ADAPTIVE MANAGEMENT OF ENTREPRENEURSHIP MODEL AS A COMPONENT OF ENTERPRISE RESOURCE PLANNING

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ABSTRACT

The conducted analysis of the results of the modern scientific researches on the problems of adaptive management of economic systems and entrepreneurship models demonstrated that the further development of methodological approaches takes place, considering the complications of information structure of economic systems of micro level, digitalization and intellectualization of their management systems and, as a consequence, led to the integration of monoapproaches to management with modern corporate automated control systems of the MRP/ERP/BPM class. It is established that the information support of management processes is based on mathematical provision of corporate automated control systems for which the bases are complex models of economic systems of micro level. Modeling requires formalization of its structural objects-components in various aspects of analysis which raises the problem of considering such peculiarities as the multiplicity of approaches to modeling, asynchrony of model complexes and the complexity of ensuring the model compatibility of its individual components and requires justification of a new methodology for modeling adaptive control system.

Keywords: Entrepreneurship Model, Adaptive Management, Enterprise Resource Planning, Management Processes, Corporate Systems.

JEL Classifications: M5, Q2.

INTRODUCTION

The organization of micro level economic systems (MiES) as an innovative trend created the phenomenon of fundamental change of MiES business models due to the flexible combination of virtual and physical production systems with artificial intelligence systems, their full scale automatization, robotization and computerization on the basis of a single digital platform (MiES activity model) Industry 4.0. It gives a new impulse to the integration of the IT-sector with the industrial segment and directs their common movement to the rapid modernization of industrial automation systems (ERP, MES, etc.) creating special models of adaptive management systems- intellectual BPM-systems(Business Process Management).

To develop these models it is necessary to solve a number of methodological problems which complicate MiES digitalization, and are primarily related to the asynchrony of management of cross-processes and the requirement of systemic IT-interoperability of the MiES activity model and determine the use of complex models which reflect important features of MiES, create and provide systematic coordination of a holistic base of models (analytical, simulation, hierarchal, hybrid), built for its structural and functional heterogeneous subsystems.

A modern MiES modeling methodology postulates that there is no a priori set complex model for it and method of its construction, that is why the analysis and formalized description is advisable to carry out from different points of view, stratifying MiES into its partial representations (strata), for which the models and methods of their construction are already known (multi-dimensional MiES object decomposition). Such decomposition is variable and ambiguous because of the heterogeneity of the MiES infrastructure which objectively causes the use of a variety of mathematical, verbal and information descriptions for modeling its individual objects-components, often causes their semantical mismatch and leads to violation of the systematic consistency of models of these heterogeneous objects due to rigidity of established formal relations between them.

The models of modern automated control systems (ACS) are also developed on the grounds of MiES stratification on a modular principle and usually contain a set of static metamodels at the levels of database and knowledge for certain MiES subject areas. The heterogeneity of these models significantly complicates the mechanisms of structural and parametric adaptation of the MiES complex model due to the asynchrony of internal models and, as a consequence, full or partial difference between the functionals of the corresponding MiES subsystems and the corporate ACS which raises the problem of model information asymmetry in the control system (relativity of knowledge) which has not been completely methodologically solved so far.

Thus, taking into account the priority of management decentralization, the preferences of MiES modeling as a network structure, the shift of the project focus from the modular hierarchical structure of corporate ACS towards a set of simultaneously operating asynchronous models of interacting local IT-applications integrated on the basis of the BPM-concept of information management of the MiES cross-processes, an urgent scientific problem is revealed which involves the development of a methodology for adaptive control systems modeling on the ground of the integration of stratification and multimodality principles in the development of models, methods and IT-solutions for the display, analysis, synthesis and coordination of asynchronous models of dynamically interacting MiES subsystems in the conditions of their digitalization.

The aim of this study is to develop a concept and appropriate mathematical tools for adaptive control systems modeling based on the integration of methodological principles of multimodality and stratification to reflect, analyze and coordinate asynchronous models of dynamically interacting heterogeneous subsystems of the microeconomic system which allows to improve the quality and economic efficiency of the made decision in the conditions of digitalization of economy.

REVIEW OF PREVIOUS STUDIES

Setting the goals of economic development of economic systems of the micro level actually initiates a number of problems or problematic situations that will arise in the future and need to be solved in real time scale. In order to do this, the existing management system must be ready for such transformation which would enable to receive "readymade" effective solutions from which the basis of variable solutions will be formed and would enable to build adaptive mechanisms of synthesis of these solutions which are adequate to the existing conditions (Fujitani, et al., 2017); Lakhno, et al. (2018).

As Mendling et al. (2018) point out, whose professional interests are in one way or another related to the management of economic systems of micro level, today the main difficulties in management appear due to the complication of tasks which are solved by managers of all levels and links of management.

Drobyazko et al. (2019a), Drobyazko et al. (2019b) name the following main reasons for this state of affairs: ambiguity of situations due to increase in the number of significant factors which leads to a rapid rise of the space dimension of managerial decision making; a significant increase in the problem in the holistic view of situations, the identification of hidden deep links and factors which affect the development of one situation or the other, etc.

Most often a situation is understood as a combination of states of economic systems of micro level (managed system) and its environment (surrounding) at the very same moment of time (Titon, 2019). If the situation has a negative, undesirable nature it is classified as a problematic situation or problem (depending on the level of complexity of its solution).

In the general scientific sense, a problematic situation (a problem) is considered, on the on hand, as an obstacle, a complexity, a theoretical or practical question or a task of practical or theoretical interest and which needs solution, and, on the other hand, as a complex of questions, a set of unsolved tasks or questions which are prepared to be solved (Zedler, 2017).

From the point of view of system approach and management theory, a problematic situation (problem) is understood as: the difference between the desired and the real; as a mismatch between the existing and the target state of micro level economic systems under certain environmental conditions; as a state of economic systems of the micro level which will certainly lead to a negative result and requires immediate intervention of the governing body (Hilorme, et al., 2019a); Hilorme, et al. (2019b).

METHODOLOGY

Both general-scientific and special methods were used in the study to solve the set tasks. In particular, the system approach allowed to critically comprehend the contradictions of the existing methodological basis of MiES adaptive control systems modeling and to evaluate the perspectives of its development in the context of digitalization of the economy on the basis of agreed application of mathematical models and information technologies.

The author's concept of MiES adaptive control system modeling is based on the theory of hierarchical systems, stratification approach to modeling, metamodeling technology and is constructed using object-oriented modeling methods.

RESULTS AND DISCUSSIONS

The success of the practical implementation and efficient use of an automated control system (ACS) of the MRP class is connected with the fact that they allow, on the basis of simple set and sequence of actions and calculations which are functionally realized by the basic modules-components (BOM; MPS; ITS; SIC), to create and maintain sufficiently reliable goods production plans-schedules according to the enterprise order portfolio. Hence, "a scheduled order" is an active element of the MRP system which is embodied in the preliminary plan for the manufacture (purchase) of semi-finished products, an assembly unit or full assembly of the unit on a fixed date.

However, the principle of "*Custom Production*" is gradually reorienting to marketing and a consumer. There is an understanding of the need to supplement the scheduling function in all MRP modules-components by the procedures of analytical forecasting.

Further development of the methodological base and model tools in order to eliminate the indentified disadvantages in the operation of the individual modules and synchronization of their complex use led to the expansion (or replacement) of the MRP concept to the MRP II (Manufacturing Resource Planning) concept - "Planning of Production Resources" on the basis of which the so-called closed system of planning was implemented, when the management was carried out at all stages, from the supply of raw materials, through detailed production planning and modeling of production capacities loading to the shipment of finished products to the consumer.

The circularity of a planning system in MRP II was ensured by the presence of feedbacks for planning in its modules (BP; CRP; DM; DRP; IOC; MRP; PL; SFC; S&OP), which function as components of a single system and use operational information from the integrated database.

The MRP II system completely absorbed the MRP system modules extending their functionality and integrating into its design as a separate module component. Besides that, MRP II assumes financial planning of the prime cost of material and production expenses as well as personnel planning.

Rapid development of information technologies and application software opened up the possibilities for the ACS of MRP II class to go beyond the limits of computational nature and the widespread use of modeling and optimization methods in the procedure of generating and reasoning of effective management decisions at all its hierarchical levels. Within nearly a decade the MRP II information management concept has remained dominant for application software producing companies while developing and upgrading ACS-solutions, undergoing nonessential conceptual changes and expanding its functionality.

The listed target orienting points go beyond the limits of MRP II concept and this concept is replaced by a new concept of effective planning and management of all internal not just material, enterprise resources-ERP (Enterprise Resource Planning) which turned to be relevant mainly for large corporations with a network of subsidiary enterprises and organizations as well as for large enterprises with territorially separated production and/or technological lines.

The effect of ERP-system implementation for most foreign enterprises was received due to optimization (in time and resources) of all internal business processes of the enterprise and integrated data processing; approximate estimates of the expected efficiency are given in Table 1.

On the other hand, functional full scale simultaneously makes the task of integrating management efforts more difficult which becomes a major problem while implementing an IRP-system at a specific enterprise (so called human factor).

The results of the conducted researches on the evaluation of qualitative indicators of ERP-systems integration into the corporate information environment of foreign industrial enterprises which are briefly presented in a summarized form in Table 2.

Table 1
GENERALIZED INDICATORS OF ECONOMIC EFFICIENCY OF ENTERPRISES AFTER IMPLEMENTATION OF ERP-SYSTEM (AUTHOR'S DEVELOPMENT)

Target measures-indicators	Expected changes	
	direction, ↑/↓	Quantitative value %
Time to close the period	↓	25-50
Time for making payments	↓	up to 200
Profitability	↑	5-15
Expenses on contracting and monitoring of implementation of contracts for purchase	↓	5-10
Cost of purchased materials and services	↓	2-5
The level of stocks of material assets	↓	20-40
Storage expenses	↓	10-20
The expenses on reconciliation of the subsidiary and general ledgers	↓	up to 80
Expenses on interfaces	↓	up to 60
Number of sales which did not take place	↓	up to 25
Number of customer complaints due to incorrect charges	↓	up to 25
Expenses on IT-transaction processing	↓	up to 25
Profits loss due to incorrect calculations	↓	up to 15
Expenses connected with assessing the solvency of business partners and probability of payment of deferred non-payments	↓	up to 15

Table 2
QUALITATIVE INDICATORS OF ERP-SYSTEM INTEGRATION PROCESSES AT INDUSTRIAL ENTERPRISES (AUTHOR'S DEVELOPMENT)

Target measures-indicators	Quantitative assessment
Projects completed within the established deadlines	does not exceed 60%
Projects completed in compliance with the budget	does not exceed 70%
Projects which are not completed and deferred	5-7%
Carrying out preliminary analysis and economic justification of the ERP-system implementation project	over 70%
Target concretization of IT-benefit for the enterprise from the implementation of ERP-system and their evaluation (plan-fact)	does not exceed 35%
Projects after which the goals of the enterprise were not reached	up to 40%
Projects which upon completion have uncompleted functions and unrealized possibilities	over 40%
Projects where unforeseen expenses occurred which were connected with the	around 50%

Thus, the main hidden reserves for gaining positive effect from ERP-systems implementing are savings of different types of expenses, in particular, connected with the release of time to process any transactions in the system and its subsequent redistribution to discharge other official functions and responsibilities by employees, as well as optimization of streaming processes throughout the production chain including the elimination of risks of making incorrect or erroneous calculations which leads to more efficient use of current assets of the enterprise, etc.

When considering the issue of possibility and expediency of an ERP-system implementation, often the enterprises already have their own automated production management system. Hence, there is such a variety of individual systems. Under these circumstances, the modular principle of ERP-system organization allows the enterprise to variatively form on its basis the structure of its own ACS of the required functionality and configuration with the possibility of its further modernization and modification. "*The success formula*" of ERP-system integration with the information environment of an enterprise can be formulated as: The process of an ERP-system implementation should be controlled :A priori process approach to enterprise management (standardization of business processes of an enterprise); previous staff training (first of all of senior and middle managers); financing of operations connected with creation of corporate databases; permanent experienced implementation project manager; availability of and sticking to a clear implementation plan.

Undesirable expression of the typical risks of unsuccessful integration of an ERP-system with an existing ACS is the organizational and technological "*Unpreparedness*" of an enterprise to innovations as well as any unexpected deviations from the plan of implementation or noncompliance with clear instructions by the executors of the ERP-system project.

A new scientific paradigm for modeling economic systems points out the fundamental possibility and the need to involve modern economic and mathematical tools from different formal and informal theories, which are integrated and synthesized on the basis of system approach, to the solution of the abovementioned problem.

The goals, tasks and objective complexity of such a synthesis imply the need for development of not one comprehensive model but plenty of models of different classes as a set of conditionally independent components (asynchronous, as usual) which formalize particular aspects of the operation of a modeled object or a process and create multi-level model architectures. Modeling of an economic system should be carried out in different angles each time taking into account only some aspects of its functioning, temporarily abstracting from others.

On the other hand, it is not enough to model and perform a corresponding scenario analysis of the behavior of only these individual parts since it is necessary to also have the possibility of their generalized review using certain model constructions of the higher level of abstraction. Traditional modeling tools are not able to completely solve the similar tasks.

The solution of these obvious problems is seen in the further development of the methodology of economic and mathematical modeling in the direction of stratification metamodeling, the technologies of which are hardly ever used in scientific and applied researches of microeconomic systems and, as a result, require additional scientific substantiation.

RECOMMENDATIONS

The conceptual basis of ERP-systems more and more often conflicts with the new requirements to enterprise management systems which functioning takes place under the conditions of undetermined dynamism when the time to make managerial decisions is reduced several folds and becomes one of the most important criteria for management optimality and, therefore, requires fundamental changes.

The intensifier of these trends is the "*Revolutionary*" increase in the power of computer systems which is accompanied by the simultaneous rapid development of new methods and hardware design tools for application software.

This encourages software application developers to constantly update their offers entering the IT-market with innovative analytical solutions in which a complex of methods, algorithms, procedures and models, developed in relation to ERP-systems and synthesized into specialized software packages (APS-platform),is laid out.

The solution of this contradiction is connected with the development of the concept of adaptive production cycle management of an enterprise of APS (Advanced Planning and Scheduling), which is aimed at elimination of the mentioned problems combining the hardware capabilities of the latest information technologies, economic and mathematical methods to solve planning tasks (constrained optimization) and economic-managerial experience of managers (expert evaluation).

Today the architecture of APS class systems is formed taking into account functional and software capabilities of ERP class systems and their modifications (ERP, ATP (CTP); EP; PS; SCP). At the system level, potential possibilities are laid out for their integration in future with application software which in perspective will realize the dominant concepts of enterprise information management.

CONCLUSIONS

The analysis of current trends and perspectives for the development of theories and methodological approaches to MiES management shows the priority of the adaptive management concept in which the possibilities of modeling MiES control systems are laid out which can perform targeted actions of a proactive or reactive nature in response to changes in the internal and external environment.

The conducted analysis of the results of modern scientific researches on the problematic of adaptive management of economic systems demonstrated that the further development of methodological approaches occurs taking into account complications of MiES information structure, digitalization and intellectualization of their management systems and, as a consequence, led to the integration of monoapproaches to management with modern corporate ACS.

The evolution of the ACS generations (MRP/ERP/BPM classes) takes place right after the new MiES information management concepts appear which created an independent direction in the theory and practices of management. These concepts are the reflections of different adaptive management approaches and provide automated support for a complete management cycle based on a designed common integrated MiES activity model which formalizes the progress of key organizational processes using mathematical tools and very latest information technology.

Information backing for management processes is based on the mathematical support of corporate ACS for which the bases are integrated MiES models. The comparative analysis of the basic complex models of different ACS gave a possibility to reveal the limitations, to summarize the existing contradictions, to evaluate the degree of their research within the existing MiES modeling methodology and to outline the perspectives of using the existing theoretical and methodological basis for modeling the MiES control systems.

With this in mind, it was established that the problem of modernization of industrial automation systems is urgent where, in the conditions of MiES digitalization, the priority and growing role belongs to the solution of the issue of system integration and coordination of local

IT-solutions within the corporate ACS taking into account the model compatibility, balance and functional interoperability of heterogeneous MiES objects-components in comparison with the tasks of mathematical and software support development for unique ACS-modules specially designed for business models of individual MiES functional areas.

Based on generalization of the prerequisites for the systematic solution of this problem, the general conclusion was made about the fact that modern management theory lacks the unified consistent concept of asynchronous information management of MiES cross processes which is based on methodological framework of formal theories using economic and mathematical tools.

Therefore, it is necessary to arrange, structure and systematize the set of principles, concepts, means and methods for the development of MiES activity models which integrate with corporate ACS based on a common digital platform with the purpose to create special models of adaptive control systems which are referent for MiES classes, related by the type of economic activity, to implement dynamic support for the process of model complexes management and model knowledge on this ground taking into account their system coordinations, logical and informational consistency in the MiES management system.

REFERENCES

Drobyazko, S., Alieksieienko, I., Kobets, M., Kiselyova, E., & Lohvynenko, M. (2019). Transnationalisation and segment security of the international labor market. *Journal of Security and Sustainability Issues 9*(2), 547-559.

Drobyazko, S., Pavlova, H., Suhak, T., Kulyk, V., Khodjimukhamedova, S. (2019). Formation of hybrid costing system accounting model at the enterprise. *Academy of Accounting and Financial Studies Journal, 23*(6).

Fujitani, M., McFall, A., Randler, C., & Arlinghaus, R. (2017). Participatory adaptive management leads to environmental learning outcomes extending beyond the sphere of science. *Science Advances, 3*(6).

Hilorme, T., Sokolova, L., Portna, O., Lysiak, L. & Boretskaya, N. (2019). The model of evaluation of the renewable energy resources development under conditions of efficient energy consumption. Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020. 7514-7526.

Hilorme, T., Sokolova, L., Portna, O., Lysiak, L. & Boretskaya, N. (2019). Smart Grid Concept as a Perspective for The Development of Ukrainian Energy Platform. *IBIMA Business Review, 2019*, 923814-923814.

Lakhno, V., Malyukov, V., Bochulia, T., Hipters, Z., Kwilinski, A. & Tomashevska, O. (2018). Model of managing of the procedure of mutual financial investing in information technologies and smart city systems. International Journal of Civil Engineering and Technology, *9*(8), 1802-1812.

Mendling, J., Weber, I., Aalst, W.V.D., Brocke, J.V., Cabanillas, C., Daniel, F. & Gal, A. (2018). Blockchains for business process management-challenges and opportunities. *ACM Transactions on Management Information Systems (TMIS), 9*(1), 1-16.

Titon, J.T. (2019). Sustainability, resilience, and adaptive management for applied ethnomusicology. Theory. *Method, Sustainability, and Conflict: An Oxford Handbook of Applied Ethnomusicology, 1*, 156.

Zedler, J.B. (2017). What's new in adaptive management and restoration of coasts and estuaries?. *Estuaries and Coasts, 40*(1), 1-21.