11TH INTERNATIONAL SCIENTIFIC CONFERENCE
ON DEFENSIVE TECHNOLOGIES
OTEH 2024
Serbia, Tara, 9-11 October 2024

IMPROVEMENT OF PRODUCT QUALITY BY IMPLEMENTATION QFD METHODS

BRANKO VUJATOVIĆ
Center for Applied Mathematics and Electronics, Belgrade, branko.vujatovic@vs.rs

MARIJA VUJATOVIĆ
Directorate for Telecommunications and Informatics (J-6) GS VS, Belgrade, marija.vujatovic@vs.rs

DARKO GRUBAČ
Center for Applied Mathematics and Electronics, Belgrade, darko.grubac@vs.rs

NENAD STOJANOVIĆ
Center for Applied Mathematics and Electronics, Belgrade, nenad.m.stojanovic@vs.rs

Abstract: *In nowadays business conditions, such as increased competition and the rapid market changes, companies can be distinguished by the quality of services resulting from analysis and matching opportunities with market requirements. One way is to use the Quality Function Deployment (QFD) method. This method has shown a significant effect in the EU countries, the USA, and especially in Japan, while in our country its use is not widespread in the quality system. From the market perspective, there are three basic product characteristics: price, quality and delivery time. These facts are used in the planning process, based on user requirements interpretation into appropriate quality characteristics for each phase of the product life cycle (marketing, planning, design, prototype development, production process testing and development, production, sales). The common goal of the entire team working on the project must be the product competitiveness on the market. This method application has led to significant improvements in solving deficiencies in planning, designing, testing and developing the production process. In this paper, we presented the QFD method application for selecting products or services that meet the quality, price, and delivery time requirements.*

Keywords: *QFD, product competitiveness, quality system.*

1. INTRODUCTION

Production engineers were the first to deal with the problems of product quality control and then quality management. The Quality Function Deployment (QFD) method was developed in Japan, more precisely in Kobe in the 1970s, in the Mitsubishi shipyard, while it later found application in other branches of industry.

The QFD method is used by:

- Toyota since 1973,
- Honda since 1979,
- Ford since 1983,
- Volvo and Saab since 1987.

Quality function deployment term originated from the Japanese words "hinshitsu kino tenkai", which refer to the methodology developed by Yoji Akao and Kogure Mizuno in Japan in 1966 [1].

The aim of the paper is to introduce the concept of QFD method through the basic principles and description of the application through a suitable example.

In the second part of the paper are described principals of the QFD method. Third part gives input data for the further analysis. In the forth part of the paper concrete applications and basic results are given. Finally, the most important conclusions are given.

2. QFD METHOD - HOUSE OF QUALITY AND MATRIX

The complete and complex QFD method is based on the establishment of relationships: for each WHAT, a corresponding HOW should be found. One of the necessary conditions for the successful implementation of the QFD method is the quality composition of the QFD team.

In the paper, we have dealt with the case of choosing a printer that would enable printing on several types of materials: cardboard, stickers, used paper, hologram foils, paper, envelopes, etc., and to fulfill the requirements during the production process. The choice of the printer needed in the production process was reflected in the fact that they also meet the conditions prescribed by the tender.

There are three basic factors of the product from the point of view of the customer/market:

- price of the product,
- product quality,

Corresponding author: B.Vujatović;
E-mail: branko.vujatovic@vs.rs
DOI: 10.5937/OTEH24124V

- product delivery terms.

It is very important to emphasize that the implementation of the QFD method requires teamwork, but also that the composition of the team does not have to be the same through the analysis of all phases of the product life cycle. It is also very important that each phase is carried out with the highest possible quality, and in order to achieve this, members chosen for the part of the team should be professional, knowledgeable and best aware of the problem. Another important condition for the successful implementation of the QFD method is that the problem is defined clearly and in as much detail as possible.

The QFD method defines the following:

1) What users want – user requests related to product description and its features are collected and processed;
2) The importance of user preferences – emphasizing the importance of user requirements that have been gathered from direct experience with users and/or from research and
3) How to turn perceived user needs into a competent advantage – define engineering characteristics that represent measurable product characteristics that describe each of the functional requirements, among which identify those that bring a competent advantage.

We made the choice after complete and complex analyzes obtained using the QFD method.

The matrix of the QFD "house of quality" method consists of seven phases. Phases are shown in Figure 1 [2].

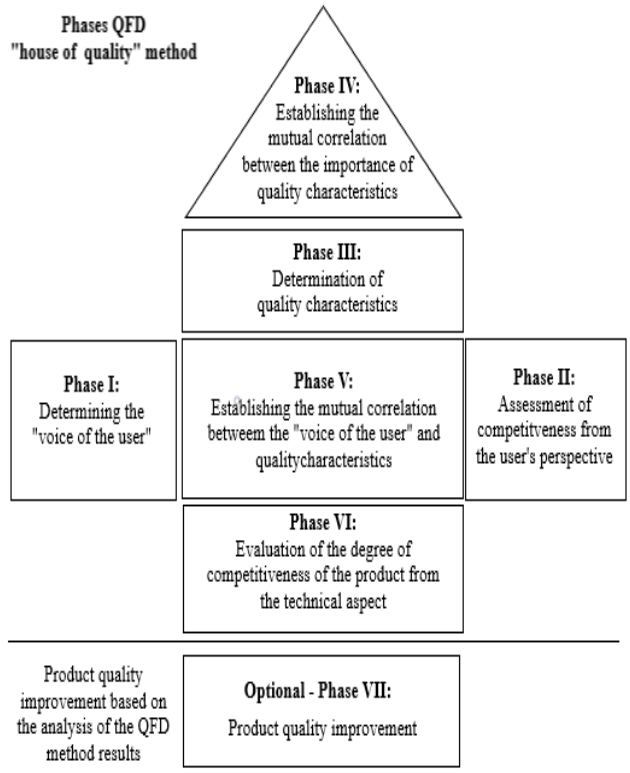


Figure 1. Matrix QFD - House of Quality

Phase I: Determining the "voice of the user"

The initial and most critical step in the process of the QFD method is determining the user's requirements in relation to the product's characteristics, and then obtaining the value of the user's importance rating.

Phase II: Assessment of competitiveness from the user's perspective

In this phase, competitive weaknesses and strengths of the bidder are determined.

Phase III: Determination of quality characteristics

In this phase, established user requirements are transformed into product quality characteristics.

Phase IV: Establishing the mutual correlation between the importance of quality characteristics

The roof of the "house" is designed to determine the relationships between the importance of quality characteristics.

Phase V: Establishing the mutual correlation between the "voice of the user" and quality characteristics

The construction of the "house of quality" continues by determining the strength of the connections between the user's voice and the quality characteristics of the product.

Phase VI: Evaluation of the degree of competitiveness of the product from the technical aspect

The degree of competitiveness is calculated for each quality characteristic and represents the product of the user's rating of importance and the strength of the connection between the user's voice and the product's quality characteristics.

Phase VII: Product quality improvement

After determining the importance of all product quality characteristics, it can be determined which characteristics should be improved first, so that further work can be concentrated on them. The phase is optional if the results are satisfactory, it does not have to be implemented.

3. DATA PREPARATION

Given that suppliers are not able to fully satisfy the set criteria of users, it is necessary to define which quality characteristics are more important than others.

The results collected by a structured questionnaire are shown in Table 1 through mean value and standard deviation. With a structured questionnaire, we asked future consumers to assess and define the importance of certain product characteristics by assigning them values from 1 to 5, where 1 is requirement with relatively little importance, and 5 is requirement with very significant requirement.

Before the surveying users, we conduct market research of WHAT companies offer, in order to collect technical characteristics of products from manufacturers.

This is how we arrive at the results that we need for further research, namely the mean values of the product characteristics and the standard deviation of the user's assessment of the importance of the required qualities of individual product characteristics.

We can conclude that Phase I is the most demanding phase in which the requirements of the customer and/or user, which the product needs to satisfy, are defined.

In the WHAT field, enter the characteristics of the product that are significant for satisfying the customer's and/or user's requirements.

Table 1. Overview of mean values and standard deviation of user ratings

Characteristics	Mean value	Standard deviation
Double-side printing	3,40	1,62
Print resolution 1200x1200 dpi	2,80	0,40
Network work	4,60	0,49
Power suply 220V/50Hz	5,00	0,00
working and spare toner in the set	4,00	0,00
Weight up to 20 kg	3,00	0,63
Touch screen and laser	1,80	0,40
Price	3,00	0,63
Warranty period 12 months	2,80	0,40
possibility of installation OS Win7, Win10	4,40	0,80
Ecological aspects: ENERGY STAR, RoHS	2,00	0,00

4. APPLICATION OF THE QFD METHOD

We applied the QFD method to select a printer supplier. In order to apply the QFD method, we used: Template Traditional House of Quality, version 2.0.346.0, 11.12.2007. years [3].

The interdependence of requests is shown by values and labels:

1 (Δ)→ Weak Relationship,
3 (*O*)→ Moderate Relationship and
9 (Θ)→ Strong Relationship.

In the first house of quality, which is shown in Figure 2, in its left part, we enter user requirements with mean values, and in the upper middle part, we enter the researched characteristics of product quality. We enter the correlation of user requirements according to product characteristics in the middle part of the quality house, with previously defined values and labels.

In the "roof" of the first house of quality, the correlation of product properties is shown, where are:

- ++ → represents a strong positive correlation,
- \+ → represents positive correlation,
- \- → represents a negative correlation and
- −− → represents a large negative correlation and
- → if there is no correlation, then the field is left blank.

The fully filled graphic layout of the first house of quality is shown in Figure 2.

The results of the first house of quality give us information about the weighting coefficient of the HOW technical characteristics of the product for each of the listed characteristics of product quality that need to be paid attention to in the selection of the product, which are ranked by importance and shown in Table 2.

Table 2. Weight coefficient of HOW technical product characteristics

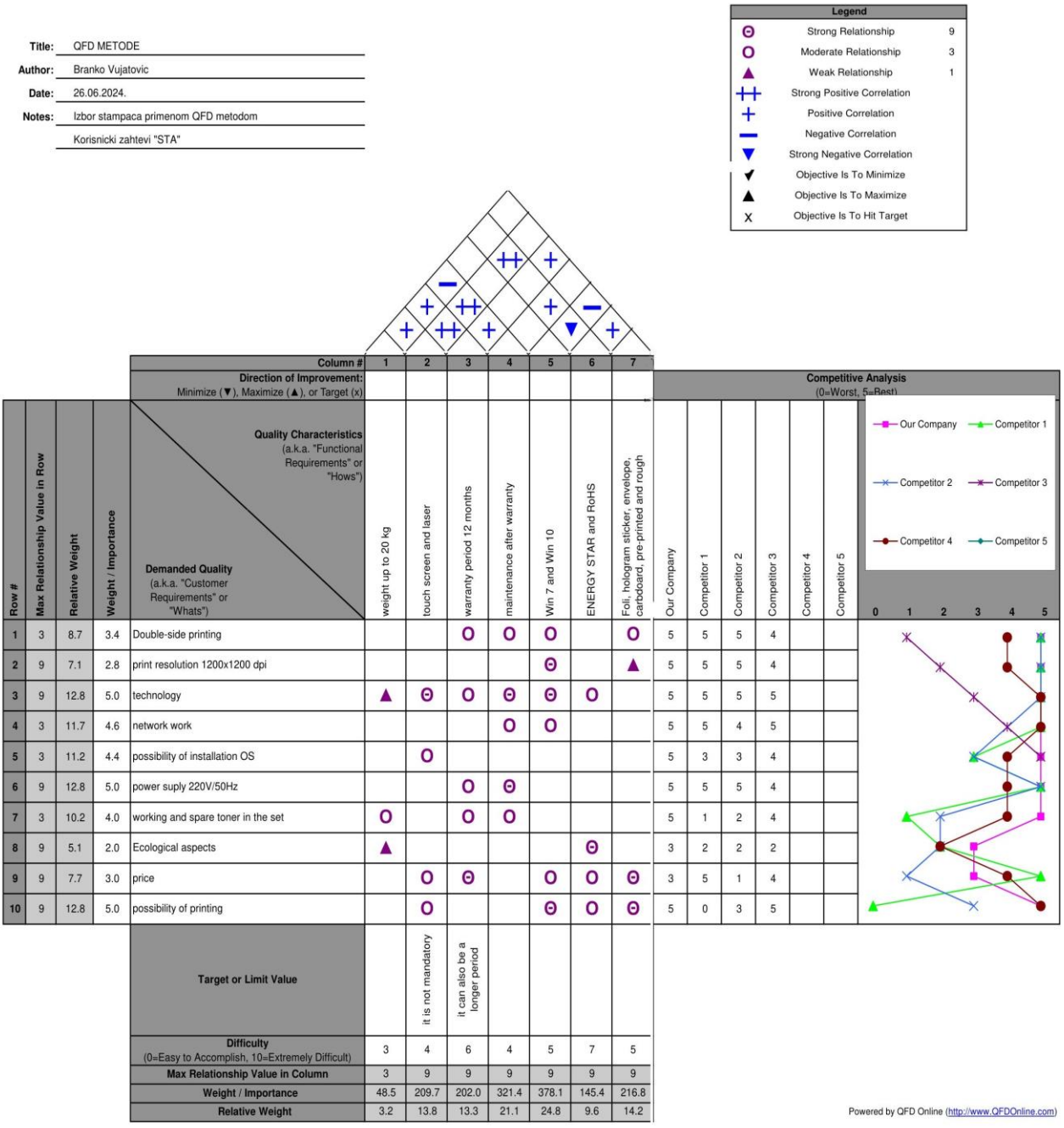
Weight importance	Quality characteristics
378,1	Win 7 and Win 10
321,4	Maintenance after warranty
216,8	Foil, hologram sticker, envelope, cardboard, pre-printed and rough
203,7	Touch screen and laser
202,0	Warranty period 12 months
145,4	ENERGY STAR and RoHS
48,5	Weight up to 20 kg

By analyzing the results shown in Table 2, and based on the results from the first quality house, we can get conclusion about the importance of the required qualities of certain product characteristics and the choice of products that we rank according to the concretely obtained value of the importance of the requirements for the quality characteristics of the product.

In the right part of the first quality house, we perform a comparative analysis of the bidders by evaluating the requirements users according to the weighting coefficient with the values: 1 - not suitable, 5 - extremely suitable, as well as based on the weighting coefficient of each product quality characteristic.

In the second house of quality, in the left part of the house

of quality, we enter the technical characteristics of the product, and in the middle part of the user's requirements in order to determine the weight of the importance of the technical characteristics of the manufacturer's product. We enter the correlation of the technical characteristics of the product according to the user's requirements into the middle part of the quality house, with previously defined values and labels. The graphic layout of the second house of quality is shown in Figure 3.



Title: QFD METODE
Author: Branko Vujatovic
Date: 26.06.2024.
Notes: Izbor stampaca primenom QFD metodom
Korisnicki zahtevi "STA"

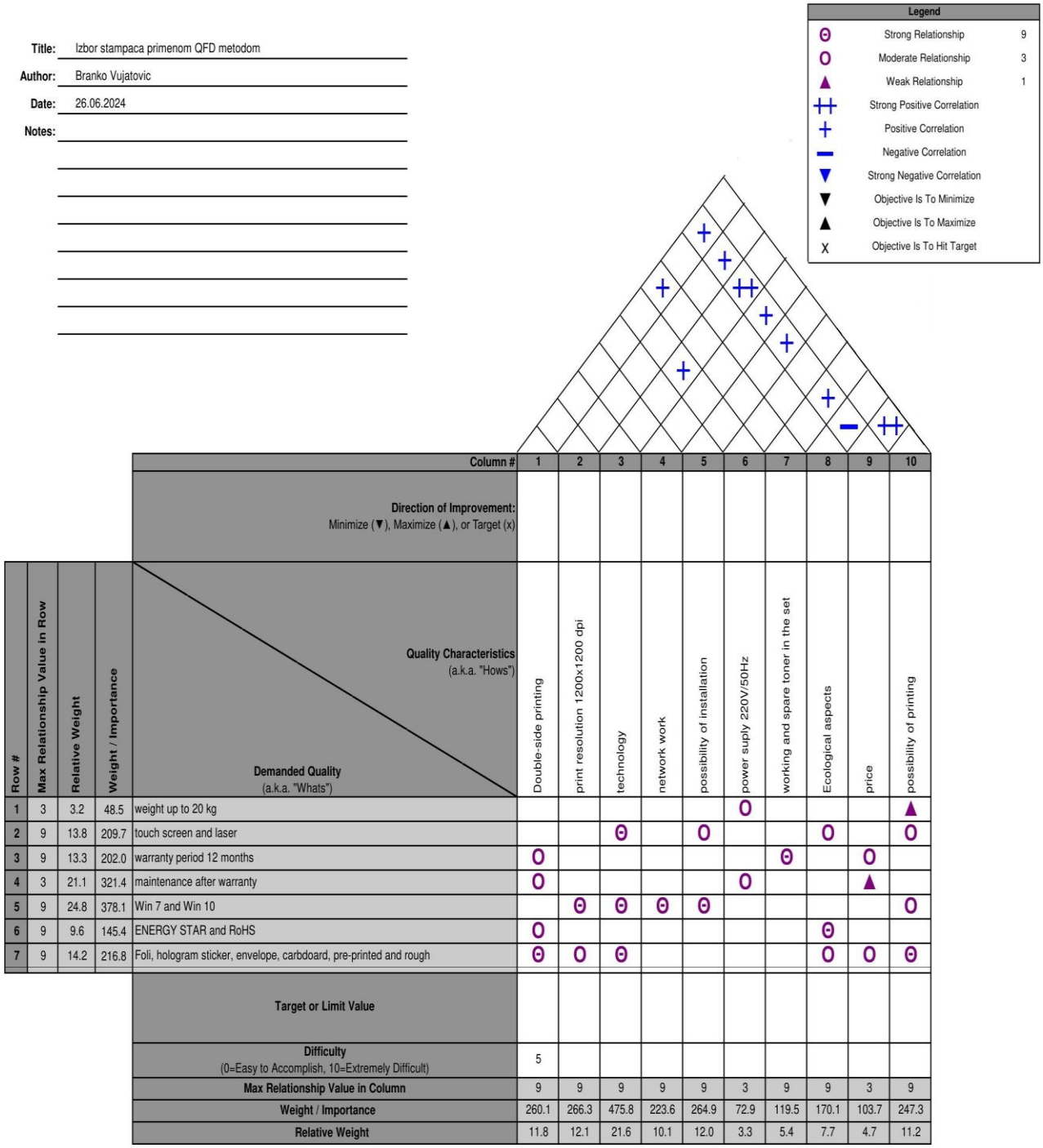
Legend

⊖	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
✓	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats") / Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")	1 weight up to 20 kg	2 touch screen and laser	3 warranty period 12 months	4 maintenance after warranty	5 Win 7 and Win 10	6 ENERGY STAR and RoHS	7 Foil, hologram sticker, envelope, cardboard, pre-printed and rough	Our Company	Competitor 1	Competitor 2	Competitor 3	Competitor 4	Competitor 5
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)													
				Competitive Analysis (0=Worst, 5=Best)													
1	3	8.7	3.4	Double-side printing			O	O	O		O	5	5	5	4		
2	9	7.1	2.8	print resolution 1200x1200 dpi					⊖		▲	5	5	5	4		
3	9	12.8	5.0	technology	▲	⊖	O	⊖	⊖	O		5	5	5	5		
4	3	11.7	4.6	network work				O	O			5	5	4	5		
5	3	11.2	4.4	possibility of installation OS		O						5	3	3	4		
6	9	12.8	5.0	power suply 220V/50Hz			O	⊖				5	5	5	4		
7	3	10.2	4.0	working and spare toner in the set	O		O	O				5	1	2	4		
8	9	5.1	2.0	Ecological aspects	▲					⊖		3	2	2	2		
9	9	7.7	3.0	price		O	⊖		O	O	⊖	3	5	1	4		
10	9	12.8	5.0	possibility of printing		O			⊖	O	⊖	5	0	3	5		
				Target or Limit Value		it is not mandatory	it can also be a longer period										
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	3	4	6	4	5	7	5						
				Max Relationship Value in Column	3	9	9	9	9	9	9						
				Weight / Importance	48.5	209.7	202.0	321.4	378.1	145.4	216.8						
				Relative Weight	3.2	13.8	13.3	21.1	24.8	9.6	14.2						

Powered by QFD Online (http://www.QFDOnline.com)

Figure 2. The first house of quality



Title: Izbor stampaca primenom QFD metodom
Author: Branko Vujatovic
Date: 26.06.2024
Notes:

Legend		
Θ	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Whats") / Quality Characteristics (a.k.a. "Hows")	Double-side printing	print resolution 1200x1200 dpi	technology	network work	possibility of installation	power suply 220V/50Hz	working and spare toner in the set	Ecological aspects	price	possibility of printing
				Column #	1	2	3	4	5	6	7	8	9	10
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)										
1	3	3.2	48.5	weight up to 20 kg						O				▲
2	9	13.8	209.7	touch screen and laser			Θ		O			O		O
3	9	13.3	202.0	warranty period 12 months	O						Θ		O	
4	3	21.1	321.4	maintenance after warranty	O					O			▲	
5	9	24.8	378.1	Win 7 and Win 10		Θ	Θ	Θ	Θ					O
6	9	9.6	145.4	ENERGY STAR and RoHS	O							Θ		
7	9	14.2	216.8	Foli, hologram sticker, envelope, carbdoard, pre-printed and rough	Θ	O	Θ					O	O	Θ
				Target or Limit Value										
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	5									
				Max Relationship Value in Column	9	9	9	9	9	3	9	9	3	9
				Weight / Importance	260.1	266.3	475.8	223.6	264.9	72.9	119.5	170.1	103.7	247.3
				Relative Weight	11.8	12.1	21.6	10.1	12.0	3.3	5.4	7.7	4.7	11.2

Figure 3. The second house of quality

The results of the second quality house give us information about the weight and importance of the user's request HOW for each specified characteristic of the user's request that needs to be paid attention in the selection of products, which are ranked by importance and shown in Table 3.

Table 3. User requirements

Weight importance	Quality characteristics
475,8	Technology
266,3	Print resolution 1200x1200 dpi
264,9	Possibility of installation
260,1	Double-side printing
247,3	Possibility of printing
223,6	Network work
170,1	Ecological aspects
119,5	Working and spare toner in the set
103,7	Price
72,9	Power suply 220V/50Hz

5. CONCLUSION

In our case, by applying the QFD method, we were able to select the product and the bidder that best suits our requirements and conditions of the tender procedure. We found that the QFD method can be successfully applied in the procurement process itself, harmonizing all the necessary procedures and requirements of the successfully implemented steps applied in the QFD method.

By applying the QFD method, we obtained an objective result of the selection of bidders for the required product, which was the goal of solving and concretizing the specified request.

It can be concluded that the QFD method contains seven phases, with the fact that certain phases can be combined, and considering that the method also requires teamwork with the variability of the members by phase, by analyzing the obtained results, we get an objective choice of product or service.

Through complex and specific work, we determined individual and team results that are extremely important in order to implement this method from start to finish, in order to obtain an objective result.

the procurement process itself, harmonizing all the necessary procedures and requirements of the successfully implemented steps applied in the QFD method.

By applying the QFD method, we obtained an objective result of the selection of bidders for the required product, which was the goal of solving and concretizing the specified request.

It can be concluded that the QFD method contains seven phases, with the fact that certain phases can be combined, and considering that the method also requires teamwork with the variability of the members by phase, by analyzing the obtained results, we get an objective choice of product or service.

Through complex and specific work, we determined individual and team results that are extremely important in order to implement this method from start to finish, in order to obtain an objective result.

References

[1] SIVASAMY, K., ARUMUGAM, C., DEVADASAN, S. R., MURUGESH, R., THILAK, V. M. M.: *Advanced models of quality function deployment: a literature review*. *Quality & quantity*, 50 (2016) 1399-1414.

[2] ISRAR, M., GANGELE, A.: *Quality function deployment methodology for product development*, International Journal of Multidisciplinary and Scientific Emerging Research, 3(2) (2014) 989-997.

[3] *Traditional House of Quality*, version: 2.0.346.0, December 11, 2008, (at again 04.2024)

https://qfdonline.com/templates/