



## Quality Functions Modeling of Industrial Enterprises Products

Anvar V. Gumerov<sup>1\*</sup>, Milyausha K. Biktemirova<sup>2</sup>, Vitalii M. Babushkin<sup>3</sup>,  
Svetlana M. Nuryyakhmetova<sup>4</sup>, Roman E. Moiseev<sup>5</sup>, Anna B. Nikolaeva<sup>6</sup>, Regina R. Kharisova<sup>7</sup>,  
Vera P. Rukomoinikova<sup>8</sup>

<sup>1</sup>Kazan National Research Technical University Named after A. N. Tupolev - KAI, Kazan, Russia, <sup>2</sup>Kazan (Volga Region) Federal University, Kazan, Russia, <sup>3</sup>Kazan National Research Technical University Named After A. N. Tupolev - KAI, Kazan, Russia, <sup>4</sup>Almetyevsk State Oil Institute, Almetyevsk, Russia, <sup>5</sup>Kazan National Research Technical University Named after A. N. Tupolev - KAI, Kazan, Russia, <sup>6</sup>Kazan National Research Technical University Named after A. N. Tupolev - KAI, Kazan, Russia, <sup>7</sup>Kazan State University of Architecture and Engineering, Kazan, Russia, <sup>8</sup>Volga State University of Technology, Yoshkar-Ola, Russia. \*Email: solo73@inbox.ru

### ABSTRACT

One of the integral aspects of the quality management systems of industrial enterprises is the requirement of a continuous positive development of all its processes. In this regard, it is necessary to implement the principle of “continuous improvement” and in terms of products produced by the enterprise, thereby reducing loss of product’s quality. The purpose of the paper is to identify possible loss of quality in the stages of the product’s life cycle through the functions’ modeling of product’s quality. The authors carried out the functions’ modeling of product’s quality based on Quality Function Deployment methodology taking into account existing production, technological and material resources of the enterprise, allowing to formulate the condition for structuring of the quality functions and to increase the degree of the consumer’s satisfaction. This article is intended for top-managers, quality service’s employees of industrial enterprises, researchers interested in the development of the quality management system of industrial enterprise.

**Keywords:** Industrial Enterprise, Quality Management System, Product Quality, Modeling, The vote of the Customer

**JEL Classifications:** C32, C52, D11, D12

## 1. INTRODUCTION

### 1.1. Background

Modern industrial enterprises operate in conditions of globalized economy, the offered goods’ and services’ diversity increase and the information availability provision which inevitably intensifies the competition of products manufactured and, therefore, requires new approaches to the activities’ organization, the potential and direction of the enterprise’s development determination. According to Porter (2005), the following points (five powers plus state regulation) form industrial competition: Competitors’ potential, the threat of a similar product’s appearing (substitute), stakeholders’ influence, suppliers’ and consumers’ power. In connection with necessity to take into account these factors and gain organization’s own niche in the market industry, it must seek a competitive advantage and determine the method how to hold

it (Juran, 1992; Ishikawa, 1988; Crosby, 2004). Quality provides not only customer’s satisfaction, but also the creation of quality values in a sense. Consequently, the consumer’s needs in relation to goods and services remain a priority in their manufacture.

Competitive industrial enterprises have quality certificates and documentation, implemented quality management system, introduce integrated management systems that provide environmental, health and labor safety, implementing the principles of corporate social responsibility, both to its employees and the population as a whole. The modern market economy conditions, the need for continuous improvement of products and services on order to preserve competitiveness make relevant the issues of quality management, change and implementation of optimal concepts that ensure quality requirements and customers’ satisfaction.

## 1.2. Status of a Problem

The modern consumer, as a rule, has the possibility to choose products, and in addition to the quality of the product, which is considered to be necessary among the market competitive participants, the product must possess unique characteristics and vary in accordance with the changing needs of the consumer. The gap in the understanding of the production requirements of customers and manufacturers is the factor differences of qualitative characteristics of the product. With the current modern high competitiveness of products and services the product's consumer perceives the quality from the point of view of compliance with the requirements as an integral characteristic of the product, and what makes this product unique (design, packaging, the specific function) - as an additional characteristic of quality that have the highest impact on purchase of this particular product (Kume, 1990; Bragin and Korol'kov 2003).

Not only engineering characteristics of the product and after-sales service are important for the buyer, but also the degree of participation in creating or improving of the product, the level of communication between potential producer and buyer of goods, the response time of the manufacturer in buyer inquiries, the possibility of predetermining the changing needs.

## 1.3. Problem of Investigating

Current trends in the industry put forward on the forefront the competitiveness of domestic enterprises, which is closely linked to the continuous improvement of product's quality, improvement of the quality management's efficiency, taking into account the needs of all stakeholders.

The state standard 1546779 gives the following definition of quality - "set of product's properties that determines its suitability to meet certain requirements, in accordance with its purpose." Such a formulation corresponds to the modern philosophy of quality under which the main idea is the customer's satisfaction. Requirements for quality satisfaction and its constant improvement are given and a series of ISO standards that require monitoring of customers' satisfaction and analysis of dynamics of changes, as a means of quality control.

Products consumers' requirements, government commitments and provision of competitive advantages put forward the conditions for the implementation of programs of consistent quality, which requires changes not only in management, but also the philosophy of products' quality itself. It is obviously, the higher the degree of customer's satisfaction, the higher the profit of organization, and continuous improvement in quality ensures the required level of competitiveness in the market of goods.

## 2. MATERIALS AND METHODS

### 2.1. The Realization of Defect-free Production of Products at Industrial Enterprise

It is obvious that in terms of a high competitiveness of goods and services it is not enough to produce quality products to meet the standard, one must constantly carry out the assessment of:

Market conditions; opportunities for development/product's improvement; the degree of customer's satisfaction; the needs of consumers. Thus, there is a need in an effective implementation of total quality management system, the concept of which is a stable and continuous quality improvement and increasing of customer's satisfaction with products (Deming, 2011; Gorbashko, 2008).

This concept can successfully be accompanied by the methodology of functions' structuring of product's quality (Quality Function Deployment), the basic idea of which is "the development of the system of enterprise's functioning, in which customers' requirements are considered to be a priority in the design and manufacturing of the product" (Shaklin, 2010; Gorbunova and Gumerov, 2012). When implementing such a system the following key positions are created, based on the so-called "vote of the consumer" when in the planning stage of production of the goods consumer's requirements are taken into account, including the desires of the consumer concerning the characteristics of the product or its components if there is complying with the terms of manufacturing standards and resources.

However, even if the technical standards and specifications are satisfactory and the number of defective items in the lot is less than a predetermined the received quality of products cannot meet the consumer. The modern consumer, as a rule, has the opportunity to choose products, and in addition to the quality of the product, which is considered to be necessary among the competitive market participants, the product must possess unique characteristics and vary in accordance with the changing needs of the consumer.

Thus, the current stage of development of the "defect-free production" includes the following concepts:

1. The quality from the point of view of the manufacturer, as compliance with the technical requirements is an indispensable condition of the product.
2. All quality issues (certification, management system, quality programs) are internal issues of product's producers, which are not directly related to its consumers.
3. Produced by the company product should contain specific characteristics that can meet the unique needs of the consumer.
4. The product must be constantly updated to meet the latent needs of consumers.

The gap in understanding of product requirements of customers and manufacturers is in the factor differences of qualitative characteristics of the product, in this connection, there is a need for "stock" provision of product quality, exceeding customer's requirements.

### 2.2. Stocks and Loss of Product's Quality

Considering categorically the concept of "product's quality" as correspondence to certain conditions it should be noted that mostly often modern organizations determine the quality of its product as compliance with "regulatory requirements" in line with the technical requirements on the item (product), while for the consumer it is provision of his expectations on the produced good.

### 3. RESULTS

In addition, it is known that “the characteristics of the products’ value/quality for the consumer are changed in the transition process from one organizational unit to another one” (Vasilevskaya, 2010), that is there is a significant loss of quality for the consumer in the implementation of production processes:

- When marketing assessing the expectations of the consumer the loss of quality can be obtained at the cost of a representative survey sample of potential consumers of products, low sample size, errors in the processing of statistical data, questionnaires with a low validity.
- During the product’s project development the designers must formalize its description and properties, taking into account the technical possibilities of its manufacturing, the required equipment, raw materials and resources. Errors formalization and limitations (including price) for each of these mentioned objects lead to loss of product quality.
- With the implementation of supply quality losses can be accumulated when obtaining insufficient high-quality raw materials, resources and equipment, failures of delivery terms, etc.
- While production the quality loss occurs as a result of the accumulation of all previous error types and is expressed in defective products, that do not meet the technical specifications.
- Sale of products (sales), loses quality when improper storage and delivery of goods.

It is obviously, that the quality indicators are reduced if there are non-compliance with the corridors and delivery times, production and sales, in case of defects throughout the supply chain, production and marketing, human errors at all stages of production, considerable time waiting for the consumer. From the analysis it follows that it is necessary to have a stock of product’s quality that exceeds the requirements of standards and the consumer.

Under the quality stock the authors understand the potential of the product’s quality, i.e. the presence of a positive gap between the requirements of normative documents on products and their implementation in the commodity (goods).

From our point of view, the quality stock of the product, ensuring its high competitiveness is:

- Compliance with the requirements of regulatory documents (with a decrease in allowance)
- Compliance with the needs of the consumer (with an excess of expectations)
- Compliance with the demand (including projected)
- Compliance with the service (reducing of claims)
- Establishing the optimum value of the goods
- Reducing of quality loss at the stages of the product’s life cycle.

The quality stock is a value which is relative and difficult to measure. It is affected by many factors: External environment, market conditions, technical and technological developments, etc. Therefore, quality stock’s management must be based on predictable trends and statistical methods that provide reliable indicators of management, decisions’ making and admission.

#### 3.1. Modeling of Product’s Quality

As it is noted in the paper (Gumerov et al., 2015), the composition of the processes which are needed for the IMS depends directly on the type of product and is considered to be unchanged while new goods’ production. Undoubtedly, the main processes of the quality management are the design and production of goods and the need for other processes is determined depending on their impact (closeness of the connection) with the quality of produced goods.

The main difficulties in quality functions’ structuring in relation to the goods’ production are the reliability of customer’s requirements formalization into the commodity’s technical specifications and the possibility of its development in existing production environments.

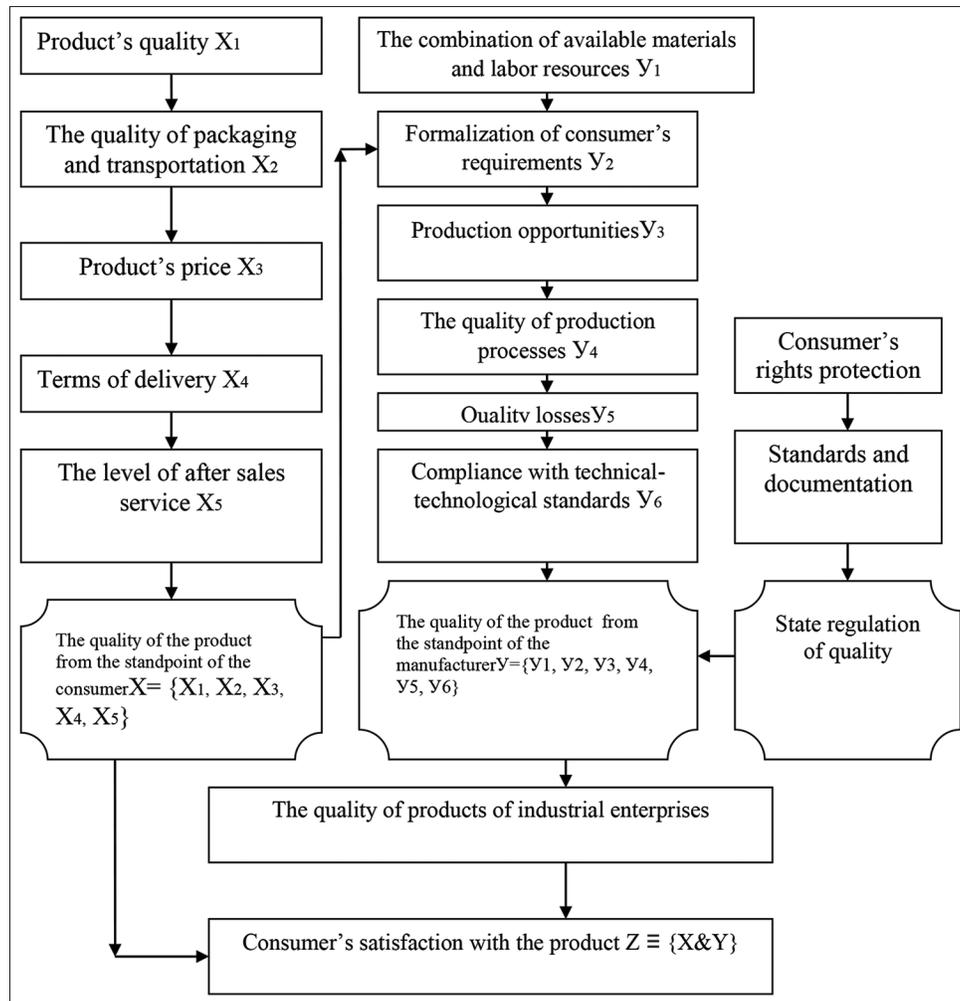
From the author’s point of view, the product’s quality at industrial enterprise is a synthesis of qualitative characteristics of consumer’s expectations on the commodity (consumer’s point of view) and the degree of compliance with the standard and certification (point of view of the manufacturer), while, customer’s satisfaction is measured by the difference between expected and realized by the manufacturer commodity’s specifications (Figure 1).

The modern consumer is almost always has the possibility to choose the products, so his choice of goods from a specific manufacturer is influenced by not only the engineering characteristics of the product and after-sales service, but also the so-called latent needs and unique characteristics embodied in the product. The possibility of consumer’s desires and expectations’ realization can come true only if the concept of creating attractive quality is implemented, satisfying the expected, desired and admired needs of the consumer. Quality, as a property of the commodity is movable and unstable, even with compliance with regulatory and technical documentation, because the consumer’s demands are changed. Also important is the fact that the consumers are “the most vulnerable participants in the economic system and need enhanced protection by the state” (Vasilevskaya, 2010), which requires extensive use and improvement of methods of their protection.

#### 3.2. Structuring Algorithm of Quality Functions of Industrial Enterprises’ Products

Mathematical description of these data will allow formulate a condition for the structuring of the quality functions.

To describe the model a representation of an object is used, its properties and dependences that can be variation, depending on external conditions and this is the demand of the consumer, or controlled, to which according to a characteristic by Suleymanov (2004), are allocated resource indicators of the process, functions of the process and of objectives’ forming, elements of analysis and decisions’ making. Considering the determination of the consumer’s requirements compliance with the product, and the formalization of these requirements at the enterprise, as a process that transforms inputs into outputs within existing constraints, it is possible to carry out the mathematical formulation of the problem.

**Figure 1:** Components of quality of industrial enterprises' production

Let's introduce the following notations:

- A set of consumer's requirements to the product  $Tr \{tr_1, tr_2, \dots, tr_n\}$
- The set of product's characteristics measured in units of  $P \{p_1, p_2, \dots, p_f\}$ . It is obvious that one of the requirements of the consumer in  $tr_i$  in accordance can be delivered with several characteristics of the final product  $p_j$ , for example, the term "convenient" can mean compact, light, weight, ergonomic shape, etc.
- The set of technologies for products' components production  $T \{t_1, t_2, \dots, t_m\}$
- Resources (and opportunities) of the enterprise-producer (raw materials, equipment, human resources)  $S \{s_1, s_2, \dots, s_k\}$ .

The output of the formalization process that satisfies the client's requests can be denoted as a vector  $V = \{v_1, v_k\}$ , it is obvious that the output of the process should be as close as possible to the requirements of  $Tr$ .

The input process is delivered by systematic client's requirements to the developed (or modified) product  $Tr \{tr_1, tr_2, \dots, tr_n\}$ , they are also the conditions for implementation.

The function describing the result of a process can be represented as follows:

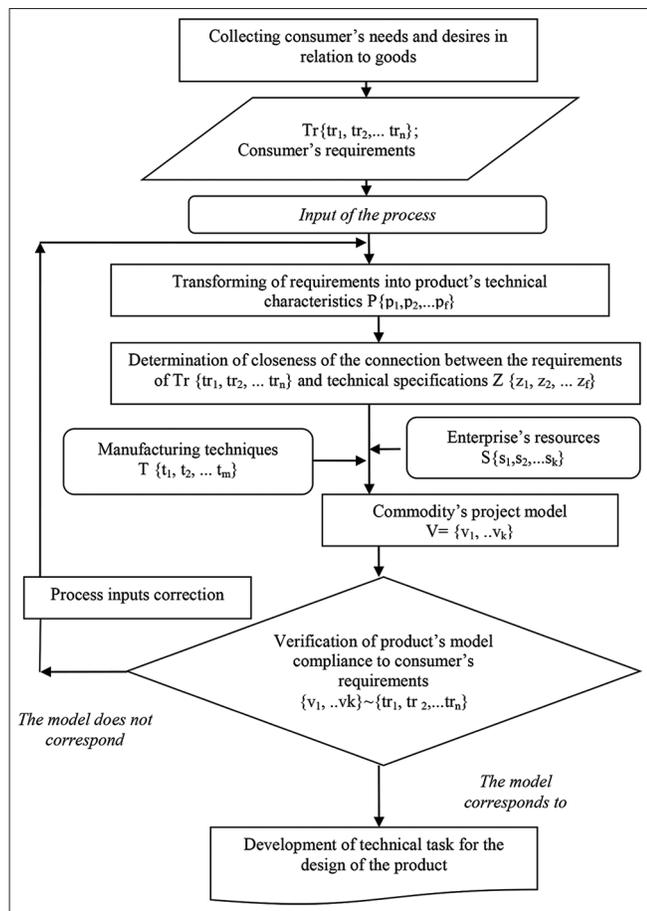
$$V_k = F_k(Tr, P, T, S) \rightarrow \text{optimum} \quad (1)$$

This function (1) is limited on the one hand by the technical capabilities of the plant  $T$ , on the other hand by resources  $S$ .

The process of formalization of consumer's requirements into product's project with a certain level of quality can be described by a multi-parameter function  $F_k$  - relation between inputs and outputs (the implementation process) in accordance with the algorithm of quality functions' structuring (Figure 2).

In a simplified theoretical model it is necessary to carry out optimization, choose the best method among the possible ones at a variation of parameters (input or output of the process).

The purpose of the model is to obtain the necessary numerical values of the parameters when designing the product with a pre-defined level of process quality that meets the client. The variation of the parameters of the model, solving the optimization problem with a constraint on financial, material and human resources will ensure the development of a product's quality project. The implementation of the concept of defect-free production at the stage of its production will provide the necessary required by the consumer product's quality.

**Figure 2:** The algorithm for quality functions structuring

#### 4. DISCUSSIONS

The modern consumer is almost always has the opportunity to choose products, so his choice of goods of a certain manufacturer is not influenced only by the engineering characteristics of the product and after-sales service, but it is also influenced by the so-called latent needs and unique characteristics which are embodied in the product. The possibility of realization of consumer's desires and expectations can only be realized if the concept of creating attractive quality is implemented, satisfying the expected, desired and admired needs of the consumer (Mosyakin, 2007; Esaulova and Esaulov, 2009; Angel et al., 2005; Yakovlev, 2009).

Quality, as a property of the commodity is mobile and unstable, even if there is a compliance with regulatory and technical documentation, because consumers' demands are changed. The constant variation, the instability of the notion of "quality" makes necessary use special methods to enhance and measure the level of customers' satisfaction, since reliance on the number of products' returns did not reflect fully the consumers' needs.

#### 5. CONCLUSIONS

Thus, the authors identified the possible loss of quality in the stages of the life cycle of the product, the necessary requirements of the consumer to the enterprise's products and proposed technique of modeling of products taking into account the necessary stock of quality, ensuring the implementation of the principle of continuous improvement and meeting the expectations of the consumer.

The implementation of this method at each stage of the product's life cycle and identifying of conditions for quality's stock accumulation will ensure the statistical quality control, and ultimately improve the competitiveness of the enterprise in terms of a market economy.

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