

Modern benchmarks in educational process for economics and organization of mechanical engineering production

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Abstract. Nowadays economics and organization of mechanical engineering production needs several benchmarks for its modernization not only in technical and technologic aspects of functioning but also in educational process for future professionals in this area. Today's education should be problem-based and inquiry based and includes experimental learning. The trends of domestic economy is adapting of economic units to modern business reality that is developing and implementing of quality management system (ISO 9001: 2015). That means forming of process management for business entities in mechanical engineering production sphere. Therefore problem-based, inquiry based and experimental learning basic should be process management forming tools that are also feasible for strategy improving and functioning under stochastic conditions.

1. Introduction

Nowadays economics and organization of mechanical engineering production are the very important parts of business sphere that should be modern and follow the newest trends in techniques and technologies. Therefore highlights for educational process are problem-based, inquiry based and experimental learning. The modern tendencies of economy is domestic economic units adapting to modern business realities – developing and implementing of quality management system (ISO 9001: 2015). That means process management forming for business entities. Consequently problem-based, inquiry based and experimental learning basic should be process management forming tools that are also feasible for improving and functioning of strategy under stochastic conditions. In previous publications there were disclosed topical points in adapting of domestic economic units to modern business realities – task for developing and implementing of BSC-oriented process management system was formalized and algorithm for its solution was formed. After the decision of business processes transformation which is taken into account the fact that economic unit faces the problem of appropriate tools choosing for implementing of the mentioned above. There are large numbers of methodological approaches and software tools that can be aimed to business entity activity and achieving of its management improvement. Their insufficient application leads to incorrect model forming, excessive one causes disproportionate complexity and deepening, increasing of project time and cost, and in the future – the executed researches relevance is lost during long preparation period and environment high variability. All this should be taken into account as benchmarks to educational process for preparing professionals in economics and organization of mechanical engineering production.



2. Materials and methods

General scientific and special research methods were used for research. There were applied content analysis, economic modeling, graphical analysis, system and process approaches, statistic, techno-economic, system and structural analyses, standard of quality management system – methodology ISO 9001 : 2015, requirements of environment management system ISO 14004 : 2016, the theory of constraints by E. Goldratt; expert estimation method. It was studied theoretical and applied papers on the research topic [1-12], also official statistics data on business activity of economic units.

3. The study on modern benchmarks in educational process for economics and organization of mechanical engineering production

In the research were covered several benchmarks for mentioned topic which are methodical tools as such as methodologies: ISO 9001 : 2015, process approach, total quality management; functional modeling IDEF 0, mathematical statistics, business process functional modeling tool erwin Data Modeler R9.7; IBM SPSS Modeler 18.1 data processing programs for statistic data; strategic planning and marketing management methods: segmenting, positioning; BSC: strategic business units, goods and their priorities definition.

The tools that are using as benchmarks for educational process were substantiated, chosen and applied during the research of process management implementation to domestic economic units taking into account resource limits and Balance Scorecard (BSC) requirements. The importance of these tools applying is well-grounded by followings: quality management system by ISO 9001 : 2015 is used for process, system and client-centric approaches application proof at economic units activities. ISO 9001 : 2015 is modern basic standard which is base for procedures in business entities abroad. It is practiced for their successful management, providing of effective functioning; it was designed for management forming and includes correlated and interacted processes and procedures, organizational and technical events, plans, targets, fixed assets, documentation, qualified personnel and other components that are necessary for business entity for its goals achieving. In the specified standard there are defined eight quality management principles for economic unit activity improving: customer orientation, leadership of managers, involvement of employees, process and system approaches to management, continuous improvement based on decision-making actual approach, mutually beneficial relations with suppliers.

ISO 9001 : 2015 regulates applying of logical principle in process approach during forming, implementing and improving of quality management effectiveness aimed to stakeholders satisfaction refining with their requirements fulfillment. Moreover, it is necessary to differentiate approaches to process management understanding for its system correct forming at economic unit (table 1).

Table 1. Comparison of approaches to process management understanding.

Comparison point	Approach “Economic unit as processes network”	Approach “Cross functional business processes”
Process definition	Stable, purposeful set of interrelated activities that transform inputs into client-valuable outputs with certain technologies.	Purposeful operations sequence (work-flows, procedures) that leads to the given process output final result.
Organization activity viewing	Complex viewing. All activities are viewed as processes network. System approach. Real connection to organizational structure.	Partial viewing. Activities consideration as forming of successive operations chains. Absence of any system. Subjectivity.
Process control availability	Present. There are corresponding to ISO 9001 : 2015 standard requirements.	Absent. There are various subjective interpretations.

Comparison point	Approach “Economic unit as processes network”	Approach “Cross functional business processes”
Process owner	Present. Process owner has all resources that are necessary for process effectiveness ensuring, also he has clear position in the organizational structure.	Present. Process owner hasn't resources and clear position in the organizational structure but has responsibilities.
Structural departments interaction	100 % determined and regulated interaction in frame of process network.	Partial description in “cross functional” processes frame.
Organization administration	Organization administration is changing. Management system is formed on methodic basics of process management in frame of process network. Department managers became process owners.	In fact organization administration doesn't change. Activities of line managers are burdened with consideration duties for requirements of processes owners.
Management system documentation	Total documentation for procedures. Documents are corresponded to existing operations and used for 90–100 %.	Creating of additional documentation with low level of practical use.
Necessity of changes for organizational structure during process management implementing	Absent. Whole organizational structure is saved until appearing of real data on changes substantiation.	Must be totally changed for achieving of real result (transition to matrix or project structure).
Quality management processes	Certification in accordance to ISO 9001 : 2015 is possible.	Certification in accordance to ISO 9001 : 2015 is impossible.

In this research, process approach is applied for forming of process management in economic unit. It is based on the fact that organization defines and manages with multiple interacted activities, when resources applying and control on “inputs” into “outputs” transformation is considered as a process. Approach advantage is administration that is on joints between separate processes in frame of processes' system, also their combination and interaction (taking into account necessity of researching on processes from the viewpoint of “value chain”); processes characteristics and results achievement efficiency, processes continuous improvement are based on objective measurement.

In the research two given above methodologies are also used as basic ones for relevance substantiation, formulating of task on process management implementing to economic unit, its algorithm forming and solution finding, and also for practical implementing of research results to specific domestic economy business entities that work on mechanical engineering production.

Total quality management methodology is used at forming of relevant capacities for process management at economic unit (based on goods that are made taking into account properties that valuable for consumer – G_{si} characteristics [6]). In accordance to aforesaid statement business processes should be controlled and manageable, and be subject for including of improvement: process defining, researching, evaluation, adjustment; identification of process errors, its problems analysis and changes, measurement of process change results; communications forming between process-oriented innovations that are implementing by manager and users.

In this research it is used business processes correcting mechanisms that is describing for volatile environment – as such as TQM quality cycles (which will also be disclosed in further publications).

IDEF 0 methodology (figure 1) is the most convenient and common language for business processes functional modeling. In IDEF 0 system modeling process begins with contextual diagram design that is the most abstract level description diagram which contains the modeling subject definition, its goals and model viewpoint.

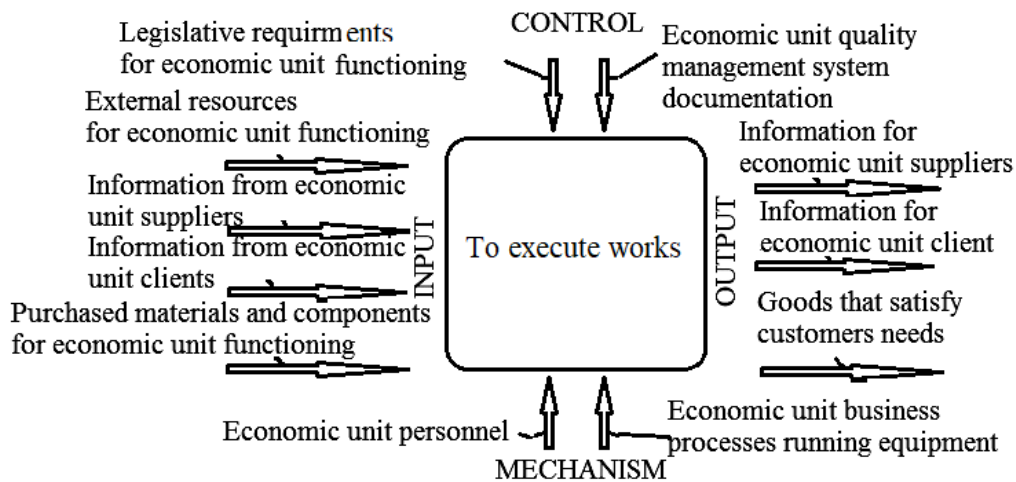


Figure 1. Context scheme of business process for economic unit (IDEF 0).

The subject is understood as the system itself, while it is necessary to define exactly what is included into the system, and what is excluded from its borders, to determine the system components and external environment. The system subject will be significantly influenced by system viewpoint and its targets position which both set questions on which designed model must give answers. At the first it is necessary to define modeling area, describe system and its components as the model forming basis. Example of fragment on inputs-outputs category for business process at economic unit in IDEF 0 notation is given at figure 2.

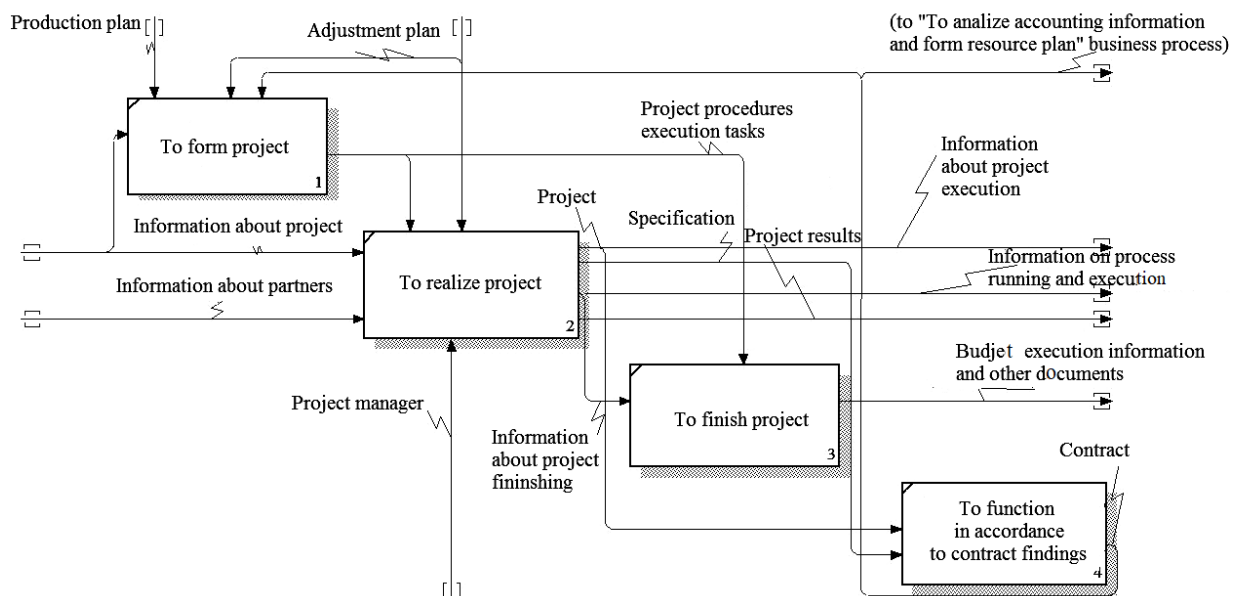


Figure 2. Example of fragment on inputs-outputs category for business process at economic unit in IDEF 0 notation.

Model area can be adjusted during modeling procedure, but it should be initially basically formulated whereas it determines modeling direction. When the area is formulated two of its components that must be taken into account is span and depth. The span implies model boundaries definition – what will be considered into the system, and what – outside. The depth determines model details level on which it is completed. When one determines the system depth it is necessary to consider time limitation – laboriousness of model design grows exponentially with increasing of decomposition depth. After model boundary defining it is assumed that new objects should not be added into the simulated system; whereas all model objects are interrelated, and new object can be not just an arithmetic additive, but is able to change existing correlations.

In the research mathematical statistics methods are used for forming of methodical approach to process management implementation during analysis and modeling.

Business processes functional modeling tool Erwin Data Modeler R 9.7 is methodical tool that is suggested to be used for modeling, analysis, documentation and optimization of business processes, and their graphical representation. Scheme that graphically presents procedures execution, information exchange, document circulation visualizes business process model, allows economic unit management tasks shift from complex area to engineering technologies sector. This software package helps to document clearly important aspects of business processes: actions that need to be taken, implementing ways and their controlling, required resources and results obtained from these actions. It increases business solutions efficiency, allowing to analysts and model designers to correlate corporate goals and objectives with business requirements, information and designing processes. An economic unit functioning integral scheme from work flows in small divisions to complex organizational functions can be formed with that tool.

Program Erwin Data Modeler R 9.7 is effective for description of existing economic units, reorganization of business processes, introduction of corporate information system; it allows to optimize business entity procedures and check it for compliance of ISO 9001 : 2015 standard, design of organizational structure, reduce costs, eliminate unnecessary operations and increase efficiency. The product is based on IDEF 0 generally accepted modeling methodology. Models simplicity and clarity simplifies mutual understanding between all processes participants. Itself distribution of Erwin Data Modeler R9.7 allows coordination with partners in electronic form of functional models.

In the research IBM SPSS Modeler 18.1 statistical information processing software is used to analyze certain relationships and their graphical interpretation. In IBM SPSS Modeler 18.1 are implemented information statistical processing methods: summary statistics on variables; frequencies, summary statistics and graphs for variables arbitrary number, construction of N-dimensional conjugation tables and obtaining communication measures; average, standard deviations and their amounts by groups; variance analysis and multiple comparisons; correlation analysis; variance analysis; general linear model of variance analysis; factor analysis; cluster analysis; hierarchical cluster analysis; multivariate variance analysis; non-parametric tests; multiple regression; optimal scaling methods, etc. The package allows receiving various graphics. This program significantly facilitates data accumulation and systematization, helps data processing and analysis optimizing, and excludes standard data determining, converting and selecting objects errors. In the research it is used for goods of segment (G_{si}) data systematizing and accumulating, also their priorities identifying and determining.

In the research it is also applied strategic planning and marketing management methods to determine strategic business units, goods and their priorities; also for segmentation, positioning during economic unit process management forming taking into account limited resources and Balanced Scorecard requirements.

4. Conclusion

Suggested BSC-oriented process management forming task solution tools selection for economic units in stochastic conditions allow to model and form its sufficient level detail system without its relevance losing. All mentioned above should be included into educational process not only as benchmarks but

also valuable information on economic and organizational data. It makes future professionals education as potential employees for economic units as competitive ones. Nevertheless, the listed methods for economic units are insufficient for nowadays domestic economy conditions in mechanical engineering production. Additional research and improvement requires is necessary ones for: basic business processes forming method taking into account goods properties for satisfaction of clients at specific market segment, efficiency assessing criteria formulating and business processes improving approach taking into account limited resources and strategic benchmarks requirements, business processes adjusting in macro environment changes conditions and organizational structure reforming during economic unit process management implementing.

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