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Harmonizing the Engineering Voice with the Customer's Voice: An Advancement in QFD

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Abstract: *The study discussed harmonizing the engineering voice with the customer's voice: an advancement in Quality Function Deployment (QFD). The study acknowledged that QFD is a structured approach that aims to ensure that customer needs and requirements are integrated into every stage of product development and service delivery. Thus, Traditionally, the QFD process involves capturing the voice of the customer (VOC) through various methods such as surveys, interviews, and market research. The study is structured in such a way that QFD and VOC is discussed using chats and case studies. The concluded that advancements in QFD have significantly contributed to harmonizing the engineering voice with the customer's voice. Alignment ultimately leads to enhanced competitiveness and sustained success in today's dynamic market landscape. The integration of advanced analytics will play a pivotal role in advancing QFD practices.*

Keywords: Harmonizing, Engineering, QFD, VOC. Advancement

Introduction

Quality Function Deployment (QFD) is a structured approach that aims to ensure that customer needs and requirements are integrated into every stage of product development and service delivery (Tim, John, Ernie, Andrian, Harriet, & Edward, 2009). It originated in Japan in the late 1960s and has since been widely adopted by organizations globally as a powerful tool for translating customer needs into specific engineering characteristics and design requirements. QFD as effective as it is, there are key challenges with traditional QFD which is the potential disconnect between the voice of the customer and the voice of the engineer. Engineers may interpret customer requirements differently or prioritize technical specifications over customer preferences, leading to products that do not fully meet customer expectations.

Traditionally, the QFD process involves capturing the voice of the customer (VOC) through various methods such as surveys, interviews, and market research (Tim, John, Ernie, Andrian, Harriet, & Edward, 2009). This information is then translated into engineering characteristics using a series of matrices known as the House of Quality. While this approach has been effective in aligning engineering decisions with customer needs, it has often been criticized for its lack of direct engagement with the engineering team. According to Akao, (1997), a connection between the marketing requirements and the deployment mechanisms (like QFD) is necessary to create more appealing products. As a result, new techniques and instruments must be developed in order for VOC to align corporate operations with customer priorities. As a result, the product and the commercialization processes need to use the VOC process' outputs. Customer-Oriented Product Concepting (COPC) and Quality Function Deployment (QFD) are the two most popular deployment mechanisms (Sérgio & Carlos, 2003).

Quality Function Deployment (QFD) and Its Role in the Design Process

Quality Function Deployment (QFD) is a structured approach used in product development and design to ensure that customer needs and requirements are met (Akao. 1997). It is a method that translates customer demands into specific technical requirements, guiding the entire design process from concept to production. QFD originated in Japan in the late 1960s and has since been widely adopted by organizations around the world as a powerful tool for improving product quality and customer satisfaction (Akao. 1997).

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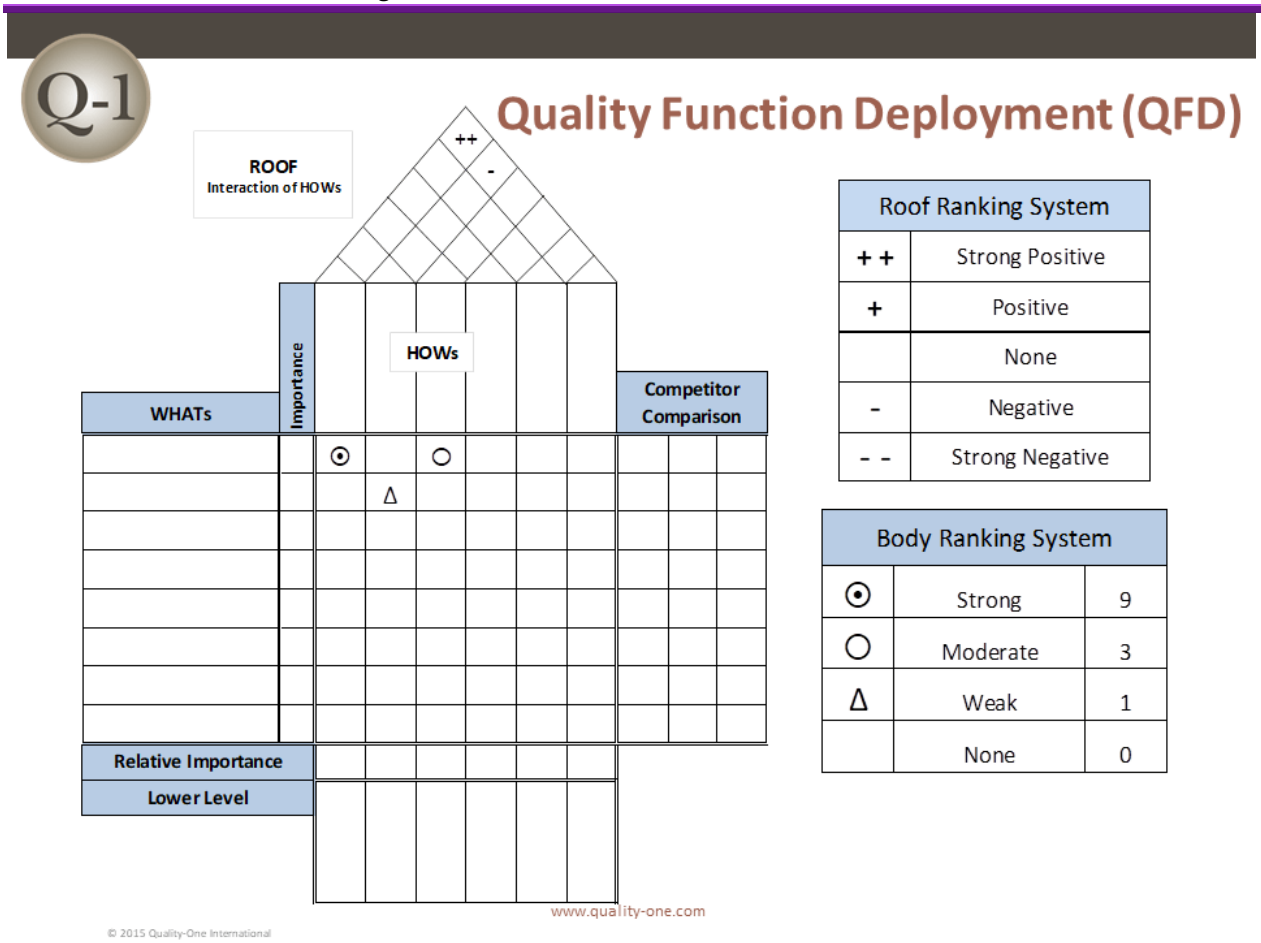


Figure 1: Functional QFD

QFD is based on the principle that customer needs should be at the forefront of any design or development process. It involves capturing the "voice of the customer" and using this information to drive decision-making throughout the product development lifecycle. The process typically begins with identifying customer requirements through market research, surveys, feedback, and other means of gathering customer input (Akao. 1997). These requirements are then organized and prioritized to form the basis for subsequent design activities.

The QFD Process

The QFD process involves several key steps Cudney, E. A. & Elrod, C. C. (2011) listed and explained QFD process as discussed:

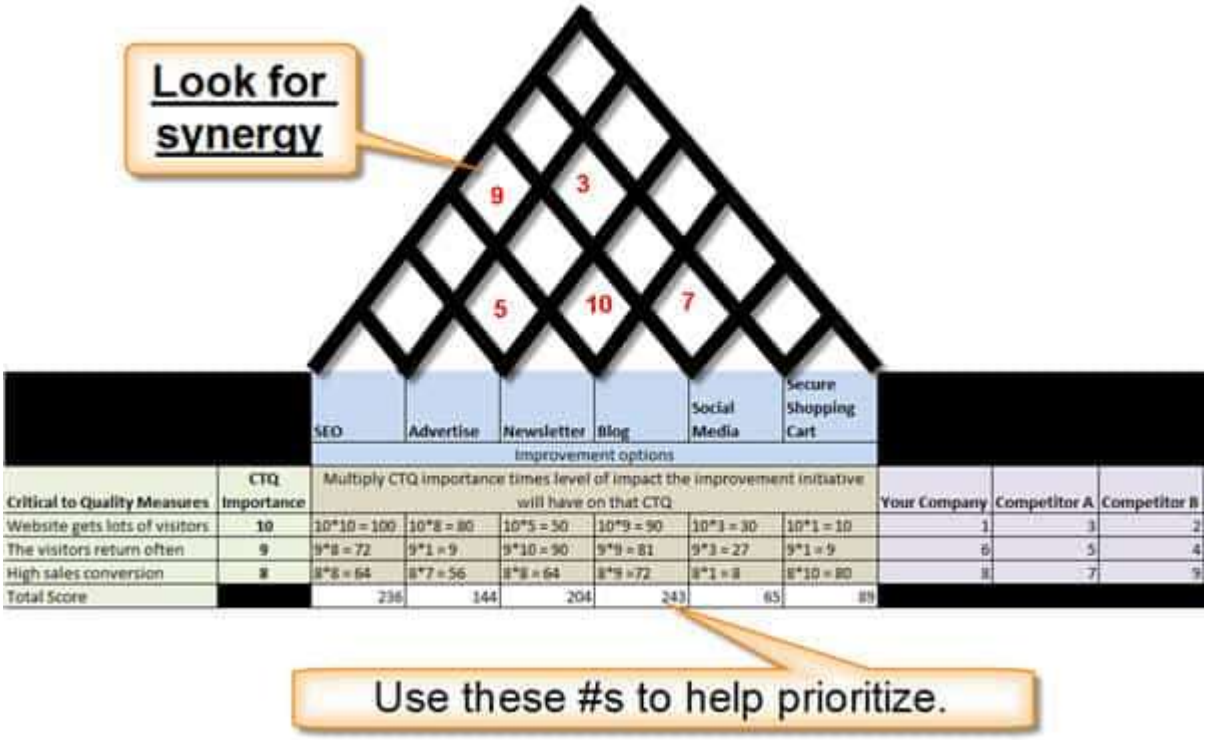
1. Identifying Customer Requirements: This step involves gathering data on customer needs, preferences, and expectations. It may include direct interaction with customers, analysis of market trends, and examination of competitor products.
2. Translating Customer Requirements into Engineering Characteristics: Once customer requirements are identified, they are translated into specific engineering characteristics or parameters that can be measured and incorporated into the design process. This step ensures that customer needs are reflected in the technical specifications of the product.
3. Prioritizing Technical Requirements: Not all engineering characteristics carry equal weight in meeting customer needs. QFD helps prioritize technical requirements based on their impact on customer satisfaction, allowing designers to focus on aspects that are most critical to customers.
4. Developing Design Solutions: With the prioritized technical requirements in hand, design teams can begin developing solutions that align with these specifications. QFD provides a framework for systematically addressing each requirement and ensuring that no critical aspects are overlooked.
5. Verifying Design Performance: Throughout the design process, QFD facilitates ongoing verification of design performance against customer requirements. This may involve testing, simulation, prototyping, and other validation methods to ensure that the final product meets or exceeds customer expectations.

Benefits of Using QFD in the Design Process

According to Bahia, Idan, and Athab, (2023) argued that, there are QFD application design process which has been outline by the researcher, benefits include: i). Enhanced Customer Satisfaction: By placing a strong emphasis on understanding and fulfilling customer needs, QFD helps create products that resonate with target markets, leading to higher levels of satisfaction. ii). Reduced Design Iterations: QFD's systematic approach to translating customer requirements into engineering characteristics minimizes the need for extensive redesigns or modifications later in the development cycle. iii). Improved Cross-functional Collaboration: QFD encourages collaboration between different departments within an organization, fostering a shared understanding of customer needs and aligning efforts toward meeting those needs effectively. Iv). Early Issue Identification: By identifying potential issues early in the design process, QFD allows teams to address them proactively, reducing the likelihood of costly rework or post-launch problems. v). Data-driven Decision Making: QFD relies on data and evidence rather than assumptions or guesswork, enabling informed decision-making at every stage of product development.

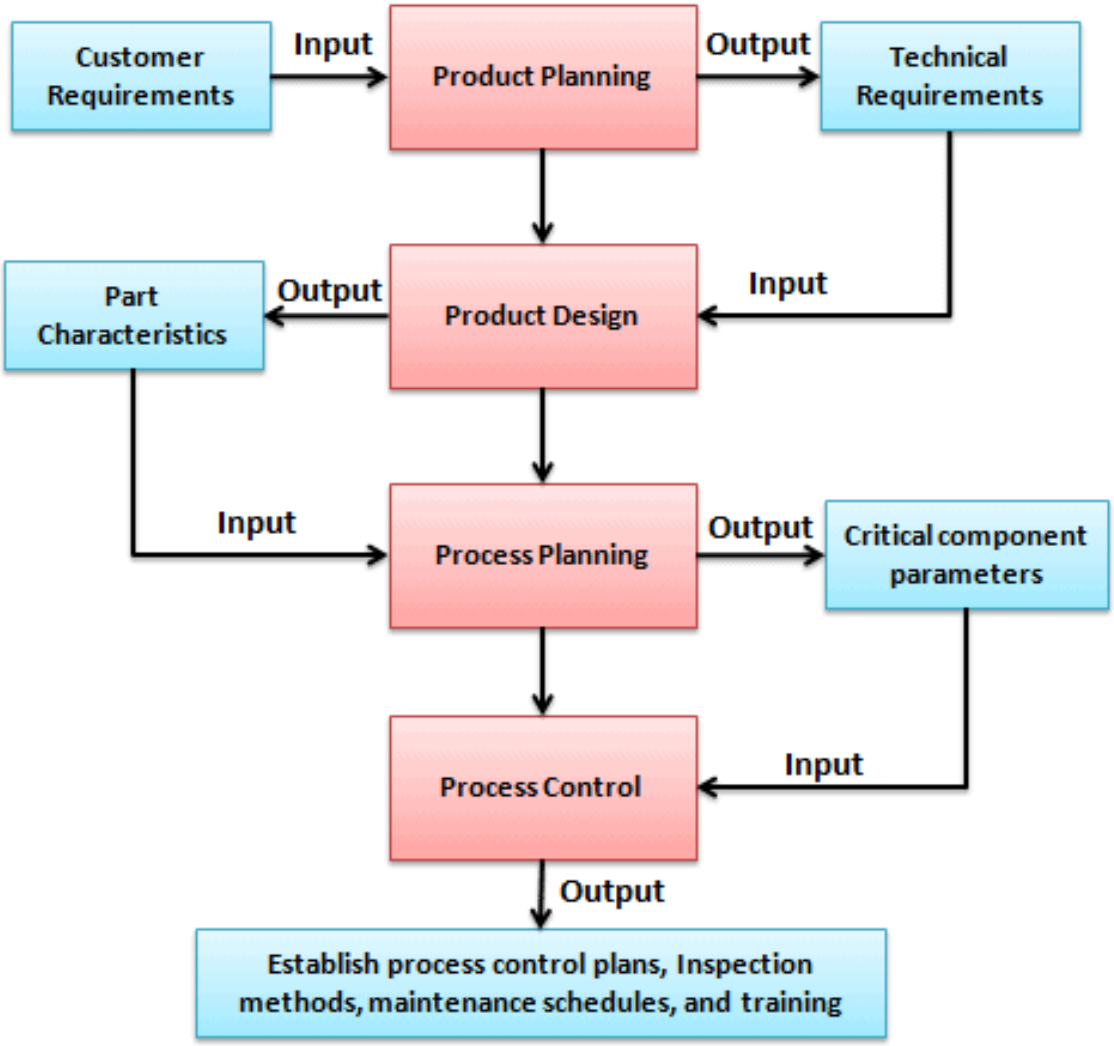
Consequently, QFD plays a crucial role in the design process by ensuring that customer needs are thoroughly understood and integrated into product development activities (Bahia, et. al., 2023). By systematically translating customer requirements into engineering characteristics and guiding design decisions based on these inputs, QFD helps organizations create products that align closely with market demands and deliver high levels of satisfaction.

QFD and VOC is a planning process for products and services that starts with the voice of the customer. Basically, it enables people to think together. People on your team will be better aligned and able to think together toward a solution.



		SEO	Advertise	Newsletter	Blog	Social Media	Secure Shopping Cart			
		Improvement options								
Critical to Quality Measures	CTQ Importance	Multiply CTQ importance times level of impact the improvement initiative will have on that CTQ						Your Company	Competitor A	Competitor B
Website gets lots of visitors	10	10*10 = 100	10*8 = 80	10*5 = 50	10*9 = 90	10*3 = 30	10*1 = 10	1	3	2
The visitors return often	9	9*8 = 72	9*1 = 9	9*10 = 90	9*9 = 81	9*3 = 27	9*1 = 9	6	5	4
High sales conversion	8	8*8 = 64	8*7 = 56	8*8 = 64	8*9 =72	8*1 = 8	8*10 = 80	8	7	9
Total Score		236	144	204	243	65	89			

Akao first developed Quality Function Deployment in Japan in 1966 (Akao, 1997). QFD helps incorporate all the customer needs into the final product in the early stages of the design phase. Furthermore, it is a planning tool to determine the key areas in which the effort should focus in relation to our technical capabilities. According to Ted (2023) there are four primary phases of QFD – Product development steps which are product planning, product design, process planning, process control (production planning) as shown in the chat below:



QFD and VOC Harmonization

QFD is a methodology that focuses on identifying and prioritizing customer requirements and translating them into specific design and production requirements (Uppalanchi, 2010). It is a systematic approach to product development that ensures that the customer's needs and expectations are met throughout the entire product lifecycle. VOC on the other hand, is the process of capturing and analyzing customer feedback and preferences to understand their needs and expectations. It involves collecting data from various sources, such as customer surveys, focus groups, and market research, and using that data to identify trends and patterns in customer behavior and preferences (Uppalanchi, 2010).

Chat 1: QFD and VOC Harmonization

Phase IV - Production Planning		Difficulty	Frequency	Severity	Ability To Detect	Risk Factors	Planning Requirements			Importance Rating	Process Parameter Values	Process Capability
							Training	Control Method	Maintenance Schedule			
Processes to Make Cheese Burger	Thaw Meat											
	Time	3	4	5	6	360	Bob/Qtr	Timer	Weekly	69057	4 hours	1.90
	Temperature	2	7	9	3	378	Ed/Yearly	Thermostat	Hourly	40311	43 degrees	1.93
	Humidity	1	9	2	2	36	Sue/Qtr	Humidistat	Quarterly	2157	57%	1.47
	Atmospheric Pressure	9	1	3	8	216	Ed/Qtr	Barometer	Quarterly	35961	30.12 In.	0.98

Figure 2: QFD and VOC Product Planning Function

Thus, from the diagram above QFD and VOC have some attributes which reflects their functions which are:

1. QFD is focused on the development process, while VOC is focused on understanding customer needs and preferences.
2. QFD is a broader approach that encompasses the entire product lifecycle, while VOC is focused on the early stages of product development.
3. QFD uses a systematic approach to identify and prioritize customer requirements, while VOC relies on customer feedback and preferences to understand their needs.
4. The purpose of QFD is to ensure that the product meets the customer's needs and expectations, while the purpose of VOC is to identify and understand customer needs and preferences (Dinesh, Rajesh, & Benjamin, 2017).

QFD and VOC are both important tools for businesses to understand and meet the needs of their customers. QFD is a systematic approach to product development that ensures that the customer's needs and expectations are met throughout the entire product lifecycle, while VOC is a process of capturing and analyzing customer feedback and preferences to understand their needs and expectations (Dinesh, Rajesh, & Benjamin, 2017).

Quality Function Deployment (QFD) for a Mousetrap

Quality Function Deployment (QFD) is a structured approach used to ensure that the customer's needs and expectations are met through the product development process. When applying QFD to a mousetrap, it involves identifying the Voice of the Customer (VOC), which represents the customer's requirements and translating them into specific design characteristics (Thomas, 2004). The following steps outline how QFD can be used for a mousetrap: Step 1: Identify Customer Needs - the first step in QFD is to identify the customer needs related to the mousetrap. These needs can include effectiveness in catching mice, safety for children and pets, ease of use, durability, and cost-effectiveness. Step 2: Translate Customer Needs into Engineering Characteristics - once the customer needs are identified, they are translated into specific engineering characteristics that can be measured and implemented in the design of the mousetrap. For example, the need for effectiveness in catching mice can be translated into an engineering characteristic such as trap sensitivity or bait placement. Step 3: Prioritize Engineering Characteristics - after translating customer needs into engineering characteristics, these characteristics are prioritized based on their importance to the customer. This step ensures that resources are allocated to address the most critical aspects of the mousetrap design. Step 4: Develop Design Requirements - the prioritized engineering characteristics are then used to develop design requirements for the mousetrap. These requirements guide the design and development process, ensuring that the final product aligns with customer needs and expectations. Step 5: Continuous Improvement - QFD is an iterative process, and it involves continuous improvement based on feedback from customers and performance data. This ensures that any necessary adjustments or enhancements can be made to meet changing customer needs and market demands (Thomas, 2004).

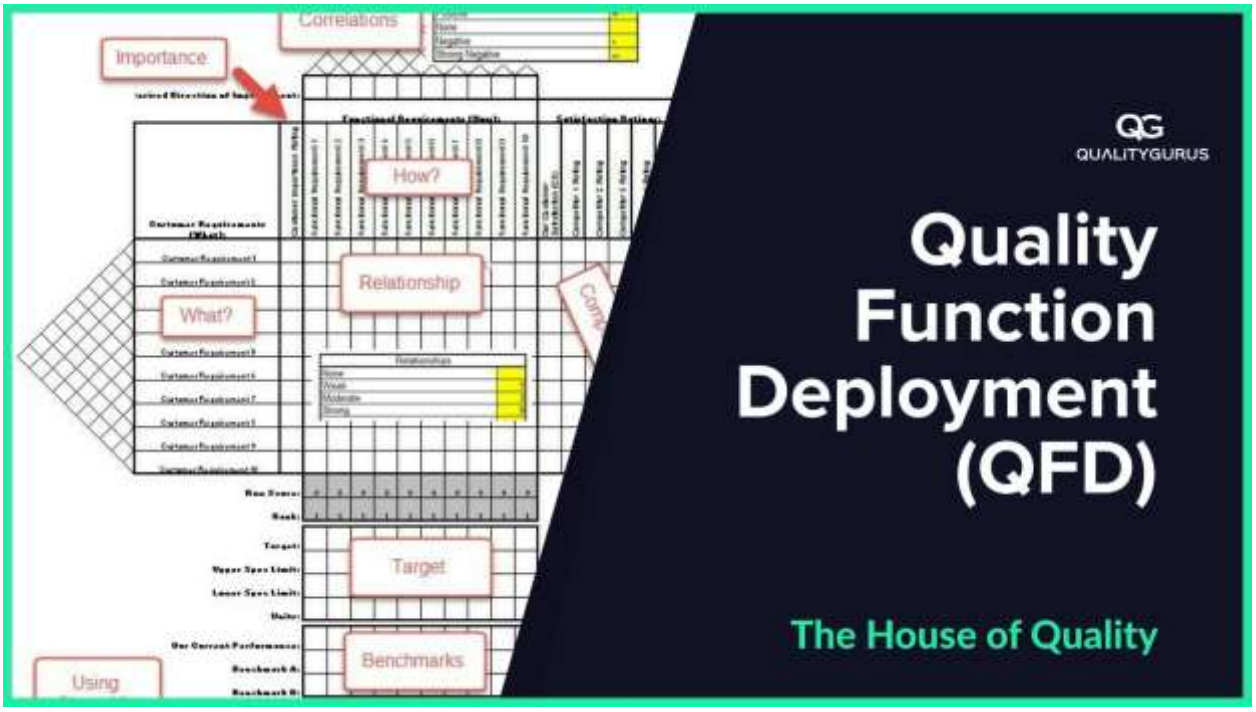


Figure 3: Quality Function Deployment (QFD) for a Mousetrap

Voice of the Customer (VOC) for a Mousetrap

The Voice of the Customer (VOC) represents the collection of customer needs, preferences, and expectations regarding a product or service. In the context of a mousetrap, capturing the VOC involves gathering information directly from customers or potential users about what they desire in a mousetrap. This can be achieved through various methods such as surveys, interviews, focus groups, and market research (Eshan, 2012).

When collecting VOC for a mousetrap, it is essential to consider both explicit and implicit customer needs. Explicit needs are those that customers can easily articulate, such as wanting a humane way to catch mice or desiring a reusable trap. Implicit needs may not be directly expressed by customers but are inferred from their behavior or underlying desires, such as seeking a solution that is safe for household members and pets (Eshan, 2012). By understanding the VOC for a mousetrap, product developers can align their design efforts with what matters most to customers. This not only enhances customer satisfaction but also increases the likelihood of creating a successful product in the market (Eshan, 2012; Thomas, 2004).

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Quality Function Deployment (QFD) provides a systematic approach to incorporating customer needs into product design, while capturing the Voice of the Customer (VOC) ensures that those needs are accurately understood and addressed in developing a mousetrap.

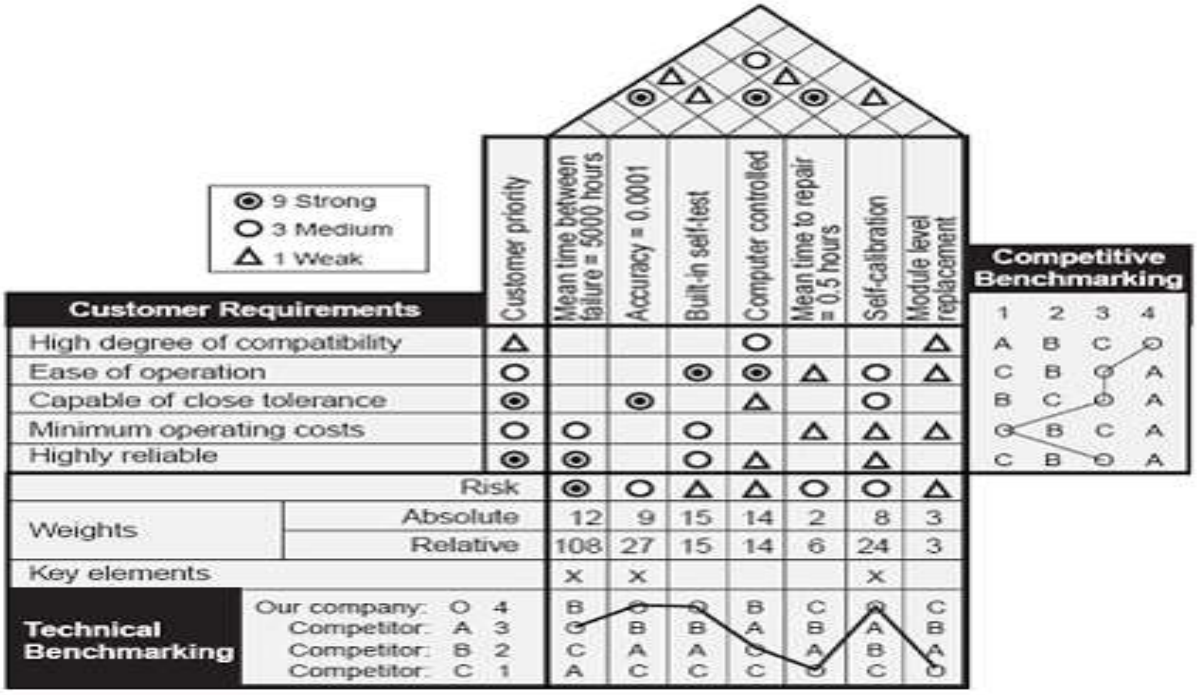

Figure 4: VOC for a Mousetrap

Case Study of QFD and VOC

QFD is a structured approach used to define customer needs and convert them into specific product or service requirements. It is a comprehensive quality management tool that aims to ensure that the final product meets customer expectations while VOC is a critical component of QFD, as it involves capturing and analyzing customer feedback and preferences to drive product development and improvement (Brusch, Trilk, Dinse, & Treppa, 2001). QFD was initially developed in Japan in the late 1960s and has since gained widespread adoption in various industries globally. The methodology involves translating customer requirements into specific engineering characteristics and parameters. QFD uses a matrix format known as the House of Quality to link customer needs with product features, ensuring that the final product aligns with customer expectations (Brusch, et. al., 2001).

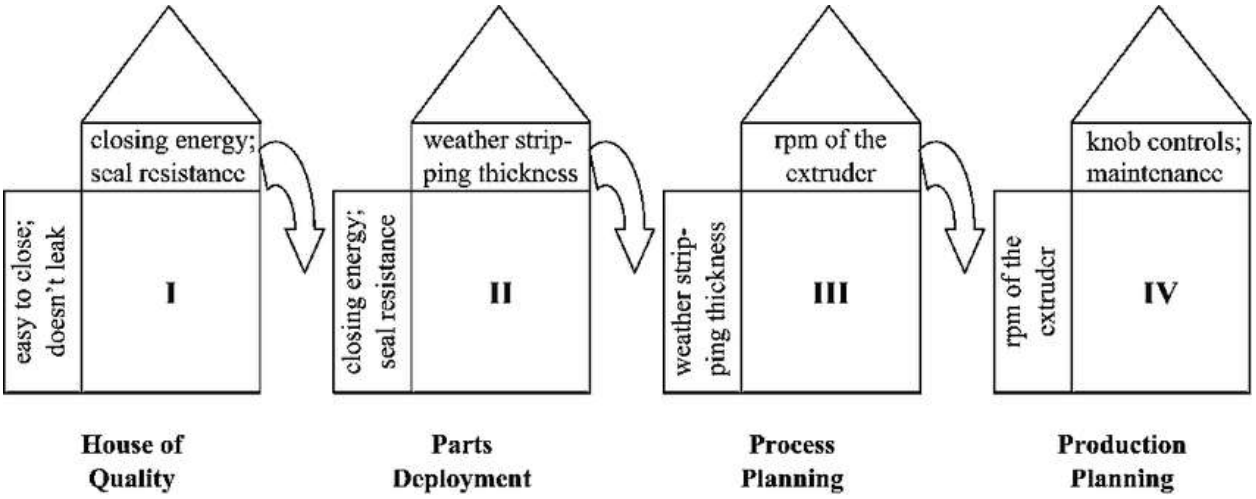

Figure 5: Harmonization of QFD and VOC

In this case study illustrating the application of QFD in product development can be seen in the automotive industry. For instance, a leading automobile manufacturer may use QFD to identify key customer requirements such as safety, performance,

comfort, and fuel efficiency. By systematically analyzing these requirements and translating them into engineering characteristics, the manufacturer can develop vehicles that meet or exceed customer expectations. Consequently, VOC serves as the foundation for QFD by providing valuable insights into customer needs, preferences, and expectations. Through techniques such as surveys, focus groups, and interviews, organizations can gather VOC data to understand what customers truly value in a product or service. This information is then integrated into the QFD process to ensure that the resulting product design reflects the voice of the customer (Brusch, et. al., 2001).

A notable case study demonstrating the integration of QFD and VOC can be observed in the consumer electronics industry. A leading technology company may utilize VOC methodologies to gather feedback from users regarding their experiences with current products and their desires for future innovations (Eshan, 2012. This VOC data is then incorporated into the QFD process to guide the development of new features and functionalities that align with customer preferences. The successful implementation of QFD and VOC can lead to several benefits, including enhanced customer satisfaction, improved product quality, reduced time-to-market, and increased competitiveness. By systematically integrating customer input into product development processes, organizations can create offerings that resonate with their target market while minimizing the risk of developing products that fail to meet customer expectations (Thomas, 2004).

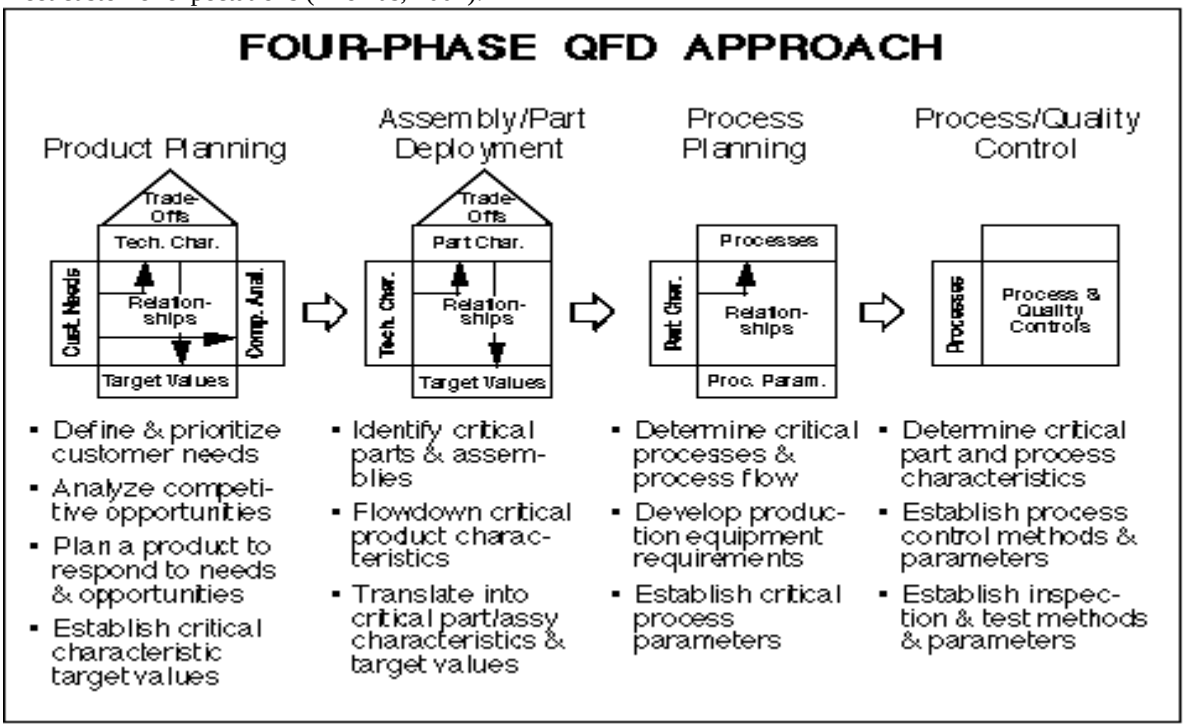

Figure 6: QFD Approach

QFD and VOC are integral components of effective product development strategies. By leveraging these methodologies, organizations can gain valuable insights into customer needs and preferences, ultimately leading to the creation of products that align closely with market demands.

Phase II-Product Design			Importance	Parts to a Cheese Burger									Target Values
				Meat			Cheese			Bun			
				Cow	Buffalo	Entrails	Milk	Butter	Flavoring	Flour	Eggs	Water	
Technical Requirements	Fresh	Bacteria count	57	⦿	○	⦿	○				○		.1
		Thawing time	87			○						⦿	4 hrs.
		Bun shelf life	96				⦿	○	○	○	△	△	3 days
	Tastes Good	# of spices	16					△				△	4
		# of returns	47	△	○	⦿			△				3%
		Cheese slice diameter	92				○	○					4 inches
	Healthy	% fat	119	⦿	⦿	○	⦿	⦿			⦿		98%
		# of organic suppliers	81	⦿	⦿	△	○	△		○	⦿		3
		# of additives to meat	58	⦿	⦿	⦿			⦿				3
Parts Target Values				OSHA Std. 209-A4	OSHA Std. DW-4225	OSHA Std. 324.3-BRF	50% fat free	80% fat free	< 5% red dye #204	6% glucose	90% range fed	< 2% minerals	
Part Characteristics				Sirloin	Range fed	Intestines	Skim	Salted	Cheddar	White	Brown	Spring	
Importance Ratings				2882	2634	2157	2625	1732	857	531	2067	895	

Figure 7: Consolidated Metric Converter Heater in QFD and VOC

In the context of QFD and VOC, a consolidated metric converter heater refers to a product or system that integrates multiple metrics, such as temperature, energy efficiency, safety, and user experience, into a single unit for converting and heating purposes (Chhanwal, Ezhilarasi, Indrani, & Anandharamakrishnan, 2014). QFD is a structured approach to product development that aims to translate customer requirements into specific engineering characteristics, while VOC represents the needs and expectations of customers. Integrating a metric converter heater into QFD and VOC involves understanding customer needs, translating them into engineering requirements, and ensuring that the final product meets or exceeds these requirements (Chhanwal, et. al., 2014). The QFD is a methodology used in product development to ensure that customer needs are met through the entire design and manufacturing process. It involves capturing the VOC and translating those needs into specific technical requirements (Dinesh, et. al., 2017). In the context of a consolidated metric converter heater, QFD would involve identifying key customer requirements related to heating, energy efficiency, safety features, ease of use, and other relevant factors. These requirements would then be translated into engineering characteristics that guide the design and development of the product. While VOC is a critical aspect of product design and development. It involves understanding the needs, preferences, and expectations of customers regarding a particular product or service (Uppalanchi, 2010). In the case of a consolidated metric converter heater, capturing the VOC would entail gathering feedback from potential users about their heating needs, desired temperature ranges, safety concerns, energy efficiency expectations, user interface preferences, and any other relevant factors (Brusch, et. al., 2001). This information serves as the foundation for developing engineering specifications that align with customer requirements.

Discussion

There are several relevant results in this research analysis. The method used are simple to understand, easy to implement, rely primarily on existing knowledge and therefore lead very rapidly to the next stage of the design process (Bahia, et. al., 2023). Thus, the method generates significant level of understanding and beyond what the companies already new. For instance, a leading automobile manufacturer may use QFD to identify key customer requirements such as safety, performance, comfort, and fuel efficiency (Bahia, et. al., 2023). By systematically analyzing these requirements and translating them into engineering characteristics, the manufacturer can develop vehicles that meet or exceed customer expectations (Bahia, et. al., 2023). Again, an organization using QFD and VOC can integrate the components for effective product development strategies. By leveraging on these methodologies, organizations can gain valuable insights into customer needs and preferences, ultimately leading to the creation of products that align closely with market demands and market supply. QFD would involve identifying key customer requirements related to heating, energy efficiency, safety features, ease of use, and other relevant factors (Dinesh, et. al., 2017). These requirements would then be translated into engineering characteristics that guide the design and development of the product. In the case of a consolidated metric converter heater, capturing the VOC would entail gathering feedback from potential users about their heating needs, desired temperature ranges, safety concerns, energy efficiency expectations, user interface preferences, and any other relevant factors (Chhanwal, et. al., 2014). This information serves as the foundation for developing engineering specifications that align with customer requirements.

Conclusion

Advancements in QFD have significantly contributed to harmonizing the engineering voice with the customer's voice. Alignment ultimately leads to enhanced competitiveness and sustained success in today's dynamic market landscape. The integration of advanced analytics will play a pivotal role in advancing QFD practices. By applying predictive analytics and machine learning algorithms to large datasets derived from VOC analysis, organizations can uncover patterns and trends that reveal underlying customer needs. These insights enable engineering teams to prioritize design features that align with customer preferences, thus harmonizing the engineering voice with the customer's voice more effectively.

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