Application of QFD Methodology to Red Wine Sector

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Abstract

Purpose/objectives: Foods by their nature constitute very complex systems; many ingredients interact with each other and can influence the process optimization. In the food chain, a distinction must be made between processed and non-processed products. Often the products do not have a brand and then the responsibility for the quality of the product is not as clear as it is for branded products. For processed products (branded), the processing industries make use of a quality system, often considering the entire production chain, from raw materials to distribution and consumption. The authors of this paper aimed to analyze the quality management of wine in general and red wine in particular.

Design/methodology: The authors designed an analysis based on a specific Quality Engineering methodology, namely "Quality Function Deployment" (QFD), which allows the translation of the beneficiary's wishes in technical and quality characteristics of the product, using the matrix diagram known in the literature as "House of Quality".

Findings: The authors have adapted this specific tool of quality engineering to the issue of wine quality management, in order to individualize the criticalities and identify the correlations between them.

Originality/value: Application of the "House of Quality" methodology of quality engineering in the food field.

Possible practical implications: Using the QFD methodology in case of negative correlations, which requires finding another solution which meets the intended purpose without adversely affecting other solution found.

Keywords: Quality Function Deployment, “House of Quality”, food quality, food chain.
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Introduction

The Quality Function Deployment (QFD) is a methodology used to organize the product development process and is an adaptation of some characteristics of Total Quality Management (Benner, et al., 2003). Through this methodology ensures close collaboration between staff from different departments to design a new product that meets the needs of the consumer (Jongen, et al., 2002).

It was introduced by Yoji Akao in 1983 in the USA, where 3M Corporation was the first company to apply it. Since then the QFD has spread in many industries and has been introduced in the food industry since 1987 (Jongen and Meulenberg, 1998 ed). The QFD method consists in the construction of two or more matrices connected to each other, which at the end have the shape of a house, hence also its name “House of Quality” (Jongen and Meulenberg, 1998). In general, it can consist of many "rooms", each one containing information about the product. The main objective is the conversion of consumer needs into product requirements. The matrices describe correlations between what's and how's (or how the consumer's requests can be translated into measurable physical units). Therefore, the consumer's needs are evaluated in relation to each other, to quantify their importance in determining the success of the product. These scales can serve importance to the construction of priority in the product development process and to provide guidelines to assign the necessary resources (Benner, et al., 2003).

Methodology

The authors analyzed the possibility to apply a specific Quality Engineering methodology, namely *Quality Function Deployment* (QFD) in agri-food industry, which allows the translation of the beneficiary's wishes in technical and quality characteristics of the product, using the matrix diagram known in the literature as "House of Quality". Therefore, we rewev the specific quality systems in the food industry, the properties and nutritional values of red wine and characteristics of some varieties of red wines.

The premises in applying QFD in the food industry

The strategic importance of a product development process makes companies unwilling to disseminate information in this regard. Foods by their nature constitute very complex systems, as many ingredients interact with each other and can influence the optimization of processes This translates into a rather complicated relationship matrix. For trayng to apply the QFD methodology in the food industry, the target values (HOW MUCH) must be replaced with target ranges, since the ingredients of a food product are active components and therefore subject to changes.

The consumer needs may be very different and variable (Jongen, and Meulenberg, 1998 ed) and this can result in a long list of WHAT and HOW, which are very difficult to summarize in a precise target value (HOW MUCH) (Figure no. 1).

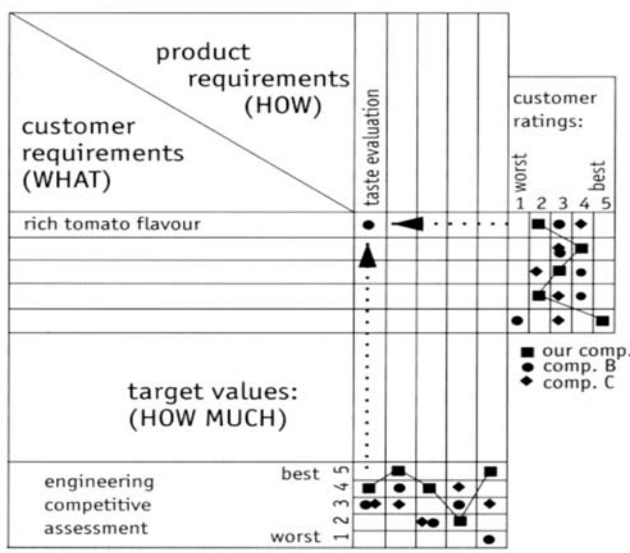


Figure no. 1. The "How Much" of the House of Quality

Source: Jongen and Meulenberg, 1998

Once the House of Quality has been built, the next step is to design additional matrices (Benner et al., 2003). In the case of the food product, this first matrix will contain up to a hundred different WHATs and HOWs. The construction of the next matrix is carried out by placing the most important HOW of the House of Quality in the left part of the second matrix and the HOW MUCH in the right part. In this way, the HOWs of the first matrix become the WHATs of the second. Each matrix along the cascade process contains more detailed information on the product, compared to the one that precedes it. One of the most used models for the construction of the entire scheme is the Four Phase Model, also known as the ASI four-phase approach or Clausing model (Cohen 1995; Chan and Wu 2002b).

The model, as the name suggests, consists of four stages:

1. The product planning matrix (House of Quality);
2. The design deployment matrix;
3. The manufacturing planning matrix;
4. The production planning matrix.

Another system for the construction of the entire scheme is the Matrix / Matrixes model, also known as the Akao model, which consists in the construction of about thirty matrices, tables and diagrams. This model, however, does not find a diffusion in the literature, so it is not possible to give a more detailed description (Benner, et al., 2003).

Application of QFD in the food industry

In the literature, there are rare examples of the application of QFD in the food industry (Benner et al., 2003; Costa et al., 2001; Januszewska and Viaene, 1999), although QFD appears to be a potentially very useful for making food product development more efficient in the direction of customer satisfaction (Jongen and Meulenberg, 1998, ed.). The application of QFD within the food industry, is delaying for some reasons as:

1. although there are concrete benefits in the application of QFD in food industry, the literature is poor in examples, since the strategic importance of the product development process makes companies reluctant to disseminate information about it;
2. foods by their nature constitute very complex systems. Many ingredients interact with each other and can influence the process optimization. This leads to a rather complex relationship matrix.
3. to make the QFD applicable in the food industry, the target values (HOW MUCH) must be replaced by target ranges, as the ingredients of a food product are presented as the active substrates, which are therefore subject to change.
4. consumer needs can be very different and variable and this can give rise to a long list of WHATs and HOWs that are very difficult to summarize in a precise target value (HOW MUCH).

Specific Quality Systems in the Food Industry

A food chain is a basic network that shows the linear flow of nutrients and energy from one trophic level to another. Within the food chain it is necessary to distinguish between processed products and not. Typical examples of unprocessed products are the fruits and fresh vegetables, fresh milk, meat, fish and game. Often the products do not have a brand, and therefore the responsibility for the quality of the product is not as obvious as it is for branded products. For processed (branded) products, the processing industries are using quality system, often considering the entire production chain, from raw material to distribution and consumption. The food industry has a number of Quality Assurance (QA) systems available like GMP (Good Manufacturing Practices), HACCP (Hazard Analysis. Critical Control Points), ISO (International Organisation for Standardisation) standards. In fact, the HACCP system is mandatory for every company that deals with the transformation, packaging, transport and / or marketing of the food product, while it is not yet extended to primary production. For example, quality systems have developed in the Netherlands, ranging from *Good Manufacturing Practices* (GMP) and *Good Veterinarian Practice* (GVP) applied to the animal feed production sector, based on ISO-9002, to *Integrated chain control* or IKB (the system of quality adopted by the meat sector in the Netherlands is the *Integral Control of the Production Chain*) in the animal sector, to the *Chain Quality of Milk* or KKM, specific for milk production, up to the quality assurance systems for fruit and fresh vegetables, such as the *Integrated Quality Assurance System* or IKZ, and the *Environmental project ornamental plant cultivation* or MPS, which tends to reduce the use of pesticides and fertilizers in the production of ornamental plants (https://www.patatino.it/img/cms/Qualità%20carni%20olandesi%201.pdf).

Due to the problems that have involved the entire agri-food chain (*Bovine Spongiform Encephalopathy* - BSE, dioxin, *genetically modified organism* - GMO), new initiatives have arisen regarding the quality certification of primary products. In 1998, the Eurep-GAP initiative was established, or the *European Retailer Working Group-Good Agricultural Practice*, which concerns the safe production of products of plant origin.

Another quality system is the British Retail Consortium (BRC), which is a technical standard for those companies that supply food products with private labels, at cheaper prices than branded products. The BRC guidelines offer greater clarity to the suppliers of private labels, through a list that combines the principles of HACCP with specific parts of the GMPs (*Good Manufacturing Practices* regarding pesticide control) and parts of the ISO (system control).

The Global Food Safety Initiative (GFSI) created in 2000, is a task force that was established as a response to the loss of consumer confidence in food production in general. The GFSI community is composed of the world's leading food safety experts from retail, manufacturing, and food service companies, as well as international organisations, governments, academia and service providers to the global food industry.

Properties and nutritional values of red wine

With regard to the wine, with the technical characteristics expressed in a very qualitative way correlate to the sensory quality characteristics and the corresponding chemical characteristics. All characteristics change from year to year depending on the amount and quality of the harvest various grape varieties. Table no. 1 shows the ratio between the bunch and the grape berry.

Table no. 1.

Grape bunch and grape berry	**% on weight of grape bunch**	**% on weight of grape berry**
Bunch	3-7	-
Grape peel	93-97	9-11
Grape core	93-97	85-90
Pips	93-97	2-6

Wine contains water and alcohol, carbohydrates, minerals (potassium, calcium, magnesium, sodium, phosphorus), trace elements (copper, zinc, magnesium), vitamins (especially B vitamins), polyphenols, acids, so over 800 substances. And although it is classified as "alcoholic drink", wine is a genuine food, with great energy power. Wine, whether we are talking about the red, white or rose, is a natural drink, obtained only from grape and the properties of black grapes, from which it is made, are largely transferred to red wine. Thus, in 100 ml of red wine we have on average the following nutritional values (table no.2):

Table no. 2. General composition of table red wine per 100 ml

Calories: 63-85	Calcium: 7-8 mg
Carbohydrates: 2,1	Copper: 0.2-1 mg
Sugars: 0.60 grams	Phosphorus: 20-23 mg
Protein: 0.10 grams	Betaine: 0.3 mg
Vitamin A (Retinol): 2 IU	Potassium: 100-127 mg
Vitamin B1: 0.01 mg	Flor: 105 mcg
Vitamin B2: 0.02 mg	Magnesium: 20 mg
Vitamin B3 (Niacin): 0.2 mg	Iron: 0.9 mg
Vitamin B6 (Pyridoxine): 0.10 mg	Selenium: 0.20 mg
Vitamin B8 (Choline): 5.7 mg	Zinc: 0.10 mg
Vitamin B9 (folic acid): 1.00 mcg	Resveratrol: 0.2-0.713 mg / l
Vitamin K: 0.4 mcg	Alcohol: 75-160 g / l

Source: Authors elaboration based on different available data

In addition to vitamins and minerals, red wine contains other substances beneficial to the human body, including:

- *Polyphenols* - Antioxidant substances, with action in preventing the formation of free radicals and with regenerative action on the human body.
- *Resveratrol* - The most powerful antioxidant and a polyphenol with anti-aging properties and found in large quantities in the peel and pips of grapes, especially black ones. Resveratrol is produced by plants to defend against disease.
- *Flavonoids* - Antioxidants with effect on the immune system, but also with anti-inflammatory effects.
- *Melatonin* - The natural hormone involved in regulating the circadian rhythm, with an important role in terms of sleep quality.

By and large, all red wines have approximately the same properties, but if we analyze each variety separately, we will find that they differ to some extent and that we can make a choice based on its properties:

  - Pinot Noir from cool and wet areas - has the highest concentration of resveratrol therefore has strong anti-aging and anti-tumor effects.
  - Cabernet, Shyraz, Merlot have a high content of procyanides and flavonoids that help maintain healthy blood vessels and reduce the risk of a heart attack or stroke.
  - Sagrantino, Cabernet Sauvignon are the wines with the highest level of polyphenols

From *Wine Value Chain* to *House of Quality* for Romanian red wine

Efficiency of wine making involves many actors and each of them participate to the creation of wine value chain (Figure no.2).

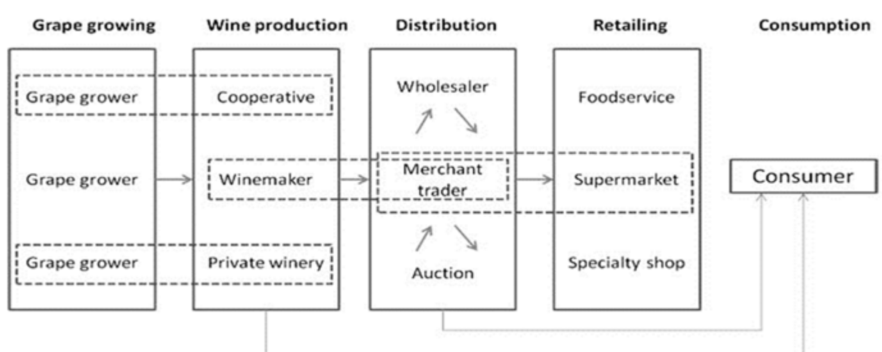
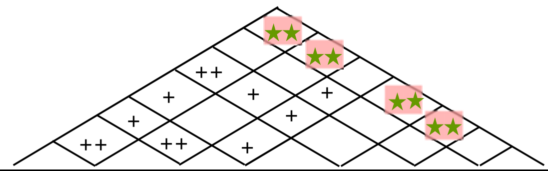


Figure no. 2. The Framework of Wine Value Chain
Source: Goncharuk, 2017

The label helps us to know exactly what we are consuming and to make sure that they do not contain a higher amount of sulfites than the one agreed at European level by the health norms (150 mg / l of sulfites for red wine, 210 mg / l of white wine). Thus, price can be a good criterion. Producers' and sommeliers associations warn that a wine whose price is less than five euros / 750 ml bottle is most likely of questionable quality and should be avoided. A wine really good, cost more than 10 euro / bottle of 750 ml. The norms adopted at European level and respectively in force in Romania, certainly have in view the support of an optimal state of health. In the case of country wine in general there are no verified and reliable data of the type mentioned above and place these wines in the category of very cheap wines.

We elaborate the *House of Quality* for Romanian red wine on the basis of the answers given by 364 respondents to an online questionnaire addressed to consumers, producers and entrepreneurs involved in the wine business. Therefore, for this purpose we take into account 8 criticalities and we individualize 7 solutions.

Symbol	Meaning
★★	Strong relation
★	Moderate relation
–	not obvious correlation
★★ (shaded)	Negative correlation
++	Strong affinity
+	Moderate affinity



	SOLUTIONS / CAUSES	1 Improve product quality	2 Product control	3 Packaging characteristics	4 Subsidies wine producers	5 Wine supply chain control	6 Length of wine distribution	7 Reduction of sulfite content and production of bio wines
1	Price of the branded red wine	★★	★★	★★	★★	★★	★	★★
2	Price of red wine depending on the variety	★★	★★	★★	★★	★★	★	★★
3	Red wine purchase directly from farmers	-	-	-	-	-	-	★★
4	Packaging	★★	-	★★	-	-	-	-
5	Wine Storage and Preservation	★★	★★	★★	-	★	-	★★
6	Sulfite content	★★	★★	-	★	-	-	★★
7	Massive import of famous wines	-	★	★	★	★	-	-
8	Stiff competition	★	★	★★	★	-	★	★
	CONCLUSIONS:	**Beware of negative correlations. An economical solution must be found.**						

Figure no. 2. *House of Quality* for Romanian red wine

The criticalities analyzed within the *House of Quality* are: the price of the branded red wine, the price of red wine depending on the variety, red wine purchase directly from farmers (Dragulanescu et al., 2020), packaging, wine storage and preservation, sulphites content, massive import of famous wines, stiff competition. As possible solutions we indicate: improve product quality, product control, packaging characteristics, subsidies wine producers, wine supply chain control, length of wine distribution chain, reduction of sulphites content and orientation to production of bio wines.

Conclusions

Using the methodology provided by quality engineering, the authors analyzed the main issues and criticisms to highlight the main issues related to the production and marketing of wines. Following this analysis, the authors drew seven solutions to the main problems highlighted by the analysis of the properties and characteristics of wines. To see to what extent these solutions found respond to the highlighted problems, the authors used the QFD methodology and built a "House of Quality" consisting of two matrices. The central (basic) matrix of the QFD methodology proves to be extremely useful in studying the degree of relationship of the solutions found with the problems highlighted by interviews or questionnaire analyzes. The secondary matrix, the "roof" of the House of Quality highlights the affinity, which is created or not, between the solutions found and especially triggers an alarm signal if there is a negative correlation. This negative correlation requires finding another solution that fulfills the proposed purpose, without negative implications on the other solutions found.

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