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# Quality Function Deployment: Definition, Benefits And Disadvantages In Its Application For Customer Satisfaction Management. Critical Analysis By Data Mining

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***Abstract***

*The Quality Function Deployment (QFD) has been applied in various industries and has proven to be an effective tool in continuous quality improvement and customer satisfaction. QFD was developed in Japan in the late 1960s and early 1970s as a way to enhance the quality of products and services. Our research involved a scientific literature review process, and the information analysis was facilitated using the Atlas ti software. We examined the benefits, drawbacks, and limitations of QFD, as well as some case studies of its application in different business processes. The conclusion drawn is that QFD is widely used to align products and services with customer needs, leading to improved satisfaction and cost reduction. While its implementation can be complex, it has demonstrated effectiveness and adaptability across various fields.*

***Keywords:*** *Quality Function Deployment (QFD), Customer satisfaction, Quality, Continuous improvement*

## Introduction

Quality management is a crucial issue for any company that aspires to succeed in an increasingly competitive market. In this sense, there are several methodologies and tools that have been developed to improve the quality of products and services offered by companies. One of these methodologies is Quality Function Deployment (QFD), which is used to translate customer needs and expectations into technical and operational characteristics of products or services. (Kulcsár et al., 2022a).

Since its introduction by Akao in 1966, QFD has been applied in various industries and has proven to be an effective tool in continuous quality improvement and customer satisfaction. (Akao, 2004). QFD was developed in Japan in the late 60s and early 70s as a way to improve the quality of products and services. (Kinker et al., 2021). Its development was influenced by Japan's total quality philosophy, which focuses on continuous improvement of products offered in the market and customer satisfaction. QFD was initially used by Japanese companies, such as Toyota, and its

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success in improving quality and customer satisfaction caught the attention of companies around the world.

The QFD is a methodology that is divided into several phases, each of which focuses on a different aspect of the product or service design and development process. The first phase focuses on identifying customer requirements, which can be obtained through surveys, interviews or focus groups. In the second phase, the customer's requirements are transformed into technical characteristics of the product or service, which are represented in a QFD matrix. In the third phase, requirements are prioritized and development parameters are selected. In the fourth phase, prototypes are developed and a pilot test of the product or service is carried out. (Lizarelli et al., 2021).

The Quality Function Deployment (QFD) Methodology is a tool used to improve the quality of the products or services offered, through the identification of customer needs and the translation of these needs into specific characteristics of the product or service. (Loya et al., 2023), (Kamvysi et al., 2023a) and (Ping et al., 2020). Therefore this methodology is based on the idea that the success of a product or service depends largely on its ability to meet customer needs. (Kulcsár et al., 2022a).

QFD has been used in a wide range of industries, from manufacturing to healthcare. In manufacturing, QFD has been used to improve product quality, perfecting consumer goods manufacturing processes and thus meeting customer demands. (Kamvysi et al., 2023b). In healthcare, QFD has been used to improve the quality of healthcare services and improve patient satisfaction. In construction, QFD has been used to improve quality and efficiency in building construction.

The application of the QFD methodology in the service sector is increasingly common, due to the importance given to quality in this sector and the need to meet customer requirements. The QFD methodology can be used at different stages of the service delivery process, from service planning and design to service evaluation and continuous improvement. (Shen et al., 2022).

The QFD has proven to be a valuable tool for improving customer satisfaction in various industries. Among its main benefits are the reduction of product development time, the improvement in communication between departments, the identification of key features that are important to the customer and the prioritization of areas for improvement (Y. Zhang et al., 2022). In addition, the QFD allows a better understanding of customer needs, which facilitates innovation and differentiation from the competition.

However, despite the popularity and effectiveness attributed to the QFD methodology, there are some doubts about its applicability and effectiveness in different contexts and productive sectors. (Park et al., 2021). For example, some studies suggest that the QFD methodology may be more effective in designing new products, but may be less useful in continuously improving existing products. Likewise, the complexity and time that the implementation of the QFD methodology may require in some companies has also been discussed. (Iqbal et Suzianti, 2021).

In this sense, it is necessary to carry out a bibliographic review that allows a careful analysis of the QFD methodology, as well as its benefits and disadvantages in quality management in different contexts and productive sectors. This literature review can help clarify doubts and provide relevant information for decision-making on the implementation of the QFD methodology in companies, and also for the identification of possible improvements and adjustments that can make its application more effective.

The objective of this research is to conduct a bibliographic analysis of the QFD methodology, its benefits, and disadvantages in quality management across different production contexts.

## Methodology

The study is based on a bibliographic review based on a database of articles selected for analysis. The selection process was carried out after an initial reading process of 97 articles that were found in a database where "Quality Function Deployment" was used as the composite search word, of which 30 were considered appropriate for their content for the theoretical analysis of the QFD quality tool (See Table 1).

**Board 1.-** Database of articles of interest for analysis

| Code | Title | Year | Author |
|---|---|---|---|
| ART20231 | Service quality analysis using quality function deployment for two-wheeler service center | 2023 | (Loya et al., 2023) |
| ART20232 | Deployment of quality features | 2023 | (Kamvysi et al., 2023a) |
| ART20233 | A linear programming-based QFD methodology under fuzzy environment to develop sustainable policies in apparel retailing industry | 2023 | (Aydin et al., 2023) |
| ART20221 | Network-based – Quality Function Deployment (NB-QFD): The combination of traditional QFD with network science approach and techniques | 2022 | (Kulcsár et al., 2022a) |
| ART20222 | An integrated behavior decision-making | 2022 | (H. C. Liu et al., |

| | | | |
|---|---|---|---|
| | approach for large group quality function deployment | | 2022) |
| ART20223 | Hypergraph and network flow-based quality function deployment | 2022 | (Abonyi et Czvetkó, 2022) |
| ART20224 | Integration of safety quality function deployment in ferry services: Empirical study of Indonesia | 2022 | (Shang et al., 2022) |
| ART20225 | A voice of the customer real-time strategy: An integrated quality function deployment approach | 2022 | (Shen et al., 2022) |
| ART20226 | Large-scale group decision-making for prioritizing engineering characteristics in quality function deployment under comparative linguistic environment | 2022 | (Yang et al., 2022) |
| ART20227 | Customer-oriented product design using an integrated neutrosophic AHP & DEMATEL & QFD methodology | 2022 | (Karasan et al., 2022) |
| ART20211 | Coping with diversity ratings in prioritizing design requirements in quality function deployment: A consensus-based approach with minimum-maximum adjustments | 2021 | (Xiao et al., 2022) |
| ART20212 | An integrated behavior decision-making approach for large group quality function deployment | 2021 | (H. C. Liu et al., 2022) |
| ART20213 | Application of the quality function deployment method in the mechanical structure design of subsea power devices | 2021 | (Syreyshchikova et al., 2021) |
| ART20214 | Picture fuzzy set and quality function deployment approach based novel framework for multi-criteria group decision making method | 2021 | (Singh and Kumar, 2021) |
| ART20215 | Applying Quality Function Deployment in Open Innovation Engineering | 2021 | (Rianmora and Werawatganon, 2021) |
| ART20216 | Customer-oriented product and service design by a novel quality function deployment framework with complex linguistic evaluations | 2021 | (Wu and Liao, 2021) |
| ART20201 | A new integrated approach for engineering characteristic prioritization in quality function deployment | 2020 | (Ping et al., 2020) |

| | | | |
|---|---|---|---|
| ART20191 | Identification of product's design characteristics for remanufacturing using failure modes feedback and quality function deployment | 2019 | (X. Zhang et al., 2019) |
| ART20192 | Identifying passengers' needs in cabin interiors of high-speed rails in China using quality function deployment for improving passenger satisfaction | 2019 | (Chin et al., 2019) |
| ART20193 | Fuzzy cognitive map based quality function deployment approach for dishwasher machine selection | 2019 | (Efe, 2019) |
| ART20194 | An Evaluation on Lifecycle of Products in Textile Industry of Turkey through Quality Function Deployment and Pareto Analysis | 2019 | (Erdil, 2019) |
| ART20181 | A group decision model based on quality function deployment and hesitant fuzzy for selecting supply chain sustainability metrics | 2018 | (Osiro et al., 2018) |
| ART20182 | Fuzzy QFD approach for managing SCOR performance indicators | 2018 | (Akkawuttiwanich and Yenradee, 2018) |
| ART20183 | Participatory decision-support model in the context of building structural design embedding BIM with QFD | 2018 | (Eleftheriadis et al., 2018) |
| ART20151 | A new integrated fuzzy QFD approach for market segments evaluation and selection | 2014 | (Dat et al., 2015) |
| ART20152 | An improved grey quality function deployment approach using the grey TRIZ technique | 2015 | (H. T. Liu & Cheng, 2016) |
| ART20111 | Technical importance ratings in fuzzy QFD by integrating fuzzy normalization and fuzzy weighted average | 2011 | (Y. M. Wang & Chin, 2011) |
| ART20112 | A rough set approach for estimating correlation measures in quality function deployment | 2011 | (Li et al., 2012) |
| ART20113 | An integrated linguistic-based group decision-making approach for quality function deployment | 2011 | (X. T. Wang & Xiong, 2011) |
| ART20021 | Quality function deployment: A literature review | 2002 | (Chan & Wu, 2002) |

Note: Database of scientific articles selected for data mining.

After the selection process, a bibliographic file was made in Word to record the year of publication, the author and the title of the article. After reading it, we proceeded to translate and create the

**Remittances Review**
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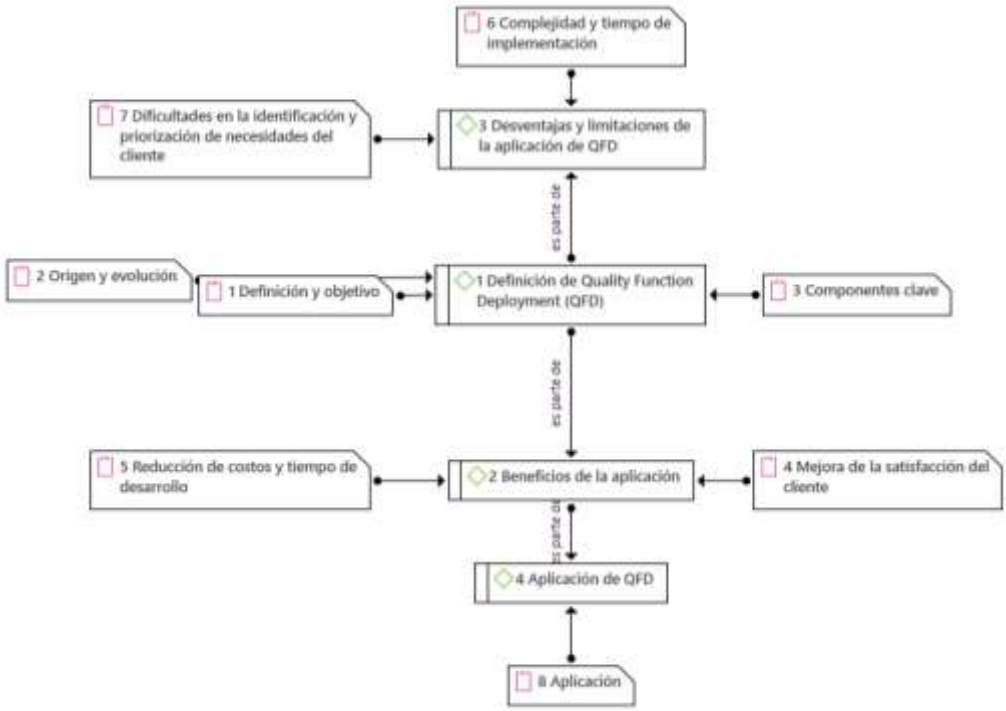
analysis unit in the Atlas ti qualitative analysis software in version 9, where the entities of codes and memos were used, which allowed categorizing the information into 4 categories and 9 subcategories.

**Figure 1-** Network analysis of codes and memos used in Atlas ti.




**Note:** Analysis networks generated after data mining with Atlas ti version 9 software.

After the process of analysis of the selected articles, we proceeded to make a theoretical contribution combining the interpretation of several authors, establishing the main definitions of the tool, as well as its application.

## Results and discussion

### *Definición de Quality Function Deployment (QFD)*

**Remittances Review**
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**Figure 2-** Code Analysis Network QFD definition


Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

As shown in Figure 2. Quality Feature Deployment (QFD) is a highly valued quality management

**Remittances Review**
June 2023
Volume: 8, No: 4, pp. 1269-1290
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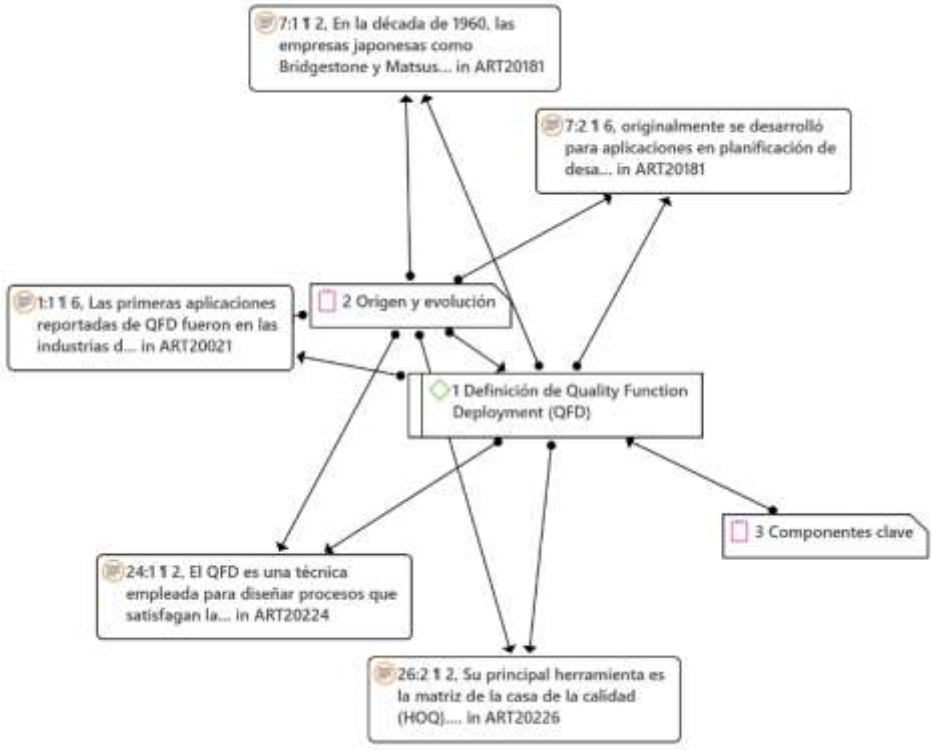
tool that takes into account customer preferences and opinions when designing or improving systems with the aim of increasing customer satisfaction. (Aydin et al., 2023). This methodology is used for the systematic planning and development of products and services, with the purpose of accurately identifying customer requirements and evaluating how those needs are met through an objective evaluation of the proposed product or service capability. (Loya et al., 2023).

**Figure 3-** Code of Origin analysis network and evolution




Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

The origin of the QFD dates back to the 1960s in Japan, where it was proposed by Akao based on the concept of the quality table used by Mitsubishi Heavy Industry. Since then, it has evolved and been applied in various manufacturing and service industries, such as automotive, electronics, software, government, banking, healthcare, education, among others. (Chan et Wu, 2002). Its popularity is due to its ability to design customer-centric products and improve customer satisfaction and competitive advantage. (Karasan et al., 2022; Yang et al., 2022).

**Remittances Review**
June 2023
Volume: 8, No: 4, pp. 1269-1290
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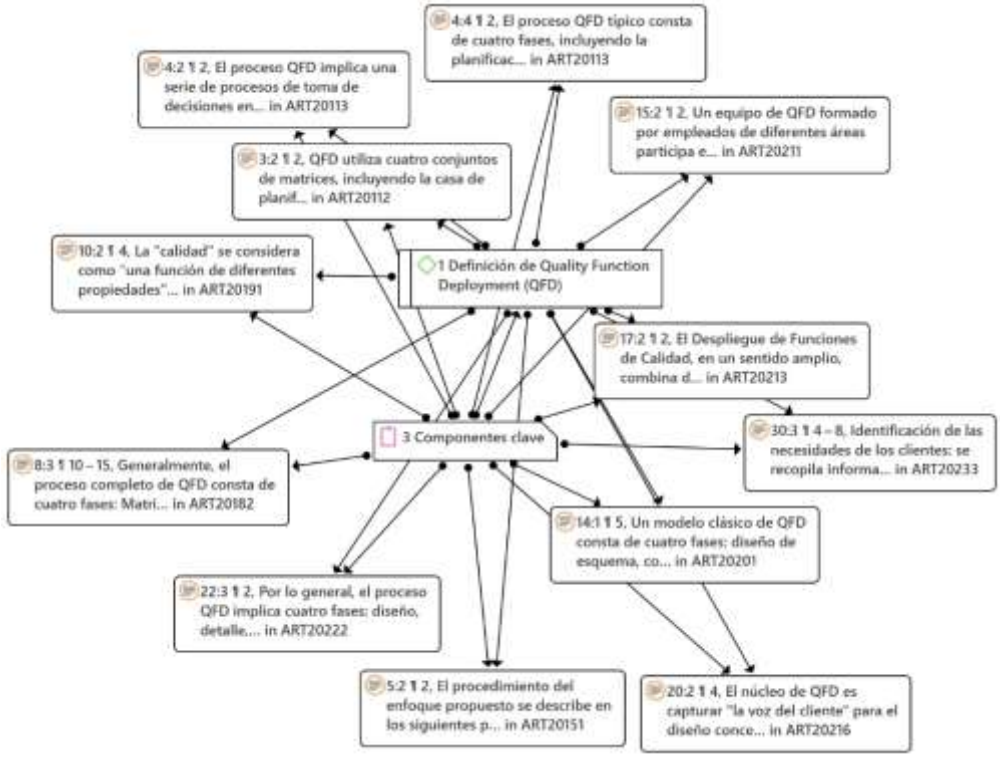
**Figure 4-** Code Analysis Network Key Components




Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

Key components of the QFD include:

- Identification of customer needs: information is collected from customers, known as "voice of the customer" (CEs), to determine their needs and desires in relation to the product or service (Aydin et al., 2023).

- Identification of the engineering characteristics that influence the needs of customers: the technical characteristics of the product or service, called "voice of the company" (SRs), are identified to meet the needs of customers (Aydin et al., 2023).

- Establishing the correlations between customer needs and engineering features: Physical relationships are established between engineering features and customer needs, and represented in a matrix called "the roof section" (Aydin et al., 2023).

- Analysis of competitors: The performance of competitors is analyzed to determine the marketing strategy (Aydin et al., 2023).

- Establishment of overall priorities and performance values of engineering features: The most important engineering features and their performance values are determined to meet customer needs (Aydin et al., 2023).

- The Quality House Matrix (HOQ) is the main tool used in the QFD. This hybrid matrix processes information and data to determine priorities and establish relationships between existing and potential customer requirements and engineering characteristics (Yang et al., 2022).

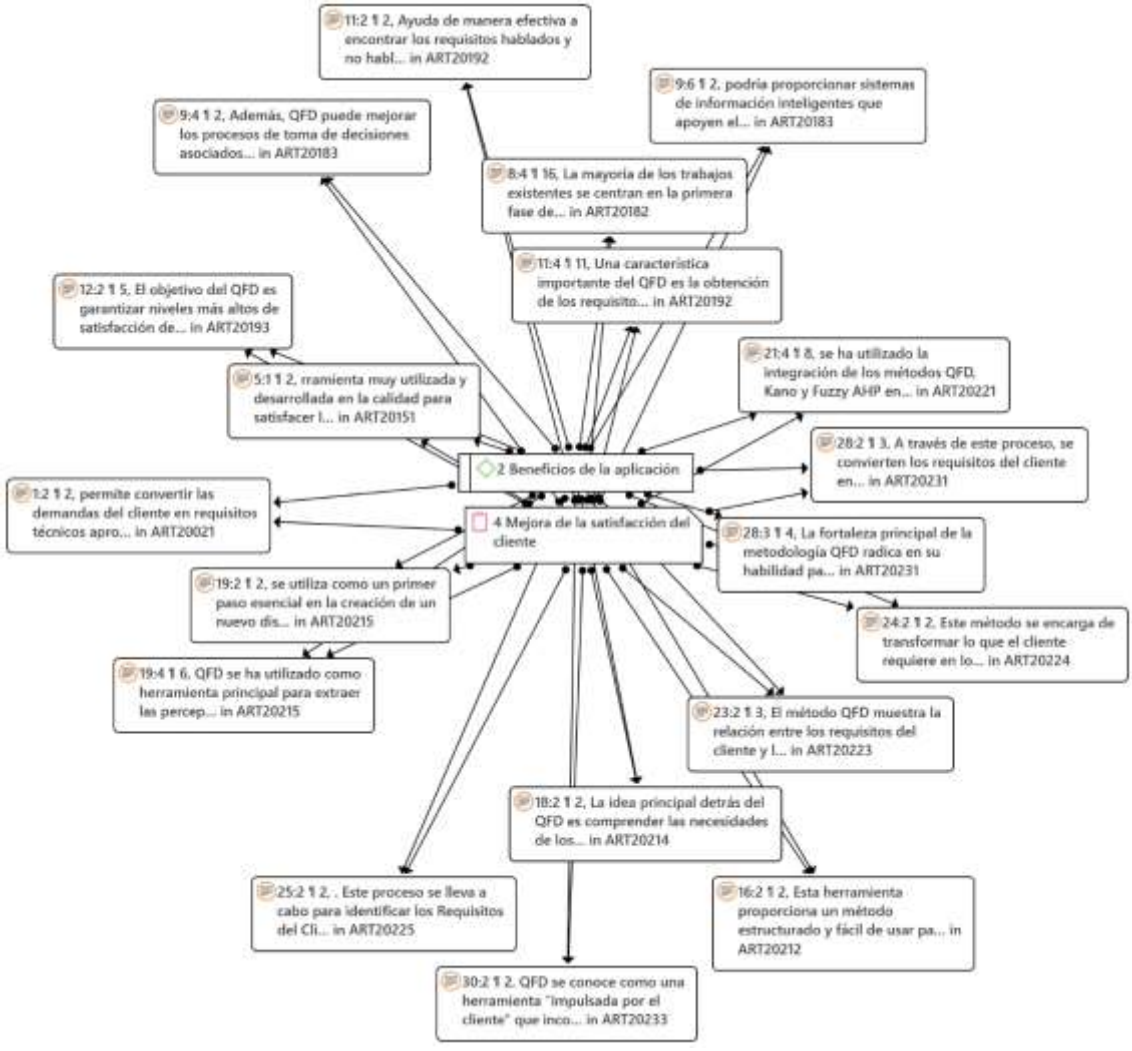
The Deployment of Quality Functions (QFD) is a quality management tool whose main objective is to satisfy the needs and desires of customers when designing or improving products and services. It emerged in Japan in the 1960s and has evolved over the years, being widely used in various industries. Key components of the QFD include: identifying customer needs, engineering characteristics, correlations between them, competitor analysis, and setting priorities and performance values. The quality house matrix (HOQ) is the main tool used in the QFD process (Aydin et al., 2023; Karasan et al., 2022; Yang et al., 2022; Loya, Mate, and Kane, 2023).

### *Benefits of the application*

Quality Feature Deployment (QFD) offers numerous benefits in product design and development. According to Chan and Wu (2002), QFD makes it possible to convert customer demands into appropriate technical requirements for each phase of the process, ensuring that marketing, design, prototype evaluation, production and sales strategies are aligned with customer expectations. In addition, the QFD provides a systematic way to translate the voice of the customer into engineering features, as highlighted by (Akkawuttiwanich et Yenradee, 2018), in its focus on the Quality House (HOQ) matrix where it establishes a clear relationship between customer requirements and engineering characteristics, facilitating the planning and decision-making process.

**Remittances Review**
June 2023
Volume: 8, No: 4, pp. 1269-1290
ISSN: 2059-6588 (Print) | ISSN: 2059-6596 (Online)

**Figure 5-** Code Analysis Network Improving Customer Satisfaction

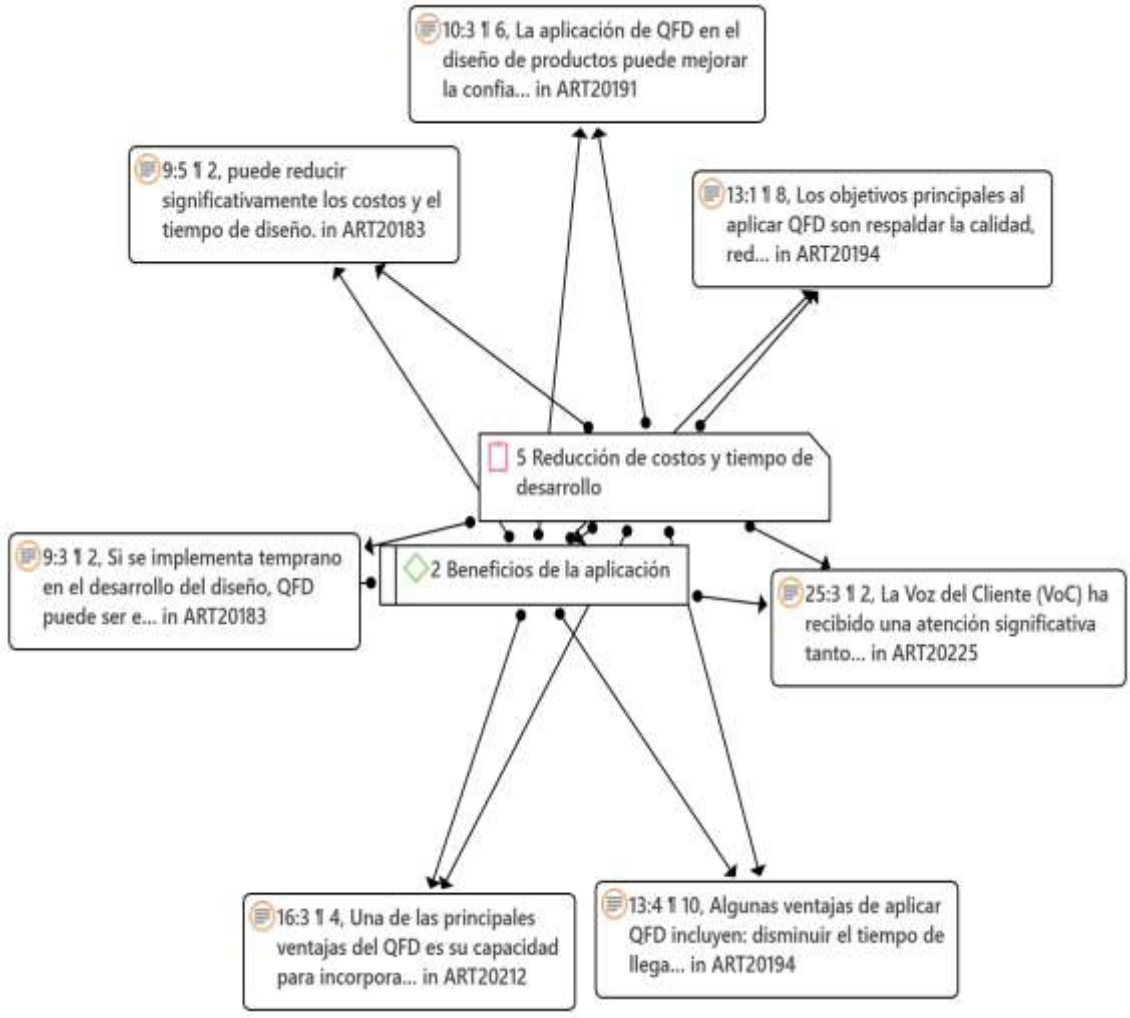


Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

QFD has a direct impact on customer satisfaction (Eleftheriadis et al., 2018), point out that implementing QFD early in design development allows prioritizing project requirements, articulating design criteria, and efficiently managing resources. This ensures that the products or services meet the needs and expectations of customers. In addition, the analysis of the needs of customers and users, together with the specification of technical and functional performance evaluations, improves the decision making associated with structural design, as stated by the same authors. As a result, the QFD contributes to delivering high-quality products that meet or exceed customer expectations, as mentioned by (H. C. Liu et al., 2022).

**Figure 6-** Code Analysis Network Reduced development time

**Remittances Review**
June 2023
Volume: 8, No: 4, pp. 1269-1290
ISSN: 2059-6588 (Print) | ISSN: 2059-6596 (Online)




Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

The QFD offers significant advantages in terms of cost reduction. Eleftheriadis, Duffour, and Mumovic (2018) highlight that QFD can significantly reduce design costs and time. By incorporating customer requirements effectively into different phases of the product or service development process, as mentioned by Liu et al. (2022), the development cycle is shortened and design changes are minimized. This leads to a decrease in design and manufacturing expenses, as highlighted by (Erdil, 2019), which in turn improves the efficiency and profitability of the company.

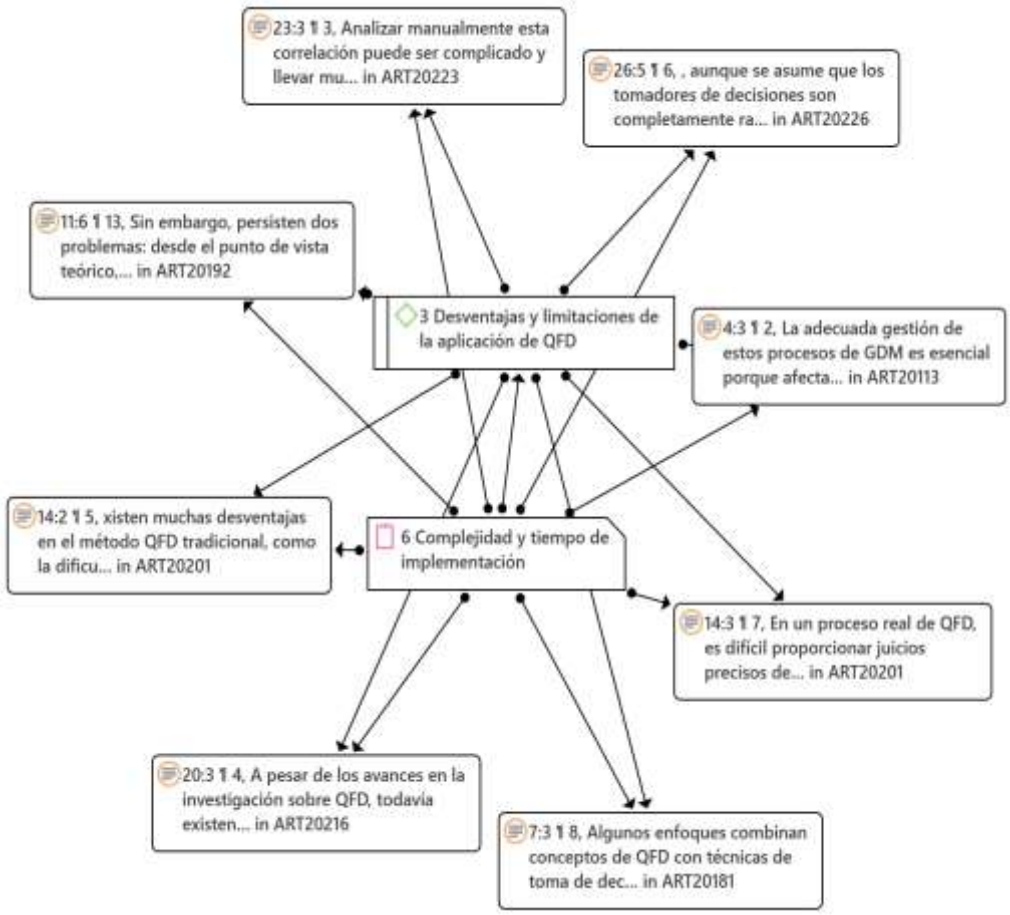
The QFD also has a positive impact on reducing development time. The QFD methodology, using

the House of Quality (HoQ), allows to collectively determine the absolute final weights of the technical requirements, according to Erdil (2019). By implementing customer requirements in a structured manner and throughout the entire product development process, companies can shorten the product development cycle, as highlighted by Liu et al. (2022). This translates into a faster response to market demands and a greater ability to adapt to changes in customer preferences.

In summary, the application of the QFD offers a number of significant benefits, since it allows the translation of customer demands into appropriate technical requirements, improves customer satisfaction by aligning products with their needs, reduces costs by optimizing design and minimizing changes, and accelerates development time by efficiently implementing customer requirements. These benefits are based on the ability of the QFD to integrate the voice of the customer into the product or service development process and make decisions based on quantitative and qualitative data, as evidenced in the aforementioned studies.

***Disadvantages and limitations of QFD application***

**Figure 7-** Code Analysis Network Complexity and implementation time

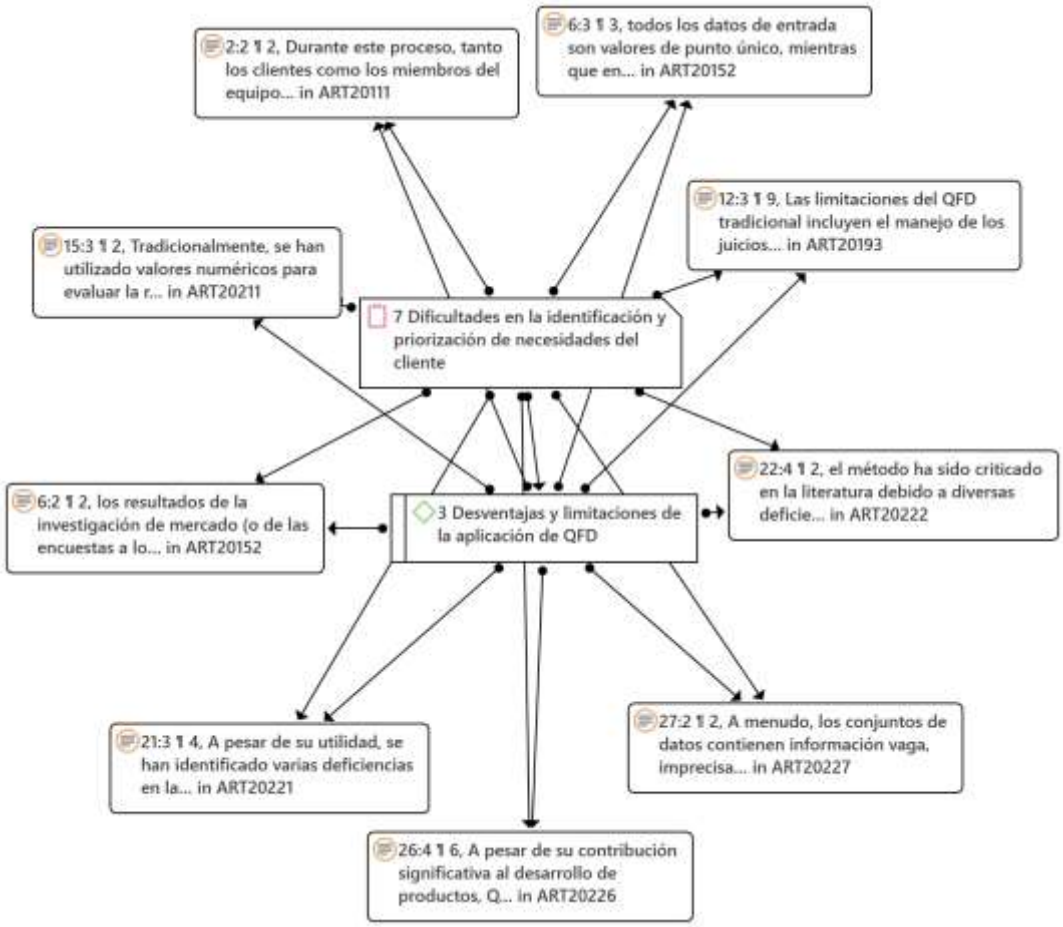



Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

QFD implementation can be a complex and time-consuming process. According to Wang and Chin (2011), during this process, both clients and QFD team members need to make subjective judgments, which can lead to uncertainty and vagueness in the results. In addition (H. T. Liu et Cheng, 2016) They mention that it can be difficult to find experts in specific fields, which can further complicate QFD implementation. Proper management of Group Decision Management (GDM) processes is essential to ensure effective implementation, as highlighted (X. T. Wang and Xiong, 2011)

**Remittances Review**
June 2023
Volume: 8, No: 4, pp. 1269-1290
ISSN: 2059-6588 (Print) | ISSN: 2059-6596 (Online)

**Figure 8-** Code Analysis Network Difficulties in identifying and prioritizing customer needs




Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

Identifying and prioritizing customer needs can be challenging in implementing the QFD. Liu and Cheng (2016) note that the results of market research or customer surveys can be uncertain and incomplete, making it difficult to get a clear picture of customer needs. In addition, there are limitations in quantifying the relationships between customer requirements and design requirements due to the uncertainty and vagueness of human perception. (Ping et al., 2020; Xiao et al., 2022). These difficulties can affect the accuracy of QFD test results.

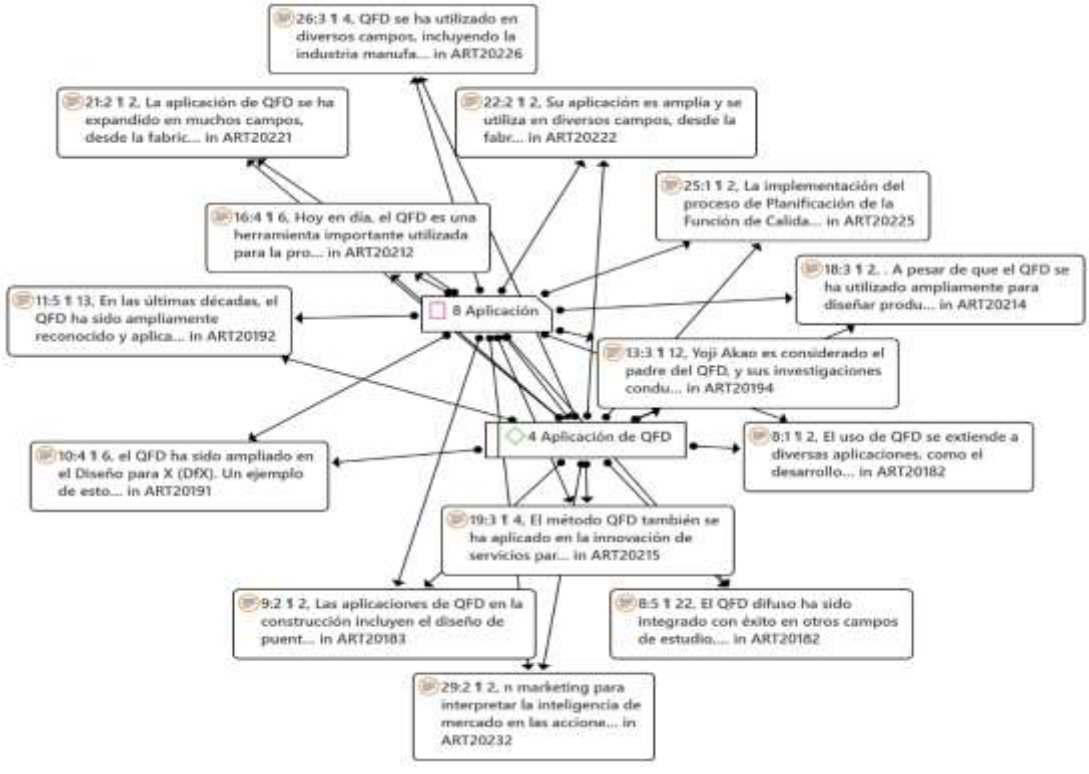
Uncertainty and vagueness are major challenges in the implementation of the QFD. Liu and Cheng

(2016) mention that, all input data in the QFD are single-point values, which does not adequately reflect the uncertain and vague information contained in the input data. In addition, Wang and Xiong (2011) highlight the need to address the subjectivity of quality matrix analysis. In this sense (Osiro et al., 2018) mention that approaches have been proposed that combine the QFD with multicriteria decision-making techniques and fuzzy numbers to manage uncertainty in the analysis of the quality matrix.

In summary, the application of the QFD faces challenges in terms of complexity and implementation time, difficulties in identifying and prioritizing customer needs, and managing uncertainty and vagueness. These limitations require a careful approach and the use of appropriate methods and techniques to overcome these challenges and obtain accurate results in the application of the QFD.

### *QFD Application*

**Figure 9-** QFD Application Code Analysis Network



Own authorship. Prepared using the Atlas you Software, with the articles to be analyzed

Quality Function Deployment (QFD) has been widely applied in various industries and fields of study. It is used in product development, quality management, customer needs analysis, product design, engineering decision making, supplier selection, budget allocation and strategic management in logistics services (Akkawuttiwanich and Yenradee, 2018). In addition, it has been successfully integrated into other fields, such as parts deployment, material selection, service evaluation, and supply chain management (Akkawuttiwanich and Yenradee, 2018). In the field of construction, it has been applied in bridge design, maintenance, energy efficiency in buildings and sustainable performance evaluation (Eleftheriadis, Duffour and Mumovic, 2018).

The QFD has also been expanded to be applied in other fields, such as design for automotive engine remanufacturing and water system design. (X. Zhang et al., 2019). It has been successfully used in transport, logistics, fast food, software systems and education sectors to improve service quality (Chin et al., 2019). Yoji Akao is considered the father of QFD and his pioneering research led to its first application at the Mitsubishi Heavy Industries Kobe shipyard in 1972 (Erdil, 2019). Currently, QFD is applied in a wide variety of fields, including lean production, concurrent engineering, robot technology, self-service kiosk design, solar photovoltaic technology, and home appliance selection (Liu et al., 2022).

It has also been used in service innovation and in combination with techniques such as TRIZ to solve product and service design problems. (Rianmora et Werawatganon, 2021). The application of QFD has expanded in various fields, from manufacturing to healthcare, and consists of different phases and matrices that are tailored to each specific process. (Kulcsár et al., 2022b). In short, the QFD is a versatile and widely used tool that provides a structured and systematic approach to translating customer needs into technical specifications across a wide range of industries and disciplines.

## Conclusions

In conclusion, Quality Function Deployment (QFD) is a quality management tool widely applied in various industries and fields. The QFD makes it possible to convert customer demands into appropriate technical requirements, aligning products and services with customer needs and improving customer satisfaction.

In addition, the QFD helps reduce costs by optimizing design and minimizing changes, while accelerating development time by efficiently implementing customer requirements. Although QFD implementation can be complex and time-consuming due to the need for subjective judgments and

difficulty in identifying and prioritizing customer needs, this tool is still valuable in the planning and development of products and services.

QFD has proven its effectiveness in different sectors, from manufacturing to healthcare. In addition, it has evolved to adapt to various applications, such as design for remanufacturing, service management and structural optimization. This versatility of the QFD makes it applicable in a wide range of business contexts.

Synthesizing the QFD is a powerful methodology that drives continuous improvement and customer satisfaction. Its ability to translate customer demands into technical specifications and its systematic approach to the design and development of products and services make it an indispensable tool in quality management and customer satisfaction.

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