

Natalia V. Gritsuk
Nadezhda V.
Gamulinskaya
Elena V. Petrova

THE INNOVATIVE APPROACH TO MANAGING THE PRODUCT QUALITY IN THE DIGITAL ECONOMY: INTELLECTUAL ACCOUNTING AND AUDIT

Article info:

Received 24.10.2019

Accepted 11.02.2020

UDC – 338.246.83

DOI – 10.24874/IJQR14.02-13



Abstract: *The purpose of the article is to develop the innovative approach to managing the quality of products in the digital economy based on intellectual accounting and audit and to determine the conditions of its application. The authors determine the essence and advantages of intellectual accounting and audit as compared to the traditional approach to managing the quality of products and perform a comparative analysis of the traditional and innovative approaches to managing the quality of products in view of the forms of organization of entrepreneurship. Based on this, the authors determine the cases in which the innovative approach is preferable and determine the expedience of transfer to it. During comparison of the approaches to managing the quality of products the authors formulate the task of multi-criterial non-linear optimization and solve it with the help of the analytical hierarchical procedure (method of Thomas L. Saaty). Advantages of the innovative approach to managing the quality of products in the digital economy based on intellectual accounting and audit are substantiated, and it is shown that they are recognized by companies of all forms of organization. However, the possibilities of gaining these advantages and their value for companies are different. That's why each case requires consideration of possibilities and priorities of a company in the aspect of managing the product quality.*

Key words: *Quality management; Product quality; Digital economy; AI; Authomatization of management; Intellectual accounting and audit*

1. Introduction

Quality management is very important for the functioning and development of entrepreneurship with any form of its organization – i.e., regardless of the size, sphere of specialization, and other characteristics. This is explained by the fact that low quality of the issued products could

lead to the company's losses. Due to lower quality, as compared to the announced quality, the sold products could have lower demand in the market. In case of a slight reduction of quality and/or small share of defect, the company will lose a part of the planned revenues (alternative expenses will be high).

¹ Corresponding author: Natalia V. Gritsuk
Email: nv_gritsuk@vyatsu.ru

Complication of sales of a large batch of products could lead to the company's crisis. Overloaded storages and forced (unplanned) storing of finished products increase the logistics expenses. In case of return of products of low quality (defect), the company will also bear transport losses due to the necessity for its transportation. As free money assets were invested into production of low-quality products, the company cannot start a new production cycle (production capacities are not used).

As a result, in case of impossibility to sell the products by the planned conditions, the company will bear losses that are connected to organization of sales by subsidized conditions (at cost price) or liquidation (utilization). During this crisis, the indicators of effectiveness (e.g., profitability) and financial indicators (e.g., profit) reduce, which leads – in the best case – to decrease of investment attractiveness (in particular, market capitalization) of the company, and in the worst case – to its insolvency and bankruptcy.

Secondly, violation of the requirements to quality of products could cause non-material costs for the company. Even a slight or temporary reduction of product quality could be observed by the interested parties and accepted very critically. Consumers' loyalty to the company and its products could reduce, which will lead to decrease of the sales volumes. However, if the quality of this process is increases, this could be reversed.

However, in a worse situation, the irreversible changes are connected to reduction of the company's competitiveness and formation of its negative reputation (decrease of the brand's strength and loss of consumers' trust). In this case, even further growth of quality will not allow the company to sell its products successfully. This marketing crisis could be overcome by rebranding of the company – though this measure will not necessarily restore the company's reputation in the B2C market (business-to-consumers).

Consumers' loyalty and trust of business partners (intermediaries) could be decreased as well. They may bear losses from purchasing low-quality products from this company – due to impossibility to sell them. Even if the contract envisages the possibility of return of low-quality products with a fine, the company's competitiveness in the B2B (business-to-business) could be decreased, and its business ties could be destroyed. In this case, the company will require the search for new intermediaries, which will cause the growth of its transaction costs.

The government – through controlling bodies – could cancel the company's license, if the company produces low-quality goods, and if consumption of these goods threatens life or health of consumers or national security. The company will bear expenditures for legal issues and could be put into the government's "black list". All this determines the strategic significance of managing the product quality for modern companies.

For this, a complex of managerial measures is conducted; it includes development and adoption of corporate standards of product quality, norming of labor in view of the requirements to product quality, and introduction of the system of labor stimulation (stimulation for higher quality and punishment for defects). The central element of this complex is control over product quality. Unlike other managerial measures, which differ among modern companies depending on the specifics of their activities, control over product quality is universal.

That's why here focus is made on product quality as the main element of the approach to managing the quality of products. The traditional approach to this management envisages quantitative and qualitative accounting of products and their accounting. The problem is that in practice management of product quality could be ineffective if expenditures for accounting and audit of the products exceed the advantages from the

products' high quality. Due to this, companies refuse from quality management, accepting the related risks and planning expenses for overcoming the consequences of low quality and product's defects.

Thus, there's a necessity for the alternative approach to managing the quality of products, which will allow diversifying this management and will make it accessible for all modern companies. The offered hypothesis is that in the conditions of the digital economy the form the approach that is based on automatization of accounting and audit with application of AI. The purpose of this work is to develop the innovative approach to managing the quality of products in the digital economy based on intellectual accounting and audit and to determine the conditions of its application.

This purpose is achieved with the help of the following tasks:

- determining the essence and advantages of intellectual accounting and audit as compared to the traditional approach to managing the quality of products;
- performing a comparative analysis of the traditional and innovative approaches to managing the quality of products in view of the forms of organization of entrepreneurship and determining the cases when the innovative approach is preferable, as well as determining the expedience of transition to it.

2. Literature review

The foundations and practical experience of managing the product quality at modern companies within the traditional approach, based on accounting and audit, are set in the works of the following scholars. Al-Saedi & Paślawski (2019) write that during management or product quality it is necessary to perform systemic accounting of the interested parties' opinions – with the help of the method of analysis of hierarchies.

El Manzani et al. (2019) express doubts regarding the universal character of the system of quality management based on the IS 9001 standards. In particular, the experts note that this system is not adapted to the specifics of the activities of innovative companies.

Samuel and Schwartz (2019) point out that competition has a large influence on product quality management, which, in their opinion, should be primarily endogenous and envisage internal audit. Blum et al. (2019) think that product quality determines the opportunities for well-being and prospering of the company and the economic system on the whole. These authors determine – through the prism of product quality – the differences in revenues (level and growth rate of GDP) between countries. Zhou and Sun (2019) come to the conclusion that quality management should be inseparable from the production process. The scholars disprove the idea of external audit of quality and its selective control as a result of production, emphasizing the necessity for full coverage of production with quality control for timely determination of the signs of violation of the sectorial and corporate standards of quality and for minimization of the company's losses.

Enríquez et al. (2019) thin that the approach to characteristics and evaluation of product quality should be integrated into the system of management of products' life cycle – the scholars prove the connection between life cycle and quality (the connection is strong and direct). Koczkodaj et al. (2019) suggest using the method of paired comparisons for measuring product quality (approbating it by the example of software). Şerbancea et al. (2018) think that during control over product quality it is necessary to pay attention to the ethical issues of knowledge management.

Prabusankar et al. (2018) emphasize the significance of influence of the practice of supply chain management on product quality and the results of activities of the organized retail sector. Farooq et al. (2019) think that

quality management is necessary not only in industrial production but also in the service sphere. The scholars offer methodological provision of analysis of quality of servicing private university libraries in Malaysia in the age of transformation marketing. Mulema and García (2018) state that quality and efficiency determine the market success of modern entrepreneurship and thus require systemic and targeted corporate management.

Cruz and Mendes (2019) note significant influence of quality of services on the behavioral intentions of users in developing countries (the scholars present the results of cross-study in government hospitals of Republic of Cabo Verde). Fadeyi et al. (2019) think that quality of product management should be successive for organizational survival. Simat et al. (2018) write that orientation at customers of tourist agencies should be expressed in their susceptibility to quality of services.

The current tendencies of transformation of the practices of managing the product quality and the emerging opportunities of their improvement in the conditions of the digital economy are studied in Petrenko et al. (2018), where digital modernization of the practice of managing the product quality is tied to optimization of the processes and achievement of the goals of sustainable development of the service sphere in the post-industrial economy. Popkova (2019) and Sozinova (2019) write that there are preconditions for establishment and development of Industry 4.0 in the conditions of the knowledge economy, which envisages systemic digitization of the economic activities, including quality control.

Popkova et al. (2019) develop a model of state management of economy based on the Internet of Things – managing the quality of state services has a special role in this model. Popkova et al. (2018) think that transformation processes in the media-system in the conditions of Industry 4.0

determine new contours and future perspectives of the practice of management of services' quality. Popkova and Parakhina (2019) note that managing the global financial system based on AI opens new opportunities for increasing the quality of financial services.

Popkova and Sergi (2018) write that the more attention should be paid to the issues of quality management during innovative economic activities in Industry 4.0; and this management should be organized based on digital technologies. Popkova and Sergi (2019) write of contradiction of the digital economy. In particular, the scholars note that absolute rationality of AI limits the possibilities for “healthy” deviation from strict norms, which hinders the increase of product quality based on know-how.

Ragulina (2019) thinks that Industry 4.0 progresses on the platform of the knowledge economy, and this tendency stimulates the formation of new standards of product quality, which requires a new – intellectual – approach to quality management. Sergi et al. (2019) perform modeling of the Russian industrial, technical, and financial cooperation with the Asia-Pacific region – in particular, in the issues of managing the product quality based on digital technologies.

Sergi (2019) states that digital technologies, smart cities, and regional development in modern Russia are based on guarantees of high quality of goods and services, which management is the strategic priority of state and corporate management at the modern stage of the economic systems' evolution. Ramachandran and Karthick (2019) note a clear interconnection between development of digital technologies and modernization of the practices of quality management. Huo et al. (2019) study management of online business' quality and come to the conclusion that perspectives of its improvement are connected to application of “smart” technologies based on AI.

Behmer and Jochem (2019) are sure that organizational planning for quality management in the age of digital technologies should take into account the possibilities of technological progress for supporting its high effectiveness. Stransky and Matejka (2019) provide recommendations for digital management of quality in the construction sphere within the BIM projects. Buckhorst and Schmitt (2017) study quality management in the technological mode 4.0 and determine the need for a comprehensive cloud approach to the production system with the digital reflection.

Irizar-Arrieta et al. (2018) note the necessity for accounting of the diversity of users in design for sustainable behavior in intellectual offices. Baniyounes et al. (2019) note the necessity for and describe the process of institutionalization of intellectual energy audit of “smart” buildings. Huerta & Salazar (2019) describe the structure of the process of audit for protection of data and observation of confidentiality with the usage of AI and cognitive services in Smart Cities. Kallunki et al. (2019) see the connection between IQ and effectiveness of audit of product quality. Based on this, the scholars substantiate the preference of intellectual audit based on AI, which has higher IQ than the average statistical skilled auditor.

The performed literature overview allows for a conclusion that the signs of emergence of the innovative approach to managing the quality of products in the digital economy and the idea of the perspectives of its creation are seen in the existing publications. However, the essence and advantages of the innovative approach are not clearly defined, and the terms of its application are unknown. Thus, there’s a necessity to fill these gaps in the scientific knowledge for specification of the fragmentary scientific developments and provision of their effective application in the activities of modern entrepreneurship for them to become the general practices of

managing the product quality. This is done in this work.

3. Methodology

When comparing the approaches to managing the quality of products, we formulate a task of multi-criterial non-linear optimization and solve it with the help of the analytical hierarchical procedure (method of Thomas L. Saaty). This method is used for comparative analysis of approaches to managing the quality of products according to the following criteria:

- expenditures for implementation: cost evaluation of the measures for implementation of the approach into the practice of managing the product quality at a company (initial investments);
- expenditures for quality control: cost evaluation of the measures for implementation of the practice of managing the product quality at a company according to the approach (operational costs);
- expenditures for corporate accounting: cost evaluation of the measures for financial (business) accounting at a company (managerial costs);
- complexity of implementation: qualitative evaluation of the complexity of the measures for implementing the approach into the practice of managing the product quality at a company (organizational costs);
- complexity of organization and control over production: qualitative evaluation of the complexity of implementing the practice of managing the product quality at a company according to the approach (organizational costs);
- level of quality: result of quality management, which reflects the correspondence of the company’s

products to the existing (e.g., GOST or ISO 9001) and intra-corporate standards of quality;

- risks of violation of quality: share of products of lower quality (as compared to the announced standards) and with defects.

For providing a system of idea of the specific features of application of the approaches to managing the quality of products this research is conducted not on the basis of any specific company but on the basis of a selection of companies of certain forms of organization:

- large industrial companies with high level of automatization;
- medium industrial companies, with low or moderate level of automathatization;

- small companies of the service sphere;
- agricultural companies.

As the digital economy is in the process of formation, and statistical data on practical implementation of the approaches to managing the quality of products are not accessible, in order to collect the factual data we conduct our own empirical research in the form of a survey of representatives of the companies of the given forms of organization. We obtained data from 2,000 companies of Russia (500 companies of each organizational form) in September 2019. For the purpose of the survey, we developed and used the following evaluation form (Table 1).

Table 1. Evaluation form: “Comparing the innovative approach to the traditional (basic) approach” (instruction for respondents)

Criterion of comparison of approaches	Observation of criterion		Significance of criterion, points 1-10	Logic of assigning points to criteria*
	Traditional approach	The innovative approach		
Expenditures for implementation	1			<i>switching places</i>
Expenditures for quality control	1			<i>switching places</i>
Expenditures for corporate accounting	1			<i>switching places</i>
Complexity of implementation	1			<i>switching places</i>
Complexity of organization and control over production	1			<i>switching places</i>
Level of quality	1			<i>leave as it is</i>
Risks of violation of quality	1			<i>switching places</i>

*Additional graph for analytics, which is not shown to the respondents.

Source: developed and compiled by the authors.

As shown in Table 1, the developed evaluation form offers the respondents to compare the innovative approach to the traditional approach. The traditional approach is accepted as a basis (1), and evaluations of the innovative approach could be different (below 1 or above 1). Specific features (advantages or drawbacks) of the approach according to the set criteria and significance of the criteria for the company of the given organizational form are evaluated.

For example, during observation of the criterion of expenditures for implementation, the volume of expenditures for implementation of the innovative approach, as compared to the traditional approach, is determined. During determining the significance of the criterion, importance of expenditures during decision making regarding the approach to quality management at a company is determined (points 1-10 – the higher the better). The logic of assigning points to the criteria

consists in norming and assigning weight coefficients to the criteria.

4. Results

4.1. The essence and advantages of intellectual accounting and audit as compared to the traditional approach to managing the quality of products

The essence of intellectual accounting and audit consists in the fact that it is conducted by AI, which allows for full automatization of the process of corporate accounting and audit of the products. The results of comparative analysis of the traditional and innovative approaches are shown in Table 2.

Table 2. Comparative analysis of the approaches to managing the quality of products.

Object of comparison	Criterion of comparison	Traditional approach	Innovative approach
Accounting and audit	Subject of quality management	manager, auditor	AI
Accounting	Order of accounting	stage-by-stage	simultaneous
	Risk of errors	high	low
	Order of accounting of products and financial accounting	conducted separately and manually (in case of mechanization)	automatized and are conducted simultaneously
Audit	Coverage of audit	selective	full
	Risk of subjectivity	low	zero
	Probability of finding the reason of violation of the quality standards	low	high
	Order of conducting the audit	as a result of production (one time)	in the process of production (regularly)

Source: developed and compiled by the authors.

As shown in Table 2, the subject of quality management within the innovative approach is AI, which ensures the following advantages of this approach:

- high speed of accounting: due to simultaneous accounting of the quantity and quality of the products, these processes are accelerated, as compared to manual accounting and evaluation of product quality;
- reduction of the risks of accounting: probability of errors due to 0% influence of “human factor; in case of the traditional approach these risks are high;
- saving money for accounting: corporate accounting is automatic, which allows for increase of labor efficiency, while during the traditional approach the accounting

of quantity and quality of product is conducted separately;

- fullness of audit: audit covers not separate products of the company (as is seen during the traditional approach) but all products – the comprehensive audit allows guaranteeing product quality;
- objectivity of audit: unlike the auditor, AI is always objective and independent, which allows for correct results of control over product quality;
- higher information value of audit: AI takes into account not only the result (product quality) but also the process of its receipt – which allows determining the facts of violation of the production technology or low quality of resources and materials, thus

establishing causal connections of violation of the requirements to product quality;

- timeliness of audit: audit is conducted not as a result of production (one time in case of the traditional approach) but in the process of production (regularly),

which allows determining the signs of violation of the requirements to product quality immediately, thus reducing the defects due to stopping a set of products with defects.

This approach is shown in Figure 1.

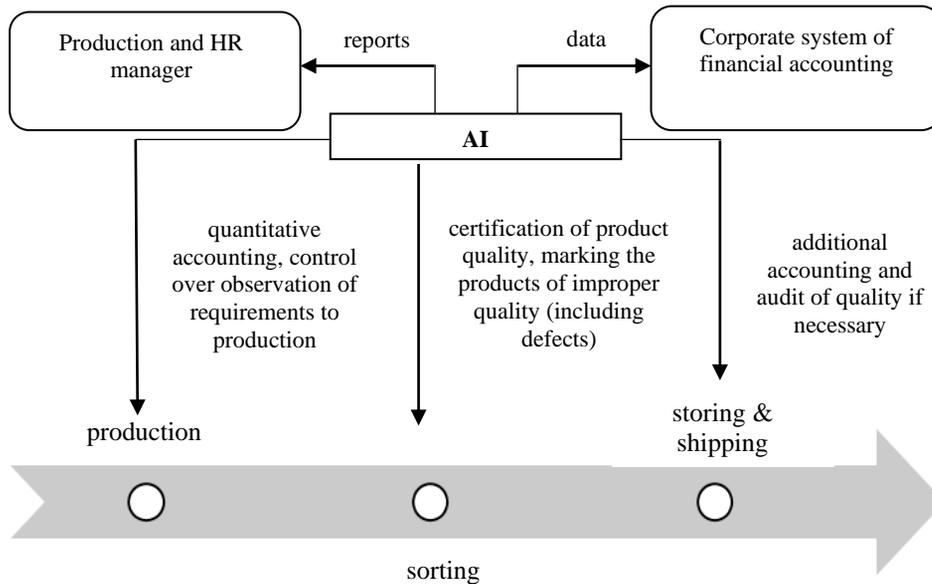


Figure 1. The innovative approach to managing the quality of products in the digital economy based on intellectual accounting and audit.

Source: developed and compiled by the authors.

As shown in Figure 1, AI conducts quantitative accounting, control over observation of requirements at the stage of production, certification of product quality, marking of products of improper quality (including defects) at the stage of sorting and additional accounting and audit of quality if necessary, at the stage of storing and shipping. It transfers data on quantity and quality of manufactured products to the corporate system of financial accounting and to the production and HR management. This allows for automatization of the whole complex of organizational and managerial

functions at a company and for highly-effective control over quality of its products.

4.2. Comparative analysis of approaches to managing the quality of products in view of the organizational forms of entrepreneurship

The results of comparative analysis of approaches to managing the quality of products according to the criterion of expedience of their application at large industrial companies with high level of automatization are shown in Tables 3-5.

Table 3. Evaluation of observation of the criteria and their norming.

Criteria of approaches' comparison	Estimate values of criteria				Sum of points for norming
	Traditional approach		The innovative approach		
	points	normed	points	normed	
Expenditures for implementation	1.2	0.55	1.0	0.45	2.2
Expenditures for quality control	0.8	0.44	1.0	0.56	1.8
Expenditures for corporate accounting	0.7	0.41	1.0	0.59	1.7
Complexity of implementation	1.3	0.57	1.0	0.43	2.3
Complexity of organization and control over production	0.6	0.38	1.0	0.63	1.6
Level of quality	1.0	0.22	3.5	0.78	4.5
Risks of violation of quality	0.1	0.09	1.0	0.91	1.1

Source: calculated and compiled by the authors.

Table 4. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Significance, points 1-10	Weight coefficients as a result of norming (weight)
Expenditures for implementation	3.3	0.08
Expenditures for quality control	6.2	0.15
Expenditures for corporate accounting	4.7	0.11
Complexity of implementation	2.4	0.06
Complexity of organization and control over production	5.3	0.13
Level of quality	10.0	0.24
Risks of violation of quality	10.0	0.24
Sum of values	41.9	1.00

Source: calculated and compiled by the authors.

Table 5. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Weight	Traditional approach		The innovative approach	
		Value of criterion	Weighted sum	Value of criterion	Weighted sum
Expenditures for implementation	0.08	0.55	0.04	0.45	0.04
Expenditures for quality control	0.15	0.44	0.07	0.56	0.08
Expenditures for corporate accounting	0.11	0.41	0.05	0.59	0.07
Complexity of implementation	0.06	0.57	0.03	0.43	0.02
Complexity of organization and control over production	0.13	0.38	0.05	0.63	0.08
Level of quality	0.24	0.22	0.05	0.78	0.19
Risks of violation of quality	0.24	0.09	0.02	0.91	0.22
Sum of values	1.00	-	-	-	-
Hierarchical synthesis	-	0.31		0.69 (more preferable by 2.22 times)	

Source: calculated and compiled by the authors.

The performed analysis showed that at industrial companies with high level of automatization the innovative approach is more preferable – by 2.22 times – than the traditional approach to managing the quality of products. The results of comparative

analysis of the approaches to managing the quality of products according to the criterion of expedience of their application at medium industrial companies with low or moderate level of automatization are shown in Tables 6 and 7.

Table 6. Evaluation of observation of the criteria and their norming.

Criteria of approaches' comparison	Estimate values of criteria				Sum of points for norming
	Traditional approach		The innovative approach		
	points	normed	points	normed	
Expenditures for implementation	2.5	0.71	1.0	0.29	3.5
Expenditures for quality control	0.6	0.38	1.0	0.63	1.6
Expenditures for corporate accounting	0.8	0.44	1.0	0.56	1.8
Complexity of implementation	2.9	0.74	1.0	0.26	3.9
Complexity of organization and control over production	0.5	0.33	1.0	0.67	1.5
Level of quality	1.0	0.15	5.7	0.85	6.7
Risks of violation of quality	0.7	0.41	1.0	0.59	1.7

Source: calculated and compiled by the authors.

Table 7. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Significance, points 1-10	Weight coefficients as a result of norming (weight)
Expenditures for implementation	6.4	0.13
Expenditures for quality control	7.6	0.15
Expenditures for corporate accounting	5.9	0.12
Complexity of implementation	5.2	0.10
Complexity of organization and control over production	8.7	0.18
Level of quality	7.3	0.15
Risks of violation of quality	8.5	0.17
Sum of values	49.6	1.00

Source: calculated and compiled by the authors.

Table 8. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Weight	Traditional approach		The innovative approach	
		Value of criterion	Weighted sum	Value of criterion	Weighted sum
Expenditures for implementation	0.13	0.71	0.09	0.29	0.04
Expenditures for quality control	0.15	0.38	0.06	0.63	0.10
Expenditures for corporate accounting	0.12	0.44	0.05	0.56	0.07
Complexity of implementation	0.10	0.74	0.08	0.26	0.03
Complexity of organization and control over production	0.18	0.33	0.06	0.67	0.12
Level of quality	0.15	0.15	0.02	0.85	0.13
Risks of violation of quality	0.17	0.41	0.07	0.59	0.10
Sum of values	1.00	-	-	-	-
Hierarchical synthesis	-	0.43		0.57 (more preferable by 1.32 times)	

Source: calculated and compiled by the authors.

The performed analysis showed that at medium industrial companies, with low or moderate level of automatization, the innovative approach is more preferable – by 1.32 times – than the traditional approach to managing the quality of products. The results

of comparative analysis of the approaches to managing the quality of products according to the criterion of expedience of their application at small companies of the service sphere are shown in Table 9-11.

Table 9. Evaluation of observation of the criteria and their norming.

Criteria of approaches' comparison	Estimate values of criteria				Sum of points for norming
	Traditional approach		The innovative approach		
	points	normed	points	normed	
Expenditures for implementation	6.4	0.86	1.0	0.14	7.4
Expenditures for quality control	0.9	0.47	1.0	0.53	1.9
Expenditures for corporate accounting	0.9	0.47	1.0	0.53	1.9
Complexity of implementation	5.6	0.85	1.0	0.15	6.6
Complexity of organization and control over production	2.4	0.71	1.0	0.29	3.4
Level of quality	1.0	0.40	1.5	0.60	2.5
Risks of violation of quality	0.8	0.44	1.0	0.56	1.8

Source: calculated and compiled by the authors.

Table 10. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Significance, points 1-10	Weight coefficients as a result of norming (weight)
Expenditures for implementation	10.0	0.17
Expenditures for quality control	8.7	0.15
Expenditures for corporate accounting	7.9	0.14
Complexity of implementation	9.3	0.16
Complexity of organization and control over production	8.1	0.14
Level of quality	6.4	0.11
Risks of violation of quality	7.2	0.13
Sum of values	57.6	1.00

Source: calculated and compiled by the authors.

Table 11. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Weight	Traditional approach		The innovative approach	
		Value of criterion	Weighted sum	Value of criterion	Weighted sum
Expenditures for implementation	0.17	0.86	0.15	0.14	0.02
Expenditures for quality control	0.15	0.47	0.07	0.53	0.08
Expenditures for corporate accounting	0.14	0.47	0.06	0.53	0.07
Complexity of implementation	0.16	0.85	0.14	0.15	0.02
Complexity of organization and control over production	0.14	0.71	0.10	0.29	0.04
Level of quality	0.11	0.40	0.04	0.60	0.07
Risks of violation of quality	0.13	0.44	0.06	0.56	0.07
Sum of values	1.00	-	-	-	-
Hierarchical synthesis	-	0.62 (more preferable by 1.63 times)		0.38	

Source: calculated and compiled by the authors.

The performed analysis showed that at small companies of the service sphere the traditional approach to managing the quality of products is more preferable – by 1.63 times – than the innovative approach. The results of comparative analysis of

approaches to managing the quality of products according to the criterion of expedience of their application at agricultural companies are shown in Tables 12-14.

Table 12. Evaluation of observation of the criteria and their norming.

Criteria of approaches' comparison	Estimate values of criteria				Sum of points for norming
	Traditional approach		The innovative approach		
	points	normed	points	normed	
Expenditures for implementation	5.1	0.84	1.0	0.16	6.1
Expenditures for quality control	0.7	0.41	1.0	0.59	1.7
Expenditures for corporate accounting	0.6	0.38	1.0	0.63	1.6
Complexity of implementation	2.3	0.70	1.0	0.30	3.3
Complexity of organization and control over production	0.6	0.38	1.0	0.63	1.6
Level of quality	1.0	0.18	4.7	0.82	5.7
Risks of violation of quality	0.3	0.23	1.0	0.77	1.3

Source: calculated and compiled by the authors.

Table 13. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Significance, points 1-10	Weight coefficients as a result of norming (weight)
Expenditures for implementation	9.8	0.15
Expenditures for quality control	9.5	0.15
Expenditures for corporate accounting	7.3	0.11
Complexity of implementation	8.6	0.13
Complexity of organization and control over production	10.0	0.15
Level of quality	9.5	0.15
Risks of violation of quality	10.0	0.15
Sum of values	64.7	1.00

Source: calculated and compiled by the authors.

Table 14. Evaluation of criteria significance and their norming.

Criteria of approaches' comparison	Weight	Traditional approach		The innovative approach	
		Value of criterion	Weighted sum	Value of criterion	Weighted sum
Expenditures for implementation	0.15	0.84	0.13	0.16	0.02
Expenditures for quality control	0.15	0.41	0.06	0.59	0.09
Expenditures for corporate accounting	0.11	0.38	0.04	0.63	0.07
Complexity of implementation	0.13	0.70	0.09	0.30	0.04
Complexity of organization and control over production	0.15	0.38	0.06	0.63	0.10
Level of quality	0.15	0.18	0.03	0.82	0.12
Risks of violation of quality	0.15	0.23	0.04	0.77	0.12
Sum of values	1.00	-	-	-	-
Hierarchical synthesis	-	0.44		0.56 (more preferable by 1.27 times)	

Source: calculated and compiled by the authors.

The performed analysis showed that the innovative approach at agricultural companies is more preferable – by 1.27 times – than the traditional approach to managing the quality of products.

5. Discussion

As a result of the research it has been established that despite the objective differences between the traditional and innovative approaches to managing the

quality of products, which are acknowledged by companies of all organizational forms, the perceived differences between these approaches are diverse. Thus, expenditures for implementation of the innovative approach are objectively higher due to necessity for purchasing AI and the tied technologies and equipment, as well as personnel training. However, the volume of these expenditures is treated by companies of different organizational forms in a different way.

Large industrial companies with high level of automatization accept digital modernization, as investments into it are quickly returned by means of “scale effect”. That’s why expenditures for implementation of the innovative approach for them are only by 1.2 times higher (almost identical expenses). Significance of the criterion of expenditures for implementation during the selection of the approach by these companies is low (3.3 points), which reflects their readiness to invest into digital modernization. Medium industrial companies with low or moderate level of automatization feel the load of investments into digital modernization to a higher extent. The perceived expenditures for implementation of the innovative approach are higher by 2.5 times. Significance of this criterion is also rather high (6.4 points).

Small companies of the service sphere have to perform automatization “from scratch” and thus perceived expenditures for implementation of the innovative approach are by 6.4 times higher than expenditures for implementation of the traditional approach. This criterion is the most significant for them (10 points). Agricultural companies also consider the expenditures for implementation of the innovative approach as rather heavy (exceeding the expenditures for implementation of the traditional approach by 5.1 times). Significance of this criterion is also very high for them (9.8 points).

Increase of product quality and reduction of the risks of quality violation are achieved during application of the innovative approach. Thus, according to the evaluation of large industrial companies with high level of automatization the level of product quality during the innovative approach is by 3.5 times higher than during the traditional approach (significance of the criterion is maximal: 10 points). The perceived risks of violation of quality are lower (0.1) within the innovative approach (significance of the criterion is maximal: 10 points).

Medium industrial companies with low and moderate level of automatization evaluate the growth of product quality even higher (by 5.7 times) during the innovative approach. However, significance of this criterion for them is lower as compared to the above form of organization of entrepreneurship (7.3 points). Risks of violation of quality, according to then, reduce slightly (0.7), but are still rather significant (8.5 points).

Small companies of the service sphere envisage the growth of product quality by only 1.5 times due to transition to the innovative approach to quality management, considering this criterion to be moderately significant (6.4 points). The perceived reduction of the risks of quality violation is low (0.8), but this criterion is rather significant (7.2 points). Agricultural companies also acknowledge significant increase of product quality (by 4.7 times) during transition to the innovative approach to its management (significance of the criterion is very high: 9.5 points). They also note the reduction of risks of quality violation by 0.3 times (significance of the criterion is maximal: 10 points).

Thus, the advantages of the innovative approach to managing the quality of products in the digital economy based on intellectual accounting and audit are acknowledged by companies of all organizational forms. However, the possibilities of obtaining these advantages

and their value for companies are various. That's why each separate case requires consideration of possibilities and priorities of the company in the aspect of managing the product quality. In certain cases, the innovative approach to this management could be unjustified and even unprofitable – though it is preferable in most cases.

6. Conclusion

Thus, the offered hypothesis has been proved. In the conditions of the digital economy, an innovative approach to managing the quality of products based on automatization of accounting and audit with application of AI is formed. This approach has multiple advantages as compared to the traditional approach, including quick accounting of products and their quality, reduction of risks of accounting, reduced expenditures for accounting, fullness of audit, and its objectiveness, timeliness, and informative value. This leads to increase of product quality and its guarantees and to reduction of entrepreneurial risk of violating the requirements to quality.

However, an inevitable drawback of the developed approach is certain expenditures

(for the companies that implement it), connected to purchase and usage of AI and the tied technologies and equipment, training of personnel, and increased complexity of organization and management of this process. According to the results of the empirical part of the performed research, the developed innovative approach to managing the quality of products in the digital economy based on intellectual accounting and audit is most interesting for large industrial companies with high level of automatization (this approach is more preferable than the traditional approach - by 2.22 times).

Application of the innovative approach at small companies of the service sphere is inexpedient (the traditional approach is more preferable – by 1.63 times). In the activities of agricultural companies, the innovative approach is in higher demand (by 1.27 times), as well as in the activities of medium industrial companies with low or moderate level of automatization (1.32 times). Therefore, the perspectives of practical application of intellectual accounting and audit at companies of different organizational forms are diverse, but high.

References:

- Al-Saedi, A., & Paślawski, J. (2019). Influence of stakeholder management and communications management in choosing of the best product achieve quality by Analytic Hierarchy Process method. *IOP Conference Series: Materials Science and Engineering*, 518(2), 22-68.
- Baniyounes, A. M., Ghadi, Y. Y., & Baker, A. A. (2019). Institutional smart buildings energy audit. *International Journal of Electrical and Computer Engineering*, 9(2), 783-788.
- Behmer, F. J., & Jochem, R. (2019). Organizational planning for quality management in the digital age. *Business Process Management Journal*, 2(1), 36-47.
- Blum, B. S., Claro, S., Dasgupta, K., & Horstmann, I. J. (2019). Inventory management, product quality, and cross-country income differences. *American Economic Journal: Macroeconomics*, 11(1), 338-388.
- Buckhorst, A., & Schmitt, R. H. (2017). Quality Management 4.0 - Potentials and requirements of a holistic cloud-based approach towards a digital reflected production system. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 2017(JUL), 251-252.

- Cruz, V., & Mendes, L. (2019). The influence of service quality on users' behavioural intentions in developing countries: A cross-sectional study in Cape Verde'S Public Hospitals. *International Journal for Quality Research*, 13(2), 361-380.
- El Manzani, Y., Sidmou, M. L., & Cegarra, J.-J. (2019). Does ISO 9001 quality management system support product innovation? An analysis from the sociotechnical systems theory. *International Journal of Quality and Reliability Management*, 36(6), 951-982.
- Enrriquez, J. G., Sánchez-Begines, J. M., Domínguez-Mayo, F. J., García-García, J. A., & Escalona, M. J. (2019). An approach to characterize and evaluate the quality of Product Lifecycle Management Software Systems. *Computer Standards and Interfaces*, 61, 77-88.
- Fadeyi, O., Oladele, K., Imhonopi, D., & Nwachukwu, C. (2019). Analyzing succession management practise in the context of organizational survival: A qualitative approach. *International Journal for Quality Research*, 13(2), 413-432.
- Farooq, M., Khalil-Ur-Rehman, F., Tijjani, A. D., Younasm W., Sajjad, S., & Zreen, A. (2019). Service quality analysis of private universities libraries in Malaysia in the era of transformative marketing. *International Journal for Quality Research*, 13(2), 269-284.
- Huerta, J., & Salazar, P. (2019). Audit Process Framework for Data Protection and Privacy Compliance Using Artificial Intelligence and Cognitive Services in Smart Cities. *2018 IEEE International Smart Cities Conference, ISC2 2018*, 8656877.
- Huo, D., Chen, Y., Hung, K., Ouyang, R., Sun, B., & Cai, Y. (2019). Quality management of e-business: A key node analysis of ecological network in digital economy by using artificial intelligence. *Romanian Journal of Economic Forecasting*, 22(2), 166-179.
- Irizar-Arrieta, A., Casado-Mansilla, D., & Retegi, A. (2018). Accounting for User Diversity in the Design for Sustainable Behaviour in Smart Offices. *2018 3rd International Conference on Smart and Sustainable Technologies, SpliTech 2018*, 8448352.
- Kallunki, J., Kallunki, J.-P., Niemi, L., Nilsson, H., & Aobdia, D. (2019). IQ and Audit Quality: Do Smarter Auditors Deliver Better Audits? *Contemporary Accounting Research*, 29(1), 56-67.
- Koczkodaj, W. W., Dymora, P., Mazurek, M., & Strzałka, D. (2019). Consistency-driven pairwise comparisons approach to software product management and quality measurement. *Advances in Intelligent Systems and Computing*, 761, 292-305.
- Mulema, S. A., & Garcia, A. C. (2018). Quality and productivity in aquaculture: Prediction of oreochromis mossambicus growth using a transfer function arima model. *International Journal for Quality Research*, 12(4), 823-834.
- Petrenko, E., Pritvorova, T., & Dzhazykbaeva, B. (2018). Sustainable developmet processes: Service sector in post-industrial economy. *Journal of Security and Sustainability Issues*, 7(4), 781-791. doi: 10.9770/jssi.2018.7.4(14).
- Popkova, E. G. (2019). Preconditions of formation and development of industry 4.0 in the conditions of knowledge economy. *Studies in Systems, Decision and Control*, 169(1), 65-72.
- Popkova, E. G., Egorova, E. N., Popova, E., & Pozdnyakova, U. A. (2019). The model of state management of economy on the basis of the internet of things. *Studies in Computational Intelligence*, 826(1), 1137-1144.
- Popkova, E. G., Morozova, I. A., & Litvinova, T. N. (2018). Transformational processes in the media system under industry conditions 4.0: future outlines and perspectives (reflections on the article by Alexander P. Sukhodolov, DSc. In Economics, Professor and Irina A. Kuznetsova, PhD in Engineering, Associate Professor "Designing the mass media as a homeostatic system by means of automation engineering: Basic concepts, structure, components"). *Theoretical and practical issues of journalism*, 7(1), 145-154.

- Popkova, E. G., & Parakhina, V. N. (2019). Managing the global financial system on the basis of artificial intelligence: possibilities and limitations. *Lecture Notes in Networks and Systems*, 57(1), 939-946.
- Popkova, E. G., & Sergi, B. S. (2018). Will Industry 4.0 and Other Innovations Impact Russia's Development? In Bruno S. Sergi (Ed.) *Exploring the Future of Russia's Economy and Markets: Towards Sustainable Economic Development* (pp. 51-68). Bingley, UK: Emerald Publishing Limited.
- Popkova, E. G., & Sergi, B. S. (Eds.) (2019). *Digital Economy: Complexity and Variety vs. Rationality*. Springer International Publishing.
- Prabusankar, R., Praveenkumar, V., & Rajkumar, N. (2018). A study on influence of supply chain management practices on product quality and performance of organized retail sector in Tamil Nadu. *International Journal of Mechanical Engineering and Technology*, 9(7), 46-54.
- Ragulina, Y. V. (2019). Priorities of development of industry 4.0 in modern economic systems with different progress in formation of knowledge economy. *Studies in Systems, Decision and Control*, 169, 167-174.
- Ramachandran, K. K., & Karthick, K. K. (2019). Digital technology and quality management. *International Journal of Recent Technology and Engineering*, 8(2 Special Issue 3), 1651-1654.
- Samuel, A., & Schwartz, J. (2019). Product Market Competition's Effect on Earnings Management When Audit Quality Is Endogenous: Theory and Evidence. *Review of Law and Economics*, 2(1), 18-29.
- Șerbancea, F., Stănescu, A., & Lazăr, V. (2018). Ethics in knowledge management to monitor the quality of food products. *Quality - Access to Success*, 19(167), 159-165.
- Sergi, B. S., Popkova, E. G., Sozinova, A. A., & Fetisova, O.V. (2019). Modeling Russian Industrial, Tech, and Financial Cooperation with the Asia-Pacific Region. In Bruno S. Sergi (Ed.) *Tech, Smart Cities, and Regional Development in Contemporary Russia*. Bingley, UK: Emerald Publishing Limited.
- Sergi, B. S. (Ed.) (2019). *Tech, Smart Cities, and Regional Development in Contemporary Russia*. Bingley, UK: Emerald Publishing Limited.
- Simat, K., Blešić, I., Božić, S., Avramović, M., & Ivkov, M. (2018). Customer orientation of employees in travel agencies as a predisposition of service quality: Test of cose consequences model. *International Journal for Quality Research*, 12(4), 851-868.
- Sozinova A. A. (2019). Causal connections of formation of industry 4.0 from the positions of the global economy. *Studies in Systems, Decision and Control* 169, 131-143.
- Stransky, M., & Matejka, P. (2019). Digital quality management in construction industry within BIM projects. *Engineering for Rural Development*, 18, 1707-1718.
- Zhou, X., & Sun, S. (2019). Quality Management Research of the Manufacturing Process Based on Q Company Products. *Advances in Intelligent Systems and Computing*, 885, 620-626.

Natalia V. Gritsuk
Vyatka State University
Kirov, Russian Federation
nv_gritsuk@vyatsu.ru

Nadezhda V. Gamulinskaya
Vyatka State University
Kirov, Russian Federation
nv_gamulinsky@vyatsu.ru

Elena V. Petrova
Vyatka State University
Kirov, Russian Federation
usr10877@vyatsu.ru
