MANAGEMENT SYSTEM OF INNOVATIVE DEVELOPMENT STRATEGY IN ENGINEERING

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The choice of innovation development strategy by an engineering university is the most adequate answer to the challenges conditioned by the governmental policy in the sphere of education, one of priorities of which is to provide innovation character for basic education, development and implementation of integrated innovation programs solving personnel and research problems in development of innovation economics on the basis of integration of education, scientific and production activities. Success in innovation development strategy realization of engineering university independently of its type is to the full extent determined by the management system efficiency of innovation strategy, the model of which is presented in the article.

Key words: *innovative development strategy management system in technical university, balanced scorecards, monitoring, risk management, mission, organization structure, competitive strategy, development perspectives, targets and aims of innovative developmentstrategy.*

Achievement of strategic goal of governmental policy in the sphere of education – to increase the availability of qualitative education meeting the requirements of innovative economic development, modern demands of society and every citizen - is solved by a set of tasks including implementation of the innovative character of basic education. Development of personnel efficiency for enterprises of high-technology industries is a general goal of engineering university activity in the sphere of innovation strategy of its development (ISD). Innovation strategy of engineering university is a goal-oriented activity in choosing priorities of perspective development and their achievement as a result of which a new quality of educational and research activity and management is to be provided [1,2]. Hence, ISD should and is implemented through progressive non-standard management decisions depended on the conditions of internal and external media, developed and taken in terms of specific peculiarities of engineering university activity [3]. Efficiency in implementation of innovation development strategy is determined by management system including the system of efficiency strategy indicator, monitoring of process performance, performance evaluation, development and realization of corrective actions and management decisions.

1. Management system structure of engineering university innovation development strategy.

The developed management system of innovation development strategy is based on methods of balanced score

card (BSC), risk management, failure mode and effect analysis (FMEA), methods of qualimetry and scaling as well as management techniques such as QFD (Quality Function Deployment), FTA (Failure Tree Analysis), ETA (Events Tree Analysis).

The key concepts of ISD management system consist in the following:

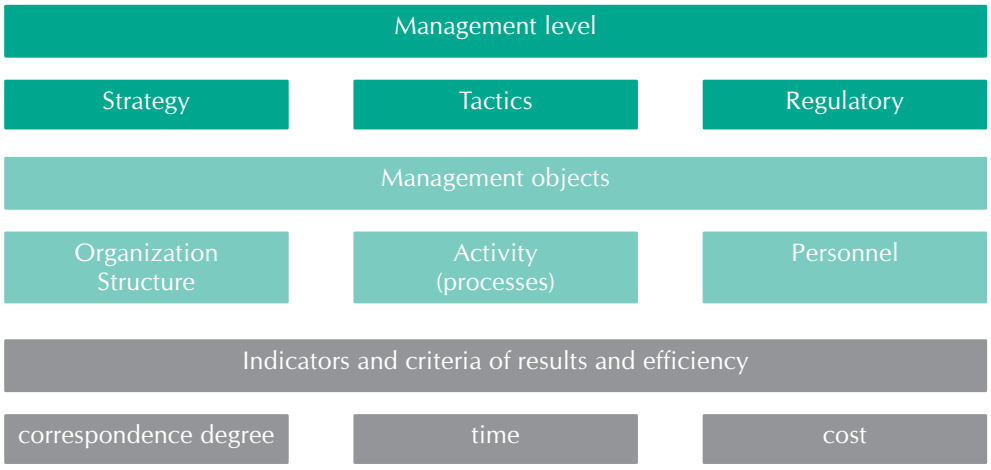
- ISD management is performed at three levels – strategic, tactic and regulatory-procedure;
- The objects of ISD management are at each level: structure, activity (processes) and personnel (staff) of university, students, graduates and employers;
- Results and efficiency of ISD are estimated by three indicators: quality, time and cost of goal achievement (Fig.1).

Criteria for ISD result and efficiency evaluation at all levels are correspondence of the results obtained to the values of planned indicators. At the strategy level management is performed on the basis of estimation of result correspondence by such elements of ISD as: mission, organization chart, competition strategy, development perspectives, goals and tasks (Fig. 2).

The basis of the Program tactic management is process result and efficiency evaluation including: evaluation of process structure and planning, evaluation of process goal and result indicator adequacy, process scheme, procedures of their performance as well as monitoring, development and performance of corrective and preventive actions, management decisions (Fig. 3).

Regulatory level of management system of engineering university innovation strategy development is goals and processes in documents necessary for their achievement structured in three groups - main, supporting and management processes (group of main processes includes those of educational, research and innovation activities), indicators and criteria of process results and efficiency, estimation methods of obtained result correspondence to the set goals. A structure of regulatory documents (RD) of management system of engineering university development innovation strategy is shown in Fig. 4. Documents of regulatory level for management system of engineering university development innovation strategy include analysis and evaluation procedures of educational, research and innovation activities, methods of indicator determination of the ISD process results, analytical methods of support for providing the process results.

Fig.1 Structure of Innovation Strategy System of Engineering University Development



2. Balanced score card in ISD management of engineering university

Planning, performance and evaluation of ISD results and efficiency is made on the basis of balanced score card (BSC). Balanced score card consists of groups of financial and non-financial indicators. Intention and task of BSC is to transform goals and tasks of university innovation strategy into specific indicators and coefficients. These indicators set the balance between the external account data and internal characteristics of the most significant business-processes, innovations, training and development in university. BSC allows for evaluation of the obtained results and forecast of development in all types of university activities. Balanced score card presents a set of objective, quantitatively estimable results and pre-set values and indicators in development. BSC accounts for the processes of strategic development in the educational and research sphere, cooperation with strategic partners and ISD financial processes, budgeting (Fig. 5). Structure of ISD efficiency indicators at each level (management and performance – Fig. 6) is presented in Fig. 7.

Every group of indicators is structured in four directions:

- indicators of performance evaluation for the ISD requirements;
- indicators of ISD resource evaluation;
- indicators of ISD financial activity and commercial coefficients;
- indicators of ISD personnel evaluation.

The basis for ISD efficiency analysis is qualimetric evaluation in terms of complex efficiency indicators defined as an average evaluation of five constituents (Table 1).

The weight indicators (βn) are stated by the method of expert estimation depending on the level of indicator importance Nn .

The complex ISD efficiency indicator is calculated by the formulae:

$$N = \frac{\sum_{i=1}^{4} \beta_n \cdot Nn}{\sum_{i=1}^{4} n}$$

3. Methods of risk management of balanced score card (BSC) in ISD implementation

Forecast of consequences in the conditions of uncertainty and probability

Fig.2 Objects of Engineering University Innovation Strategy Management and Evaluation

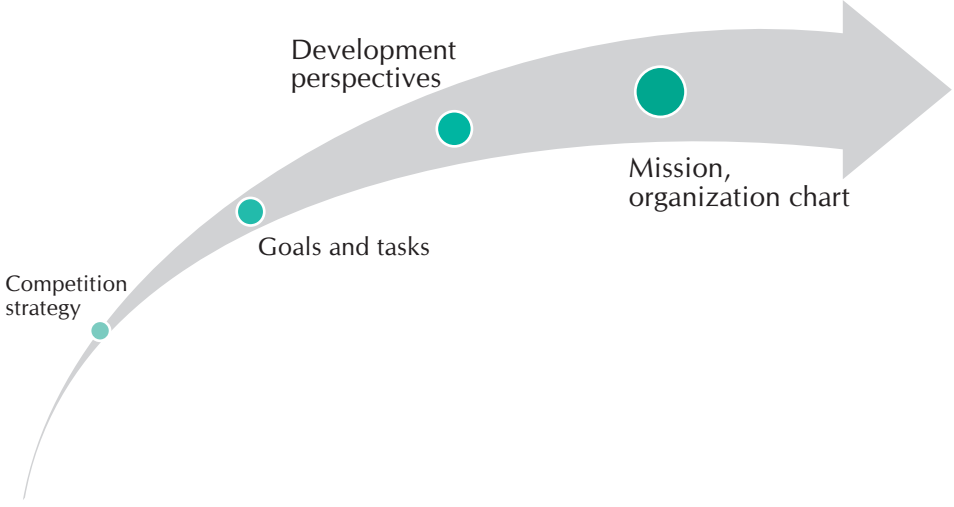


Fig.3 Stages of Tactic Level in Management System of Engineering University Innovation Development Strategy

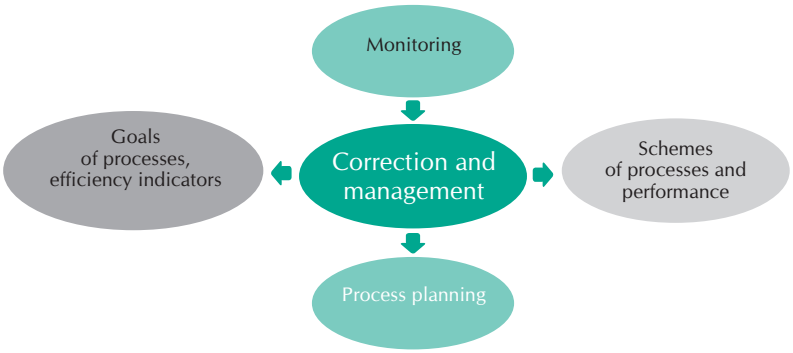
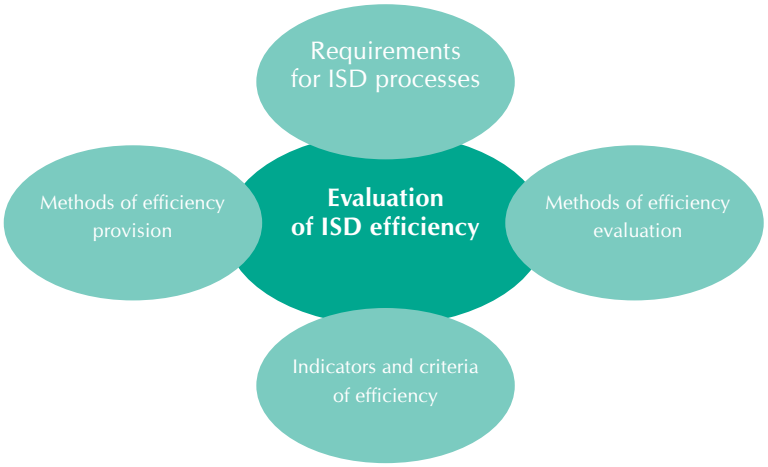


Fig.4 Structure of Regulatory Level in Management System of Engineering University Innovation Development Strategy



of consequences of possible deviations in ISD implementation as well as development and performance of appropriate preventive measures have become possible due to technique of risk management performed as a set of coordinated actions in ISD management. Risk assessment and forecasts of their consequences is carried out according to the recommendations of GOST p 52806-2007 Project risk management. General instructions.

To choose critical level of analyzed risks the initial conditions of probable event or circumstance, sequence of potentially hazardous events, any mitigating factors and characteristics as well as origin and frequency of possible negative consequences of identified hazards are studied in the course of risk value assessment. These criteria and measures are related to all activities of ISD and include the values of assessment uncertainties. The objective of risk assessment is taking decisions based on risk analysis establishing the priorities in taking decisions in terms of risk to which one needs to respond first of all.

Risk analysis in ISD realization of engineering university is to be performed taking into account the peculiarities of its research-educational and innovative activity using such methods as «event tree analysis» (ETA), «failure modes and effects analysis» (FMEA), «failure tree analysis» (FTA), «hazard and operability study» (HAZOP), «human resource analysis» (HRA), «preliminary hazard analysis»

Fig.5 Constituents of Balance Score Card in Management System of Engineering University Innovation Development Strategy

Fig.6 Groups of ISD Efficiency Indicators

Fig.7 Structure of Balanced Score Card (BSC)

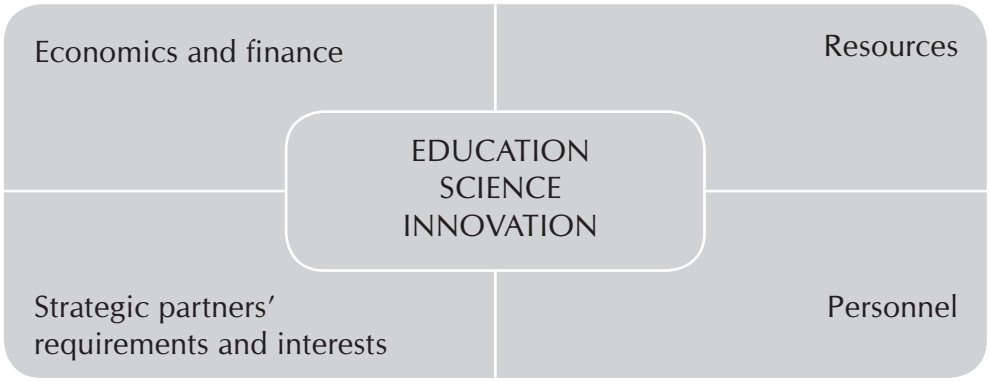


Table 1. Constituents of ISD efficiency evaluation

№ п.п	Indicator designation N_n	Intention of indicator	Weight indicator (β_n) ($0 < \beta_n < 1$)
1	N_1	Requirement performance evaluation	β_1
2	N_2	Financial and commercial activity evaluation	β_2
3	N_3	Education, research and innovation activity evaluation	β_3
4	N_4	Personnel evaluation	β_4
5	N_5	Resource evaluation	β_5

(PHA), «reliability structure diagram of ISD».

The external risks conditioned, as a rule, external objective conditions and the internal risks caused by conditions of ISD performance are analyzed. Types of analyzed risks in the ISD system management are shown in Table 2.

4. Monitoring of ISD performance

In ISD monitoring the initial information is obtained through questionnaire, inner audits, self-control, testing.

Character, periodicity of collection and volume of data is set in terms of the condition of information storage on continuous process at its modeling in the form of sequence of discrete values of information units (Fig. 8).

For analysis and evaluation of such qualimetric methods as expert evaluation method, calculation methods (differential – for evaluation of individual elements of the process and complex one – for evaluation of the process as a whole) are used. Analysis and evaluation are performed by the methods based on index system and efficiency criteria.

To evaluate individual processes and their elements by differential and complex calculation methods simple and complex quality indexes are used. Processes to which calculation methods cannot be applied are evaluated by the expert evaluation method.

The principle stages of monitoring: establishment of threshold index values, determination of true values within the analyzed period, comparison of true and threshold values and evaluation of efficiency using the set grade scale (Fig. 9).

Evaluation results are used in analysis of ISD performance results in all activity directions, determination of efficiency level in developed grade scale, evaluation of process consistency, development of management decisions, formation of database on the course and results of ISD performance.

Periodicity of data collection in the system is defined by the process variability. Quick changing system processes include those of educational, research and innovation activities, development of scientific-engineering production and their commercialization. It implies the necessity of constant data on them. The data about set and stable processes which can include management and supporting processes (including resource management, infrastructure management, operating environment management, personnel management) can be collected and analyzed with higher periodicity.

Monitoring efficiency in the ISD management system of engineering university can be increased by using continuous acquisition and life-cycle support technologies (CALS). At this monitoring organization, data collection can be performed in common information space at all stages. In the integrated information environment information acquisition and processing on ISD processes as well as introduction of changes into the processes and other management decisions are performed by means of formalized functional models in real time scale.

Table 2. Composition and structure of risks analyzed in management engineering university innovation development strategy

Risks	Basic causes
EXTERNAL	
Country	Peculiarities of state law, changes in forms of property etc.
Currency	Changes in currency exchange, currency regulation
Tax	Changes in tax policy, tax rates
Force majeure	Natural and technogenic accidents
INTERNAL	
Organization	Low level of ISD performance organization, planning errors, forecast errors, inefficient management, poor organization of executive work etc.
Resource	Insufficient level of resource availability, fails to deliver, low qualification of executive workers, absence of resource reserves
Investment	Investment risks: equipment and row material delivery interruptions, errors in investment project development or innovation activity
Financial	Risks associated with probabilities of financial losses (investment risks, direct financial losses) and risks connected with circumstances, in particular, financial losses due to the fault of ISD financial bodies, employees or partners due to changes in conditions of ISD performance
Portfolio	Changes in contract terms, errors in choice of activity directions, incorrect choice of financial operations
Credit	Credit and interest default, non-compliance with credit conditions, borrower's involuntary bankruptcy, changes in borrower's paying capacity, incorrect choice in innovations, incorrect calculations, application and introduction of research developments
Legal	Licenses used, patent rights, breach of contracts, trials with external partners, internal trails,
Social	Risks directly connected with employees' working capacity as well as their personal qualities and labor conditions
Commercial	Risks associated with business activity, in particular, aimed at profit maximization and in the course of innovation activity, purchases and equipment delivery
Production	Risks associated with unforeseen deviation from preset process performance in terms of the Program due to different reasons as well as those conditioned by incorrect usage of equipment and techniques, basic and working asserts, production resources and working time
Professional	Risks associated with performance of ISD professional duties by executive officers

Fig.9 Algorithm of Result and Efficiency Evaluation of ISD Processes as a whole

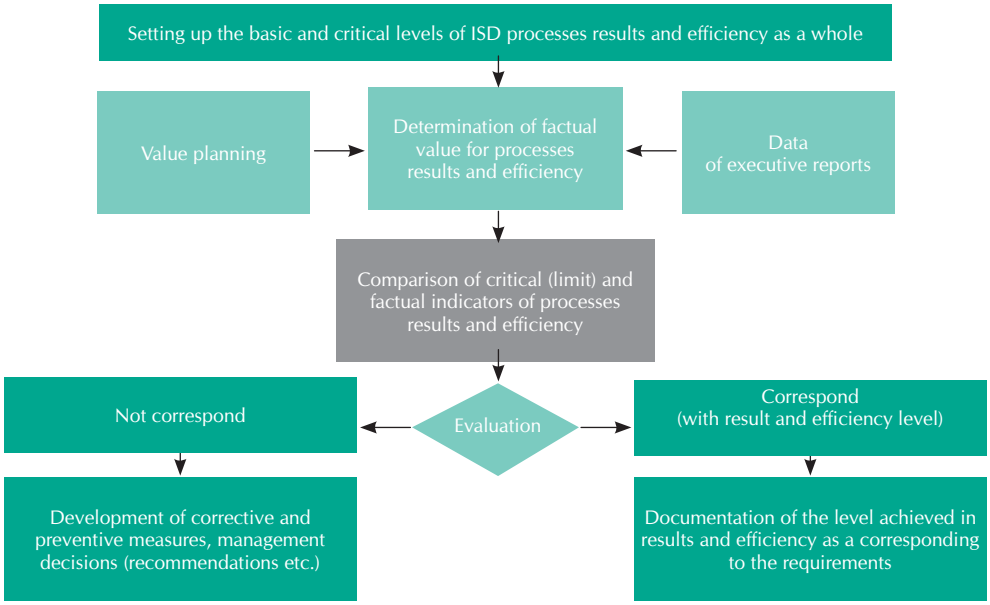
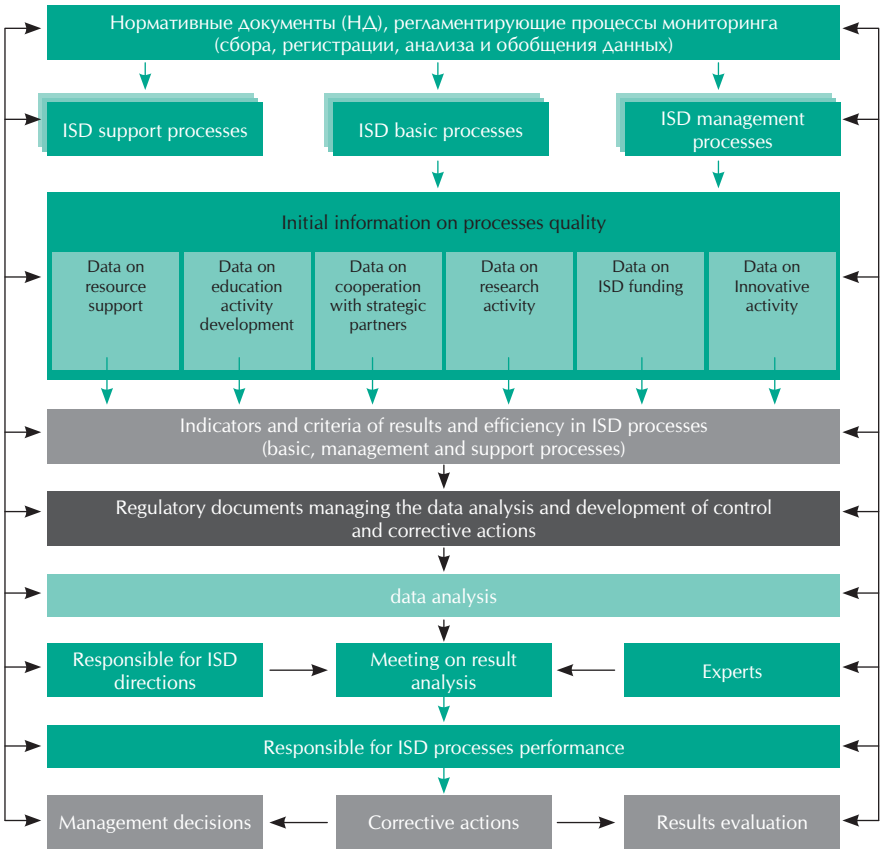


Fig.8 Monitoring of ISD Performance



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