Structuring Organizational and Technical Measures of the Production Program

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Abstract. The main problem of the functioning of the organizational, technical and technological structures of the enterprise is the insufficient formalization of business processes, which, in turn, is based on the uncertainty of business process tasks influence level to the whole process, which complicates its further effective development. In this article, the structuring of such elements is based on the approach of forming the system of design and technological preparation of production (DTPP) at the enterprise, and the business processes are the subject of the study. The objective of the study is to improve the DTPP control system within the framework of research and development (R&D) with further deeper formalization for the implementation of an automated DTPP control system. To achieve this objective, tasks for assessing the business processes of DTPP control have been identified, as well as for analyzing the effectiveness of the business processes tasks for DTPP control.

To achieve the target goals and solve the tasks, the research plan includes such stages as the formation of a schedule of research, identifying the necessary resources and their sources, identifying the direct executors and bringing the plans to them, fixing the results of planning in the form of a project. The study is based on the use of expert assessment method. To obtain the correct result from two groups of expert assessments, individual assessments have been used, which are based on the use of the individual experts’ opinions who are specialists of the enterprise, and functionally independent from each other. The implementation of the individual assessments formation is based on an individual expert survey in the form of an interview with an analysis of expert assessments.

1. Project management business process evaluation criteria

The concept of a business process is defined as a set of interrelated tasks aimed at creating a specific product or service for consumers [1, 6]. Flowcharts of business processes are used as a graphical description of the activity.

In some works [2-7], concerning the study and investigation of business processes in their topic, three types of business processes are considered:

Control processes which are business processes on which the functioning of the system depends.

Operating processes are business processes that make up the core business of the company and create the main revenue stream.

Supporting processes are business processes that serve the core business.

Based on the definitions, the control of DTPP for the enterprise is the control business process.
The method for assessing the tasks of business processes according to the evaluation criteria is based on the analysis of the existing project management system, which has 5 stages of DTPP implementation. The influence of the external environment is also taken into account, which allows you to form a set of six groups of criteria for evaluating the business process shown in the table.

**Table 1. Project Management Business Process Evaluation Criteria.**

| Criteria | Name | Description |
|----------|------|-------------|
| PrM<sub>0</sub> | External Environment (EE) | Interaction with marketing services, procurement and supply departments, product sales units |
| PrM<sub>1</sub> | Project Initiation (PI) | The phase of documents preparation for the project justification and deadlines |
| PrM<sub>2</sub> | Design Preparation of Production (DPP) | The phase of preparation of design documentation, including technological development |
| PrM<sub>3</sub> | Technological Preparation of Production (TPP) | The phase of development of technological projects, including bill of materials and labor-intensive calculations |
| PrM<sub>4</sub> | Fitting-Out of Production (FOP) | The phase of development and manufacturing of technological equipment, including their implementation |
| PrM<sub>5</sub> | Start of Production (SP) | The phase of production of prototypes and coordination of documents for the release of batches of products |

The general complex criterion for evaluating a business process depends on the particular criteria of the stages and is determined by the formula (1).

\[
PrM_{BP} = PrM_0 + \alpha \cdot PrM_1 + \beta \cdot PrM_2 + \gamma \cdot PrM_3 + \delta \cdot PrM_4 + \varepsilon \cdot PrM_5
\]  

(1)

where \( \alpha, \beta, \gamma, \delta, \varepsilon \) are the coefficients characterizing the degree of influence of the stage on the entire business process. The criterion \( PrM_0 \) depends on the external environment and is subject to risks that are not inherent in the described business process, and its calculation should be carried out, for example, by SWOT analysis. Other criteria are considered in the table. 2.

**Table 2. Project Management Business Process Criteria.**

| Assessed Stage | Calculation Method | Significance of the criteria |
|----------------|--------------------|-----------------------------|
| \( PrM_1 \) Project Initiation (PI) | \( PrM_1 = \sum_{i=1}^{14} PrM_{1,n} \) | 20 |
| \( PrM_2 \) Design Preparation of Production (DPP) | \( PrM_2 = \sum_{i=1}^{16} PrM_{2,n} \) | 25 |
| \( PrM_3 \) Technological Preparation of Production (TPP) | \( PrM_3 = \sum_{i=1}^{20} PrM_{3,n} \) | 23 |
The coefficients $\alpha, \beta, \gamma, \delta, \varepsilon$ characterize the degree of influence of the stage on the entire business process. The coefficient $\alpha$ is determined by the formula:

$$\alpha = \alpha_1 \cdot \alpha_2 \cdot \alpha_3,$$

(2)

where $E_{X_{PrMn}}$ is the number of typical stage output data (documents, information, material objects), $z_{PrMn}$ is the number of tasks on the stage.

The number of tasks in each stage is distributed as follows: project initiation - 20, design preparation of production - 16, technological preparation of production - 20, fitting-out of production - 13, start of production - 14. For the project initiation stage the output data responsible tasks are: development of technical specifications for research and development, registration of the contract, holding of scientific and technical council, preparation of an order and a schedule for the development of the product. The output data responsible tasks for the Project Initiation phase are: development of technical specifications for research and development, registration of the contract, holding of scientific and technical council, preparation of an order and a schedule for the development of the product. The output data responsible tasks for Design Preparation of Production phase include weekly meetings on the projects, planning the design department works, operational control of the project phases execution, development of draft design documentation, development design documentation for the technical project, development of a set of detailed design documentation of the product. The output data responsible tasks for the Technological Preparation of Production phase are development the bill of materials, development the operational procedures, development the means of technological equipment (MTE) registers, development the terms of reference for MTE, elaboration of applications for development of CNC, development of CNC and setup sheets, formation the schedule of CNC introduction, approval the engineering documentation package, labor rationing of operational procedures, formation of outsourcing bids for parts manufacturing, approval of conditions for competitive procurement, organization and conduct of the competitive procurement, the operational control of the project phase execution, weekly meetings on the project. The output data responsible tasks for the Fitting-Out of Production phase include operational control of the project stage execution, weekly meetings on the project, development of the MTE manufacturing schedule, analysis of MTE on the factory labour hours, formation of the purchased tools list, development of design documentation for MTE, development of technical processes for MTE, development of design documentation for MTE of the second order, procurement of tools for the tool warehouse, calculation of needs in materials and planning of procurements, organization of material procurements for MTE production. The output data responsible tasks for Start of Production phase include approval of the Act on CNC code implementation, outsourcing parts manufacturing order, receipt of products manufactured by outsourcing, procurement of materials and third-party components, planning the production of a prototype, incoming control, production of the prototype, development of a set of detailed design documentation of the product, testing of the prototype.
2. Assessment example

Typical outputs of the stages are responsible tasks of the project activity, distributed by specific subdivisions [8-12]. Therefore, for \(\alpha_1=4/20=0.2\).

The second coefficient characterizes the weight of the stage in the overall business process, and is calculated by the formula:

\[
\alpha_2 = \frac{z_n}{z_s},
\]

(4)

where \(z_n\) — is the number of tasks on the stage, \(z_s\) is the overall number of tasks. For \(\alpha_2=20/83=0.24\).

The third coefficient takes into account the weight of each subdivision at each stage in the overall business process:

\[
\alpha_3 = \frac{1}{z_s} \sum_{d=1}^{n} z_{DEP_n} QP_{DEP_n}
\]

(5)

where \(z_{DEP}\) — is the number of the subdivision tasks on this stage, \(QP_{DEP}\) — the number of incoming and outgoing connections for the tasks of the unit at this stage, \(n\) is the number of subdivisions (in this case this number is 18).

For \(\alpha_3=1/83 \cdot (28+2+2+8+2+0+0+2+0+2+0+2+0+15+2+0+8+2) = 77/83 = 0.92\)

Then: \(\alpha=0.2\cdot 0.24\cdot 0.92=0.044\).

Other coefficients are determined similarly, the essence of which is a quantitative assessment of the share of "inputs" and "outputs" of a business process, the degree of regulation of product development activities and the absence of zones of responsibility and irresponsibility zones when performing business product development processes [13, 16-20].

Therefore, for \(\alpha_{PrM_1}=0.044\cdot 12 = 0.528\). Substituting the calculation results in the formula (1), we obtain \(PrM_{BP}=7.4\).

Based on the developed methodology, data are generated on the assessment of business processes in the context of the execution of tasks of the business process (the dynamic component of \(PrM\) for each stage) and in the context of the constant component that determines the weight of the business process, which allows the following measures:

1) To analyze the tasks of the business process distributed in stages;
2) Rank tasks according to financing criteria and duration of execution in the context of the business process;
3) Calculate the predicted reduction in the values of the criteria in a three-year period by 20, 10 and 5 % annually.

An analysis of the tasks of the business process consists in monitoring and tracking the dynamics of \(PrM_i\) indicators. For each stage, these indicators vary depending on the performance or non-performance of the task, as shown in the table 3.

**Table 3. Business process task analysis.**

| Criterion | Value (Plan) | Value (Fact) | Stage efficiency |
|-----------|--------------|--------------|------------------|
| \(PrM_1\) | 20           | 13,5         | 67,5             |
| \(PrM_2\) | 25           | 14,5         | 58               |
| \(PrM_3\) | 23           | 16           | 69,57            |
| \(PrM_4\) | 17           | 8,5          | 50               |
| \(PrM_5\) | 15           | 14           | 93,33            |

Coefficients have a more static tendency and affect the overall \(PrM_{BP}\) score. Thus, the bottleneck of the business process, which is the manufacture of equipment, is identified.

The significance of each stage task is determined in various ways:

- based on the duration of the task by the method of expert evaluations;
- based on the amount of investment;
based on an index of temporary losses due to a delay in the execution of a task.

Table 4 shows the results of ranking tasks, where the order of execution of tasks is defined, but the importance of tasks is determined depending on the General goal.

Table 4. The Results of Ranking the Implementation of the Tooling Production Phase Tasks in the Project Management System.

| Task Rank | Based on Task Execution Criterion | Based on Task Duration Method, in Days | Based on Amount of Investments, in KRub. Criterion | Based on Temporary Losses Index Due to the Task Execution Delay Criterion |
|-----------|-----------------------------------|----------------------------------------|-----------------------------------------------|-----------------------------|
| 1         | PrM4.1                            | 1                                      | PrM4.15                                       | PrM4.15                     |
| 2         | PrM4.2                            | 2                                      | PrM4.12                                       | PrM4.7                      |
| 3         | PrM4.3                            | 3                                      | PrM4.14                                       | PrM4.6                      |
| 4         | PrM4.4                            | 4                                      | PrM4.6                                        | PrM4.1                      |
| 5         | PrM4.5                            | 5                                      | PrM4.16                                       | PrM4.8                      |
| 6         | PrM4.6                            | 6                                      | PrM4.14                                       | PrM4.5                      |
| 7         | PrM4.7                            | 7                                      | PrM4.9                                        | PrM4.9                      |
| 8         | PrM4.8                            | 8                                      | PrM4.8                                        | PrM4.12                     |
| 9         | PrM4.9                            | 9                                      | PrM4.11                                       | PrM4.2                      |
| 10        | PrM4.10                           | 10                                     | PrM4.13                                       | PrM4.16                     |
| 11        | PrM4.11                           | 11                                     | PrM4.14                                       | PrM4.3                      |
| 12        | PrM4.12                           | 12                                     | PrM4.1                                        | PrM4.14                     |
| 13        | PrM4.13                           | 13                                     | PrM4.5                                        | PrM4.11                     |
| 14        | PrM4.14                           | 14                                     | PrM4.16                                       | PrM4.10                     |
| 15        | PrM4.15                           | 15                                     | PrM4.4                                        | PrM4.13                     |
| 16        | PrM4.16                           | 16                                     | PrM4.10                                       | PrM4.4                      |

Next, a ranking of tasks should be carried out, where the order of task execution is defined, but the importance of tasks is determined depending on the general goal [15]. The ranking results can show, for example, that the optimization of the stage depending on the duration of the task by the method of expert estimates and the time loss index due to the delay in the execution of the task will be different.

The result of the predicted reduction in the values of the criteria over a three-year period is the elimination of inefficient tasks and the optimization of relationships between tasks (correlation of the corresponding coefficients).

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