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**METHODOLOGICAL BASES FOR MODELING MARKETING DECISION-  
MAKING IN CONDITIONS OF UNCERTAINTY AND  
MULTIDIMENSIONALITY OF MARKET ENVIRONMENT**

Effective management of the marketing decision-making requires the identification of its scientific and methodological basis. The application of the system-cybernetic approach [1] to study these processes objectively determines the use of modeling in the following areas of research:

- theoretical and methodological direction, aimed to study objective laws of managing the enterprise activities in general and the theory of decision-making in particular, their manifestation in socio-economic processes, the creation of a methodological basis for the adoption of scientifically based decisions;
- applied direction, related with research of specific issues in the making of managerial decisions, in particular, the assessing alternatives and the choice of the most suitable ones for a certain criterion of effectiveness, the calculation of estimates of a priori and a posteriori efficiency of decisions and providing them with meaningful interpretation, identifying the necessary means and methods for their solution, forecasting properties of researched systems;
- instrumental direction, oriented on the developing new models that are applied in the theory and practice of decision-making to solve specific issues arising during the modeling these processes;
- heuristic direction, associated with the use of creative intuition in the decision making process, the ability of the model to act as a means of data generalization, their interpretation, explanation of obtained results, specifying theoretical knowledge and the obtaining new ideas and hypotheses.

The development of economic and mathematical modeling tools for marketing decision-making should have a methodological basis. To reach this goal, we propose a system of conceptual provisions.

1. Multidimensionality of attribute space for describing the processes and phenomena inherent in the modern market environment is due to their complex and multifaceted nature. This is reflected in the increasing of the aggregate of quantitative and qualitative characteristics due to the expansion of the sphere of enterprise marketing activities, needs to assess age, socio-demographic, behavioral, physiological and other properties of consumers, taking into account competitive advantages, etc.

2. Making the reasonable marketing decisions requires taking into account the uncertainty for the evaluation of the developed alternatives, in particular through methods and models of the theory of fuzzy sets, due to objective unpredictability, and therefore uncertainty in the nature of the market environment.

3. The discrepancy between the conditions for obtaining marketing data and the requirements of the theory of probabilities postulates necessitates to use heuristic methods for analyzing data that do not involve the use of the classical probabilistic model of the researched processes.

4. Creation of an information basis for marketing decisions leads to use a wide range of approaches to analytical data processing in the chain "data-information-knowledge". This determines the need to use a variety of methods for collecting and analyzing data in order to create an attribute space.

5. Automation of data processing is substantiated by the existence of significant volumes of information flows in the process of formation of an information basis. This necessitates harmonizing a model basis for marketing decision-making with information technologies in order to identify a model profile aimed to solve specific issues.

6. The use of methods and models of multidimensional statistical analysis, which are mostly heuristic, is due to the multidimensionality of the market environment and the specific features of marketing data.

7. The use of fuzzy preference relationships to assess alternatives of marketing decisions is justified by the limited use of classical decision-making methods due to the complexity of the formation of a single criterion of efficiency. This allows, without starting a pre-selection search, to guarantee certain properties of a given set of optimal decisions and thereby reject knowingly ineffective alternatives.

This conception identifies the structure of theoretical and methodological substantiation of economic and mathematical modeling of the marketing decision-making, which is presented on Figure 1. It contains methodological principles, functions, methods, models and tools of information technology for analytical data processing and the development of alternatives in conditions of uncertainty and a multidimensional description of the market environment.

The necessity to use economic and mathematical modeling in marketing decision-making is determined on the one hand by its significant gnoseological capacity, as a tool for research, and on the other hand - by objective factors caused by the development of a market environment as a complex economic system.

Marketing data are the result of the registration of various attributes of phenomena and processes that reflect the formation, existence, interaction and development of all components of the market environment and factors that affect it. They are a systematic set of quantitative and qualitative characteristics of this environment, obtained during the study of the process of sharing the results of socially useful activities and interaction of all subjects of the economic system.

The course of market processes has features of stochasticity due to the influence of a lot of various uncontrollable factors and their high dynamism. This explains the uncertainty of the research results and the high variability of the data.

The stochastic nature of attributes space causes to use data processing methods, based on toolkit of probability theory and mathematical statistics. However, the direct use of these methods requires the compliance with the conditions for obtaining marketing data strict requirements of statistical theorems, which does not always take place in reality. Among the most common reasons for this discrepancy, we can distinguish the follow.

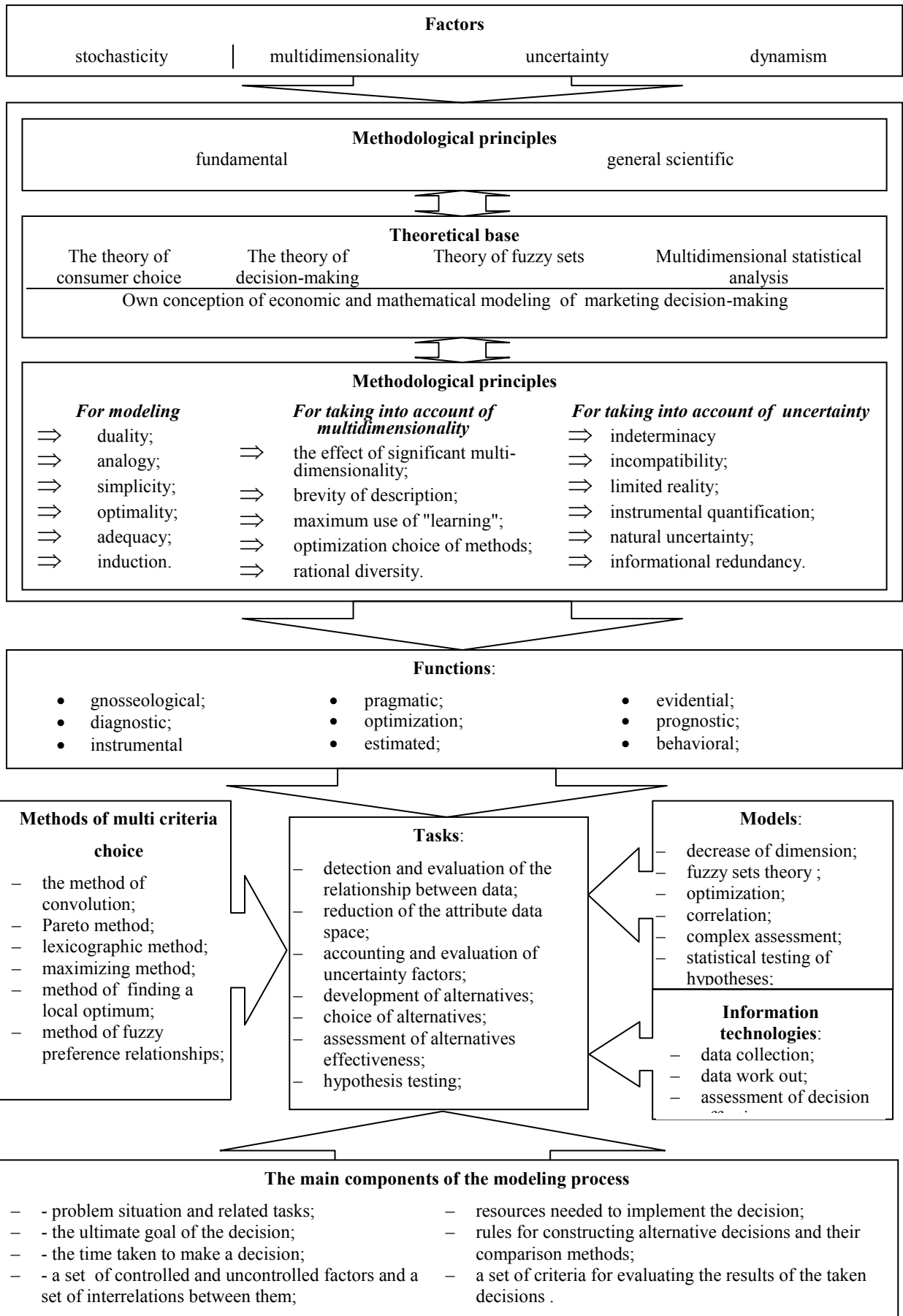


Figure 1. Theoretical and methodological substantiation of economic and mathematical modeling of marketing decision- making

At first, the conditions for the probabilistic origin of marketing data are often violated in practice. This is due to the fact that the definition of probability implies the immutability (repeatability) of the conditions of research. But it is far from always possible to state and substantiate the fulfillment of this requirement. Moreover, the objective variability of the market environment usually leads to receive data with new characteristics each time.

Secondly, properties of the general aggregate from which the selective aggregate (sample) is formed, are far from always known. Furthermore, usually only one sample is processed in marketing research.

Thirdly, the attributes that make up the subject of marketing research are usually characterized by a variety of measurement scales. In particular, data can be measured on a nominal or order scale. The direct use of mathematical operations against them is incorrect.

Fourthly, the real data obtained during the marketing research are represented by small samples in space of big dimension and have lack of information on the nature and degree of dependence of some characteristic from others. This establishes certain limitations on the conclusions that based on such sample.

Fifthly, data may be characterized by the presence of noise and data gaps; non-stochastic character of the formation of a sample. In these conditions, the methods for data processing are compulsory based on heuristic techniques.

The above considerations objectively reflect the fact that for certain processes of marketing decision-making, there are no properly substantiated mathematical methods. However, the importance and necessity of solving problems makes it necessary to take risky empirical hypotheses and use non-strict methods. This necessitates of using some adaptation of statistical methods, which are the data analysis methods.

They are aimed to study the obtained statistical data in order to form certain ideas about the nature of the phenomenon described by these data, which do not foresee to use a strict probabilistic model of the investigated processes, but with certain assumptions suggest the use the probabilistic statistical tools and heuristic

approaches. Methods and models of multidimensional statistical analysis [2] have the such properties. They are based mainly on the use of the logical-algebraic concept of data processing, which is in full agreement with the specific features of marketing data defined above.

The multidimensional nature of marketing data is a consequence of the following trends:

- expansion of the area of enterprise's marketing activity from the boundaries of local markets to the national scale, which leads to increase of quantitative characteristics of this activity;
- transition from competition in prices to non-price competition, which is associated with the appropriation of brand names, the widespread use of advertising, sales promotion, etc., which leads to use qualitative indicators;
- the main source of data concerning information provision of marketing decisions are consumers that are characterized by a combination of age, socio-demographic, behavioral, psychophysiological and other properties, which leads to the need to use both quantitative and qualitative indicators;
- one of the main goals of marketing decisions is to develop a controlling influence on the consumer's behavior when choosing a product, which leads to need assess the effect of customer satisfaction by product that is not directly measurable and is usually a latent characteristic.

A diversity of internal and external factors determines the need to identify those indicators that are the most complete and sufficiently determine the attribute space of the problem under study. Information base for the marketing decision is formed on this basis. The selected attributes, regardless of their nature, should represent a holistic unity that adequately reflects the market environment from the standpoint of the goals and objectives of it study. The above circumstances determine to solve a non-trivial task of selecting adequate methods and models for processing multidimensional data.

The lack of strictly single-valued relationships between the external influences of the market environment and the response to them in marketing decisions needs the

quantitative assessment of uncertainty as the objective property of the market environment in the preparing alternative decisions. To reach this goal, it is necessary as far as possible to take into account factors that are the source of its occurrence, among which one should note:

- unpredictable behavior of consumers or the impossibility of taking into account all the motives and factors that affect it;
- inaccessibility of some properties and characteristics of consumers (or other researched objects) to collect the necessary data;
- influence of the variability of the market environment on the results of data collection, which accelerates their aging and leads to the loss of the characteristic of relevance;
- the uncertainty of the market environment, reflected by the features of the developed marketing decisions and complicates the determination of preferences of some alternatives over others.

In order to reduce its impact on the decisions, it is necessary to use effective tools that are adequate to coordinating researched processes on all stages of the decision's development; in particular, these can be methods and models of the fuzzy sets theory and rules of the fuzzy inference.

The theoretical basis for modeling of marketing decision-making includes the main scientific directions, the tools of which are aimed to take into account certain factors and own concept for modeling.

The methodological principles are methodological basis of the economic and mathematical modeling of the processes of marketing decision-making. They reflect the general requirements imposed on its content, structure and methods of organization. They determine borders and rules for constructing theoretical statements, outline the range of scientific issues, influence the formulation of theoretical and experimental hypotheses, combine and organize separate methods, techniques and techniques in a united approach. Observance of principles gives the decision-making process the features of scientific knowledge, which makes its results more reliable, and managerial decisions as scientifically based.

Methodological principles on the one hand perform the regulatory function of scientific cognition, and on the other - heuristic, directing the process of marketing decision-making. Philosophical and general scientific principles reflect the fundamental and applied levels of research, organize and direct the cognitive side of modeling marketing decision-making [3]. In addition to they use special principles that specify the general direction of the modeling procedures, the conditions of their application, and requirements to the tools. Table 1 presents principles that are used as a base in modeling [4, 5]. They represent the necessary conditions when the modeling will be effective and achieve the goal.

*Table 1*

Characteristics of common principles of modeling

Principle	Interpretation
the principle of analogy	the model is similar to the original for certain, distinguished properties that defined as the most significant ones, which allows to transfer obtained results to the original;
the principle of duality	the model has properties of unity and contradiction of the inaccessible ideal of the researched reality and the limitation of model. Therefore, on the one hand, the model will never be completely identical to the original, but on the other hand, it can replace it from the point of view of the properties under study;
the principle of simplicity	the model should be designed and explored by accessible methods. The simpler the model, the easier it is to be researched;
the principle of optimality	among all the models used to study reality, the advantage should be given to one that is the best on the chosen criterion of effectiveness;
the principle of adequacy	the model should be match the level of complexity and the possibility of applying to research objectives for which it was design;
the principle of induction	the model should allow adaptation and use to solve a certain suite of similar tasks.

Taking into account the multidimensionality of the description of the market environment determines the use of methodological principles on which the methods of multidimensional statistical analysis are based (Table 2). Supporting the ideas expressed in [6, pp. 14-17] regarding these principles, we are invited to supplement them with the principle of rational diversity.

Table 2

Characteristics of methodological principles of taking into account the multidimensionality

Principle	Interpretation
the principle of the effect of significant multi-dimensionality	conclusions obtained as a result of the analysis of a set of statistically researched on a range of properties of objects , should simultaneously rely on a set of these interrelated properties, with due consideration of their structure and nature;
the principle of brevity of description	results of statistical processing of objects of observation are either in the form of an "object-property" matrix, or as a matrix of pair wise comparisons of objects. This provides an opportunity to describe the phenomenon under study, that has smaller number of factors than the initial one with preserving both the structure of objects and the interconnections between their features;
the principle of maximum use of "learning"	model tested on a certain sample allows to obtain good results when applied for new data, that have structure corresponding to the training sample;
the principle of optimization choice of methods	the best method to solve specific problems is selected according to predefined quality criterion;
the principle of rational diversity	the choice of properties for the description of the phenomenon under study should be carried out taking into account the solved problems. This allows you to vary both their properties and characteristics.

It is often impossible to obtain accurate data to the extent necessary, which leads to the use of simplified models of reality. Actually, they can lead to more understandable and substantiated conclusions than more detailed and more precise models.

This was reflected in the principle of incompatibility formulated by L. Zade [7, p. 201] that associated with the way of perception and human considerations. For systems whose complexity passes a certain threshold, accuracy and practical meaning become mutually exclusive characteristics. It is in this sense that the quantitative analysis of the behavior of economic systems does not have a significant practical significance in real social, economic and other issues associated with the participation of one person or their group. As a result, generalized, schematized, and therefore inaccurate subjective representations of the system under study are used. Summarizing the results of the researches [8-11] methodological principles for taking into account uncertainty are shown in Table 3.

Table 3

Characteristics of methodological principles of taking into account the uncertainty

Principle	Interpretation
the principle of indeterminacy	the impossibility of accurately describing the system as a result of the unpredictability of its behavior in the future, which leads to their presentation in fuzzy terms with an assessable representation of characteristics;
the principle of incompatibility	reduction of the ability of a person to provide accurate and practically meaningful judgments about the behavior of the system as a result of the increase in its complexity, which prefers verbal representation of its characteristics in relation to their quantitative representation;
the principle of limited reality	the impossibility of a complete and accurate study of the system due to the limited availability of methodological, methodical and model tools that requires the use of assumptions and estimates presented in a probabilistic or other interpretation;
natural uncertainty	a lot of characteristics by their nature are qualitative, which does not allow to establish the exact limits of their categories and leads to the need to use quantitative interval estimates of boundaries;
the principle of informational redundancy	an increase in the indeterminacy of the analysis of the system as a result of an increase in the number of indicators that conflict, which determines the creation of a toolkit to determine the preference of quality assessments;
the principle of instrumental quantification	the need for a quantitative assessment of the verbal characteristics of the uncertainty in order to adequately account for it.

The above methodological principles determine the functions of the analytical component of the model basis of the decision-making process presented in Table 4.

Table 4

Contents of the main functions of the analytical component of the model base of marketing decision-making

Function	Essential direction
gnoseological	obtaining new knowledge about solved tasks, their combination with already existing knowledge and developing on this basis new methods of decision-making;
diagnostic	an analytical description of the state and the properties of the problem under investigation in order to determine the tasks to be solved and to choose the most suitable decision-making models;
evidential	verification and proof of theoretical statements and their implementation in the practice of marketing activities
instrumental	development of alternatives by different methods, their research in different scenarios of the system under study;
pragmatic	preparing a decision aimed at solving a specific task and achieving the intended effect;
optimization	the choice of the most suitable model for constructing a better alternative according to the criteria defined at the stage of goal-setting;
estimated	comparison of different methods in relation to the completeness of problem solving;
prognostic	assessment of the consequences of the developed decision;
behavioral	study of organizational and economic behavior of consumers.

The implementation of functions is carried out using methods and models. Methods of decision-making are the procedures for finding an alternative that meets the purpose or solution of a specific task, by applying a set of certain techniques or operations. Each method is one way or another related to a particular model. The decision-making model is a combination of formalized procedures related to the preparation, evaluation and selection of alternatives in the course of research and problem solving that helps determine the best of them according to a certain quality criterion. In practice, in many situations, modeling is limited by the adoption of some acceptable solution that satisfies the minimum or specified level of its effectiveness.

This is this causes a fairly wide range of models that can be applied to solve the different tasks of decision-making. The choice of specific tools is determined by the objectives of the study, the available data and the type of tasks to be solved.

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