

System of indicators and the classifier of methods for quality control and evaluation of agricultural products in the structure of multidimensional inter-industry production cooperation

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Abstract. The article deals with the main issues of product quality management and control in multidimensional inter-industry production cooperation. Regulatory requirements and industry methods for assessing the quality of agricultural raw materials and finished industrial products on the example of leather and foot-wear industry are analyzed. The article presents the structural and logical scheme of the integrated classifier of methods for comprehensive quality assessment of objects and processes in multidimensional organizational structure of interindustry production cooperation. The conditions of digital transformation of agro-industrial complex aiming at improving the quality of leather footwear production on the basis of information-organizational inter-branch interaction between industrial and agricultural enterprises are formed in the article.

1 Introduction

A human provides himself not only with food, but also with natural raw materials for everyday goods production, using the land, water, plant and energy resources for that. More than 50% of agricultural products are sent to industrial processing and are used as raw material in many industries. It is the light industry, where the consumer quality of products is closely connected with the level and culture of agricultural production. There have aroused trends towards the formation of multi-dimensional inter-industry production cooperation in the era of digital transformation in the course of the implementation of the

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development model of human civilization, based on the need to keep balance between solving social and economic problems and preserving the natural environment.

Aiming at the sustainable development of rural territories, the further development of the organizational structure of the co-operation may be based on the outsourcing principles. In this case, the legal entity of industrial production transfers certain types or functions of the production activity (process) to another entity, including those concerning management and quality control of the raw materials from which the component materials, units and parts that determine the quality of the finished product as a whole are made. However, in this situation, the consumer often becomes hidden from the business entities, as his or her requirements for product quality are unknown to the outsourcer.

2 Materials and methods

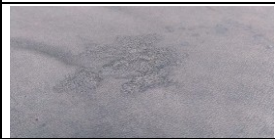

The research has been carried out on the basis of tanneries directly interlinked with agricultural production. The method of consistent dynamic quality assessment of production objects and processes proposed by the authors has been tested in conjunction with specialists in agriculture when conducting research in the agro-industrial sector [1, 2]. The solution of the problems set is based on the theoretic and empirical research which uses the principles and techniques of standardization, system and situational modelling, qualimetric analysis [3], expert assessment and analysis, statistical methods, tabular and graphical methods of data conceptualization and interpretation [4, 5].

3 Results

The socio-economic conditions for the development of Russian light industry and the up-to-date issues of import substitution of everyday goods call for the transition to an innovative model of production focused on increasing the competitiveness of agricultural and industrial enterprises and increasing the production of a new level of quality.

One should note that from the point of view of leather and footwear production it is important to be able to manufacture products with given characteristics and technical and economic indicators, which depend on related industries, including the organization of agricultural production (animal housing and feeding), which have a significant impact on product quality (Table 1).

Table 1. The example of farm animal housing causing impact on the quality of leather and footwear products.

Visualization	Defect/Fault	Signs of defect	Solution
	A sore	Holes with uneven edges or scars	Bypass
	Healed scar	A tear or deep, elongated scratch on the face of the pelage	Bypass

The consumer evaluation of footwear quality, in its turn, is based on the effectiveness footwear used as an object of consumption, which is also conditioned by the quality of the raw material. Which means that there exists a dependence on the factors determining the

competitiveness of a dynamically renewing and expanding range of products on the one hand, and on the parameters affecting the consumer properties of products and their cost on the other hand. The quality of raw materials and finished products is the main unifying factor determining the competitiveness of products, from both producer and consumer points [6].

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The traditional approach to quality management is mainly focused on the measurable data that quantify the performance of products and the performance of flexible organizational and technological processes. There are up-to-date techniques for quantitative data analysis, which meet the needs of both scientific research and management and quality control practice. We believe that it is necessary to pay attention to the qualitative component of non-compliance within the ontology of knowledge (in our case product management and quality control). Concerning the mode of their existence objective and subjective forms of quality mismatch should be divided into actual and potential ones.

Actual forms are functional systems as a set of processes and interactions. Potential forms are the results of functioning in their objectified, materialized and idealized form, i.e. in the form of projects, products and consumer culture.

The qualitative analysis of the main properties of the data to be measured involves the application of appropriate quality assessment methods. A.I. Subetto offered a four-element comparison system (1), including the Subject (S_b) and the Object (O_b) of evaluation, the Comparison Base (B_{sr}) and the Comparison Operator (θ_{sr}) [7]:

$$S_r = \langle S_b, O_b, B_{sr}, \theta_{sr} \rangle \quad (1)$$

However, there are significant differences in the regulatory requirements, procedures and methods of quality assessment and the presentation of quality indicators for the nomenclature groups of raw materials, basic and auxiliary materials, component parts and components among the different actors of multidimensional inter-industry production cooperation.

For an end product it is important that its properties are as close as possible to the assessment carried out by the consumer, and in our opinion, this can be ensured by forming an integrated system of indicators and a classifier of methods to control and evaluate the quality of agricultural raw materials and finished products in the organizational structure of multidimensional inter-industry production cooperation (Figure 1).

The multi-loop organization of forward and backward links in the "Integrated Classifier of Comprehensive Quality Assessment Methods", which follows the method of consistent dynamic quality assessment of objects and processes of both agricultural raw materials and industrial production, is directed first from the block "Normative requirements for selecting methods and methods of quality assessment" to the block "Values of critical and allowable defects of the object" has a directive nature. Then vice versa, it is transformed into the report on the fulfillment of decisions taken [8].

According to the regulatory requirements the choice of techniques and ways of quality assessment is defines based on the two groups of indicators:

- General quality indicators, which are determined in accordance with the standard procedures for producers and traders.

- Laboratory quality control indicators are determined by the instrumental techniques used at the design stage (modelling and construction) and when products are put into production.

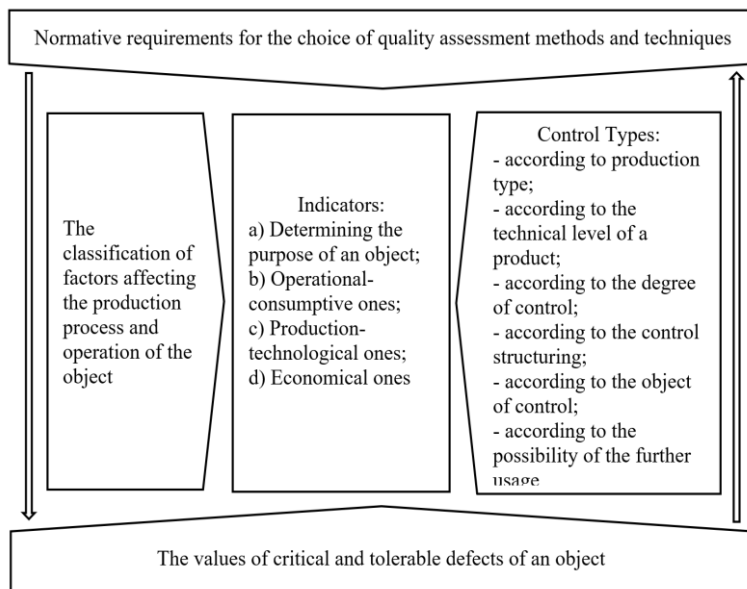


Fig. 1. Structure-logic diagram of the integrated classifier of methods for comprehensive object quality assessment.

Based on a content analysis of regulatory requirements, the list of the main critical and permissible defects in leather footwear has been established (Table 2).

Table 2. Fragment of the matrix of critical and permissible defect values.

Permissible defects	Permissible defects values			Critical defects
	GOST 28371-89 fashion footwear	GOST 28371-89 casual footwear	GOST 26165-2003 children footwear	
1	2	3	4	5
Mild: looseness, healed scar, lash marks, scratches, allotriophagy, veininess, hide neck wrinkle defect, pockmarks, sores, damaged grain. Milk ridge	On all parts except the tips and the front of the bellows	On all parts except the tips	On all parts except the tips	through damage to shoe parts; alligating, peeling and stickiness of the leather finish of the top and lining material; inappropriate shoe size and last fitting;
Mild drawn grain. Moderate: looseness, healed scar, lash marks, scratches, allotriophagy, veininess, hide neck wrinkle defect, pockmarks, sores, damaged grain.	1/4 from the upper edge of the cuffs on the outside, 1/3 on the inside	On all parts except the tips and the front of the bellows	On all parts except the tips and the front of the bellows	

In the presented integral classifier, the anticipatory influences for the effectiveness of integrated quality assessment methods are regulated through the technological solutions of the production process by implication of binary links in the blocks: “The classification of factors affecting the production process and operation of the footwear” ⇒ ”Quality Indicators”.

Based on the reliability theory of the technical system, the probability of a defect-free production can be described by the mathematical relationship (2):

$$K_{system} = (1 - k_1) \cdot (1 - k_2) \cdot \dots \cdot (1 - k_n) \tag{2}$$

When: K_{system} is the proportion of quality criteria mastered in production process that determine the value of the final product; - $k_1, k_2 \dots k_n$ – proportion of potential quality indicators that are present in the elements but not realized in the final product, Missing Qualities.

The Missing Qualities of the system k_{system} , which unite the individual elements of a consumer need, can be described by dependence (3):

$$k_{system} = 1 - (1 - k_1) \cdot (1 - k_2) \cdot \dots \cdot (1 - k_n) \tag{3}$$

In the research the statistic estimation of the level of defectiveness of leather and footwear products on the basis of such an approach has allowed us to fix the average statistical accuracy of the functional parameters of the production process of the main domestic productions based on the quality grade of agricultural raw materials (table 2).

Table 3. The accuracy of functional parameters of the production process.

No.	Defects classification	%
1	Critical	up to 5
2	Significant	15-20
3	Insignificant	60-80

The whole row of acceptable solutions (P_d) in the management and quality control system is represented by variants of technological processes organization, allowing to choose the optimal solution (4) for footwear production with the required properties (Ok):

$$P_{ws} \in \sum P_d, a P_d \subset \sum P_B \tag{4}$$

When: - \in - adhesion sign; - \subset - concatenation sign.

A formalized model (5) for depicting the technological process in an indicator evaluation and quality monitoring system would look like this:

$$P_{ws} \in \sum P_d \subset \sum P_B \tag{5}$$

The subjects of multidimensional inter-industry production cooperation possessing the situational awareness on the comprehensive quality assessment (block "Indicators") based on the input information about footwear $O = OO, \dots, Ok$ from TU (Technical Specifications) or STO (Company Standard) for manufacturing $C = C1, \dots, Cn$ is provided by block Control Types.

4 Discussion

The correct design and execution of the technological process in the manufacturing of groups of workpieces, carrying out operations in their assembly, based on the qualitative evaluation of different basic and auxiliary materials is one of the decisive conditions for improving product quality in the multi-dimensional organizational structure of inter-industry production cooperation. The selection of raw materials and components is based on their cost, rate of consumption per unit, manufacturability, aesthetic requirements.

The properties of leather footwear must be taken into account in the selection of materials and must be interrelated in the man-footwear-environment system. This correlation is due to:

- The purpose of the product [12].
- Being age- and gender-sensitive and personalised.
- Type and quality of the materials used.
- Climate conditions of wearing [9].

The comparison of the regulatory requirements for ready leather and footwear products and the component materials shows that they do not only significantly differ in terms of quality indicators, but also accordingly in terms of quality assessment methods.

5 Conclusion

Thus, the formation of an integrated classifier of quality control techniques of the expanding competitive range of products as a tool of flexible regulation in a multi-dimensional inter-industry production cooperation of business entities is an integral part of the quality management system, as timely adjustments of the organizational and technological process by assessing the level of defects will allow to assess the state of both production and its result [10, 11].

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