J. Basic. Appl. Sci. Res., 2(4)4167-4173, 2012

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Quality Function Deployment in Engineering, Procurement and Construction Projects

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ABSTRACT

Quality function deployment (QFD) is an important customer-oriented tool, which is capable of measuring, managing and improving services to increase customer satisfaction. An increasing number of studies focus on design quality in products. There is a paucity of papers for improving the services in QFD fields while education, e-banking, information services and hospitality needs are almost considered. However, this paper transforms the engineering requirements (ERs), a novel kind of services, in EPC Project Company with respect to the owner needs (ONs) and aggregates the ERs ratings to get relative importance scores of ERs.
KEYWORDS: quality function deployment, house of quality, EPC project, project management.

1- INTRODUCTION

Every organization in today's competitive world of business and industry has customers. It is necessary that the companies know its customers well, identify their most important requirements and that the products it supplies meet them satisfactorily. Whilst delivering high service quality is considered an essential strategy for success and survival in this competitive environment. (Clow and Vorhies, 1993; Zeithaml et al., 1996; Kandampully, 1998).

According to Yasin (2002) quality function development (QFD) is one of the methods for developing products and services to reach these goals and it may be considered as an important predecessor of the current benchmarking approach. Indeed when we are working to determine what we need to accomplish to satisfy or delight customers, we have a vast selection of techniques in the total quality management to ensure the consideration of customer needs. QFD is one of these techniques that aim the satisfaction of the customers by listening to the customer's voice. Quality professionals refer to QFD by many names, including matrix product planning, decision matrix, and customer-driven engineering. It is a kind of methodology for listening to the voice of customers with cross-functional team members and satisfying their expectations.

For many years now it seems that the most desired way for an Owner to procure a major construction project, particularly one being project financed, was via a fixed price, lump sum turnkey route; the so called engineering, procurement and construction contract ("EPC contract"). (Loots, Phil; Nick Henchie, 2007-11). Therefore, we have developed the owner needs in EPC project by means of the house of quality.

In this paper, we will focus on how the engineering requirements could be developed for performing the ONs of the EPC contracts through the use of QFD.

The rest of paper is structured as follows: Section 2, we present a literature review, the next section; we present a brief description of the HOQ. Section 4 describes EPC projects. In section 5, the result and analysis, the project consultant company is selected as a case study to deploy ERs with respect to owner's needs.

2. LITERATURE REVIEW

The literature has been reviewed from two perspectives; applications of QFD and benchmarking with AHP.

2.1 Literature review on applications of QFD

QFD was first conceptualized in the late 1960s (Akao, 1997). It was immediately adapted by various companies but it did not draw much public attention. It was conceived in Japan in the late 1960s with the purpose of meeting the need for a quality assurance system of the industries (Kogure and Akao, 1983). Firmly grounded on the principles of total quality management (TQM), QFD focuses on delivering value by understanding the customers' needs and deploying this information throughout the development process as well as to the manufacturing process and control systems (Sullivan, 1986; Hill, 1994).QFD focuses on delivering

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"value" by seeking out both spoken and unspoken customer requirements, translating them into actionable service features and communicating them throughout an organization (Mazur, 1993, 1997; Pun et al., 2000).

QFD is developed by a cross-functional team and provides an excellent interdepartmental means of communication that creates a common quality focus across all functions/operations in an organization (Stuart and Tax, 1996).The unique approach of QFD is its ability to integrate customer demands with the technical aspects of a service.

QFD has been introduced successfully to the service sector. The reported implementations are in various service area such as healthcare (Lim et al., 1999; Lim and Tang, 2000), public sector (Curry and Herbert, 1998; Gerst, 2004), hospitality (Stuart and Tax, 1996; Dube et al., 1999),retail(Trappey et al., 1996; Sher, 2006), spectator event (Enriquez et al., 2004), technical libraries and information services (Chin et al., 2001), education (Koksal and Egitman, 1998; Lam and Zhao, 1998) and e-banking (Gonzalez et al., 2004) etc.

2.2 Literature review on AHP approach

AHP was adopted to evaluate the importance ratings of stakeholder requirements. The alternative education design requirements were then prioritized based on the AHP ratings together with the relationship weightings between the education requirements and stakeholder requirements.

Recently, the combined AHP-QFD approach has been applied to many areas. The integrated AHP-QFD approach to improve the quality of education for the Department of Industrial Engineering at the Middle East Technical University in Turkey by Ko¨ksal and Egitman (1998) applied. Lam and Zhao (1998) used the integrated AHP-QFD approach to identify appropriate teaching techniques.As the other studies is including logistics (Chuang, 2001; Partovi, 2006), manufacturing (Wang et al., 1998; Partovi, 1999; Zakarian and Kusiak, 1999; Hsiao, 2002; Kwong and Bai, 2002; Madu et al., 2002; Kwong and Bai, 2003; Myint, 2003; Bhattacharya et al., 2005; Hanumaiah et al., 2006), military (Partovi and Epperly, 1999), and sports (Partovi and Corredoira, 2002).

To the best knowledge of the authors, this approach has not yet been applied in the field of project management with respect to the engineering, procurement and construction project.

In this paper, the alternative engineering techniques were prioritized based on the AHP ratings and the relationship weightings between owner needs and engineering techniques.

3. The house of quality

The HOQ is a kind of conceptual map that provides the means for interfunctional planning and communications. (Hauser and Clausing, 1988)

The HOQ provides important information about what areas need to be improved. A typical HOQ comprises six parts as shown in figure 1.The customer needs (WHATs) also known as voice of the customer, customer attributes, customer requirements or demanded quality. The relative importance of customer needs as the initial input was perceived by the owner estimated in Matrix A.

Customer needs, usually collected by focus groups or individual interviews should be expressed in customers' own phrases. In this survey, we have gathered with the QFD group and Individual one-to-one interviews with managers. Relative importance of the customer needs may be obtained using simple methods such as direct rating or more complex one, analytic hierarchy process (AHP), while we have applied this method for rating customer needs.

ERs (HOWs) are also known as design requirements, product features, engineering attributes, engineering characteristics or substitute quality characteristics. They are listed in Matrix B. Customer needs tell the company 'what to do' while the ERs tell 'how to do it'. The degree of relationship between WHATs and HOWs are measured in Matrix C. The relationship matrix indicates how much each ER affects each customer need. The relations can either be presented in numbers or symbols. It is usually captured using four levels no relationship, weak or possible relationship, moderate and finally strong relationship. The symbols are converted into numbers using a measurable scale (0, 1, 3, and 9). In this paper, we will use symbols to denote the relationship between WHATs and HOWs. In general, the significant interrelations between the DRs have been identified by a correlation Matrix D emphasizing necessary trade-offs. The absolute and relative importances of DRs are calculated in Matrix E. For benchmarking, the absolute and relative importance of the customer needs is shown in Matrix F.

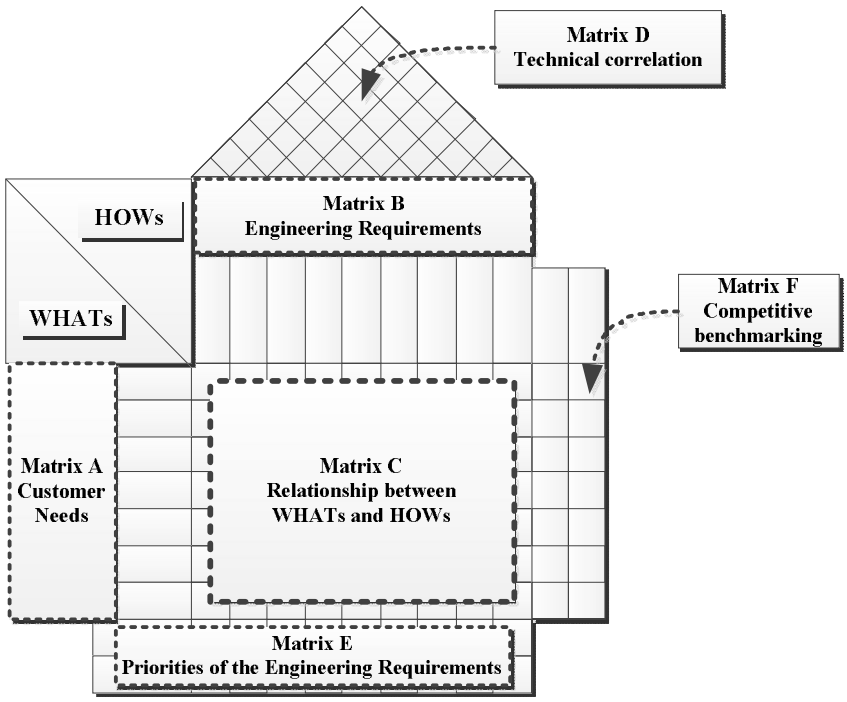

Fig 1. House of quality.

4. EPC project

What is a project? Given the variety of organizational scenarios within which projects are initiated and managed, some confusion will inevitably arise in relation to how a project should be defined. The following sentiment could embrace all broad indications of what the purpose of project efforts generally is: Projects should transform an unsatisfactory (existing or future) state to a better state within a certain time, using a limited effort. (Cleland and Gareis, 1994)

EPC stands for Engineering, Procurement and Construction. It is a common form of contracting arrangement within the construction industry. Under an EPC contract, the contractor will design the installation, procure the necessary materials and construct it, either through own labour or by subcontracting part of the work. In some cases, the contractor will carry the project risk for schedule as well as budget in return for a fixed price, called lump sum or LSTK depending on the agreed scope of work. (Loots, Phil; Nick Henchie, 2007-11)

5. RESULT ANALYSIS

The proposed owner needs in EPC project's companies using combined AHP and QFD has been described in the following steps. The approach comprises in figure 2 (refer to steps 1 to 5).

Step 1: identify the project owner's needs.

To determine the customer needs (in project "owner"), we used a questionnaire that was designed according to the company's managers and QFD team. This questionnaire includes 15 questions about the most important criteria affecting with respect to the quality services. Questions were based on the LIKERT scale 1 to 5. For more confident we have calculated simple mean and standard deviation for selecting the most important owner's needs.

At the result, we have analyzed seven categories or departments:

1) Quality in engineering document
2) Quality in procurement
3) Quality in construction
4) Making owner's comments during the project
5) Intention of legal consequences
6) Competent parities
7) Delivery on time

Step 2: determine the importance rating of each owner's needs category.

An owner's need with a higher importance rating means that it has more impact on the quality services during the project. Summation of the importance ratings is equal to one.

Step 3: identify the engineering requirements.

In this step, the engineering requirements were identified through the brainstorming session among the QFD team. Therefore they are categorized in the following order:

a. Appropriate infrastructure & coordinating in engineering phase
b. Appropriate quality system for analysing customer's needs
c. Provide feedbacks and control mechanisms
d. Effective firm relationship with executive & processing departments
e. Designing appropriate processing structure
f. Specifying inputs by SIPOC mechanism

   As a brief description of SIPOC mechanism:

   Refer to the characteristics of" Specifying inputs by SIPOC mechanism", SIPOC stands for the sequence across a process of:

   - **Supplier**, who provides...
   - **Inputs**, which are used in the...
   - **Process**, which converts the inputs into...
   - **Outputs**, which are delivered to the...
   - **Customer**

   SIPOC is sometimes reversed as COPIS, to highlight the priority of customers and indicate a 'pull' system.

g. Provide supplier management system
h. Project tracking with events
i. Monitoring system during the process of a project
j. The creation of infrastructure information & coordinating between E & P phases
k. Safety management
l. Control optimization of resources
m. Specifying customer's need
n. Effective monitoring to increase customer satisfaction
o. Continues & effective relationship with customers

Step 4: determine the relationship weights between the owner's need and engineering requirement using AHP.

To calculate the importance of engineering requirements, the relationship between the owners and their requirements were determined using AHP.

Step 5: compute the importance rating of each engineering requirement.

Following the above procedure for determining the relationship weights of each engineering requirement, they are computed in HOQ as shown in figure 2. It has been shown that the most important quality characteristics were in the EPC projects.

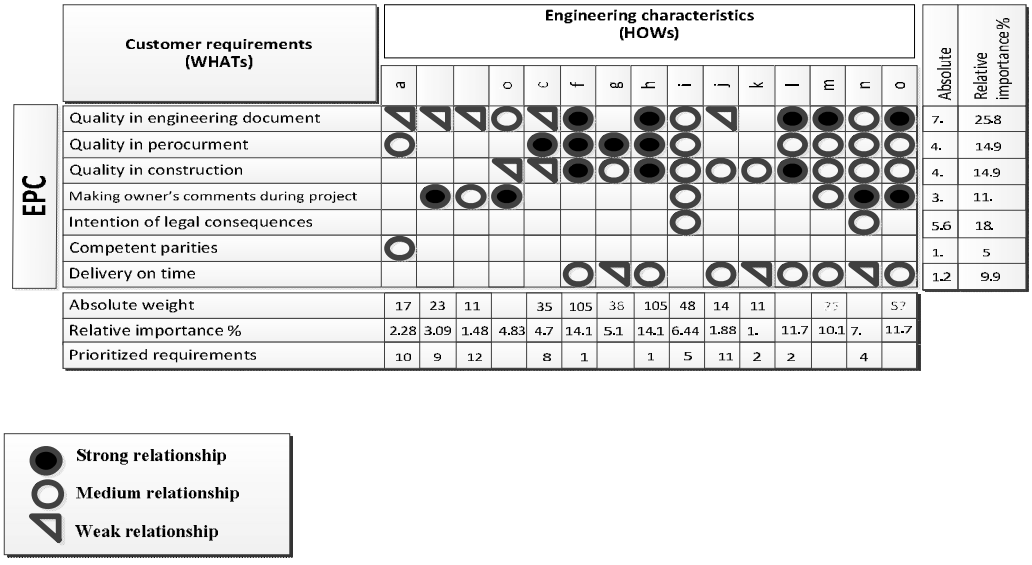

Fig 2.The result HOQ on EPC projects

6. Conclusion

The main scope of this paper is to develop a combined QFD and AHP approach in EPC projects as a novel deployment in customer services. In this approach, QFD has been used to translate the owner's needs into the engineering requirements, which are used to benchmark the owner's need. As a result, the most important criteria with respect to the customer needs are "quality in engineering document". "Intention of legal consequences" has the second ranking. Other criteria has been prioritized in the following order, quality in procurement and construction have the same ranking. Therefore, making owner's comments during project, delivery on time and competent parities are the last factor. The output of the model will help to improve service quality in engineering, procurement and construction projects. The final ranking in ERs has been shown in table 1.

Table 1.priority of engineering requirement according to the ONs.

Engineering requirements	Priority
▪ Specifying inputs by SIPOC mechanism ▪ Project tracking with events	1
▪ Safety management ▪ Control optimization of resources ▪ Continues & effective relationship with customers	2
▪ Specifying customer's need	3
▪ Effective monitoring to increase customer satisfaction	4
▪ Monitoring system during the process of a project	5
▪ Provide supplier management system	6
▪ Effective firm relationship with executive & processing departments	7
▪ Designing appropriate processing structure	8
▪ Appropriate quality system for analysing customer's needs	9
▪ Appropriate infrastructure & coordinating in engineering phase	10
▪ The creation of infrastructure information & coordinating between E & P phases	11
▪ Provide feedbacks and control mechanisms	12

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