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Article info:
Received 03.06.2021.
Accepted 25.10.2021.

UDC – 005.6
DOI – 10.24874/IJQR16.01-04



MARKETING MANAGEMENT OF QUALITY BASED ON INDUSTRIAL AND MANUFACTURING ENGINEERING OF PROJECT ACTIVITIES: SOCIAL ENTREPRENEURSHIP VS. TECHNOLOGICAL ENTREPRENEURSHIP

Abstract: *The purpose of this paper is to substantiate the advantages and to develop applied recommendations for marketing management of quality based on industrial and manufacturing engineering of project activities, in view of the specifics in social and technological entrepreneurship. Originality and novelty of the research are due to its following competitive advantages as compared to the existing published works. Firstly, the essence of quality management based on industrial and manufacturing engineering of project activities in the unity of social and technical criteria of quality is specified. Secondly, the specifics of the COVID-19 are determined, and the recommendations and qualitative landmarks for quality management for the purpose of economic crisis management are offered. Thirdly, the advantages are substantiated, and perspectives of marketing quality management for its systemic increase in view of all modern criteria are determined. Fourthly, the corresponding recommendations for managing products' quality separately for social and technological entrepreneurship are offered. The contribution of this paper to development of the theory and practice of quality management consists in development of marketing tools of quality management, substantiation of differences between quality management in social and technological entrepreneurship, consideration of influence of the COVID-19 crisis on quality, and development of the framework foundations for preventing the reduction of quality.*

Keywords: *Quality; Marketing Management; Quality Management; Project Activities; Entrepreneurship; Social Entrepreneurship; Technological Entrepreneurship; Industrial and Manufacturing Engineering.*

1. Introduction

Quality is a complex subjective dynamic characteristic of goods and services, which undergoes constant changes in the market economy. The more products satisfy the

consumers' current needs, the higher the products' quality. At the modern stage of development of the world market economy, requirements to products' quality form under the influence of two global tendencies.

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1st tendency: social progress. Increase of the global level of education together with adoption of sustainable development goals leads to formation of a responsible society, which strives to consumption of products which do not deal any damage to environment and which are manufactured I favorable conditions for realizing the human potential of a company's employees. Thus, the criteria of products' quality are corporate social responsibility and products' eco-friendliness.

2nd tendency: technological progress. In the conditions of the Fourth technological revolution, the leading technologies become more accessible and widespread. In the digital society, consumers are ready and able to master new technologies, and also set high demand for them. That's why high technology becomes a priority of entrepreneurship's development. The criteria of quality in a technocratic social environment, which values knowledge, information, and technology, are high technology export and digital competitiveness of products.

These tendencies form a new environment for the world markets of goods and services and new conditions for their competition from the positions of quality. However, the specifics of quality in a new global context have not been sufficiently studied, and the modern concept of quality of products has not been formed, due to certain research gaps. One of the most important gaps is ambiguity of the essence of quality which is formed on the basis of industrial and manufacturing engineering of project activities.

Project activities are innovations of entrepreneurship, and industrial and manufacturing engineering is the technological provision of these innovations. Criteria of quality are contradictory. Most of the leading technologies are connected to high risk for environment (e.g., the risk of ecological disasters due to exponential growth of the volume of energy consumption) and for society (e.g., automation causes the growth of unemployment).

In their turn, socio-oriented and "green" innovations are often connected to a refusal to use the leading technologies. Due to contradiction of the criteria of quality and underdevelopment of the concept which determines the foundations of correspondence to these criteria, industrial and manufacturing engineering of project activities allows observing either some criteria or other criteria – but not all at the same time – which allows only for partial increase of quality of a narrow market segment.

Another serious gap is insufficient consideration of the new context of quality management based on industrial and manufacturing engineering of project activities in the conditions of the COVID-19 global economic crisis. Though the criteria of quality in the crisis conditions remain the same, the possibilities for observing them are limited. In view of general reduction of innovative activity of entrepreneurship due to the large deficit of financial resources in the conditions of the crisis, industrial and manufacturing engineering of project activities is oriented at innovations as a goal in itself and an independent tool of increase of products' competitiveness.

In the conditions of deficit, quality goes to background, giving way to accessibility of products as a landmark of demand in the market. Though in the short-term this could be profitable for companies under the condition of increased power of offer in the market, neglecting quality in the long-term will lead to decline of competitiveness, especially under the pressure of international competition, and reduction of satisfaction of public needs. That's why there's a necessity for a guide with the scientific support for quality management of products in the conditions of the COVID-19 crisis.

Another important gap is poor elaboration of the specific features and advantages of marketing during quality management based on industrial and manufacturing engineering of project activities. In the conditions of the

market economy, marketing in consumer society has to support the satisfaction of public needs – which is especially important if they are contradictory.

Another gap is also the absence of a clear idea of entrepreneurship's structure. Business structures, which are oriented at observation of such criteria of quality as corporate responsibility and support for sustainable development belong to social companies, and business structures that strive for observation of such criteria of quality as high technology and digital competitiveness belong to technological companies. Differences in quality management between these companies have not been studied sufficiently.

The above gaps predetermine the scientific and practical problem of uncertainty and low effectiveness of quality management in the activities of modern entrepreneurship. This is proved by the low global level of happiness. According to World Happiness Report 2020, no country of the world approached the maximum level of happiness (10 points) Helliwell et al. (2020). Even in Finland, which is the leader of the global rating, the level of happiness is relatively low – 7.809 points. Therefore, the leading opportunities of developed countries do not allow for full satisfaction of the modern society's needs.

In Afghanistan, which occupies the last, 153rd, position, the level of happiness is critically low (2.567 points). Therefore, despite the globalization, international entrepreneurship cannot ensure a high level of quality of products and make humanity happy. Here we offer a hypothesis that this problem could be solved by quality management based on industrial and manufacturing engineering of project activities, the use of marketing management, and differentiation of the practices of quality management in social and technological entrepreneurship.

The purpose of this paper is to substantiate the advantages and to develop applied recommendations for marketing management of quality based on industrial and

manufacturing engineering of project activities, in view of the specifics in social and technological entrepreneurship. Originality and novelty of the research are due to its following competitive advantages as compared to the existing published works. Firstly, the essence of quality management based on industrial and manufacturing engineering of project activities in the unity of social and technical criteria of quality is specified. Secondly, the specifics of the COVID-19 are determined, and the recommendations and qualitative landmarks for quality management for the purpose of economic crisis management are offered. Thirdly, the advantages are substantiated, and perspectives of marketing quality management for its systemic increase in view of all modern criteria are determined. Fourthly, the corresponding recommendations for managing products' quality separately for social and technological entrepreneurship are offered.

The goal of this paper predetermines the logic and structure of this paper: introduction; literature review; description of materials and methodology; results: 1) determination of advantages and key tools of marketing management of quality based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship; 2) determination of the consequences of the COVID-19 global economic crisis for quality of products in social and technological entrepreneurship; 3) recommendations for marketing management of quality based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship for the purpose of economic crisis management COVID-19 in 2021; conclusions.

2. Literature Review

The theoretical basis of this research is formed of the results of publications and works on the following thematic blocks.

1st block: marketing management of quality in entrepreneurship, which is studied in the works Popkova et al. (2020), and Popkova and Sergi (2018).

Solimun and Fernandes (2018) note the mediation effect of customer satisfaction in the relationship between service quality, service orientation, and marketing mix strategy to customer loyalty.

Lasrado (2019) substantiates the role of marketing motives and benefits of quality award frameworks. Pattanayak et al. (2017) point out the influence of TQM, service quality and market orientation on customer satisfaction and loyalty in the Indian banking sector. Ali et al. (2020) prove the effect of entrepreneurial orientation, market orientation and total quality management on performance: (based on the data Saudi SMEs).

Iqbal et al. (2020) determine the nexus between product market competition and the quality of analysts' forecasts: empirical evidence from Chinese-listed firms. Iqbal et al. (2017) perform modeling of product market competition and reporting quality by the example of the transitional economy of China. Dubey et al. (2019) provide an analytical viewpoint on perceived quality and customer delight in entrepreneurial marketing.

2nd block: quality management based on industrial and manufacturing engineering of project activities, which is studied in the works Gritsuk et al. (2019) and Popkova (2020). Antunes et al. (2017) show the relationship between innovation and total quality management and the innovation effects on organizational performance. Sciarelli et al. (2020) prove the relationship between quality management practices, organizational innovation, and technical innovation in higher education.

Sahoo (2019) draw the connection between quality management, innovation capability and firm performance (based on empirical insights from Indian manufacturing SMEs). Maistry et al. (2017) study total quality

management and innovation in view of relationships and effects on performance of agricultural R&D organisations.

Lilja et al. (2017) draw connection between innovation and the future of quality management and think that quality and innovation management merging is necessary. El Manzani et al. (2019) performs an analysis from the sociotechnical systems theory and substantiates that ISO 9001 quality management system supports product innovation in entrepreneurship. Ershadi et al. (2019) offer methodological recommendations for measuring the impact of soft and hard total quality management factors on customer behavior based on the role of innovation and continuous improvement.

3rd block: social entrepreneurship as a special economic subject that conducts sustainable production and manifests high corporate social and ecological responsibility – studied in Sergi (2019), Sergi et al. (2019). Lyne et al. (2018) offer scientific understanding of social enterprise, social entrepreneurship and the social economy in rural Cambodia.

Kokko (2018) thinks that social entrepreneurship creates not only commercial but also social value (benefits). Phipps and Prieto (2018) think that social entrepreneurship could increase social injustice. Canestrino et al. (2019) deem it necessary to create social value through entrepreneurship (by the example of the social business model of La Paranza).

Lorenzo-Afable et al. (2020) state that 'social' value creation is care and determine the perspective beneficiaries in social entrepreneurship. Maalaoui et al. (2020) point out that knowledge management explains the poor growth of social enterprises and give the key insights from a systematic literature review on knowledge management and social entrepreneurship. Pittz et al. (2017) think that social entrepreneurship is a catalyzer of social innovations and deem it necessary to use compassion and open strategy in social entrepreneurship.

4th block: technological entrepreneurship as a subject of the digital economy, which implements the leading technologies and produces and sells hi-tech products in the global markets – studied in the works Inshakova and Bogoviz (2020), Popkova and Sergi (2019), Ragulina (2019a; 2019b).

Meil and Salzman (2017) note the specifics of technological entrepreneurship in India. McNulty (2018) states that High-tech workplace tools are key to winning the war for talent. Chiu et al. (2018) deem it necessary to enhance knowledge sharing in high-tech firms and prove the moderating role of collectivism and power distance.

Tanabandeh et al. (2019) perform a systematic mapping study on risk management in the export development of high-tech products. Hallam et al. (2018) note culture and social capital network effects on the survival and performance of high-tech micro and small firms. Zhu et al. (2019) perform a comparative study of the effects of different factors on firm technological innovation performance in different high-tech industries.

Summing up the performed literature review, it is possible to conclude that the components of the formulated problem are studied in detail in the existing scientific literature. However, the existing studies do not allow forming a comprehensive idea and outlining the scientific perspective of the systemic observation of all criteria of quality in the activities of modern entrepreneurship due to the following gaps. 1st gap: insufficient elaboration of the methodological provision of quality management. In particular, marketing management of quality based on industrial and manufacturing engineering of project activities in entrepreneurship is poorly studied.

2nd gap: new market context, which has formed in the conditions of the COVID-19 global economic crisis, is not studied sufficiently, which does not allow offering recommendations for quality management in entrepreneurship and determining the

perspectives and landmarks of its increase. 3rd gap: absence of a clear differentiation in economic literature of quality management in social and technological entrepreneurship. Though these types of entrepreneurship are usually differentiated, their experience and specifics of quality management are not studied separately. This research aims to fill the mentioned gaps.

3. Materials and methodology

For the empirical purposes, the research objects in this paper are top countries with developed social entrepreneurship, according to social entrepreneurship ranking from the Dataset “Social Entrepreneurship in the World Economy: a Path from Virtual Scores to Big Data – 2020” (Institute of Scientific Communications, 2020b), and top countries with developed technological entrepreneurship, according to World Digital Competitiveness Ranking 2019 (IMD, 2020).

Uniqueness and advantage of this selection consist in the following: it does not contain countries that are at the top of both these rankings (e.g., the USA, Singapore, etc.). This allows differentiating social and technological entrepreneurship for the first time. Performing the research on the basis of countries with developed entrepreneurship of both types leads to limited and distorted results, not allowing determining the differences between them. This drawback of the existing works is overcome with the help of a new approach to formation of a selection of countries. This approach is used here.

As there are no separate statistics in the sphere of marketing entrepreneurship, in order to use the most detailed (a lot of indicators) and comparable (from the same source) data, we use – as the factors of marketing quality management in modern entrepreneurship – the complex of indicators from The Global Competitiveness Report 2019 (World Economic Forum, 2020). Original titles of the indicators that are used in the report do not reflect their marketing essence.

That's why original titles are preserved and then translated in "materials and methodology" – thus the performed calculation can be verified by all interested parties. However, in results and conclusions we use the titles of indicators that are specified from the positions of marketing. The list of the indicators of marketing management and their original and specified titles are as follows:

- multi-stakeholder collaboration (marketing research and communications);
- trademark applications (product marketing);
- buyer sophistication (marketing of relations with consumers);
- shareholder governance (marketing of investments);
- international co-inventions (international marketing);
- state of cluster development (marketing of relations with rivals);
- cooperation in labour-employer relations (HR marketing);
- strength of auditing and accounting standards (marketing of relations with government).

The data on the above indicators in the selected countries are given in Table 1.

Table 1. Marketing factors of quality management based on industrial and manufact. engineering of project activities in social and technological entrepreneurship in 2020, points 0-100

Category	Country	Indicators' titles, which reflect their essence and are used in this paper							
		Marketing research and communications	Product marketing	Marketing of relations with consumers	Marketing of investments	International marketing	Marketing of relations with rivals	HR marketing	Marketing of relations with government
		Original titles of the indicators, which are used in the WEF report							
		Multi-stakeholder collaboration	Trademark applications	Buyer sophistication	Shareholder governance	International co-inventions	State of cluster development	Cooperation in labour-employer relations	Strength of auditing and accounting standards
Top countries with developed social entrepreneurship	Russia	49.5	65.44	41.2	73.0	15.91	40.3	56.5	54.6
	Italy	45.6	94.34	48.6	60.0	51.72	74.9	49.4	57.2
	Ireland	62.8	96.68	57.6	63.0	93.02	58.3	69.6	71.3
	India	53.3	57.54	49.8	87.0	10.13	54.3	58.4	62.5
	Brazil	44.3	71.23	43.1	73.0	8.20	48.7	44.1	61.1
	UAE	63.1	82.56	62.4	73.0	25.31	69.5	71.4	71.7
	Thailand	52.1	67.79	55.4	67.0	9.59	51.4	64.9	65.6
Top countries with developed technological entrepreneurship	China	57.3	79.23	58.2	67.0	19.70	59.6	59.6	59.1
	France	58.3	93.04	55.7	77.0	77.38	62.1	54.1	73.9
	Belgium	63.3	77.80	57.0	53.0	98.61	64.9	60.5	80.6
	Malaysia	69.0	70.96	62.9	73.0	32.54	69.8	72.6	73.8
	Iceland	62.6	96.67	54.4	73.0	81.56	52.2	74.1	79.5
	Estonia	52.9	98.84	46.5	57.0	54.48	43.9	72.3	74.3
	Lithuania	54.7	89.99	40.6	73.0	24.28	40.8	64.2	69.9

Source: compiled by the authors based on World Economic Forum (2020)

In this paper, we use the following indicators, which reflect the manifestations of quality that is increased on the basis of industrial and manufacturing engineering of project activities:

- social entrepreneurship index as the indicators of corporate social responsibility, according to Social entrepreneurship ranking of Institute of Scientific Communications (2020b);
- digital competitiveness index, according to the IMD ranking (2020);
- sustainable development and fight against climate change index, according to Ranking of sustainable development and

fighting climate change based on corporate social and ecological responsibility in countries of the world in 2020, provided in the Data set “Corporate social responsibility, sustainable development, and fighting climate change: imitation modeling and neural network analysis in regions of the world – 2020” of Institute of Scientific Communications (2020a);

- High technology export according to the materials of World Bank (2020).

The data on the above indicators in the selected countries are given in Table 2.

Table 2. Manifestations of quality that is increased on the basis of industrial and manufacturing engineering of project activities in social and technological entrepreneurship in 2020.

Category	Country	Social entrepreneurship index, points 0-100	Digital competitiveness index, points 0-100	Sustainable development and fighting climate change index, points 0-100	High-technology exports, % of manufactured exports
Top countries with developed social entrepreneurship	Russia	70.406	61.147	6.247	11.0
	Italy	67.903	57.568	16.883	8.0
	Ireland	85.863	57.565	13.512	25.0
	India	64.952	54.086	4.438	9.0
	Brazil	57.346	49.027	6.690	13.0
	UAE	90.295	48.035	5.712	11.0
	Thailand	68.434	47.193	5.522	23.0
Top countries with developed technological entrepreneurship	China	84.292	46.685	4.456	31.0
	France	82.522	55.341	27.354	26.0
	Belgium	82.491	45.775	48.758	12.0
	Malaysia	82.390	52.959	5.100	53.0
	Iceland	79.935	38.859	20.986	23.0
	Estonia	78.669	42.042	14.930	16.0
	Lithuania	77.578	40.094	13.177	12.0

Source: compiled by the authors based on IMD (2020), Institute of Scientific Communications (2020a), Institute of Scientific Communications (2020b), World Bank (2020)

The following methodology is used here. Firstly, correlation analysis, which is very good for full-design study of a large array of

data on the full set of indicators, when determining the advantage and key tools (with the highest correlation) of marketing

quality management based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship.

Secondly, forecasting with the help of random numbers generation – automatically on the basis of direct average and standard deviations with creation of histograms of normal distribution, for determining the consequences of the COVID-19 global economic crisis for quality of products in social and technological entrepreneurship.

Thirdly, regression analysis and simplex method of multi-parametric optimization – for the most precise preparation of recommendations on marketing management of quality based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship for the purpose of economic crisis management COVID-19 in 2021.

The hypothesis is deemed proved if there is vivid positive correlation between marketing factors of management based on industrial and manufacturing engineering of project activities and the manifestations of quality,

and if there are significant differences in correlation between top countries with developed social entrepreneurship and top countries with developed technological entrepreneurship.

4. Results

4.1 Advantages and key tools of marketing quality management based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship

In order to determine the key tools of marketing quality management based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship, let us use averaged results of correlation analysis of the data from Tables 1 and 2 (Figures 1-2). Systemic correlation between quality and marketing management in social entrepreneurship (21.65%) is higher than in technological entrepreneurship (14.35%). That's why for better perception of data, the data on top countries with developed social entrepreneurship are put in bold type.

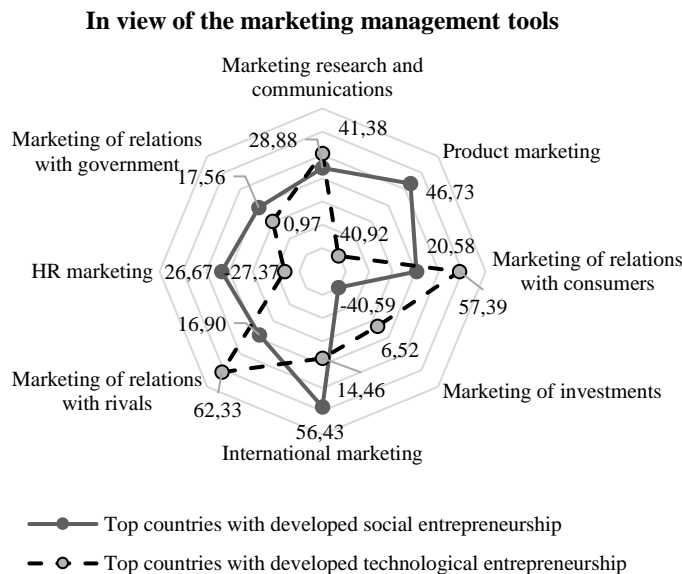


Figure 1. Averaged correlation between quality and tools of marketing management, %
 Source: calculated and compiled by the authors

As shown in Figure 1, the key tools of marketing quality management in social entrepreneurship are marketing of relations with rivals (62.33%), marketing of relations with consumers (57.39%), and marketing of research and communications (41.38%). Minor, but positively influencing, factors are international marketing (14.46%) and marketing of investments (6.52%) – but these factors cannot be considered key ones (correlation is below 15%), that’s why we do not consider them further.

In technological entrepreneurship, the key tools of marketing management of quality are international marketing (56.43%), product marketing (46.73%), HR marketing (26.67%), marketing research and communications (28.88%), marketing of relations with consumers (20.58%), marketing of relations with government (17.56%), and marketing of relations with rivals (16.90%).

As shown in Figure 2, in social entrepreneurship marketing factors of quality management based on industrial and manufacturing engineering of project activities determine only the following manifestations of quality: social entrepreneurship index (57.31%), sustainable development and fight against climate change index (15.09%), and high technology export (24.59%).

In technological entrepreneurship, the marketing factors of quality management based on industrial and manufacturing engineering of project activities determine all manifestations of quality: social entrepreneurship index (10.42%), digital competitiveness index (13.21%), sustainable development and fight against climate change index (14.61%), and high technology export (19.14%).

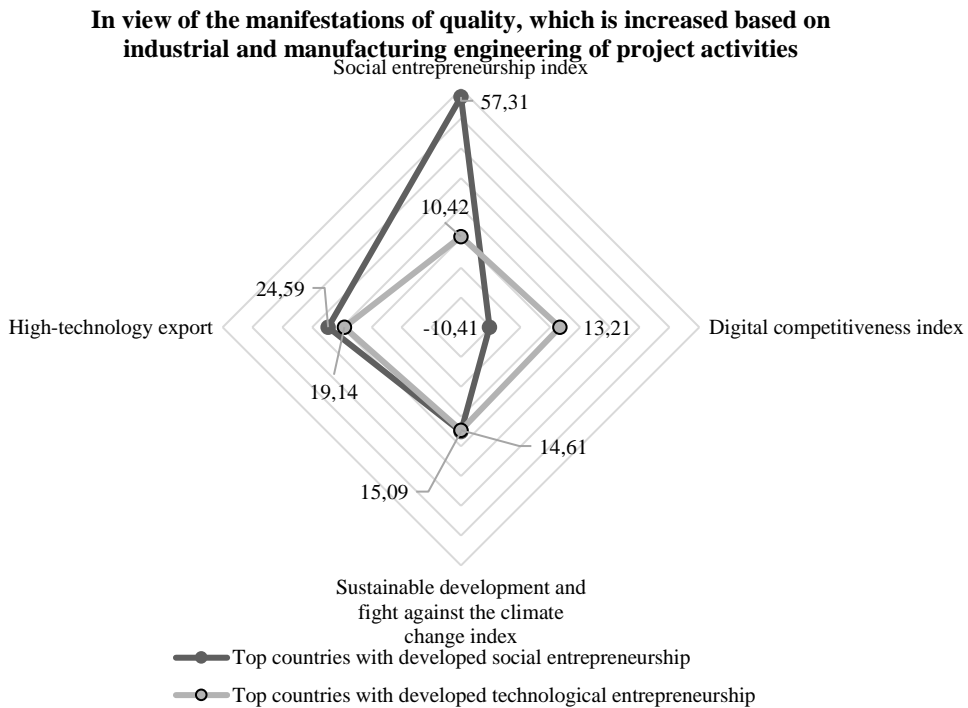


Figure 2. Averaged correlation between marketing management and the manifestations of quality, %

Source: calculated and compiled by the authors

To determine the advantages of marketing management of quality based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship and to choose non-

contradictory (no correlation coefficients should be negative) factors, let us use the detailed results of correlation analysis of data from Tables 1 and 2 (Figures 3-6).

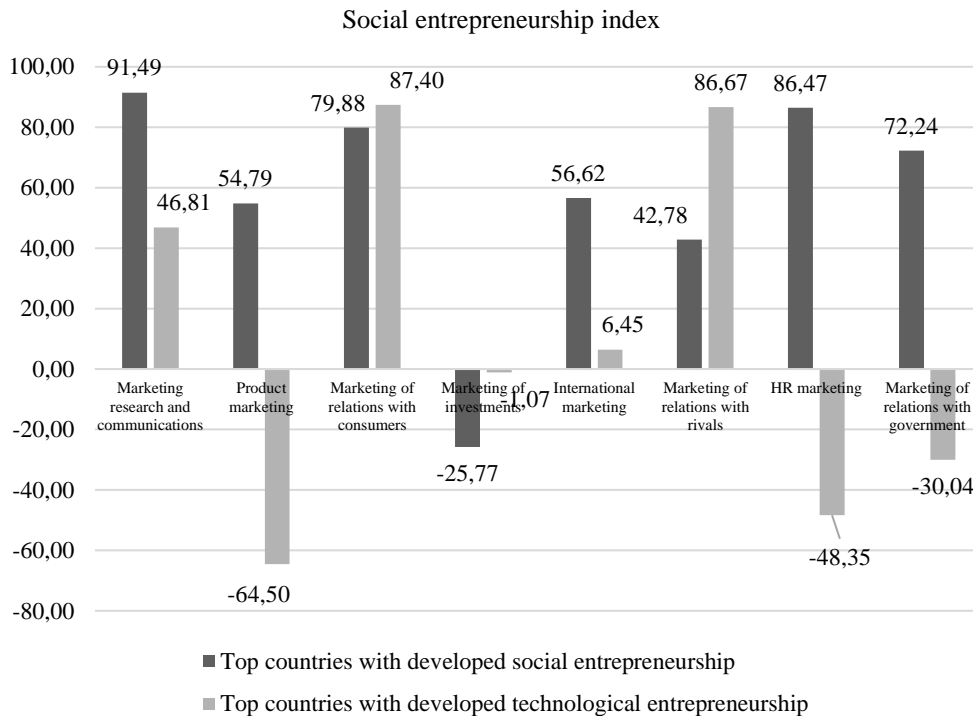


Figure 3. Correlation between social entrepreneurship index and marketing factors, %
Source: calculated and compiled by the authors

As shown in Figure 3, social entrepreneurship in countries with developed social entrepreneurship shows positive connection with previously selected marketing factors: marketing of relations with rivals (42.78%), marketing of relations with consumers (79.88%), and marketing of research and communications (91.49%).

Corporate social responsibility (social entrepreneurship index) in technological

entrepreneurship shows positive connection with international marketing (6.45%), marketing of research and communications (46.81%), marketing of relations with consumers (87.40%), marketing of relations with government (-30.04%), and marketing of relations with rivals (86.67%); but negative connection with product marketing (-64.50%) and HR marketing (-48.35%) – therefore, we shall not consider these factors.

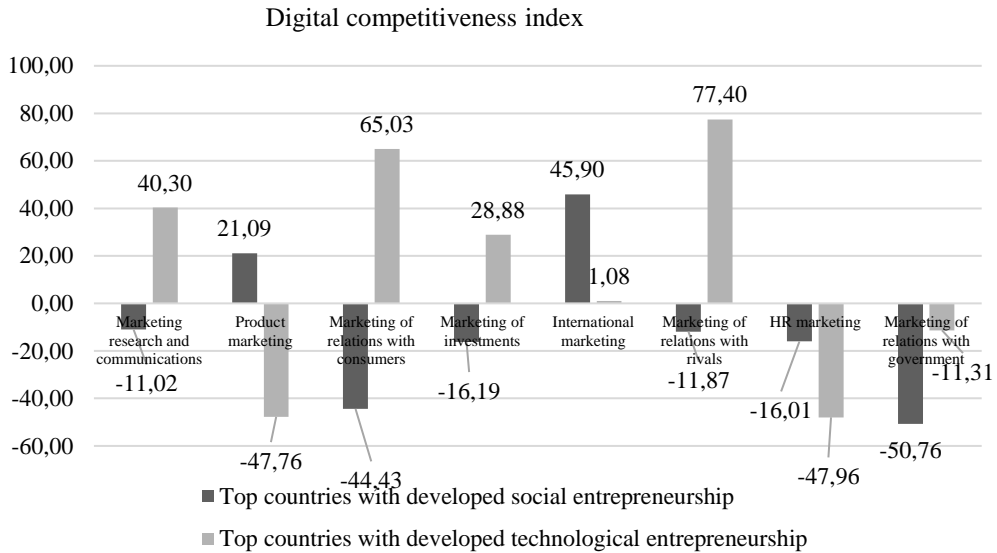


Figure 4. Correlation between social entrepreneurship index and marketing factors, %
Source: calculated and compiled by the authors

As shown in Figure 4, digital competitiveness in technological entrepreneurship shows positive connection with international marketing (1.08%), marketing research and communications (40.30%), marketing of

relations with consumers (65.03%), and marketing of relations with rivals (77.40%); but negative connection with marketing of relations with government (-11.31%) – therefore, we shall not consider this factor.

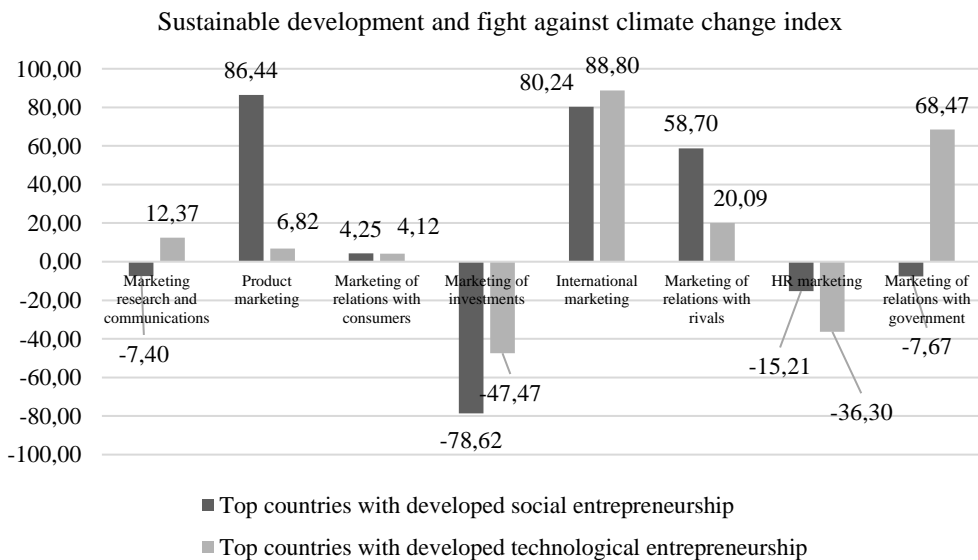


Figure 5. Correlation between social entrepreneurship index and marketing factors, %
Source: calculated and compiled by the authors

As shown in Figure 5, sustainable development index in countries with developed social entrepreneurship shows positive connection with previously selected marketing factors: marketing of relations with rivals (58.70%) and marketing of relations with consumers (4.25%); but negative connection with marketing research and communications (-7.40%) – therefore, we

shall not consider this factor.

Sustainable development index in technological entrepreneurship shows positive connection with international marketing (88.80%), marketing research and communications (12.37%), marketing of relations with consumers (4.12%) and marketing of relations with rivals (20.09%).

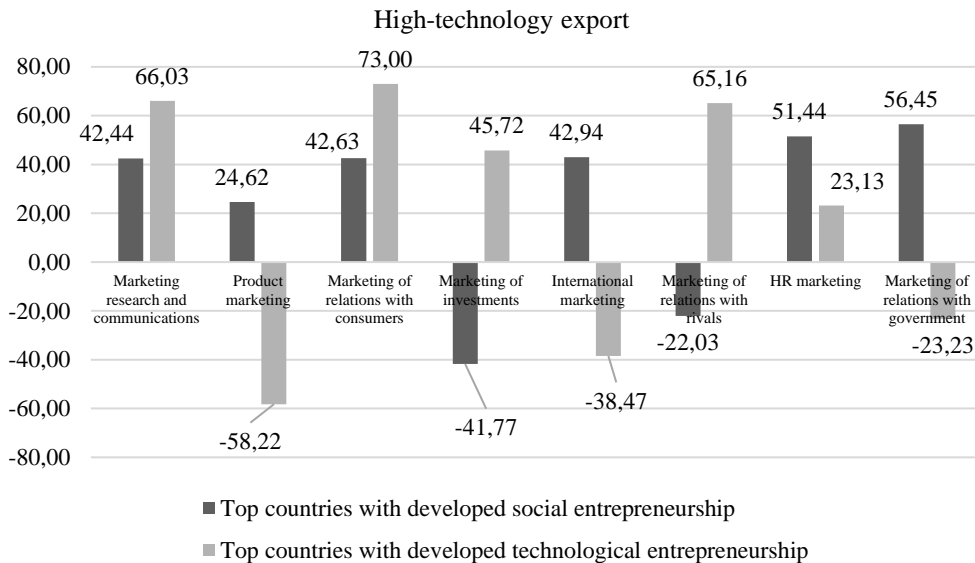


Figure 6. Correlation between social entrepreneurship index and marketing factors, %
Source: calculated and compiled by the authors

As shown in Figure 6, high technology export in countries with developed social entrepreneurship shows positive connection with previously selected marketing factors: marketing of relations with consumers (42.63%); but negative connection with marketing of relations with rivals (-22.03%) – therefore, we shall not consider this factor.

High technology export in technological entrepreneurship shows positive connection with marketing research and communications (66.03%), marketing of relations with consumers (73.00%), and marketing of relations with rivals (65.16%); but negative connection with international marketing (-38.47%) – therefore, we shall not consider this factor.

Thus, the key and non-contradictory marketing factor of quality management in social entrepreneurship is marketing of relations with consumers (x) – it defines all manifestations of quality, except for digital competitiveness (social responsibility: y_1 , sustainability: y_2 , high technology export: y_3). In technological entrepreneurship, the key and non-contradictory marketing factors of quality management are marketing research and communications (x_1), marketing of relations with consumers (x_2) and marketing of relations with rivals (x_3) – they define all manifestations of quality (social responsibility: y_1 , digital competitiveness: y_2 , sustainability: y_3 and high technology export: y_4).

4.2 Consequences of the COVID-19 global economic crisis for quality of products in social and technological entrepreneurship

To determine the consequences of the COVID-19 global economic crisis for quality of products, we calculate – on the basis of the data from Table 2 – direct average and standard deviations of the manifestations of quality, which are subject to marketing

management and which are the following for social entrepreneurship: for social entrepreneurship index – 72.17 and 11.71; for sustainable development index – 8.43 and 4.78; for high-technology export – 14.29 and 6.85. Microsoft Excel functions “Random numbers” and “Histogram” were used to obtain the following forecasts of the selected indicators’ values (Figure 7).

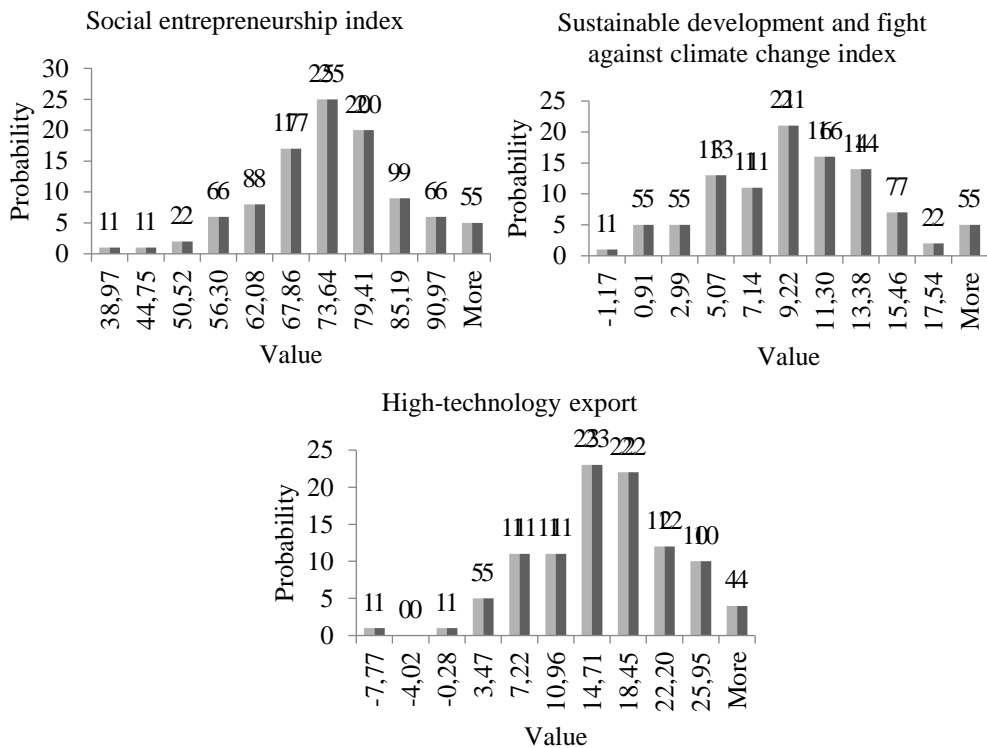


Figure 7. Histograms of normal distribution of forecast values of the manifestations of quality in social entrepreneurship

Source: calculated and compiled by the authors

We suppose that the COVID-19 crisis will reduce the indicators of quality in 2021, but insignificantly – to the minimum forecast level, which follows the average values in 2020. That’s why, as shown in Figure 7, forecast values of quality, which is reduced due to the influence of the COVID-19 crisis are as follows: for social entrepreneurship index – 67.86 (the value following 72.17), for

sustainable development index – 7.14 (the value following 8.43), and for high-technology export – 10.96 (the value following 14.29).

Similarly, on the basis of data from Table 2 we calculate direct average and standard deviations of the manifestations of quality, which are subject to marketing management and which are as follows for technological

entrepreneurship: for social entrepreneurship index – 81.13 and 2.43, for digital competitiveness – 45.97 and 6.29, for sustainable development index – 19.25 and 15.35, and for high-technology export – 24.71

and 14.40. Microsoft Excel functions “Random numbers” and “Histogram” were used to obtain the following forecast of the selected indicators’ values (Figure 8).

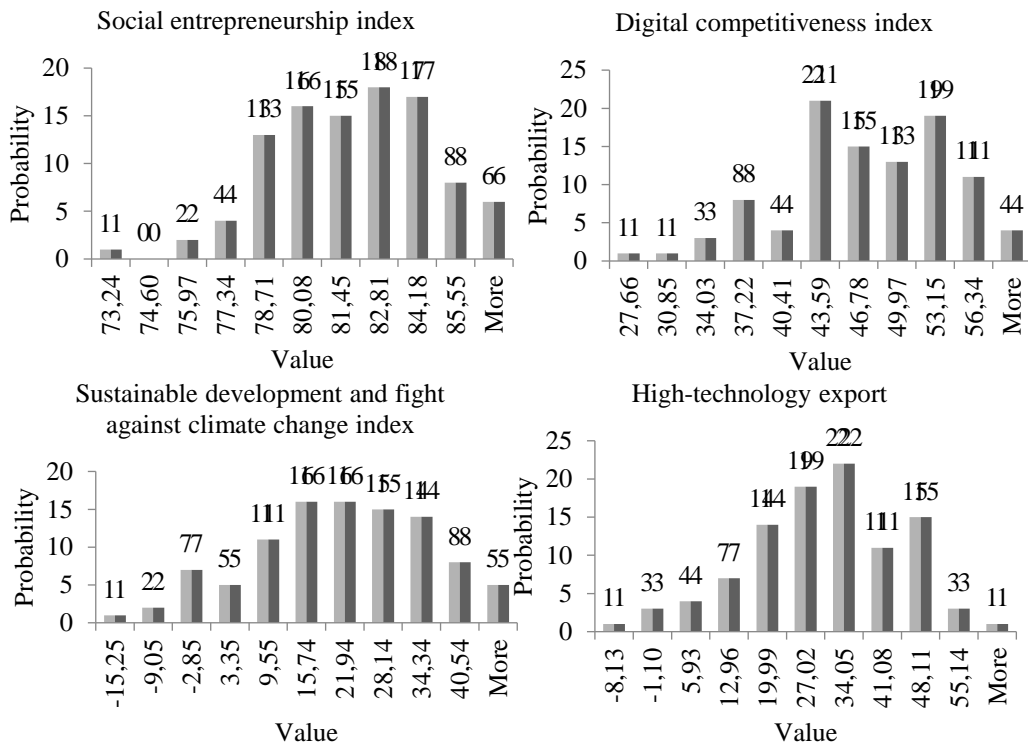


Figure 8. Histograms of normal distribution of forecast values of the manifestations of quality in technological entrepreneurship
Source: calculated and compiled by the authors

As shown in Figure 8, the forecast values of quality, reduced due to the influence of the COVID-19 crisis, are as follows: for social entrepreneurship index – 80.08 (the value following 81.13), for digital competitiveness – 43.59 (the value following 45.97), for sustainable development index – 15.74 (the value following 19.25), and for high-technology export – 24.71 (the value following 19.99).

4.3 Recommendations for marketing management of quality based on industrial and manufacturing engineering of project activities in social and technological entrepreneurship for the purpose of economic crisis management COVID-19 in 2021

To prepare recommendations for marketing management of quality based on industrial and manufacturing engineering of project activities in social and technological

entrepreneurship for the purpose of economic crisis management COVID-19 in 2021, we

perform regression analysis of the selected indicators from Tables 1 and 2 (Figure 9).

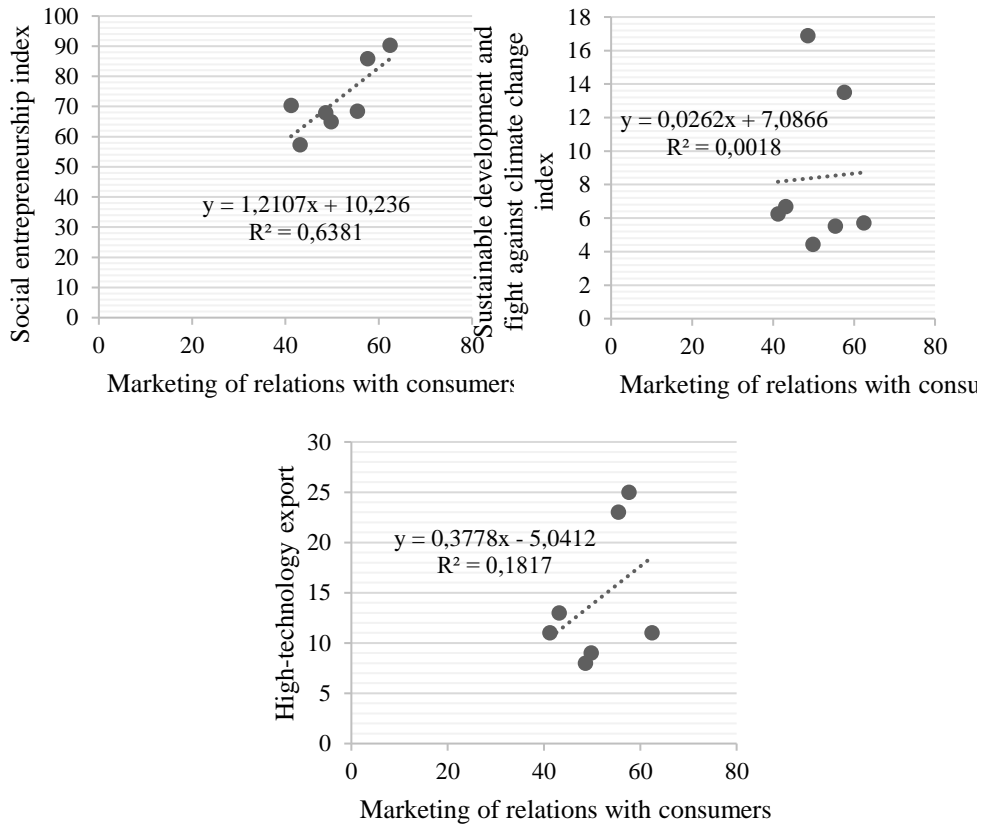


Figure 9. Regression curves of the dependence of the manifestations of quality on marketing of relations with consumers in social entrepreneurship

Source: calculated and compiled by the authors

As shown in Figure 9, all regression dependencies of the manifestations of quality on marketing of relations with consumers in social entrepreneurship are positive. For technological entrepreneurship, the following equations of multiple linear regression have been obtained:

- $y_1 = 77.16 - 0.30x_1 + 0.24x_2 + 0.15x_3$
(correlation – 97.11%);
- $y_2 = 51.16 - 0.59x_1 - 0.52x_2 + 1.03x_3$
(correlation – 87.32%);
- $y_3 = 48.27 + 0.13x_1 - 2.98x_2 + 2.19x_3$
(correlation – 50.78%);

- $y_4 = -82.58 + 0.74x_1 + 1.90x_2 - 0.69x_3$
(correlation – 76.01%).

To overcome the negative influence of the COVID-19 economic crisis on the manifestations of quality, they have to be increased by per cent, by which, according to Figures 7-8, they will reduce. The results of optimization of the influence of marketing management factors on the manifestations of quality in 2021 for social entrepreneurship are reflected in Table 3, for technological entrepreneurship– in Table 4.

Table 3. Optimization of the influence of marketing management factors on the manifestations of quality in 2021 for social entrepreneurship

Indicator	Symbol	Average value in 2020	Achieved value in 2021	Growth in 2021 as compared to 2020, %	Forecast value in 2021	Reduction of forecast value as compared to 2020	Targeted value in 2021
Marketing of relations with consumers	x	51.16	100.00	95.48	-	-	-
Social entrepreneurship index	y ₁	72.17	131.31	81.94	67.86	4.31	76.48
Sustainable development and fight against climate change index	y ₂	8.43	9.71	15.16	7.14	1.29	9.72
High technology export	y ₃	14.29	32.74	129.17	10.96	3.33	17.61

Source: calculated and compiled by the authors

As shown in Table 3, to prevent the reduction of social entrepreneurship index by 4.31%, sustainable development index – by 1.29%, and high-technology export by 3.33% in 2021, as compared to 2020, under the influence of the COVID-19 crisis and to

preserve quality of social entrepreneurship's products at the pre-crisis level, it is necessary to increase marketing of relations with consumers by 95.48% up to 100 points (as compared to 51.16 points in 2020).

Table 4. Optimization of the influence of the factors of marketing influence on the manifestations of quality in 2021 for technological entrepreneurship.

Indicator	Symbol	Average value in 2020	Achieved value in 2021	Growth in 2021 as compared to 2020, %	Forecast value in 2021	Reduction of forecast value as compared to 2020	Target value 2021
Marketing research and communications	x ₁	59.73	65.00	8.83	-	-	-
Marketing of relations with consumers	x ₂	53.61	60.00	11.91	-	-	-
Marketing of relations with rivals	x ₃	56.19	66.50	18.36	-	-	-
Social entrepreneurship index	y ₁	81.13	82.71	1.95	80.08	1.05	82.17
Digital competitiveness index	y ₂	45.97	50.16	9.14	43.59	2.38	48.34
Sustainable development and fight against climate change index	y ₃	19.25	23.51	22.14	15.74	3.51	22.76
High technology export	y ₄	24.71	33.62	36.03	19.99	4.72	29.44

Source: calculated and compiled by the authors

As shown in Table 4, to prevent the reduction of social entrepreneurship index by 1.05%, digital competitiveness index by 2.38%, sustainable development index by 3.51%, and high-technology export by 4.72% in 2021, as compared to 2020, under the influence of the COVID-19 crisis and to preserve quality of technological entrepreneurship's at the pre-crisis level, it is necessary to increase marketing of research and communications by 8.83% up to 65 points (as compared to 59.73 points in 2020), increase marketing of relations with consumers by 11.91% up to 60 points (as compared to 53.61 points in 2020), and increase marketing of relations with rivals by 18.36% up to 66.50 points (as compared to 56.19 points in 2020).

5. Conclusion

Thus, the offered hypothesis has been proved. It has been determined that marketing factors are very important in quality management based on industrial and manufacturing engineering of project activities. Marketing management could allow for full overcoming of the consequences of the COVID-19 crisis for social and technological entrepreneurship. However, in view of the proved specifics of these types of entrepreneurs, this requires different approaches to marketing management of quality based on industrial and manufacturing engineering of project activities.

The approach to social entrepreneurship envisages development of marketing of relations with consumers as the key factor of marketing management of quality based on industrial and manufacturing engineering of project activities. Due to low effectiveness of other marketing factors, marketing of

relations with consumers should be developed to the maximum level – however, this might be difficult in the course of 2020-2021. That's why additional measures of crisis management of quality of products of social entrepreneurship, which are outside of the scope of marketing, might be necessary.

The approach to technological entrepreneurship is based on a wide set of marketing tools of increase of quality based on industrial and manufacturing engineering of project activities with the possibility of diversification and flexible combination of these tools. The most optimal combination of the marketing factors envisages increase of marketing research and communications by 8.83%, marketing of relations with consumers by 11.91%, and marketing of relations with rivals by 18.36% in 2021, as compared to 2020.

Contribution of the performed research to development of theory and practice of quality management consists in scientific elaboration of the marketing tools of quality management based on industrial and manufacturing engineering of project activities, substantiation of differences between quality management in social and technological entrepreneurship, and provision of recommendations for the designated types of entrepreneurship, as well as consideration of the influence of the COVID-19 crisis on quality and development of framework foundations and quantitative landmarks for preventing the reduction of quality as compared to 2020 under the influence of the COVID-19 crisis and its preservation at the pre-crisis level by means of marketing quality management based on industrial and manufacturing engineering of project activities.

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