Integrated management systems as a basis for sustainable development of the organization

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Abstract The definition of integrated management systems is considered in the paper from the point of view of various authors. The purpose of the paper is to develop a method for determining the possibility of hiring a candidate based on knowledge of the likelihood of selection signs. To determine the possibility of hiring a candidate, a system of independent informative features was developed and the frequencies of their occurrence in the workers’ questionnaires with positive or negative assessments of their work activity by the head were established. A distinguishing criterion is proposed and its threshold values are selected. A program that helps a personnel officer to make a decision on hiring a candidate is developed. Confidence probabilities for decisions are established.

Keywords: management system, integrated management system, integration, probabilistic and statistical method of hiring a candidate, confidence probabilities for decision-making, sustainable development.

Introduction

Modern conditions, which are characterized by a sufficiently high level of competition and significant requirements of consumers, dictate to organizations the need to take into account the various aspects of their activities for successful development. This applies not only to the quality of products/services, but also to the development of long-term strategy, environment, product/service safety, labor protection, social responsibility, information security, financial stability, personnel management, logistics, etc. The solution of only one question cannot guarantee the success of an organization, especially its competitiveness in the international market. In this regard, almost all industrialized countries are actively implementing integrated management systems.

An integrated management system is a logical transition to a new quality of system management: from an autonomous, local management system aimed at achieving specific goals in one of the areas of activity of an enterprise (in most cases in the field of quality management) to an organization’s management system ensuring the sustainable development of enterprises and, accordingly, countries [8].

Issues of integrating management systems have been considered by many authors, and their research continues to this day. A large number of publications are devoted to IMS of industrial enterprises of various industries, the synergy of integrating the management systems of an industrial enterprise with its other systems, new approaches to the development and implementation of integrated systems [14,15]. The study of theoretical material on the disclosure of the essence of integrated management systems, allowed identifying a number of definitions of IMS, formulated by domestic scientists (Table 1).
Table 1. Definitions of an integrated management system

| Author                        | Definition (necessity) of IMS                                                                 |
|-------------------------------|-----------------------------------------------------------------------------------------------|
| M. Z. Svitkin                 | “A part of an organization’s general management system that meets two or more international standards for management systems and functions as a whole” [5] |
| G.P. Serov                    | "Part of the management of the company, focused on providing high quality products (services) with mandatory and unconditional compliance with the requirements and standards of labor and environmental legislation" [6] |
| A. E. Khachaturov-Tavrizyan   | “The effective development of industrial enterprises in Russia is currently greatly hampered by the fact that the existing systems of organizational management do not pay enough attention to the integrated use of a set of key management systems providing opportunities and conditions for the transition to sustainable development” |
| S.V. Vasilevskaya             | ISM is characterized as “a large target system that serves the fulfillment of a given function necessary for the realization of business goals. Effective ISM is a synthetic system combining the best applicable approaches, practices, tools” [1] |
| Rules for the integration of management systems | “A combination of at least two organization's management subsystems that meet the requirements of standards / technical conditions (international, industry-specific or national) for management systems oriented to various interested parties, having fully or partially integrated elements and functioning in an organization as a whole.” There is also an understanding of IMS as such a management system that integrates the components of a business in such a way as to facilitate the early achievement of the goals and objectives of the company. [3] |
| T. A. Salimova, A. N. Yaskin  | “A comprehensive management system that meets the requirements of two or more international standards in the field of management, which is focused on the implementation of business goals, quality and competitiveness, creating the conditions for sustainable development of the organization, as well as meeting the needs of all parties interested in the results of its activities” [4] |

From the definitions in Table 1, it follows that this is not about integrating management systems into the overall management of a company, but about combining the requirements of various international standards. The main problem of integration is the coincidence or inconsistency of the structure of the requirements of the standards. The result of this understanding of ISM is a management system of an organization consisting of two parts.

**Development of probabilistic and statistical methods for determining the possibility of hiring a candidate**

The development of this technique was based on an experiment, for which 30 questionnaires were selected (half filled with workers with a positive assessment of their activities, and the second half with a negative rating). Questionnaires were offered to HR staff and regional HR managers of sales departments in a large
company [16-18]. Generally speaking, it is necessary to form a set of features, conduct a survey of employees and evaluate their work (on a two-point scale), for the practical implementation of the proposed methodology for each specific division of the company, which requires new staff. Then, using the proposed probabilistic-statistical method, the results are processed and candidate questionnaires with the obtained criterion are compared.

Thus, the presentation of further material is conducted by the example of the personnel management department of a large company to show the efficiency of the methodology. The obtained numerical results do not relate to any other case.

**Description of the method of probabilistic statistical processing of questionnaires**

The initial information contained in the questionnaire is the presence or absence of signs listed in Table 2.

The presence or absence of a sign with a number $i$ is indicated by value $\varepsilon_i$ that assumes a value of 0 or 1. If the candidate has the sign $i$, then $\varepsilon_i = 1$, otherwise $\varepsilon_i = 0$.

The questionnaires were known to be filled by people who had positive (superscript P index) or negative (superscript N index) assessments of their work activity by the head. The result of the survey questionnaire after identifying the presence or absence of signs was the vector of observations $\varepsilon_i^{P/N} = \{\varepsilon_i\}$, $i = 1..N$, where $N = 82$ is the number of signs.

**Table 2. Informative signs and frequencies of their occurrence in the questionnaires of workers with positive and negative assessments of activity**

| № sign, of signs | Group of signs | Name of the sign | The probability of occurrence in the questionnaire | Differential significance of the sign |
|-----------------|---------------|-----------------|---------------------------------|--------------------------------------|
|                 |               |                 | a positive assessment, $P_i^P$ | log $\left( \frac{P_i^P}{P_i^N} \right)$ | log $\left( \frac{1 - P_i^P}{1 - P_i^N} \right)$ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Age up to 25 years | 0.19 | 0.50 | -0.43 | 0.21 |
| 2 | 25 - 35 years | 0.69 | 0.33 | 0.31 | -0.33 |
| 3 | 35 – 45 years | 0.13 | 0.00 | 2.10 | -0.06 |
| 4 | Age greater than 45 years | 0.00 | 0.17 | -2.22 | 0.08 |
| 5 | Woman | 0.88 | 1.00 | -0.06 | 15.05 |
| 6 | Man | 0.13 | 0.00 | 2.10 | -0.06 |
| 7 | Married | 0.38 | 0.17 | 0.35 | -0.12 |
| 8 | Children | 0.38 | 0.25 | 0.17 | -0.08 |
| 9 | Driver's license | 0.63 | 0.25 | 0.40 | -0.30 |
| 10 | Higher education | 0.88 | 0.75 | 0.07 | -0.30 |
| 11 | Special education | 0.19 | 0.25 | -0.13 | 0.03 |
| 12 | Refresher courses | 0.38 | 0.08 | 0.65 | -0.17 |
| 13 | Whether a prestigious educational institution | 0.50 | 0.42 | 0.08 | -0.07 |
| 14 | Whether a prestigious previous job | 0.69 | 0.83 | -0.08 | 0.27 |
|   | Change of job 1 time per year | Change of job 1 time in 2-3 years | Job change is rarer | Was going to this position with "growth"? | Experience for 1 year in this field | Experience for 1-3 years in this field | Experience for more than 3 years in this field | Total working experience 1 year | Total working experience 1-3 years | Knowledge of English is fluent | Knowledge of English - read, write | Knowledge of English - read, write with a dictionary | MS Word skills | MS Excel skills | Skill work with 1C | Skills with Consultant + | Power Point Skills | Contract skills (analysis) | Accounting skills | Human Resource Skills | Knowledge of labor law | Knowledge of labor and civil law | Knowledge of the basics of a market economy, entrepreneurship and business | Knowledge of the labor market, labor and educational services | Knowledge of information databases of labor market |
|---|-----------------------------|----------------------------------|---------------------|---------------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------------|-----------------------------------|-------------------------------|-------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------|---------------------|------------------|------------------|------------------|-------------------|---------------------|---------------------|----------------------|---------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 15 | 0.06                       | 0.00                             | 1.80                | -0.03                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 16 | 0.38                       | 0.58                             | -0.19               | 0.18                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 17 | 0.56                       | 0.42                             | 0.13                | -0.12                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 18 | 0.75                       | 0.58                             | 0.11                | -0.22                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 19 | 0.25                       | 0.33                             | -0.13               | 0.05                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 20 | 0.25                       | 0.42                             | -0.22               | 0.11                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 21 | 0.44                       | 0.25                             | 0.24                | -0.12                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 22 | 0.00                       | 0.08                             | -1.93               | 0.04                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 23 | 0.06                       | 0.42                             | -0.82               | 0.21                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 24 | 0.81                       | 0.67                             | 0.09                | -0.25                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 25 | 0.38                       | 0.42                             | -0.05               | 0.03                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 26 | 0.38                       | 0.17                             | 0.35                | -0.12                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 27 | 0.31                       | 0.42                             | -0.13               | 0.07                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 28 | 0.94                       | 0.92                             | 0.01                | -0.12                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 29 | 1.00                       | 0.92                             | 0.04                | -1.92                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 30 | 0.75                       | 0.42                             | 0.25                | -0.37                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 31 | 0.69                       | 0.08                             | 0.91                | -0.47                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 32 | 0.63                       | 0.58                             | 0.03                | -0.05                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 33 | 0.69                       | 0.50                             | 0.14                | -0.20                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 34 | 0.94                       | 0.50                             | 0.27                | -0.90                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 35 | 0.94                       | 0.50                             | 0.27                | -0.90                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 36 | 0.88                       | 0.42                             | 0.32                | -0.67                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 37 | 0.63                       | 0.33                             | 0.27                | -0.25                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 38 | 0.63                       | 0.75                             | -0.08               | 0.18                                        |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 39 | 0.56                       | 0.50                             | 0.05                | -0.06                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| 40 | 0.56                       | 0.25                             | 0.35                | -0.23                                       |                                     |                                      |                                           |                                   |                               |                               |                                              |                                              |                                              |                      |                      |                   |                   |                   |                   |                      |                      |                      |                      |                                                                                   |                                                                                   |                                                                                   |
| No. | Description                                                                 | Knowledge | Professional | Selection | Proficiency Testing |
|-----|------------------------------------------------------------------------------|-----------|--------------|-----------|---------------------|
| 41  | Knowledge of the technology of finding occupations and positions using information systems. | 0.63      | 0.42         | 0.18      | -0.19               |
| 42  | Knowledge of professional selection methods and proficiency testing techniques. | 0.13      | 0.00         | 2.10      | -0.06               |
| 43  | Knowledge of the foundations of general and special psychology, sociology and psychology of labor, labor activity. | 0.63      | 0.50         | 0.10      | -0.12               |
| 44  | Knowledge of ethics of business communication. | 0.81      | 0.83         | -0.01     | 0.05                |
| 45  | Knowledge of testing, interviewing techniques | 0.75      | 0.33         | 0.35      | -0.43               |
| 46  | Knowledge of the basics of the organization of personnel office work. | 0.81      | 0.33         | 0.39      | -0.55               |
| 47  | Knowledge of how to solve organizational, managerial and personnel tasks. | 0.69      | 0.08         | 0.91      | -0.47               |
| 48  | Methods of information processing using modern technical means of communication and computers. | 0.81      | 0.67         | 0.09      | -0.25               |
| 49  | Rules of the internal labor schedule. | 0.94      | 0.75         | 0.10      | -0.60               |
| 50  | Rules and regulations of labor protection. | 0.75      | 0.58         | 0.11      | -0.22               |
| 51  | Knowledge of marketing basics | 0.63      | 0.67         | -0.03     | 0.05                |
| 52  | Knowledge of principles of selection and placement | 0.69      | 0.08         | 0.91      | -0.47               |
| 53  | Having an idea about the principles of work with the city and territorial organizations: military registration and enlistment offices, departments of social services, employment centers, SIF, etc. | 0.75      | 0.33         | 0.35      | -0.43               |
| 54  | Accuracy | 0.81      | 0.92         | -0.05     | 0.35                |
| 55  | Attentiveness | 0.63      | 0.92         | -0.17     | 0.65                |
The probability of the appearance of signs in the questionnaires of workers with positive and negative assessments (columns 4 and 5 of Table 2) was calculated by the formulas:

\[ P^p_i = \frac{1}{M} \sum_{j=1}^{M^p} E^p_{ij}, \quad P^n_i = \frac{1}{M} \sum_{j=1}^{M^n} E^n_{ij}, \]

where \( j \) – questionnaire number, \( M^{p/n} \) – the number of questionnaires filled by employees with positive and negative assessments. For mathematical correctness, in the case when the sample gave the probability of occurrence of a sign equal to 0, it was replaced with a value of 0.001, which does not affect the accuracy of the method.

Formulas for calculating the differential significance of signs are shown in Table 2. It should be noted that some of the characteristics listed in Table 2 have a very low differential significance.
\[
\log \left( \frac{1 - P^p}{1 - P^n} \right)
\]

In the future (when examining a larger number of questionnaires as source data), if the low significance of a sign is confirmed, it can be excluded from the list.

When applying for work in the unit under study, the greatest differential significance (more than 10) has the absence of the following signs:
- №5 – «woman»;
- №56 – «obligation»;
- №62 – «listening skills».

The sign №5, obviously, reflects the general social situation, when women mostly work in the personnel departments of enterprises, who, accordingly, more often receive a negative assessment of their work. If there is a greater amount of experimental data on men, the differential significance of this sign should decrease. Two other signs are essential when working with recruitment.

The presence of signs has an average differential significance (more than 2) when hiring in the studied unit:
- №4 – «age greater than 45 years»;
- №6 – «man»;
- №42 – «knowledge of professional selection methods and proficiency testing techniques»;
- №60 – «dynamic - medium slow»;
- №61 – «dynamic - slow»;
- №77 – «activity (in relation to corporate culture) - “non-arrogance”».

The sign №6, reflecting the preference of a set of men, is a consequence of the small amount of experimental data on them. It is possible that the sign №4, reflecting the preference of the recruitment of people over the age of 45 years, shows the current situation when experienced personnel officers have a higher appreciation of their activities. Naturally, the list of preferred signs included the main indicator of professional competence of an employee of the personnel department - feature №42. Psychological signs №60, 61, 77 show the overall situation in the team.

By the accepted statistical independence of the signs, the distinguishing criterion (for each text with the number \( j \), \( j = 1..M \) ) was written as follows:

\[
I_j = \sum_{i=1}^{N} \left( E_{ij} \log \left( \frac{P_i^p}{P_i^n} \right) + (1 - E_{ij}) \log \left( \frac{1 - P_i^p}{1 - P_i^n} \right) \right)
\]

The task of differentiating questionnaires mathematically was reduced to the adoption of one of the three decisions:
- \( N = \{ \text{Recommendation to hire} \} \)
- \( H = \{ \text{Recommendation not to hire} \} \)
- \( H/Y = \{ \text{It is impossible to make a recommendation} \} \)

by criterion value.

**Results of probabilistic-statistical processing of questionnaires**

In Figure 1, the results of calculating the distinguishing criterion for experimental questionnaires are presented. Points corresponding to workers with positive and negative assessments form two practically disjoint sets.
The results of calculating the expectation and standard deviation for the resulting sets are given in Table 3 and in Figure 2. There are shown the boundaries of the intervals with a confidence level of 67%.

**Table 3.** Mathematical expectation and standard deviation for the values of distinguishing criterion

| Assessment | Mathematical expectation of the criterion | Standard deviation of the criterion | The boundaries of the interval with a confidence level of 67% |
|------------|----------------------------------------|-----------------------------------|----------------------------------------------------------|
| Positive   | 9,18                                   | 9,91                              | Upper: –, Lower: –0,74                                     |
| Negative   | –6,40                                  | 2,63                              | Upper: –3,76, Lower: –                                        |

The variation of the criterion for workers with a negative assessment is significantly less than for workers with a positive assessment.

**Figure 1.** Values of distinguishing criterion for initial experimental questionnaires

**Figure 2.** Values of distinguishing criterion, its average values and boundaries for the initial experimental questionnaires
Analysis of the results showed that the lower bound of the interval of the distinguishing criterion (with a confidence level of 67%) for positively evaluated employees does not overlap with the upper bound for negatively evaluated employees. Thus, in the case when the value of the distinguishing criterion falls within the confidence interval for positively or negatively evaluated workers, a conclusion can be made with a probability of 67%. The conclusion cannot be made in the case when the value of the distinguishing criterion lies between the intervals.

The final decision rule for determining the possibility of hiring a candidate is written in:

\[
I < -3.76 \rightarrow \text{It is recommended not to accept (with a probability of 67%)}
\]

\[
-3.76 \leq I \leq -0.74 \rightarrow \text{it is impossible to make a recommendation}
\]

\[
I > -0.74 \rightarrow \text{It is recommended to accept (with a probability of 67%)}
\]

Testing the performance of the criterion on experimental questionnaires showed that the probability of making the right decision for positively and negatively evaluated workers made 96%, which was higher than the confidence level proposed in the criterion. Thus, it confirmed the reliability of the developed criterion and the correctness of the assignment of the confidence interval.

**Conclusion**

Based on the analysis, it is worth noting that the IMS can be implemented when the requirements and recommendations of two or more international/national standards are integrated into the business processes of the organization and those synergies are obtained in terms of product quality, processes and meeting the requirements of interested parties. The synergistic effect, in this case, is based on the elimination of duplication of repetitive processes in the enterprise.

There are standards that contain recommendations for the process of creating an integrated management system:

- ISO GUIDE 72:2001. Guidelines for the justification and development of management system standards;
- BH139 Integration Guide. Requirements of standards for QMS, EMS, SMBTS;
- FD X 50-189 AFNOR. Management Systems - Integration Guidelines;
- AC X-50-200 AFNOR. IMS. Good practice and data from experience;
- AS/NZS 4581 Management system integration – guidance to business, government and community organizations.

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