ECONOMIC AND MATHEMATICAL MODELING AND INFORMATION TECHNOLOGIES IN ECONOMICS

THE CONCEPT OF MARKETING PLANNING IN THE BUSINESS MARKET IN THE DIGITAL ECONOMY

Ivanov S.M.

Zaporizhzhya National University
Ukraine, 69600, Zaporizhzhia, Zhukovsky str., 66
flydaiver@gmail.com
ORCID: 0000-0003-1086-0701

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The analytical review of the marketing planning tools in the business market shows a problem associated with the insufficient level of adaptability of management systems to changes in the sources and nature of external data. This leads to difficulties in working with up-to-date analytics from various sources and types of data, and the need to take into account quantitative and qualitative economic information. This problem requires the development of new conceptual approaches, mathematical methods and models for the formation of effective management decisions, as well as justification of the need to use information technology at two levels: technological (Big Data, OLAP technologies, fuzzy sets, neural networks) and functional (digital marketing, human resource management, etc.), which will allow combining the use of tools of the fourth industrial revolution with promising areas of marketing planning in the business market. The article develops a concept of modelling marketing planning in the business market with the use of intelligent information systems, which contains four levels (conceptual, methodological, model, instrumental), combines the developed methods, models and tools for solving marketing planning tasks and, through the implementation of a developed system of economic and mathematical models (in particular, models and methods of intellectual analysis, use of neural network technologies for forecasting multidimensional data and neuro-fuzzy management), provides a substantiation of the system interaction of the levels. The concept provides a justification for the systemic interaction of levels, which opens up ways to modernise the existing information systems of marketing planning in the business market with the developed set of tools to improve the economic efficiency of enterprise management by means of intelligent information systems.

КОНЦЕПЦІЯ МАРКЕТИНГОВОГО ПЛАНУВАННЯ НА ДІЛОВОМУ РИНКУ В УМОВАХ ЦИФРОВОЇ ЕКОНОМІКИ

Іванов С.М.

Запорізький національний університет
Україна, 69600, м. Запоріжжя, вул. Жуковського, 66

Ключові слова:
маркетинг, концептуальна модель, моделювання, інформаційна система, маркетингове планування.

Проведений аналітичний огляд інструментарію маркетингового планування на діловому ринку свідчить про проблему, яка пов'язана з недостатнім рівнем адаптивності систем управління до змін джерел та характеру зовнішніх даних. Це зумовлює складнощі в роботі з актуальною аналітикою з різних джерел і типів даних, необхідність врахування кількісної та якісної економічної інформації. Зазначена проблема потребує розробки нових концептуальних підходів, математичних методів і моделей для формування ефективних управлінських рішень, а також обґрунтування необхідності застосування інформаційних технологій на двох рівнях: технологічному

(Великі Дані, OLAP-технології, нечіткі множини, нейронні мережі) та функціональному (цифровий маркетинг, управління людськими ресурсами та інші), що дасть змогу поєднати використання інструментарію четвертої промислової революції з перспективними напрямками маркетингового планування на діловому ринку у режимі реального часу. Розроблено концепцію моделювання маркетингового планування на діловому ринку із застосуванням інтелектуальних інформаційних систем, яка містить чотири рівня (концептуальний, методичний, модельний, інструментальний), об'єднує розроблені методи, моделі та інструменти для вирішення задач маркетингового планування та за рахунок реалізації розбудованої системи економіко-математичних моделей (зокрема, моделей і методів інтелектуального аналізу, використання нейромережевих технологій для прогнозування багатовимірних даних та нейро-нечіткого управління в режимі реального часу) дає змогу підвищити ефективність маркетингового планування. Концепція забезпечує обґрунтування системної взаємодії рівнів, яке відкриває шляхи модернізації існуючих інформаційних систем маркетингового планування на діловому ринку розробленим комплексом інструментів для підвищення економічної ефективності управління підприємством засобами інтелектуальних інформаційних систем.

Problem Statement

The modern economy is focused on the use of information technology in solving marketing planning tasks in the business market aimed at organizing efficient operations, supporting sales and increasing profits. Information technologies are becoming a tool for increasing the competitiveness of enterprises, and their development is a priority area and strategic goal both in the world and in Ukraine. That is why scientists and practitioners in developed countries are now trying to integrate the use of digital technologies into all business management processes. For example, according to the Digital Spillover report [1], for every dollar invested in digital technologies, an increase in revenue of $20 was obtained.

Today, the necessary requirements for information technology are to take into account the conditions of the Fourth Industrial Revolution. According to Academician of the National Academy of Sciences of Ukraine Prof. A. Chukhna [2], «big data, cloud technologies and computing, neural systems, industrial Internet of things, real and virtual components of the market of goods and services, fuzzy modeling – new technologies are now entering our lives and forming the image of the future society». The rapid growth of data volumes, their heterogeneity and variability necessitate the use of intelligent information systems by enterprises, which ensure the implementation of intelligent technologies (big data, cloud technologies, artificial neural networks, fuzzy logic, robot programs, etc.) for business, predictive analytics, information exchange, and support of management processes. These intelligent information systems are based on self-learning and self-adjustment processes, which enable the development and use of intelligent technologies to open up new opportunities and directions for the effective organization and support of marketing planning in the business market.

Analysis of recent research

One of the key areas of development of intelligent information systems is marketing. With the development of information network technologies, marketing has acquired new mechanisms for its functioning. Thus, in the work of Berko A. Y., Vysotska V. A. and Pasichnyk V. V. [3] the results of a study on solving the problem of modeling and designing electronic content commerce systems are presented. The authors propose a classification of e-commerce systems and e-content commerce systems, develop formal models of e-content commerce systems, their individual components, websites, methods and algorithms for designing e-content commerce systems.

To build information tools to support management in marketing, a prerequisite is to maintain the competitiveness of the enterprise. Thus, the authors Orlov O. O., Gavenko M. S., in [4] studied the role of marketing research in retail and the main source of reliable information about the market. Based on the research, the authors developed a process for forming a system for assessing the competitive position of a retailer.

The creation of information systems based on these processes and models requires prompt processing of data, which is a key issue in the synthesis of marketing and information systems and the development of an effective monitoring system.

Thus, in the works of Nizhnyk V. M., Sharko V. V., Gromova O. E. [5, 6], the solution of applied marketing problems is considered. They studied the tasks of marketing and logistics of an industrial enterprise, on the basis of which an algorithm for the formation of a marketing and logistics service of an industrial enterprise was developed. The authors also paid considerable attention to the process of monitoring the performance of the enterprise to obtain operational information on changes in the indicators characterizing the components of innovation and investment, production, marketing and sales, and economic and operational activities of the enterprise. The author establishes that the system of monitoring indicators is a prerequisite for stability and competitiveness of an enterprise.

For adaptive planning in marketing, information systems also need to have modules that will be aimed at managing the development potential of the enterprise. Thus, in the works of Gonchar O., Polishchuk I. [7, 8], the modern conditions and problems of development of marketing

activities were studied. The authors formulated the principles of building a mechanism for managing the marketing potential of industrial enterprises, as well as built a scheme of functional components of the introduction of a mechanism for managing the marketing potential.

The presented developments in marketing management need to be integrated into a holistic concept with a combination of digital technologies and applied mechanisms to support enterprise management. The works of Balabanova L. V., Zaremba V. P. [9] and Holodniuk O. S. [10] are devoted to this task. They substantiate the concept of organizing marketing management of enterprises and applied marketing (branding, benchmarking and competitive intelligence), taking into account their importance for market participants. The authors propose scientific and methodological approaches to diagnosing, analyzing the organization of interaction, and evaluating the effectiveness of strategic changes. The authors pay considerable attention to the scientific and methodological recommendations for improving the organization of marketing management of enterprises based on the use of information systems for monitoring marketing innovations.

However, a holistic concept of marketing planning in the business market in the new conditions of the digital economy has not been proposed.

Goal setting

The purpose of the article is to develop the concept of marketing planning in the business market in the digital economy, which involves the use of intelligent information systems.

Presentation of the main material

The main areas of development of marketing planning technologies are digital marketing management, human resource management and proactive management. Development in these areas will be ensured by the introduction of technologies inherent in the fourth industrial revolution, namely: cloud technologies, Big Data, OLAP technologies, fuzzy logic, neural networks. The introduction of new technologies in marketing planning requires the construction of a concept that will reflect the interaction of models, methods and tools to achieve the goals of enterprise management in the current conditions of society development.

Therefore, on the basis of research [11], the concept of marketing planning in the business market in the digital economy with the use of intelligent information systems has been developed (Fig. 1).

The presented concept shows the relationship between the four levels of application of an intelligent information system for marketing planning.

The first level is conceptual. This level includes three conceptual models (conceptual model of human resource management, conceptual model of digital marketing management system, conceptual model of adaptive planning and management) in the key areas of using intelligent information systems in marketing planning.

In order to increase the level of automation of marketing planning, the methods described in the concept use the principles and technologies of the fourth industrial revolution, which allows modifying a standard information system to an intelligent one.

The presented intelligent information system highlights the application of the principles of the Industrial Revolution 4.0 through the structure of database management, knowledge base management, and model base management systems. The structures that transform an information system into an intelligent one are highlighted in Fig. 1 are highlighted in color (Big Data, OLAP technologies, heuristic models, knowledge acquisition system).

The third level is modeling. This level contains models (cognitive model of enterprise sales activities, model of sales forecasting based on a neural network, model of marketing activities of an enterprise, model of operational processing of Internet data, structural model of a marketing analytical system, model of a neuro-fuzzy system of automated enterprise management, structural model of data exchange in human resources management, neuro-fuzzy model of adaptive enterprise management, adaptive model of human resources management, structural model of human resources management).

For the qualitative application of the set of models of enterprise management processes presented at the model level, it is important to determine the relationship between them, which characterizes the achievement of marketing planning goals. That is, combining models based on modern technologies into a set is not enough to improve management processes. It is necessary to present this set as a system of economic and mathematical models of marketing planning in the business market, which determines the use of models for strategic and operational marketing planning.

Therefore, we will present the set of models of marketing planning in the business market in the digital economy in the form of a system – S. The elements of the system are three subsystems ($S_i, i = \overline{1,3}$): marketing (S_1), adaptive management (S_2), human resource management (S_3). Each of the subsystems consists of models (M_{ik_i})) that access information about resource capabilities (human resources), product market, assortment, competitors, and other commercial information through the enterprise information system:

$$S_i = \left\{ M_{i1},..,M_{ik_i} \right\}, k_i = \overline{1,K_i}, i = \overline{1,3}, \qquad (1)$$

whare i – number of subsystems of enterprise management models,

K_i – total number of models in the subsystem i ($K_1 = 3, K_2 = 5, K_3 = 2$).

The marketing subsystem (S_1) is represented by a set of models: a cognitive model of the enterprise's sales activities (M_{11}), a model of the enterprise's marketing activities (M_{12}),), a model of sales forecasting based on a neural network (M_{13}).

The adaptive management subsystem (S_2) includes a set of models: a model of operational processing of Internet data (M_{21}), a structural model of a marketing analytical system (M_{22}), a model of a neuro-fuzzy system of automated enterprise management (M_{23}), an adaptive model of human resource management (M_{24}), a structural model of human resource management (M_{25}).). The models of subsystem S_2 are aimed at implementing enterprise
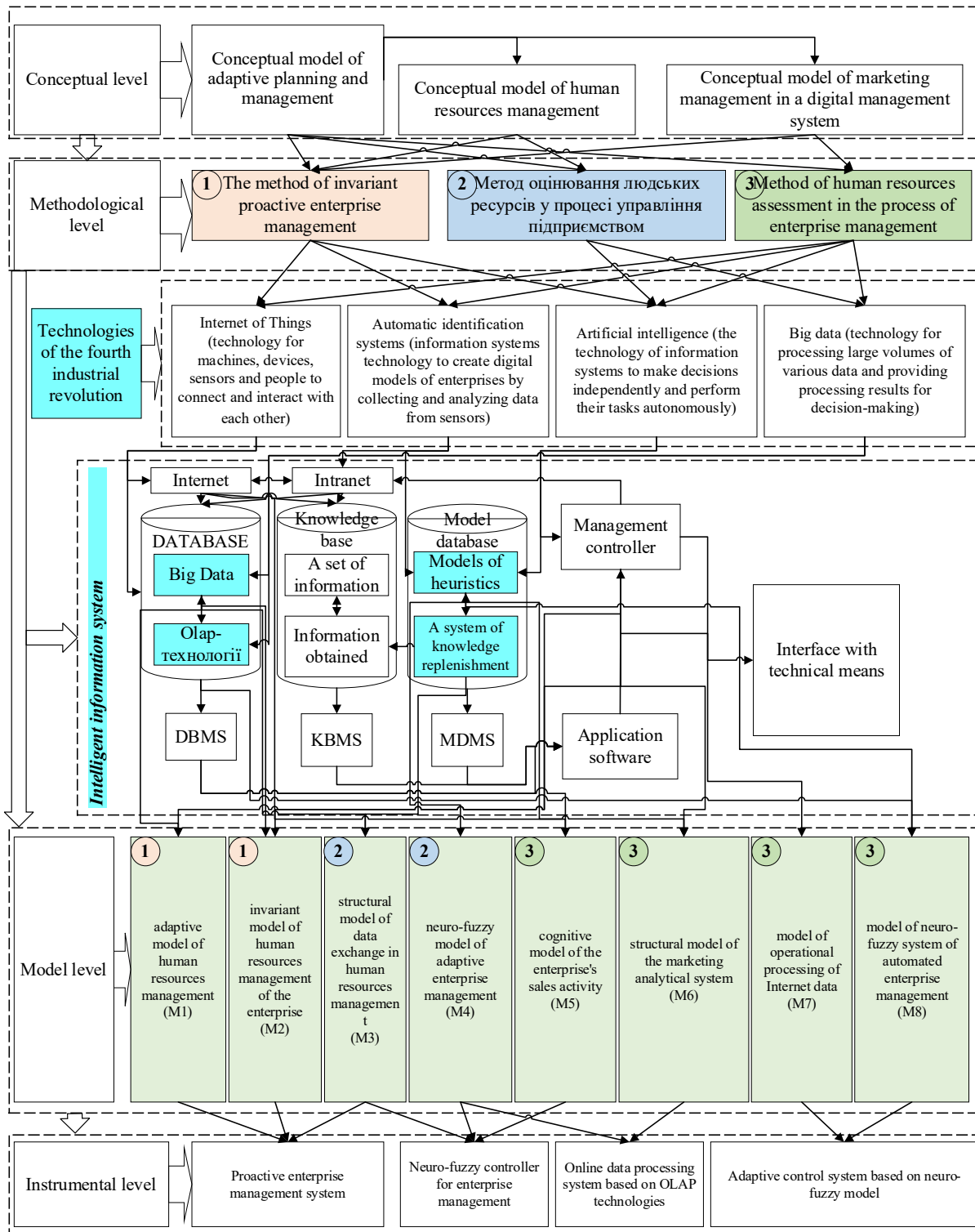
Figure 1 – The concept of marketing planning in the business market in the digital economy

management processes, so the results of their application are used to determine the set of marketing and human resource management decisions.

The human resource management subsystem (S_3) consists of models: a structural model of data exchange in human resource management (M_{31}), a neuro-fuzzy model of adaptive enterprise management (M_{32}.).

The system of models will be considered as a platform on the basis of which the results of the models are created, interpreted, and interacted to find common marketing planning for the effective functioning of the enterprise. Also, the system of models will determine the organization and functioning of the intellectual information system of enterprise management.

Thus, the system of models developed by [11] allows to form the result of interaction of models, which is laid down in the developed concept of modeling the processes of enterprise management using intelligent information systems.

The fourth level is instrumental. It contains practical solutions for the implementation of marketing planning in the business market in the digital economy as mechanisms for automating enterprise activities based on intelligent technologies.

The interaction of intelligent information systems in the economy, created on the basis of the synthesis of information systems with the developed tools, with the external environment is carried out at the level of systems: synchronization of work, discrete control system, data exchange model in human resources management, fuzzy modeling of human resources, marketing analytics, forecasting based on neural networks, showcase of order and sales distribution data, evaluation of the marketing activities of the enterprise and the controller in the management of the enterprise. This approach allows to combine the levels of the concept of marketing planning in the business market in the digital economy (conceptual, methodological, modeling, instrumental) based on the principles of the fourth industrial revolution.

Conclusions

Thus, the application of new approaches and the use of new economic and mathematical models and methods is a prerequisite for the development of marketing planning in the business market with the use of intelligent information systems.

A concept of marketing planning in the business market in the digital economy has been developed, which includes four levels: conceptual, methodological, model, and instrumental, and allows taking into account the interaction of the information system with the external environment. The proposed concept allows to formulate further development of marketing planning technologies in the business market with the use of intelligent information systems.

The article considers a system of economic and mathematical models of marketing planning in the business market in the digital economy, which defines the links between the models of three management subsystems (marketing, human resources, adaptive management), which allows to coordinate the use of these models in one intelligent information system to find a common management solution.

On the basis of the proposed conceptual, methodological, model and instrumental levels and the developed system of models, a fundamentally new concept of modeling enterprise management processes using intelligent information systems has been built.

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