

6.4. Algorithm for measuring TSPM

In order to differentiate the performance of satisfaction for CPM, this study developed a novel model of TSPM to measure a service provider’s performance status that can be an index for performance improvement. TSPM considers all dimensions in two stages and accumulates the scores according to a normalized scale. The TSPM is calculated by Eq. (1), in which,  $S_i$ , the mean satisfaction score for dimension  $i$ , is calculated by Eq. (2);  $W_i$ , the relevant weight for dimension  $i$ , is calculated by Eq. (3);  $S_{max}$  is the maximum value for the satisfaction score—10 in this case;  $n$  is the number of dimensions in this study—8 in this case. In Eq. (2),  $S_j$  is the satisfaction score in  $j$  question;  $m$  is the number of dimensions in dimension  $i$ . In Eq. (3),  $I_i$  is the mean importance score in dimension  $i$  and is calculated by Eq. (4), in which  $I_j$  is the importance score of  $j$  question;

and  $m$  is the number of dimensions in dimension  $i$ . In the TSPM scale, a score above 8 is in the interval of very satisfied area and a score between 6 and 8 is in the satisfied area. Table 3 presents the values for calculating the TSPM index in the studied cases.

$$TSPM = \frac{\sum_{i=1}^n (S_i W_i)}{S_{max}} \times 100\%, \tag{1}$$

$$S_i = \frac{\sum_{j=1}^m S_j}{m}, \tag{2}$$

$$W_i = \frac{I_i}{\sum_{i=1}^n I_i}, \tag{3}$$

$$I_i = \frac{\sum_{j=1}^m I_j}{m}. \tag{4}$$

According to the developed TSPM index, the TSPM value in Taiwan is 6.99. The CPM service in Taiwan falls in the interval of satisfied. This is in accordance with the results obtained by the importance-performance matrix that uses the respondent overall impressions as scores. These analytical results indicate that service providers must provide more effective and efficient services to earn client trust and satisfaction.

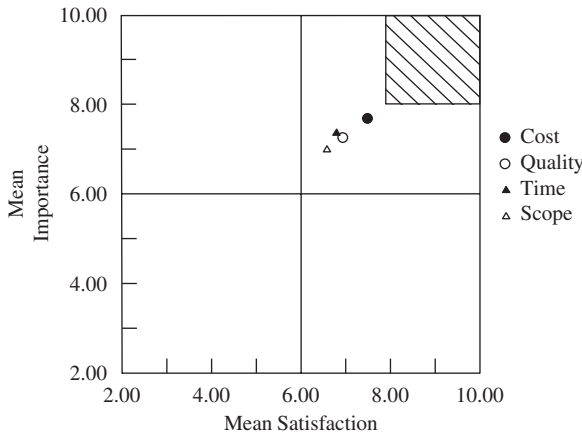


Fig. 9. Importance–performance relationship of post-service stage.

7. Formal model development

7.1. Factor analysis

To construct the formal evaluation model for CPM services, this study employed factor analysis technique to identify essential factors. This analysis is made by using the results of mean value analysis depicted above.

Factor analysis technique attempts to reduce the number of variables and to detect the structure from the relationships between variables; that is, factor analysis is applied as a means of data reduction or structure detection. Factor analysis can be either exploratory or confirmatory in nature. The objective of exploratory factor analysis is to distinguish the common factors from specific factors and to

Table 3  
Calculation information for TSPM

Stage	Dimension	Mean importance score $I_i$	Weight $W_i$ (%)	Mean satisfaction score $S_i$	Weighted dimension satisfaction score
In-service	Cost	7.68	12.70	6.77	0.8598
	Quality	7.24	11.97	6.98	0.8357
	Time	7.39	12.22	6.97	0.8518
	Communication	7.95	13.15	7.18	0.9440
	Technique/Tool	7.60	12.57	7.05	0.8861
Post-service	Scope	—	—	—	—
	Cost	7.79	12.88	7.51	0.9675
	Quality	7.30	12.07	6.92	0.8354
	Time	7.52	12.44	6.55	0.8146

explain their relationships according to the observed data [27]. As the employed process of questionnaire development is a forward thinking process and the correlations between questions are unclear, this study used the factor analysis technique to identify the structure of the satisfaction evaluation model. The processes of factor analysis include factor extracting, factor loading, factor rotating and factor labeling.

7.1.1. Factor extracting

To extract common factors reflecting raw data, this study used the method of principal components factoring

to calculate the eigenvalues, communality and factor-loading coefficient of factors for further analysis. The calculation was run in SPSS<sup>®</sup> software. Kaiser’s Rule [28], which recommends retaining only principal components with eigenvalues exceeding unity, was used to remove some insignificant factors, 39 factors in the in-service stage and 19 factors in the post-service stage were utilized for factor analysis.

7.1.2. Factor loading

Tables 4 and 5 are the factor-loading matrices for the in-service and post-service stages, respectively. The values in

Table 4  
Factor analysis results for the in-service stage

No. of question	Eigenvalue	Variance by each factor (%)	Variance accounted for (%)	Eigenvalue						Communality
				Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
AD3*	18.435	47.27	47.27	0.853	0.105	0.259	0.253	0.145		0.902
AE1				0.755	0.320		0.438		0.197	0.910
AD5				0.747	0.214	0.244	0.244	0.268		0.827
AD7				0.737				0.216	0.231	0.668
AD1				0.716	0.372	0.295		0.232	0.399	0.967
AA8				0.629	0.439	0.221				0.767
AE3				0.536	0.473			0.308	0.174	0.161
AC7	3.504	8.98	56.25	0.149	0.913		0.202	0.104		0.910
AC6					0.857	0.144			0.157	0.826
AB13				0.164	0.823	0.264	0.235	0.186	0.240	0.930
AC3				0.418	0.684	0.289	0.272		0.180	0.837
AC4				0.436	0.577	0.210	0.278		0.427	0.844
AC5				0.190	0.570	0.509	0.192		0.254	0.736
AB16					0.495	0.433				0.391
AB9	2.857	7.33	63.58		0.310	0.698	0.133	0.469		0.856
AB11				0.244	0.281	0.678	0.212	−0.117	0.410	0.886
AA6				0.442		0.643	0.295	0.292	0.193	0.824
AB12				0.484	0.343	0.619	−0.218		0.268	0.878
AA4						0.616	0.542	0.289	0.142	0.839
AA7				0.455	0.219	0.609	0.516			0.896
AB10				−0.159	0.251	0.607	0.379	−0.138	0.206	0.847
AA1	0.551	0.154	0.588				0.707			
AB6	2.463	6.31	69.89		0.191		0.771	0.185		0.767
AB1				0.360	0.118		0.707		0.158	0.687
AB5				0.159	0.174	0.296	0.700	0.377		0.790
AA3					0.139	0.321	0.682	−0.122	0.470	0.899
AA5				0.377	0.125	0.525	0.638			0.848
AD4				0.477	0.307	0.123	0.581		0.356	0.846
AA9				0.396	0.117	0.362	0.488			0.666
AA2	0.160	0.221	0.247	0.487	0.111		0.800			
AE4	2.007	5.15	75.04			−0.179	−0.103	0.899		0.890
AB7				0.229		0.144	0.106	0.883	0.213	0.914
AC1				0.122	0.176	0.445	0.272	0.663		0.830
AD2				0.574	0.245		0.171	0.588	0.212	0.818
AD6				0.258		0.477	0.408	0.569	0.354	0.916
AD8				0.438	0.490	0.226	0.128	0.568	−0.238	0.918
AC9				0.215	0.244	0.182				0.869
AB20		0.187			0.144	0.377	0.759	0.787		
AB3	0.262	0.193	0.334	0.244	0.296	0.597	0.799			

Note: \*: AD3, the third question in forth dimension of first stage.



the columns of factor name are the correlations between original variables and common factors. Using the results of factor loading, the communality (the proportion of variation in each test accounted for by the factors) can be calculated subsequently. The community in each new dimension is greater than 0.70, which is an acceptable level.

### 7.1.3. Factor rotating

In factor analysis, the common factor model has an infinite number of solutions; therefore, rotating the factor solution plays a key role in finding a more meaningful solution. Kaiser's Varimax Rotation [29] was applied for factor rotation to achieve a simple structure by focusing on the columns of factor-loading matrix. After numerous scenarios of factor analysis by SPSS<sup>®</sup> software, the analytical results reached a stable status (all eigenvalues are meaningfully different from zero [27]).

### 7.1.4. Factor labeling

Because the accumulated accounting variance is greater than 75%, the numbers of retained factors (new dimension) in the two stages are 6 and 3, respectively. This study re-labeled the factors as follows: (1) ability for change management (accounting for 42.27% of the variance), (2) ability for schedule management (accounting for 8.98% of the variance), (3) ability for resource management (accounting for 7.33% of the variance), (4) ability for data inspection (accounting for 6.31% of the variance), (5) team performance (accounting for 5.15% of the variance) and (6) ability for other activities (accounting for 4.76% of the variance) in the in-service stage; and (1) achievement of in-

service activities (accounting for 55.53% of the variance), (2) achievement of construction payment and inspection (accounting for 13.06% of the variance) and (3) achievement of construction tendering (accounting for 8.76% of the variance) in the post-service stage.

## 7.2. Model framework

After extracting the essential factors, the model framework was constructed. Fig. 10 shows the proposed model structure with the evaluation items. The in-service stage has 6 dimensions with 39 evaluation items and the post-service stage has 3 dimensions with 19 items.

## 8. Conclusions and suggestions

Success of a consulting firm depends on its ability to satisfy customers. Firms must redefine their bottom lines by using client satisfaction, high-quality standards, and profits as their top priorities in today's extremely competitive markets. For clients and service providers, developing an appraisal system for achieving their needs in service transaction is the most effective means of achieving project success. This study presented a customer satisfaction evaluation model that should benefit both clients and service providers in developing their own appraisal systems and serves as a framework for further research in CPM performance evaluation. Although the model is just validated for Taiwan's CPM environment, the development process and framework offer a valuable reference for

Table 5  
Factor analysis results for the post-service stage

No. of question	Eigenvalue	Variance by each factor (%)	Variance accounted for (%)	Eigenvalue			Communality			
				Factor 1	Factor 2	Factor 3				
BC3	11.662	55.53	55.53	0.935			0.891			
BC1				0.865	0.143	0.215	0.815			
BC8				0.860	0.333		0.858			
BC7				0.824	0.170		0.807			
BD2				0.770		0.387	0.783			
BD5				0.630	0.386	0.144	0.788			
BD6				0.599	0.462	0.332	0.684			
BC6				0.592	0.272	0.273	0.788			
BC2				0.587	0.369	0.379	0.747			
BB3	2.743	13.06	68.60	0.133	0.908		0.900			
BB2				0.183	0.870	0.189	0.913			
BB1				0.380	0.823	0.281	0.917			
BD7					0.709	0.158	0.836			
BD9				0.368	0.563	0.344	0.813			
BD8				0.439	0.562	0.462	0.737			
BC4				1.840	8.76	77.36		0.153	0.942	0.924
BD3							0.339	0.191	0.870	0.944
BD4	0.178	0.231	0.783				0.865			
BC5	0.163	0.275	0.759				0.932			

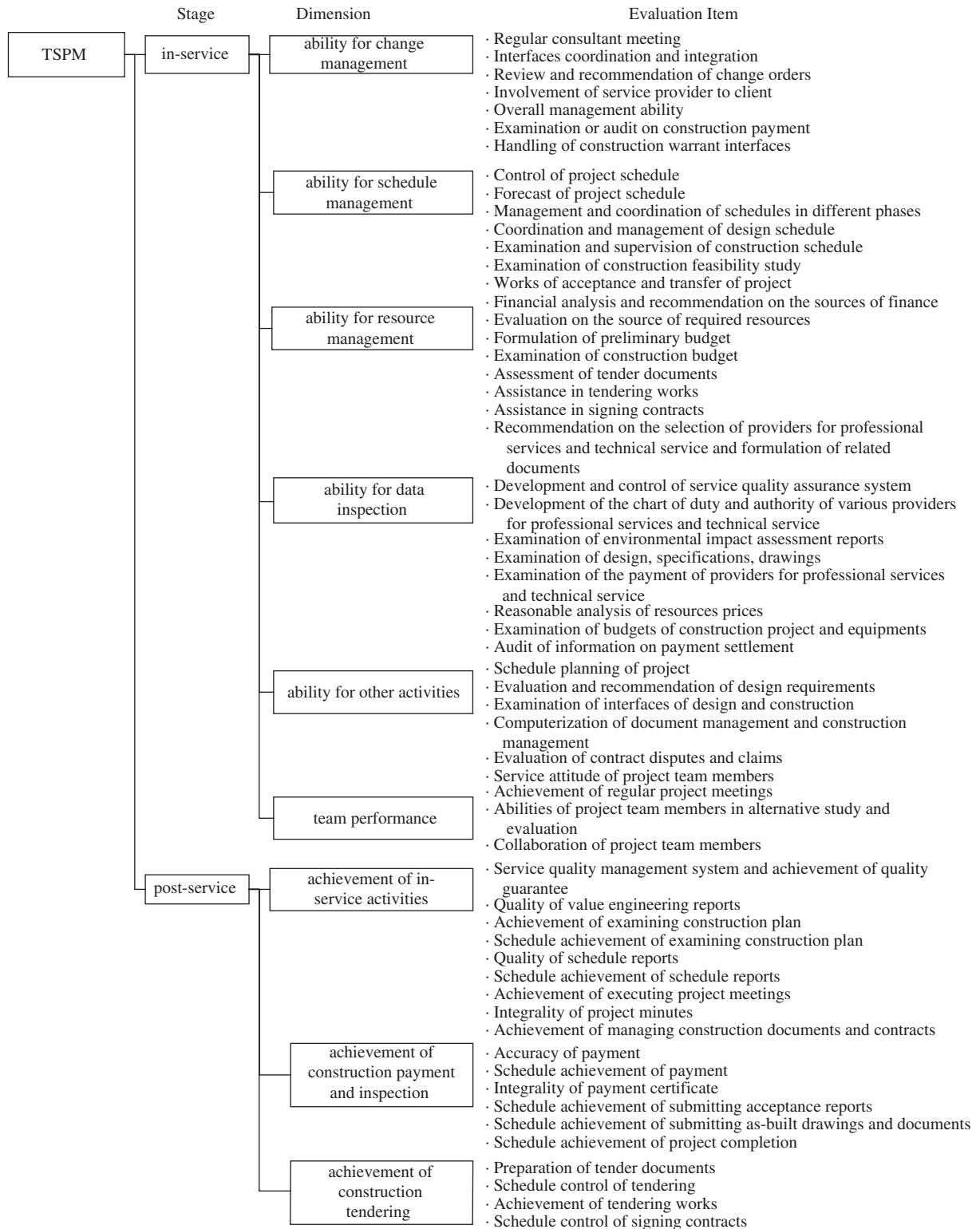


Fig. 10. Evaluation framework for TSPM.

evaluation and assessment of CPM performance in other contexts.

Different countries or economic entities may have different project delivery systems. Furthermore, the scope

of CPM in each country or economic entity may be totally different in contents. Thus the developed model may not be appropriate for other countries or economic entities. To establish a universal appraisal system for CPM is

impracticable. However, the PMBOK developed by PMI has recently been taken as a standard for project management. For the construction industry, the “construction extension to a guide to the project management body of knowledge” [30] can be regarded as a common basis for construction project management. To develop an appraisal system for the CPM service in accordance with the knowledge areas of PMBOK’s construction extension would benefit service buyers or providers in the future.

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