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# Design of New Product Specification with Fuzzy AHD & QFD (Case Study: Digital scales Production Company)

Khadijeh Yousefipour Jeddi [a], Maryam Haghshenas [b]

[a]M.Sc.graduate, IT Management, Islamic Azad University, Science and Research branch Tehran, Iran
[b]PhD student, Media Management, Tehran University, Iran

## Abstract

New Product has been recognized as key drivers for corporate profitability and growth in today's fast changing environments. To predict correctly the development of the new product becomes a critical issue. Accordingly, this study adopted the fuzzy AHP method to obtain professional's opinions on this issue. To deal with this typical situation the current researchers combined the much known AHP (Analytic Hierarchy Process) with QFD (Quality Function Deployment). Here the AHP method redefined under fuzziness. Then QFD process is applied to identifying and ranking customer's need and translating them into technical specification. Take a look at obtained results; we could mention the role of each of these external factors in satisfaction of digital scale customers and technical characteristics in providing these factors and the prioritization of product specification of integration of the fuzzy AHP & QFD.

**Keywords:** Fuzzy Analytic Hierarchy Process (FAHP), Quality Function deployment (QFD), New Product Development (NPD)

## Introduction:

Many companies assign a significant sum of their annual budget to new products development such that the presentation of said new products distinguishes them from their rivals. These new products are appropriate choices for customer requirements and satisfaction. In this regard, NPD=New Product Development is vital for company business therefore relevant decision making is of high value. Hence, customer-oriented and knowledge-based products development is of vital importance (Stiliano and Liberato 1995). For this purpose, the presentation of knowledge and information based on a specific time, location and template to develop for new products development is necessary to support effective decision making within companies. (Advza and Alan Harris, 2011)

The expansion of QFD=Quality Function Deployment, is a method to develop and expand attributes, characteristics or functions that add to the quality of products or services (Madhushi, Zali and Najimi 2010). The main objective of QFD is to convert customer requirements (referred to as the voice of customers VOC) to products or services quality attributes (Chou, 2004). Therefore, if the organization mission is to maximize customer satisfaction based on a specific set of resources (budget), this method is a highly beneficial tool to utilize (Kumar, Antony, Dhakar 2006) (Javadnia, Nik-khah, Nassiri 2012).

Despite the mentioned advantages, QFD has weaknesses in terms of multi-criteria decision making (Amy H. I. Lee, Chun-Yu Lin, 2011). To solve this problem, one of the most prominent methods to address MCDM= Multiple Criteria Decision Analysis is to utilize AHP=Analytical Hierarchy Process such that based on this method, the relationship between criteria values is determined and the total value of each criteria is identified (Sa'ati, 2001). Therefore, AHP is used more extensively for multi-criteria decision making and harvests better results (Chan and Shezling 2011). Due to criticism regarding AHP incapability in managing uncertainties (Fereydun Shams Ali'ie, Mahsa Razavi Davudi, Kambiz Badi, 2011), Fuzzy AHP (FAHP) is used in this research for criteria prioritization and results are utilized for QFD design.

## Research Method:

### *Methodology, Tools for Data Collection and Data Analysis*

The present study is of applied type in terms of objectives, because, application of QFD Model is the main objective of this study in order to determine quality specifications of products and also determine priority of customers' requirements. On the other hand, since requirements of customers of a subject (Arvin Dosari Company) are analyzed and since we have not enough information at hand on the industry, customers and specification of their requirements, the present study is of exploratory type in terms of extraction of information related to the determination of specifications of QFD Model in products of Electronic scale industries and also is of survey type in terms of data collection method.
Content validity method is the validity of questionnaire according to the view of experts in Management field.

### *Process of applying research model*

The model of the present study is originated from the adjusted conceptual model which has been used by Khadijeh yousefipour jeddi et al (2014) in order to design decision support system for new product specification selection.
Given the necessary adjustments in the mentioned model, the following steps have been taken into consideration for designing a digital scale in order to implement the above-said technique:

**1st Step: Identifying and Reckoning Customers' Needs**
Identifying customers' demands of the company was the main objective of this step. To attain this aim, an open questionnaire form was designed and was submitted to nine organizations, considered as major customers of the company, in order to announce their needs and demands from the digital scale product as produced by Arvin Dosari Company. Finally, this step led to the
**Table 1: Customer attributes for purchasing Digital Scales**

| | |
|---|---|
| 1-Max Weight | 10- PLU numbers |
| 2-Accuracy | 11- Protect against liquid |
| 3-Display (Type and position) | 12- Count Function |
| 4-Keypad (Type and position) | 13- backup Battery |
| 5-Printer Width | 14- Reports |
| 6-Printer type | 15- Product guide and Learning CD |
| 7-Plate dimension | 16- Ability to Transfer data |
| 8-Color | 17- After-sales services |
| 9-Proper packaging | |

Identification of 17 factors (Table 1) affecting customer's satisfaction.

**2nd Step: Setting up Decision-Making Team**

The decision team is comprised of five people from senior managers of different departments of the company, in which, necessary information such as correlation matrix, relationship matrix, sales points and objective of performance, was collected.

**3th Step: Completing Column of Numbers of Function Objective**

The information related to these two columns in the House of Quality was collected by the Decision Team and through its specific questionnaire and interview with the senior member of the team. The sales point indicates competitive advantage of each component or need to its rival in the community (country).

**4th Step: Identifying Management Requirements / Products Design**

As a matter of fact, management requirements are the completion of ceiling of House of Quality. This part is related to the way of meeting requirements and demands of customers. In other words, this part of House of Quality is related to the factors, where the organization may face problems in providing them. These factors (Table 2) were identified through questionnaire and interview, way of meeting customers' demands in the company. Management requirements or voice of organization state that how customers' demands can be presented with the controllable tools of the organization?

**Table 2: The product's features**

| | |
|---|---|
| Max weight | 30,50 kg |
| Accuracy | 5,10 g |
| Display | LED Up, LED down |
| Keyboard | Press Down, Flat Down |
| PLU | 100, 1000 |

**5th Step: Completing the Communication Matrix**

This matrix, which has placed a large part of data of House of Quality in itself, studies the relationship between customers' needs and demands and management requirements/products design. In this step, Construct the pair wise comparison matrices between CAs and ECs using Satty's nine –point scale, filled by the decision team, are allocated to the communications matrix. However, human decision making

often contains ambiguity and uncertainty, and conventional AHP is inadequate to explicitly capture the importance assessment of CAs and ECs. To confront this problem, a new trend of studies is to incorporate fuzzy set theory into AHP-QFD .Design and calculation of QFD matrix is done by QFD 2000 application trial version;
The scale, used in this part, is inspired by the literature of subject, background and conceptual model of the research.

***Discussion and interpretation of house of quality***

After the data have been collected from the decision makers, 48 matrices for the ECs' comparisons are built. The priority weights of the selected features based on fuzzy AHP model are determined using the program in MATLAB Software as follows:

Step (1) Preparing the input data to program, the first decision maker's preference scores are presented. (Table 3)

**Table 3: comparison matrix for the ECs with respect to the first Customer attribute-Suitable Max weight**

| | | Max weight | | Accuracy | | Display | | Keyboard | | PLU | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 kg | 50 kg | 5g | 10g | LED Up | LED down | Press Down | Flat Down | 100 | 1000 |
| Max weight | 30 kg | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | 50 kg | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Accuracy | 5 kg | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 10 kg | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Display | LED Up | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | LED down | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| Keyboard | Press Down | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Flat Down | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| PLU | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Step (2) the weights of ECs for the first decision maker are shown in Tables 4. If CI $\geq$ 0.1, the program is showed error, the related matrix would refill by the decision maker

**Table 4: ECs' weight for the first decision maker's judgment with respect to the first Customer attribute-Suitable Max weight**

| 30 kg | 50 kg | 5g | 10g | LED Up | LED down | Press Down | Flat Down | 100 | 1000 |
|---|---|---|---|---|---|---|---|---|---|
| 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Repeating the steps (1) and (2) for other decision makers (number 2 to number 7). The final results for the ECs' weights for the seven decision makers are shown in Table 5.

**Table 5: ECs' weights of for all decision makers with respect to the first Customer attribute-Suitable Max weight**

| | Max weight | | Accuracy | | Display | | Keyboard | | PLU | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 30 kg | 50 kg | 5g | 10g | LED Up | LED down | Press Down | Flat Down | 100 | 1000 |
| DM1 | 0.4693 | 0.5307 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DM2 | 0.5360 | 0.4640 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DM3 | 0.5300 | 0.4700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DM4 | 0.5325 | 0.4675 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DM5 | 0.4671 | 0.5329 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DM6 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DM7 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Overall weight | 0.5042 | 0.4942 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In this investigation, the results obtained from the previous steps (fuzzy AHP model) are used to denote the relationship between Whats and Hows. To use the QFD 2000 software, we determined and entered the Following Marks according to scores:

1- strong (●) "0.75~1"
2- Medium (❍)"0. 5 ~ 0.75"
3- Weak (△) "0. 25 ~ 0. 5"
4- No relation (Blank) "0 ~ 0. 25".

At the end, QFD matrix design and fill same as Fig.1;

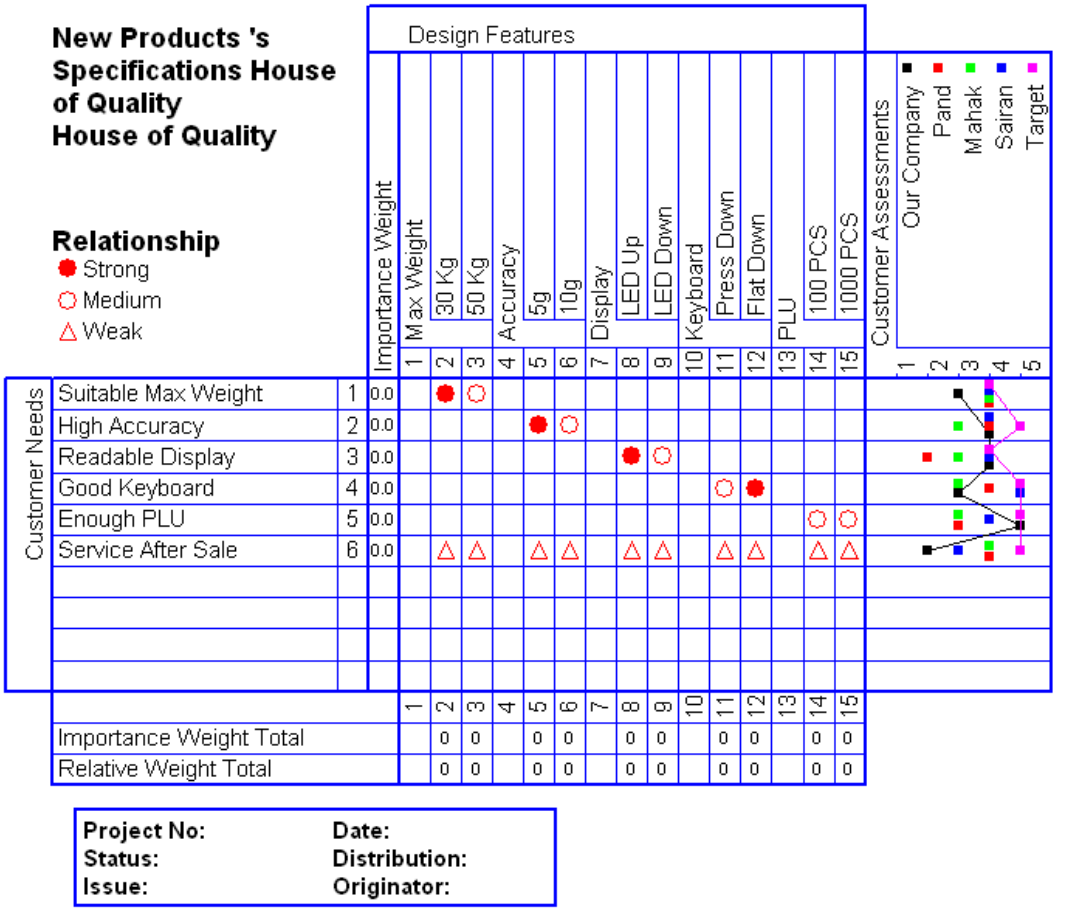



**Fig 1: HoQ matrix for the evaluation alternatives**

These results clearly show the accuracy and power of the proposed model that based Fuzzy AHP program. So, the proposed decision support system by combining the fuzzy AHD and QFD in this work can be used as an active tool to select the most suitable Specification for new product to satisfy customer's needs.

## Conclusion:

Agile and evolved organizations in the field of computer technologies have created a set of DSS (decision support system) applications. In this regard, DSS is used in this research as the application tool to design companies' new products. With technological advances and changes in consumption patterns, product lifecycles are becoming shorter. Hence, the development of current products is considered organizations' main strategy and new products are produced based on customer needs. Hereby, the fuzzy QFD model is a powerful tool to develop new products. Primary data was collected for HOQ (House of Quality) using surveys and AHP was used to determine the influence of entrants on QFD results.

This model covers decision making in order to achieve two objectives. Firstly, parameters are identified which have the most effect on the model results. Secondly, engineering connections between the input and results are determined. Therefore, based on obtained results, it can be stated that the utilization of this system along with appropriate decision making in manufacturing companies and organizations results in the reduction of costs related to product development and quality improvement.

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