

## **THE ROLE OF THE QFD METHOD IN IMPROVING PRODUCT QUALITY: AN EXAMPLE**

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**Abstract:** In this changeable market condition where each customer has a different opinion about product quality are continuous improvement and customer orientation strategic plans of any organization. In the present market, where supply exceeds demand and customer has many alternatives to compare, is important to focus on quality. The beverage industry faces various challenges, not just changing dietary choices towards healthy food patterns and lifestyles but as well increasing customers' requirements for quality products. Despite this knowledge, most beverage companies do not succeed in ensuring the quality of their products to consumers. The basis for the design and creation of new or modified products should be to examine customer preferences. In the evaluation and planning of product quality, producers use a different language than consumers, based on the above is the primary objective of this paper is to identify customer requirements on the orange juice quality and its subsequent transformation into technological characteristics, using the Quality Function Deployment- QFD method.

**Key words:** quality, quality management, product improvement, QFD method

### **Introduction**

Among fruits and fruit products, orange juice is one of the most popular soft drinks of perhaps every generation. The commercial value of orange juice is due to its sensory qualities and above all, to the high content of natural antioxidants, such as Vitamin C. One small glass (150 ml) of 100% orange juice contains more than 50% of the daily requirement of Vitamin C and helps ensure that the iron from fruit and vegetables is well-absorbed by our bodies (Rapisarda et al., 2001; Morand, et. al., 2011, Sicari et al., 2016). Other authors claim that orange juice is little more than a source of sugar, predisposing consumers to weight gain and obesity (Gillespie, 2008, Lustig, 2012). Nevertheless, for some, orange juice is an essential part of breakfast. However, because orange juice is traded and consumed worldwide, its quality is more than important. In the beverage industry, quality (level of excellence) can be defined as a product that achieves great rewards and performance. A quality beverage is defined as a product that meets the demands of the producer as well as the consumer in the sense of performance, quality standards, preferences, excellency, safety, and healthy (Aadil, et. al., 2019). Most juice quality depends on its raw material or ingredient quality, specifically fruits, water, sweeteners, additives, flavors, and preservatives (Ashurst et al., 2017).

The AIJN Market Report regarding 2018 shows that European juice consumption continues to decline. Total consumption of fruit juices (100% Juice content) in the EU-28 in 2018 was at the level of 5,900 mils. litres. Volume decreased by 0.90% compared to 2017. In 2018, private labels, ambient and juices from concentrate, also had a declining trend in terms of consumption in the EU-28. The largest market in terms of consumption in 2018 was Germany with a total consumption of 2,321 mils. liters. The largest market in terms of consumption in liters per capita in 2018 was Cyprus, with a total consumption of 30.9 liters per capita (Table 1).

**Table 1. The Fruit Juice Industry: Overall Fruit Juice Consumption in 2014 – 2018**

EU 28						
Fruit Juice (100 % Juice content) volume (million liters)						
	2014	2015	2016	2017	2018	The annual change 2017-2018 (%)
Total Fruit Juice	6,140	6,054	5,921	5,956	5,900	-0.90%
Branded	3,438	3,497	3,493	3,511	3,522	0.30%
Private Label	2,072	2,556	2,427	2,445	2,378	-2.70%
Ambient	4,783	4,675	4,522	4,465	4,365	-2.20%
From Concentrate	4,311	4,118	3,915	3,865	3,766	-2.60%
Not From Concentrate	1,829	1,935	2,005	2,091	2,134	2.10%
Chilled	1,357	1,379	1,399	1,492	1,535	2.90%
Largest EU Fruit Juice (100 % Juice content) market by volume consumption, 2018						
Country	Million Litres					
Germany	2,321					
France	1,359					
United Kingdom	1,060					
Largest EU Fruit Juice (100 % Juice content) market by capital consumption, 2018						
Country	Population (million)		Litres per person			
Cyprus	0.9		30.9			
Malta	0.4		29.4			
Germany	83.5		27.8			

Source: AIJN European Fruit Juice Association. (2019). AIJN LIQUID FRUIT MARKET REPORT 2019. Retrieved from <https://www.aijn2019report.com/ajn2019report/homepage>

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**Table 2 Fruit Juice (100% Juice content) Consumption in the Slovak Republic in 2014 – 2018**

Slovak Republic						
Fruit Juice (100% Juice content) Volume in Million Litres						
	2014	2015	2016	2017	2018	The annual change 2017-2018 (%)
Total Fruit Juice	22	24	26	27	29	6.50%
Branded	15	16	17	19	21	9.70%
Private Label	8	9	9	8	8	-1.30%
Ambient	20	22	23	24	25	3.70%
Chilled	2	2	2	3	4	27.90%
From Concentrate	20	22	23	24	25	3.70%
Not From Concentrate	2	2	2	3	4	27.90%
Top 2 Brands of Fruit Juice (100% Juice content) with the highest market share in 2018						
Fruit Juice (100% Juice content)	Relax					4.8
Volume in Million Litres	Rio (McCarter)					4.4
Consumption of Fruit Juice (100% Juice content) per capita						
Country	Population (million)		Consumption (litres)			
Slovak Republic	5.4		5.3			

Source: AIJN European Fruit Juice Association. (2019). AIJN LIQUID FRUIT MARKET REPORT 2019. Retrieved from <https://www.aijn2019report.com/ajn2019report/homepage>

The total consumption of fruit juice (100% juice content) in Slovakia in 2018 was at the level of 29 mils. liters. Volume increased by up to 6.50% compared to 2017. The declining trend in terms of consumption in Slovakia can be seen only in private labels, by 1.30% compared to 2017. Relax with a total consumption of 4.8 mils. liters and Rio (McCarter) with a total consumption of 4.4 mils. liters are brands with the highest market share in Slovakia in 2018. Consumption per capita in the Slovak Republic in 2018 was 5.3 liters.

## Methodology

The quality plan identifies all customers, regulates the flow of processes that produce the specific desired results of customers, proposes the entry of suppliers into the process, ensures the organization's intuition regarding the evolution of customer requirements, monitors the progress of the implementation of individual activities and the achievement of objectives (Sony et al., 2020).

Currently, we know the following planning methods: QFD (Quality Function Deployment), product FMEA (Failure Modes and Effects Analysis), process FMEA, FTA analysis (FTA) (Fault Tree Analysis), design review, and new quality management tools (Chiarini, Kumar, 2021).

Although the QFD method was originally used in the automobile industry nowadays has wide application in different industries. One of these industries is the food and beverage industry. Every product developed aims to fill a specific customer need, but identifying what customers need is more difficult than it seems. The QFD method as a customer-oriented design method can be used to design new products and services and modify existing ones so that they satisfy (to the highest possible degree) the requirements specified by the customer (Wolniak, 2018). Traditionally, food product manufacturers have used methods such as market research and sensory characterization for product quality planning, but the latest research showed that usage of the quantitative tool such as the QFD method suits in tailored and integrated form for the development of the quality planning stage (Pable et al., 2010). In this paper, the quality function deployment method, QFD, was used as an effective tool to support pro-quality action.

The QFD method focuses on providing a clear framework for addressing customer needs, beginning with a matrix called the House of Quality (Waterworth, Eldridge, 2010). House of Quality is used by a team to understand customer requirements (What?) and to translate these requirements into technical specifications (How?). House of Quality matrix with related technical objectives in the "WHATs" rows and product/process parameters in "HOWs" columns (Xie et al., 2003, Pable et al., 2010). Quality Function Deployment (QFD) is one of the most commonly used methods in order to provide a customer-oriented product design (Karaşan, et al., 2022).

The planning matrix, commonly referred to as the "house of quality," is an essential component of Quality Function Deployment (QFD). It provides a visual representation of the relationship between customer needs and the technical characteristics of a product. Guidelines for using the House of Quality also known as QFD (Quality Function Deployment):

1. **Identify Customer Needs:** The first step in creating the planning matrix is to gather and document the various needs and requirements of the customers. In this paper, we conducted a questionnaire survey, which was held online in June 2022.
2. **Determine Importance:** Once the customer needs are identified, they need to be prioritized based on their significance to the customers. This is done by assigning relative weights or importance ratings to each need.
3. **Identify Technical Characteristics:** Technical characteristics are the specific features or attributes of a product that can influence its performance or meet the customer's needs. These characteristics should be measurable and clearly defined.
4. **Establish Relationships:** The next step is to establish the relationships between customer needs and technical characteristics. This is done by creating a matrix or grid where the customer needs are listed on one side, and the technical characteristics are listed on the other side. The matrix serves as a tool to visually connect the needs with the corresponding technical characteristics.

5. **Evaluate Interactions:** In the planning matrix, each intersection of a customer need and a technical characteristic represents the importance or degree of correlation between them. The strength of the relationship is evaluated using numerical ratings.
6. **Set Targets and Prioritize:** After evaluating the relationships, it's necessary to set targets or goals for each technical characteristic to fulfill the customer needs.
7. **Generate Improvement Actions:** Once the targets and priorities are determined, the planning matrix helps identify areas that require improvement.

By following these steps, the planning matrix, or the "house of quality," provides a structured framework to align customer needs with the technical characteristics of a product. It enables organizations to prioritize and focus their efforts on developing products that meet or exceed customer expectations.

## Results and Discussion

To present the applicability of the QFD method as a tool for customer needs analysis, orange juice was chosen from a diverse range of soft drinks in the beverage industry. It is not possible to fulfill each customer's desire, but we can approach most customer satisfaction using this method. In this paper, the QFD method was used as an effective tool for translating customer requirements into technical quality indicators.

To evaluate orange juices, the selected products had to comply with the following criteria:

- Orange juice;
- Made from concentrate;
- 100% Juice content;
- Pasteurized;
- Tetra Pak (1 liter) containers.

In accordance with the above criteria, we decided to evaluate the following products:

- Relax Juice 100% Orange (main product);
- BILLA Orange Fairtrade 100% (competitor A);
- Rauch happy day 100% Orange Vitamin C (competitor B);
- TESCO value 100% Orange Juice Pure fruit (competitor C);
- Solevita Orange Juice 100% Fruit Content Vitamin C (competitor D).

There are two types of sensory analysis such as subjective (by means of human senses) and objective (instrumental analysis) to measure the quality of any food product. In this paper, we decided to use the subjective sensory analysis. We used fresh orange juice packed in Tetra Pak (1 liter) containers.

The customer's quality requirements for 100% orange juice from concentrate and the customer's quantitative preferences, while the evaluation of their importance is from 1 - "low" to 5 - "high", are displayed in

Table 3 below.

*Table 3. Customer Requirements and Preferences*

Customer requirements	Importance
taste intensity	5
density	5
aroma	4
color	3
acidity	3
sweetness	3
bitterness	2

Source: Own processing based on questionnaire survey realized during June 2022



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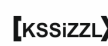
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of Management



Department of Applied Sociology  
and Human Resource Management

The customer's requirements are influenced by the following technical parameters, the improvement of which is expressed by the sign + resp. – (Table 4).

*Table 4. Technical parameters*

Technical parameters	Improvement +/-
fruit variety	+
degree of ripeness of the fruit at concentrations	+
recipe	+
technological process of concentration	-
technological process of pasteurization	-
method of storage	+

Source: Own processing

In the Quality Function Deployment (QFD) method, the direction of improvement refers to the process of identifying areas or aspects of a product that require enhancement in order to better meet customer needs and expectations. This step is a crucial part of the QFD process, as it helps prioritize improvement actions and guide product development efforts.

As part of the direction of improvement, we determined the importance of the influence of technical parameters on customer requirements, on a scale from 1 - "insignificant" to 5 - "significant" (Table 5).

In the roof of the quality house, we determined the correlations between the individual technical parameters, where the positive correlation is "+" when both characteristics improve at the same time, and the negative correlation is "-", when the characteristics act separately, which means that we change one technical parameter, the other one will not change.

The positive correlations were identified between:

- •Fruit variety and recipe
- •Fruit variety and degree of ripeness of the fruit in concentrations
- •The degree of ripeness of the fruit in concentration and recipe
- •Technological process of pasteurization and method of storage

*Table 5. Direction of improvement*

Direction of improvement		+	+	+	-	-	+
Technical requirements	Importance	Fruit Variety	Degree of ripeness of the fruit at concentrations	Recipe	Technological process of concentration	Technological process of pasteurization	Method of storage
Customer requirements							
Taste intensity	5	4	5	3	5		2
Density	5			2	4		
Aroma	4	3		2			
Color	3	3			3	4	2
Acidity	3	5	4	5			
Sweetness	3	5	3	5			
Bitterness	2	5	3	5			

Source: Own processing

In the planning matrix, we identified and appropriately quantified the individual products through a blind tasting test, on a scale from 1 - "unsatisfactory" to 5 - "satisfactory". Subsequently, we determined our goal - the best value among all evaluated products in terms of the relevant requirement. We also

determined the necessary improvement, the ratio between the value of the requirement of our product and the best-rated product and subsequently the point of sale - customer preference, potentially increased on the manufacturer's initiative.

From the above, it can be stated that in the blind tasting test, Rauch Happy Day 100% Orange Vitamin C won with the highest number of points, followed by Relax Juice 100% Orange – main product and Billa Orange Fair Trade 100% with the same number of points placed second. Solevita Orange Juice 100% Fruit Content Vitamin C placed third in the test, while the worst-rated is TESCO Value 100% Orange Juice Pure Fruit.

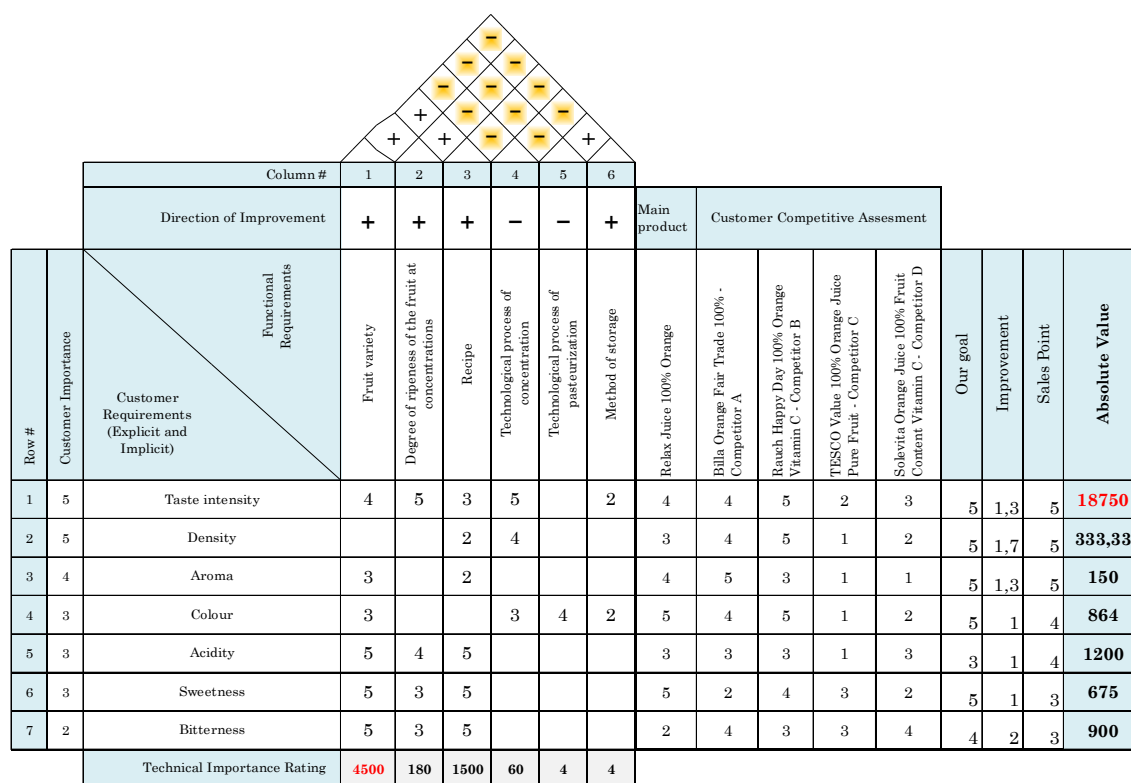


Figure 1. Strategic matrix

Source: Own processing

In the strategic matrix, we calculated the total line value for individual customer requirements, and for the individual technical parameters, we calculated the column value priorities, which are the basis for the final interpretation of the strategic matrix. The developed QFD method shows that the most important customer requirement for orange juice is the intensity of taste, which can be influenced by the manufacturer of the main product by targeting or changing the most important technical parameter, which is the fruit variety. However, the technical parameter of the fruit variety positively correlates with the technical parameters of the degree of ripeness of the fruit at concentration and recipe, and those characteristics need to be improved at the same time.

Therefore, if the manufacturer of the main product changes the fruit variety to satisfy the customer's requirements, it must also consider changing the degree of ripeness of the new fruit variety during the concentration as well as changing the recipe. By changing these technical parameters, the manufacturer would be able to achieve its goal - to achieve or outperform in the product evaluation of the main competitor Rauch Fruchtsäfte GmbH & Co. KG, which won the blind test.

## Summary

Quality Function Deployment (QFD) serves as a systematic framework for identifying and transforming customer needs and desires into actionable strategies for creating products that cater to those needs. The term "voice of the customer" refers to both explicitly expressed and implied requirements articulated by customers. Capturing the voice of the customer involves employing various methods such as direct discussions, interviews, surveys, focus groups, customer specifications, observation, warranty data, and field reports. By comprehending these customer needs, a comprehensive product planning matrix, also known as the "house of quality," is constructed. These matrices play a vital role in converting broader needs or objectives into specific product requirements or technical characteristics, thereby ensuring the satisfaction of those needs. In this paper, we use this method as an effective tool to support pro-quality action. The QFD method reveals that the primary customer demand for orange juice is the intensity of taste, which can be influenced by Hermann Pfanner Getränke GmbH, the manufacturer. The most crucial technical parameter to address is the fruit variety.

However, it is important to note that the fruit variety is positively correlated with other technical parameters such as the degree of ripeness during concentration and the formula. Therefore, any improvements in the fruit variety must also consider adjustments in the degree of ripeness during concentration and changes in the recipe. These technical parameters need to be aligned in the same direction to meet customer expectations.

By making changes to these technical parameters, Hermann Pfanner Getränke GmbH can successfully achieve its objective of surpassing its main competitor, Rauch Fruchtsäfte GmbH & Co. KG, in the product evaluation and overall customer satisfaction.

It is crucial for Hermann Pfanner Getränke GmbH to carefully evaluate and strategically implement these technical changes to optimize the intensity of taste in their orange juice, thereby gaining a competitive advantage in the market.

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