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A Quality Function Deployment Based Approach in Service Quality Analysis to Improve Customer Satisfaction

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Abstract In metropolitan development management, quality of public services is influential in every public sector to satisfaction of citizens on quality of services. Nowadays, satisfaction are with such important matters that should be considered in the planning, implementation, management and maintenance of many public services such as subway, transportation, traffics, parks, markets and so on. The purpose of this study, using quality function deployment (QFD) methodology and mathematical optimization is improving the quality of services in Tehran's municipality to deliver services from. QFD methodology acts as a technical translator of citizens' requirements to engineering characteristics. Consequently, this method used to reduce the gap between municipal managers and citizens. In the present research, we apply QFD and linear programing to improve leaflet of service's tariff, urban and civil laws based on collecting data from citizens' requirements and expert's opinions. Finally, the priority ranking indicators based on citizen preferences weights were obtained mathematically. The results show that QFD is a very effective tool that enables municipal managers to identify demands of the citizens and to perform engineering and technical requirements.

Keywords: Service quality, Customer satisfaction, Municipality management, Urban development management, Quality Function Deployment (TQM).

1 Introduction

In developed countries, Service organizations were employed maximum a third of the human resources in last decades. Today, more than three-quarters of the human resources are employed in these organizations, and is rising. To manage the big cities, municipals gives some services to their citizens in various sectors such as town cleaning, public transportation, repair and maintenance of streets, entertainment of the citizens, inner city development management and etc. This research has tried to analyze service quality in urban development duties in Tehran municipality based on applying QFD and linear programing method and provided solutions to improve the quality of services.

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QFD is a Japanese development and design technology. Yoji Akao was the first pioneer of QFD in 1972 at Mitsubishi's Kobe shipyard site. Then Toyota Company and its suppliers developed it further for a rust prevention study. Thereafter, the popularity of QFD spread across the world. QFD was introduced in the US through auto manufacturers and parts suppliers, many US firms, such as AT&T, Digital Equipment, Ford, GM, Hewlett-Packard, Procter & Gamble, and Raychem, applied QFD to improve product development and communication [1].

Quality may define as meeting customer needs and providing superior value [2]. Product designers need to know how to make trade-off in the selection of design features that result in the highest level of customer satisfaction. QFD translates the customer needs into the target values for the engineering characteristics of a product [3]. Main goal of QFD is maximization of customer satisfaction. QFD provides the opportunity for companies through three strategies to reduce costs, increase revenues, reduce production time and provide a new product or service, to maintain their competitiveness [4].

In addition, QFD has also been used in other areas such as for business process, medical treatment, quality improvement in the service industry, education, etc. Rong-Tsu Wang studied on improving service quality using quality function deployment: The air cargo sector of China's airlines case study. They employed quality function deployment to integrate quality technology and the voice of consumers, and using "House of Quality," illustrates the performance of the company in terms of service and offer suggestions for improvement [5].Kay, C. Tan and Theresia A. Pawitra Integrating SERVQUAL and Kano's model into QFD for service excellence development. The approach aims to help organizations to consider customer satisfaction, to guide improvement efforts in strengthening their weak attributes, and to accelerate the development of new services through the identification of attractive attributes and set them into future services.

A case study presented to evaluate the image of Singapore from the Indonesian tourists' perspective. Several strong and weak attributes on Singapore's tourism were identified and analyzed [6]. Thirumanas K R and K C Joseph improved the service quality and customer satisfaction in automobile service industry using QFD [7].For For improving customer satisfaction and to enhance the shopping experience, Hui-Ming Kuo and Cheng-Wu Chen, understand the customer quality needs particular to the Internet shopping website, then to meet these needs through suitable website interface design by using QFD [8].Ben Clegg and Boon Tan show how QFD can be used as part of a structured planning and analysis framework for micro-sized enterprises to build-up their e-business capabilities [9].

John J. Cristiano et al, have presented the design of a product and the manufacturing system to produce it is indeed a process very influenced by the organizational structure and culture that support it [10]. Glenn H. Mazur has used QFD to design a new course in TQM that has increased the ration of number of students to teacher in a course, grown from one section to three and continuously sends student teams into various departments in the university and local businesses to improve their quality programs as well [11].

Franceschini [2002] believed that the principal stages necessary for the construction of the first HOQ matrix includes:

- Identifying customer requirements (CRs) and their perceptions.
- Identifying product and engineering design requirements (ECs)
- Drawing up a relationship matrix
- Planning and deploying expected quality (by listing CRs in order of importance and benchmarking competitive products)
- Comparing ECs through a technical importance ranking

- o Analyzing the correlations existing between the various characteristics (correlation matrix)
- o Prioritizing ECs.

Figure 2 illustrates the functional bonds linking operative phases and appropriate HOQ zones.

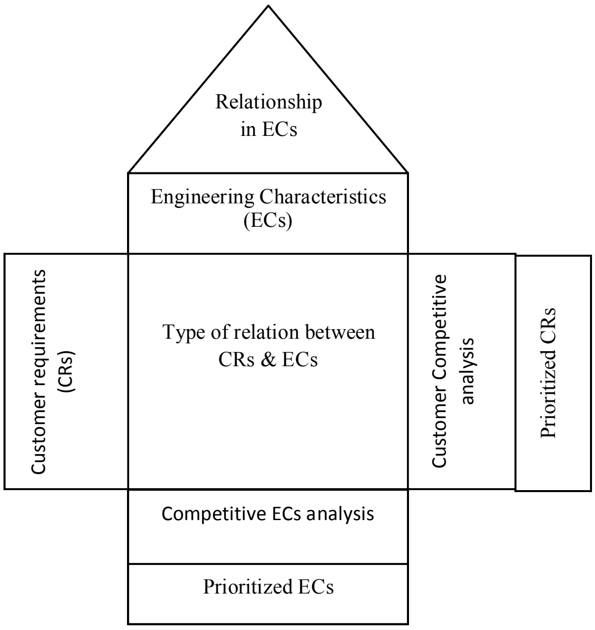

Fig. 2 Main components of the house of quality (HOQ)

As previously said, the QFD technically translates the voice of customers into the target values for the engineering characteristics of a product or service. By using this translation, managers and experts identify the Strength and weakness departments then provide solutions for improving the customer's satisfaction. In the next section, quality of services in urban development management of Tehran municipality will analyze and provide some solutions for improving the customer's satisfaction.

2 Analyzing Citizens' Requirements

The QFD progresses implemented by development of a composite matrix known as "House of Quality" or HOQ. The conceptual features of HOQ are shown in Figure 1. As shown, HOQ consists of six main sub matrices [12].

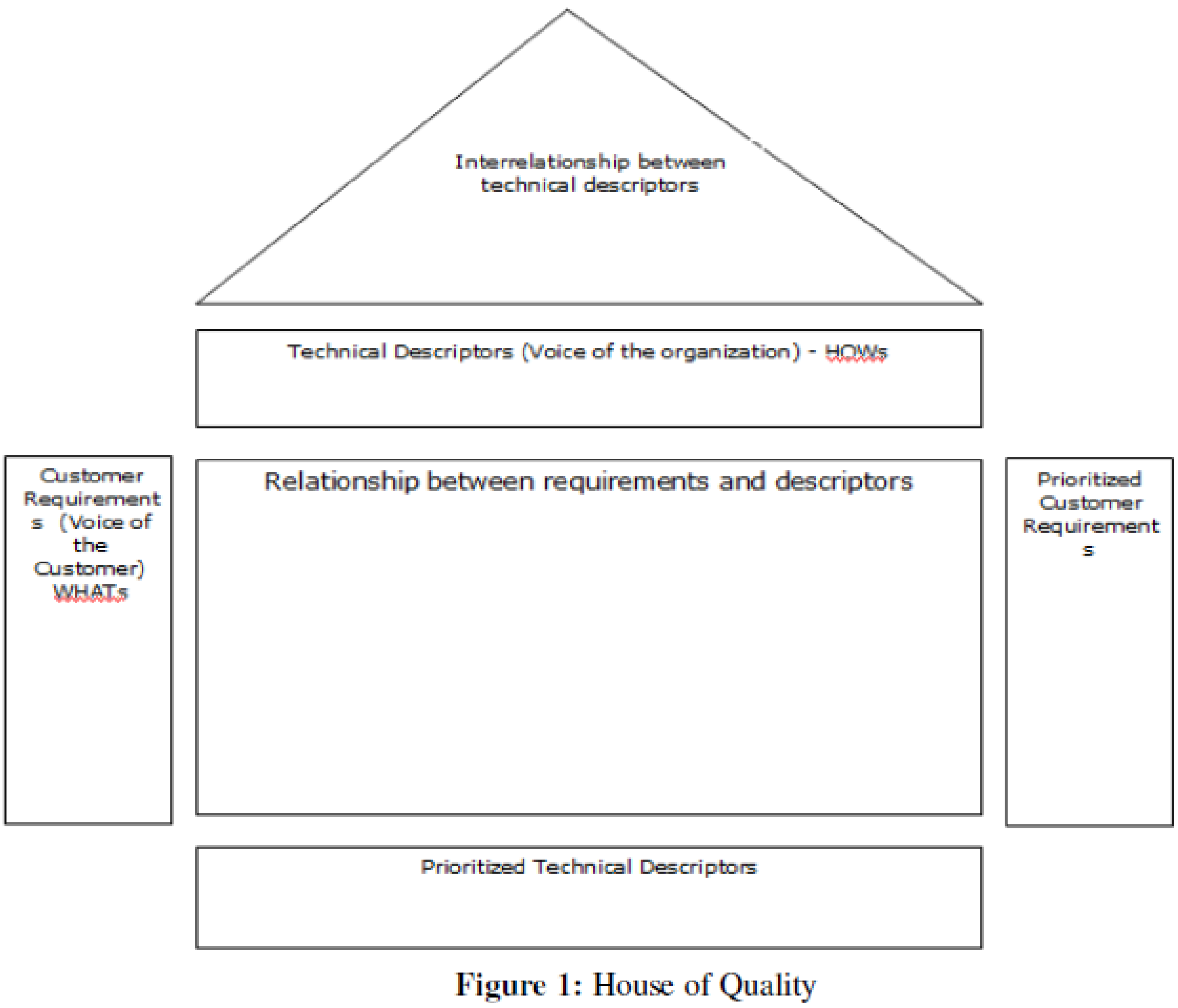

Fig. 1 House of Quality

For municipal services, the structure of HOQ starts with listing the customer demands in the rows in the left part of the house. QFD team define voice of customer as flow:

Table 1 Voice of Customer

Parameter	Voice of Customer
W_1	Ensure that the rules apply equally to the citizens
W_2	Calculation of tax correctly and without error
W_3	Appropriate and respectful behavior of incumbents
W_4	Reducing the traffic of the citizens to the Electronic Services Office for conforming the architectural map
W_5	Expert or owner able to takes time for two-way communication at any stage of the process
W_6	Get a sheet of Engineers (Architectural, Structural, Mechanical, observer and surveyor) as soon as possible
W_7	Owner able to view an inspection report and comments on its
W_8	Owner able to view and accept (or reject) his unlike in urban development system
W_9	Acceleration in comment of detailed design
W_{10}	Uploading documents via the Internet for filing and view the tariff
W_{11}	Acceleration in final confirmation of license exportation and post it for owner in one day

W_{12}	Inquiry of separation, partition and license are visible in Land Office
W_{13}	State the owner rights clearly in ordered map
W_{14}	Immediately notification to fix incomplete files
W_{15}	Office cleaning
W_{16}	Waiting room convenience

Consequently, the degree of importance of the customer needs is developed. The values indicating the ranks of the customer needs are determined by considering the municipality's affordability in fulfilling the customer needs.

Experts were designed questionnaire to obtain the importance of each customer's demands. Then distribute them to the 17 experienced employ managers of urban development department of municipal region 9. In questionnaire, managers and employees assigned 16 customer needs in 1 to 16 levels. Individual Approach is allocated 15 points to first level, 14 points to second level, … and zero points to last level. Table 2 shows allocated points to level of customer needs by Managers and employees:

Table 2 Allocated points to level of customer needs by Managers and employees

Parameter	Managers and employees number																	Sum
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
W_1	15	14	14	9	14	15	15	14	15	6	12	12	14	13	2	15	14	213
W_2	14	7	5	15	15	4	3	13	3	13	5	11	15	5	11	14	15	168
W_3	13	15	15	7	8	3	4	15	2	5	15	10	8	15	12	6	8	161
W_4	12	8	12	8	7	8	8	12	6	8	6	13	7	9	7	12	7	150
W_5	11	9	9	14	5	14	14	9	7	7	11	15	4	10	6	10	5	160
W_6	10	13	3	6	4	2	2	5	13	4	1	9	5	4	13	2	4	100
W_7	9	10	4	5	3	5	5	6	14	10	10	14	3	6	5	3	3	115
W_8	8	1	8	4	6	13	13	7	9	11	13	8	6	8	3	8	6	132
W_9	7	0	13	13	13	10	10	8	12	14	4	7	13	3	4	13	13	157
W_{10}	6	6	7	3	0	7	7	4	8	1	9	6	0	7	1	4	0	76
W_{11}	5	11	6	12	1	9	9	0	11	12	3	4	1	0	15	11	11	121
W_{12}	4	5	2	2	2	11	11	1	10	0	2	5	2	1	0	7	2	67
W_{13}	3	3	11	11	12	6	6	11	5	15	8	3	12	2	14	9	12	143
W_{14}	2	4	10	10	11	12	12	10	4	9	14	2	11	14	10	5	1	141
W_{15}	1	12	0	0	10	0	1	3	0	2	0	1	10	12	9	0	9	70
W_{16}	0	2	1	1	9	1	0	2	1	3	7	0	9	11	8	1	10	66

According to the sum of the points in table 2, customer needs deploys based on the follow order.

$$W_1 > W_2 > W_3 > W_5 > W_9 > W_4 > W_{13} > W_{14} > W_8 > W_7 > W_{11} > W_6 > W_{10} > W_{15} > W_{12} > W_{16}$$

Hence, importance levels for the customer needs calculated using the previous ranking based on [13] model. Consequently the customer preferences could be obtained based on solving a linear presented by Model 1.

$$\begin{aligned}
&Max\ Z \\
&s.t: \quad Z-(W_1-W_2)\le 0 \\
&\qquad Z-2(W_2-W_3)\le 0 \\
&\qquad Z-3(W_3-W_4)\le 0 \\
&\qquad Z-4(W_4-W_5)\le 0 \\
&\qquad Z-5(W_5-W_6)\le 0 \\
&\qquad Z-6(W_6-W_7)\le 0 \\
&\qquad Z-7(W_7-W_8)\le 0 \\
&\qquad Z-8(W_8-W_9)\le 0
\end{aligned} \tag{1}$$

$$Z - 9(W_9 - W_{10}) \leq 0$$
$$Z - 10(W_{10} - W_{11}) \leq 0$$
$$Z - 11(W_{11} - W_{12}) \leq 0$$
$$Z - 12(W_{12} - W_{13}) \leq 0$$
$$Z - 13(W_{13} - W_{14}) \leq 0$$
$$Z - 14(W_{14} - W_{15}) \leq 0$$
$$Z - 15(W_{15} - W_{16}) \leq 0$$
$$Z - 16W_{16} \leq 0$$
$$\sum W_i = 1$$

Figure 2 presents the HOQ after applying the customer preferences achieved based on Model 1.

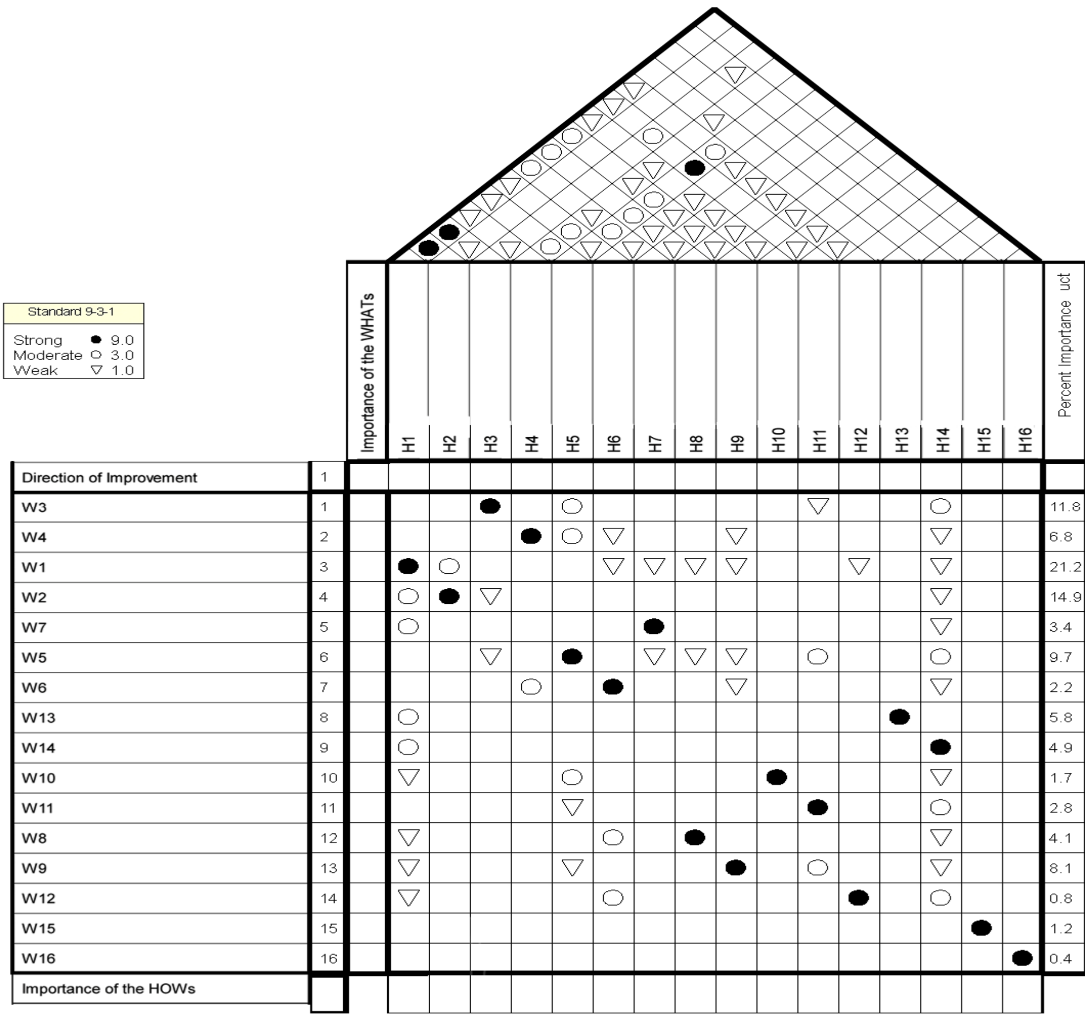

Fig. 2 House of quality structure

The next step is listing the engineering requirements in the columns in the top of the House of Quality, and entering values to present the degree of relationships between customer needs and the engineering requirements. The symbols that show these relationships are: strong

relationship: ● , moderate relationship: ○ , weak relationship: Δ. A blank field indicates that no relationship exists. These symbols were substituted with numbers: 9, 3 and 1 [14].
QFD team define engineering requirements to answer the voice of customers:

Table 3 Engineering requirements

Parameter	Engineering Requirements
H_1	Leaflet of services tariff, urban and civil laws, and allows the owner to view and make comments by providing access to municipal urban development system
H_2	Make intelligent system for calculating the taxes
H_3	Teaching skills of the work and deal with clients
H_4	Synchronic meeting between architect engineering, owner and the expert architecture controller of municipal maps
H_5	Owner scan reserve time in urban development system for visiting expert
H_6	Developing the link of the urban development system to construction engineering organization (until exportation of the license)
H_7	Make accessibility for owners to view an inspection report and add their comments in urban development system
H8	Make accessibility for owners to view their unlike offence report and add their comments in urban development system
H_9	Linking the Floor and mainland Department and Urban Development management
H_{10}	Make accessibility for owners to uploading their document in urban development system
H_{11}	Monitoring the continuous presence of the manager and experts
H_{12}	linking the Land Office and Floor and mainland Department
H_{13}	Change the formation and text of the ordered map
H_{14}	Sending message (SMS) to owners in all steps
H_{15}	Cleaning schedule
H_{16}	Entertainment facilities

Last step is the correlation matrix, which is constructed by entering the values to represent the correlation between the technical requirements. Like relationship matrix, symbols of the correlation matrix are: strong relationship: ●, moderate relationship: ○ , weak relationship: Δ, and no relation is empty.

In this step, normalized value of engineering requirement and normalized value of correlated weight are obtained.

$$Normalized\ value\ of\ engineering\ requirement = \frac{weight\ of\ engineering\ requirement}{\sum_{i=1}^{16} weights\ of\ engineering\ requirement}$$

If d_{ij} define the relation between the customer need (i) and engineering requirement (j) then weight of engineering requirement (w_j) calculated as follow:

$$w_j = \sum_{i=1}^{16} w_i d_{ij} \quad i = 1, 2, \dots, 16 \;, j = 1, 2, \dots, 16$$

$$Normalized\ value\ of\ correlated\ weight = \frac{Correlated\ weight\ of\ engineering\ requirement}{Sum\ of\ correlated\ weight}$$

Summing of the normalized value of engineering requirement and normalized value of correlated weight presents the importance level of each engineering requirement. Ranking of engineering requirements are shown in table 4:

Table 4 Ranking of engineering requirements

Engineering Requirements	Ranking
Leaflet of services' tariff, urban and civil laws, and allows the owner to view and make comments by providing access to the municipal urban development system	37.76
make intelligent system for calculating the taxes	18.53
teaching skills of the work and behavior to clients	16.9
Synchronic meeting between architect engineering, owner and control expert of municipal map for architect surveying	11.2
Owners can reserve time in urban development system for visiting expert	25
Developing the link of the urban development system to engineering system organization (until exportation of the license)	9.76
Make accessibility of urban development system for owners to view an inspection report and add their comments	10.81
Make accessibility for owners to view their unlike report and add their comments in urban development system	10.6
Linking Land Office, Floor and mainland Department, Urban legislation Department and Urban Development management together	14.1
Make accessibility for owners to uploading their document in urban development system	5.5
Supervising on continuous presence of manager and experts	14.3
Improving the link of Land Office and Floor and mainland Department	7.48
Change the formation and text of the ordered map	3.96
Sending message (SMS) to owners in all steps	11.8
Cleaning schedule	1.26
Entertainment facilities	0.23

3 Conclusion

In our research in Tehran municipality, customer satisfaction means fulfillment of citizen's expectations and it is the most important issue in this service organization. Here, managers tend to seek ways to deploy citizens requirements. Applying QFD help us to transform qualitative citizen's demands into quantitative parameters, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and ultimately to specific elements of the servicing process. Hence deriving rankings of citizens' requirements and the relevant engineering characteristics is a crucial step towards successful QFD process especially when experts and managers have different points of view. Ranking on the importance of each citizens' requirement is extremely important in every QFD process and is on the main focus of the present effort. In this paper, we proposed a method to prioritize the Tehran citizens' requirement in a two sequentially phases. The proposed methodology having already been used an efficient voting process to assess perception information in the QFD process based on a linear programing model. Based on the proposed model, the most important engineering requirements for responding to the voices of citizens are: "Leaflet of services' tariff, urban and civil laws, and allowing owners to view and make comments by providing access to the municipal urban development system". QFD here helped us to focus on characteristics of a existing services from the viewpoints of citizens' segments. Also this technique help us to transform citizen's need into a list of prioritized engineering characteristics while simultaneously setting development targets for services.

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