Model of an automated information control system based on key performance indicators for controlling production processes

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Abstract. The article presents the problems of managing the key performance indicators of the organization's production processes. Various situations of terminological conflict and other issues of interpretation of indicators reflecting the effectiveness of management of production systems are considered. A model of automated information and control system and its decomposition of components for managing the goals and objectives of structural divisions is proposed.

1. Introduction
Certain models of production systems are characterized by the application of various principles of production organization, which are reduced to one: the entire technological cycle of the developed or existing system is based on the principles laid down by the Japanese scientist K. Ishikawa—a combination of such elements as personnel, materials, equipment and technology. The common uniting of all such elements are production functions [1-3]. The principles of production organization are based not only on the postulates described by Russian scientists [4-8], such as the sequence of processes, traceability of processes, acceptable accuracy and energy efficiency of technological operations and the necessary level of unification, but also on the principles of production organization, a certain percentage of financial costs for research of new principles of product functionality are laid.

In other words, an organization that manufactures high-tech products in the process of planning and developing its own product, made certain costs aimed at scientific and technical research, allowing if not to transform the existing functionality of the product, then add new characteristics necessary for the market, which will constitute a competitive feature of the product being developed.

The structural representation of the production system is such that all technological operations are provided with the necessary resources: equipment and equipment, design and technological documentation, as well as the necessary personnel.

2. Problem area
However, in such a linear organizational system, a real problem has been identified: how to create effective organizational and technical solutions aimed at improving the efficiency of structural divisions that continuously create production orders with partial or complete changes in the functionality of the external consumer.
How to solve production problems of operational changes in design documentation as a response to consumer complaints or take into account the flow of feedback from the organization from the side of operation.

A similar problem clearly exists among scientific and technical and industrial organizations. The main conflict of interests between line personnel and functional management is the desire to bring quality assurance processes to the maximum result with minimal costs and minimal involvement of production personnel, naturally, without interrupting their immediate responsibilities. If this question is decomposed according to some features related to the quality management system and the method of tactical goal formulation, then it is not clear how tactical goals are formulated and tasks are set, and how management takes place on the ground. Since the existing concept of hierarchical relationships within departments is responsible for the physical implementation of the process, the task of the quality service is to track the immediate processes of a managerial nature. Different goals and different tasks are performed by structural divisions and for the description of their activities, there is a regulatory documentation of the quality management system, such as: a process map, a strategic goal map, a standard operations map, and other documents.

However, it remains unclear what happens if the goals are misinterpreted and illusions are mistaken for a real situation. When the flow of actions that are responsible for achieving the goal is a deliberately losing strategy. The answers to these questions have long been found and presented in the works of domestic and foreign scientists [10-15], and it consists in indicators that characterize the effectiveness, efficiency and success of production processes. Key performance indicators play a special role in achieving a successful state. The correct interpretation of the key performance indicators responsible for successful activities is a serious and important task that must be solved by any successful manager and specialist who wants to control the main activity that brings value. Therefore, research processes are needed, including audit, analysis, and other measures to collect information about the current state of affairs and risk situations.

3. Discussion of the problem of setting the essence and content of key performance indicators

The right question is how to measure key performance indicators and how they reflect the real situation. This is a very big problem because all sorts of factors include success rates. Such factors are not unique to the known elements of Ishikawa's theory: personnel, equipment, or materials. It is also impossible to lose sight of the external influencing factors that influence the features of the process, the moment and the importance of the attributes of the output of the process under study. To total controlling the major activities of the factors for the successful flow of basic processes and monitoring of external influencing factors need to create a model of management information system, which should be formed with the basic objective: automate the process of accounting, control and monitoring of key performance indicators, and indicators characterizing the course of the process, i.e. the production of indicators, indicators of process and performance indicators of the process.

The terminological difference between the key performance indicators and the overall performance indicators of the process is in relation to the result achieved and the resources spent for this in the first case, and in eliminating the factors of failure in the second case. Key performance indicators are a set of significant indicators that can characterize the factors of successful performance. Therefore, it is necessary to develop a procedure for determining and identifying key performance indicators and to understand which structural units are needed in this process. The need to create an automated information system is dictated by the peculiarity and mentality of decisions related to the control and consideration of key performance indicators, and a strong competitive decision will be the action to create, introduce and operate an automated information system that takes into account the real-time operational activities of the structural unit.
4. The structural content of the model of the automated information management system

The relationship between the management of an organization based on an automated information and management system is as follows: in accordance with the main organizational attributes that characterize the development of the organization, the numerical values of strategic indicators are adjusted. Under the influence of external environmental factors described by PEST analysis and SWOT analysis, the production system is managed using two types of indicators: key performance indicators and OKR indicators. Groups of key performance indicators have been formed for different levels of management of the organization, which must be measured during the course of the process. It is these indicators that form a sustainable understanding of the success of the main activities that carry value. External environmental factors actively affect both the technological process itself and those structural units that are responsible for communication with external consumers and all stakeholders in the organization. In accordance with the active impacts that the external environment creates, it is necessary to use risk management to minimize possible negative events, where it is necessary to prescribe solution scenarios and use FMEA analysis to understand critical processes. The structure of an automated information system consists of some program cells that characterize the activities of each of the structural divisions in the production chain. The software environment contains an accessible interface for the operator to access text and numerical values that characterize the purpose of the structural unit and the regulated, planned effectiveness of the process under study implemented by the structural unit. In general, in accordance with the purpose and objectives of the structural units, a critical success factor is formed and entered into an electronic process map, the dynamics of the state of which is measured hourly. Thus, in the quality service, it becomes possible to quickly monitor the activities of all participants in the production system and maximize the visualization of the current process progress.

![Figure 1. Model of the information and control system.](image)

The decomposition of the automated information and control system consists of four modules in accordance with the Ishikawa theory, the modules are provided with weight coefficients that reflect the degree of significance of the model component obtained on the basis of rank ratings of experts from third-party organizations. (figure 2).
Automated information and control system

Personnel
- Department performance indicators

Materials
- Indicators of % usage

Equipment
- Indicators of effective service
- Risk indicators

Wednesday

Visualization of indicators and indicators

Workplace

Plot, line

Functional management

Linear control

**Figure 2.** Decomposition of the information and control model.

The standard for such cases related to the interpretation of numerical values of the studied potential with target values is the differential method, which includes a qualimetric scale of relations, represented by the following expression (1):

\[ Q_{\text{um}} = \sum_{n=1}^{q} q_i \frac{F_{\text{fact}}}{F_{\text{goal}}} \]

where \( Q_{\text{um}} \) is a generalized indicator of the information and control model; \( F_{\text{goal}} \) is the planned target quantitative values of the process parameters; \( F_{\text{fact}} \) is the actually achieved quantitative values in the process [17].

**Table 1.** Quality indicators selected to reflect the operational activities of the unit under study.

| Process                                      | Parameter                          | Unit.                  | Result / Criterion                                                                 |
|----------------------------------------------|------------------------------------|------------------------|----------------------------------------------------------------------------------|
| Management of non-conforming products        | Maximum allowed time to resolve critical non-conformities | 12 hours               | Eliminating the negative effect in 12 hours / Not eliminating the negative effect in 12 hours |
| KPI indicators                               |                                    |                        |                                                                                  |
| KPI indicators "leading" indicators:         |                                    |                        |                                                                                  |
|     — % of nonconformities not taken into account within 2 hours; |                                    |                        |                                                                                  |
|     — % of non-compliance decisions over 1 day old; |                                    |                        |                                                                                  |
|     — % of nonconformities redirected to another specialist more than 3 times; |                                    |                        |                                                                                  |
|     — average number of nonconformities per specialist. |                                    |                        |                                                                                  |

An important aspect is the certain applicability of those quality indicators that were selected to reflect the operational activities of the unit under study (table 1). The tasks of selecting quality indicators or
operational indicators require knowledge and experience, as well as skills in managing the process under study.

The necessary attributes of the information management system are primarily indicators and indicators of all the modules of the system that track the achievability of goals and the performance of tasks in real time. However, there is another opinion that the system of indicators has an archaic appearance and all monitoring processes of a tracking nature take into account only the potential of the past periods [10-18], for which the corresponding results were achieved, these are performance indicators.

However, such indicators are very difficult to influence, since the time of the activity, the results of which they reflect at the current moment has already passed, therefore, the performance indicators are indicators of the multi-day work carried out. Of course, such indicators are also necessary for an adequate assessment of the performance of processes, the only question is their number. The following concepts are presented in various sources describing the methodology of the balanced scorecard system: Norton and Kaplan believe that twenty key performance indicators are sufficient to track processes; David Parmenter, in his book, presents the ratio 10/80/10, key performance indicators/production indicators/key performance indicators, and the current production opinion of experts also varies in a similar range - 15/70/15.

Each of the modules contains hierarchical indicators in the form of quantitative values that reflect the current operational activities of the unit or process. However, the peculiarity of this model is not only the operational visualization of current indicators and performance indicators of departments or processes [7], but also the moment of transition of responsibility along the process chain, observing the regulated format for the successful transfer of the object of transformation within the entire production system. Therefore, the following organizational and technical solution has a local novelty - the creation of operational reference visualizations at workplaces, sections in workshops, including both horizontal structures and vertical departments. Horizontal structures are understood as the main linear activity of a production system that creates value in the form of a production product or service. From the point of view of the concepts of TQM (Total Quality Management) [8,19,20], the simplified format of interaction between structures, regulating the transfer of responsibility for the transformation object along the process chain, is a continuous linear horizontal structure, with broken interprocess barriers. This format allows you to optimize the technological processes of creating a product and minimize the costs associated with excessive document flow.

5. Conclusion
The presentation of the decomposition of the information and control model for the processes of the product life cycle will allow you to make an informed decision on the formation of a comprehensive information platform for visualizing operational data received from structural divisions. The next stage should be considered the stage of implementation of the system of lagging and advancing indicators as a result of the process restructuring based on the information management model integration, which will allow to make a technological breakthrough to the system of synchronized production, creating prerequisites for improving the management of functional levels.

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