Improvement of the Method for Selecting Innovation Projects on the Platform of Innovative Supermarket

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Abstract **–The method of selection of innovative projects on the rating assessment of their economic efficiency was improved in the course of the study.**

This method implies systematization of different orientation of the lighting aspects of economic efficiency of innovative projects of individual indicators and justification of the procedure of generalization of the integral criterion of economic efficiency.

Thus, the indicators of economic efficiency of innovative projects have a very narrow direction of application and allow you to compare only the same capital costs of the project.

In order to facilitate the comparative evaluation of innovative projects in the paper it is proposed to carry out an integrated assessment, which involves ranking of the projects on the level of individual indicators of economic efficiency.

This method makes it possible to comprehensively assess projects of different characteristics, economic sphere, duration of implementation and contains a set of characteristics of the studied projects, which systematically describe the level of economic efficiency.

Generalization of single indicators of economic efficiency of innovative projects is carried out on the basis of a point assessment of level.

The scoring is carried out using the "3 Sigma rule", followed by the normal distribution of the data, almost reliably, can be distributed within the average value. This allows you to determine the score and rank of each indicator.

The proposed method allows for multi-criteria evaluation of the project to quantitative comparison of individual parameters of different projects and allows you to hide different economic content and units of measurement indicators in a single matter. This allows you to make informed management decisions on investing.

Keywords **– Innovative project, innovative supermarket, economic efficiency, rating of innovative projects, indicator of efficiency of innovative projects.**

1. Introduction

The current state of innovation development of the national economic system is characterized by a decline in industrial production and lack of investment in scientific research.

Increasing the competitiveness of Ukrainian enterprises is possible only in case of well-coordinated work of intellectual property owners, entrepreneurs, and investors.

At the stage of assessing innovation projects, the main task is to define the sphere of application of the innovative idea and ensure legal registration of the invention as an object of intellectual (industrial) property.

Further commercialization of the patented intellectual property and the development of a business plan for the innovation project are possible upon condition of their integral assessment.

Modern investors require justifying management decisions on feasibility of investing in a particular project.

To assess efficiency of innovation investment projects, there used various indicators, namely: quantitative, qualitative, absolute, relative, static, dynamic, expert ones, etc.

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Financial and economic assessment criteria are the most common. They make it possible to identify the main aspects of a project and assess the feasibility of practical implementation of the innovation.

However, they have a very restricted application, since they can only be used for comparing projects that involve identical capital expenditures.

This necessitates applying a comprehensive approach to the analysis of efficiency of investment in innovation projects that involve different capital expenditures.

This necessitates introducing a method that will allow for systematizing individual indicators of financial and economic efficiency and justify the procedure for combining them into an integral criterion for assessing economic efficiency of innovation projects that have different spheres of application.

2. Literature review and problem statement

Under modern conditions, the intensification of innovation activities of an enterprise is a prerequisite for its successful financial and economic functioning.

This fact is confirmed by modern researchers [1], [2]. On the one hand, the implementation of innovation projects contributes to obtaining additional competitive advantages by enterprises, qualitative improvement of their production and staff capacity [3].

On the other hand, as recent research shows, an innovation project will require time and considerable resources, it has certain risks [4] and may turn out to be economically inefficient.

The successful implementation of an innovation project primarily depends on assessing the projects available by executives and their right decision on choosing the most efficient one.

Some researchers suggest that an expert approach be used to assess innovation projects [5]. This approach takes into account the creativity and perspectiveness of some innovative ideas, however, it is rather difficult to organize and implement, especially for small enterprises [6].

In addition, it requires a lot of time, consistency of experts, and can be applied only to one or similar projects.

Methods for assessing commercial potential of innovation using computerized methods for analyzing information [7] do not allow for a preliminary selection of innovative ideas.

Modern researchers point out the need to assess innovation projects based on certain standard indicators (Net Present Value (*NPV*), Benefit Cost Ratio (*BCR*), etc.) or their modifications [8].

Some authors use these indicators to select the optimal innovation project based on minimax decision-making criteria and the theory of fuzzy sets [9].

However, this approach has a very restricted application, since these indicators are illustrative only for projects that are similar in terms of capital expenditures required for their implementation.

Thus, to compare innovation projects that differ in terms of their characteristics, capital expenditures required, sphere of application, and duration of implementation, it is necessary to develop an integral index.

Such an index will allow executives to assign ranking scores to innovation projects and select the most promising innovations.

3. Research aim and objectives

The aim of the research is to improve the method for selecting innovation projects based on the integral index of economic efficiency on the platform of innovative supermarket.

To achieve the aim, the following scientific objectives are set:

- substantiating the composition of the set of indicators for assessment of innovation projects and calculating the individual indicators;
- scoring individual indicators of economic efficiency of innovation projects using the three sigma rule;
- calculating the integral index of economic efficiency of innovation projects, which would involve ranking projects by the level of their individual indicators of economic efficiency.

4. Analysis of the economic efficiency of the investigated innovation projects

An innovative supermarket is a form of trading network cooperation between intellectual property owners, entrepreneurs, and investors.

The strategic goal of its creation is project identification and combination of efforts of inventors, investors, and consumers aimed at transforming their technologies into products that have fundamentally new properties and are of value to end users.

Specialists of the innovative supermarket need to define the area of application of an innovative idea, establish the type of protection document to confirm the property rights of inventors and provide legal registration of the invention as an object of intellectual (industrial) property (Table 1.).

These are requirements for the formation of an innovation project and its commercialization.

The innovation projects presented in Table 1. have been preliminary selected in the framework of the innovative supermarket in view of the innovative

ideas they use, which is highlighted in our previous studies, and require further commercialization.

The investment practice is based on financial indicators of an innovation project, since it is this category of parameters of a project that allows for determining the key aspects of its implementation in the market economy environment and evaluating the feasibility of practical implementation of the innovation from the standpoint of investment-profit.

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Table 1. Registered objects of intellectual (industrial) invention property of customers of the innovative supermarket

Project №	Object of legal protection	Protection document	Source
№ 1	A method for diagnosing the state of an intelligent digital sensor	Patent (Ukraine) № 110811	http://uapatents.com/6-110811-sposib-diagnostuvannya-stanu-cifrovogo-intelektualnogo-datchika.html#formula
№ 2	A method of cascade conversion of mechanical energy into electric energy	Patent (Ukraine) № 110835	http://uapatents.com/6-110835-sposib-kaskadnogo-peretvorennya-mekhanichno-energi-v-elektrichnu.html
№ 3	An energy efficient electric burner	Patent (Ukraine) № 110837	http://uapatents.com/7-110837-energoefektivna-konforka-elektrichna.html
№ 4	Granules of expanded pearlite with coating, a methods for their manufacture and methods for producing concrete and products from them	Patent (Ukraine) № 110839	http://uapatents.com/7-110839-granuli-spuchenogo-perlitu-z-pokrittyam-sposib-kh-vigotovlennya-i-sposobi-vigotovlennya-betonu-jj-virobiv-z-nikh.html
№ 5	A device for measuring the viscosity of liquid substances	Patent (Ukraine) № 110865	http://uapatents.com/7-110865-pristrijj-dlya-vimiryuvannya-vyazkosti-ridkikh-rechovin.html

Modern investors require justifying management decisions on feasibility of investing funds in a particular project based on comparative analysis of financial aspects of its implementation.

That is why in the work there carried out the calculation of financial indicators of the investigated innovation projects based on the data specified in their technical documentation (Table 2.).

Table 2. Financial indicators of the innovation projects implementation on the platform of the innovative supermarket

Indicator\ innovation projects №	№ 1	№ 2	№ 3	№ 4	№ 5
Project implementation period, years	3	5	2	4	3
Financial indicators for the 1st year of project implementation, UAH					
Total initial investments, incl .:	7 778 960	7 148 580	19 467 790	9 462 440	13 853 450
Capital investments, incl.:	7 702 110	6 941 230	19 356 140	9 195 640	13 788 200
Acquisition of permits	5 000	8 570	3 250	18 500	7 200
Acquisition of intangible assets	1 500	3 200	5 310	24 500	7 760
Acquisition (creation) of fixed assets	6 949 830	6 242 400	18 020 500	8 403 000	12 813 000
Installation and commissioning costs	745 780	687 060	1 327 080	749 640	960 240
Operating expenses	76 850	207 350	111 650	266 800	65 250

The data in Table 2. illustrate the structure of the seed round in implementing the innovation projects, in particular, capital investment and operating expenses.

However, there is a lack of information about the method of project commercialization, the volume of attracted investments, in particular, the investor's own capital and credit resources, etc.

This requires calculating financial results from operating activities based on the data reflecting the effect from the practical implementation of the innovation projects (Table 3.).

The data in Table 3. demonstrate a positive financial result from the implementation of the investigated innovation projects, which indicates the possibility for implementing the studied objects of intellectual property in practice.

But the data presented are not enough for the formation of fundamental conclusions about the feasibility of investing into the considered innovation projects, and in-depth criteria are needed to justify investment decisions for each of the investigated totality of projects.

The task of the experts of the innovative supermarket is to calculate the indicators of economic efficiency of implementing the investigated innovation projects based on the project and financial documentation and to present economic justification for selecting the most attractive among them for particular investors.

This requires systematizing a set of indicators for assessing the economic efficiency of the innovation projects and calculating each individual innovation investment project as necessary conditions for the commercialization of the studied objects of intellectual property.

To analyze economic efficiency of innovation investment projects, various indicators are used, namely: quantitative, qualitative, absolute, relative, static, dynamic, expert ones, etc.

Table 3. Financial indicators of operating activities, based on the commercial results of the innovation projects, UAH

Indicator\projects №	№1	№2	№3	№4	№5
Implementation plan, UAH					
Production capacity	340 000	2 550 600	6 000	4 500	500 000
Sales volumes	272 000	2 040 480	4 800	3 600	400 000
Operating expenses budget, UAH					
Total operating expenses, incl.:	8 404 709	8 064 561	13 656 972	6 881 709	12 910 495
Variable expenses	2 091 850	3 841 994	2 928 450	1 319 794	4 266 000
Fixed expenses	6 312 859	4 222 566	10 728 522	5 561 916	8 644 495
Operating income budget, UAH					
Total operating income, incl.:	12 207 546	10 632 615	26 252 934	10 760 901	19 525 084
Net income (revenue) from sales of products (goods, works, services)	11 346 357	9 919 409	21 714 586	9 909 662	17 816 483
Other operating income	293 871	217 235	3 452 619	355 757	817 777
Financial income	-	-	-	-	-
Other income	567 318	495 970	1 085 729	495 483	890 824
Financial performance results					
Earnings before tax	3 802 837	2 568 054	12 595 962	3 879 192	6 614 589
Income tax expense (benefit)	722 539	487 930	2 393 233	737 046	1 256 772
Net financial result	3 080 298	2 080 124	10 202 729	3 142 146	5 357 817
Net cash flow	3 914 652	2 830 012	12 366 517	4 156 631	6 897 317

Financial and economic assessment criteria are most common, which is due to the existing model of the national economy — in the market economy environment the determining criterion of efficiency of any business is its level of profitability and the derived indicators. But the development of market relations and the emergence of new financial instruments necessitate a comprehensive analysis of efficiency of innovation investment projects.

Such an analysis acts as an informational support for making sound management decisions on choosing the most optimal areas for the commercialization of intellectual property.

We have analyzed innovation activities of industrial enterprises of Ukraine [10], the Law of Ukraine "On state regulation of activities in the field of technology transfer" [11], and approaches to assessing efficiency of innovation projects [12, 13].

Based on the information received, a set of indicators used for assessing efficiency of innovation investment projects is systematized.

They include: Net Present Value (*NPV*), Benefit Cost Ratio (*BCR*), Accounting Rate of Return (*ARR*), Internal Rate of Return (*IRR*), Pay Back Period (*PBP*), Equivalent Annual Annuity (*EAA*), Modified Internal Rate of Return (*MIRR*).

These indicators of economic efficiency of an innovation project are the basis for solving problems of justifying management decisions in the field of innovation investment.

It should be noted that they focus on different aspects in characterizing individual indicators of the project under investigation.

The calculation of the key indicators of economic efficiency of the investigated innovation projects is presented in Table 4.

Table 4. Results of calculating the indicators of economic efficiency of the investigated innovation projects

Indicator\projects №	№ 1	№ 2	№ 3	№ 4	№ 5
Discount Rate *(DR)*, %	25.23	19.56	38.86	29.20	27.44
Net Present Value *(NPV)*, UAH	28 843 677	46 014 495	33 038 078	33 581 166	44 721 801
Benefit Cost Ratio *(BCR)*, %	371	644	170	355	323
Accounting Rate of Return *(ARR)*, %	50.32	39.59	63.52	43.93	49.79
Internal Rate of Return *(IRR)*, %	23.23	40.33	10.63	22.23	20.22
Pay Back Period *(PBP)*, years	2.5	3.4	1.9	3.0	2.6

The data in Table 4. testify to the economic efficiency of all of the investigated innovation projects. The *PBP* for all of the projects is shorter than their implementation period.

However, the comparison of the five projects in terms of this indicator shows that Project №3 is the most attractive among them, since its *PBP* is 1 year and 9 months; the second place is taken by Project №1. All of the projects have a relatively high *DR* compared to the refinancing rate.

The *NPV* is positive for all of the projects, but in terms of this indicator the advantage is given to Project №2, since its *NPV* is UAH 46 014 495; Project № 5 ranks the second, with its *NPV* amounting to UAH 44 721 801.

If we compare the projects in terms of *BCR*, which shows the return on investment in an investment project in relative terms, Project №2 is the most attractive one, since its *BCR* amounts to 644 %; Project №1, with the *BCR* of 371 % , takes the second place.

Project №3 is the most attractive in terms of *ARR*, with the level of this indicator amounting to 63.52 %, and Project №2 demonstrates the best results in terms of *IRR*.

Thus, it is rather difficult to select one of the investment projects, since none of the indicators applied alone provides comprehensive information about the efficiency of the projects.

Solving this problem requires a systemic use of the set of assessment indicators in the form of an integral efficiency criterion, which will provide for a synthesizing multi-criteria assessment and comprehensive comparison of innovation projects in the process of selecting them by investors.

Using the integral index of economic efficiency of an innovation project has a lot of advantages, since it

- allows for a comprehensive assessment of projects that differ in terms of characteristics, sphere of application, duration of implementation, etc.;
- comprises a set of characteristics of investigated projects, which provide for system description of the level of their economic efficiency;
- allows for carrying out a multi-criteria assessment of a project instead of performing a quantitative comparison of individual indicators of different projects;
- provides for combining indicators that vary in economic content and units of measurement into a single index, etc.

5. Method for selecting innovation projects based on the integral index of their economic efficiency

Calculating the integral index of economic efficiency of innovation projects requires:

- calculating individual indicators of economic efficiency of innovation projects to determine their feasibility;
- scoring individual indicators with the use of the three sigma rule (the three sigma rule allows defining confidence intervals for each indicator separately to identify their ranks taking into account their standard deviation);
- synthesizing the scores into an integral assessment criterion that allows for comparing projects in terms of sphere of application, capital expenditures as well as for making sound management decisions.

We propose scoring individual indicators of economic efficiency of an innovation project with the use of the three sigma rule. According to this rule, almost all values of a normally distributed random variable are distributed within the limits of $\pm 3\sigma$ of the mean (mathematical expectation):

$$P\{a - 3\sigma \le \xi \le a + 3\sigma\} = 0.9973 \qquad (1)$$

This rule implies calculating the standard deviation of a random variable.

This allows determining confidence intervals of the spread of the variable: if the random variable is distributed normally, then the absolute value of its deviation from the mathematical expectation does not exceed the three sigma limits.

Having calculated the standard deviation, it is reasonably safe to suggest that the spread of the random variable fits into the interval $M(x) \pm 3\sigma(x)$.

The probability that the value of the random variable will be in this interval, with a normal distribution, is 0.9973. The probability that the absolute value of the deviation exceeds the three sigma limits is very small (0.0027). This can happen only in 0.27 % of cases.

The random variable in this case is the corresponding indicator of the economic efficiency of the innovation project.

As demonstrated by previous studies, the variability is subject to the normal law of distribution, which makes it possible to apply this approach to define confidence intervals for indicators of economic efficiency of innovation projects.

Based on the results of calculations, according to the above rule, for each individual indicator of economic efficiency of an innovation project, it is necessary to determine the confidence intervals, which, in turn, are assigned scores that characterize the level of economic efficiency of the project.

The assignment of scores involves ranking the studied indicators by the level of increase, i.e., the higher the rank indicating the increment of the indicator i, the higher the score assigned to it (the lag

between the rank scores is set not to affect the results of the calculations).

It should be noted that for each individual indicator of economic efficiency of an innovation project, there are established confidence intervals for determining their ranks, which allow taking into account the standard deviation calculated separately for each indicator.

The system of ranking criteria and scoring are presented in Table 5.

Table 5. System of ranks and scores of the indicators of economic efficiency of an innovation project

Ranking scores	Rank	Ranking criteria
3.0	1	$x > \bar{x} + 3\sigma$
2.5	2	$x \in (\bar{x} + 2\sigma ; \bar{x} + 3\sigma]$
2.0	3	$x \in (\bar{x} + \sigma ; \bar{x} + 2\sigma]$
1.5	4	$x \in (\bar{x} - \sigma ; \bar{x} + \sigma]$
1.0	5	$x \in (\bar{x} - 2\sigma ; \bar{x} - \sigma]$
0.5	6	$x \in (\bar{x} - 3\sigma ; \bar{x} - 2\sigma]$
0.0	7	$x < \bar{x} - 3\sigma$

Table 6. presents the individual ranks for the set of individual indicators of economic efficiency of an innovation project.

Moreover, according to the applied method, the indicators are equivalent to each other, i.e., they equally affect the aggregate level of economic efficiency of an innovation project, which is reflected by the integral index.

The next stage in carrying out the integral assessment of the economic efficiency of the innovation projects is the scoring of each individual indicator according to the rank established for it (Table 7.).

Table 6. Ranks of individual indicators of economic efficiency of an innovation project

Indicator	Discount Rate *(DR)*		Net Present Value *(NPV)*		Benefit Cost Ratio *(BCR)*	
$\bar{x}$	0.28		3 723.98		3.72	
σ	0.05		650.26		1.09	
2σ	0.10		1 300.53		2.17	
3σ	0.14		1 950.79		3.26	
Rank 1	0.42	10 000	5 674.78	10 000	6.98	10 000
Rank 2	0.38	0.42	5 024.51	5 674.78	5.89	6.98
Rank 3	0.33	0.38	4 374.25	5 024.51	4.81	5.89
Rank 4	0.23	0.33	3 073.72	4 374.25	2.64	4.81
Rank 5	0.19	0.23	2 423.46	3 073.72	1.55	2.64
Rank 6	0.14	0.19	1 773.19	2 423.46	0.47	1.55
Rank 7	-10 000	0.14	-10 000	1 773.19	-10 000	0.47
Indicator	Accounting Rate of Return *(ARR)*		Internal Rate of Return *(IRR)*		Pay Back Period *(PBP)*	
$\bar{x}$	0.50		0.23		2.69	
σ	0.06		0.07		0.42	
2σ	0.12		0.14		0.85	
3σ	0.18		0.20		1.27	
Rank 1	0.68	10 000	0.44	10 000	3.97	10 000
Rank 2	0.62	0.68	0.37	0.44	3.54	3.97
Rank 3	0.56	0.62	0.30	0.37	3.12	3.54
Rank 4	0.44	0.56	0.17	0.30	2.27	3.12
Rank 5	0.38	0.44	0.10	0.17	1.84	2.27
Rank 6	0.32	0.38	0.03	0.10	1.42	1.84
Rank 7	-10 000	0.32	–10 000	0.03	–10 000	1.42

Table 7. Scores assigned to the indicators of economic efficiency of the innovation projects

Project	Indicator						
	DR	*NPV*	*BCR*	*ARR*	*IRR*	*PBP*	Integral index
№ 1	1.5	1	1.5	1.5	1.5	1.5	5.5
№ 2	1	2	2.5	1	2.5	2	7
№ 3	2.5	1.5	1	2.5	1	1	7.5
№ 4	1.5	1.5	1.5	1.5	1.5	1.5	6
№ 5	15	2	1.5	1.5	1.5	1.5	6.5

The final stage of this assessment is synthesizing the scores received by individual indicators of economic efficiency of a particular innovation project into a single assessment criterion according to the formula:

$$I_{EEIP} = Score_{DR}+Score_{NPV}+Score_{BCR}+ +Score_{ARR}+Score_{IRR}-Score_{PBP} \quad (2)$$

The results of the calculation of the integral index of economic efficiency of the investigated innovation projects are presented in Table 8.

Table 8. Integral index of economic efficiency of the investigated innovation projects

Investment project	Integral index
№1. A method for diagnosing the state of an intelligent digital sensor	5.50
№2. A method of cascade conversion of mechanical energy into electric energy	7.00
№3. An energy efficient electric burner	7.50
№4. Granules of expanded pearlite with coating, a method for their manufacture	6.00
№5. A device for measuring the viscosity of liquid substances	6.50

There are singled out the indicators, the increase in which is a positive characteristic for the projects: Discount Rate (*DR*), Net Present Value (*NPV*), Benefit Cost Ratio (*BCR*), Accounting Rate of Return (*ARR*), Internal Rate of Return (*IRR*).

Also, there are identified the indicator, the increase in which is presented a negative trend in the context of economic efficiency of an innovation project (*Pay Back Period*).

When synthesizing a single criterion of economic efficiency of an innovation project, the economic content of the considered indicators was taken into account.

The results obtained can be interpreted as follows: the higher the assessment (integral) index of economic efficiency of an innovation project, the higher the level of advantages of the project in relation to alternative offers of the innovative supermarket - consequently, the higher is the place the project occupies in the commercialization ranking.

The results of the integral assessment of economic efficiency of innovation projects with the view of their further commercialization by means of an innovative supermarket are graphically presented in Figure 1.

According to Figure 1., a sequence of positive decisions of potential investors on approving innovation projects with the view of their further commercialization is traced.

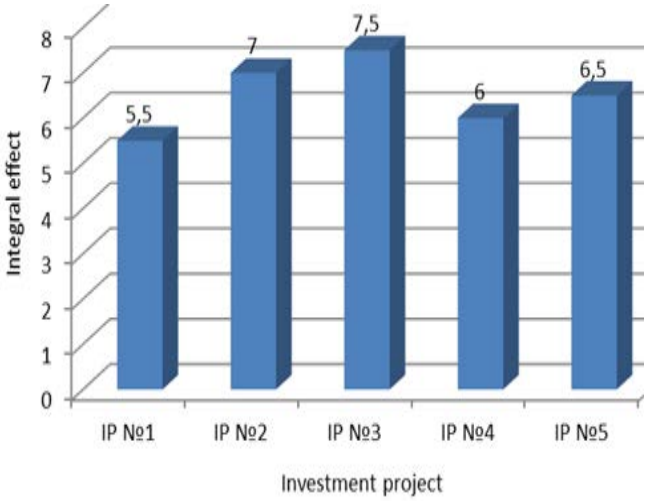

Figure 1. Results of the integral assessment of economic efficiency of innovation projects for the purposes of further commercialization

Thus, in general, the proposed method for selecting innovation projects based on the integral index of their economic efficiency on the platform of an innovative supermarket can be represented by four main stages.

Stage I.

Substantiating the composition of the set of indicators for the assessment of innovation projects and calculating individual indicators.

Method: systems analysis and synthesis.

Parameters: Discount Rate (*DR*), %; Net Present Value (*NPV*), UAH; Benefit Cost Ratio (*BCR*), %; Accounting Rate of Return (*ARR*), %; Internal Rate of Return (*IRR*),%; Pay Back Period (*PBP*), years.

Stage II.

Scoring individual indicators of economic efficiency of innovation projects.

Method: the three sigma rule.

System of ranks and scores: see Table 5.

Stage III.

Determining the integral index of economic efficiency of innovation projects.

Calculation: using the formula (2).

Stage IV.

Ranking the innovation projects based on the integral indexes of their economic efficiency.

Method: comparisons, graphic shown in Figure 1.

The proposed approach allows carrying out a multi-criteria assessment of a project instead of performing a quantitative comparison of individual indicators of different projects as well as combining indicators varying in economic content and units of measurement into a single index.

6. Discussion of the results of assessing the efficiency of the projects by the integral index

The results of assessing the economic efficiency of innovation projects contain a set of characteristics of the investigated projects, which provide for a system description of the level of their economic efficiency.

Furthermore, they allow for carrying out a multi-criteria assessment of a project instead of performing a quantitative comparison of individual indicators of different projects. The weak point is that the proposed method for selecting innovation projects based on the integral index of economic efficiency requires certain qualifications and skills of the staff for its implementation on the supermarket platform.

Unlike the existing methods for assessing economic efficiency, the proposed method allows for combining indicators that vary in economic content and units of measurement into a single index by calculating the integral index.

This makes it possible to identify the most and the least attractive to investors innovation projects and justify management decisions on investing funds.

7. Conclusion

The calculation of individual indicators of economic efficiency of innovation projects carried out in the article did not allow selecting the best one.

For an integral assessment of projects that differ in terms of characteristics, sphere of application, duration of implementation, it was necessary to combine indicators varying in economic content and units of measurement into a single index.

There are proposed scoring individual indicators of economic efficiency of innovation projects with the use of the three sigma rule. According to the rule, almost all values of a normally distributed random variable are distributed within the limits of the mean, which allows determining the score and the rank for each indicator. There are developed the method for calculating the integral index of economic efficiency of innovation projects with the use of scoring individual indicators, which involves ranking projects according to their economic efficiency. The proposed method makes it possible to select the most effective innovation project with the view of its further commercialization.

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