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Serhii Bai

D.Sc. in Economics, Professor, Head of Management Department, State University of Trade and Economics, Kyiv, Ukraine;
 e-mail: s.bay@knute.edu.ua
 ORCID: [0000-0003-0599-2582](https://orcid.org/0000-0003-0599-2582)
 (Corresponding author)

Iryna Fedulova

D.Sc. in Economics, Professor, State University of Trade and Economics, Kyiv, Ukraine;
 ORCID: [0000-0002-8802-137X](https://orcid.org/0000-0002-8802-137X)

Yuliia Drozdova

PhD in Philological Sciences, Associate Professor, State University of Trade and Economics, Kyiv, Ukraine;
 ORCID: [0000-0002-2047-1075](https://orcid.org/0000-0002-2047-1075)

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MANAGEMENT DECISION-MAKING: MULTI-CRITERION ASSESSMENT OF UNCERTAINTY

ABSTRACT

The article highlights the main characteristics of uncertainty and risk, which need to be taken into account when making management decisions to ensure the controllability of all processes at the enterprise. The significant attention of scientists to risk and uncertainty, and their significance for management decision-making is very high, so the debate about risk and uncertainty identification and their levels still remains open. The article defines the character and types of uncertainty, identifies a number of differences between risk and uncertainty in the process of management decision-making, structures the main characteristics of uncertainty, and determines the impact of levels and types of uncertainty on management decision-making. We conducted an empirical analysis of scientific literature to determine the essence of the concept of "uncertainty" and its differences from the concept of "risk", a structural-genetic analysis of the main characteristics and causes of uncertainty, and a comparative analysis of models for determining levels of uncertainty. We identified the main characteristics of uncertainty which cause its existence and require careful consideration. The paper offers a methodical approach to assessing the level of uncertainty for managerial decision in general and for individual factors ensuring its success, which will allow management to focus on those decisions that have the highest level of uncertainty and may pose a threat to achieving the goals of enterprise development.

We proposed an approach according to which the level of uncertainty can be determined both for a management decision in general and for separate factors of its success. A methodical approach to assessing the level of uncertainty is proposed to ensure the success of management decisions which will allow management to focus on those that have the highest level of uncertainty and may pose a threat to achieving goals.

Keywords: uncertainty, risk, decision-making, management

JEL Classification: C13, D81, D83, O32

INTRODUCTION

Modern economic conditions are characterized by a high level of aggressiveness and unpredictability in the behaviour of all market participants. This is due to the fact that it is impossible to predict everything that affects the course of events in the future. Sometimes there is no understanding of what can affect business situations and management decisions. These are typical conditions for the existence of all humanity, not just the economy. Uncertainty and risk are an integral part of every manager's activity, regardless of whether he takes it into account or ignores it. The desire to get the best result is characteristic of the strategy and tactics of every management system, so the frequency of decision-making related to uncertainty and risk is constantly increasing. However, if the desire is not based on a comprehensive analysis of all characteristics in a specific type of activity, does not take into account all possible outcomes of risky actions and characteristics of a specific market entity it will lead to unforeseen, in most cases, negative results. Management decision-making in conditions of uncertainty and risk requires the mobilization of the manager's entire intellectual, professional, and psychological potential. The more perfect the methodological toolkit of uncertainty and risk research, the more the factor of their adverse impact on the results of adopted and implemented management decisions can be reduced to a greater extent.

LITERATURE REVIEW

The question of the uncertainty in the enterprise's functioning has been considered by many researchers.

Work [1] examines the capabilities of the Data Science toolkit for the identification and assessment of economic uncertainty when making management decisions at the macroeconomic and microeconomic levels. Work [2] examines the main aspects of managerial decision-making in business structures in various spheres of activity under conditions of uncertainty. Work [3] uncertainty is considered a cause of risk, but the parameters of uncertainty themselves need clarification. Work [4] examines the essence and multivariate nature of the concept of uncertainty. In work [5] uncertainty is considered as the absence or lack of information. A study on the influence of the factors of uncertainty, inconsistency, and variability of the market economy on the flexible behaviour of enterprises was also carried out there. Qualitative and quantitative identification of factors for uncertainty and inconsistency to improve management requires further research. According to [6], the reduction of the degree of uncertainty is manifested in moral norms and legal laws, which have both a stimulating and a restraining effect.

Holton G. A. (2004) claims that two parameters are necessary for the risk existence of [7].

First, there is uncertainty about the potential outcomes of the experiment, and second, the outcomes must be meaningful in terms of providing utility. He points out, for example, that a person who jumps out of an aeroplane without a parachute is not taking a risk because he is certain that he will die (there would be no uncertainty), and that drawing marbles from an urn is not risky because no prosperity or wealth results from, a red or black ball is drawn. Of course, attaching different monetary values to the red and black balls will make this activity risky.

From the point of view of the above T. Merna notes that [8]:

- a decision is considered risky when there are several possible outcomes and when known probabilities can be added to the outcome;
- uncertainty exists when there is more than one possible outcome, but the probability of each outcome is unknown.

Douglas Hubbard notes that uncertainty is the absence of complete certainty, that is, the existence of more than one possibility [9]. The real result (state, consequences, cost) is unknown. He proposes to consider many probabilities that determine possibilities as indicators of uncertainty. He proposes to consider many probabilities that determine possibilities as indicators of uncertainty. However, he defines risk as a state of uncertainty when losses, disasters, or other undesirable outcomes are included in the calculation along with probabilities. He calls risk indicators a set of opportunities with their assigned quantitative probabilities and quantified loss [9].

That is, risk belongs to those cases when some events, although unknown, people believe that they have information about their probability distribution; uncertainty refers to those events where such information is completely absent. In addition, with uncertainty, we may not understand what the outcome of the course of events will be, and with risk, these outcomes can be outlined.

Risk also differs from uncertainty by the presence of interest of the subject from whose position the situation is considered and decisions are made. If the subject who makes the decision does not care about the results, and he is neutral about how the situation is realized, then one speaks of a situation of uncertainty. If not all results are equal for the subject, then this is a risky situation. With this approach, risk means the possibility of a certain outcome being of lower priority than others. If the subject is neutral, then there can be no losses.

Smith et al. [10] suggest that risks and uncertainties are divided into three categories: known, known unknown and unknown. Known risks include minor fluctuations in income and (or) costs and inevitably influence the results. They are usually covered by certain amounts to cover additional costs. Known uncertainties are due to incomplete knowledge of the phenomenon, but we can at least understand what information we are missing, with the decision dependent on a judgment known as "epistemic uncertainty". Known unknowns are risk events, the occurrence of which is predictable, either the probability of their realization or the possible outcome. Unknown unknowns are those events whose probabilities of occurrence and outcome are impossible to predict, these are situations of complete randomness and unpredictability. They are often considered to be force majeure events.

Epistemic uncertainty is due to the fact that it is impossible to obtain accurate knowledge about certain factors that influence decisions. And in this case, they resort to neglecting them and believe that this will not distort the overall result. Sometimes certain data can be intentionally hidden. Such uncertainty is determined by some factors, such as lack of clarity in the structuring of the problem; inability to determine alternative solutions to the situation; limited amount and quality

of available information; futuristic nature of decision-making; the level of confidence in the decision made; the amount of available time; personal qualities of decision makers.

In work [11], uncertainty is determined by such parameters as dynamism, the presence of non-functional connections between elements, and the influence of subjective factors related to human participation in management processes. And the main sources of uncertainty are the lack of complete information about economic processes, the influence of random factors, and opposition from other economic subjects. But the dynamism parameter does not always reflect uncertainty. Yes, if we understand development trends, their speed and direction, then at least we can understand development scenarios and their consequences.

The work [12] considers the differences between certainty, risk and uncertainty, which are based on the amount and clarity of information possessed by the subject of management. Lack of clarity means incompleteness or inaccuracy of information about the conditions of activity implementation. Lack of confidence means the impossibility of accurately predicting which of the possible values the studied parameter will take, that is, the impossibility of knowledge.

Summarizing all of the above, uncertainty should be considered as a state of complete or partial lack of information regarding the understanding of the event, the experience of dealing with it, as well as regarding its consequences or probability, the presence of factors in which the results of actions are not deterministic, and the degree of a possible influence of these factors on the results are unknown, the degree of predictability of operating conditions is low [11]. Uncertainty refers to the awareness of a lack of knowledge about current events or future possibilities. Risk-related events such as the death of an individual, a fire, or an automobile accident are potentially insurable. Events characterized as uncertain cannot be insured. That is, it is a situation when there is a complete or partial lack of information about the probability of a future event and the magnitude of the consequences.

In works [13] the stochastic and non-stochastic nature of uncertainty is considered. One of the main reasons that create uncertainty in our lives is the randomness of many phenomena, which, by their nature, in principle cannot be fully determined. Randomness can be called "stochastic uncertainty". However, some inherently non-random phenomena can also be considered uncertain due to the lack of information about them. Therefore, various non-random factors are also distinguished among the possible causes of uncertainty. The uncertainty generated by such factors is called "non-stochastic uncertainty".

R. Duncan proposed a two-dimensional model for determining the levels of uncertainty of the external environment [14]. The level of uncertainty of the external environment is determined by two parameters: complexity and dynamism. Complexity and dynamism are defined by two levels: low and high. Accordingly, a two-dimensional matrix is formed, in which four quadrants are distinguished: high uncertainty (high complexity and high dynamism); moderately high uncertainty (high complexity and low dynamism); moderate uncertainty (low complexity and high dynamism); low uncertainty (low complexity and low dynamism).

I. Ansoff [15] proposed a model for determining the level of uncertainty of the external environment. In his opinion, the external environment is a key parameter for determining the company's strategic position. According to this model, uncertainty has five levels of turbulence: from easily predictable to the most vague, unreliable, and non-specific. These are the following levels: stability, reactivity, prediction, research, and creativity. Each of these levels can be identified by the following parameters of uncertainty: variability of the market environment; the speed of change; the intensity of competition; technological capabilities; purchasing preferences; pressure from the government and certain influential groups. Determining the level of uncertainty of the external environment allows companies to better understand strategic behaviour and form a balanced and optimal strategy for achieving goals. Thus, a high level of uncertainty in the external environment requires aggressive and flexible strategic behaviour from the organization, on the other hand, a low level allows the best use of its internal potential and information about the existing strategic position.

Dave Snowden (Dave Snowden) [16,17] proposed the method of determining the context of the complexity of the problem "The Cynefin framework", which is based on the definition of the type of complexity and uncertainty of the environment in which managers make decisions. This model allows you to create tactics of behaviour in a problematic environment. The general logic of management is subject to the states in which the organization is. Thus, certain management methods work only when the enterprise is in the right state for them.

Naturally, further analysis and evaluation of the level of uncertainty will bring management closer to a better understanding of the problems that enterprises may face in the course of their activity.

AIMS AND OBJECTIVES

We aim to study the essence, types of uncertainty and differences between risk and uncertainty in the process of management decision-making. We have as a goal to structure the main characteristics of uncertainty, and determine the impact of levels and types of uncertainty on management decision-making. To achieve the goal, it is necessary to solve the following tasks: consider the essence of the concept of "uncertainty" and its differences from "risk", identify the characteristics of uncertainty that determine the influence on the process of making a management decision, conduct an analysis of models for determining levels and types of uncertainty, substantiate a methodological approach to overcome uncertainty for the success of management decisions and the achievement of management goals.

METHODS

An empirical analysis of scientific literature was conducted to determine the essence of "uncertainty" and its differences from "risk". A structural and genetic analysis was carried out to determine the main characteristics and causes of uncertainty. A comparative analysis of uncertainty level determination models was conducted. Morphological analysis was carried out to determine the levels of uncertainty for the main parameters of the innovative project evaluation.

RESULTS

Having considered the main differences between risk and uncertainty, it is possible to conduct an analysis and synthesis of the views of scientists who have considered these issues to outline the main characteristics of uncertainty. First, uncertainty is considered as the level of availability or awareness of the content of the necessary information, and lack of time or other resources to learn about the object. Secondly, uncertainty reflects the random nature of the course of events and the realization of the circumstances of reality. Thirdly, the uncertainty is due to the existence of many scenarios of the development of events, among which it is difficult to choose the best one. Fourth, uncertainty determines the quality of information that can be determined with certain reliability, objectivity, consistency, and precision. The fifth approach is characterized by the fact that uncertainty is a source of risk due to the impossibility of assessing the probability of outcomes and sources. Sixth, uncertainty is also determined by the subjective nature of the understanding of the information situation of the functioning of the system and the causal and logical connections of decision-making factors. Regardless of the subjective or objective nature of uncertainty, it exists and needs to be taken into account.

The main characteristics of uncertainty are:

- Spontaneity of natural processes and phenomena, natural disasters (earthquakes, hurricanes, floods, drought, frost, ice).
- Conflict. Conflict of interests (military actions, international conflicts, competitive behaviour).
- The non-linear nature of scientific and technological progress.
- The impossibility of unambiguous knowledge of the object with the established levels and methods of scientific knowledge.
- Different reflection of real phenomena in human consciousness. Different level of qualification of specialists.
- Incompleteness, lack of knowledge and information about the object, process, phenomenon.
- Unreliability, that is, when doubts arise regarding the correctness, truthfulness, and lack of trust in information.
- Limited material, financial, labour and other resources.

Such a wide list of sources of uncertainty in the functioning of economic systems causes the existence of various types.

There are the following types of uncertainty [18]: uncertainty of goals; uncertainty of nature; uncertainty of actions of the opponent or partner. Ambiguity of goals means the complexity of their structuring, description, the ambiguity of goals, and the existence of several goals. Uncertainty can be caused not only by a lack of information but also by limited possibilities for its processing. The uncertainty of nature means the impossibility of knowing the object under study and its environment. The uncertainty of the functioning of the economic system is associated with the inaccuracy of indicator measurements, the stochastic nature of information, and errors that occur during the aggregation and normalization of indicators. The uncertainty of the partner's actions is related to the uncertainty of the external environment. Uncertainty about the actions of subjects of economic activity may arise due to the presence of adversarial tendencies in them and

due to the concealment of part of the information according to their motives [18]. During uncertainty analysis, there is a need to define levels of uncertainty. Several analytical models address this issue. Let's consider the main ones.

Four levels of uncertainty are defined in [19]. The first level means a fairly accurately predicted future. In this case, it is possible to develop a forecast that has the necessary level of accuracy and will become the basis for corporate strategy. For its preparation, a standard set of strategic analysis methods is used: market research, competitor analysis, value chain analysis, Michael Porter's five forces model, and others.

The second level means the existence of alternative options for the future. That is, the future is described as several scenarios, namely options for the development of events. The use of analysis tools does not allow us to say with confidence which scenario will be implemented. Determining the probability of the realization of a particular scenario can help make a choice. Studying the different paths of the course of events will allow you to understand which market signals should be monitored most carefully.

The third level of uncertainty means the existence of a range of possible options for the implementation of activities in the future. This range is determined by several key variables, but the actual result could be anywhere within that range. Separate scripts no longer exist. In this case, you can define several scenarios that describe alternative options for the future, and then focus on tracking market signals that indicate which scenario the development will follow. However, developing clear meaningful scenarios at this level of uncertainty is difficult.

The fourth level of uncertainty means complete unpredictability. In this case, the characteristics of the development of the environment are practically impossible to predict. Neither isolated scenarios, nor the range of possible outcomes, nor the variables upon which the future depends can be defined. Analysis at this level is mostly qualitative rather than quantitative in nature. Here it is necessary to systematize known and unknown information. This will help identify certain parameters that can determine the direction of market development, and some indicators that can signal positive or negative changes in these variables.

High uncertainty is characterized by the presence of a large number of factors that affect the result of activity, the factors are dissimilar and constantly changing. Moderately high uncertainty is characterized by the presence of a significant number of factors that affect the result, the factors are dissimilar but do not change significantly. Moderate uncertainty is characterized by a small number of factors that affect the result, the factors are similar, but constantly changing. With low uncertainty, few factors affect the result, they are similar and do not change.

At different stages of their development, companies are in certain states: from complex orderliness to chaos. In addition, tasks, circumstances, and behaviour patterns change. According to this tool, the state of the environment is divided into five types [16,17]: obvious, complex, confusing, chaotic, and disordered. Each of these environments has its unique characteristics and requires different decision-making approaches to work in these environments.

In simple [16,17] systems, cause-and-effect relationships are obvious to all participants in the management process, the procedures for obtaining the best solution are clearly defined, all variables are well-known and understood, and it is possible to get the best result. While in this state, you can use the "best practices" developed over the years. Here, there are often clear steps that define the stages of the decision-making process. To work in simple systems, you need to: determine all the parameters for making a decision, classify them, involve a known and working procedure to solve the problem, get the result, and check it for compliance with the conditions. Often there is only one "correct" answer when solving a problem. There is already experience in solving similar tasks and problems in a certain way, and it is necessary to maintain these established and best management practices to get a deliberately good result. This requires knowledge, skills, and abilities to perform understandable tasks correctly. However, there is a danger that the apparent contexts may be oversimplified. This can happen if a business becomes successful and then stops being vigilant and fails to see other circumstances that may arise over time. To protect yourself from this, you need to have an established communication system for monitoring situations in which certain changes have occurred.

In complicated [16,17] systems, cause-and-effect relationships require preliminary analysis, these relationships may not be noticeable at first glance, but most of the factors that need to be taken into account to make a decision are known and understood, the need is recognized, but it is not clear how to achieve a better result. There is much less certainty about the outcome. Obvious and complex situations are part of mature and well-ordered systems. The lack of experience in solving such problems does not allow for predicting the result with accuracy to all the nuances. Someone, somewhere, once faced similar problems and you can integrate this experience into the activities of your company. Here it is appropriate to use "good practices" as opposed to "best practices" used in simple systems. There is a difference between "good" and "best practices", which is that a person needs the necessary competencies to use "good" practices, which can be acquired with experience. Good practices take time to become established management practices. The use of good practices allows

you to form several options for decision-making, among which you need to choose the most suitable option for the specific conditions of the enterprise's operation. Finally, we can get a good result, but not necessarily the best. Therefore, experts are used in complex systems. The invited expert consultant has already worked with similar problems and tasks and can provide recommendations on how to act in this situation. The result is still ambiguous, but there is an approach to understanding what can be evaluated and how. When working in complicated systems, it is necessary to: determine and list everything that is needed to make a decision, analyze how to achieve the best result, compare possible results, and choose the best solution. There is no need to rely too much on experts in difficult situations, rejecting or ignoring the creative suggestions of employees. Examples of complicated systems work are the processes of improving an already existing product when we know all the characteristics of the product, but it is not known what can be changed in the product and how, the use of new methods in the production process, when you know what to do, but do not exactly understand how to do it in the best way. Hiring employees is also a complex system, as you ask the necessary questions that you think are important for the job during the interview, but the result still cannot be guaranteed.

In complex systems [16,17] causal relationships become clear only over time, but the situation cannot be predicted, several uncertain factors affect the situation, but not all of them are known yet. This system works under light constraints. There may be several correct solutions, but the choice among them is not yet obvious. Today, many business situations fall into this category of solutions. There is no understanding of how to act, sometimes there is no understanding of what the problem is and what questions need to be asked to understand it. When working in complex systems, it is necessary to: search for solutions that have worked in past situations or other companies, use knowledge and intuition to evaluate possible outcomes, determine the best outcome in these circumstances, and check whether this outcome meets the requirements. In this situation, the optimal solution can be found as a result of setting up an experiment (or a series of experiments). If the experiment is successful, it should be expanded, if it fails, it should be collapsed and moved to a new one. To proceed to experimentation, it is necessary to firstly decide on the strategy of expanding and collapsing the experiments. New knowledge emerges here, which forms new practices that are just in the process of emerging. Uncertainty in such situations is even greater. At first, you can involve your inner feeling and only later you will be able to understand what is happening. In a complex system, the result is unclear. Therefore, to get some information, it is necessary to establish feedback with reality. It is impossible to control the situation, but you can patiently look for patterns and encourage the company's personnel to solve problems. In such situations, failure is perceived as part of the learning process. An example of a complex system is the stock market game, since it is never possible to have all the information of the stock market, and insider information may be practically unavailable.

In chaotic systems [16,17] there are no connections between cause and effect, no one understands what to expect, anything can happen, predicting the future is impossible, and there is a certain chaos in activity. If entering a chaotic area is deliberate, then it can lead to innovation, but if it happens by accident, then you need to stabilize as soon as possible. When working in chaotic systems, it is necessary to act by identifying priority tasks, using knowledge and intuition to understand the results, determine the best outcome and be ready for change. There is no experience in solving problems in this area. Chaos occurs when a significant problem arises and the approaches to its solution are unknown. Often this is a crisis or emergency in which urgent action is needed to limit the possibility of negative consequences and bring some understanding to the situation. Traditional practices in most such cases will only harm. The decision made must take into account the chaos and unpredictability of the system's behaviour. It is likely that the decision taken will not be optimal, but it is still necessary to try to establish control and stabilize the situation. Such situations require quick and decisive decisions and actions that will help to get closer to understanding the problem and move from chaos to a difficult situation. During a crisis, it is important to establish communication in the team to exchange thoughts, ideas, and assumptions. Here we can only act and receive feedback. If in a complex system, we can "guess" where to move and what to do, in a chaotic environment we can only move and adjust the movement based on new information. An example of a chaotic environment is the production of an innovative product when it is impossible to know in advance what the demand will be, what properties and characteristics of the product may be interesting to the consumer, at what price he will want to buy this product, how people will react to the novelty in general. Crises, revolutionary events, and military actions are all chaotic situations when you need to act urgently and the activity is more about adaptation and response to challenges.

All the listed models determine the general level of uncertainty of the problem, environment, and situation. But in practice, sometimes it is advisable not only to determine the general level and type of the problem environment but also to determine the level of uncertainty of individual, most significant factors for decision-making that can contribute to success or threats. For this, it is necessary to find out the factors that are decisive for making a decision and determine the level of uncertainty for each of them.

The most important factors of the uncertainty for the internal environment include enterprise flexibility; information support; the level of complexity of the management system; clarity and professionalism of staff behaviour. Important factors

of the uncertainty for the external environment include the level of competition and globalization; speed and predictability of technological changes; demographic and social changes; political conflicts; instability of financial markets. All of them have their level of uncertainty depending on the field of activity of the enterprise (Figure 1).

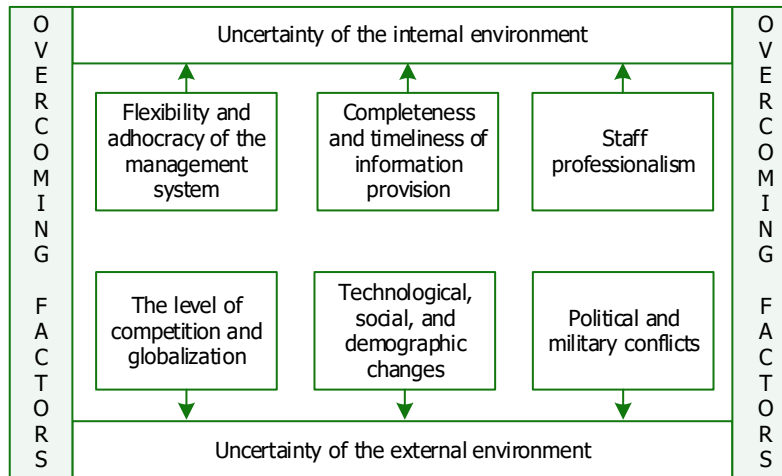


Figure 1. Factors for overcoming environmental uncertainty.

Enterprises operate in the conditions of competition, which is complex and global in nature, this requires a reduction in reaction time to changes in conditions of limited resources. The lack of flexibility of management systems is caused by their unpreparedness for effective competition and inability to adequately respond to the demands of dynamic globalization processes. Enterprises that can identify uncertainty factors, accumulate, develop, and improve their organizational and economic advantages in a timely manner become more competitive in the market. Scientists note that "companies are often prevented from envisioning the future and opening a new space for competition, not at all by fog on the horizon, but by the tendency of managers to look ahead through a narrow aperture of existing opportunities. After all, if a person sees a set of skills and technologies in a company, then a whole spectrum of new potential opportunities usually opens before him [20]. Therefore, managers should use in their activities only modern tools for resolving uncertainty taking into account changes in the management paradigm and determining a certain model of enterprise development, which will not allow entropy processes to exceed the reliability threshold permissible for an individual enterprise during their possible growth. Otherwise, organizational entropy will lead to disorganization, destruction of integrity, weakening of productive relationships, and reduction of overall efficiency. In this case, the ascending principles, according to which the establishment and operation of the enterprise, as well as the improvement of management principles, took place, are of particular importance. These basic provisions become a reflection of those regularities that will determine the peculiarities of development and the mode of coordination of all types of relations with both the external and internal environment [21].

The problem of the specific conditioning of decisions is the question of what role personal characteristics play when solving tasks and how they regulate individual behaviour in situations of uncertainty and risk.

In our opinion, it is possible to reveal this most fully through the operation of a number of factors that reflect, in particular, the desires of the decision-making subject (DMS) in choosing one or another alternative to a management decision. They can be:

- the desire to achieve success $/M_y/$ and the desire to avoid failure $/M_n/$ are rightly considered relatively stable traits of DMS, which have a deep individuality and a certain influence on the decision-making process of the company's system. The intensity of the desire for success, as well as the degree of avoidance of failure, can be smaller or larger. The actions of the management system depend on the relations that exist between $/M_y/$ and $/M_n/$, can be compared in terms of strength and form a system of relations consisting of individual properties of the DMS and can be expressed as:

$$M_y > M_n; M_y < M_n; M_y = M_n; \quad (1)$$

- the probability of success $/P_y/$ and the probability of failure $/P_n/$, which depend on the level of preparedness of the DMS and indicate the degree of difficulty in achieving the set goals;

- the value of success $/V_y/$ or failure $/V_n/$. It is assumed that success or failure in achieving a set goal has a certain value for a specific management system. And the greater the probability of success, the lower its value, and vice versa - as the chances of success decrease, its attractiveness increases.

The choice of an alternative management decision for DMS will depend on a combination of the following factors:

$$(U_i) = (M_y * P_y * V_y) + (M_n * P_n * V_n) \quad (2)$$

They will determine the behaviour of the DMS through the description of its subjective perception of the sources of success or failure of its activity and are a reflection of the managerial potential of the DMS, its competence, professionalism, the ability to carry out effective activities in the presence of conditions of environmental uncertainty regarding the generation of optimal management decisions and the ability to conduct an adequate and reliable assessment of results.

Qualitative and quantitative assessment of uncertainty requires a gradual comparison of expected results and the circumstances preceding them. This requires the manager to distinguish not only specific areas of activity but also factors that determine probable changes and limits of the final expected result. As a generalizing indicator in the quantitative analysis, we consider it expedient to choose the expected increase in effectiveness from the implementation of the selected management decision:

$$U_k = (W_k + L_k) p_k + L_k (1 - p_k) - C_k \quad (3)$$

$$\text{or } U_k = W_k p_k + L_k - C_k \quad (4)$$

where k - the chosen alternative of management decision U ; L_k - projected losses; W_k - the expected increase in effectiveness from the implementation of the chosen alternative of the management decision U $/+/, while $W1 = 0$ p_k - the probability of successful implementation of the selected management decision alternative U , where $p1 = 0$ C_k - gross costs, where $C1 = 0$$

It is obvious that the result of making a management decision has a negative value for SPR, if:

$$U_{ij} - Z < 0 \quad (5)$$

where ij - the expected/predicted value of the result when choosing alternative i for outcome j ; Z - the necessary value of the result from the adoption of a management decision;

and a positive value in the case of:

$$U_{ij} - Z \geq 0 \quad (6)$$

Let's assume that it is possible to make some completely objective forecast, which is a conditional mathematical expectation of the future state of the market, that is, calculated taking into account all the currently available information:

$$M(S_{t+1} / I_t) = S_{t+1} + / U_{t+1} / \quad (7)$$

where $M(S_{t+1} / I_t)$ - the mathematical expectation of the future state of the market, determined by the volume of all available information J_t at the moment t , S_{t+1} - the future market state, X_t - random variable.

Let's imagine a situation where both types of forecasts coincide. In other words, the subjective expectation of the control system is equal to the conditional mathematical expectation. Moreover, it can be assumed that such a coincidence happened not in one, but in most market subjects in general. The generally accepted definition indicates that the expectations of an economic entity regarding a certain variable are considered rational if its subjective expectations coincide with the conditional mathematical expectation of this variable, that is, the mathematical expectation calculated using publicly available information. The hypothesis of rational expectation states that the collective subjective expectations of the market should coincide with the mathematical expectation determined by all arrays of available information. Therefore, DMS, whose expectations are rational, will be able to characterize the situation on the market and the position of its enterprise in the best of all possible ways.

Therefore, in the notation we have adopted, the hypothesis of rational expectation can be presented in the form:

$$E_t S_{t+1} = M(S_{t+1} / I_t) = S_{t+1} + U_{t+1} \quad (8)$$

where $E_t S_{t+1}$ – the rational expectation of DMS regarding the state of the market at the time t .

How the forecast was obtained does not play any role in this context, if, based on this assumption, the expectation of the control system coincides with the objective conditional mathematical expectation, it will be rational from the point of view of DMS. Thus, from the above considerations, it is clear that the degree of effectiveness of the DMS activity will be higher, the higher the quality of the information at its disposal, and the more fully it is used. Therefore, special attention should be paid to the study and analysis of uncertainty and its components. This will allow managers of enterprises to determine the appropriateness of risk, and the boundaries of risk in which a specific enterprise can function without harming decisions with risk. Thus, attention is focused on the development of a management strategy in conditions of reasonable risk to achieve the maximum effect at the optimal cost of all types of resources. Comprehensive risk analysis will allow a qualified manager to develop solutions that are close to optimal.

This approach will allow us not only to adequately assess the general level of problem uncertainty but also to determine the uncertainty of individual structural components of this problem. Under these conditions, an objective assessment of the real state and development prospects of the enterprise becomes possible. That will allow directing management efforts to overcome uncertainty to ensure successful activity and the constant invention of constructive solutions to problems.

DISCUSSION

Work [1] does not consider the issue of identifying the type and characteristics of uncertainty during the analysis of the economic system. In work [2] remains the problem of determining approaches to taking into account the level of uncertainty during management activities. In work [3] the parameters of uncertainty themselves need clarification. In work [4] the issues of criteria for evaluating uncertainty and the impact of uncertainty on the main indicators of the development and activity of the enterprise were neglected. Work [5] does not allow one to determine the essence and make a qualitative assessment of the state of the research object. According to [6] the mechanism for taking this uncertainty into account during enterprise management needs to be refined.

The formation of an effective enterprise management system and the construction of relevant organizational processes should be based on clear guidelines for behaviour in specific functional areas and the use of appropriate methodological tools. And since the development scenario of each enterprise is strictly individual and the sets of means of achieving the goals available to enterprises will differ - the fundamental methodological principles of the system approach recommend moving only from the abstract to the concrete [22,23], and when studying a certain problem, first of all, it is expedient to first determine the level of uncertainty for the conditions of activity. Otherwise, the enterprise will remain only a "black box" [24].

In many scientific works uncertainties is considered alongside risk. According to Knight F., uncertainty is fundamentally different from risk, although sometimes they are not separated. The opinion of Knight F. [25] is that risk is considered a quantity that can be measured, and uncertainty is not. Accordingly, there are important and fundamental differences in the development of phenomena depending on whether uncertainty or risk is present in it. The informational approach considers the differences between risk and uncertainty, which are related to the amount of available information about the situation under study, and more precisely - the probability of distribution of the results. If we know the probabilities of the results - this is a risky situation, if there is no such information – uncertainty. Knight F. also determines that the main factor underlying probabilistic thinking is our ignorance [25]. If it were possible to measure all the determinants with absolute precision, we would probably be able to predict the outcome in each particular situation, but it is quite clear that in many cases we cannot do this.

CONCLUSIONS

The conducted research showed that uncertainty should be considered as a lack of complete information in terms of understanding the factors affecting the problem, cause-and-effect relationships of the action of these factors, the consequences, sufficiency of the personnel's competencies in solving problems of this type, level of trust and interest in obtaining the desired result.

Uncertainty is often considered together with risk, and sometimes these concepts are equated. The main differences between risk and uncertainty are:

- in a situation of risk, the future result can be predicted with a certain degree of probability, but in a situation of uncertainty - not;
- risks can be managed and in certain situations their impact can be limited, but uncertainty cannot be controlled;
- risks can be measured and quantified, but uncertainty cannot;
- in a situation of risk, the number of alternative scenarios can be determined, and in a situation of uncertainty, there can be a lot of them.

The following causes of uncertainty were found: spontaneity, randomness, conflict or contradiction, non-linear nature of scientific and technical progress, impossibility of knowledge, ambiguity in perception of real phenomena and events, incompleteness and mistrust of information, and limited resources. Understanding the listed causes and characteristics of uncertainty will allow company management to better understand and identify uncertain parameters and form various development scenarios in conditions of uncertainty.

A comparative analysis of existing models for the identification of uncertainty levels showed that there are different approaches to the selection of its descriptive characteristics. But it is important not only to describe the uncertainty of the existing situation or problem, but also to single out specific factors that are important for decision-making, and to determine the level of uncertainty for each factor. Such an analysis will allow management to focus on those factors that have the greatest level of uncertainty and may pose a threat to achieving goals.

Further research will concern the improvement of the methods for assessing the level of uncertainty according to several parameters that cause its existence, namely: unknownness, unreliability, ambiguity, and structuring of the problem.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally

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Бай С., Федулова І., Дроздова Ю.

УХВАЛЕННЯ УПРАВЛІНСЬКИХ РІШЕНЬ: ПОЛІКРИТЕРІАЛЬНА ОЦІНКА НЕВИЗНАЧЕНОСТІ

У статті розглянуто основні властивості невизначеності та ризику, які потребують урахування під час ухвалення управлінських рішень для забезпечення керованості всіх процесів на підприємстві. Незважаючи на значну увагу науковців до ризику та невизначеності, їх значущість для ухвалення управлінських рішень є дуже високою, тому залишається відкритою дискусія щодо ідентифікації їхніх рівнів. У статті уточнено сутність, види невизначеності, ідентифіковано низку відмінностей між ризиком і невизначеністю в процесі ухвалення управлінських рішень, проведено структурування основних властивостей і характеристик невизначеності, визначено вплив рівнів і типів невизначеності на ухвалення управлінських рішень. Проведено емпіричний аналіз наукової літератури для визначення сутності поняття «невизначеність» і її відмінностей від поняття «ризик», структурно-генетичний аналіз визначення основних характеристик і причин невизначеності, компаративний аналіз моделей визначення її рівнів. Виявлено основні властивості невизначеності, які спричиняють її існування й потребують урахування. Компаративний аналіз моделей визначення рівнів і типів невизначеності показав, що переважно невизначеність визначається для конкретної проблеми чи ситуації. Проте доцільно визначати невизначеність для окремих параметрів оціночної моделі. Відтак у роботі запропоновано методичний підхід оцінювання рівня невизначеності для управлінського рішення загалом та для окремих факторів забезпечення його успіху, що дозволить менеджменту зосередити увагу на тих рішеннях, які мають найбільший рівень невизначеності й можуть становити загрозу для досягнення цілей розвитку підприємства.

Ключові слова: невизначеність, ризик, управлінське рішення, менеджмент

JEL Класифікація: C13, D81, D83, O32