

Sergei G. Vagin<sup>1</sup>  
Yuri N. Lascencov  
Maria E. Konovalova  
Eugene V. Frank

## QUALITY AND SAFETY IN THE DIGITAL ECONOMY: SPECIFICS OF DEVELOPING COUNTRIES

### Article info:

Received 30.08.2020.  
Accepted 18.02.2021.

UDC – 005.336.3  
DOI – 10.24874/IJQR15.03-06



**Abstract:** *This paper aims at studying quality from the positions of safety in the digital economy of developing countries. Originality of this research consists in the following: firstly, quality is evaluated from the positions of safety. Not only safety as a feature of product quality (internal effects) but also influence of product quality on safety in society and economy (external effects) – negative and positive – are taken into account. Secondly, the essence and structure of safety are specified and the scientific and methodological approach to evaluation of products' quality from the positions of safety is developed and approbated by the example of modern developing countries. Products' safety is studied in the unity of all its components. Thirdly, quality from the positions of safety is considered in the context of the digital economy and in view of specific experience of developing countries. Fourthly, the influence of economic freedom on quality from the positions of safety in the digital economy of developing countries is considered, which allows determining the role of state standardization and control in this process. It is determined that general level of products' quality from the positions of safety in developing countries is rather high, regardless of the level of economic freedom – 63.48% on average in 2020. Due to optimization of influence of digitalization, products' quality from the positions of safety in developing countries could be increased by 1.55 times – up to 98.16% until 2025. A complex of practical recommendations is offered for this.*

**Keywords:** *Quality; Safety; Digital economy; Developing countries; Systemic optimization; Quality management.*

## 1. Introduction

Quality of products, which are manufactured and sold in the market, is evaluated in economic from the positions of result, expressed in the form of advantages that are created for consumers (satisfaction of needs), for state, and for society (economic growth, creation of jobs, import substitution, economic safety, and increase of living standards and quality of life), and for

business (competitiveness, loyalty of target audience, and commercial effectiveness).

Products' safety is recognized as a mandatory condition of manufacture of products and its realization, so it is considered separately from quality. However, contrary to this, very often in practice products are not safe – which

<sup>1</sup> Corresponding author: Sergei G. Vagin  
Email: [vsg63@hotmail.com](mailto:vsg63@hotmail.com)

depends on the specifics of production and which determines quality. This leads to a scientific and methodological problem of specifying the theory and practice of evaluation and management of product quality, which should take into account not only result but also expenditures, of which safety is the manifestation. The barriers on the path of solving this problem include the following gaps in the concept of quality from the positions of safety.

One of the gaps is obscureness of the role of safety in the system of estimate indicators of product quality. Safety is equaled to result, because it does not create an obvious value for consumers, which is connected to satisfaction of needs at which products aim according to the classical economic theory. As a matter of fact, safety could create indirect value for consumers – e.g., due to safety for environment. Though the scale of indirect value is subjective and depends on consumer preferences, products' safety always determines its costs for consumers and for society and state. Consideration of costs from the positions of safety is necessary for full, precise, and correct evaluation of product quality – but requires a new methodology.

Another gap is obscureness of the structure of safety as a characteristic of product quality. Only fragmentary data on product safety are given in the existing scientific literature. Certain authors take into account product safety for life and health of consumers – i.e., consider the internal effects. Contrary to them, certain authors pay attention to product safety for environment and its ecological costs – i.e., consider the negative external effects. Here we offer a hypothesis that products could also create positive effects – internal and external – due to which not only safety determines quality, but quality influences safety on society and economy.

Another gap is poor elaboration of a new – digital – context, in which quality is formed and product safety is ensured. On the one

hand, a new requirement to safety – cyber security – appears in the digital economy. Products have to conform to its requirements, and it determines quality. On the other hand, leading digital technologies expand the capabilities of state, society, and business for monitoring, control, and management of product safety – which raises products' quality. Both these aspects have to be thoroughly studied.

Other gaps include insufficient elaboration of developing countries, in which safety management is specific due to the three following reasons. 1<sup>st</sup> reason: less effective institutions, and also – in some developing countries – emerging markets, the action of the mechanism of competition at which is decreased or distorted. Thus, stimuli for increase of product safety could be reduced. 2<sup>nd</sup> reason: less demanding and less responsible consumers, who might evaluate quality not from the positions of safety (costs) but only from the positions of advantages. 3<sup>rd</sup> reason: slow transition to the digital economy, due to which the significance of cyber security could be reduced, and possibilities of the use of digital technologies for monitoring of safety could be limited.

In order to fill these gaps, we seek the goal of studying quality from the positions of safety in the digital economy of developing countries. Originality of this research consists in the following: firstly, quality is evaluated from the positions of safety. Not only safety as a feature of product quality (internal effects) but also influence of product quality on safety in society and economy (external effects) – negative and positive – are taken into account. Secondly, the essence and structure of safety are specified and the scientific and methodological approach to evaluation of products' quality from the positions of safety is developed and approbated by the example of modern developing countries. Products' safety is studied in the unity of all its components. Thirdly, quality from the positions of safety is considered in the

context of the digital economy and in view of specific experience of developing countries. Fourthly, the influence of economic freedom on quality from the positions of safety in the digital economy of developing countries is considered, which allows determining the role of state standardization and control in this process.

The structure of this paper is as follows. Introduction is followed by literature review (description of the theoretical basis of the research) and gap analysis, as well as description of materials (information and empirical basis of the research) and methodology. Then, results include the following:

- Assessment of the influence of digitalization on quality from the positions of safety in developing countries, depending on the level of economic freedom;
- Systemic optimization of influence of digitalization on quality from the positions of safety in developing countries;
- Practical implications for improving quality management from the positions of safety in the digital economy of developing countries.

The paper ends with conclusion.

## 2. Literature Review

Product safety – as a component of quality – is studied in the works Bogoviz et al. (2019c), Osipov et al. (2018), Osipov (2019), and Osipov (2020). Wang et al. (2017) note wide perspectives of transferring information on quality and safety of consumer goods via social networks. Qayoom and Hadikusumo (2019) develop a systemic and dynamic approach to studying the multi-level culture of safety that influences the indicators of organization's safety. Zhang et al. (2019) perform a study of the influence of employees' votes on the issues of safety on the level of workplaces' safety at small and medium companies.

Olsen (2018) notes significant influence of organizational factors on safety of patients and safe behavior of nurses and hospital personnel. Yu et al. (2019) suggest forecasting instantaneous safety of driving in emergency scenarios based on the main messages of the connected transport vehicle. Nayak and Taylor (2018) present an opinion of food inspectors on the culture of food products' safety. Ahmad et al. (2019) perform empirical analysis and monitoring of safety and behavior of employees on provision of information safety.

Anand et al. (2018) determine the transformation of information safety management in India (based on a thematic study of safety, IT policy, and online management based on SAP-LAP). Koster and Fleischmann (2017) perform an international comparison of guarantees of employment, social provision, and additional efforts in the sphere of safety. Ferjani et al. (2018) note the significance of contribution of Swiss agriculture to food safety with the help of the system of decision support on the strategy of food safety.

Ferracane (2019) determine the connection between data flows and national safety and offer a conceptual basis for evaluating the limitations on data flows within exclusion of safety of GATS. Karanja (2017) substantiates the key role of the main employee on information safety in IT safety management. Sadok et al. (2020) study the mismatch between corporate policies of safety and factual methods of safety provision at small and medium companies.

The specifics of treatment and management of product quality in the digital economy are described in the works Alpidovskaya and Popkova (2019), Jain (2020), Bogoviz et al. (2020a), Bogoviz et al. (2020b), Bogoviz et al. (2019a), Bogoviz et al. (2019b), Inshakova and Bogoviz (2020), Popkova and Sergi (2020), Popkova (2017), Popkova (2019), Popkova (2020), Popkova et al. (2020), Popkova et al. (2017), Popkova and Sergi (2018), Popkova and Sergi (2019),

Ragulina (2019), Sergi et al. (2019a), Sergi et al. (2019b), Sergi et al. (2019c), and Shulus et al. (2020).

Mohsenin et al. (2018) determine the styles of decision making by customers as a tool of segmenting the market of digital products in Iran. Hender (2019) perform a qualitative analysis of development of digital and physical products. Vendrell-Herrero et al. (2017) determine digital dark matter in the systems of product maintenance, which is connected to uncertainty of cybersecurity. Li et al. (2020) study the systems of products and services in the digital age and outline wide perspectives of socio-technical systems' development.

The experience of regulation of entrepreneurship's activities, including in the aspect of quality, in developing countries is described in the works Calavrezo (2007), Savoia et al. (2016), Khwaja et al. (2020), Stanovcic et al. (2016), Susilowati et al. (2019), and Vuorensyrjä (2018). Salinas et al. (2019) determine the regulation of business, supremacy of law, and formal entrepreneurship, providing the data and arguments from developing countries. Zhang and Patil (2017) study the issue of guaranteeing the quality of agencies on provision of quality and study the advantages of creation and development of the Asia-Pacific Quality Register (APQR).

Singh and Rawani (2019) deem it necessary to use the function of quality for determining the priorities of parameters of quality of the National Council on Accreditation. Alipour et al. (2019) substantiate the interconnection between quality of disclosure of ecological information and quality of profit, performing a panel study of developing markets. Kusumawati and Syamsuddin (2018) prove the influence auditor's quality on professional skepticism and its connection with audit's quality.

Sturm et al. (2019) point out the long-term dynamic connection between the cost of quality and the indicators of quality. Anttila and Jussila (2017) think that

understanding the essence of quality for interested parties – conceptualization of the fundamental concepts of quality management in entrepreneurship. Shahzad et al. (2019) note the vivid influence of quality of financial reports and quality of audit on effectiveness of investments, based on the data on Pakistan.

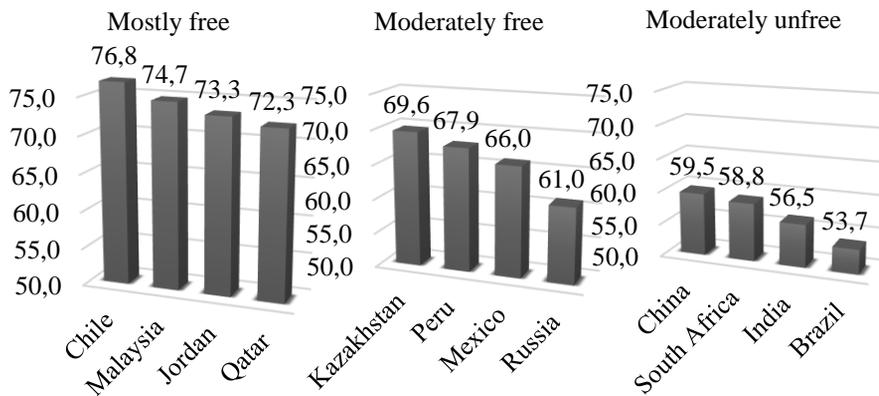
Thus, it is possible to conclude that safety – as a characteristic of quality – is acknowledged by a range of scholars, and quality management in the digital economy and experience of quality management in developing countries are studied in detail in the existing research literature. The existing publications provide a reliable theoretical basis of the research, but there are certain gaps. They include fragmentary nature and non-systemic character of scientific treatments of quality from the positions of safety, as well as obscurity of the specifics of measuring and management of quality from the positions of safety in the digital economy of developing countries. In order to fill these gaps, we perform a systemic study of quality from the positions of safety in the digital economy of developing countries.

### 3. Materials and methodology

This research aims at systemic analysis of quality from the positions of safety in the digital economy of developing countries. On the one hand, it is to determine the source of provision of product safety as a characteristic of quality. The source of quality could be state regulation (standardization) or market's pressure (competition) and corporate initiatives of increase of quality from the positions of safety. For specifying the provision of product safety as a characteristic of quality in developing countries, the research objects are three categories of developing countries, which are distinguished by the level of economic freedom:

- Mostly free (full economic freedom): countries with strong market’s pressure (competition);
- Moderately free (moderate economic freedom): countries in which the market and regulatory mechanism have strong influence on entrepreneurship;
- Moderately unfree (low economic freedom): countries in which state regulation dominates (standardization of quality from the positions of safety).

The level of economic freedom in countries of the selection in 2020 is determines based on 2020 Index of Economic Freedom, calculated by The Heritage Foundation (2020) (Figure 1).



**Figure 1.** Level of economic freedom in countries of the selection in 2020, points 1-100.  
Source: compiled by the authors based on The Heritage Foundation (2020)

As shown in Figure 1, in countries from the category “mostly free”, the level of economic freedom varies from 72.3 points in Qatar to 76.8 points in Chile; in countries from the category “moderately free” – from 61 points in Russia to 69.6 points in Kazakhstan; in countries from the category “moderately unfree” – from 53.7 points in Brazil to 59.5 points in China.

For evaluating the influence of digitalization on quality from the positions of safety in developing countries, depending on the level of economic freedom, the following indicators of quality from the positions of safety are used:

- Climate index as the indicator of ecological safety of products, reflected in Quality of life index 2020 mid-year and calculated by Numbeo (2020);
- Healthcare index as the indicator of product safety for life and health of consumers, reflected in Quality of life index 2020 mid-year and calculated by Numbeo (2020);
- Safety index as the indicator of products’ contribution to fighting crimes in society, reflected in Quality of life index 2020 mid-year and calculated by Numbeo (2020);
- Shadow economy as the indicator of financial safety of products in the aspect of tax risks, calculated by The Global Economy (2020);
- Annual rate of economic growth as the indicator of economic safety of products from the positions of the risk of economic crisis (increase of economic systems’ cyclicity), from World Economic Outlook Database

for 2020, calculated by International Monetary Fund (2020);

- Cybersecurity index as the indicator of personal data and information protection, calculated by International Telecommunication Union (2020);

- Food safety index as the indicator of food products' safety, calculated by The Economist Intelligence Unit (2020).

The selected indicators of safety as characteristics of quality in developing countries with the different levels of economic freedom in 2020 are shown in Table 1.

**Table 1.** Safety as a characteristic of quality in developing countries with different levels of economic freedom in 2020.

Level of economic freedom	Country	Climate index, points 1-100	Healthcare index, points 1-100	Safety index, points 1-100	Shadow economy, %	Annual rate of economic growth, %	Cybersecurity index, shares of 1	Food safety index, points 1-100
Mostly free	Chile	90.21	64.38	50.40	13.16	2.900	0.470	75.5
	Malaysia	59.21	68.87	41.45	26.07	4.880	0.893	73.8
	Jordan	89.05	65.46	59.17	15.16	2.900	0.556	61.0
	Qatar	36.03	73.03	88.10	13.07	2.038	0.860	81.2
Moderately free	Kazakhstan	39.78	60.94	45.19	32.82	3.210	0.778	67.3
	Peru	97.69	56.45	34.35	41.53	3.709	0.401	63.3
	Mexico	86.29	72.11	46.69	28.07	2.682	0.629	69.4
	Russia	39.51	58.01	59.40	33.72	1.500	0.836	69.7
Moderately unfree	China	78.17	66.62	68.82	12.11	5.900	0.828	71.0
	South Africa	95.25	64.16	22.71	21.99	2.201	0.652	67.3
	India	64.74	66.21	55.58	17.89	7.921	0.719	58.9
	Brazil	94.10	56.87	31.69	35.22	2.000	0.577	70.1

Source: compiled by the authors based on International Monetary Fund (2020), International Telecommunication Union (2020), Numbeo (2020), The Global Economy (2020).

The data on the influence of digitalization on quality from the positions of safety are taken from the materials of World Digital Competitiveness Ranking 2019, presented by IMD (2020). Three groups of factors are distinguished by the subject of quality management from the positions of safety (business, state, and society).

The factors of digital modernization of business:

- Digital personnel management;
- Investments in digitalization;
- Implementation of digital innovations.

Factors of state regulation of digitalization:

- Regulation of digital education;
- Normative regulation of digitalization;
- E-government.

Factors of public support for digitalization:

- Innovative activity of employees;
- Activity of using digital technologies in society;
- Social support for digitalization.

The data on the above factors are given in Table 2.

**Table 2.** Factors of the influence of digitalization on quality from the positions of safety in developing countries with different levels of economic freedom in 2020, positions 1-63.

Level of economic freedom	Country	Factors of digital modernization of business			Factors of state regulation of digitalization			Factors of public support for digitalization		
		Indicators' titles that are used in this paper								
		Digital personnel management	Investments in digitalization	Implementation of digital innovations	Regulation of digital education	Normative regulation of digitalization	E-government	Innovative activity of employees	Activity of the use of digital technologies in society	Social support for digitalization
		Indicators' original titles								
		Talent	Capital	Business agility	Training & education	Regulatory framework	IT integration	Scientific concentration	Technological framework	Adaptive attitudes
Mostly free	Chile	36	44	50	55	36	39	57	42	27
	Malaysia	22	14	17	11	29	33	27	20	30
	Jordan	43	41	22	32	47	54	63	55	61
	Qatar	15	23	12	48	28	27	61	38	18
Moderately free	Kazakhstan	39	54	15	1	16	46	55	43	39
	Peru	59	45	59	42	50	59	62	61	49
	Mexico	55	47	51	53	48	53	40	53	47
	Russia	45	57	54	9	40	43	18	39	40
Moderately unfree	China	19	32	1	37	20	41	9	32	24
	South Africa	49	30	40	58	53	42	48	59	55
	India	38	3	29	47	55	56	28	62	54
	Brazil	61	61	58	59	57	49	44	47	33

Source: compiled by the authors based on IMD (2020).

Correlation analysis is used for determining the connection of between the indicators from Table 1 and the indicators from Table 2 in view of the distinguished categories of developing countries by the level of economic freedom. For systemic optimization of influence of digitalization on quality from the positions of safety in developing countries, we calculate the index of quality from the positions of safety according to the following algorithm. At the first step, the above indicators of quality

from the positions of safety from Table 1 are calculated as a share of factual values as compared to maximum.

For the indicators which value is the higher the better, the ratio of the value from Table 1 to maximum possible value of the indicator is calculated. The mentioned indicators of climate index (maximum: 100 points), healthcare index (maximum: 100 points), safety index (maximum: 100 points), and annual rate of economic growth (maximum in the selection in Table 1: 7.921%), cyber

security index (maximum: 1), and food safety index (maximum: 100 points) are calculated. For the indicator which value is the lower the better, difference between 1 and the value from Table 1/maximum ratio is calculated. The mentioned indicators of the shadow economy (maximum: 100%) are calculated.

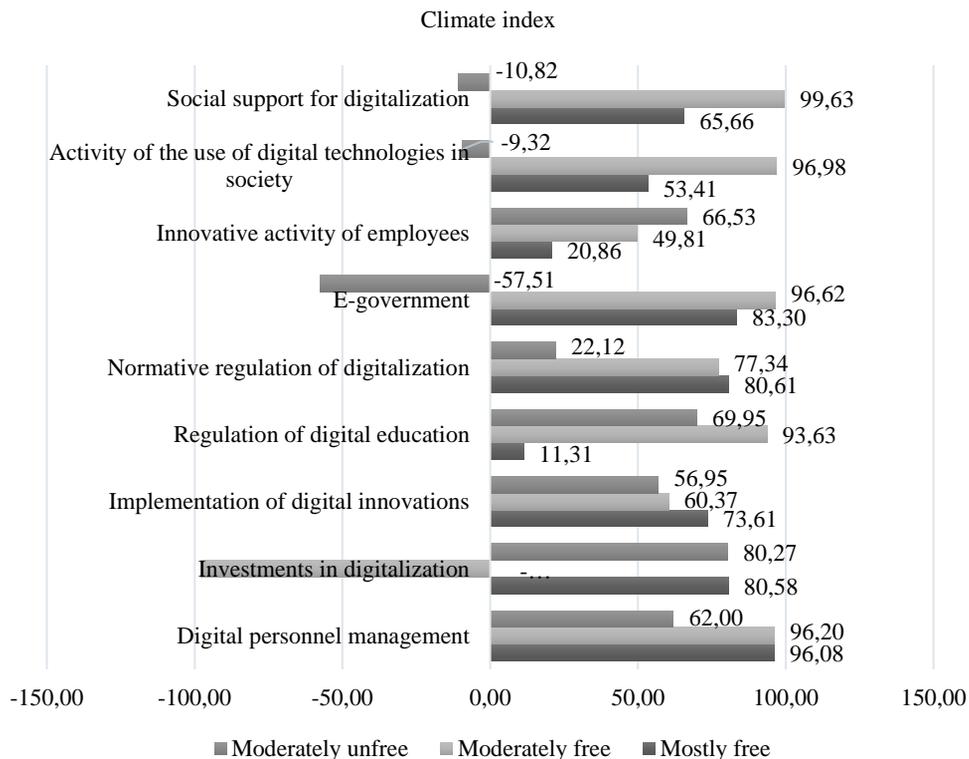
At the second step, direct average of all mentioned indicators is calculated, which is then multiplied by 100%. Quality index from the positions of safety is measured in per cent. Regression analysis is used for determining the influence of the indicators of digitalization from Table 2 on the obtained quality index from the positions of safety. Based on the equation of multiple linear regression and with the help of simplex method, the optimal values of the indicators of digitalization and their growth in the

period until 2025 are calculated – for the purpose of maximizing quality from the positions of safety.

## 4. Results

### 4.1 Evaluation of the influence of digitalization on quality from the positions of safety in developing countries depending on the level of economic freedom

Evaluation of the influence of digitalization on quality from the positions of safety in developing countries depending on the level of economic freedom based on the data from Table 1 (performed with the help of correlation analysis) is shown in Figures 2-8.

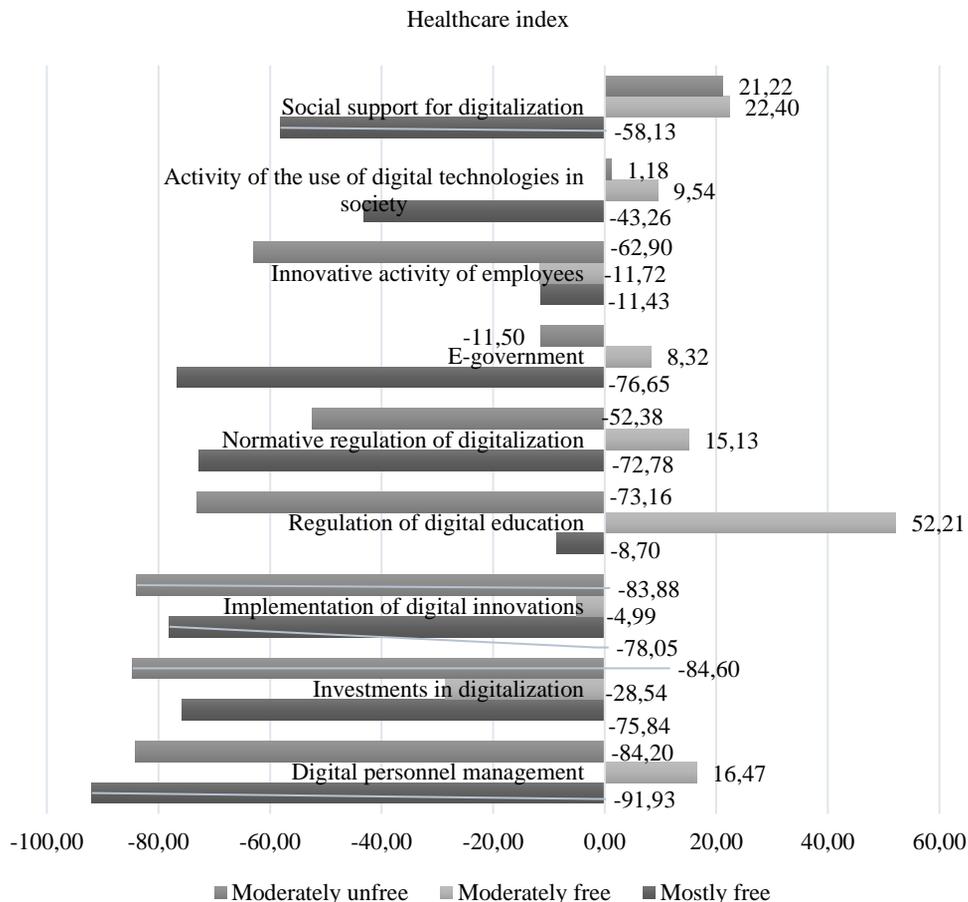


**Figure 2.** Correlation between climate index and the indicators of digitalization in developing countries in 2020, %

Source: calculated and compiled by the authors

As shown in Figure 2, a lot of indicators of the digital economy in countries with low economic freedom (moderately unfree) positively influence ecological products' safety and increase their quality. Thus, negative correlation with climate index is observed with such indicators as social support for digitalization (-10.82%), activity of the use of digital technologies in society (-9.32%), e-government (-57.51%), and investments in digitalization (-97.72%). In countries with moderate economic freedom (moderately free), negative influence of digitalization on ecological

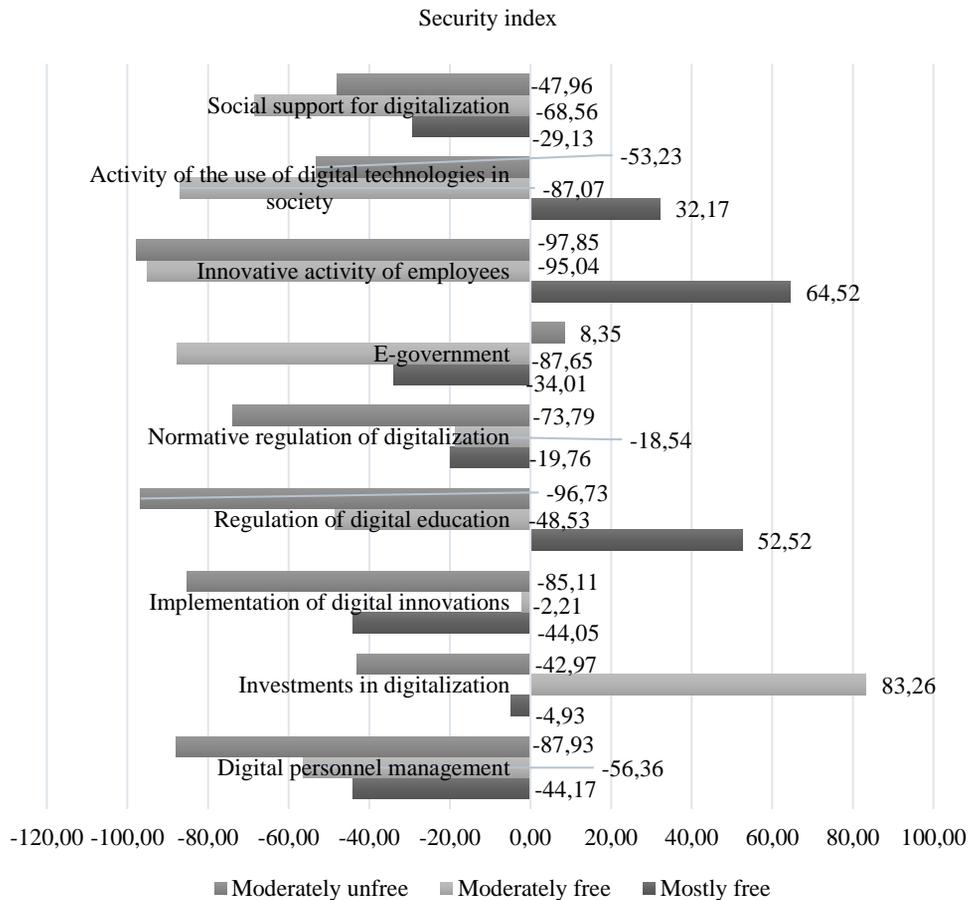
products' safety is most vivid. Correlation with climate index is the highest (i.e., negative) with social support for digitalization (99.63%), activity of the use of digital technologies in society (96.98%), regulation of digital education (93.63%), and digital personnel management (96.20%). In countries with high economic freedom (mostly free), the influence of digitalization on ecological products' safety is also negative. Correlation with climate index is the highest (negative) with digital personnel management (96.08%).



**Figure 3.** Correlation between healthcare index and the indicators of digitalization in developing countries in 2020, %  
 Source: calculated and compiled by the authors

As shown in Figure 3, the influence of digitalization on products' safety for consumers' health is strong and positive in countries with low economic freedom (moderately unfree) and in countries with high economic freedom (mostly free). In countries with moderate economic freedom

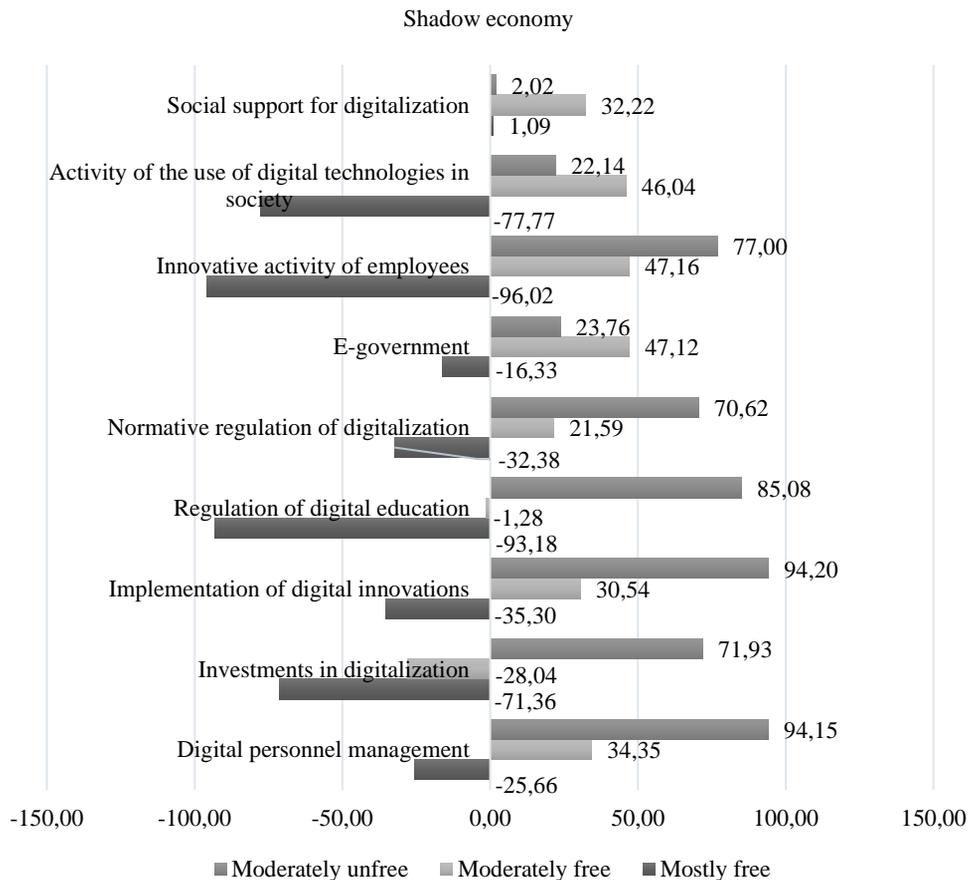
(moderately free), an opposite situation is observed – a lot of indicators show positive correlation with healthcare index – e.g., regulation of digital education (52.21%), social support for digitalization (22.40%), and digital personnel management (16.47%).



**Figure 4.** Correlation between safety index and the indicators of digitalization in developing countries in 2020, %  
 Source: calculated and compiled by the authors

As shown in Figure 4, the digital economy positively influences safety in the aspect of crime prevention in countries with low economic freedom (moderately unfree). In countries with moderate economic freedom (moderately free), investments in digitalization are the only factor of digitalization that has positive correlation

with safety index (83.26%). In countries with high economic freedom (mostly free), negative influence on safety index is performed by such factors of digitalization as activity of the use of digital technologies in society (32.17%), innovative activity of employees (64.52%), and regulation of digital education (52.52%).



**Figure 5.** Correlation between share of the shadow economy and the indicators of digitalization in developing countries in 2020, %  
 Source: calculated and compiled by the authors

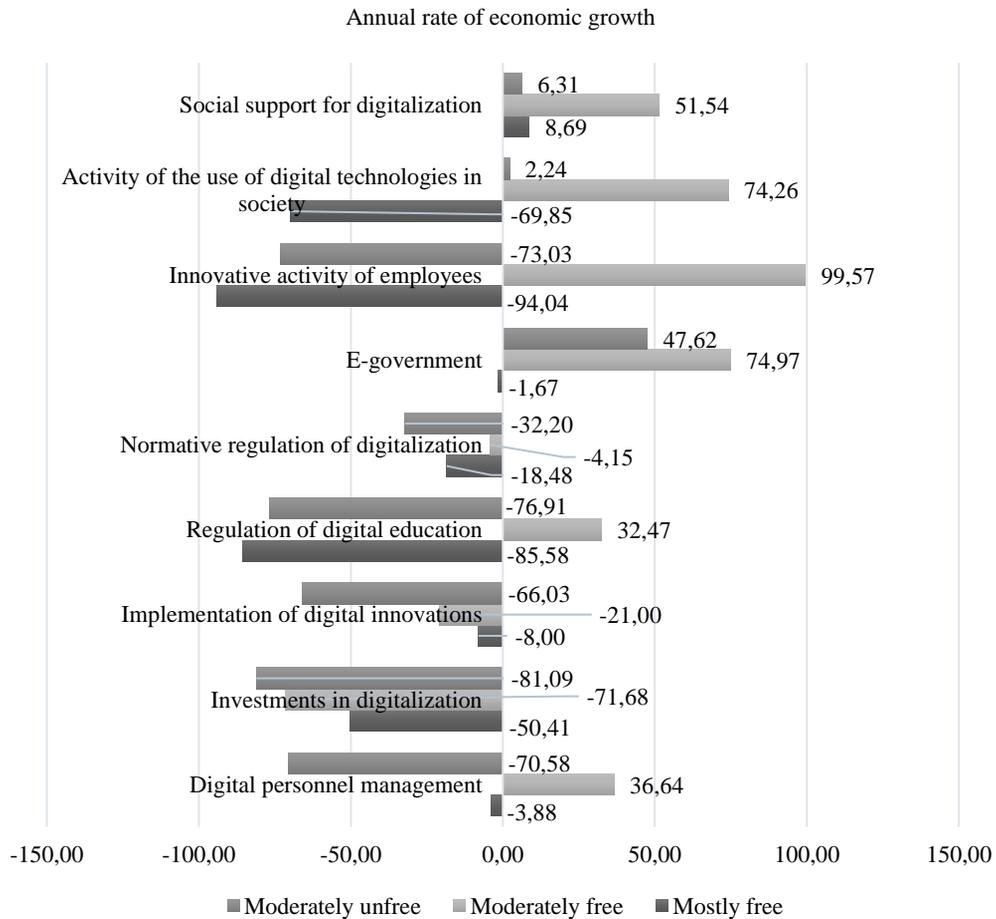
As shown in Figure 5, tax safety as a feature of product quality in countries with low economic freedom (moderately unfree) grows due to development of the digital economy. For example, correlation between implementation of digital innovations and share of the shadow economy constitutes 94.20%. In countries with moderate economic freedom (moderately free) the situation is similar. Correlation between innovative activity of employees and the share of the shadow economy constitutes 47.16%. In countries with high economic freedom (mostly free), the shadow economy is overcome due to digitalization.

Correlation between innovative activity of employees and share of the shadow economy constitutes -96.02%.

As shown in Figure 6, economic safety grows in the course of development of the digital economy in in countries with low economic freedom (moderately unfree). Regulation of digital education has the most vivid negative correlation (-76.91%) with annual rate of economic growth. This is also peculiar for countries with high economic freedom (mostly free), in which correlation between innovative activity of employees and the rate of economic growth constitutes -94.04%.

Only in countries with moderate economic freedom (moderately free), digitalization on the whole stimulates the reduction of economic safety. Correlation between the rate of economic growth and innovative

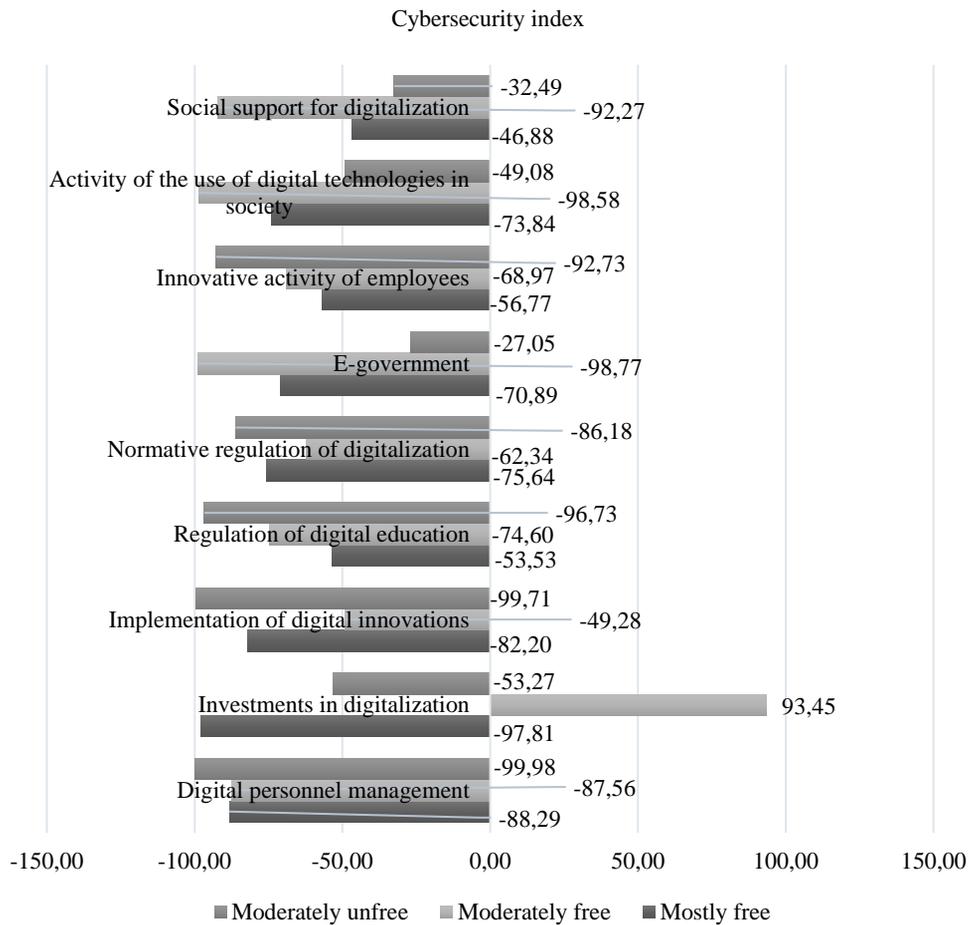
activity of employees constitutes 99.57%, activity of the use of digital technologies in society – 74.26%, and e-government – 74.97%.



**Figure 6.** Correlation between the rate of economic growth and the indicators of digitalization in developing countries in 2020, %  
Source: calculated and compiled by the authors

As shown in Figure 7, regardless of the level of economic freedom, digital economy reduces the risks of cybersecurity, thus increasing products' quality, which is shown by large (above 50%) and negative values of correlation coefficients. In countries with

moderate economic freedom (moderately free), the only indicator of digitalization that shows positive correlation with cybersecurity index is investments in digitalization (93.45%).

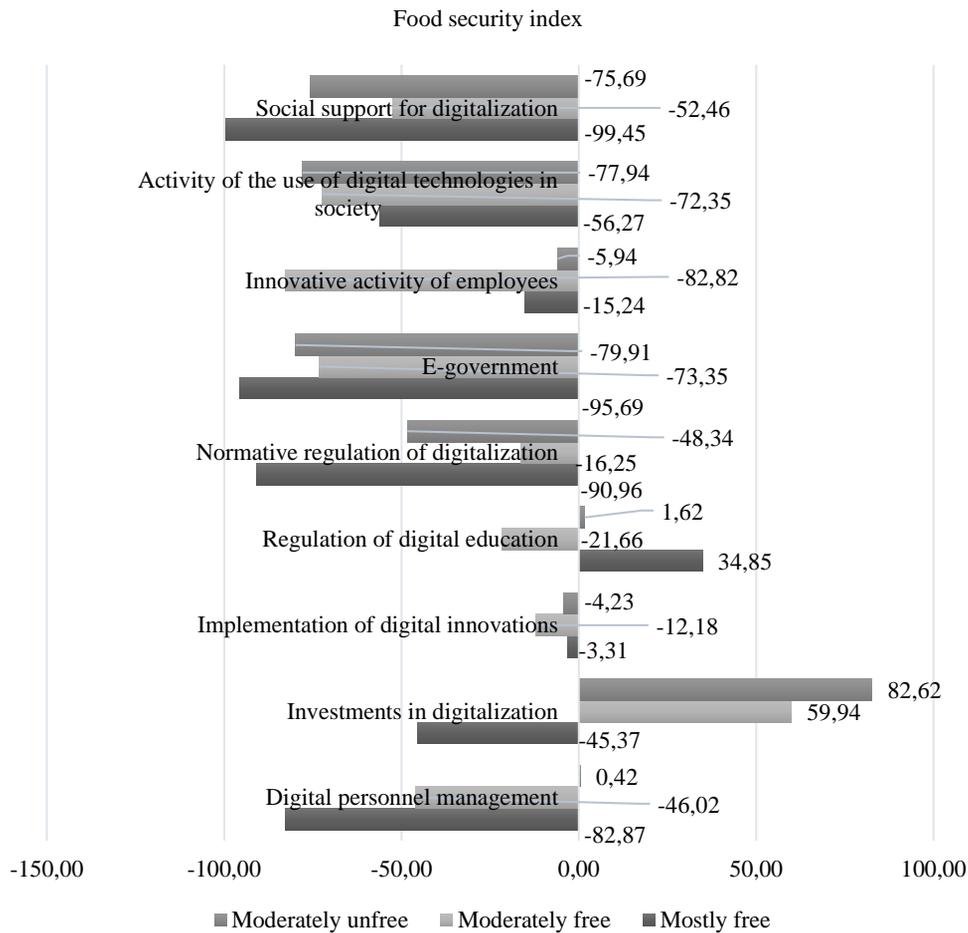


**Figure 7.** Correlation between cybersecurity index and the indicators of digitalization in developing countries in 2020, %.

Source: calculated and compiled by the authors.

As shown in Figure 8, most of the indicators of the digital economy in countries with different levels of economic freedom showed positive influence on food safety as a characteristic of food products' quality. However, there is positive correlation between food safety index and investments in digitalization (82.62%) in countries with low economic freedom (moderately unfree) and in countries with moderate economic freedom (moderately free, 59.94%), and with regulation of digital education (34.85%) in countries with high economic freedom (mostly free).

Thus, influence of digitalization on quality from the positions of safety in developing countries is contradictory and largely depends on the level of economic freedom. Generalized influence of the digitalization factors on the indicators of safety is moderately positive in countries with low economic freedom (moderately unfree, -22.60%) and in countries with high economic freedom (mostly free, -19.63%), and neutral in countries with moderate economic freedom (moderately free, -1.07%).



**Figure 8.** Correlation between food safety index and the indicators of digitalization in developing countries in 2020, %

Source: calculated and compiled by the authors

#### 4.2 Systemic optimization of the influence of digitalization on quality from the positions of safety in developing countries

For integral evaluation of quality from the positions of safety in developing countries in 2020, we use the proprietary methodology (see Materials and methods) for calculating quality index from the positions of safety based on the data from Table 1 (Table 3).

According to the results from Table 3, index of quality from the positions of safety is approximately equal in all developing countries. In countries with low economic freedom (moderately unfree), it constitutes 66.00%; in countries with moderate economic freedom (moderately free) – 58.38%; in countries with high economic freedom (mostly free) – 66.08%.

**Table 3.** Calculation of quality index from the positions of safety in developing countries in 2020.

Country	Indicators							Index of quality from the positions of safety	
	Climate index	Healthcare index	Safety index	Shadow economy	Annual rate of economic growth	Cybersecurity index	Food safety index		
Chile	0.90	0.64	0.50	0.87	0.37	0.47	0.76	64.42	On average: 66.00
Malaysia	0.59	0.69	0.41	0.74	0.62	0.89	0.74	66.88	
Jordan	0.89	0.65	0.59	0.85	0.37	0.56	0.61	64.53	
Qatar	0.36	0.73	0.88	0.87	0.26	0.86	0.81	68.15	
Kazakhstan	0.40	0.61	0.45	0.67	0.41	0.78	0.67	56.96	On average: 58.38
Peru	0.98	0.56	0.34	0.58	0.47	0.40	0.63	56.74	
Mexico	0.86	0.72	0.47	0.72	0.34	0.63	0.69	63.31	
Russia	0.40	0.58	0.59	0.66	0.19	0.84	0.70	56.49	
China	0.78	0.67	0.69	0.88	0.74	0.83	0.71	75.68	On average: 66.08
South Africa	0.95	0.64	0.23	0.78	0.28	0.65	0.67	60.06	
India	0.65	0.66	0.56	0.82	1.00	0.72	0.59	71.35	
Brazil	0.94	0.57	0.32	0.65	0.25	0.58	0.70	57.21	

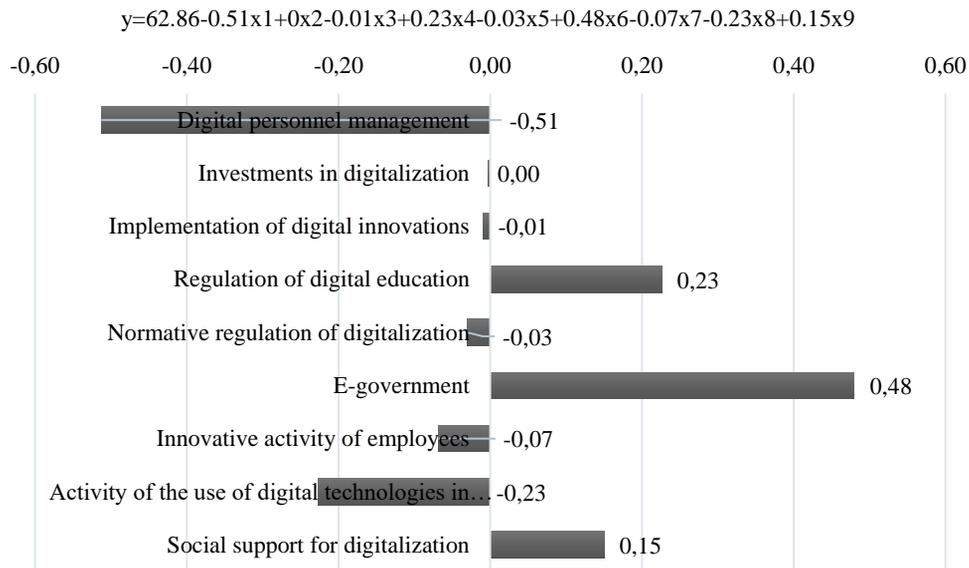
Source: calculated and compiled by the authors.

Regression dependence of index of quality from the positions of safety (y) on the indicators of digitalization in developing countries in 2020 from Table 2 is shown in Figure 9.

According to the multiple linear regression equation (Figure 9), decrease (improvement) of digital personnel management by 1 position leads to increase of index of quality from the positions of safety by 0.51%; index of quality from the positions of safety remains unchanged in case of decrease (improvement) of investments in digitalization by 1 position and decrease

(improvement) of implementation of digital innovations by 1 position.

Decrease (improvement) of regulation of digital education by 1 position leads to decrease of index of quality from the positions of safety by 0.23%; decrease (improvement) of normative regulation of digitalization by 1 positions leads to increase of index of quality from the positions of safety by 0.03%; decrease (improvement) of e-government by 1 position leads to decrease of index of quality from the positions of safety by 0.48%.



**Figure 9.** Regression dependence of index of quality from the positions of safety on the indicators of digitalization in developing countries in 2020.

Source: calculated and compiled by the authors

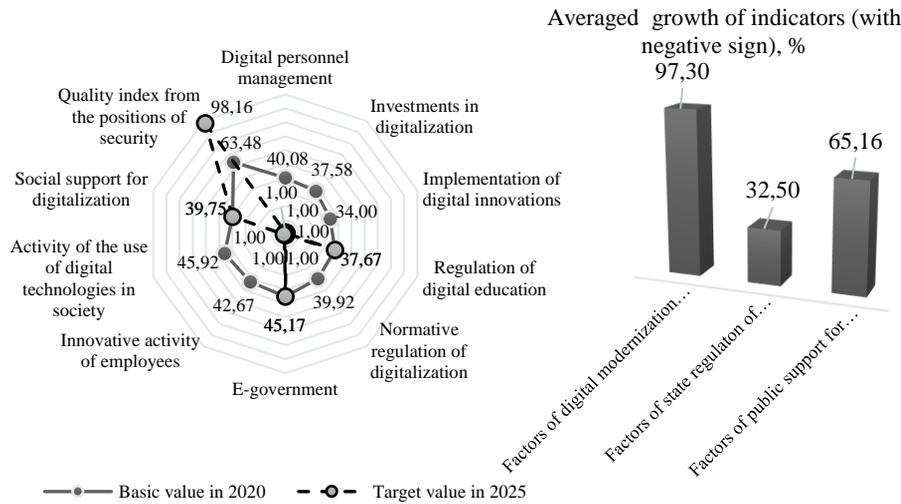
Decrease (improvement) of innovative activity of employees by 1 position leads to increase of index of quality from the positions of safety by 0.07%; decrease (improvement) of activity of the use of digital technologies in society by 1 position leads to increase of index of quality from the positions of safety by 0.23%; decrease (improvement) of social support for digitalization by 1 position leads to decrease of index of quality from the positions of safety by 0.15%.

The results of optimization of influence of digitalization on quality from the positions of safety in developing countries in the period until 2025, based on the data from Figure 9, are shown in Figure 10. Average value of index of quality from the positions of safety in developing countries in 2020 constitutes 63.48%. The purpose of optimization is to take it to the highest possible level (up to 100%).

As shown in Figure 10, the maximum level to which index of quality from the positions of safety could be taken with the help of digitalization by 2025 is 98.16%, which is by 1.55 higher than on average in 2020 (63.48%). For this, the factors of digital modernization of business on should be improved by 97.30%, factors of state regulation of digitalization – by 32.50%, and factors of public support for digitalization – by 65.16%.

### 4.3 Practical implications for improving quality management from the positions of safety in the digital economy of developing countries

According to the obtained results of optimization, the practical implications for improving quality management from the positions of safety in the digital economy of developing countries until 2025 have been developed. Let us consider them in the order of priority.



**Figure 10.** Optimization of the influence of digitalization on quality from the positions of safety in developing countries in the period until 2025.  
Source: calculated and compiled by the authors

Acceleration of digital modernization of business is considered to be of the highest significance. For this it is offered to use “smart” technologies for intellectual monitoring of the issued products’ quality from the positions of safety. In case of high level of management automization at a company, the offered monitoring will not require separate technologies and expenditures. This will allow establishing safety as a generally recognized characteristic of product quality in the digital economy and will create marketing stimuli for companies for publishing reports as a result of monitoring of safety within corporate reports on social responsibility.

Then – in terms of significance – comes increase of public support for digitalization. For this, it is recommended to raise consumers’ awareness of the digital technologies’ capabilities’ application in the interests of safety increase, which envisages specialized courses of digital literacy for wide groups of population. Also it is important to raise the level of consumers’ responsibility and requirements to products’ safety, for which state social advertising

could be used.

The third place (last one) in terms of significance belongs to increase of activity of state regulation of digitalization. For this, it is expedient to implement flexible standards of product quality, which will set requirements to their safety, but will not limit entrepreneurship’s innovative activity. This will allow achieving the society’s priorities in the sphere of safety and keeping other aspects of quality at the required level. “Smart” technologies should be used for controlling the observation of standards.

## 5. Conclusion

Thus, we have determined the close connection between digitalization and safety – as a characteristic of product quality in developing countries in 2020. It has been proved that digitalization creates positive internal effects, increasing healthcare index by 4.84% on average, and food safety index – by 75.87%, i.e., making products safer for consumers’ health. However, due to digitalization, climate index decreases by

20.62%, which shows high ecological costs of the digital economy and the risks for products' safety for the environment.

Quality also influences safety in the digital society and the digital economy, which proves the offered hypothesis. Thus, digitalization of safety index by 48.55% leads to decrease of the shadow economy by 11.78%, increase of annual rate of economic growth by 22.18%, and increase of cybersecurity index by 57.21%. Economic freedoms changes the influence of digitalization on quality from the positions of safety. It has been determined that in countries with low economic freedom (moderately unfree, -22.60%) and in countries with high economic freedom (mostly free, -19.63%), generalized influence of the factors of digitalization on the indicators of safety is moderately positive, and in countries with moderate economic freedom (moderately free, -1.07%) – neutral.

The general level of products' quality from the positions of safety in developing countries is rather high, regardless of the level of economic freedom, constituting 63.48% on average in 2020. Due to optimization of influence of digitalization, products' quality from the positions of safety in developing countries could be increased by 1.55 times, up to 98.16% in the period until 2025. For this, a complex of practical recommendations, which are ranked by significance, is offered.

The contribution of the performed research to development of economics consists in specification of the concept of product quality – it should be evaluated not only from the positions of direct, main target result (advantages for consumers), but also from the positions of additional internal and external positive (results) and negative (expenditures) effects by the criterion of safety. We have distinguished and systematized the indicators of products' safety as the characteristics of quality and

offered a methodological approach to integral evaluation of quality from the positions of safety in the unity of all its manifestations.

Theoretical significance of the research consists also in determining the influence of the digital economy on quality of products from the positions of safety – in view of the factors of digitalization and in view of the level of economic freedom. Practical significance of the obtained results consists in the determined specifics of influence of digitalization on safety allowing developing and implementing different strategies of state regulation of quality from the positions of safety in countries with various levels of economic freedom, as well as increasing or decreasing the level of economic freedom in the interests of quality from the positions of safety.

Empirical value of the authors' conclusions and recommendations consists in the high level of detailization of optimization of influence of digitalization on quality from the positions of safety, as well as in consideration of the specifics of developing countries. Due to this, the authors' developments could be successfully implemented into the activities of state regulators of the digital economy and entrepreneurship for significant increase of products' quality from the positions of safety.

This research has a drawback – emphasis on safety as the least studied characteristic of product quality. The standard and thoroughly studied and elaborated characteristic of product quality – advantages for consumers in the form of satisfaction of their target needs – is not considered here, which is a certain limitation of the obtained results. In the future scientific works, it is expedient to study the influence of digitalization on advantages for consumers and on safety for systemic evaluation of product quality with special attention to the experience and specifics of developing countries.

## References:

- Ahmad, Z., Ong, T. S., Liew, T. H., & Norhashim, M. (2019). Safety monitoring and information safety assurance behaviour among employees: An empirical analysis. *Information and Computer Safety*, 27(2), 165-188. <https://doi.org/10.1108/ICS-10-2017-0073>
- Alipour, M., Ghanbari, M., Jamshidinavid, B., & Taherabadi, A. (2019). The relationship between environmental disclosure quality and earnings quality: a panel study of an emerging market. *Journal of Asia Business Studies*, 13(2), 326-347. <https://doi.org/10.1108/JABS-03-2018-0084>
- Alpidovskaya, M. L., & Popkova, E. G. (2019). *Marx & Modernity: A Political and Economic Analysis of Social Systems Management*. A volume in the series Popkova, E.G. (Ed.) Advances in Research on Russian Business and Management, Charlotte, NC, USA, Information Age Publishing.
- Anand, R., Medhavi, S., Soni, V., Malhotra, C., & Banwet, D. K. (2018). Transforming information safety governance in India (A SAP-LAP based case study of safety, IT policy and e-governance). *Information and Computer Safety*, 26(1), 58-90. <https://doi.org/10.1108/ICS-12-2016-0090>
- Anttila, J., & Jussila, K. (2017). Understanding quality – conceptualization of the fundamental concepts of quality. *International Journal of Quality and Service Sciences*, 9(3/4), 251-268. <https://doi.org/10.1108/IJQSS-03-2017-0020>
- Bogoviz A. V., Lobova S. V., & Alekseev A. N. (2020a). Current state and future prospects of hydro energy in Russia. *International Journal of Energy Economics and Policy*, 10(3), 482-488.
- Bogoviz A. V., Lobova S. V., & Alekseev A. N. (2020b). Social development versus economic growth: current contradictions and perspectives of convergence. *International Journal of Sociology and Social Policy*. <https://doi.org/10.1108/IJSSP-03-2020-0061>
- Bogoviz A. V., Lobova S. V., Karp M. V., Vologdin E. V., & Alekseev A. N. (2019a). Diversification of educational services in the conditions of industry 4.0 on the basis of ai training. *On the Horizon*. 27(3-4), 206-212.
- Bogoviz A. V., Prokofiev V. N., Lobova S. V., Alekseev A. N., & Gimelshtein I. V. (2019b). Managing the modernization of regional markets of educational services in the conditions of formation of industry 4.0. *On the Horizon*, 27(3-4), 187-192.
- Bogoviz, A. V., Elykomov, V. A., Osipov, V. S., Kelina, K. G., & Kripakova, L. A. (2019c). Barriers and perspectives of formation of the e-healthcare system in modern Russia. *Studies in Computational Intelligence*, pp. 917-923.
- Calavrezo, O. (2007). The Effects of Fixed-term Employment Spells on the Integration of School-leavers on the Labour Market: Evidence from France. *International Journal for Quality research*, 1(4), 267-279.
- Ferjani, A., Mann, S., & Zimmermann, A. (2018). An evaluation of Swiss agriculture's contribution to food safety with decision support system for food safety strategy. *British Food Journal*, 120(9), 2116-2128. <https://doi.org/10.1108/BFJ-12-2017-0709>
- Ferracane, M. F. (2019). Data flows and national safety: a conceptual framework to assess restrictions on data flows under GATS safety exception. *Digital Policy, Regulation and Governance*, 21(1), 44-70. <https://doi.org/10.1108/DPRG-09-2018-0052>

- Hendler, S. (2019). Digital-physical product development: a qualitative analysis. *European Journal of Innovation Management*, 22(2), 315-334. <https://doi.org/10.1108/EJIM-01-2018-0026>
- IMD (2020). *World Digital Competitiveness Ranking 2019*. Retrieved from: <https://www.imd.org/wcc/world-competitiveness-center-rankings/world-competitiveness-ranking-2019/> (data accessed: 18.08.2020).
- Inshakova, A. O., & Bogoviz, A. V. (Ed.) (2020). *Alternative Methods of Judging Economic Conflicts in the National Positive and Soft Law*. A volume in the series Popkova, E.G. (Ed.) *Advances in Research on Russian Business and Management*, Charlotte, NC, USA, Information Age Publishing.
- International Monetary Fund (2020). *World Economic Outlook Database: Gross domestic product, constant prices, percent change*. Retrieved from: <https://www.imf.org> (data accessed: 18.08.2020).
- International Telecommunication Union (2020). *Cybersafety index*. Retrieved from: [https://www.itu.int/dms\\_pub/itu-d/opb/str/D-STR-GCI.01-2018-PDF-E.pdf](https://www.itu.int/dms_pub/itu-d/opb/str/D-STR-GCI.01-2018-PDF-E.pdf) (data accessed: 18.08.2020).
- Jain, E. (2020). Quality of services and customer loyalty: a study of private banks in nct of Delhi through servqual. *Proceedings on Engineering Sciences*, 2(4), 361-372.
- Karanja, E. (2017). The role of the chief information safety officer in the management of IT safety. *Information and Computer Safety*, 25(3), 300-329. <https://doi.org/10.1108/ICS-02-2016-0013>
- Koster, F., & Fleischmann, M. (2017). Under pressure: an international comparison of job safety, social safety, and extra effort. *International Journal of Sociology and Social Policy*, 17(13/14), 823-839. <https://doi.org/10.1108/IJSSP-03-2016-0031>
- Kusumawati, A., & Syamsuddin, S. (2018). The effect of auditor quality to professional skepticism and its relationship to audit quality. *International Journal of Law and Management*, 60(4), 998-1008. <https://doi.org/10.1108/IJLMA-03-2017-0062>
- Khwaja, M. G., Mahmood, S., & Jusoh, A. (2020). The impacts of quality management on customer focus in the beverages industry. *Proceedings on Engineering Sciences*, 2(1), 81-92.
- Li, A. Q., Rich, N., Found, P., Kumar, M., & Brown, S. (2020). Exploring product-service systems in the digital era: a socio-technical systems perspective. *The TQM Journal*, 32(4), 897-913. <https://doi.org/10.1108/TQM-11-2019-0272>
- Mohsenin, S., Sharifsamet, S., Esfidani, M. R., & Skoufa, L. A. (2018). Customer decision-making styles as a tool for segmenting digital products market in Iran. *Journal of Islamic Marketing*, 9(3), 560-577. <https://doi.org/10.1108/JIMA-04-2017-0041>
- Nayak, R., & Taylor, J. Z. (2018). Food safety culture – the food inspectors’ perspective. *Worldwide Hospitality and Tourism Themes*, 10(3), 376-381. <https://doi.org/10.1108/WHATT-02-2018-0013>
- Numbeo (2020). *Quality of life index 2020 mid-year*. Retrieved from: [https://www.numbeo.com/quality-of-life/rankings\\_by\\_country.jsp?title=2020-mid&displayColumn=8](https://www.numbeo.com/quality-of-life/rankings_by_country.jsp?title=2020-mid&displayColumn=8) (data accessed: 18.08.2020).
- Olsen, E. (2018). Influence from organisational factors on patient safety and safety behaviour among nurses and hospital staff. *International Journal of Organizational Analysis*, 26(2), 382-395. <https://doi.org/10.1108/IJOA-05-2017-1170>

- Osipov, V., Zeldner, A., & Skryl, T. (2018). Making the smart city: Technologies, experiences, and future perspectives. *MATEC Web of Conferences / Volume 212*, ICRE.
- Osipov, V. S. (2019). The rise of unemployment in the cyber economy. *The Cyber Economy. Contributions to Economics. Vol. Part F2*, pp. 105-116.
- Osipov, V. S. (2020). Digital future: Economic growth, social adaptation, and technological perspectives. *Advances in Intelligent Systems and Computing. 1100 AISC*, pp. 272-292.
- Popkova, E. G., & Sergi, B. S. (2020). Human Capital and AI in Industry 4.0. Convergence and Divergence in Social Entrepreneurship in Russia. *Journal of Intellectual Capital*, <https://doi.org/10.1108/JIC-09-2019-0224>.
- Popkova, E. G. (2017). *Economic and Legal Foundations of Modern Russian Society*. A volume in the series Popkova, E.G. (Ed.) *Advances in Research on Russian Business and Management*, Charlotte, NC, USA, Information Age Publishing.
- 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. (2020). A new treatment of quality of goods and services in the conditions of the knowledge economy: opposition of traditions and innovations. *International Journal for Quality Research*, 14(2), 329-346. <https://doi.org/10.24874/IJQR14.02-01>.
- Popkova, E. G., Przhedetsky, Yu V., Przhedetskaya, N. V., & Borzenko, K. V. (Ed.) (2020). *Marketing of Healthcare Organizations: Technologies of Public-Private Partnership*. A volume in the series Popkova, E.G. (Ed.) *Advances in Research on Russian Business and Management*, Charlotte, NC, USA, Information Age Publishing.
- Popkova, E. G., Poluyufta, L., Beshanova, Y., Popova, L. V., & Kolesnikova, E. (2017). Innovations as a basis for marketing strategies of Russian oil companies in the conditions of oil prices reduction. *Contributions to Economics*, (9783319606958), 449-455. [https://doi.org/10.1007/978-3-319-60696-5\\_57](https://doi.org/10.1007/978-3-319-60696-5_57)
- 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*. Berlin, Springer International Publishing.
- Qayoom, A., & Hadikusumo, B. H. W. (2019). Multilevel safety culture affecting organization safety performance: a system dynamic approach. *Engineering, Construction and Architectural Management*, 26(10), 2326-2346. <https://doi.org/10.1108/ECAM-08-2018-0355>
- 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 & Control*, 169, 167-174.
- Sadok, M., Alter, S., & Bednar, P. (2020). It is not my job: exploring the disconnect between corporate safety policies and actual safety practices in SMEs. *Information and Computer Safety*, 28(3), 467-483. <https://doi.org/10.1108/ICS-01-2019-0010>
- Salinas, A., Ortiz, C., & Muffatto, M. (2019). Business regulation, rule of law and formal entrepreneurship: evidence from developing countries. *Journal of Entrepreneurship and Public Policy*, 8(2), 254-271. <https://doi.org/10.1108/JEPP-03-2019-0019>

- Sergi, B. S., Popkova, E. G., Bogoviz, A. V., & Litvinova, T. N. (2019a). *Understanding Industry 4.0: AI, the Internet of Things, and the Future of Work*. Bingley, UK: Emerald Publishing Limited.
- Sergi, B. S., Popkova, E. G., Bogoviz, A. V., & Ragulina, J. V. (2019b). *Costs and Profits of Technological Growth in Russia*. In Bruno S. Sergi (Ed.) *Tech, Smart Cities, and Regional Development in Contemporary Russia* (pp. 41-54). Bingley, UK: Emerald Publishing.
- Sergi, B. S., Popkova, E. G., Bogoviz, A. V., & Ragulina, J. V. (2019c). *Entrepreneurship and Economic Growth: The Experience of Developed and Developing Countries*. In Bruno S. Sergi and Cole C. Scanlon (Eds.) *Entrepreneurship and Development in the 21st Century* (pp. 3-32). Bingley, UK: Emerald Publishing Limited.
- Shahzad, F., Rehman, I. U., Hanif, W., Asim, G. A., & Baig, M.H. (2019). The influence of financial reporting quality and audit quality on investment efficiency: Evidence from Pakistan. *International Journal of Accounting & Information Management*, 27(4), 600-614. <https://doi.org/10.1108/IJAIM-08-2018-0097>
- Shulus, A. A., Akopova, E. S., Przhedetskaya, N. V., & Borzenko, K. V. (2020). Intellectual Production and Consumption: A New Reality of the 21st Century. *Lecture Notes in Networks and Systems*, 92, 353-359.
- Singh, A. K., & Rawani, A. M. (2019). Application of quality function deployment for the prioritization of National Board of Accreditation quality parameters. *Quality Assurance in Education*, 27(1), 127-139. <https://doi.org/10.1108/QAE-11-2017-0078>
- Stanovicic, T., Bacovic, M., Pekovic, S., Jovanovic, J., & Savovic, I. (2016). The role of human resource practices on profits generated by the innovations: the role of top management support and regularity of employees meetings. *International Journal for Quality Research*, 10(4), 839-846. <https://doi.org/10.18421/IJQR10.04-13>
- Sturm, S., Kaiser, G., & Hartmann, E. (2019). Long-run dynamics between cost of quality and quality performance. *International Journal of Quality & Reliability Management*, 36(8), 1438-1453. <https://doi.org/10.1108/IJQRM-05-2018-0118>
- Susilowati, L., Ananda, C. F., Khusnul, A., & Susilo, S. (2019). Labour productivity in micro and small industries (research on leather craftsmen in magetan agency). *International journal for quality research*, 14(1), 111-128. <https://doi.org/10.24874/IJQR14.01-08>
- The Economist Intelligence Unit (2020). *Global Food Safety Index*. Retrieved from: <https://foodsafetyindex.eiu.com/> (data accessed: 18.08.2020).
- The Global Economy (2020). *Shadow economy - Country rankings*. Retrieved from: [https://www.theglobaleconomy.com/rankings/shadow\\_economy/](https://www.theglobaleconomy.com/rankings/shadow_economy/) (data accessed: 18.08.2020).
- The Heritage Foundation. (2020). *2020 Index of Economic Freedom*. Retrieved from: <https://www.heritage.org/index/ranking> (data accessed: 18.08.2020).
- Vendrell-Herrero, F., Myrthianos, V., Parry, G., & Bustinza, O. F. (2017). Digital dark matter within product service systems. *Competitiveness Review*, 27(1), 62-79. <https://doi.org/10.1108/CR-11-2014-0037>
- Vuorensyrjä, M. (2018). Police management reform, labor productivity, and citizens' evaluation of police services. *Policing: An International Journal*, 41(6), 749-765. <https://doi.org/10.1108/PIJPSM-02-2017-0025>
- Wang, X., Xu, Y., Wang, L., Xu, X., & Chen, Y. (2017). Transmission of information about consumer product quality and safety: a social media perspective. *Information Discovery and Delivery*, 45(1), 10-20. <https://doi.org/10.1108/IDD-10-2016-0035>

- Yu, K., Peng, L., Ding, X., Zhang, F., & Chen, M. (2019). Prediction of instantaneous driving safety in emergency scenarios based on connected vehicle basic safety messages. *Journal of Intelligent and Connected Vehicles*, 2(2), 78-90. <https://doi.org/10.1108/JICV-07-2019-0008>
- Zhang, J., & Patil, J. (2017). Who guarantees the quality of the quality assurance agencies? The exploration of the establishment and growth of the Asia-Pacific Quality Register (APQR). *Higher Education Evaluation and Development*, 11(2), 58-67. <https://doi.org/10.1108/HEED-07-2017-0001>
- Zhang, J., Mei, Q., & Liu, S. (2019). Study of the influence of employee safety voice on workplace safety level of small- and medium-sized enterprises. *Nankai Business Review International*, 10(1), 67-90. <https://doi.org/10.1108/NBRI-08-2017-0045>

---

**Sergei G. Vagin**

“MIREA - Russian  
Technological University”  
Moscow, Russia  
[vsg63@hotmail.com](mailto:vsg63@hotmail.com)

**Yuri N. Lascencov**

Moscow State Institute of  
International Relations  
(University) of the Ministry of  
Foreign Affairs Russian  
Federation, Moscow, Russia  
[secret.pf@yandex.ru](mailto:secret.pf@yandex.ru)

**Maria E. Konovalova**

Samara State University of  
Economics, Samara, Russia.  
[mkonoval@mail.ru](mailto:mkonoval@mail.ru)

**Eugene V. Frank** Samara  
State Technical University,  
Samara, Russia  
[evgeny-frank@mail.ru](mailto:evgeny-frank@mail.ru)

---

