Methodology for assessing the performance of the integrated management system

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Abstract The paper deals with the formation of an integrated management system. The dynamic model of the quality of industrial production is developed and analyzed. The method for evaluating the effectiveness of the integrated management system is proposed. It includes activities to form criteria for assessing the effectiveness of the IMS, the definition and evaluation of indicators of each criterion, the assignment of weight coefficients criteria, direct calculation of the effectiveness of the integrated management system and determine the level of effectiveness of the system with further decision-making on the management of the integrated management system.

Keywords: Dynamic model, system of differential equations, integrated management system, performance evaluation, operations research; quality of business processes

1. Introduction

Currently, many domestic and foreign companies are showing increasing interest in integrated quality management systems. Each subsystem of the integrated system performs the function necessary to achieve the overall goal of the company. The benefits of integration are based on combining key procedures and documentation, which allows systematizing the management process and reducing various costs. The introduction of an integrated management system is a fairly time-consuming process that influences almost all departments of the company and is aimed at improving the efficiency of the overall management of the company. At the same time, the planned effectiveness of the integrated management system can be achieved subject to the competent management of its member systems.

The study of the performance and efficiency of management systems, as well as their impact on the competitiveness of organizations, on the one hand, showed that the operation of these systems gives companies a real advantage over competitors based on improving the organization of the company’s work under modern conditions. On the other hand, one of the important components of the organization’s management is the intensive development of integration processes both within the company and with the external environment, increasing the degree of interaction between the management entities and their integration.

The activity of the integrated quality management system is analyzed and assessed based on the results of internal audits, monitoring processes, information on the satisfaction of interested parties, etc. For this purpose, a methodology should be developed for assessing the effectiveness of the integrated management system based on criteria in order to notice the changes that have occurred in the company’s activities,
determine the extent of implementation of planned tasks and achievement of planned results; choose the most rational way to accomplish activity change. Performance evaluation should be carried out on key indicators, developed taking into account the main activities and requirements of standards.

The proposed methodology for assessing the effectiveness of the integrated management system is represented by the following stages:
- formation of criteria for assessing the effectiveness of IMS;
- definition and evaluation of indicators for each criterion;
- determination of weight coefficients of criteria;
- calculation of the effectiveness of the integrated management system;
- assessment of the level of effectiveness of the integrated management system and decision-making on the management of the integrated management system.

When an integrated management system is implemented, the underlying system is usually the quality management system, which is due to the universal nature of management methods and uniform approaches to the organization of the company. Since the national standard GOST R ISO 9001-2015 “Quality Management Systems. Requirements” is aimed at applying the process approach in developing, implementing and improving the effectiveness of the quality management system in order to increase customer satisfaction by fulfilling their requirements. It is advisable to develop a system of performance indicators for evaluating the processes of each of the systems included in the company's integrated quality system. This is also confirmed by the implementation of the process approach is an important step, regardless of the company's activities, when introducing an integrated management system complying with ISO standards.

In the standard GOST R ISO 9001-2015 "Quality management systems. Requirements", a process approach is used to identify those areas that are subject to management for the efficient and effective delivery of products or services. Understanding and management of interrelated processes as a system contributes to the effectiveness and efficiency of the organization in achieving the intended results. This approach allows the organization to manage the relationships and interdependencies between the processes of the system, so that the overall performance of the organization can be improved. [1].

Standard GOST R ISO 14001-2016 “Environmental Management Systems. Requirements and application guidance” requires the implementation, maintenance and continuous improvement of the environmental management system, including the necessary processes and their interaction to achieve the intended results [2].

In the standard GOST R 54934-2012 / OHSAS 18001: 2007 “Occupational health and safety management systems. Requirements”, the occupational health and safety management system include an organizational structure, planning activities, established responsibilities, operating rules, procedures, processes, and resources. Improvement activities are based on the PDCA methodology, which can be applied when structuring all company processes. [3].

GOST R ISO / IEC 20000-1-2013 “Information Technology (IT). Service management. Part 1. Requirements for the service management system” highlights a number of processes, such as:
- processes of service provision;
- control processes;
- relationship processes;
- resolution processes [4].

In addition, the standard identifies the most important aspects of an integrated process approach and PDCA methodology when using a service management system.

Standard GOST R ISO / IEC 27001-2006. "Information technology. Methods and means of security. Information Security Management System Requirements" involves using the process approach to develop, implement, maintain, monitor, analyze, maintain and improve the organization's information security.
management system [5].

This standard also highlights factors of particular importance to users in accordance with the proposed process approach in relation to information security management.

The requirement for implementing the process approach in the company’s activities may be absent in some other standards/technical conditions. However, this approach can be effectively implemented in order to identify problems in the functioning of the company's management system, and further to identify aspects that require monitoring and control.

Thus, the obtained process performance indicators can be viewed as criteria used to assess the effectiveness of any integrated management system. At the same time, an integrated quality management system assumes the existence of general and specific requirements of standards for management systems, which in practice are implemented within general and specific processes. Based on the provisions of the standard GOST R 53893-2010 "Guidelines and requirements for integrated management systems" we can distinguish the following general processes of an integrated management system:

- document management;
- activity planning;
- implementation and operation;
- performance improvement;
- management review;
- performance evaluation [6].

Each management system includes its own defined processes. However, the above processes will be implemented within all management systems. Therefore, when determining criteria for evaluating the performance of an integrated management system based on the process approach, the company needs to compile a register of general and specific IMS processes.

At the stage of determining indicators for each criterion, the company should apply the necessary methods for monitoring and measuring the processes of the integrated management system. These methods indicate the ability of processes to achieve planned results. If actual results are unacceptable, development of corrective actions is required.

In accordance with the requirements of the standard GOST R ISO 9001-2015 "Quality management systems. Requirements", the organization have to determine:

- what should be monitored and measured;
- methods of monitoring, measuring, analyzing and evaluating to ensure reliable results;
- when monitoring and measurements should be carried out;
- when monitoring and measurement results are to be analyzed and evaluated.

The organization should analyze and evaluate relevant data and information obtained during monitoring and measurement. The results of the analysis should be used to assess the performance and effectiveness of the quality management system [1].

Requirements of GOST R ISO 9001-2015 Standard “Quality Management Systems. Requirements” for monitoring and measuring processes determine the need to define the object and purpose of monitoring, measuring, a system of assessment indicators, as well as the choice of methods for monitoring and measuring processes.

The objects of monitoring and measurement are inputs, outputs, and the process. The main goals of monitoring and measuring processes include:

- Confirmation of compliance of inputs and outputs with the established requirements, as well as the stability of the process;
- identifying opportunities to optimize the requirements for inputs and outputs of the process, as well as areas for its improvement.

Based on the objects and goals of monitoring and measuring processes, it is possible to form an
appropriate system of assessment indicators. When developing them, it is necessary to take into account:
- relationship with the strategic and tactical objectives of the company,
- possibility of integration into the business planning system;
- adequacy, completeness and objectivity of data;
- frequency of monitoring and measurement;
- data collection and processing costs;
- clarity from the point of view of interested parties;
- ability to compare data with best practices [16].

The indicators for monitoring and measuring the processes of the integrated quality management system can be divided into two groups: qualitative and quantitative (Table 1).

Table 1. Monitoring and Measuring Process Indicators

| Qualitative indicators | Quantitative indicators |
|------------------------|------------------------|
| Process Owner Ratings  | Technical indicators    |
| Expert estimates       | Cost                   |
| Other ratings          | Lead time              |
|                        | Quality indicators      |
|                        | Comparison with other processes |

The system of indicators characterizes the process parameters such as:
- effectiveness describes the ratio of the obtained result and the requirements of interested parties;
- efficiency shows how well processes are performed;
- adaptability indicates how well the process is able to respond to changes in the environment;
- performance characterizes the ratio of the number of units at the output to the number of units at the input;
- duration (time required to complete the process);
- cost (set of all costs in a single process).

The system of process assessment indicators requires the selection of suitable methods and tools for monitoring and measuring.

The choice of a particular method of monitoring and measuring the process depends on their environment and goals, which can be both internal and external [17].

Today the methods presented in Table 2 are the most common. We classify them depending on the source of information and the purposes of monitoring and measuring.

Table 2. Methods for monitoring and measuring processes

| Methods                           | Purposes of monitoring and measuring                                      | Source of information |
|-----------------------------------|---------------------------------------------------------------------------|-----------------------|
| Seven basic quality control tools:| confirmation of process stability; search for product and process improvement directions | Technological         |
| FMEA; QFD-method; FCA             |                                                                           |                       |
| SWOT analysis                     | identifying the strengths and weaknesses of the Expert process, opportunities for its improvement and the risks of reduced performance | Expert                |
| Self-assessment                   | assessment of the level of maturity of the process; search for areas for improvement | Expert                |
Benchmarking identifying weaknesses in the management compared with the best practices Expert

Internal and external audit confirmation of compliance of processes with the requirements of management system standards Expert

Polling; Interviewing; Questioning evaluation of the satisfaction of interested parties Socio-psychological

The presented methods and tools are used, as a rule, in a complex or in various combinations depending on the purposes of monitoring and measuring, as well as the characteristics of the tasks to be solved.

2. A dynamic model of industrial product quality

The most important aspects and characteristics of the quality of industrial products will be reliability and durability, associated simultaneously with physical depreciation and obsolescence. We consider the model of industrial products quality proposed by V.P. Milovanov and named by the author as a dynamic logistics model [1].

We assume that consumer enterprises organize the flow of $z$ requests through supply channels to supply agencies, measured by the number of requests per unit of time through which customer enterprises wish to purchase a particular type of industrial product and therefore come into contact with the supply channel $c$. Under application $z$ we mean in general a generalized requirement related to the need to obtain this product. As a result of interaction with the supply channel, an application can change its state regarding satisfaction with its industrial product and become satisfied with the application $\bar{z}$ or remain in the class of applications, if its interaction with the supply channel does not lead to the desired result - obtaining the desired product of a certain quality. Satisfied applications $\bar{z}$ after a while turn back into applications $z$ for this type of product (we assume that this product is always needed by the consumer), since the purchased product changes its physical properties over time (becomes useless as a result of operation, as well as moral aging technical properties of the product, etc.) [18-20].

First of all, we write the system of equations characterizing this dynamics, and then we explain the contribution of each term in the kinetic equations:

\[
\begin{align*}
\frac{dz}{dt} &= -k_1zc + k_2[zc] + k_4\bar{z} \\
\frac{dc}{dt} &= -k_1zc + k_2[zc] + k_3[zc] \\
\frac{d[zc]}{dt} &= k_1zc - k_2[zc] - k_3[zc] \\
\frac{d\bar{z}}{dt} &= k_3[zc] - k_4\bar{z} \\
\frac{dn}{dt} &= k_4\bar{z}
\end{align*}
\] (1)

In this system of equations, $[zc]$ denotes the time complex of the application and the supply channel,
which is always formed when deciding on the purchase of a product. The value \( k_3 \) denotes the speed with which this complex is formed; \( k_2 \) and \( k_3 \) denote the rate of collapse of the complex into the channel, whether the application remains an application or becomes a satisfied application for a while (consumer purchase the desired product). The value \( k_4 \) denotes the rate of transformation of the satisfied application \( z \) again into the application \( z \) and into the failed product \( n \), and also characterizes the quality of the product itself. The inverse of this speed \( 1/k_4 \) is proportional to the durability of the product during operation or obsolescence.

The first equation of the system (1) characterizes the dynamics of free applications in the system. The decrease in the number of requests per unit of time is proportional to the total number of free applications with a constant number of supply channels, and with a constant number of applications, it is proportional to the number of supply channels. Therefore, the rate of decrease in the number of applications is proportional to the product of the number of applications and supply channels with the proportionality coefficient \( k_1 \) (the first term of the first equation of the system (1)). The second term of the first equation is due to the fact that the influx of unsatisfied applications is proportional to the total number of supply-demand channel \([zc]\), complexes, decaying to form a free application with a speed \( k_2 \). The third term of the first equation contributes to the increase in the number of free applications resulting from changes in the physical properties of the purchased product as a result of using the product or its obsolescence. This contribution is proportional to the number of successful applications, or, equivalently, to the number of purchased products with proportionality coefficients \( k_4 \). Here we assume that the application for a technical product arises immediately whenever a product fails as a result of a breakdown or obsolescence.

The second equation of the system (1) characterizes the dynamics of supply channels in the system. The reasons for the appearance of the first and second members of the second equation of the system (1) are similar to the reasons for the appearance of the corresponding members of the first equation of the system (1). The third member of the second equation is due to the release of the application-channel supply chain \([zc]\) from the application as a result of its satisfaction with some product. In this case, the \([zc]\) complex decays at a rate of \( k_3 \) and a free supply channel \( c \) and a satisfied request \( z \) are formed. The increase in the unit time of the number of supply channels due to this circumstance is proportional to the number of the complexes \([zc]\) with the proportionality coefficient \( k_3 \).

The third equation of the system (1) reflects the dynamics of the complexes \([zc]\). The reasons for the appearance of the first and second terms of the third equation of the system (1) are similar to the reasons for the appearance of the corresponding terms of the first equation. The reasons for the appearance of the third term of the third equation of the system (1) are similar to the reasons for the third term in the second equation of the system. However, in the third equation of the system (1), the corresponding terms should be taken with opposite signs.

The fourth equation of the system (1) characterizes the dynamics of satisfied applications \( \bar{z} \). The increase per unit time of the number of satisfied applications is proportional to the number of complexes \([zc]\), which decay with a speed \( k_3 \). Reduction in the number of satisfied applications in proportion to the number of products operated or, which is the same, to the number of satisfied applications \( \bar{z} \) with the proportionality coefficient \( k_4 \).

The fifth equation of the system (1) characterizes the dynamics of the number of failed products in operation \( n \) due to a change in the physical characteristics of the products or due to obsolescence. The increase in this number of products unsuitable for operation in proportion, obviously, to the number of products involved or, which is the same, the number of satisfied applications \( \bar{z} \) with the proportionality coefficient \( k_4 \).

The system (1), consisting of 5 autonomous ordinary nonlinear differential equations, can be simplified. Adding the second and third equations of system (1), we obtain the conservation law for the number of supply channels
\[
\frac{d(c + [zc])}{dt} = 0, \quad c + [zc] = c_0
\]  
(2)

which states that the sum of the number of supply channels that are not occupied by applications and the number of supply channels that interact with applications is constant in time and equal to some constant \(c_0\), which seems completely natural.

Now we add the equations 1, 3, 4 of the system (1). We also obtain the conservation law in this form:

\[
\frac{d(z + [zc] + \bar{z})}{dt} = 0, \quad z + [zc] + \bar{z} = z_0
\]  
(3)

This law of conservation states that the number of applications both interacting with supply authorities and not interacting with them, in total with satisfied applications, is a constant and equal to \(z_0\).

Further, since the fifth equation of the system (1) is immediately solved, if the function \(\bar{z}(t)\) is known, which is determined by the first four equations, then instead of the system (1), taking into account the mentioned conservation laws, we have only two differential equations. We also introduce constraints, assuming that \(\frac{d[zc]}{dt} = 0\), i.e. the number of complexes consisting of applications and supply channels is stationary in time.

Firstly, assuming \(\epsilon = 0\) (the case when the product has an ideal quality - it functions indefinitely) and denoting the stationary value \([zc]\) through \([zc]\), we find that taking into account (3):

\[
[zc] = \frac{zc_0}{k + z}
\]

where \(k = \frac{(k_2 + k_1)}{k_1}\).

The fact that the right part for \([zc]\) depends on the time should not be misleading, since we consider the real case of saturation of supply channels with applications, i.e. \(z \gg c\), and in this case as \(z \to \infty\) the value \([zc]\) is simply equal to \(c_0\).

In relation to the dynamics, \(k\) has the meaning of the number of applications, in which half of the supply channels are occupied by applications. Integrating now the first equation of the system (1), we get:

\[
z + k \ln \frac{z}{z_0} = z_0 - k_3c_0(t - t_0)
\]  
(4)

If we neglect the logarithmic term on the left side of equation (4) as compared to the linear term, we get a very simple and natural conclusion that the number of applications decreases (demand is satisfied) the faster, the more supply channels and the higher the speed of their work. More precisely, in this case, the quantity demanded will be understood as the value \(\epsilon = c_0\) (normalized demand).

Value

\[
\lambda = 1 - \epsilon
\]  
(5)

it is natural to call the coefficient of satisfaction of needs. In the indicated approximation, the coefficient of satisfaction of needs \(\lambda\) grows linearly with time:

\[
\lambda = 1 - \epsilon = \frac{k_3c_0}{z_0}(t - t_0) = \frac{(t - t_0)}{T_0}
\]  
(6)

where \(T_0 = \frac{z_0}{k_3c_0}\), and the faster, the more supply channels, the higher the speed of their work and the smaller the total number of applications. In the case under consideration (when the ideal product has an infinite lifetime) the demand is fully satisfied in the time \(T_0 = \frac{z_0}{k_3c_0}\), then the coefficient of satisfaction of needs \(\lambda\) becomes equal to 1.

Now, leaving the condition \(\frac{d[zc]}{dt} = 0\) in force, we consider a real case, when the average lifetime of the product, is proportional to \(\frac{1}{k_4}\), and of course random. In this case, the first equation of the system (1) is
integrated into the final form under conditions (2) and (3), and we get:

\[
\frac{1}{2} \ln \frac{(z + \delta/2)^2 - (\delta^2/4 + \gamma^2)}{(z_0 + \delta/2)^2 - (\delta^2/4 + \gamma^2)} + \frac{k - \delta/2}{2 \sqrt{\delta^2/4 + \gamma^2}} \ln \frac{(z + \delta/2 - \sqrt{\delta^2/4 + \gamma^2})}{(z_0 + \delta/2 + \sqrt{\delta^2/4 + \gamma^2})} = k_4(t - t_0) \tag{7}
\]

where \( \delta = \frac{k_3c_0}{k_4} + c_0 + k - z_0, \gamma^2 = kz_0. \)

From equation (7) the function \( z(t) \) is determined. Using condition (3), you can find \( z(t) \), and from the fifth equation of system (1), you can find \( n(t) \), if it is necessary.

Now we eliminate the restriction \( \frac{dz}{dt} = 0 \). In this case, we have a system of two ordinary autonomous nonlinear differential equations:

\[
\begin{align*}
\frac{dz}{dt} &= (k_1z_0 - k_1c_0 - k_2)x - k_1z^2 - k_1z\bar{z} + (k_4 - k_2)\bar{z} + k_2z_0 \\
\frac{d\bar{z}}{dt} &= -k_3\bar{z} - (k_3 + k_4)\bar{z} + k_3z_0
\end{align*}
\tag{8}
\]

This system is obviously defined on the phase plane \( z \geq 0 \) and \( \bar{z} \geq 0 \). For the convenience of analyzing the system (8), we turn to variables in this system by entering the following notation:

\[
\begin{align*}
x &= z, & \bar{x} = \bar{z}, & z_0 = e_0, & c_0 = \delta_0 \\
k_1 &= \eta_1, & k_2 &= \eta_2, & k_3 &= \eta_3 = 1, & k_4 &= \eta_4 \\
k_3t &= \tau
\end{align*}
\]

In this notation, the system of equations (8) is written as:

\[
\begin{align*}
\frac{dx}{dt} &= (\eta_1k(e_0 - \delta_0) - \eta_2)x - \eta_1kxx^2 - \eta_1kxy + (\eta_4 - \eta_2)y + \eta_2e_0 \\
\frac{dy}{dt} &= -x - (1 + \eta_4)y + e_0
\end{align*}
\tag{9}
\]

The system of equations (9) in its domain of definition has one equilibrium position \( \bar{x}, \bar{y} \):

\[
\bar{x} = \frac{-\left(1 + \eta_4\right)A + \sqrt{(1 + \eta_4)^2A^2 + 4\eta_1\eta_4^2(1 + \eta_2)ke_0}}{2\eta_1\eta_4k} \\
\bar{y} = \frac{e_0 - \bar{x}}{1 + \eta_4} \tag{10}
\]

where \( A = \frac{\eta_1k_0 + \eta_4 - \eta_2}{1 + \eta_4} - [\eta_1k(e_0 - \delta_0) - \eta_2]. \)

We divide both sides of equation (10) into \( e_0 \). We obtain the relationship between the equilibrium demand \( \bar{e} \) and the equilibrium coefficient of satisfaction of the requirements \( \bar{z}/z_0 \) in the following form:
which is expressed through the product quality indicator \( \eta_4 \) and shows that the proportion of satisfied applications with constant demand is the more, the better the quality of the goods. At the same time, from the relation (12) it follows that with constant durability the need satisfaction ratio is the more, the smaller the demand. Therefore, the introduction of the coefficient of satisfaction of needs in the form of (12) is natural from the point of view of the economy.

The inverse value \( \eta_4 \) is proportional to the durability of the product. In the durability of the product, we include the period of obsolescence of a product. If the product fails as a result of operation with a speed \( \eta_4 \) and simultaneously morally ages with a speed \( \eta_5 \), then the total rate of transformation of the product into unserviceable is \( \eta_0 = \eta_4 + \eta_5 \). If we accept that in some units of measurement \( T_1 \) is the durability of the goods associated with physical depreciation, and \( T_2 \) is the durability of the goods associated with obsolescence, then the resulting durability \( T \) is equal to \( T = \frac{T_1 T_2}{T_1 + \eta_4 T_2} \).

3. Discussion

It is advisable to analyze how the quality indicator \( \eta_4 \) influences the number of applications that have to be satisfied. From equations (10), (11), firstly, it is clear that if a particular type of product has a finite lifetime of about \( \frac{1}{\eta_4} \), then the demand for this type of product can never be completely satisfied, since there always is some number of unsatisfied applications. Secondly, the number of applications \( \bar{x} \) tends to zero as \( \eta_4 \to 0 \), confirming the previously obtained conclusion about the dependence of the number of applications on time. Thirdly, the higher the quality of products (the higher the resulting durability associated with the technical maintenance of products and their obsolescence), the smaller the future production of this product can be saved by switching part of the released funds to the production of other types of goods, if, of course, the cost of a product with a new quality approximately remains unchanged. In the limit when \( \eta_4 \to 0 \), the production of this product can be generally minimized.

Now we find out the character of the singular point of the model (9). It turns out that a singular point is always stable and, depending on the relations between the parameters, can be a focus or a knot. If the condition is met:

\[
[\eta_4 k(\bar{x} + 1)]^2 - 4\eta_4 k(1 + \eta_4 + \bar{x} \eta_4) < 0
\]

then the focus is carried out.

The possibility of focus in the model means the possibility of an oscillatory process. Practically, this suggests that if you register, for example, applications received by supply agencies, depending on time, then under condition (13) the model predicts demand fluctuations, although the corresponding product may be in excess. Ignoring this circumstance can lead to economic damage, if, for example, at the moment corresponding to the minimum demand, one makes a false conclusion about the saturation of the market and curtail the production of these products, greatly reducing stocks in warehouses. The next wave of applications, in this case, may seem unexpected and incomprehensible in the system, and lead to a shortage of goods and to the requirement to expand the production of products of any type. Such actions in the economic system may lead to unnecessary restructuring, etc. In the case of a shortage of goods in the warehouses of the supply authorities, such waves of orders can lead to additional fluctuations in the number of products depending on the time in warehouses, which leads to irregularity in the work of industrial enterprises and associations. Thus, the practical conclusion from the model is that manufacturing enterprises would organize their work in such a way that the required products are permanently stored in warehouses.
And although this circumstance does not at all guarantee the absence of fluctuations in demand arising from the internal properties of the dynamics of the system, this situation is much better than in the case of shortage of goods in the warehouses of supply agencies.

Since not all processes of an integrated management system have the same level of risk in relation to the company's ability to achieve its goals, a weighting factor for each criterion is necessary to determine, i.e. a parameter reflecting the significance of the criterion under consideration in comparison with other criteria that influence on the performance of the integrated management system. The weighting factor is determined by an expert and can take values ranging from 0.1 to 1.0, where 1.0 is the highest degree of significance of the criterion. Let us present the data in the form of a consolidated register of criteria for IMS (Table 3).

| Table 3. Summary register of integrated management system criteria |
|---------------------------------------------------------------|
| Criterion designation | The name of the criterion (process) | Criterion weighting factor (α) |
|-----------------------|------------------------------------|-------------------------------|
| E₁                    | Document management                 | 0,7                           |
| E₂                    | Activity planning                   | 0,9                           |
| E₃                    | Implementation and operation        | 1,0                           |
| E₄                    | Performance improvement             | 0,8                           |
| E₅                    | Management review                   | 0,8                           |
| E₆                    | Performance evaluation              | 0,7                           |
| E₇                    | …                                   | …                             |

The effectiveness of the integrated management system is calculated as a weighted average of the criteria:

$$E_{ims} = \frac{\sum_{i=1}^{n} \alpha_i P_i}{\sum_{i=1}^{n} \alpha_i},$$  \hspace{1cm} (14)

where $E_{ims}$ is the integrated management system performance indicator; $\alpha_i$ is the weight of the $i$-th criterion; $P_i$ is the $i$-th criterion; $n$ is the number of criteria entered in the consolidated register of criteria for an integrated management system.

In accordance with the obtained performance indicator of the integrated management system, the assessment of the ISM performance level and further decision-making on the management of the system is carried out.

Table 4 shows a scale for determining the level of effectiveness of IMS

| Table 4. The scale of performance levels of the integrated management system |
|--------------------------------------------------------------------------|
| Performance indicator of IMS (E_{ims}) | Level of the effectiveness of IMS | Required action |
|----------------------------------------|----------------------------------|-----------------|
| E_{ims} < 0,65                        | Ineffective ISM                  | Implementation of risk assessment measures |
| 0,65 ≤ E_{ims} < 0,75                 | Critical performance level       | Inclusion in the risk management Plan |
| 0,75 ≤ E_{ims} < 0,85                 | Acceptable level of performance  | Inclusion of potential risks in the Plan |
| 0,85 ≤ E_{ims} < 0,95                 | Sufficient level of performance  | Identification of areas for improvement, implementation of measures to improve IMS |
| E_{ims} ≥ 0,95                        | Effective ISM                    | Development of measures for the development and improvement of the system |

The performance indicator of IMS is the indicator of factors that may lead to deviations from the planned results of the processes and the company's management system, i.e. risk factor. Therefore, when introducing
an integrated management system, it is advisable to determine the risks associated with the low performance of the system, to evaluate them and to develop a risk / potential risk management plan.

If the integrated management system is recognized as ineffective, then immediate implementation of measures in accordance with the risk treatment plan is required to minimize negative consequences.

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