

Using Quality Function Deployment (QFD) in the Construction Company

Siamak Bazaati, Davoud Beheshtizadeh

Department of Civil engineering, Bonab Branch, Islamic Azad University, Bonab, Iran

Received: January 13, 2017

Accepted: April 6, 2017

ABSTRACT

The objective of this study is how to use Quality Function Deployment (QFD) in the construction industry using the data related for a construction company that is in Iran, as a sample. Today, the Quality Function Deployment (QFD) is one of the most popular techniques that most companies like to apply it. The study examines the Quality Function Deployment (QFD). Hence, it engages the specifications of the living spaces for consumers of the construction firm. It also determined the quality of houses which produced by the company. The research used the questionnaires that were distributed between seventy people who are the consumers of that company. The survey evaluated the consumers' needs of houses and the ways for improving the quality of products. The outcomes of the study display that the earthquake-resistance, the accessibility, the heating and the insulation specifications are the most important needs for the customers of the construction companies.

KEY WORDS: Quality Function Deployment (QFD), Construction Company, houses, Quality of life, house demand function.

1. INTRODUCTION

Today, many companies look for new ways to stand out in the growing market by providing the best possible products or services within the contact frame. One of the stage-gate processes are rapid, faultless and based on the voice of customer will bring the market success by the improved product and the services.

The reflection of the customer requests and requirements on the technical specifications of the company is extremely important. The Quality function deployment (QFD) is a technique that availed in many industries and it is used in evaluating the customer expectations, reflecting these evidences on the product specifications. In recent years, this technique is used also in construction industry projects (Jalali & Sameni Keivani, 2013; Sameni Keivani, Jouzbarkand, Khodadadi, & Khalili Sourkouhi, 2012).

The most expectation benefits of the QFD in every organization are as follow (Franceschini, 2016; Utne, 2009):

- Reducing in time for developing product
- Declining the Variation in the number of engineering designs
- Reducing the initial costs of introducing the product to the market
- Increasing satisfaction of customers from providing their wants
- Improving capability of creating product
- To create a standard culture among different units in an organization
- To make database for users and future application

To know the needs and expectations of customers is the most important stage of doing QDF and then is identification the people who apply the goods and services. The firm should know the characteristics of the products that customers follow them. To do that are identified all consumers, sellers, employees especially after-sales service staff, distributors, contractors and other organization units (Lee, Sheu, & Tsou, 2008).

In this study, the customer requests and expectations are evaluated by referring to the quality function deployment technique. The study is prepared with the help of a construction company based in Eastern Azerbaijan, which is specialized in house construction projects.

In this study, the QFD process is applied by considering the customer requirements, the technical specifications of the company and the specifications of a rival company. In conclusion, the technical specifications of the company are evaluated according to the customer requests and expectations and the directions of technical specification improvements are indicated (Chan & Wu, 2002; Karsak, Sozer, & Alptekin, 2003).

*Corresponding Author: Siamak Bazaati, Department of Civil engineering, Bonab Branch, Islamic Azad University, Bonab, Iran.

2. THE DEFINITION OF THE QUALITY FUNCTION DEPLOYMENT AND ITS HISTORICAL DEVELOPMENT

The Quality Function Deployment (QFD) is a technique of quality improvement. In this systematic technique, the customer requests and expectations spread to every stage of the design, the process and the production. The QFD is used for the first time, in 1960, in the Kobe shipyards in Japan by Mitsubishi heavy industry. Later on, various applications are performed in Toyota and subsidiary industries of Toyota. In 1980s, it is started to use also in USA (Sameni Keivani & Khalili Sourkouhi, 2014; Shino & Nishihara, 1990).

The application of the QFD in construction industry is performed for the first time, by Shino and Nishihara (Shino & Nishihara, 1990), in Japan. Burati and Oswald (Burati Jr & Oswald, 1993) indicated that QFD technique is useful in project process and the definition of customer requests. Abdul-Rahman, Kwan and Woods (Abdul-Rahman, Kwan, & Woods, 1999) examined the application of QFD technique in construction industry by focusing on construction of low-cost housing. Pheng and Yeap (Pheng & Yeap, 2001) did a research on the advantages and disadvantages of the application of the QFD technique in design/construction projects. Eldin and Hikle (Eldin & Hikle, 2003; Hauser & Clausing, 1988) worked on the QFD application in designing the modern college classes and Haron and Khairudin (Dalle, 2010; Jalali & Sameni Keivani, 2013; Sameni Keivani, Bidarian, & Ashouri, 2014) worked on the advantages the specifications and the design of apartment building in aspect of customer satisfaction.

In this study, the requests and expectations of housing customer are evaluated by using the QFD technique. The application part of the study is made with a construction company in Eastern Azerbaijan that works in a house construction project.

3. THE METHOD AND THE MATERIAL

The QFD process consists of two parts that are described as follow (Cohen & Cohen, 1995):

3.1. Stage 1. Collecting the Customer Voice

In this study, the QFD technique is performed in the specifications of the living spaces of the customers. So the customer requests are quite necessary for the specifications of living spaces of the customers, the technical requirements and the importance of them, they are indicated in this part.

A survey is prepared to take the customer opinions about the specifications of living spaces by profiting from the pre-interview that are done with housing costumers and the studies of Suipheng and Yeap (Shillito, 1994). The survey is applied to 70 different people face-to-face and on the internet by an internet survey program called "Survey Monkey".

3.2. Stage 2. Construction of Quality House

The primary planning tool which is used in the QFD is the Quality House. It is called this name because of its shape that is like a house. Most of managers and engineers believe that it is a primary tool for the quality planning. It is a kind of cognitive map that provide the interfunctional communication and projection (Figure. 1). The people who have different problems and responsibilities can indicate the design priorities from the information motives below the roof of the house (Hauser & Clausing, 1988; Sameni Keivani, 2013).

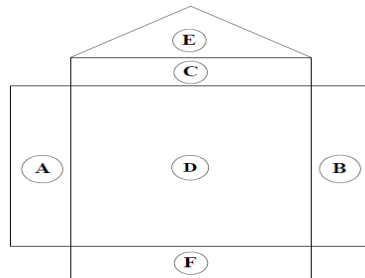


Figure 1. Quality House

The steps in construction of quality house are given below (Chan & Wu, 2002; Jalali & Sameni Keivani, 2013; Keivani; Sameni-Keivani, Almasi, Khalili-Sourkouhi, Makouei, & Bayat, 2013; Sameni Keivani, Almasi, Kamranzadeh Ezmareh, & Bayat, 2014; Zairi & Youssef, 1995).

- The construction of the customer requirements part. (Part A)
- The analyze of customer satisfaction level- customer perception analyze (Part B)

- The determination of technical specifications (Part C)
- The determination of relations or correlation matrix (Part D)
- The calculation of the technical importance and normalized technical importance
- The determination between technical importance or correlations (Part E)
- The comparison with rivals and the indication of targets. (Part F)

4. THE EVIDENCES

4.1. Stage 1. The Customer Voice

The values of mode, standard deviation and arithmetic average of the answers, about their expectations from the housing that they want to buy, of people who participate in the survey number of 70, is given on the Table No.1. When we look at the values on Table No.1, “the earthquake” is in the top priority. According to the people who participate in the survey, “the insulation” is in the second priority by $X^{\approx} = 9$ and $X^{-} = 7, 10$, “the location” is in the third priority by $X^{\approx} = 7$ and $X^{-} = 6$ and “the environment” is in the fourth priority by $X^{\approx} = 7-9$ and $X^{-} = 6, 9$.

*(These figures will be used: point 0 is completely unimportant, 1 is unimportant, 3 is partially important, 5 is important, 7 is very important, 9 is essential)

The application of the QFD that made by considering the survey data is given step by step in the parts below.

Table 1. Customer Needs who participated in the survey

		Mode	Arithmetic mean	Standard deviation
1	Earthquake	9*	8.56	1.8
2	Insulation	9	7.1	1.44
3	Location	7	6	1.4
4	Environment	7--9	6.9	1.39
5	Budget	7--9	6.7	0.024
6	Transportation	7	6.5	1.3
7	Duration	7	6.14	1.2
8	Contractor image	5	0.96	1.2
9	Heating	7	5.9	1.2
10	Service	7	5.6	1.15
11	Security	5	5.4	1.1
12	Utilization	5	5.2	1.06
13	Social facilities	3--5	4.3	1.11

4.2. Stage 2. Quality House

4.2.1. The Construction of the Part of Customer Requirements

As it is indicated in Part 3.1, the factors that form the requirement importance of housing customer, which are indicated as the results of the literature search and the pre-interviews, generates the customer requests part (Part A) of quality house. (Figure No.2)

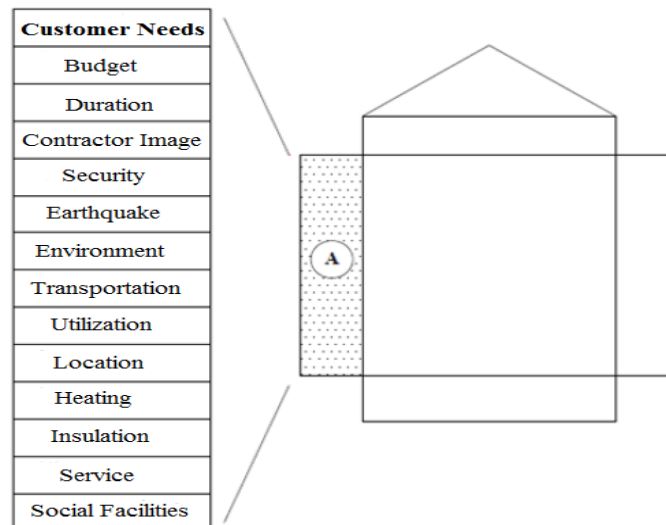


Figure 2. Customer Needs

4.2.2. The Analyze of Customer Satisfaction Levels and The Analyze of Customer Perception

In this stage, making a comparison with the product of rival company is demanded from the customers by asking them some questions about the product. So, the weak parts and strong parts are tried to determined. The customer grades the company that is doing the search and the rival companies. Later, this grading is transferred to the quality house as a scoring. (Figure No.3)

Generally, the formulas below can be used in calculating at this stage.

$$IR = \frac{IQL}{CS}$$

$$\text{Absolute Gravity} = IL \times IR$$

$$TG (\%) = \frac{\text{AG of Any Line}}{\text{TAG}} \times 100$$

In these formulas; IR indicates improvement ratio, IQL indicates intended quality level, CS, Indicates the satisfaction level of company that does the QFD research, IL indicates importance level, TG indicates tied gravity and TAG indicates total absolute gravity.

As seen on the customer satisfaction levels analyze, the customer request on “the usage” has the highest relative importance by 12, 64% and this customer request is deliberated the most.

Customer needs	Importance grade	Company satisfaction that the QFD works	A company satisfaction	B company satisfaction	The planned level of quality	Improvement rate	Absolute weight	Relative weight
Budget	7	7	7	6	7	1	7	7.37
Duration	6	7	4	7	7	1	6	6.32
Contractor image	5	6	6	6	6	1	5	5.26
Security	6	6	9	6	9	1.5	9	9.48
Earthquake	8	7	9	9	9	1.29	10.32	10.88
Environment	7	5	7	7	7	1.4	9.8	10.32
Transportation	6	7	7	7	7	1	6	6.32
Utilization	6	3	5	6	6	2	12	12.64
Location	5	4	5	3	5	1.25	6.25	6.58
Heating	4	6	5	6	6	1	4	4.21
Insulation	6	5	8	8	8	1.6	9.6	9.8
Service	5	7	5	7	7	1	5	5.26
Social facilities	5	6	6	4	6	1	5	5.26

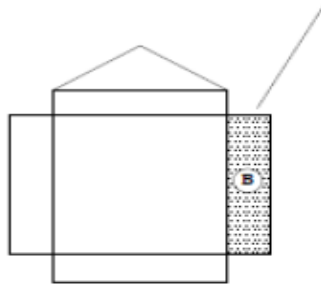


Figure 3. The Analyze of Customer Satisfaction Levels

4.2.3. The Determination of the Technical Specifications

The first step to start matrix is the transformation of the customer thoughts into the technical requirements. The subject that requires attention in the determination of the technical specifications shouldn't be finding solutions for the determination customer requests. The purpose is to transform every thought to at

least one technical requirement. The determination technical specifications indicated on Table No.2. These specifications are located in the C part of quality house (Figure No.4)

4.2.4. The Determination of Relations or Correlation Matrix

In determining the relations between the technical specifications that the company provides and the customer requests, we should start this process by asking every cell of matrix effects “what” and “how”. (Figure No.5) If the answer is “No”, the cell is left blank; it means that there is not a relation. If the answer is “Yes”, the degree of relation is indicated as weak (1), average (3) or strong (9).

Table 2. Technical Specifications

	Technical specification
1	Having a payment plant on credit
2	Delivering the work on time
3	Brand fact
4	Camera and alarm systems
5	Respecting the earthquake
6	Social profile of the neighboring buildings
7	Proximity to public transportation
8	Beautiful view
9	Sunlight situation
10	The use of solar energy installations
11	Sound and heat insulation
12	Having doorman and cleaning services
13	Having a gym and pool

4.2.5. The Calculation of the Technical Importance and Normalized Technical Importance

The absolute and relative importance of each technical specification in satisfying the customer expectations are calculated with the help of the formulas 4 and 5.

$TIL = \sum (AG \times 0 \text{ the power of the relation that belongs to the line})$

$$NTIL (\%) = \frac{TIL}{\sum TIL} \times 100$$

Having a payment plant on credit
Delivering the work on time
Brand fact
Camera and alarm systems
Respecting the earthquake regulations
Social profile of the neighboring buildings
Proximity to public transportation
Beautiful view
Sunlight situation
The use of solar energy installations
Sound and heat insulation
Having doorman and cleaning services
Having a gym and pool

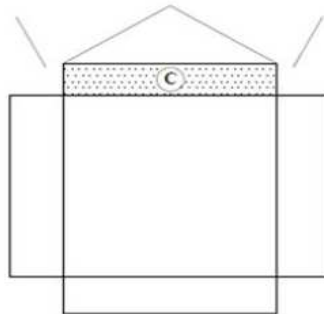


Figure 4: The customer thoughts into the technical requirements.

In these formulas; TIL indicates technical importance level, AG indicates absolute gravity, NTIL indicates normalize technical importance level and $\sum TIL$ indicates total importance level.

Technical importance of each column are determined as a result of the calculations that are done here. The technical specifications of the columns that have more technical importance are prioritized. (Figure No.6)

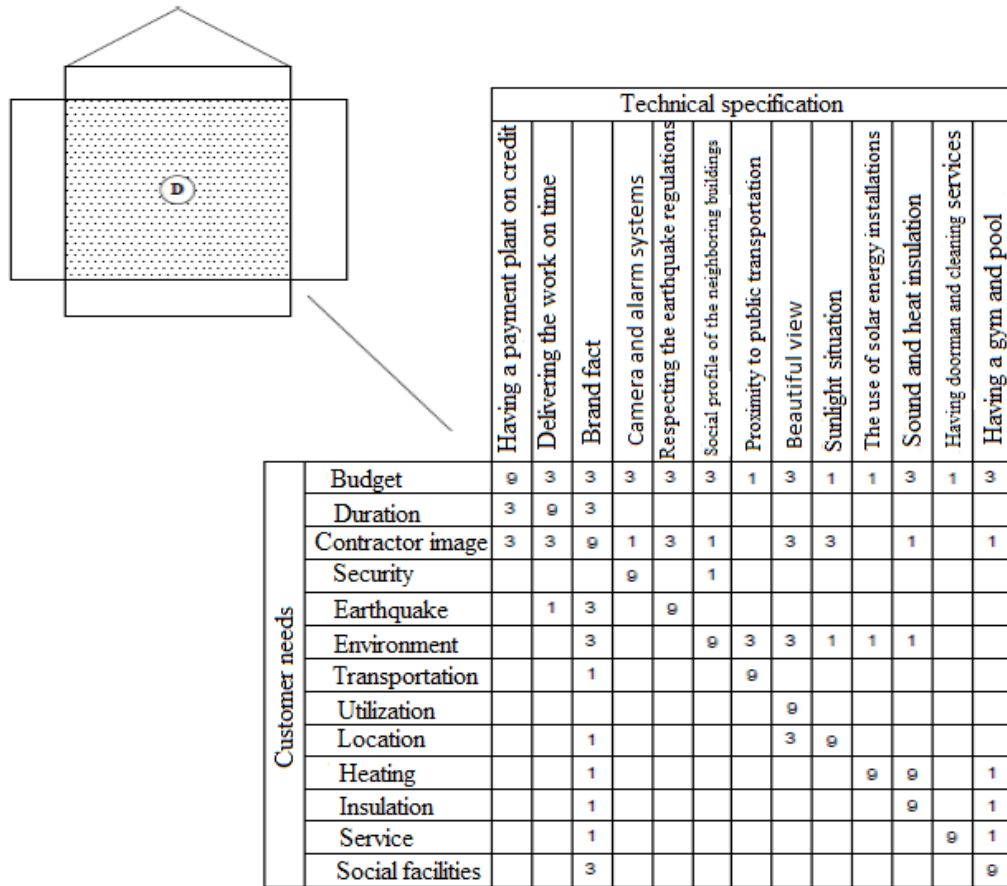


Figure 5. The relations between the technical specifications and the customer needs

4.2.6 The Determination between Technical Importance or Correlations

Many of technical requirements, may be related (has correlation) to the other technical requirements. A work to improve one of these technical requirements can help the related one and it makes a positive effect. Generally, three symbols are used in correlation matrix: For a strong relation square, for an average relation circle and for a weak relation triangle. (Figure No.7)

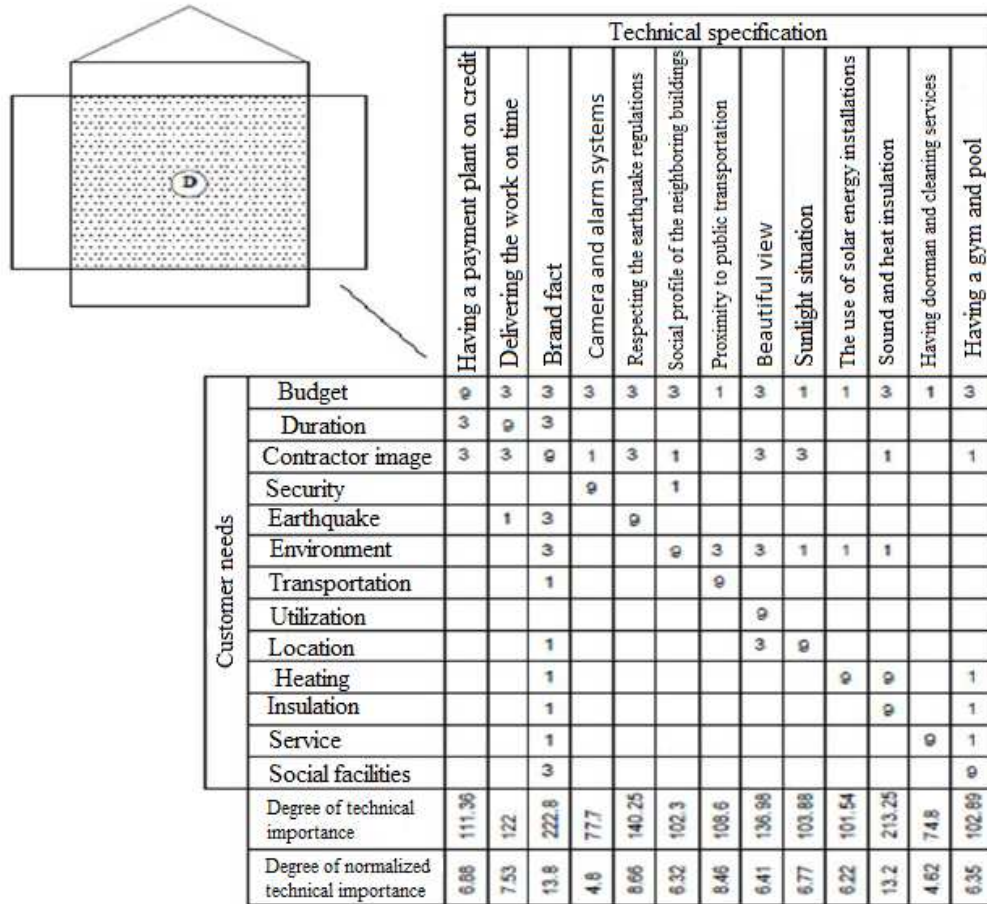


Figure 6. Technical Importance and Normalized Technical Importance

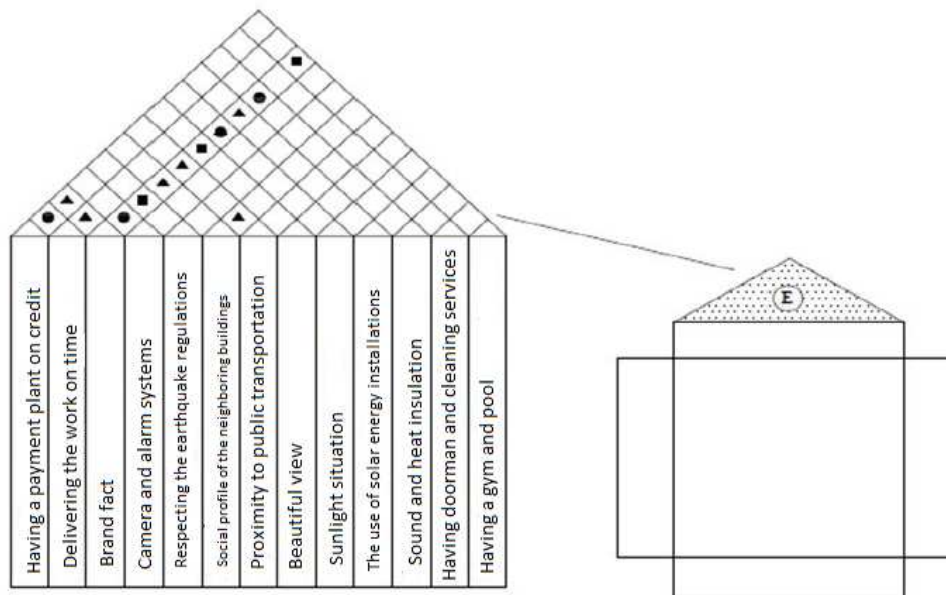


Figure 7. Correlation matrix between technical specification

4.2.6. The Comparison with Rivals and the Indication of Targets

The aspects that need to be improved are revealed and the weak and strong aspects against the rivals are determined with the comparison made at this stage. After the evaluation of the comparison, target values are determined. The weak aspects and strong aspects of the company which is performed the QFD in the quality house, against the rival company are determined after the engineering specifications of the company that is performed QFD application and two other rival companies are determined. After the comparison results are analyzed, the target values are determined. As seen at Figure No.8 “sound-heat insulation” and “respecting the earthquake regulations”, have absolute importance levels.

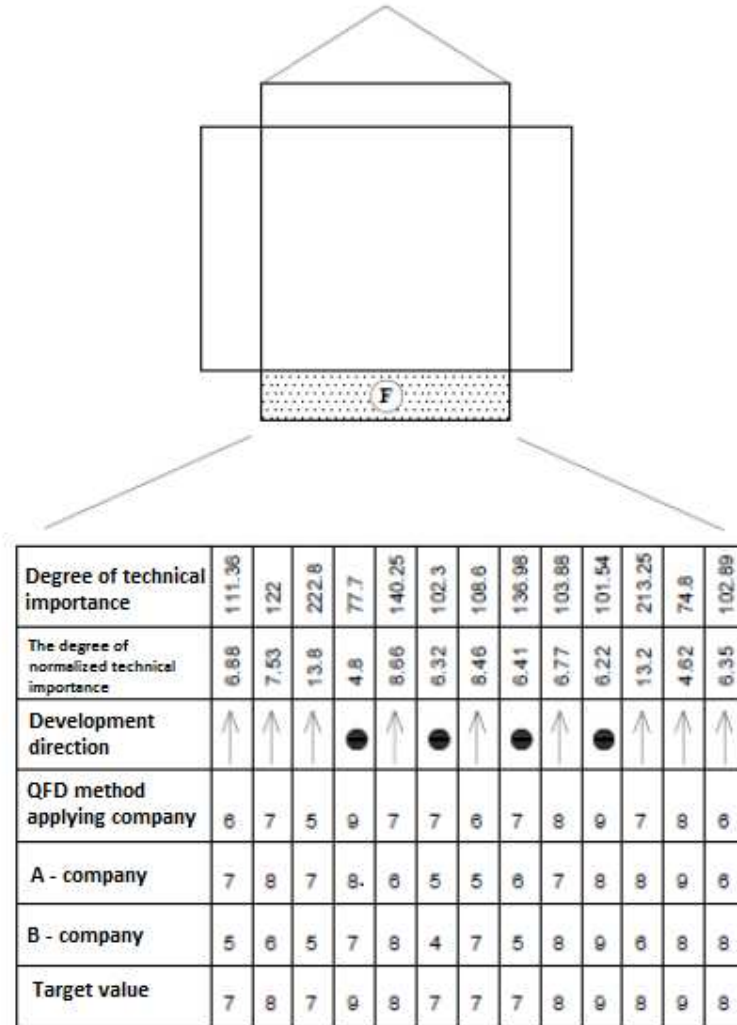


Figure 8. Presenting the targets and evaluating the results

4.2.7. Quality House

The quality house that is showed on Figure No.9 is constructed by reuniting the data and evidences that are retrieved from all these stages. As we can see on the quality house, if “having a payment plan on credit” increases from 6 to 7, “delivering the work on time” increases from 7 to 8, “brand fact” increases from 5 to 7, “respecting the earthquake regulations” increases from 7 to 8, “proximity to public transportation” increases from 6 to 7, “sound and heat insulation” increases from 7 to 8, “having doorman and cleaning services” increases from 8 to 9, “having a gym and pool” increases from 6 to 8; the level of satisfying the customers’ requests and requirements of company will increase also and the company will perform competitive advantage.

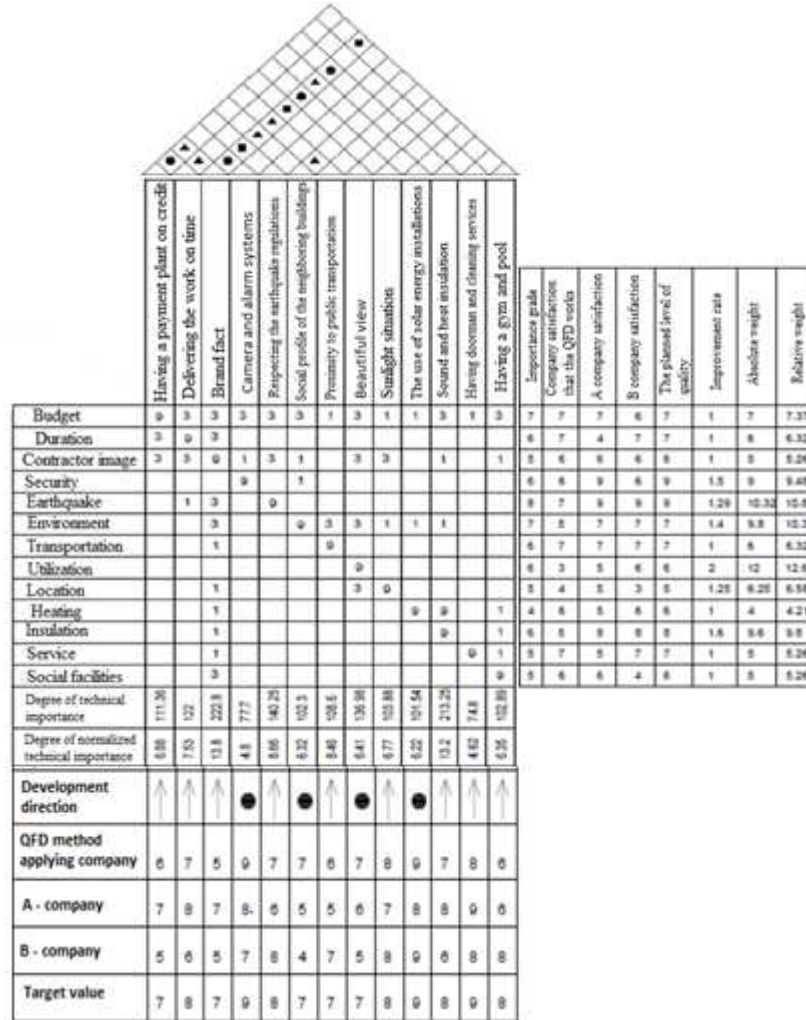


Figure 9. Quality house

5. THE CONCLUSION

The objective of this survey was how to use the Quality Function Deployment (QFD) in the construction company. The study was performed for the costumers of a construction company in Iran, as a sample. and the customers' requirements. It also determined the quality of houses which produced by the company. The research used the questionnaires that were distributed between seventy people who are the consumers of that company. The survey evaluated the consumers' needs of houses and the ways for improving the quality of products. The Earthquake-resistance, the accessibility, the heating and the insulation specifications are found as the topics that have importance for customers. The certain things to provide these topics are determined by the QFD application and all evidences are summered in the constructed Quality House. The quality house is an advisor at determination of the deficient, comparison with the rivals and taking precautions.

6. REFERENCES

- Abdul-Rahman, H., Kwan, C., & Woods, P. C. (1999). Quality function deployment in construction design: application in low-cost housing design. *International Journal of Quality & Reliability Management*, 16(6), 591-605.
- Burati Jr, J. L., & Oswald, T. H. (1993). Implementing TQM in engineering and construction. *Journal of management in Engineering*, 9(4), 456-470.

- Chan, L.-K., & Wu, M.-L. (2002). Quality function deployment: A literature review. *European journal of operational research*, 143(3), 463-497.
- Cohen, L., & Cohen, L. (1995). *Quality function deployment: how to make QFD work for you*.
- Dalle, J. (2010). *Metodologi Umum Penyelidikan Reka Bentuk Bertokok Penilaian Dalam dan Luaran: Kajian Kes Sistem Pendaftaran Siswa Indonesia*. Universiti Utara Malaysia.
- Eldin, N., & Hikle, V. (2003). Pilot study of quality function deployment in construction projects. *Journal of construction engineering and management*, 129(3), 314-329.
- Franceschini, F. (2016). *Advanced quality function deployment*: CRC Press.
- Hauser, J. R., & Clausing, D. (1988). *The house of quality*.
- Jalali, L., & Sameni Keivani, F. (2013). An Investigation of Historical Geography of Shahindezh Region. *Journal of Applied Environmental and Biological Sciences*, 3(12), 34-38.
- Karsak, E. E., Sozer, S., & Alptekin, S. E. (2003). Product planning in quality function deployment using a combined analytic network process and goal programming approach. *Computers & industrial engineering*, 44(1), 171-190.
- Keivani, F. S. Synchronization of Economic Growth and Income Distribution.
- Keivani, F. S., & Sourkouhi, Z. K. (2014). A Survey on Supply Side of Mines: a Case Study of Iran. *European Online Journal of Natural and Social Sciences*, 3(3), 589.
- Lee, Y.-C., Sheu, L.-C., & Tsou, Y.-G. (2008). Quality function deployment implementation based on Fuzzy Kano model: An application in PLM system. *Computers & Industrial Engineering*, 55(1), 48-63.
- Pheng, L. S., & Yeap, L. (2001). Quality function deployment in design/build projects. *Journal of Architectural Engineering*, 7(2), 30-39.
- Sameni-Keivani, F., Almasi, M.-R., Khalili-Sourkouhi, Z., Makouei, S., & Bayat, M. (2013). An Investigation of the Internet Effects on Business. *IOSR Journal of Business and Management (IOSR-JBM)*, 13(6), 96-99.
- Sameni Keivani, F. (2013). The Estimation of the Underdevelopment Degree of Different Regions-A Case Study of the Cities of Guilan Province in Iran". *World Applied Sciences Journal*, 22(10), 1395-1400.
- Sameni Keivani, F., Almasi, M. R., Kamranzadeh Ezmareh, A., & Bayat, M. (2014). The Evaluation of the Impact of the Government Revenues on the Government Current Expenditures A Case Study of Iran. *Journal of Applied Environmental and Biological Sciences*, 4(2), 259-263.
- Sameni Keivani, F., Bidarian, A., & Ashouri, M. (2014). The Estimation of the Elasticity of the production factors A Case Study of the Agricultural sector of Iran. *Journal of Applied Environmental and Biological Sciences*, 4(5), 161-166.
- Sameni Keivani, F., Jouzbarkand, M., Khodadadi, M., & Khalili Sourkouhi, Z. (2012). A General View on the E-banking. Paper presented at the International Proceedings of Economics Development & Research.
- Sameni Keivani, F., & Khalili Sourkouhi, Z. (2014). A Survey on Supply Side of Mines: a Case Study of Iran. *European Online Journal of Natural and Social Sciences*, 3(3), 589.
- Shillito, M. L. (1994). *Advanced QFD: linking technology to market and company needs*: John Wiley & Sons.
- Shino, J., & Nishihara, R. (1990). *Quality development in the construction industry* (pp. 263-297): Productivity Press, Portland, Oreg.
- Utne, I. B. (2009). Improving the environmental performance of the fishing fleet by use of Quality Function Deployment (QFD). *Journal of Cleaner Production*, 17(8), 724-731.
- Zairi, M., & Youssef, M. A. (1995). Quality function deployment: a main pillar for successful total quality management and product development. *International Journal of Quality & Reliability Management*, 12(6), 9-23.