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Improving Consultancy Services for Identifying Engineering Costs in Construction Projects

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I am so pleased to be one of the students in Helsinki Metropolia University of Applied Sciences. The delightful lectures in the Master's program of industrial management have helped me to learn useful skills and knowledge for the professional future. It has been a happy journey.

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This Master's thesis aims to propose improvements for the engineering cost consultation provided by the consultation enterprise for the construction process. Currently, most of the businesses in engineering cost consultation enterprise (ECCE) mainly focus on the control of engineering cost done at later stages. The purpose of this study is to improve consultancy services for ECCE in order to better match the needs of customers.

In this study, the data is collected from reviewing the external procedures and regulations, internal documents from electrical power enterprise, the interview with the executive in ECCE and the researcher's observations, and the questionnaires with stakeholders. The data collected was used to analyse the current state in engineering cost management and the services offered by ECCE. Data is also applied as input to build the proposal for improved consultancy services, which is subsequently validated with industry experts.

The outcome of this study is proposal for ECCE concerning consultancy services to make them more complete and efficient for their clients in China. Outcome of this study will help ECCE improve their consultancy services to better satisfy the needs of customers in every stage of consultancy services. Simultaneously, engineering cost would be controlled more effectively in the whole construction process.

Keywords	Consultancy services for engineering cost, engineering cost management, whole construction process

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Acronyms

ACWP	Actual Cost for Work Performed
BCWP	Budgeted Cost for Work Performed
BCWS	Budgeted Cost for Work Scheduled
CECA	China Engineering Cost Association
CSG	China Southern Power Grid Company Limited
CRM	Customer Relationship Management
ECCS	Engineering Cost Consultation Service
ECCE	Engineering Cost Consultation Enterprise
ICEC	International Cost Engineering Council
KIBS	Knowledge-intensive Business Service
MHURD	Ministry of Housing and Urban-Rural Development of the People's Republic of China
NDRC	National Development and Reform Commission
PAQS	Pacific Association of Quantity Surveyors
VA	Value Analysis
VE	Value Engineering
WTO	World Trade Organization

1 Introduction

This study deals with challenges of engineering cost management in cost consultation industry in China. Consultancy services which provide help in engineering cost calculations belong to the so-called industry of engineering cost consultation. This industry was formed with the establishment of the Chinese market economic system. The cost consulting enterprises that provide these services participate in project management of big construction projects, such as constructions of network of power lines and substations. These cost consulting enterprises provide the services of establishing and controlling the engineering cost in big construction projects. The cost consulting enterprises also ensure the efficient investment of the state and the owners resources, and safeguard the interests of parties in the market.

This thesis focuses on improving of the engineering cost consultancy services in the whole construction process. The whole construction process refers to a holistic project process from the analysis of feasibility, preparation to construct, to the completion of project. The project construction is inseparable from the scientific management provided by professional staffs from different enterprises in the whole process. This study is conducted from a point of view of an electrical power enterprise and aims to improve the cost consultancy services from this perspective. The electrical power enterprise is responsible for the investment, construction and management of a power grid, transmission and distribution operations, electricity trading and scheduling, and is often acts as a client of cost consultancy services.

1.1 Key Concepts

Engineering cost consultation service (ECCS) refers to a service of compiling and auditing the cost and related documents of construction projects. These projects and costs typically include such stages as a feasibility study, investment estimates, economic evaluation, budgetary estimate, budget, settlement, final accounts, a base price, tender quotation, and similar steps. An ECCS also means the intelligence service to monitor the project cost and provide the relevant cost information for projects (Jiang 2012: 23). At present, the business scope of cost consultation has been broadened to include also the valuation of engineering quantity list and the claim in construction.

According to the official definition by the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MHURD), *an engineering cost consultation enterprise* (ECCE) is defined as an independent legal person or enterprise which is established according to the law and the provisions of the state. Suh an enterprise obtains a qualification certificate of cost consultation and provides professional service related to the control and management of project cost for the owner, the contractor and the relevant parties in the construction market (Ministry of Housing and Urban-Rural Development of the People's Republic of China 2006). ECCE is one of the entities in construction market and belongs to the social intermediary organizations.

1.2 Background of the Industry

The industry of engineering cost consultation is an emerging industry. In this industry, ECCE and practitioners provide professional services, through establishing and controlling the project costs and issuing the official documents on the project cost. As a result, ECCE needs a highly professional organization and personnel with a professional knowledge background, project control experience, and advanced tools of cost management. In practice, it means that ECCE should be a consultant group of the experts in engineering cost management and control.

In the ECCE context, *the consultant* typically refers to an independent professional firm, legal successors, and permitted assignees to the consultant. Such consultants are typically employed by the client in order to obtain consultation services (International Federation of Consulting Engineers 1998). In China, consultants in ECCE mainly imply the national registered cost engineers and cost members in different provinces, the personnel who have obtained the certificate of registered cost engineer, and are engaged in engineering cost activities (Ministry of Housing and Urban-Rural Development of the People's Republic of China 2006). In 2000, MHURD issued the Qualification Managerial Regulation for ECCE, through which the state established the independent status of this industry.

Presently, the industry of engineering cost consultation is developing rapidly, and it plays an important role in the cost management of construction project and even in the whole market of construction, which attracts more attention from the government and society in China.

1.3 Background of the Customer

In the industry of engineering cost consultation, one of the significant customers is the project owner that is in charge of the completion of project in limited investment and schedule. In the project of electrical power construction, the customer is the electrical power enterprise, which can offer power and related infrastructure to other industries. As a result, electrical power enterprise needs help from ECCE in the construction process. From the stage of investment decision to the stage of completion acceptance, the electrical power enterprise needs to compile and check investment estimates, budgetary estimates, budgets, settlements, final accounts, and other costs. Thus, the electrical power enterprise would typically engage a professional ECCE to help them complete the documents of engineering cost. For example, in the phase of completion, electrical power enterprise needs to pay the contractor and submit the settlements to upstream authorities when the construction project was completed. The electrical power enterprise would then assign an ECCE to compile and check the engineering settlements.

Both the market of ECCS and the construction market have opened up to the world since 2005. The foreign enterprises in cost consultation have the advanced management, and efficient service. They compete with Chinese enterprises in the consultation market (Qianzhan Business Information 2014). In the next years, more and more foreign enterprises in cost consultation will offer professional consultancy services to the one of the significant customers – project owner, such as the electrical power enterprises. As a consequence, Chinese industry of engineering cost consultation faces opportunities of development and simultaneously considerable challenges.

1.4 Business Challenge

In China, in the last fifteen years, with the advent of market economy, the industry of engineering cost consultation has become an independent industry, due to the need for objective and just consultation services provided by a third-party, as a professional service. Therefore, at present, the consultation business of ECCE is growing, and ECCEs play an important role in the determination and control of engineering costs. On the other hand, upon China having joined into the World Trade Organization (WTO), the government aims to speed up the process of engineering cost management. Therefore, ECCEs have become an important force to maintain the success of construction projects and promote investments in the market.

However, presently, most of the businesses in ECCE mainly focuses on creating the budget, acting as a tender agent, and auditing. While economic evaluations, pre-feasibility studies, proposals are rarely involved into the scope of activities. Therefore, from the business and customer perspective, ECCS is currently incomplete. As a result, ECCE does not yet play a significant enough role in the construction market. Due to the incomplete consultation services and limited business scope, consultation services of ECCE need to be improved.

1.5 Objective

One of the ways for ECCE to improve their professional services is the need to participate into a more holistic process of engineering cost management, which would range from investment decision-making to completion acceptance. If a more holistic perspective to this process is accepted, through better matching the practices between ECCE and project owner in each stage, a more effective relationship could be established. In the context of customers, ECCE should more precisely recognize the needs of electrical power companies and co-create value with electrical power companies through different stages of the construction process. As a result, the engineering cost could be determined and controlled more effectively if relates to the whole construction process.

However, this clear target of extending the range of the process to a more holistic one and matching it better to the customers' process is complicated by the challenges also on the customer side. When, for example, electrical power enterprises, as customers of ECCE, offer power and related infrastructure to other industries, they need ECCE to help them determine and control the engineering cost in their construction projects. However, most of ECCEs themselves have no systematic project management process and lack CRM methods in construction processes. This results in low performance, incomplete consultancy services and the dissatisfaction of the electrical power company as a customer of ECCE, due to a lack of the effective connection between the enterprises and the customers. Consequently, the urgent need to be solved in ECCE is to establish an effective relationship with customers along the construction process and enhance the consultancy performance in the whole construction process.

This study therefore aims to develop an improved proposal to consultancy service provided by the consultation enterprises for the whole construction process. In the future,

through applying this proposal to the practices, ECCE can provide more complete and efficient consultancy service for their clients. ECCE can manage customer relationships more efficiently and enhance the performance of consultancy service more quickly. As a result, engineering cost can be controlled more accurately and effectively in the whole construction process.

Accordingly, the outcome of this thesis is a proposal for consultancy services for ECCE, through which ECCE can enhance the performance effectively in the whole process of construction project.

This thesis is composed of six main sections. Section 1, introduction, presents the background, business problem, and clarifies the objective, significance and intended outcome of this study. Section 2 overviews the research approach, research design, and describes the data collection. Section 3 presents the results of the current state analysis of the current engineering cost management based on the ECCS, in order to conclude the strengths and weakness of the consultancy services in ECCE.

The practical part, Section 4 discusses the key concepts of KIBS and CRM and outlines the approach of matching practices of the supplier and customer, as well as touches on the process of engineering cost management and consultation services. Based on these key concepts, the conceptual framework is built to improve the approach to the consultancy services of ECCE. Section 5 presents a consultancy service improvement proposal for ECCE, divided into seven consultancy stages, in order to enhance the existing consultancy services of ECCE. Finally, Section 6 concludes the study by presenting the final improvement proposal for ECCE and discussing the next practical steps for ECCE to enhance the consultancy services.

2 Method and Material

This section overviews the research design and data collection and analysis methods applied in this study.

2.1 Research Approach

This thesis utilizes case study as its research approach. A case study is research approach that investigates the contemporary phenomenon within its actual context in real life through an experimental inquiry, especially when the boundaries between the phenomenon and the context are not clearly evident (Yin 2003: 13). Basic steps of the case study are presented in Figure 1.

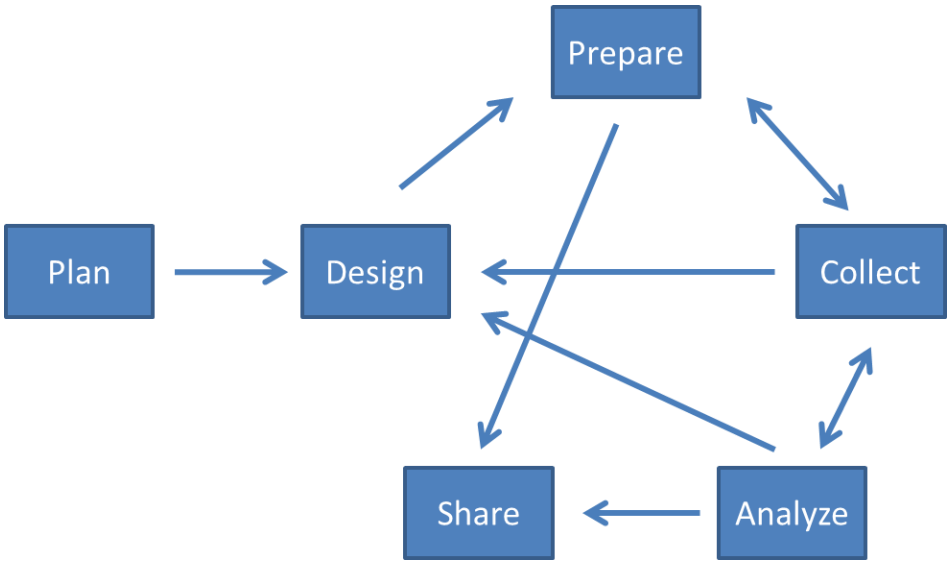


Figure 1. Flow of case study (Based on Yin 2013: 1).

As shown in Figure 1, the case study approach makes a linear but iterative process. Firstly, the researcher plans will be studied. After that, researcher designs the data collection and implementation of the first case study analysis (data collection and analysis). Repeat as many times as needed. Finally, researcher analyses and makes the conclusion (Yin 2009: 50). The case study always relies itself on multiple sources of data jointed in a triangulating fashion (Yin, 2003: 14). In this thesis, the case study approach is utilized because it is suitable for the business challenge and the case context. Since the case study allows combining both qualitative and quantitative data from multiple sources such as interviews, questionnaires, personal observations, and other types of data, it was selected as a research approach for this study.

2.2 Research Design

In this thesis, the research design includes five key steps in order to reach the objective. The study starts with identification of the business problem in the industry of engineering cost consultation. The next step includes the current state analysis of engineering cost management based on ECCS. At this stage, in order to investigate which parts need to be improved, the study includes the analysis of questionnaires and the researcher's observations in China Southern Power Grid Company Limited (CSG) to explore those poor performance points. The purpose of questionnaires is to analyze the current state of engineering cost management with the incomplete consultancy services to the electrical power company offered by ECCE in the context of the whole construction process.

Based on the results of the current state analysis, the study seeks to suggest improvements to the current process of ECCS. In order to ground these proposals in the existing knowledge, the study investigates available knowledge, theories and best practice, of matching supplier and customer practices into a holistic process, as well as discusses the approaches to CRM and engineering cost management, to build the conceptual framework for the proposal. The existing knowledge discussed in the study includes the theories of knowledge intensive business service (KIBS), customer and supplier practices, and engineering cost management.

After that, the study concentrates on investigating the background of the industry of engineering cost consultation, including the procedures and regulations related to engineering cost management. The study also analyses the internal managerial documents from CSG to build the improved proposal to consultancy service for ECCE. Finally, the study proposes (a) covering the process of ECCS divided into seven consultancy stages, (b) how to improve ECCS effectively.

Figure 2 shows the five stages included into the research design of this study.

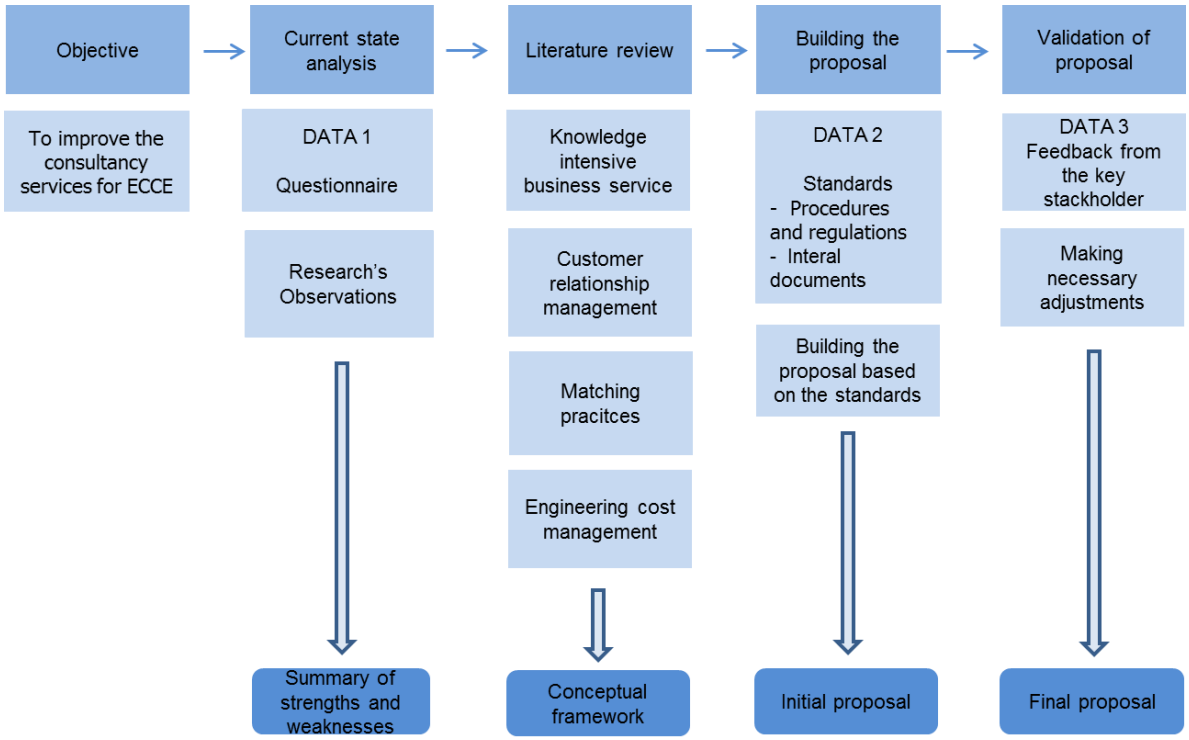


Figure 2. Research design of this study.

Figure 2 shows the stages of the research design of this study. In Step 4, proposal building, the stages of the more holistic consultancy process are proposed. The study ends with validation of the proposal which includes the final adjustments based on the validation feedback.

2.3 Data Collection and Analysis Methods

In this thesis, data is collected from four main sources: (a) the questionnaires and researcher's observations, (b) procedures and regulations from China Engineering Cost Association (CECA), (c) internal documents from CSG, and (d) interviews in CSG and ECCE. These data sources are describe in more detail below.

2.3.1 Questionnaire and Observations (Data 1)

Data 1 for this study was the questionnaire conducted by the researcher. To conduct the questionnaire, the researcher used an online software tool from the website (Shanghai Cycle Information Technology Company 2005). The website is a well-known professional survey tool in China, which offers survey services to more than 1200 universities and 16000 enterprises including 113 of the world's top 500 enterprises. In

order to conduct the survey, the researcher chose the respondents who joined into engineering cost management in the whole project construction process, and received 43 replies from the project owners, ECCE, contractors, designers, who could comprehensively evaluate the current consequence of engineering cost management with incomplete consultancy services of ECCE. All questions were asked from the perspective of the engineering cost management in whole process with the consultancy services offered by ECCE.

The objective of the questionnaire was to evaluate and recognize those performances in the current engineering cost management with ECCS. Based on the results, it was concluded that the current ECCS needs improvement in order to create better value between the project owner and ECCE. The 80 questions included in the questionnaire are given in Appendix 1. An example question is shown in Table 1 below.

Table 1. Sample question from the questionnaire.

02. How feasible the consultation work plan is?						
Very infeasible	□ 1	□ 2	□ 3	□ 4	□ 5	Very feasible

This example question is included in the topic related to I. Preparation stage in the questionnaire. In order to respond, the respondents could choose *very feasible, feasible, normal, infeasible, and very infeasible,* evaluated on the scale from 1 to 5 points.

The respondents gave their answers to the questionnaire on a five point scale. The questionnaire answers were transformed in to weighted average values for the evaluation:

$$V=[\sum_{i=1}^{n} WiTi]/\sum_{i=1}^{n} Wi \qquad \text{(n=1,2,3...43)}$$

Where V is the evaluation value, T_i represents the values for each question in the range of [1,2,3,4,5], and W_i is the number of respondents who chose the according value (T_i). The results for the questionnaire analysis are shown in Appendix 2.

In addition to conducting the questionnaire, the researcher also observed certain practices when working in CSG. In daily work, the researcher observed most of the ECCE, which are small-scale enterprises. Technologies in such enterprises are weak. Since the ECCS is one of the KIBS, ECCE needs the employees who have the knowledge

both highly specialised and learned through a professional process typically. In practice, due to lack of the top talents, the registered cost engineers and experienced cost personnel account for small proportion in ECCE, the cost personnel's professional quality would impact on the competitiveness of ECCE directly.

In the contract enforcement stage, deviation is unavoidable and the analysis of deviation is vital for controlling the engineering cost. In practice, the ECCE can rarely be assigned to calculate the deviation accurately, because both the project owner and consultant usually ignore the dynamical management. Dynamical management is an effective managerial method for investment control. Consequently, ECCE rarely analyse the reasons for investment deviation, schedule deviation and give feasible suggestions how to correct the deviation.

Based on the results from the analysis of (a) the industry questionnaire results, and (b) the case researcher's observations, the researcher built the improvement proposals for enhancing the current consultancy services for ECCE in the context of the whole construction process.

2.3.2 Procedures and Regulations (Data 2)

This study selected and analysed four procedures and regulations in order to identify clearly the standards for engineering cost management with ECCS. These documents concern (a) cost consultation procedures for the construction project, (b) managerial regulations for ECCE and the consultants, which are issued by MHURD and CECA officially.

The procedures and regulations used for building a picture of requirements, limitations and guidance in the industry of engineering cost consultation, analysed in this study, include the following documents, as listed in Table 2 below.

Table 2. Procedures and regulations concerning engineering cost management.

	Document	*Authority*	*Date of issue*	*Date of implementation*
1	Procedure for Cost Consultation in the Whole Construction Process	CECA	20.05.2009	01.08.2009

2	Consultation Contract of Engineering Cost (model text)	MHURD	22.07.2002	01.10.2002
3	Managerial Regulation for ECCE	MHURD	22.03.2006	01.07.2006
4	Managerial Regulation for National Registered Cost Engineers	MHURD	25.12.2006	01.03.2007

The procedures and regulations, listed in Table 2 above, include the regulatory documents in field of engineering cost management which, when gathered together, formed the foundations for providing professional cost consultancy services offered by ECCE. These documents were analysed to reveal the requirements, limitations and guidance for operations of ECCE in this study.

China Engineering Cost Association (CECA) is the association in the national engineering cost industry voluntarily formed by the units engaged in the construction engineering cost consulting services and engineering cost management as well as the cost engineers, senior experts and scholars with the registration qualification. CECA formation was approved by the Ministry of Construction of People's Republic of China and approved and registered by the Ministry of Civil Affairs. CECA became a full member of the Pacific Association of Quantity Surveyors (PAQS) and the International Cost Engineering Council (ICEC) separately in 2004 and 2007.

In order to analyse clearly the requirements, limitations and guidance for operations in ECCE, this study collected the terms from the four procedures and regulations, which indicate the requirements for the ECCS during the consultancy process. The terms in the procedures and regulations are shown in Appendix 3.The results were summarized into the key points of ECCS during the consultancy process; the improved proposal was later developed to enhance the performance of engineering cost management.

2.3.3 Internal Documents (Data 2)

This study selected and analysed six internal managerial documents to state clear requirements for the engineering cost management in the whole construction process, with the results summarized into the key points of engineering cost management for

every construction stage. Based on these identified requirements of customer, the improved proposal was later developed.

In order to build the improved proposal in the context of electrical projects, six documents from the real construction cost projects were collected, specifically related to the engineering cost management in CSG. The documents selected for analysis in this study are shown in Table 3 below.

Table 3. Documents for engineering cost management in CSG.

Document	*Date of issue*	*Date of implementation*
1. Management Regulation for Infrastructure Project	27.05.2014	30.05.2014
2. Regulation of Engineering Cost Management (Trial Implementation)	31.01.2011	31.01.2011
3. Managerial Regulation for Construction Drawing Budget (Trial Implementation)	25.01.2011	25.01.2011
4. Managerial Regulation for Preliminary Design Budgetary Estimate (Trial Implementation)	25.01.2011	25.01.2011
5. Managerial Regulation for Settlement (Trial Implementation)	30.01.2011	30.01.2011
6. Regulation for the Informatization Engineering Cost	12.09.2013	01.10.2013

The documents listed in Table 3 above were selected from CSG, which operates in the electrical infrastructure projects. It is one of two power companies in China. It was established in 2002 after the power sector de-regulatory reform in China. It is responsible for investment, construction and management of power grid, transmission and distribution operations, electricity trading and scheduling in five southern provinces.

This part of data collection was done in order to recognize the national standards related to the engineering cost management and the customer's needs in real projects. After that, the researcher built the improvement proposal to the consultancy services for ECCE.

2.3.4 Interviews (Data 3)

In addition to conducting the questionnaire and scrutinizing the study procedures and regulations, as well as analysis of the internal documents, the researcher also interviewed the leader from the engineering cost management department in CSG and the executive in the ECCE. Details of the interviews are shown in Table 4 below.

Table 4. Basic information of the interview.

No.	Company	Position	Date
1	China Southern Power Grid Company Limited	Head in the Department of Engineering Cost Management	Nov. 2015
2	PU CHENG ZHENG HUA Consultancy Company in Engineering Cost	Executive	Nov. 2015

The research chose the manager in charge of the engineering cost management in CSG and the executive in the ECCE to make the interview, because they are the stakeholder in the process closely familiar with the topic, familiar with the topic of this thesis. And the manager manages a number of ECCEs to conduct the consultancy jobs in his electrical power company. The interview included such topics as business scope, quality of consultancy service, communication skill, and consultants' qualification.

2.4 Validity and Reliability Plan

Validity and reliability plan is essential to academic research. Validity and reliability relates to the challenge of making research credible, transferable, dependable and confirmable (Watkins 1991: 5). Validity and reliability refer to both the research methods and outcomes in the academic research. To produce reliable outcomes, correct research methods including data collection and literature review are required to avoid researcher's bias (Maxwell 1996: 109), and that is what validity and reliability is concerned with.

Validity relates to concentrating on the right research questions which would correctly address the expected outcomes, as well as the selection of the corresponding analysis and data collection methods (Quinton 2006: 127). In this study, in order to gain a clear picture of the current cost consultancy process in the case company, the plan is to

conduct interviews with the relevant personnel and the questionnaire from all parties involved in the construction process. This is planned as a measure to ensure that researcher obtains enough information about the operations and practices related to the study. This study is also planned to collect and analyse the procedures and regulations issued by official authorities and the company internal documentation to build the improved proposal. At the proposal building phase, feedback from the manager in the case company needs to be collected for building the improved proposal to consultancy services for ECCE in the construction process. Finally, evaluation of the final proposal also needs to be arranged.

Reliability is derived from the research outcomes. The outcomes need to be compared with previous researches which have been clarified as criteria (LeCompte 1982: 32). To strengthen the reliability, data is planned to be collected by using various methods and resources according to research procedure. In this study, the data collection is planned to include the procedures and regulations in the industry of engineering cost consultancy, internal documents and the interview with manager in the case company and the questionnaire concerning engineering cost management based on ECCS. For this reason, it is assumed that the information given for the research is reliable.

All phases of the study is planned to support the concept of reliable and valid academic research. The validity and reliability issues taken into consideration in this study will be eventually evaluated in Section 7.3.2.

3 Current State Analysis of Engineering Cost Management Based on ECCS

In order to analyse the current state of engineering cost management and the CRM in the constructions process as operated by ECCEs, the study conducted the questionnaire on 80 topics concerning the current state of engineering cost management and the services offered by ECCE. In addition, the current state also analysed with the interview and the researcher's observation in the case company.

When the researcher discussed with the executive in ECCE, the executive believed their company have no efficient system of CRM recently. But the amount of consultancy business is increasing continuously, because of the favourable policy to enlarge the construction in China.

> *"We do not have the system of CRM and we do not need to establish it right now, because our company have the enough volume of business to support our development recently. And the customers contact us to assign the consultancy tasks actively."*

However, with the enough constructions completed, the national policy will change to decrease the scale in construction market in China. After that, the amount of business in ECCE will decrease gradually. Therefore, it is vital to build an improved proposal to consultancy service for ECCE. Through this proposal, ECCE can offer better consultancy services to satisfy the customers' needs and the engineering cost management also can be enhanced in the construction process.

3.1 Current Practices in the Industry

The current practices in the industry of cost engineering consultation were identified based on the analysis of the results of the questionnaire combined with the researcher's observations. These results are analysed in more detail below and lead to the strengths and weaknesses of the current consultancy services in the process of ECCS.

3.1.1 Basic Information of Respondents

The main contents of questionnaire include three parts: the basic information on companies, the basic information on responds, and the questionnaire on the key points in

engineering cost management based on ECCS. This questionnaire totally includes 69 questions except for the basic information discussed below.

In order to accurately analyse the current engineering cost management with the incomplete consultancy services offered by ECCE, the author chooses the respondents who are familiar with the knowledge of engineering cost management and consultation service. On the one hand, the respondents are the leaders, managers and operators in ECCE. Figure 3 illustrates the position of the respondents in the companies. On the other hand, the respondents are customers of ECCE in CSG, which are the project owner. In addition, the consultancy companies joining the projects are also respondents. The category of the companies in questionnaire is presented in Figure 4.

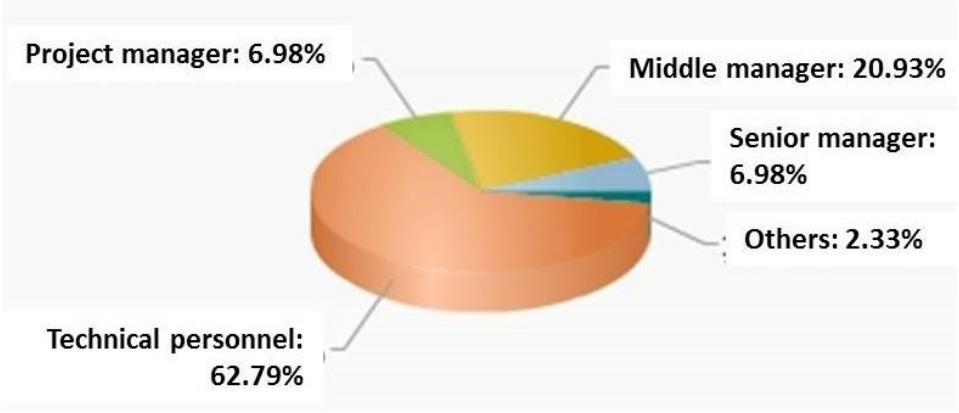


Figure 3. Position of the respondents in questionnaire.

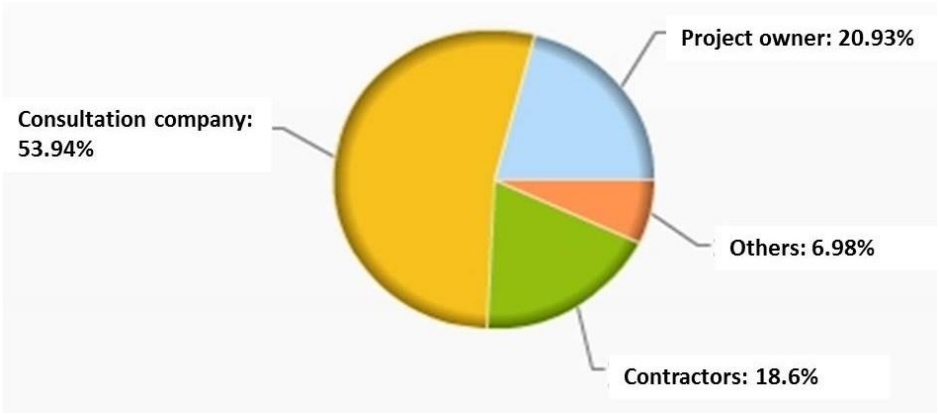


Figure 4. Category of the companies in questionnaire.

As shown in Figure 3, the major of the respondents work as technical personnel, which accounts for 62.79%, and 20.93% of the respondents work as middle managers, 6.98% of the respondents work as senior managers. As shown in Figure 4, most of the re-

spondents to the questionnaire work for ECCE and CSG in China. The main part of these respondents work in ECCE, which accounts for 53.94%, and the second major part of these respondents work in project owners, which accounts for 20.93%.

The industry of engineering cost consultation is an emerging industry. Therefore, most of ECCE were newly established, which is shown in Figure 5. Meanwhile the working experiences of cost personnel impact on the competitiveness of ECCE, and also influence the efficiency of engineering cost management directly. The working years of the respondents in ECCE is presented in Figure 6.

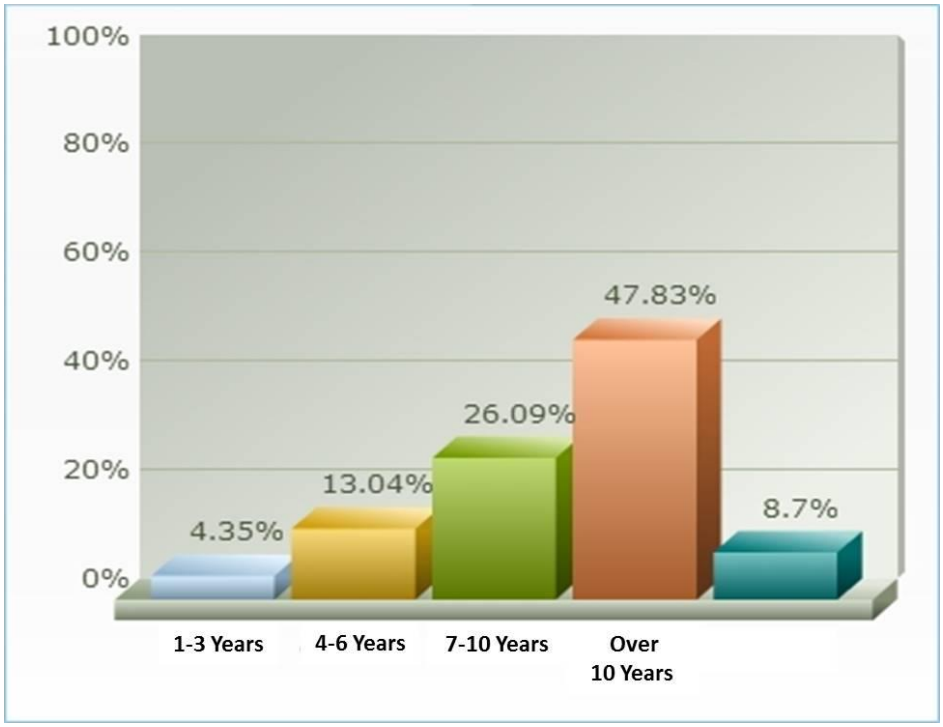


Figure 5. Establishment years of ECCE.

Figure 5 shows that the ECCE established over 10-years accounts for 47.83%, and the ECCE established in 7-10 years accounts for 26.09%. 4.35% ECCE were established only 1-3 years. Due to a huge number of projects constructed, the electrical power company needs numerous ECCEs to help them manage the engineering cost. However, not every ECCE are experienced and competent.

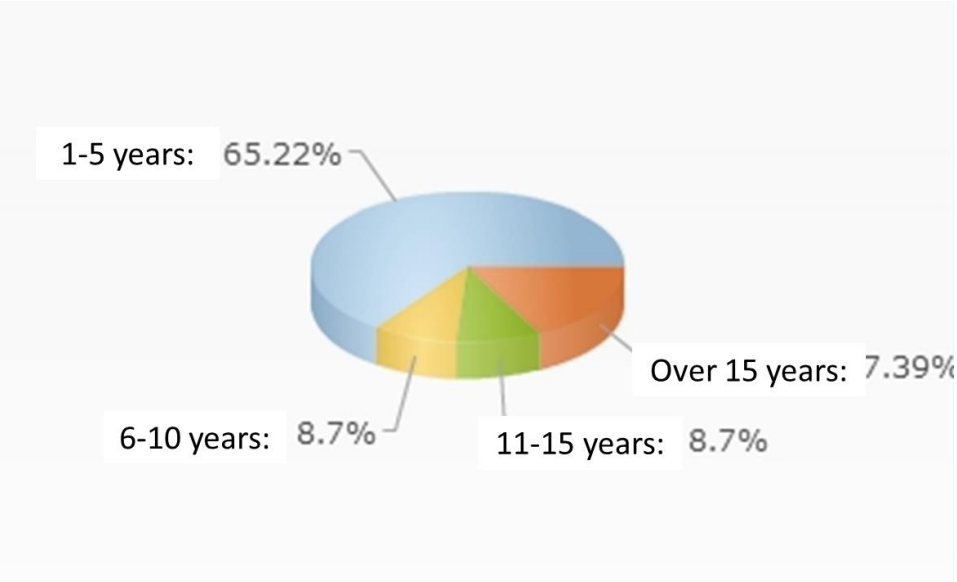


Figure 6. Working years of the respondents in ECCE.

As shown in Figure 6, in ECCE, a small part of the respondents have worked in this field for 15 years, and 65.22% of respondents only have worked in the field for 1-5 years. The consultants are lack of working experiences in real projects. The employees' professional level needs to be improved in ECCE as a KIBS.

The industry of engineering consultation belongs to KIBS, which needs qualified and experienced personnel. So far, as the education background is concerned, the consultant with the bachelor degree accounts for 82.61%. No consultant has a Master's degree or a Doctorate in ECCE. Due to the requirements in national regulations for ECCE, the consultants in ECCE have to receive the qualification issued by the authorities. The qualification of the respondents in ECCE is presented in Figure 7.

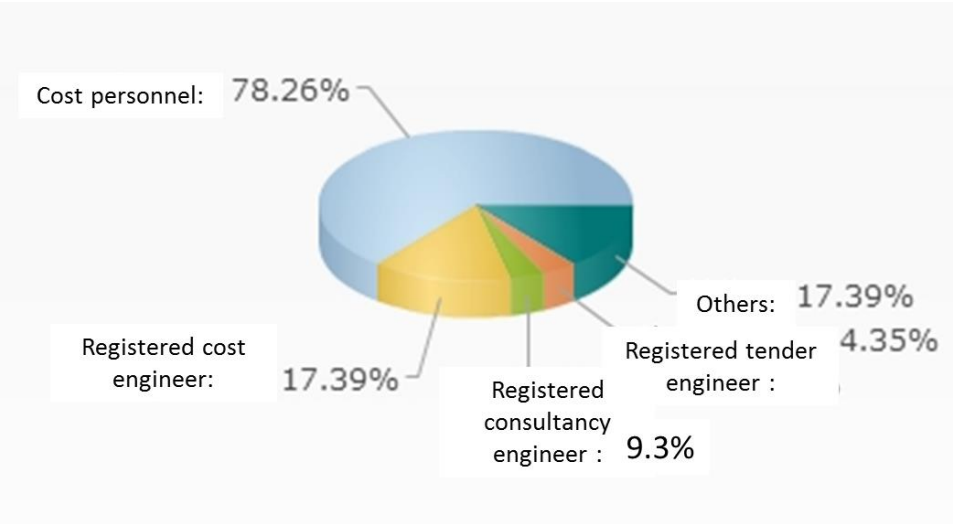


Figure 7. Qualification of the respondents in ECCE.

Figure 7 shows that the respondents in ECCE have the qualification of cost personnel accounts for 78.26%, and the respondents acquired the registered cost engineer accounts for 17.39%. The rest of respondents are registered tender engineer (4.35%) and registered consultation engineer (9.3%). As one of KIBS, ECCE is lack of the top talents presently, the registered cost engineer accounts for small proportion in ECCE.

3.1.2 The Result of Questionnaire

The questionnaire was analyzed on a five-point-scale investigating means how well the consultancy services are done at present. The scale of one to five respectively means a very poor situation, a poor situation, a normal situation, a good situation, and a very good situation. The answers of questionnaire were transformed to these average values for numerical evaluation. All the results are shown in Appendix 2. According to the result of questionnaire, the researcher points to the strengths and weaknesses of consultancy services at the end of Section 3.

Based on the results, in the stage of service preparation, ECCE organize the consultancy personnel and make the work plan of consultation service. In the opinion of in the project owner, 66.67% of respondents think the quantity of consultation personnel is reasonable, and 55.56% of respondents believe the qualification of consultation personnel is also suitable. Meanwhile, the small part of respondents thinks the work plan need to be adjusted more practical (33.33%).

In the stage of feasibility study, presently, the electrical power company usually ignores the importance of the project cost management to the investment decision-making, which leads to the feasibility study lacking of scientific proof. As the result of questionnaire, the precision of the investment estimate sometimes cannot meet the requirement for the investment selection and economic evaluation as shown in the below figure 8.

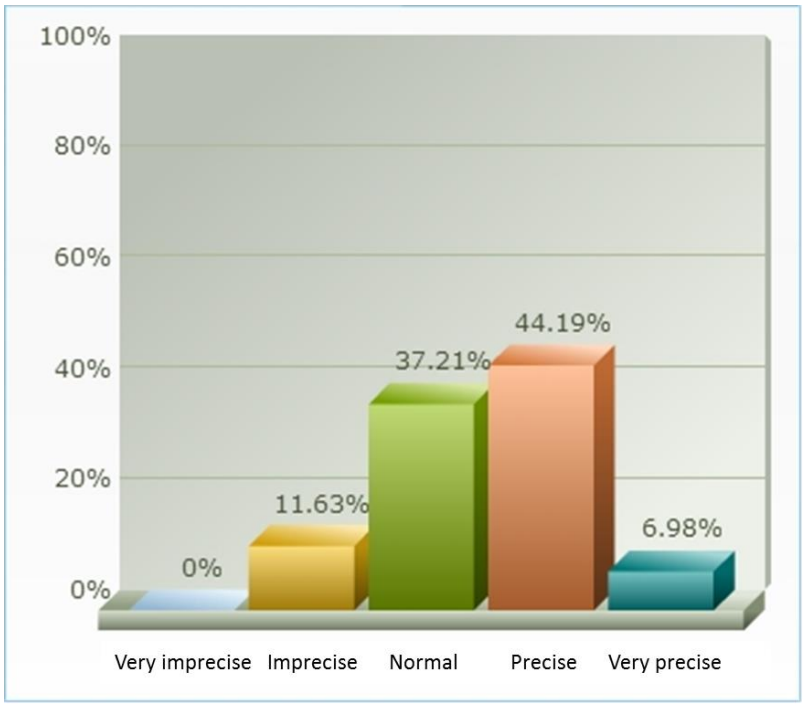


Figure 8. Precision of investment estimate.

Figure 8 shows that only 6.98% of respondents believe the investment estimate is very precise, 44.19% of respondents believe the investment estimate is precise. The rest of the respondents think the precision of the investment estimate should be improved through the professional services offered by ECCE. Meanwhile, the depth of the investment estimate is another vital factor to the right decision-making. In practice, the depth of the investment estimate sometimes also cannot meet the requirement for the investment selection and economic evaluation as shown in the below figure 9.

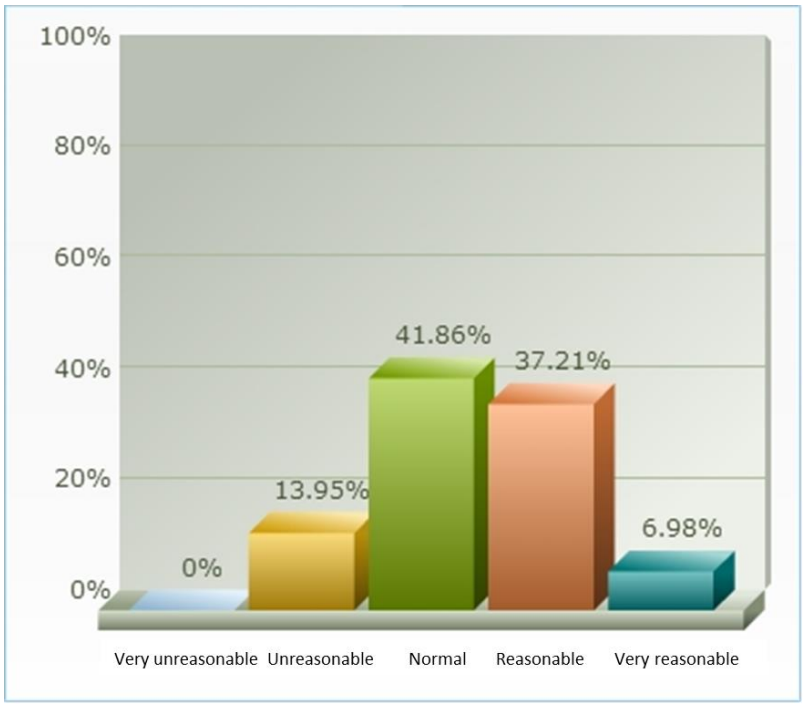


Figure 9 . Depth of investment estimate.

Figure 9 shows that only 6.98% of respondents believe the depth of investment estimate is very reasonable, some respondents think the depth of the investment estimate is reasonable (37.21%), and some respondents think the depth of the investment estimate is in normal lever (41.86%). As a result, most of respondents think the depth of investment estimate should be improved through the professional services. Both the electrical power company and ECCE ignore investment decision-making, they just pay more attention to the implementation of construction.

Due to political purpose or other reasons, some project owners are used to starting the construction without the economic evaluation of investment in China. A part of the feasibility study is lack of scientific reasoning, and exaggerate the economic benefit, through reducing the investment estimation. For a long time, due to the lack of effective basis, the investment decision-makers determine the cost evaluation only depending on their experiences in the cost of completed projects. And the bias of investment estimation leads to the low investment benefit, which is revealed from the result of the questionnaire. Figure 10, 11, and 12 below show the accuracy of economic evaluation in the stage of investment decision-making.

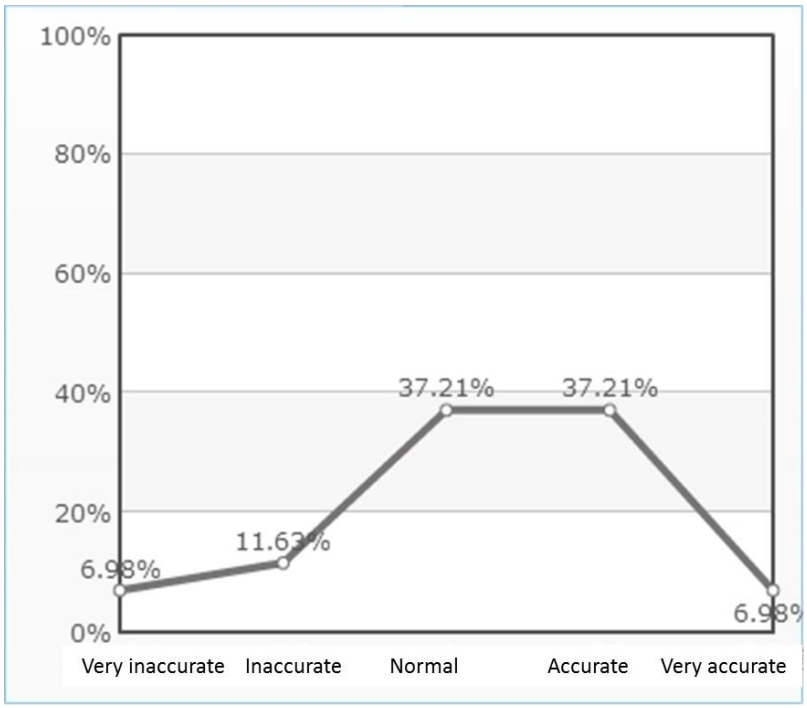


Figure 10. Accuracy in profitability analysis.

Figure 10 shows that only 6.98% of respondents believe the profitability analysis is very accurate, some respondents think the profitability analysis is accurate (37.21%), and some respondents think the accuracy in profitability analysis is in normal lever (37.21%). As a result, most of the respondents believe the accuracy in profitability analysis needs to be improved as soon as possible.

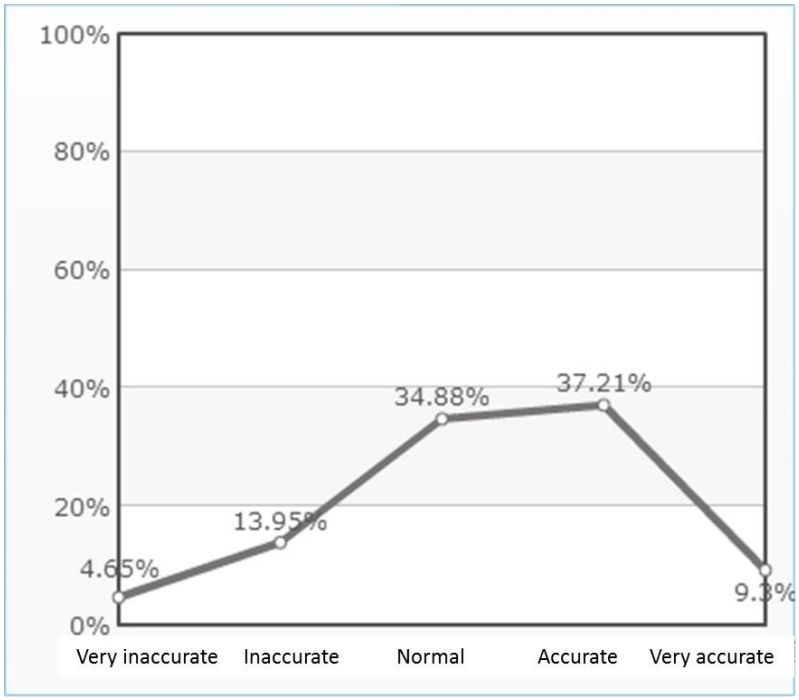


Figure 11. Accuracy in solvency analysis.

Figure 11 shows that only 9.3% of respondents believe the solvency analysis is very accurate, some respondents think the solvency analysis is accurate (37.21%), and some respondents think the accuracy in solvency analysis is in normal lever (34.88%). And 13.95% of the respondents believe the solvency analysis is not accurate. So, most of the respondents believe the accuracy in solvency analysis also needs to be improved as soon as possible.

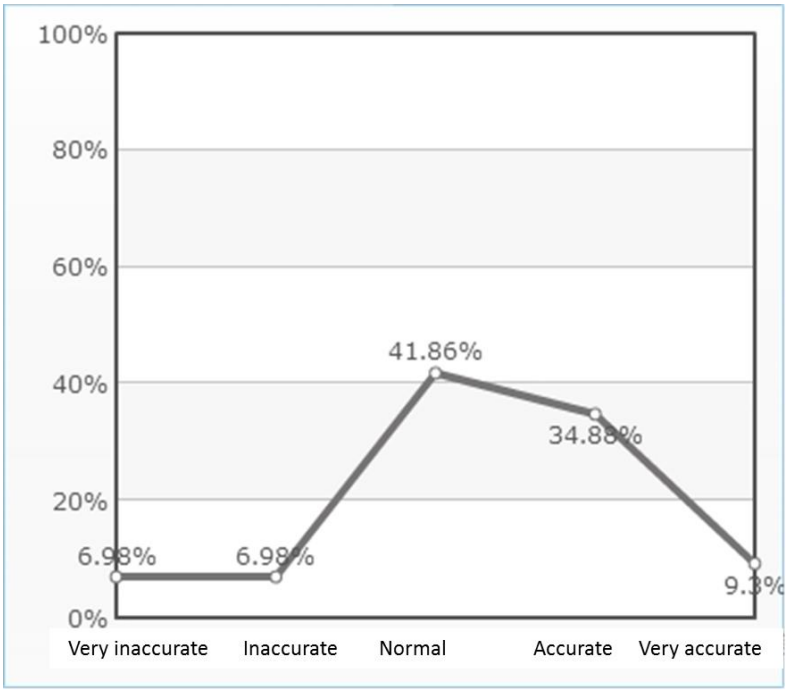


Figure 12. Accuracy in uncertainty analysis.

Figure 12 shows that only 9.3% of respondents believe the uncertainty analysis is very accurate, some respondents think the uncertainty analysis is accurate (34.88%), and some respondents think the accuracy in uncertainty analysis is in normal lever (41.86%). And 6.98% of the respondents believe the uncertainty analysis is not accurate. So, most of the respondents believe the accuracy in uncertainty analysis also needs to be improved as soon as possible.

Figure 10, 11, and 12 all in all show that the economic evaluation of investment is not precise enough for the investment decision-making. Consequently, the project cost is out of control from the beginning due to the poor quality of the feasibility study. Due to the ineffective information, the limited quantity of employees, and the poor quality of

employees, the investment estimation is not accurate. In addition, some owners are eager to implement the investment projects, there is no in-depth preparation and adequate investment forecast, some conditions of financing and cooperation are assumed based on the experiences. Consequently, the ECCE blindly compile the report of feasibility study and investment estimation, the investment decision-making is lack of scientific nature, the total target of cost control is unclear, the project is lack of technology advancement and economic rationality.

In the design phase, fortunately, the electrical power company starts to appoint ECCE to review the drawing budget, authorized drawing budget is the limited price for the bidding and construction contract, and the fees in bidding stage is controlled according to the drawing budget. However, most of owners ignore the cost control in the design stage, because they believe that the cost control is unnecessary in this stage. For the field of electrical power design, it is generally considered that the designer is responsible for design only, and engineering cost is calculated by cost personnel. Cost personnel passively receive the documents and drawing to calculate the budget without a site survey. From the results of questionnaire, the author finds out mainly two key points ignored by ECCE, designers and the electrical power company in the design stage, namely:

As the first point the designer cannot receive more reward from the cost saving, and the analysis of function and cost consume more working time, the analysis of function and cost is ignored by designer usually. Figure 13 shows how the analysis of function and cost is done presently.

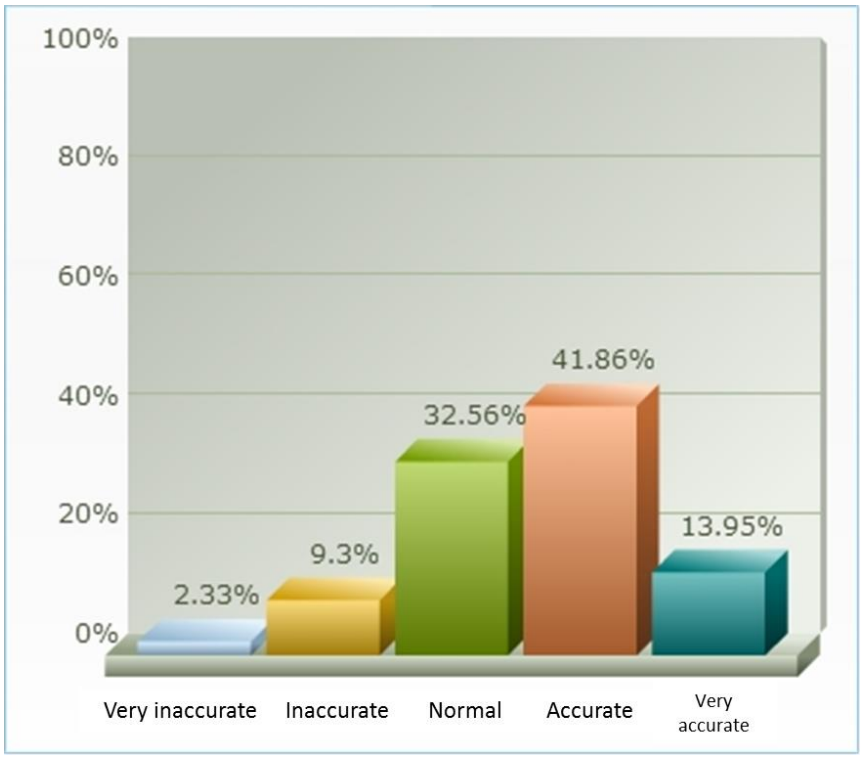


Figure 13. Analysis of function and cost.

As shown in figure 13, 41.86% of the respondents believe the analysis of function and cost is accurate, on the contrary, 44.19% of the responds believe the analysis of function and cost is less than accurate. Because the designers undertake more risk during the process of design optimizing, and the design fee is calculated based on total engineering cost, as a result, the designer is not willing to decrease the engineering cost through the design optimizing.

Due to the depth of design is not reasonable, and some contents are missed, this kind of design cannot satisfy the requirement of cost personnel. Consequently, cost personnel compile the budgetary estimate based on their own experiences and the costs in similar projects. The budgetary estimate is usually unsatisfied. However, most of the responds believe the analysis of the cost change resulted by design variation is accurate (62.79%). And 67.45% of the responds believe the deviation analysis between investment estimate and budgetary estimate is satisfied presently.

In the bidding phase, from the result of questionnaire, the tender documents of construction project have no omissions, clear and complete. The complete tender documents decrease the conflicts between project owners and contractors in the stage of settlement. Meanwhile, the most of respondents think the contracts and methods of

bidding evaluation are usually reasonable. However, some constructors lower the tender price on purpose to win the bidding. Consequently, the engineering cost is distorted seriously. Later in the stage of contract enforcement, the constructors usually gain additional income by various visas and technical changes at the construction site. This problem can be controlled by careful analysis to the tender price. Figure 14 inllustrates the situation of the analysis to tender price presently.

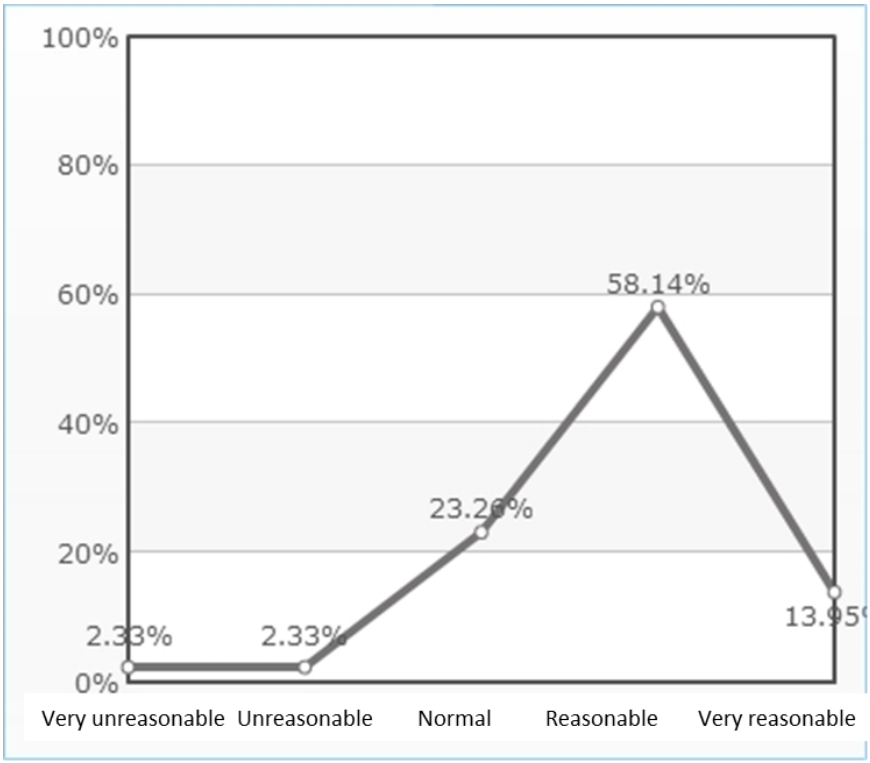


Figure 14. Analysis to tender price.

Form the result of questionnaire, 13.95% of the responds believe the analysis to tender price is very accurate, and most of the responds believe the analysis to tender price is reasonable presently (58.14%). However, 27.92% of responds think the analysis to tender price need to be more reasonable. And the project owners also believe the analysis to the tender price needs to be improved, because they think an efficient analysis can decrease the conflicts between the contractor and the project owner in the stage of contract enforement.

In the stage of contract enforcement, for the price of materials and equipment, CSG has the department to procure and supply the materials and equipment, which can control the engineering cost of materials and equipment effectively. From the result of

questionnaire, 11.63% of respondents think the price of the equipment and materials offered by owner is very accurate, 58.14% of respondents think it are accurate. A small part of the respondents believe the accuracy of the price need to be improved. Meanwhile, in a real project, the engineering claim is unavoidable. And the engineering claim concern the benifits of all parties which join in the construction project. As a result, the auditing of the engineering claim is vital to control the engineering cost management. The questionnaire indicates most of the respondents believe the compilation and audit of engineering claim is accurate, which accounts for 58.14%. 27.91% of respondents think this issue needs to be improved.

In this stage, the strict management of deviation analysis is an important works. Deviation is unavoidable during the construction process. In order to complete the project construction on time, the electrical power company usually pay more attention to the schedule, ignore the investment deviation. ECCE rarely is assigned to calculate the deviation and give feasible suggestions to correct the deviation in real projects. Based on the result of questionnaire, only 9.3% of respondents believe the deviation analysis is very satisfied. And the 39.54% of respondents believe the deviation analysis needs to be improved.

In practice, many electrical power companies are eager to start the construction building without necessary preparation. Meanwhile, the electrical power company does not monitor the amount of investment requirements, the building standards, the depth of design, the reasonability of tender documents and contracts. As a result, the design changed so many times during the construction process. And drawing mistakes and low-level designers usually lead to engineering variation. These engineering variations increase the engineering cost immediately. Electrical power companies rarely appoint professional cost personnel from ECCE to supervise the engineering variation in the construction site, which leads consultants from ECCE are not familiar with the real situation in site. Based on the questionnaire, 27.91% of the responds think the cost changes caused by the engineering variation need to be reviewed more accurately.

In the stage of completion acceptance, from the result of questionnaire, 51.16% of respondents believe the submission of settlement documents are timely, 60.46.% of respondents believe the settlement documents are complete, and 65.11% of respondents believe the settlement documents are authentic. However, the time limit in settlement

audit is another factor to a successful engineering cost management in this stage. The present situation of the time limit is shown in Figure 15.

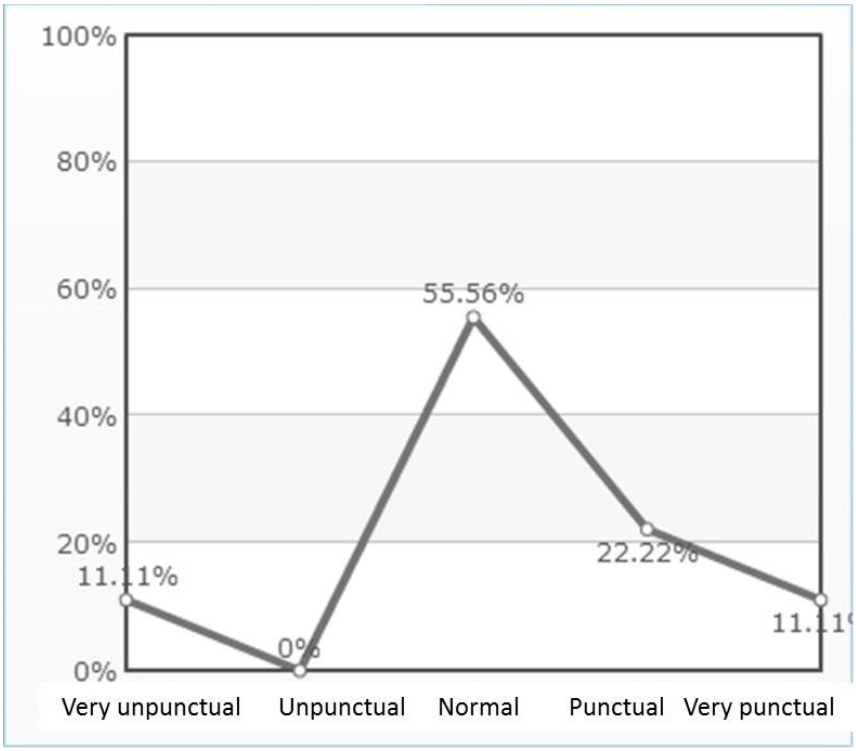


Figure 15. Time limit in settlement audit.

Figure 15 illustrates, in the opinion of project owner, only 22.22% of respondents think the settlement audit is punctual, most of the respondents believe the settlement audit is not punctual (55.56%), 11.11% of the respondent believe it is very unpunctual. Therefore, the time limit in settlement audit is unsatisfied.

In this stage, a main task to ECCE is to check the price of the equipment and material offered by owner, because it accounts most of the engineering cost. The accuracy in price audit for the equipment and material offered by owner is presented in Figure 16.

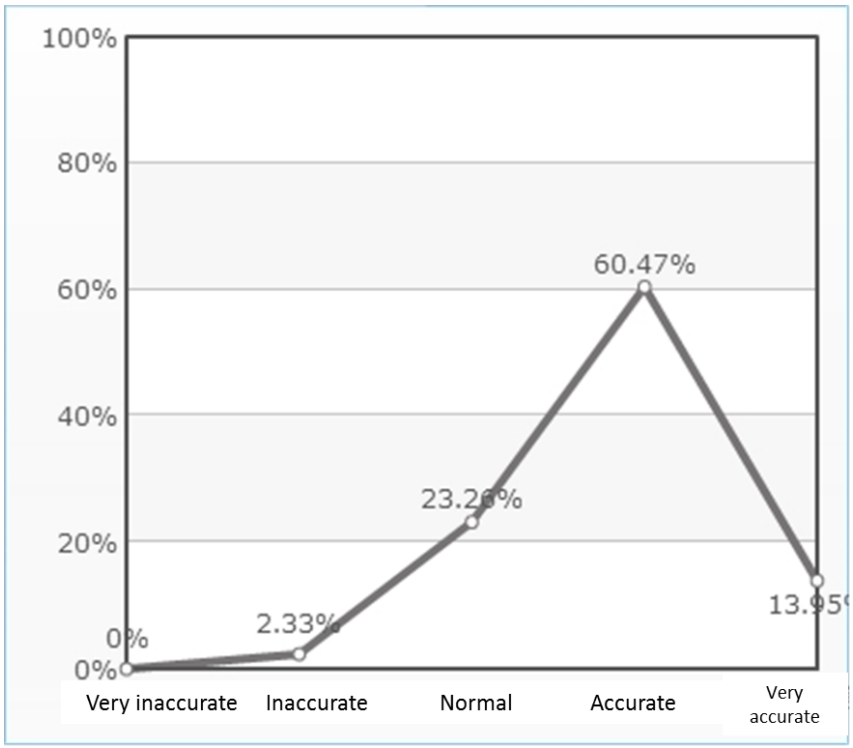


Figure 16. Accuracy in price audit for the equipment and material offered by owner.

The questionnaire shows that most of respondents believe the price and adjustment of equipment and material is accurate, which accounts for 74.42%, only a small part of respondents believe it needs to be improved, which accounts for 25.58%. Due to the special department responsible for the procurement and supply of materials and equipment, the price and amount of materials and equipment are determined reasonably in this stage.

In this stage, communication skill with other parties is vital in ECCE. According to the result of questionnaire, in the opinion of project owner, only 33.33% of respondents think ECCE make the successful negotiation with contractors. 22.22% of respondents think ECCE can communicate with the electrical power company smoothly. And 66.67% of respondents think ECCE do not give feedbacks of important issues to the electrical power company timely. So, this study believes the communication skill needs to be improved to smooth the consultancy service.

In the final service stage, 62.97% of the responds think the analysis of economic indicators is accurate at present. Meanwhile, ECCE have complete confidential measures to avoid the commercial secrets leaked. And they also have efficient regulations to avoid the consultant to bribe. However, the management for the consultation results do not

run through the whole process of construction. Because ECCE do not join every stage of construction, it is difficult to collect and sort project documents according to the progress of construction. So far as the project owner concerned, for the satisfaction of the consultancy service, 77.78% of them believe the consultation service is in normal level and needs to be improved as soon as possible.

3.2 Strengths & Weaknesses in Consultancy Services of ECCE

This section summarizes the findings of the current state analysis and refers to the previous subsections in which the findings were explored. The summary is presented based on the results of questionnaire and the researcher's observations as shown in two tables below.

The cost consultation is connected with the economic issue, which influences the social and economic stability. The industry of engineering cost consultancy is more and more vital presently. Table 5 illustrates strengths in consultancy services of ECCE.

Table 5. Strengths in consultancy services of ECCE.

Strengths in consultancy services of ECCE		
No.	Finding/Challenge	Description/Consequence
1	Work plan	Feasible. Personnel arrangement is reasonable, and assignment of responsibility is clear.
2	The deviation analysis between investment estimate and budgetary estimate	Satisfied presently.
3	The price of materials and equipment	Accurate, be controlled effectively.
4	Engineering claim	Consultants from ECCE are familiar with the provisions of the tender documents and the contracts, and can calculate claims accurately.
5	The submission of settlement documents	Settlement documents are authentic, complete, and timely.
6	Analysis of economic indicators	Accurate and satisfied at present.
7	Confidential	ECCE have complete confidential measures to avoid

	measures	the commercial secrets leaked.
8	Anti-corruption measure	Customers do not need to worry about the illegal corruption.

From the findings categorized and shown in Table 5 above, there were eight strengths in consultancy services discovered from the current state analysis: (1) feasible consultancy plans, (2) satisfied deviation analysis between investment estimate and budgetary estimate, (3) accurate prices of materials and equipment, (4) accurate engineering claims, (5) authentic settlement documents, (6) accurate analysis of economic indicators, (7) complete confidential measures, and (8) effective anti-corruption measures.

However, most of the ECCE are small-scale enterprises presently and their technology force is generally weak. There are still some managerial problems in the enterprises, especially in the CRM. And both the electrical power company and ECCE pay more attention to the clearing price, focusing only on the stage of completion acceptance, neglecting the engineering cost management in the stage of investment decision-making, design, and bidding. Consequently, the engineering cost cannot be controlled effectively. Table 6 illustrates the weaknesses in consultancy services of ECCE.

Table 6. Weaknesses in consultancy services of ECCE.

Weaknesses in consultancy services of ECCE		
No.	Finding/Challenge	Description/Consequence
1	Business scope	Incomplete. ECCE pay attention to the business in the stages of completion acceptance and bidding mainly.
2	Personnel	Most of the consultants are lack of experiences and professional qualifications.
3	Managerial method	Lack of CRM system
4	Economic evaluation	Blindly compiling the report of feasibility study and investment estimation, the investment decision-making is lack of scientific nature.
5	Precision and depth of investment estimate	The precision and depth of investment estimate cannot meet the needs of decision-making.
6	Design optimizing.	Ignored.

7	Precision and depth of budgetary estimate	Unsatisfied.
8	Analysis of tender documents	Careful analysis of the tender documents is ignored.
9	Engineering variations	Consultants are not familiar with the real situation in site.
10	Deviation analysis in the stage of contract enforcement	Ignored, no feasible suggestion is offered to the electrical power company in time.
11	Timeliness of settlement audit	Not timely, unsatisfied.
12	Communication skill	Needs to be improved.
13	Improvement analysis of consultation service	Most of customers believe the consultation service is unsatisfied. Service needs to be improved as soon as possible.

The findings presented in Table 6 show that there it is clear demands for improvement of the current consultancy services of ECCE in many stages: from the stage of service preparation, the stage of feasibility study, the stage of contract enforcement, etc. For example, items 1, 2, 3 are included into the practices in the stage of preparation; items 4 and 5 are found from the practices in the stage of feasibility study. In order to correct these issues, this study will build an improved proposal to consultancy services based on the literature review, analysis of procedures and regulations stage by stage later.

The following section explores the literature in order to find solutions for overcoming the main weaknesses in the current consultancy services of ECCE indicated in Table 6.

4 Best Practice of Consultancy Services

This section discusses the concept of KIBS, the concept of CRM, the approaches of CRM, matching supplier with customer and the concept of engineering cost management.

4.1 Knowledge Intensive Business Service

Service is typically defined from the viewpoint of difference between the tangible physical products and intangible concepts. The service definition is activities or processes, in which service refers to applying knowledge to contribute the interests of other entities. Accordingly, service is defined as the application of specialized competences skills and knowledge for the benefit of another (Lusch, et al. 2007: 9, Lusch 2004: 326)

It is an intangible experience performed for a customer who is also participating in the value creation to optimize a state of the customer. Hence, the customer owns or controls inputs that the service provider is change of optimizing according to mutual contracts (Pöppelbuß, et al. 2011: 545)

Miles (2003) argued that KIBS are the companies, who have the staff with high-level degrees and professional qualifications. And the services companies offer scientific, engineering, technical and other professional knowledge and service in the provision of services (Miles 2003: 12).

ECCS is a clear case of KIBS, thus it is essential to look at its characteristics. Firstly, knowledge is not only a key production factor in KIBS, it is also the good offered by them. The companies in KIBS provide professional services, which includes specialised expert knowledge, research and development ability, problem solving and so on (González-López 2013: 8). Secondly, the provision of the services offered by KIBS needs close interactions between supplier and customer. During the process of provision, both parties are involved in creating the value together (Strambach 2008: 156). Thirdly, the knowledge intensive service is the activity of consulting. KIBS adapt their expertise and expert knowledge to the needs of the customer (Schricke, et al. 2012: 7).

The above three features of KIBS are the keys to show the differences between normal service and the knowledge intensive service.

4.2 Customer Relationship Management

CRM is defined by Couldwell (Couldwell 1998) as “a combination of business pro-cess and technology that seeks to understand a company’s customers from the perspective of who they are, what they do, and what they’re like.”

CRM is based on four customer-centric principles, customers need to be managed as important assets, different customer could bring different profitability to service enterprise, different customers have different needs, preferences, buying behaviour and price sensitivity (Valarie, et al. 2001), through understanding customer experience and their profitability, service enterprise can adjust service offerings to maximize the overall value (Kutner & Cripps 1997). Therefore, service enterprise needs to commit to customer focus, takes customer centricity as a part of the strategy. Firstly, through the customer journey, service enterprise can collect the quantitative data and qualitative feedback during the whole service process. Secondly, according to the feedback, service enterprise needs to analyse and understand the feedback in quantitative and qualitative way. Thirdly, it is critical to make systematic processes for effective data flow. At last, service enterprise can take improvement actions and monitor the progress of the most important customer related actions (Vesterinen 2013).

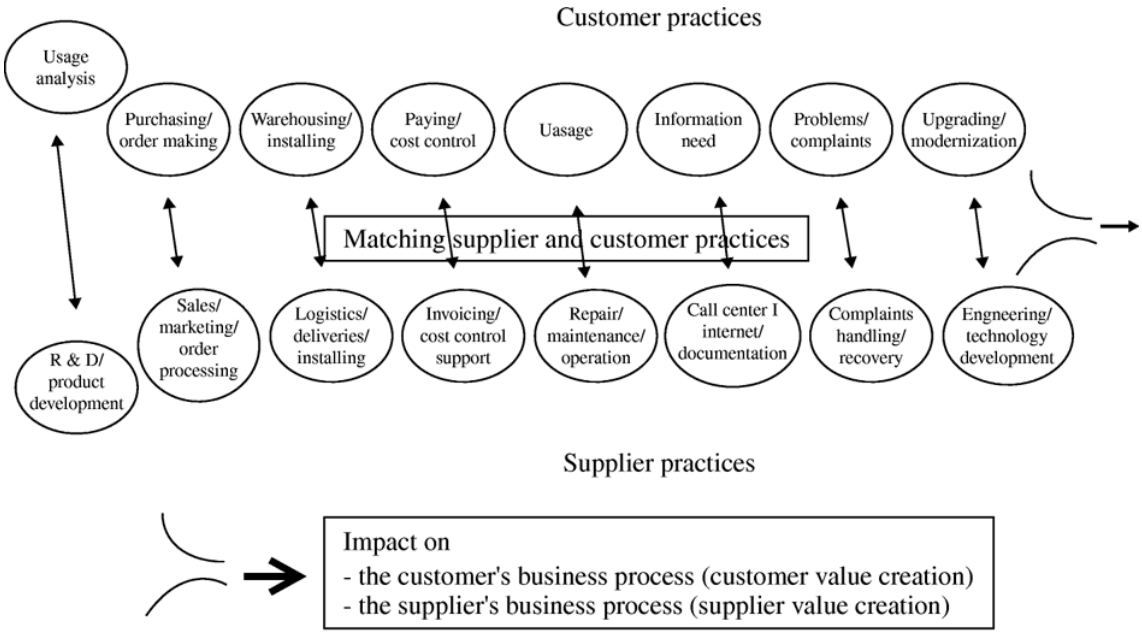
CRM aims to the long-term retention of target customers. By gathering and integrating information of customer experience, service enterprise uses software to analyse this information. After that, service enterprise segments markets according to the customer’s needs, preferences, behaviours (Zeithaml, et al. 2001). Consequently, service enterprise shifts emphasis from creating shareholder value to maximizing customer satisfaction, and shifts marketing thinking from goods-focused to the service- and interaction-focused, value co-creation delivery through service tailored to micro-segments, facilitated by detailed, integrated customer profiles (Zeithaml, et al. 2001, Edvardsson, et al. 2011, Heinonen, et al. 2010, Lynette & Simon 2001, Ramaswamy 2008).

4.3 Approaches of Customer Relationship Management and Matching Supplier with Customer

For a supplier, in order to establish an effective relationship with customer and complete the value co-creation, the starting point is that company should adopt service logic for their entire business. Company should understand the process of value co-

creation and value sharing. At the same time, company should change its business mission into a service-driven and customer-centric direction.

Company needs to gear its activities and practices towards supporting the practices of customers, so that the need of customers can be satisfied and the value is created for both parties in this matching process (Gronroos 2008: 568). Figure 17 illustrates the customer and supplier practices in business-to-business relationships. Most of existing practices are included in Figure 17.



Source: Based on a figure in Grönroos (2008)

Figure 17. Customer and supplier practices in business-to-business relationships. (Source: Gronroos et al. Adopting a Service Logic in Manufacturing Conceptual Foundation and Metrics for Mutual Value Creation, 2010).

The boxes in the upper side of Figure 17 mention the customer practices in different stages. The boxes in the lower side indicate the supplier practices to support the customer. Purchasing, paying, information need and complains that occur are examples of customer practices. Sales, cost control support, call centre and complains handing that occur are examples of corresponding supplier practices.

For the supplier, in order to know needs of customers and the corresponding practices in the business processes, supplier needs to shift the traditional product-centric way to a service-centric direction. Supplier needs to analyse the existing practices on both

sides and the impact on the business processes. So, the concept of practice matching is introduced. Supplier should shift focus from its own practices towards the practices of customer. The lower part of this figure shows how supplier practices match relevant customer practices and how it influences both sides in business processes. The connecting lines between them mention the supporting connections between practices.

All customer practices and its business process must be supported in a value creating way. The objective of matching practices is to complete value creation for both the customer and the supplier. In the matching process, service is only a mediating factor. What service should achieve is value for the customer and for the supplier, respectively (Gronroos & Helle 2010: 569).

When customers use resources provided by a supplier, they create value for themselves. So, the customer is the value creator (Gronroos 2008). Basically, the role of the supplier is to facilitate this process by providing resources. The interactions between the two parties happen throughout. The customer takes actions as co-producer inside the practices of suppliers, and the supplier takes actions inside the relevant process of customers. During such interactions, the supplier can get opportunities to influence its the value-creating process of customers. The supplier can engage itself with the customers and become co-creator of value together with the customer.

4.4 Engineering Cost Management

Engineering cost management is a branch of the project management. Through the engineering cost management, the state or the project owner can control the project cost effectively and ensure the efficient investment result.

4.4.1 Engineering Cost

Engineering cost refers to the anticipated or actual summation of cost to complete construction of a project (China Engineering Cost Association 2009, Che, et al. 2006: 1).

Engineering cost is defined by CECA in two different ways.

From the point of owner, engineering cost refers to the anticipated or actual entire payment of the investment in the fixed assets to complete construction of a project. Engineering cost includes the purchase cost of equipment and Instruments, civil and

erection cost, other cost, reserve fund, interest, and the tax of investment in the fixed assets.

From the point of contractor, engineering cost refers to the anticipated or actual price of civil and erection construction and the total price of the construction project, which is formed in trading process, such as biddings, equipment purchases, technical services, and signing contracts.

The essence of engineering cost can be recognized from different points. For investor, engineering cost is the payment to receive the project; consequently, it is the investment of construction project. For Designer, supplier of equipment, and contractor, engineering cost is the value of their labour service and commodity; as a result, it is the contract price.

4.4.2 Engineering Cost Management

Engineering cost management refers to the control statically and manage dynamically the engineering cost by scientific management methods in the whole process of project construction (China Southern Power Grid Company Limited 2014, China Southern Power Grid Company Limited 2011). Due to two different meanings of the engineering cost, engineering cost management also can be recognized in two ways. One way is the investment management of construction project. Another one is the price management of construction project (Che, et al. 2006: 2).

Because of the different interested parties, there is significant difference between investment management and price management. In the first place, the category of management is different. The first one belongs to the category of investment management, and the second one belongs to the category of price management. In the second place, the objective of management is different. The objective of investment management is to improve the investment efficiency. Under the premise of correct decision-making, acceptable quality and schedule, the investor utilise a series of project management methods to decrease the investment. However, the objective of price management is to make the price of construction project reflect the value and the law of supply and demand, simultaneously, it also needs to ensure the reasonable and legal interests of two parties according to the contract. In the third place, the scope of management is different. The investment management is implemented in the whole construction process

from the stage of investment decision to the stage of completion acceptance. Because of the different investors and the different capital sources, the investment management is related to the contractors, project owners and some parties. However, the price management could be implemented in the whole construction process or in some stages of the construction process. And it is only related to the contractors and project owners.

4.4.3 ECCS in Whole Process

The engineering cost management in whole process is a cost management mode, which is implemented by the scientific method to determine and control the engineering cost based on the activities in the whole process of construction. In this mode, the project is divided into a serious of activities. And the cost of each activity can be measured and determined (Che, et al. 2006: 4, Tao & Luo 2010).The cost management for infrastructure project should follow the principle of whole process management and dynamical control in stages. In principle, budgetary estimate does not exceed investment estimate, drawing budget does not exceed budgetary estimate, and settlement does not exceed drawing budget (China Southern Power Grid Company Limited 2014).

In the stage of investment decision-making, investment estimate refers to the activities which forecast and calculate the total investment of proposed project based on the feasibility study and project design. The report of investment estimate is the cost document which is compiled by professional cost personnel according to estimated index or estimated quota and budget compilation and calculation regulation of power construction (National Energy Administration of China 2013).

In the design stage, preliminary budgetary estimate refers to the activities which forecast and calculate the total investment of construction project based on the preliminary design documents. The report of preliminary budgetary estimate is the cost document which is compiled by professional cost personnel according to the estimate quota and budget compilation and calculation regulation of power construction (China Southern Power Grid Company Limited 2011).

After that, the budgetary based on the drawings refers to the activities which forecast and calculate the engineering cost of construction project based on the documents of drawing design. And the report of drawing budgetary is the cost document which is

compiled by professional cost personnel according to the budget quota and budget compilation and calculation regulation of power construction (China Southern Power Grid Company Limited 2011).

In the completion acceptance stage, settlement refers to the activities which collect and analyse all the actual costs during the whole construction process from feasibility study to acceptance. Settlement report is the cost document compiled by professional cost personnel according to the settlement regulations the contracts. The settlement report should include all the costs of design, construction, consulting, technical services, equipment and material, project management (China Southern Power Grid Company Limited 2011, National Energy Administration of China 2013).

ECCS in the whole process refers to the professional consultation service, ECCE is commissioned by project owner or other organization to supervise the project cost and provide suggestions to cost decisions from the early stage of construction project (establishment, feasibility study), implementation (design, construction) to the stage of completion (Wang, et al. 2004: 66).

ECCS in the whole process is systematic and continuous management of the project cost. In traditional pattern, project owners invite ECCE to participate in the investment control only in the stage of construction and completion. Project owners need to transfer the traditional pattern into the new one, in which owners require ECCE to participate in the projects in advance. Only in this way can ECCE control and determinate the project cost effectively in the whole process of projects. According to the Management Regulation for Infrastructure Project in CSG (2014), the cost of infrastructure projects should be controlled during the whole process. In different stage, the budgetary estimate could not exceed the investment estimate, the budget could not exceed the budgetary estimate, and the settlement could not exceed the budget in principle. For the power projects and small infrastructure projects, the project owner should regard the budget as the target of cost control, and for the electrical source projects, the budgetary estimate should be regarded as the target of cost control (China Southern Power Grid Company Limited 2011).

ECCS in the whole process could assistant project owner to finance the investment of construction reasonably, reduce investment deviation and investment risk. Meanwhile, it could control and adjust the engineering cost effectively, carry out the project man-

agement cored by engineering cost management (China Engineering Cost Association 2009). Consequently, ECCS in the whole process can regulate the construction market, standardize the pricing behaviour, and improve engineering cost management efficiently.

With the development of consultation organizations in engineering cost, ECCS in the whole process will be more critical, and the practitioners in ECCE will be encouraged to implement it. In Consultation Contract of Engineering Cost (Model Text) issued by MHURD, the businesses in engineering cost consultation are listed as the following five consultation services as shown in Figure 18.

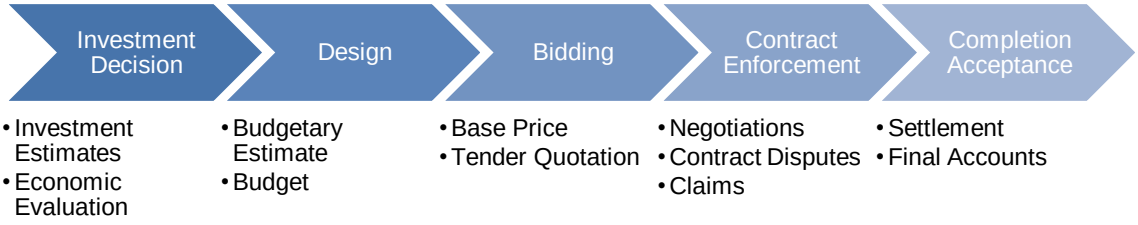


Figure 18. Consultancy services for engineering cost in the construction process. (Ministry of Housing and Urban-Rural Development, China 2002)

Figure 18 shows the contents of ECCS in five construction stages. It can be concluded as follows:

1) Compiling and auditing the investment estimates and economic evaluation in the stage of feasibility study;

2) Compiling and auditing the budgetary estimate, budget, settlement, final accounts;

3) Compiling and auditing base price, and tender quotation;

4) Appraising the negotiations, changes, contract disputes and claims;

5) Compiling the valuation criterion of engineering cost, monitoring the engineering cost and providing information about the engineering cost, etc. (China Engineering Cost Association 2009, Ministry of Housing and Urban-Rural Development of the People's Republic of China 2002).

In practice, most of the ECCE mainly focuses on compiling and auditing budgets, acting as a tender agent, and compiling and auditing settlements, others are rarely involved into the scope of business in ECCE. Therefore, from the view of the whole engineering cost management, the incomplete ECCS leads to the less effective manage-

ment. In addition, these five stages also are incomplete, because ECCE belongs to KIBS, which offer scientific, technical and other professional service to the customers. It is necessary to add two stages, the stage of service preparation and final service, to improve the quality of consultancy service according to the theory of CRM.

4.5 Conceptual Framework

According to the approaches of CRM and the theories of KIBS, and engineering cost management, the author matches the practices in ECCE with the practices in the electrical power company.

ECCE needs the in-depth interaction between the supplies and customers. Therefore, ECCE needs to gear its practices towards supporting the practices of the electrical power company, so that needs of the electrical power company can be satisfied and the value is created for both parties in this matching process. Figure 19 illustrates the practices in the electrical power company and ECCE during the construction process.

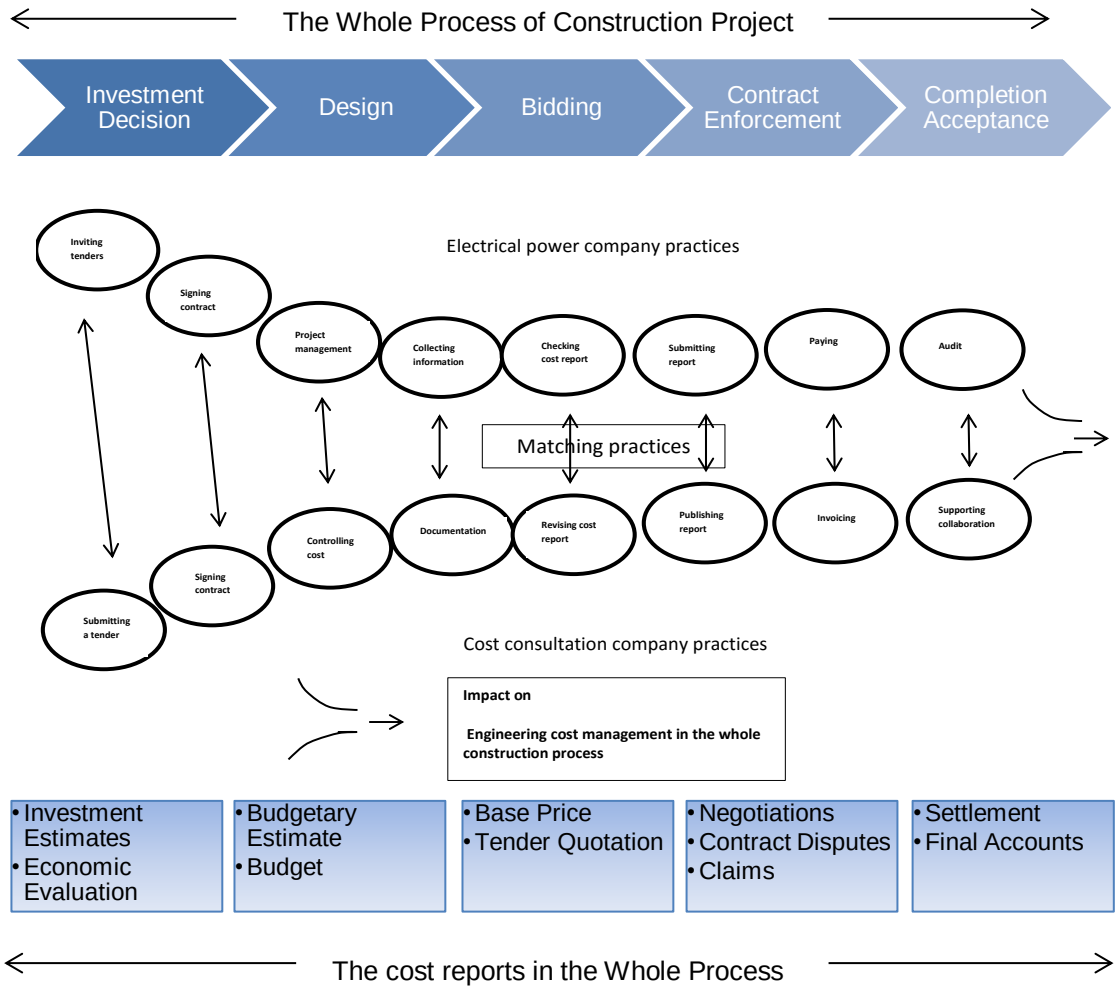


Figure 19. Practices in a construction project by the electrical power company and ECCE matched.

The boxes in the upper side of Figure 19 show the practices in the electrical power company in different stages. The boxes in the lower side indicate the practices in ECCE to support the electrical power company. Collecting information, checking report, submitting report and audit are the examples of practices in the electrical power company. Documentation, revising report, publishing report and supporting collaboration are the examples of corresponding practices in ECCE.

For ECCE, in order to know the needs of the electrical power company and the corresponding practices in the construction process, ECCE needs to analyse the existing practices on both sides and the impact on the processes. So, the ECCE needs to shift focus from its own practices towards the practices of the electrical power company. The lower part of this figure shows how ECCE practices match relevant practices in the electrical power company and how it influences processes on both sides. The connecting lines between them mention the supporting connections between practices. In the whole construction process, the objective of matching practices is to achieve the effective engineering cost management for both the electrical power company and ECCE.

The basic content of engineering cost management is to calculate the engineering cost accurately and control it effectively. Calculating the engineering cost means that ECCE need to report the true cost of projects objectively. In the whole construction process, ECCE needs to calculate the investment estimates, economic evaluation, and budgetary estimate accurately and determining the contract price, settlement, final accounts reasonably.

The stage of investment decision-making is the key stage of engineering cost management. The investment estimate is accurate or not, which directly influence the decision-making of project successful or not. The right investment decision is the premise of the effective control in engineering cost. The stage of investment decision-making is the most influential stage in five stages, which could account for 80% to 90% (Che, et al. 2006: 76). In the stage of feasibility study, ECCE can calculate the investment estimate of the proposed projects and analyse the different program in economic and technological way. After that, ECCE need to submit the result to the decision-makers

as the investment suggestions (Wang, et al. 2004). The owners consider whether the project should be invested and control the project cost in the design stage according to the investment estimate.

After the investment decision-making, the design stage becomes another vital stage for the engineering cost management. In this stage, the project owner needs to ensure the construction projects built not only with advanced technology but also economic cost. Therefore, ECCE should cooperate with the personnel in charge of project management and design personnel to control and analyse project cost, through scheme comparison, design optimization, quota design and other means of value analysis (China Engineering Cost Association 2009). Meanwhile, the designer could adjust and change the design program with low cost, but the influence to engineering cost is decisive after the stage of investment decision (Che, et al. 2006).

The design stage could be divided into two different stages. In the stage of preliminary design, ECCE could calculate the budgetary estimate according to related regulations, and regard it as the goal of the cost control in the next stage. If the projects are invested by government, the budgetary estimate needs to be submitted to the related units to review and approve, and the budgetary estimate needs to be regarded as the maximum limits (China Southern Power Grid Company Limited 2011). If the bidding is implemented in this stage, the base price can be calculated according to the budgetary estimate. In the stage of drawing design, ECCE can calculate or review the budget according to related regulations. The base price and the bid assessment need to be based on the budget (China Southern Power Grid Company Limited 2011). In the design stage, ECCE need to help the designer optimize the design with the theory of Value Engineering. Value Engineering (VE) is also known as Value Analysis (VA), which refers to the organized creative activities, which focuses on the function analysis of the product to enhance the value in the product. It strives to achieve the necessary functions of product with the lowest life-cycle cost. Some people call it as the analysis of function and cost (Che, et al. 2006: 102). Consequently, ECCE need to consider the process design, architectural design, and other factors, and then give the suggestions to the project owner (Tao & Luo 2010: 706).

In the bidding stage, cost engineers offer consultation suggestions to tender documents, evaluation methods and control prices for project owners. Meanwhile, cost engineers participate in the bidding evaluation and assist owners to sign reasonable con-

struction contracts (Wang, et al. 2004: 68). Control price refers to the maximum limit of construction cost in the bidding project, which is compiled in accordance with the relevant regulations and the list of engineering quantity (Ministry of Housing and Urban-Rural Development of the People's Republic of China 2012). Tender document is the key factor to cost control. It is the guideline in the bidding stage, even for the whole construction process. A successful tender document reflect the owner's wishes, smooth the construction progress, and monitor the quality and engineering cost in projects. On the contrary, the poor-quality bidding document would result in the trouble of project management and cost control. Meanwhile, the reasonable method of bidding evaluation can recognize the unreasonable low price and eliminate the blind tender, which would lead to engineering cost distorted maliciously. So, reasonable evaluations not only pay attention to the total price, but also pay more attention to the price structure. And in this stage, the project owner should ensure the tender price does not exceed the drawing budget. For some special projects, if the drawing budget cannot be regarded as the control price, the project owner need to report to headquarter for new approval (China Southern Power Grid Company Limited 2014).

In the project construction stage, the reasonable contract price determined through the bidding is the goal of the cost control in this stage. In this stage, it is unavoidable that site visa, engineering variation and engineering claim appear. Site visa refers to the certification signed by both owner and contractor representatives, which confirms the liability beyond the contract price (China Engineering Cost Association 2009). Engineering claim means the financial compensation to the loss caused by the fault of other parties in the process of contract enforcement (China Engineering Cost Association 2009). As a result, the engineering cost would change continuously. Designer is responsible for the cost changes caused by design change and engineering visa associated with the design. Supervising engineer is responsible for verifying the cost changes, and the project owner needs to confirm cost changes. Therefore, the project owner should master the quantities and payments of cost changes in time (China Southern Power Grid Company Limited 2014).

The stage of completion acceptance means the stage of settlement audit, which is the last part of the cost control. This stage is particularly important for the reasonable determination of engineering cost. For ECCE, The main task is the auditing of engineering quantity and price based on the contracts, agreements, construction drawings, on-site visa etc., according to the national regulations (Yu 2006: 36). In this stage, ECCE

would collect all of the cost spent in the whole construction process to compile or review the final accounts, and compare with the budgetary estimate to analyse the investment efficiency of project.

Controlling the engineering cost means that ECCE need to calculate and monitor all the costs based on the target of cost control. In order to fulfil target cost and a good investing benefit, when deviation happens, the ECCE need to analyse reasons and correct it in time. ECCE needs to control the engineering cost in the reasonable range and ensure it below the maximum limits through the design optimizations and other approaches. In order to achieve this goal, managerial measures need to be applied in each stage of construction.

The next section builds an improved proposal to the consultancy services with the help of the conceptual framework and the existing strengths identified by the current state analysis.

5 Building an Improved Proposal to the Consultancy Services for ECCE

This section presents the proposal built through matching the practices in ECCE with the practices in the electrical power company. In this section, the researcher builds an improved proposal to the consultancy services for ECCE in every stage of consultancy service.

When presented for discussion to the manager in charge of the engineering cost management in CSG, the suggestions were made for the improved proposal to consultancy service. First, collect the external procedures and regulations issued by the national authorities. This can find the limitations and guidance in the management of ECCE. Second, collect the internal documents in CSG, which can recognize the specific requirement of the customers in the field of electrical power project.

> *"The consultancy service is unsatisfied and needs to be improved as soon as possible. Since the consultancy company have no system of CRM recently, you can make the improvement proposal according to the national regulations and the internal documents in CSG from the view of the whole engineering cost management."*

5.1 Requirements for Consultancy Services Set by Procedures and Regulations

In order to build the improved proposal, the study has selected and analysed a number of procedures and regulations as Data 2 (pointing to the limitations, requirements and guidance). And this study has collected the terms form the procedures and regulations to identify the requirements for engineering cost management more clearly. The terms are given in Appendix 3.

These procedures and regulations include, for example, *the limitations* of the operations in ECCE. According to Managerial Regulation for ECCE issued by MHURD, the ECCE certified with grade A should satisfy the limitations shown in Table 7 below.

Table 7. Limitations for ECCE to apply grade A (Ministry of Housing and Urban-Rural Development of the People's Republic of China 2006).

	Aspect	Limitations
1	Working year	Obtaining Grade B more than 3 years.

2	Investor	The number of registered cost engineer is no less than 60% of the total number of investors and the investment is no less than 60% of the total registered capital.
3	Technical director	Obtaining the certificate of registered cost engineer, senior technical titles in engineering or economy, and working in the field of project cost more than 15 years.
4	Personnel	The number of full-time personnel is no less than 20. The number of full-time personnel with intermediate technical titles is no less than 16; The number of full-time personnel with the certificate of registration cost engineer is no less than 10; other personnel have professional experience in the project cost management.
5	Registered capital	No less than one million Yuan.
6	Operating income	The income in consulting business is no less than 5 million Yuan in nearly three years.
7	Work place	Fixed office space, building area is no less than 10 square meters per personnel.
8	Managerial regulation	Complete system for file management, system for quality control, and system for financial management.

Table 7 indicates the limitation for ECCE to apply grade A according to the Managerial Regulation for Engineering Cost Consultation Enterprises. The limitation includes eight aspects concerning the working years, the size of work places, and the amount of investment etc. So far, as the cost personnel are concerned, the number of full-time personnel is no less than 20. The number of full-time personnel with intermediate technical titles is no less than 16. And the number of full-time personnel with the certificate of registration cost engineer is no less than 10; other personnel have professional experience in the project cost management.

In addition to the limitations, there are procedures and regulations set for the industry, for example, *the process requirements* for the ECCE operations. In Managerial Regulation for National Registered Cost Engineers issued by MHURD, the practice scope of

cost engineer incluedes a) compiling and auditing project proposal, investment estimates and all cost reports in the whole construction process, b) appraising the negotiations, changes, contract disputes and claims; c) optimizing design, conducting economic disputes and other cost analysis and control.

Additionally, *the guidance* for the operations also set by regulations. One example of such guidance is the deviation adjustment in project cost. In Procedure for Cost Consultation in the Whole Construction Process, the term No. 7.5 deviation adjustment, points that the ECCE needs to compile a plan for progress payments in accordance with the construction schedule, and compare it with the actual completed progress payments. After that, ECCE needs to analyse the causes of the deviation and provide suggestions for the deviation adjustment. After all, ECCE can help a construction owner to raise the project funds in the next step.

In order to regulate the activities in the project management, CSG also issued the Management Regulation for Infrastructure Project (Trial Implementation) and four regulations concerning engineering cost management (Trial Implementation) in 2011. After that, CSG adjusted the Management Regulation for Infrastructure Project in 2014. According to the Management Regulation for Infrastructure Project and the Regulation of Engineering Cost Management (Trial Implementation), the whole construction process should be divided into five stages from investment decision to completion acceptance. And engineering cost management should follow the principle of phase-wise management in the whole process.

Summing up, the procedures and regulations in the industry of engineering cost consultation stipulate certain limitations and requirements (including qualification grade, business scope and legal liability). In addition, they also set some guidelines which direct the ECCEs to conduct consultancy business. ECCEs should follow in their practices of cost consultation services in the construction process.

Based on Data 2, the suggested proposal include two parts as follow: a) proposes suggestions related to consultancy service improvement in the whole constructions process, divided into seven consultancy stages; b) points how this improves the ECCE engineering cost consultancy services.

5.2 Improvements in the Consultancy Service Process

In order to determine and control the engineering cost by the scientific method, the project needs to be divided into five stages based on the activities in the whole process of construction. Engineering cost management should follow the principle of whole process management and dynamical control in stages. Simultaneously, in order to improve the consultancy services, the consultancy process needs to be added two stages, service preparation stage and final service stage, based on the theory of CRM as shown in Figure 20.

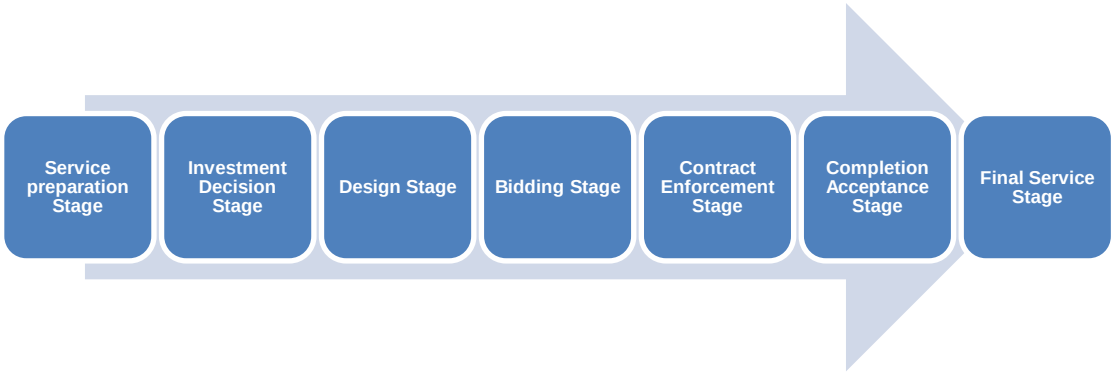


Figure 20. Process of a consultancy service.

From preparation stage to final stage in Figure 20, ECCE has different tasks according to the requirements of customer. Therefore, ECCE needs to recognize customer's needs in each stage, takes customer centricity as the core in the whole process of consultancy service. Consequently, In order to complete the value co-creation – effective engineering cost management, ECCE needs to match their practices with the practices of customers, so that the customers' need can be satisfied and the value is created for both parties synchronously.

5.3 Improved ECCE Engineering Cost Consultancy Services

The improved consultancy services need to satisfy the standards issued by authorities and requirements of customer in engineering cost management. The proposal to consultancy services of ECCE is described phase by phase, as shown below.

5.3.1 Service Preparation Stage

In Procedure for Cost Consultation in the Whole Construction Process, the term No. 3.2.1 indicates ECCE need to compile the work plan before the consultation starts, which should include the general situation of the project, the consultation scope, the schedule, the personnel arrangement, the quality management and so on. In addition, ECCE also needs to sign the consultancy contract, and master the information of project as shown in Table 8.

Table 8. Actions in preparation phase of consultancy service.

No.	Preparation actions	Contents	Result
1	Signing consultancy contract	a) Acquire the business information, b) Determine the need of customer by communication with customers, c) Clarify the consultancy object and purpose, d) Provide service proposal.	Consultancy contract
2	Compiling work plan	a) Establish organizational structure, b) Determine the consultancy personnel, c) Clarify the respective responsibilities, authorities and the ways to communicate, d) Determine the schedule, e) Determine the scope of consultancy services.	Work plan
3	Collecting project information	a) Acquire the project information by site investigation, b) Collect the documents required.	Project documents

In this stage, firstly, ECCE needs to sign the consultancy contract through acquiring the business information, recognizing the customer's needs, and providing service proposal. Secondly, ECCE needs to compile the consultancy plan to establish the organizational structure of the consultancy team, determine the schedule of consultancy work and the scope of consultancy services. Lastly, collecting the information of project is also a vital task for ECCE before the consultancy work starts.

Because KIBS differ from other business sectors, the employees need to have high levels social and institutional knowledge, as one of KIBS, ECCE need to pay more

attention to the professional education to their empolyees. Additionally, ECCE need to think highly of the relationship with customers from the preparation phase, because ECCE develop knowledge through the interactions with customers. Only understanding the problems that customers face, would ECCE find the way to solve the problems and establish the effective relationship with the customers in next stages.

5.3.2 Feasibility Study Stage

The task of feasibility study is to demonstrate the advancement and applicability in technology, the profitability and rationality in economy, the possibility and feasibility of construction. For ECCE, its service needs to focus on engineering economics. In this stage, the main services of ECCE are two aspects. One is the compilation and review of investment estimation. Another one is economic evaluation of construction projects.

The electrical power company is responsible for organizing and coordinating the work of the feasibility study. Before feasibility study, the electrical power company would organize on-site verification. Simultaneously, ECCE need to evaluate the costs of land acquisition, the fees of environmental protection, the costs of major equipment transport, etc., which are greatly impact on the project investment.

Investment estimate is one of the important criteria for the selection of investment scheme, and also the foundation of the economical evaluation.The main content of investment estimation is to calculate the total investment and evaluate the capital of construction projects. The term No. 5.5.1.1and No. 5.5.3.1 in Management Regulation for Infrastructure Project indicates the depth of investment estimation needs to satisfy the economic evaluation in different stages, such as the stage of project proposal, the stage of feasibility study and the stage of design. So, when ECCE compile the investment evaluation, they need to check if the compilation basis is accurate, the calculation method is scientific, and the cost item is comprehensive. Simultaneously, the investment estimation needs to be compiled completely and reasonably. As a result, the owner can make right investment decision.

Additionally, ECCE need to conduct the economic evaluation of construction project according to the Term No. 4.2 in Procedure for Cost Consultation in the Whole Construction Process. The main content of economic evaluation is financial evaluation, and the objective of financial evaluation is to analyse the financial feasibility and make in-

vestment decision. The financial evaluation of construction projects needs to follow the procedures as shown in Figure 21.

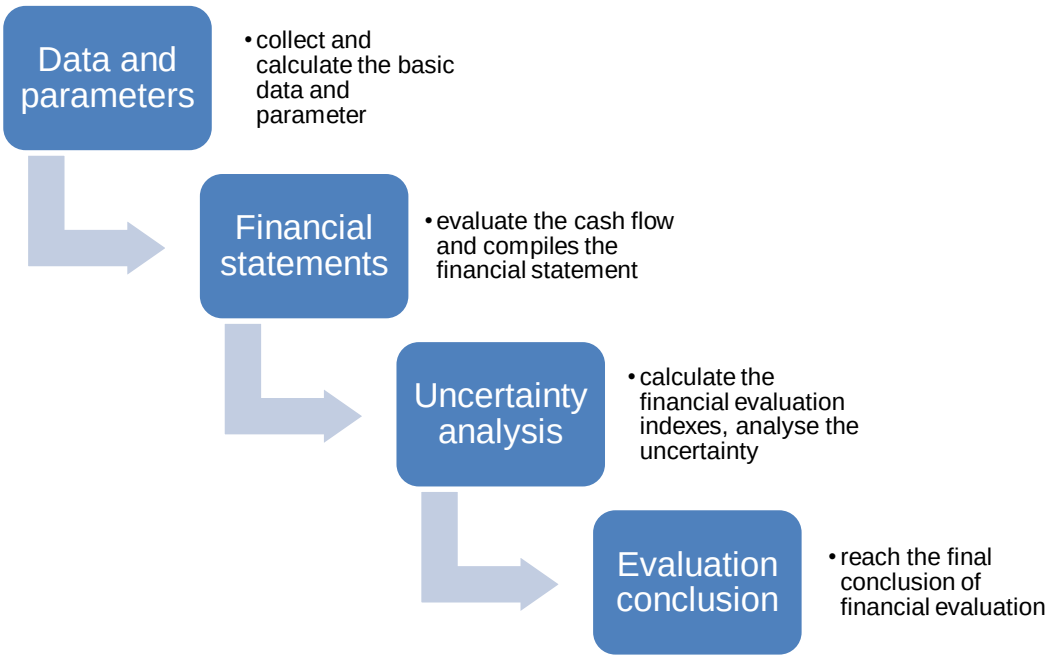


Figure 21. Process of a financial evaluation.

As seen from Figure 21, the financial evaluation needs to be conducted in 4 steps below: 1) ECCE collect and calculates the basic data and parameters of financial evaluation; 2) ECCE evaluate the cash flow and compiles the financial statements; 3) ECCE calculate and analyses the indexes of financial evaluation, and then, ECCE analyse the uncertainty; 4) ECCE reach the final conclusion of financial evaluation.

In order to analyse the project profitability, ECCE needs to calculate the financial internal rate of return, net present value, payback period, and other quantitative indicators from basic financial statements. ECCE need to calculate asset-liability ratio, current ratio, quick ratio and other quantitative indicators to analyse the project solvency. ECCE also need to implement the uncertainty analysis through two methods, the break-even analysis and sensitivity analysis.

Before the electrical power company submit the feasible study report to the superior unit, the ECCE need to complete the revise and publish the investment estimation. At last, the superior unit gives the approval, both the electrical power company and the ECCE need to save the approval into the file system.

5.3.3 Design Stage

At present, most of the electrical power companies appoint the design company to compile the budgetary estimate and budget. Based on the term No. 5.3.3 in the Regulation of Engineering Cost Management (Trial Implementation), in order to ensure both budgetary estimate and budget are scientific. ECCE, as the third party, its main task is to examine budgetary estimate and budget, which are included in the results of design. Meanwhile, during the design phase, ECCE should use the theory of life-cycle cost management, the theory of value engineering to reduce the cost in the construction phase and the fee in the period of operation and dismantling effectively.

ECCE should control the budgetary estimation not exceed the investment planned, and save investment as much as possible. Meanwhile, the design also needs to satisfy the requirements in functional and quality. In the design process, ECCE should establish tracking mechanism to check design drawings and evaluate the engineering contents timely. At the same time, in Managerial Regulation for Preliminary Design Budgetary Estimate (Trial Implementation), the term No. 5.1.5 indicates ECCE need to compare the budgetary estimate and the investment estimate planned. If the budgetary estimate is beyond the investment estimate planned, ECCE should promptly notice the designer and the electrical power company to make corrections. As a result, the project owner could ensure the investment does not exceed the limit cost.

In this stage, ECCE need to join the activities and analyse the investments according to the depth of design. In the first place, ECCE should analyse the project estimate and give feasible advices concerning investment to the designer. In the second place, during the initial design process, ECCE is responsible for the deviation analysis between budgetary estimates and estimates. In the last place, ECCE need to calculate and analyse the economic indicators. Through the review and analysis of budget, ECCE could examine the control target of proposed budget in the phase of drawing design. When the deviations emerge, ECCE should give the professional advices to cost controlling timely.

In order to achieve the necessary functions with the lowest life-cycle cost of project, ECCE need to help the electrical power company to optimize the design by Value Engineering according to the requirements in Management Regulation for Infrastructure Project. Firstly, ECCE should analyse the function in main part of project, and then calculate the function index and the cost index. Secondly, through the function index and

the cost index, ECCE need to calculate the value index, and then the theoretical cost would be determined. Lastly, ECCE need to adjust the investment to determine the final theoretical cost, which is the reasonable cost coordinating the function. Through the comparison between the theoretical cost and budget, ECCE could help the electrical power company to control the engineering cost effectively.

5.3.4 Bidding Stage

The effectiveness of cost control in bidding phase has a direct impact on the investment effectiveness of projects. In this stage, ECCE needs to help the electrical power company choose qualified contractors by tender evaluation, compiling cost documents, and the review of construction contract as shown in Figure 22.

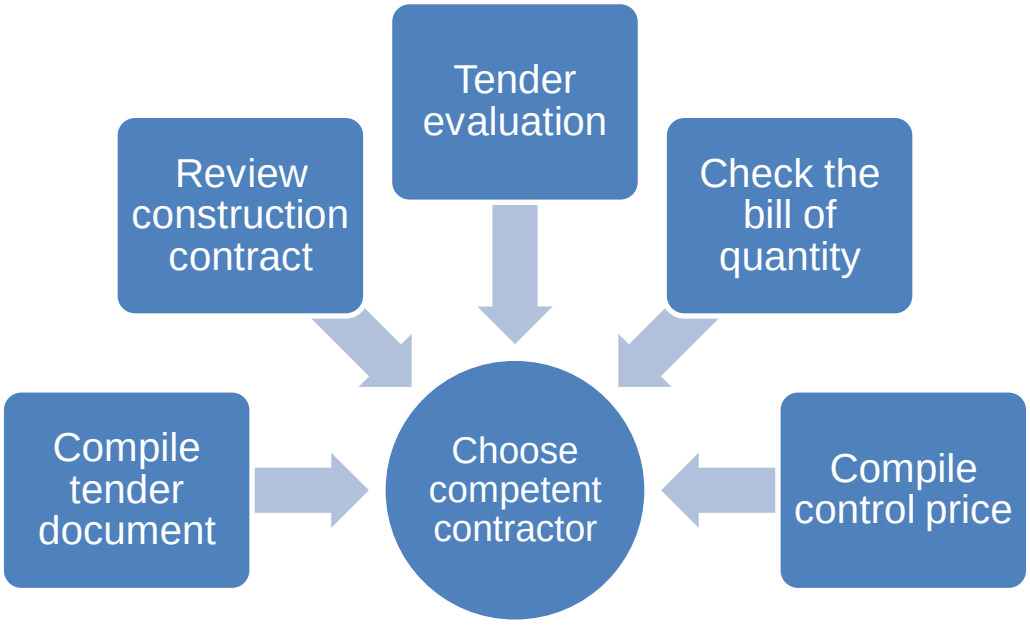


Figure 22. Activities in bidding stage for ECCE.

In order to choose qualified contractors, ECCE needs to conduct these five actions in Figure 22, which can control the engineering cost effectively in this stage. So far, as the tender document of project is concerned, the tender document contains a wide range of content. Once the tender documents have omissions, unclear or ambiguous content, it is difficult to reflect the increase or decrease of engineering work when design changes occur. This problem would seriously result in the settlement in the stage of completion acceptance, and lead to unnecessary loss to project owner.

According to Procedure for Cost Consultation in the Whole Construction Process, ECCE could help the electrical power company to compile the tender document operable and targeted. The contents of tender document should be completed and reasonable. In order to avoid misunderstandings, the tender document should be compiled according to the actual situation. The main material could be controlled by the limited prices in the tender document. And the tender document should clearly state important terms regarding to the contents of project, the supply of materials, the cost of the settlement, the specific schedule and quality assurance. As the primary document in the stage of biding and the contract enforcement, the tender document could supervise the quality, schedule and cost of the project during the whole construction process, and the tender document could guide the smooth implementation of the project. As a result, the tender document is the key point of controlling the engineering cost, the basis of the biding document from the contractors and the foundation of the construction contract.

The bill of quantity is the basis of the biding price. So, the bill of quantity is a key part of cost control. ECCE need to ensure that it does not repeat and miss. Meanwhile, ECCE need to repeatedly check its accuracy, and strive to describe the content of the project accurately to avoid the errors caused by bias. Especially vital issues, such as the strength of concrete relating to the building structure, need to be more specifically described to avoid increasing the cost. Therefore, ECCE need to clearly know the purpose of the electrical power company, the regulation of technology and the situation on-site. Only through this way, could ECCE calculate the engineering quantity accurately.

In order to choose qualified contractor, the electrical power company needs to compile the control price. On the one hand, the control price can avoid the bidders increase and lower prices on purpose. On the other hand, it can avoid the blind bidding from some contractors. Many factors could influence the tender control price such as the method of construction and the price of materials in market. ECCE should calculate the work quantities in construction accurately. After that, ECCE compile the control price objectively based on the investigation and analysis in market.

During the process of tender evaluation, ECCE should help the electrical power company to choose the contractor based on the requirement in Procedure for Cost Consultation in the Whole Construction Process. For technical standard, ECCE should choose the contractor considering with the construction plan, construction quality and other

factors. Through the comparison, ECCE need to evaluate every contractor objectively. ECCE should choose the contractor considering the construction cost and the price of materials mainly. By inquiries and clarifies, ECCE recognize the error or ambiguous items in the tender price.

5.3.5 Contract Enforcement Stage

Normally, the stage of decision-making and design are the two important stages for the investment control of construction projects. However, when the construction starts officially, the engineering cost is very easy to deviate from the budget, because of the continuous changes in the construction personnel, the construction machinery, and external environment. So, the cost control in this stage is also an important part of the engineering cost control in whole process.

The electrical power company need to monitor the construction process and control the engineering cost in the construction stage. When the construction starts officially, the electrical power company need to deal with a lot of affairs. Because they do not have enough time and personnel, they need to appoint ECCE to help them coordinate the relationship between designer, contractor and supervising engineer. Figure 23 illustrates the practices matching between the electrical power company and ECCE in this stage.

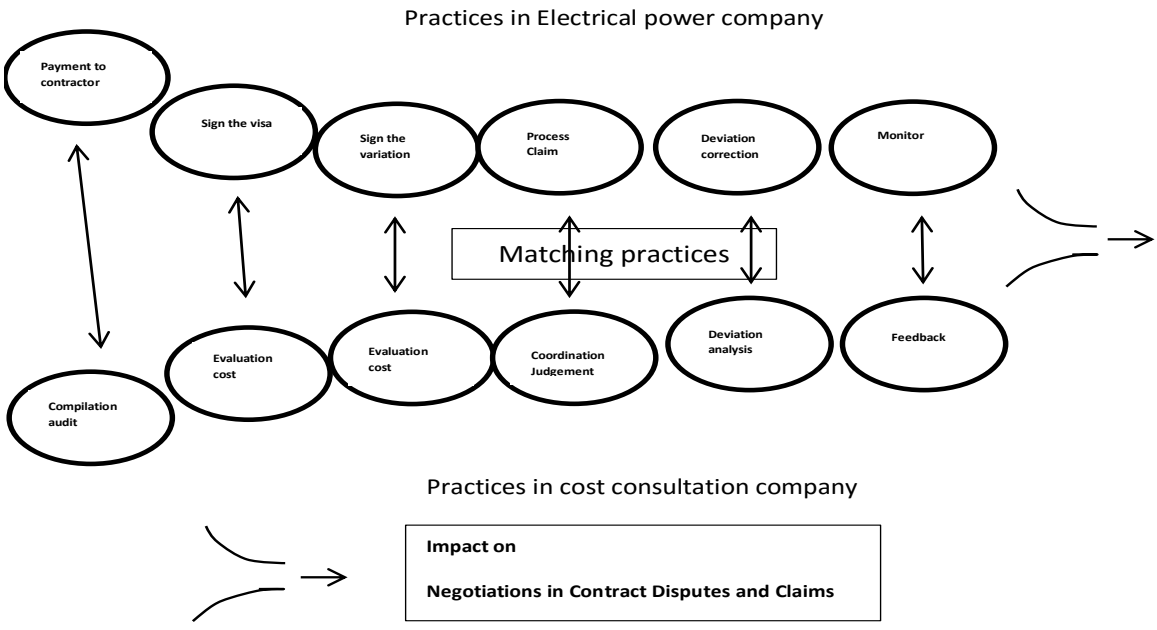


Figure 23. Practices matching in the stage of contract enforcement.

Figure 23 illustrates ECCE needs to analyse the practices to know the needs of the electrical power company and the corresponding practices in this stage. Only by this way, can ECCE help the electrical power company to deal with the affairs in engineering cost management effectively.

Engineering variation is inevitable during the whole construction process, due to the geological changes, the second transfer of the material, the schedule delays and the economic losses caused by force majeure. Force majeure is defined as an exceptional event or circumstance, which is beyond the control, could not be forecasted before signing the contract, and could not be avoided or overcome. Force Majeure may include, but is not limited to, war, invasion, terrorism, civil war, disorder, strike by persons, natural catastrophes (International Federation of Consulting Engineers 1999).

In some cases, the depth of design is not enough, the design deviates from the actual construction situation, which is also the key reason to make the design changes. However, too much engineering variations would lead to the great increase of engineering cost absolutely. In Engineering Cost Management Regulation (Trial Implementation), the term No. 5.5.1 indicates the electrical power company should appoint the on-site cost personnel from ECCE to control the engineering variations strictly. ECCE should avoid the engineering variations which expand design standards and increase construction contents specially. However, the design changes must be approved by the representative of the designer, on-site representatives of the electrical power company, and the supervising engineers, if the design changes are necessary. Meanwhile, cost personnel from ECCE should evaluate the changes of engineering cost caused by the engineering variation timely. And then, ECCE need to submit the report of cost change to the electrical power company, designer and supervising engineer simultaneously based on the term No. 5.5.2 in Settlement Management Regulation (Trial Implementation).

Except the design changes, on-site visa also influents the engineering cost. With the help from on-site cost personnel in ECCE, the electrical power company needs to strengthen the on-site visa management. Engineering Cost Management Regulation (Trial Implementation) states clearly the on-site representatives from ECCE and the electrical power company should strengthen the site management and monitor the con-

tractor to construct according to the drawings. Meanwhile, they need to strictly control the substitute of materials, site visa, and the various additional expenses. For necessary site visa, ECCE should evaluate the cost before contractor starts the construction changes. And the on-site representative should supervise contractor to make records timely, especially the hidden project records and visa works. In many projects, because the on-site visa is not serious, both the electrical power company and contractor would be in trouble in settlement stage, which cause considerable economic losses. So, the strict management of on-site visa is the key measure to control engineering cost in construction stage.

As the third party, ECCE should encourage the electrical power company and contractor to correctly deal with claims. ECCE should promote the smooth communication between two sides. Both the electrical power company and contractor would not only consider the unilateral interests. For the necessary claims, ECCE should deal with the claims fairly and impartially, even ECCE is appointed by the electrical power company according to the Procedure for Cost Consultation in the Whole Construction Process. So, the electrical power company needs to establish the team in charge in engineering cost management with the help of ECCE, which could encourage all the parties to achieve the common target by cooperation. Consequently, all parties would stride to decrease the engineering cost and achieve the benefit maximization.

During the construction process, the deviation is unavoidable, and the deviation can be divided into investment deviation and schedule deviation. Both Management Regulation for Infrastructure Project and Procedure for Cost Consultation in the Whole Construction Process clearly state the project owner and ECCE need to master the changes in project cost in time and strengthen investment control.

In order to control the investment effectively, ECCE need to calculate the investment deviation by the actual cost for work performed (ACWP) and the budgeted cost for work performed (BCWP). Meanwhile, ECCE need to calculate the schedule deviation by the budgeted cost for work scheduled (BCWS) and the budgeted cost for work performed (BCWP).

BCWS=Planned workload × Budget quota
ACWP= Completed workload × Actual price
BCWP= Completed workload × Budget quota

After that, ECCE should analyse the reason and give the electrical power company feasible suggestions to correct the deviation.

If some problems encountered in the construction, the cost personnel from ECCE should promptly contact the designer and notice the cost personnel in the electrical power company. And then, these three parties need to cooperate to select scientific and economical solution.

5.3.6 Completion Acceptance Stage

The stage of completion acceptance is the last stage of engineering cost management. In this stage, settlement not only influences the interests of project owner and contractor directly, but also reflects the actual results of project cost.

Figure 24 mentions the constitutes in construction cost generally, which mainly includes five sections - equipment cost, civil cost, erection cost, other fees and loan interest.

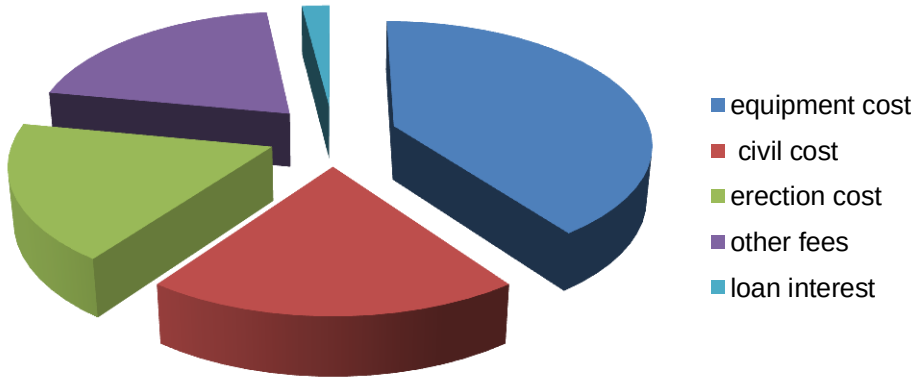


Figure 24. Constitutes of construction cost.

In figure 24, each section implies the respective benefit to all parties involved in the construction process. If the civil cost is taken as an example, the payment to contractor belongs to this section. Therefore, ECCE has to compile the settlement in fair and just attitude to ensure respective benefit to all parties.

In accordance with the contract price and the adjustment terms in contract, ECCE compiles or examines the settlement based on the on-site construction records, the notices of design change, on-site visa and other information. In Settlement Management Regulation (Trial Implementation), the term No. 5.2.1 indicates ECCE should collect various documents after the completion and acceptance of construction, and check the completion, authenticity of settlement documents. In fact, collecting and accumulating project cost information is a basic work in cost management, which needs standardization, digitization and systematization.

In accordance with Term No. 5.1.4 in Settlement Management Regulation (Trial Implementation), the headquarter requires the branches to complete the project settlements within three months and complete the total settlement reports within four months for the new projects in 220 kV and above power. Headquarter also requires the branches to complete the project settlements of the new projects in 110 kV within two and half months and complete the total settlement reports within three months. For the projects below 110 kV, headquarter requires the branches to complete the project settlements within one and half months and complete the total settlement reports within two months. In order to complete the settlements punctually, ECCE need not only professional knowledge but also good communication and negotiation ability, which could smooth the settlement process. Therefore, the electrical power company needs to monitor the process and schedule of settlement audit in ECCE.

Consultation Contract of Engineering Cost (model text) mentions ECCE have the responsibility to negotiation with contractor, communication with owner and give the feedback of important issues to the project owner in this stage. Both project owner and contractor usually could be in troubles, because of the conflict concerning the unilateral interests. As the third party, ECCE need to maintain a rigorous working attitude to avoid the increase and decrease in the engineering cost on purpose. During the process of settlement review, ECCE should pay more attention to the price of material and equipment. So, ECCE need to communicate the department responsible for the material supply in the electrical power company, because the price of material and equipment accounts most of the engineering cost. Only by this way, could ECCE ensure the price accurate.

5.3.7 Final Service Stage

Final service stage, as an additional stage, is necessary for ECCE. Since ECCE need to take some necessary actions to offer better consultancy service as shown in Figure 25.

Figure 25. Practices for ECCE in the final stage.

In order to offer better consultancy service in final stage, Figure 25 indicates ECCE need to standardize the consultancy reports firstly. According to the requirement of customer, consultancy reports would be complete, punctual and digitalized.

The data in engineering cost includes large amount of information, the efficiency of traditional manual management is low and error rate is high. In Engineering Cost Informatization Regulation, Term No. 2 mentions it is necessary to develop a convenient data system of engineering cost and realize the informatization of engineering cost. The results of cost consultation include the report of investment estimate, the report of economic evaluation, preliminary design approval and budgetary estimate, budget approval, approved design changes and cost changes, the files in bidding, audited settlement, the adjustments of contract price, the documents of cost claims, engineering visa and other accessories.

The management for the consultation results should run through the whole process of construction. The collection and sorting of the project documents need to keep pace

with the progress of construction and meet the requirement of national records management based on the Procedure for Cost Consultation in the Whole Construction Process. In addition, according to the Managerial Regulation for ECCE and Managerial Regulation for National Registered Cost Engineers, the documents in engineering cost management should be strictly confidential. ECCE need to establish the rules and regulations to ensure the business secrecy confidential, and appoint personnel to supervise specially. Without the permission of customers, ECCE cannot reveal the business secrecies and cost documents during the consultation process.

Meanwhile, ECCE needs to recognize the satisfaction of customer and analyze the improvement by return visit or questionnaire based on the requirement in the Consultation Contract of Engineering Cost (model text). The Consultation Contract also mentions ECCE need to establish a regulation of double-check audit to shorten the process of divergence. And the accuracy of consultancy results in each stage need to meet the requirement of national or industrial standards. And the consultant cannot bribe or seek other interests out of the contract in the process of consultancy service.

The analysis of economic indicators is an important part of engineering cost management. It is also an important basis for investment decisions and the evaluation of cost. In order to provide the dynamic management of engineering cost and provide reference information for the similar projects in the future, ECCE should pay attention to the accumulation of engineering data and the establishment of the database. Engineering Cost Management Regulation (Trial Implementation) indicates ECCE need to analyze and informationize economic indexes, which are important data for investment decision and the cost evaluation in future project.

5.4 Summary of the Proposal to the Consultancy Services of ECCE

Through matching the practices in ECCE with the practices in the electrical power company in their five construction stages and two additional service stages, the author builds an improved proposal to consultancy services for ECCE, based on the current state analysis, as shown in Figure 26.

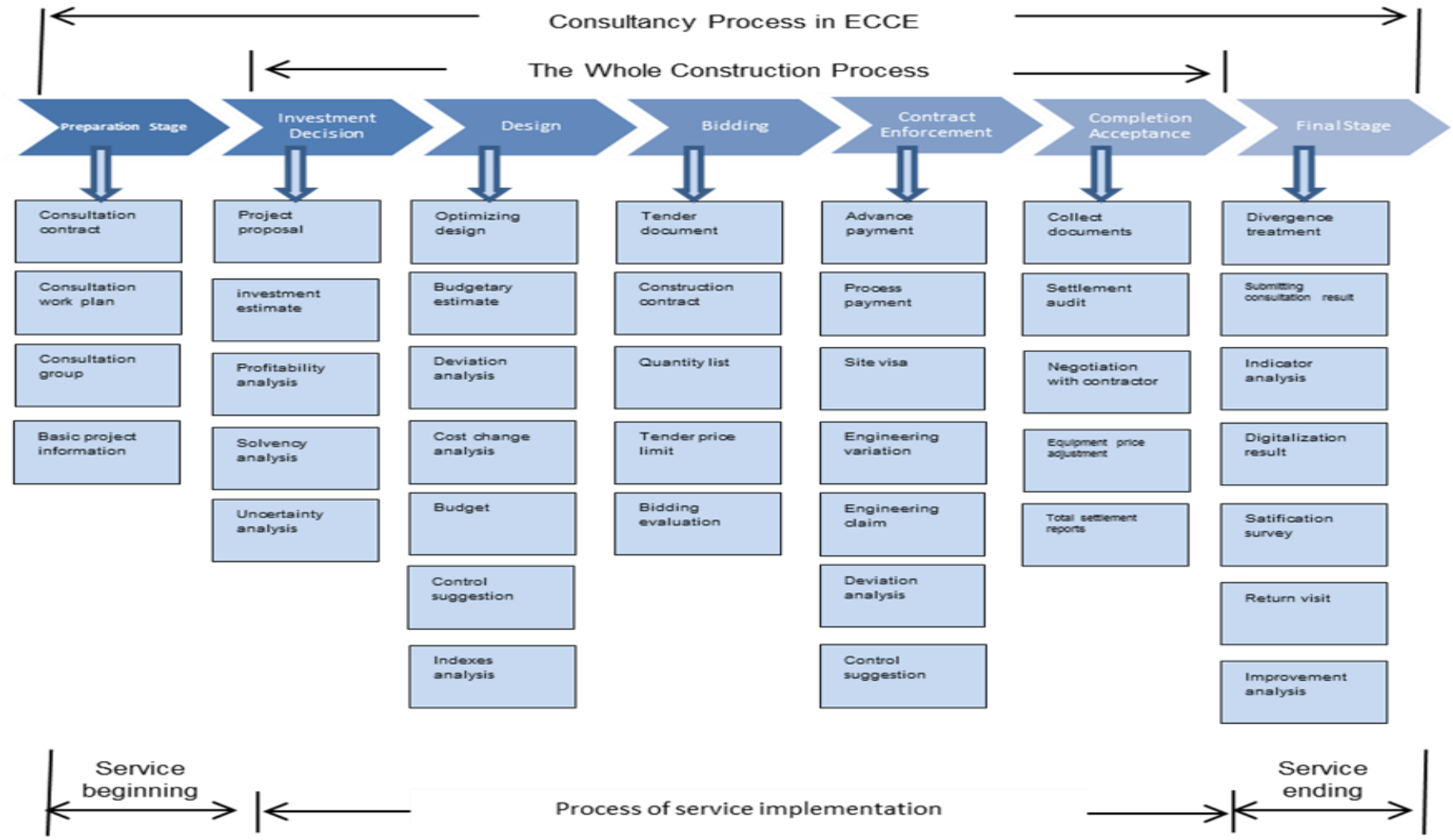


Figure 26. Improved proposal to the consultancy services for ECCE

This improved proposal is established according to the whole construction process and the consultancy process. In order to determine and control the engineering cost dynamically, the process of construction needs to be divided into five stages based on the practices in the whole process of construction. Simultaneously, in order to improve the consultancy services, the consultancy process needs to be added with two stages, service preparation stage and final service stage, based on the theory of CRM. In different stages, the tasks of ECCE are different according to the requirements of customer to control the engineering cost effectively.

This improved proposal is applied with the theory of KIBS, CRM and the whole engineering cost management to recognize the needs of the electrical power company and match the practices with the electrical power company and ECCE stage by stage. In order to overcome the weaknesses and enhance the strengths in ECCS currently, the improved proposal to consultancy service for ECCE is built on the national procedures and regulations which point to the limitations, requirements and guidance for ECCE officially. Meanwhile, the improved proposal is also built on the internal documents in case company, which illustrate the special requirements of the customer.

Through the improved proposal, ECCE could gear its practices towards supporting the practices of the electrical power company. And ECCE could reach the value co-creation, an effective engineering cost management, with the electrical power company in the process of practices matching. As a result, the consultancy service in ECCE could be improved to satisfy the customer’s needs. The performance of engineering cost management could be enhanced simultaneously in the context of the whole engineering cost management.

Therefore, ECCE needs to pay more attention to these aspects in the proposal above in the future, because the performance of ECCE in these aspects is poor-quality and the electrical power company is unsatisfied with it from the questionnaire. The proposal is vital and practical for ECCE, through which ECCE could improve the consultancy services effectively and make better performance in the whole construction process.

6 Validation of the Proposal

This section discusses the validation of the initial improvement proposal. First, research discusses the feedback from the leader in the department of engineering cost management. Second, this section describes the final proposal with the feedback implemented. At last, it iterates the recommendations to improve the consultancy services for ECCE.

6.1 Findings of Data Collection 3

For validating the initial proposal, a discussion was held with the manager who is responsible for the engineering cost management in the case company. In daily work, the manager needs to communicate with a number of ECCEs, which are assigned to help the power company to control the engineering cost.

The initial proposal was sent to the manager by email and then the proposal was discussed in chat software online. Firstly, the researcher clearly indicated the objective of this proposal is to improve the consultancy services for ECCE. Through this proposal, ECCE can help the project owner to control engineering cost effectively in the whole construction process. And then, the research asked three questions: 1) What are your attitudes to this proposal? 2) Do you think this proposal can improve the consultancy services for ECCE? 3) What part needs to be adjusted in this proposal?

> *"This proposal is useful and practical. But if you add the theory of closed-loop management, it will be better, because the internal management in consultancy companies should be closed-loop one."*

In the discussion, the manager expressed the quality of consultancy service neglected by ECCE presently. How to improve the consultancy service needs to be considered by ECCE as soon as possible. Based on his view, the proposal is practical and useful for the engineering cost management in the whole process.

According to the feedback from the manager, the business management in ECCE needs to be applied with the theory of closed-loop management. Additionally, the manager suggested the initial proposal could be included in the management method of PDCA (Plan-Do-Check-Act) circle to achieve the continuous improvement of consul-

tancy processes. Based on the feedback from the manager, the final proposal was built described in the next section.

6.2 Final Proposal

The final proposal to improve the consultancy service for ECCE during the whole construction process was built from the initial proposal, incorporating the best practice found from literature, regulation, internal document and the result from questionnaire, and the feedback from the manager, working in the department of engineering cost management.

Figure 27 describes the final proposal for the improved consultancy service according to the feedback from the manager. Different from the initial proposal, the researcher applied the closed-loop management into the consultancy business, which can help ECCE achieve the continuous improvement.

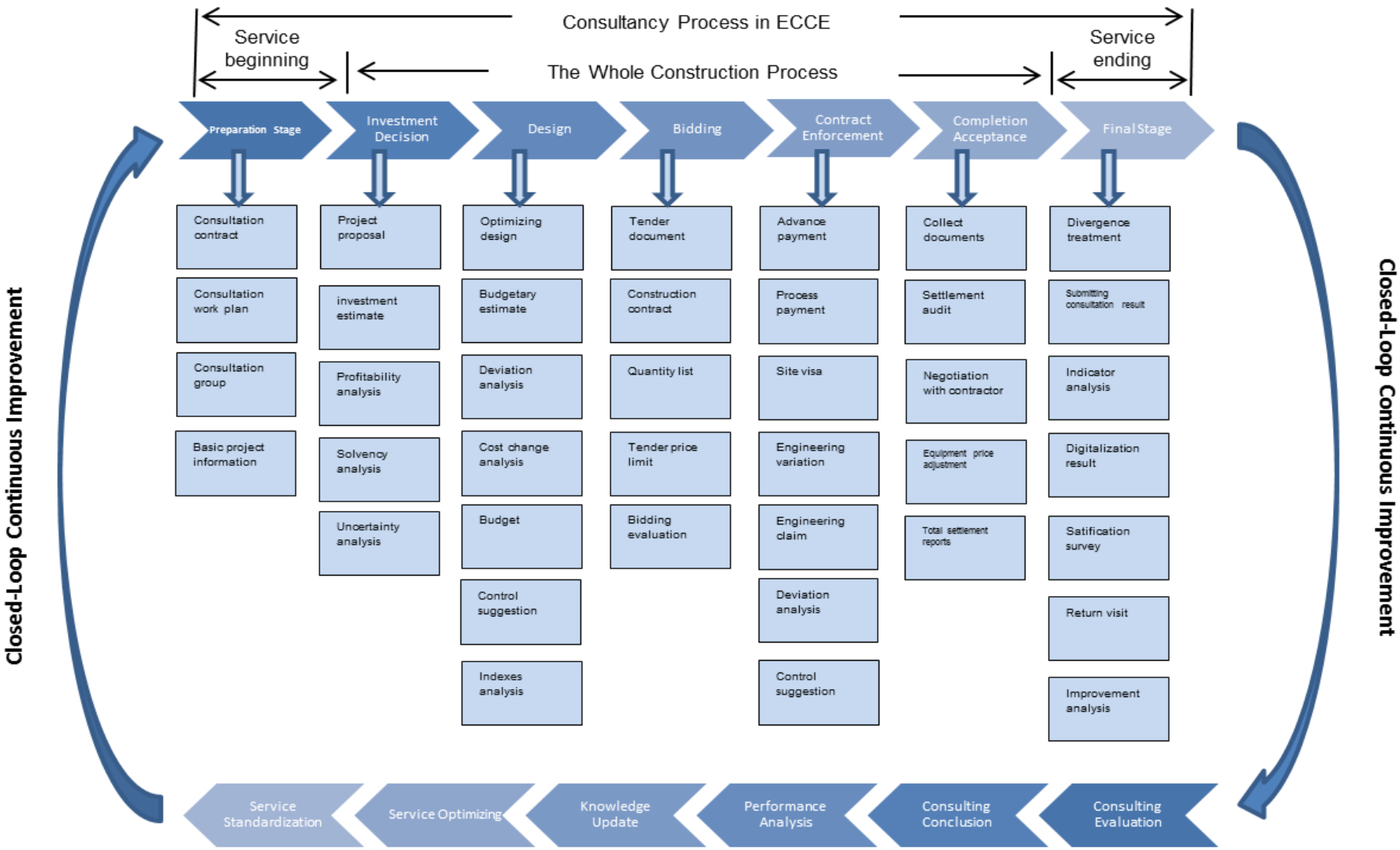


Figure 27. Final improved proposal to the consultancy service for ECCE.

In order to validate this proposal, the researcher sent the final proposal to the manager by email. And the manager firmly believed the final proposal can help ECCE improve the consultancy service and enhance the performance effectively in the whole construction process.

The following section draws a summary of the thesis and suggests further steps for the practical implementation of this proposal. Finally, the section evaluates the outcome of the thesis from the perspective of the initial objective, and from the validity and reliability perspective.

7 Discussion and Conclusions

This section contains the discussion and conclusion of this thesis. First, this section discusses the summary and then second, practical and managerial implications. Thirdly, it evaluates the outcome and objective of this thesis. Lastly, the reliability and validity of this thesis are evaluated.

7.1 Summary

This thesis focuses on improvement of the ECCS in the whole construction process. The objective of this thesis was to propose improvements for the ECCE, in order to offer better consultancy services. The improvement proposal is needed by ECCE because the current consultancy service is incomplete. Through the improvement proposal, ECCE can enhance the consultancy performance effectively in the whole construction process.

The approach of case study is applied and the data is collected from different sources in this thesis. This study conducted the questionnaire to analyse the current state combined with the interview with the executive in ECCE and the researcher's observation in the case company. After that, this study collected and analysed the procedures and regulations concerning the engineering cost management and the management of consultation enterprise to standardize the activities of ECCE. In addition, interviews also were conducted to build the improved proposal to consultancy service.

The literature review was targeted to explore the best practice in the research areas. Based on the input of best practice and procedures and internal documents, the author applies the approaches of CRM to match the practices of ECCE with the electrical power company in the five stages of project construction and two additional stages to build the improved proposal to consultancy services. In each stage, through understanding the needs and experiences of customer, ECCE, as a KIBS, could adjust consulting service to monitor the actions of customers and complete value co-creation.

The results of current state analysis and the improvement proposal were discussed with the managers in the case company. The manager gave further suggestions for the initial improvement proposal. The proposal contains, first, divided seven stages of ECCS, and second, improved the activities of ECCS. The closed-loop is designed to help ECCE enhance the consultancy performance continuously.

Through the proposal to consultancy service, ECCE could manage the customer relationship effectively and improve the consultancy service continuously in the whole construction process. Meanwhile, the electrical power company could achieve the efficient investment result.

7.2 Practical Recommendations

In order to understand the needs and requirements of customer in different stages, ECCE should bring the analysis of customer practices into internal managerial regulations, and regard it as the core of CRM. So, ECCE need to appoint a special department, which is responsible to publicize, implement, inspect and appraise the managerial regulations to improve the consultancy services in next steps.

As KIBS, the staffs in ECCE should be with high-level degrees and professional qualifications. So, it is vital for ECCE to improve the employees' professional quality in future. Only in this way, could ECCE offer scientific and efficient service to their customers. Meanwhile, ECCE need to organize intensive courses to the employees, which could improve the employees' service sense and make the employees familiar with various regulations.

7.3 Evaluation of the Thesis

This section evaluates the outcome of this study compared against the research objective defined at the beginning of this study. Additionally, reliability and validity of this thesis are evaluated and compared to the plan defined in Section 2.4.

7.3.1 Outcome vs Objective

The objective of this study was to propose improvements for the ECCE, in order to offer better consultancy services. Currently, the business scope of consultancy is limited and the consultancy service is incomplete. As a result, the project owner recognizes the difficulty to control engineering cost during the construction process. So, this study tries to propose an improved consultancy service for ECCE.

The results of this study gave ECCE an improved proposal which would make ECCE to offer better consultancy services and enhance the performance in the whole construction process. The improved proposal was built based on the procedures and internal

documents, and with the input of best practice from related literature. In addition, the proposal was built and adjusted with the feedback from the manager in charge in engineering cost.

So, it can be considered that the result of this study did meet the objective, although the effectiveness of implication can only be evaluated after ECCE practice consultancy services during the whole construction process in real life situation. When ECCE join in the engineering cost management in whole construction process, the final effect of the improved proposal could be evaluated.

7.3.2 Validity and Reliability

As described in Section 2.4, the reliability and validity of this study were ensured by taking multi-steps. To improve the validity of this thesis, the data were collected from multiple resources for the triangulation of data. Meanwhile, the data used in this study were compiled from trusted sources. Each procedure and regulation was collected from official organization. And each internal document was collected from CSG. The interview was conducted with the manager in CSG and the executive in ECCE. To increase transparency, the questionnaire used in current state analysis was made available in the Appendix of this study, including the responses. Finally, the improvement proposal was accepted by the manager responsible for the engineering cost management who communicates with ECCEs in daily work. The proposal responds to the objective of the study, which is the key requirement of validity. This study aims to devolop an improved proposal to consultancy service provided by the consultation enterprises for the whole construction process. In the future, through applying this proposal to the practices, ECCE can provide more complete and efficient consultancy service for their clients.

To ensure the reliability of this study, the following measures were taken. Firstly, multiple sources of data were used to ensure the credibility of data. In this study, the different methods of data collection had been used. Methods included interviews and discussions with the manager and the executive, questionnaire from the parties involved in construction, analysis of the internal and external documentation, and literature review for the consultancy service.

To increase reliability and validity of the outcome, more interviews would absolutely benefit the evaluations and might lead to more effective proposals. The Current State

Analysis was conducted at distance, and it was challenging to receive the information without face to face. The researcher could not recognize their emotion, when they answered the questions. The interview was conducted mainly just from the electrical power company perspective, because the stakeholder in the consultancy company was on business trip, the research did not receive the feedback, which reduced the reliability and validity of the outcome in this study. However, the improvement proposal was accepted by the manager in charge of engineering cost management.

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Appendix 1. Questionnaire of the key points in engineering cost management based on ECCS. (Translation of questionnaire from Chinese)

Dear respondents,

I would be appreciated if you can answer following questions for my master thesis. This survey is based on the theory of construction cost management in the whole process. In order to determinate and control the engineering cost reasonably and effectively, the survey is organized to improve the consultancy services in consultation companies.

The survey does not involve your work confidence and privacy. You choose the choices according to the real situations. Thank you for your support and cooperation in your busy schedule!

Basic information of the company

1. The name of the company:
2. The category of the company:

□Project owner; □Consultation company; □Contractor; □Others;

3. Qualification: (NOT filled by project owner)

□Engineering cost consultation_____class;

□Engineering bidding agency_____class;

□Others: _____;

4. The consultation services: (ONLY filled by the staff in consultation company, multiple choice)

□Engineering cost consultation in the whole process;

□Pre-planning;

□Tender agent;

□Cost consultation in contract enforcement stage;

□Compilation and audit the settlement;

□Others;

5. How many years has the consultation company established? (NOT filled by project owner)

□1-3 years; □4-6 years; □7-10 years; □more than 10 years;

6. How many employees are in the consultation company? (NOT filled by project owner)

□less than 5 employees; □6-10 employees; □11-50 employees; □51-100 employees; □more than 100 employees;

Basic information of the respondent

1. Education background of respondent:

□Undergraduate; □Master's degree; □Doctor; □Others;

2. Position in the company:

□Senior manager; □Middle manager; □Project manager; □Technical personnel; □Others;

3. How many years do you work in the field of cost consultation?

□1-5 years; □6-10 years; □11-15 years; □more than 15 years;

4. What kind of qualifications you have: (multiple choice)

□ Cost personnel; □Registered cost engineer; □ Registered consultation engineer; □ Registered tender engineer; □Others;

5. Positon in the past cost management activities: (multiple choice)

□ Leader; □Manager; □ Operator; □Others;

Questionnaire of the key points in engineering cost management based on ECCS

Please choose appropriate options and filled by "✓" in the boxes, according to your individual understanding of the consultancy service in consultation companies. This questionnaire is organized by a five-point scale for how well the consultancy services show.

I. Preparation stage

01. How complete the consultation contract is?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

02. How feasible the consultation work plan is?

□Very feasible; □ Feasible; □Normal; □ Infeasible; □Very infeasible;

03. How reasonable the number of consultation personnel is?

□Very reasonable; □ Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

04. How reasonable the qualification of consultation personnel is?

□Very reasonable; □ Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

05. How clear the assignment of responsibility in consultation group is?

□Very clear; □ Clear; □Normal; □ Unclear; □Very unclear;

06. How does the consultant know the project information?

□Very familiarly; □Familiarly; □Normally; □ Unfamiliarly; □Very unfamiliarly;

II. Investment decision stage

07. How reasonable the construction standards are?

□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

08. How precision the investment estimate is?

□Very precise; □Precise; □Normal; □Imprecise; □Very imprecise;

09. How reasonable the depth of investment estimate is?

□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

10. How correct the calculating method of investment estimate is?

□Very correct; □Correct; □Normal; □Incorrect □Very incorrect;

11. How correct the calculating basis of investment estimate is?

□Very correct; □Correct; □Normal; □Incorrect □Very incorrect;

12. How complete the cost constitutions of investment estimate are?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

13. How accurate the profitability analysis of project is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
14. How accurate the solvency analysis of project is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
15. How accurate the uncertainty analysis of project is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;

III. Design Stage

16. How accurate the analysis of function and cost is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
17. How complete the content of budgetary estimate is?
□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;
18. How precise the budgetary estimate is?
□Very precise; □Precise; □Normal; □Imprecise; □Very imprecise;
19. How reasonable the depth of budgetary estimate is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;
20. How accurate the deviation analysis between investment estimate and budgetary estimate is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
21. How accurate the cost analysis according to design variation is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
22. How precise the budget is?
□Very precise; □Precise; □Normal; □Imprecise; □Very imprecise;
23. How reasonable the depth of budget is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;
24. How precise the cost of equipment and material is?
□Very precise; □Precise; □Normal; □Imprecise; □Very imprecise;
25. How accurate the deviation analysis between budgetary estimate and budget is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
26. How accurate the indexes analysis of unit cost is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
27. How reasonable the suggestion of investment control is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

IV. Bidding stage

28. How complete the tender documents are?
□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;
29. How reasonable the contract is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

30. How complete the contract is?
□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;
31. How normative the compilation and audit of quantity list is?
□Very normative; □ Normative; □Normal; □Unnormative; □Very unnormative;
32. How normative the compilation and audit of tender price limit is?
□Very normative; □ Normative; □Normal; □Unnormative; □Very unnormative;
33. How reasonable the method of bidding evaluation is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;
34. How reasonable the analysis of bid price is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

V. Contract enforcement stage

35. How accurate the compilation and audit of advance payment is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
36. How accurate the compilation and audit of process payment is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
37. How accurate the compilation and audit of site visa is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
38. How accurate the compilation and audit of engineering variation is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
29. How accurate the compilation and audit of engineering claim is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
40. How reasonable the price used new technology is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;
41. How accurate the price inquiry of equipment and material offered by owner is?
□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;
42. How reasonable the analysis and correction of investment deviation is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;
43. How reasonable the suggestion of investment control is?
□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;
44. How timely the feedback from cost engineer in site is?
□Very timely; □ timely; □Normal; □ Untimely; □Very untimely;

VI. Completion acceptance stage

45. How timely the settlement documents are?
□Very timely; □ timely; □Normal; □ Untimely; □Very untimely;
46. How complete the settlement documents are?
□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;
47. How authentic the settlement documents are?

□Very authentic; □ authentic; □Normal; □ Inauthentic; □Very inauthentic;

48. How punctual the settlement audit is?

□Very punctual; □ punctual; □Normal; □ unpunctual; □Very unpunctual;

49. How accurate the calculation of project quantity is?

□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;

50. How accurate the price and adjustment of equipment and material offered by owner are?

□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;

51. How reasonable the Quota (unit price) of settlement is?

□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

52. How accurate the cost calculation of settlement is?

□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;

53. How reasonable the audit of estimated price is?

□Very reasonable; □Reasonable; □Normal; □ Unreasonable; □Very unreasonable;

54. How smooth the negotiation with contractor is?

□Very successful; □Successful; □Normal; □ Unsuccessful; □Very unsuccessful;

55. How smooth the communication with owner is?

□Very successful; □Successful; □Normal; □ Unsuccessful; □Very unsuccessful;

56. How timely the feedback of important issues is?

□Very timely; □ timely; □Normal; □ Untimely; □Very untimely;

VII. Final stage

57. How complete the review (approved) contents of consultation result are?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

58. How smooth the divergence treatment of consultation result is?

□Very successful; □Successful; □Normal; □ Unsuccessful; □Very unsuccessful;

59. How timely the submitting of result documents is?

□Very timely; □ timely; □Normal; □ Untimely; □Very untimely;

60. How complete the result documents are?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

61. How accurate the analysis of economic indicators in consultation results is?

□Very accurate; □Accurate; □Normal; □ Inaccurate; □Very inaccurate;

62. How timely the digitalization of consultation result is?

□Very timely; □ timely; □Normal; □ Untimely; □Very untimely;

63. How complete the return-visit records are?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

64. How feasible the improvement analysis of consultation service is?

□Very feasible; □ Feasible; □Normal; □ Infeasible; □Very infeasible;

65. Are customers satisfied with the consultation service?

□Very satisfied; □Satisfied; □Normal; □ Unsatisfied; □Very unsatisfied;

66. How often service reworks happen?

□Very frequent; □ Frequent; □Normal; □ Infrequent; □Very infrequent;

67. How often customers' complaints about the consultation service happen?

□Very frequent; □ Frequent; □Normal; □ Infrequent; □Very infrequent;

68. How complete the confidential measure of customers' information is?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

69. How complete the anti-corruption measure is?

□Very complete; □Complete; □Normal; □ Incomplete; □Very incomplete;

Thank you again for your support and cooperation!

Appendix 2. The result of questionnaire

Questions	Value for each question(Ti)					Evaluation (V)
	1	2	3	4	5	
I. Preparation stage						
01. How complete the consultation contract is?	0	3	8	28	4	3.77
02. How feasible the consultation work plan is?	0	1	9	30	3	3.81
03. How reasonable the number of consultation personnel is?	0	2	11	26	4	3.74
04. How reasonable the qualification of consultation personnel is?	0	1	10	27	5	3.84
05. How clear the assignment of responsibility in consultation group is?	0	2	7	26	8	3.93
06. How does the consultant know the basic project information?	0	2	6	27	8	3.95
II. Investment decision stage						
07. How reasonable the construction standards are?	0	2	12	25	4	3.72
08. How precision the investment estimate is?	0	5	16	19	3	3.47
09. How reasonable the depth of investment estimate is?	0	6	18	16	3	3.37
10. How correct the calculating method of investment estimate is?	0	1	16	21	5	3.7
11. How correct the calculating basis of investment estimate is?	1	0	12	25	5	3.77
12. How complete the cost constitutions of investment estimate are?	0	5	7	25	6	3.74
13. How accurate the profitability analysis of project is?	3	5	16	16	3	3.26
14. How accurate the solvency analysis of project is?	2	6	15	16	4	3.33
15. How accurate the uncertainty analysis of project is?	3	3	18	15	4	3.33
III. Design Stage						
16. How accurate the analysis of function and cost is?	1	4	14	18	6	3.56
17. How complete the content of budgetary estimate is?	0	2	10	24	7	3.84
18. How precise the budgetary estimate is?	1	2	13	22	5	3.65

19. How reasonable the depth of budgetary estimate is?	0	2	11	25	5	3.77
20. How accurate the deviation analysis between investment estimate and budgetary estimate is?	0	2	14	24	3	3.65
21. How accurate the cost analysis according to design variation is?	0	3	13	23	4	3.65
22. How precise the budget is?	0	2	11	20	10	3.88
23. How reasonable the depth of budget is?	0	2	11	21	9	3.86
24. How precise the cost of equipment and material is?	0	4	10	21	8	3.77
25. How accurate the deviation analysis between budgetary estimate and budget is?	0	3	11	19	10	3.84
26. How accurate the indexes analysis of unit cost is?	0	1	11	23	8	3.88
27. How reasonable the suggestion of investment control is?	0	1	15	23	4	3.7
IV. Bidding stage						
28. How complete the tender documents are?	0	3	10	26	4	3.72
29. How reasonable the contract is?	0	1	14	24	4	3.72
30. How complete the contract is?	0	1	12	27	3	3.74
31. How normative the compilation and audit of quantity list is?	0	2	8	26	7	3.88
32. How normative the compilation and audit of tender price limit is?	0	2	7	26	8	3.93
33. How reasonable the method of bidding evaluation is?	1	1	8	28	5	3.81
34. How reasonable the analysis of bid price is?	1	1	10	25	6	3.79
V. Contract enforcement stage						
35. How accurate the compilation and audit of advance payment is?	0	2	12	23	6	3.77
36. How accurate the compilation and audit of process payment is?	0	4	10	22	7	3.74
37. How accurate the compilation and audit of site visa is?	0	1	12	24	6	3.81
38. How accurate the compilation and audit of engineering variation is?	0	1	11	26	5	3.81
39. How accurate the compilation and audit of engineering claim is?	0	5	7	25	6	3.74
40. How reasonable the price used new technology	0	1	11	28	3	3.77

is?						
41. How accurate the price inquiry of equipment and material offered by owner is?	0	2	11	25	5	3.77
42. How reasonable the analysis and correction of investment deviation is?	0	3	14	22	4	3.63
43. How reasonable the suggestion of investment control is?	0	5	12	22	4	3.58
44. How timely the feedback from cost engineer in site is?	1	4	10	20	8	3.7
VI. **Completion acceptance stage**						
45. How timely the settlement documents are?	2	7	12	18	4	3.35
46. How complete the settlement documents are?	1	5	11	20	6	3.58
47. How authentic the settlement documents are?	0	4	11	22	6	3.7
48. How punctual the settlement audit is?	1	3	14	19	6	3.6
49. How accurate the quantity calculation is?	0	0	9	29	5	3.91
50. How accurate the price and adjustment of equipment and material offered by owner are?	0	1	10	26	6	3.86
51. How reasonable the Quota (unit price) of settlement is?	0	0	7	30	6	3.98
52. How accurate the cost calculation of settlement is?	0	2	7	28	6	3.88
53. How reasonable the audit of estimated price is?	0	1	12	24	6	3.81
54. How smooth the negotiation with contractor is?	0	4	15	21	3	3.53
55. How smooth the communication with owner is?	1	1	12	24	5	3.72
56. How timely the feedback of important issues is?	0	0	14	22	7	3.84
VII. **Final stage**						
57. How complete the review (approved) contents of consultation result are?	0	2	8	28	5	3.84
58. How smooth the divergence treatment of consultation result is?	1	4	8	26	4	3.65
59. How timely the submitting of result documents is?	0	5	7	26	5	3.72
60. How complete the result documents are?	0	0	11	26	6	3.88
61. How accurate the analysis of economic indicators in consultation results is?	0	1	15	23	4	3.7
62. How timely the digitalization of consultation result is?	1	2	12	24	4	3.65
63. How complete the return-visit records are?	1	6	10	22	4	3.51
64. How feasible the improvement analysis of consultation service is?	0	1	14	24	4	3.72

65. Are customers satisfied with the consultation service?	0	1	15	20	7	3.77
66. How often consultation service reworks happen?	0	1	14	21	7	3.79
67. How often customers' complaints about the consultation service happen?	0	0	14	14	15	4.02
68. How complete the confidential measure of customers' information is?	0	3	8	22	10	3.91
69. How complete the anti-corruption measure is?	0	3	5	21	14	4.07

Appendix 3. Terms in the procedures and regulations

Table 9. Terms in procedures and regulations.

Stage	Key points	The terms No. in procedures and regulations									
		Manage age-ment Regula-tion for Infra-struc-ture Project	Regula-tion of Engi-neering Cost Manage age-ment (Trial Imple-menta-tion)	Mana-gerial Regula-tion for Con-struc-tion Draw-ing Budget (Trial Imple-menta-tion)	Mana-gerial Regula-tion for Prelimi-nary Design Budg-etary Esti-mate (Trial Imple-menta-tion)	Mana-gerial Regula-tion for Settle-ment (Trial Imple-menta-tion)	Regula-tion for the In-formati-zation Engi-neering Cost	Proce-dure for Cost Consul-tation in the Whole Con-struc-tion Process	Consul-tation Con-tract of Engi-neering Cost (model text)	Mana-gerial Regula-tion for ECCE	Mana-gerial Regula-tion for Nation-al Reg-istered Cost Engi-neers
Prepa-ration stage	Completion of consulta-tion contract	5.6.3.1								21	
	Feasibility of consultation work plan							3.2.1	2.4		
	Reasonability of the number of consultation personnel							3.2.1	2.4	9.4,10.3	
	Reasonability of the qualification of consulta-tion personnel		5.1.3					3.2.1	2.4	9.4,10.3	
	Assignment of responsi-bility in consultation							3.2.2	2.4		

	group										
	Familiarity of the basic project information								2.11.3		
Invest-vest-ment deci-sion stage	Construction standards for projects	5.5.1.2									
	Precision of investment estimate							4.1.2			
	Depth of investment es-timate	5.5.1.1						4.1.2			
	Method of investment estimate							4.1.2			
	Basis of investment esti-mate	5.5.3.1						4.1.4			
	Cost constitutions of in-vestment estimate		5.2.4					4.1.2			
	Profitability analysis of project	5.2.3.3						4.2.4			
	Solvency analysis of pro-ject	5.2.3.3						4.2.5			
	Uncertainty analysis of project	5.2.3.3						4.2.6			
Design Stage	Analysis of function and cost	5.5.2.3									
	Content of budgetary estimate		5.3.3		5.2.4.3			5.1.2			
	Precision of budgetary estimate		5.3.3		5.2.4.5			5.1.2			
	Depth of budgetary esti-mate	5.5.4.5			5.2.4.2			5.1.6			
	Deviation analysis be-tween investment esti-mate and budgetary es-	5.5.4.5			5.1.5			5.1.6			

	timate										
	Cost analysis according to design variation	5.5.4.8						5.1.6			
	Precision of budget			5.1.2				5.2.2			
	Depth of budget			5.1.1				5.2.2			
	Cost of equipment and material			5.1.2.3				5.2.3			
	Deviation analysis between budgetary estimate and budget			5.1.1							
	Indexes analysis of unit cost			5.2.3							
	Suggestion of investment control							1.0.5			
Bidding stage	Completion of tender documents							6.1.2			
	Reasonability of contract							6.1.1			
	Completion of contract							6.1.2			
	Compilation and audit of quantity list							6.2.1			
	Compilation and audit of price limit							6.2.2			
	Method of bidding evaluation										
	Analysis of bid price							6.3.1			
Contract enforcement stage	Compilation and audit of advance payment							7.1			
	Compilation and audit of process payment							7.2			
	Compilation and audit of site visa	5.9.3	5.5.1			5.3.3					
	Compilation and audit of	5.9.3	5.5.1			5.5.2		7.3			

	engineering variation										
	Compilation and audit of engineering claim							7.4			
	The price used new technology		5.10.5								
	The price inquiry of equipment and material offered by owner					5.4.1.1					
	Analysis and correction of investment deviation	5.9.2						7.5			
	Suggestion of investment control							7.5.4			
	Feedback from cost engineer in site							1.0.9			
Completion acceptance stage	Timeliness of settlement documents		5.6.5			4.3.2			3.8		
	Completion of settlement documents					5.2.1		8.1.5			
	Authenticity of settlement documents					5.2.1		8.1.5			
	Time limit of settlement audit	5.9.4.3	5.6.5			5.1.4		8.1.2			
	Quantity calculation					5.3.1					
	Price and adjustment of equipment and material offered by owner					5.4.1.1					
	Quota (unit price) of settlement					5.4.1.4					
	Cost calculation of settlement					5.4.1.3					
	Audit of estimated price					5.4.1.4					
	Negotiation with contrac-								2.11.2		

	tor										
	Communication with owner							3.1.6	2.10		
	Feedback of important issues								2.11.1		
Final stage	Review (approved) contents of consultation result							3.5.4			
	Divergence treatment of consultation result								2.12.2		
	Timeliness of submitting result documents	5.8.5.1	5.6.5			5.1.4		3.2.3			
	Completion of result documents	5.8.5.1	5.10.5					3.6.2			
	Analysis of economic indicators in consultation results		5.6.4			5.1.2		3.4.3			
	Digitalization of consultation result	5.8.5.4					2	3.6.5			
	Completion of return-visit records							3.5.6			
	Improvement analysis of consultation service							3.5.6			
	Satisfaction of customer with the consultation service							3.5.6	2.12.2		
	Rework frequency of consultation service								2.12.2		
	Frequency of customers' complaint about the consultation service							3.5.6	2.12.2		
	Confidential measure of		5.1.5						2.6	28	17.6

	customers' information										
	Anti-corruption measure									42.3	20.2