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Theoretical modeling of organizational reflex in human resource management from the perspective of organizational biological approach

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This article presents a framework that informs about routine and creative decision-making and management practices within an organization. The primary focus of the study is on the preparedness of human resources within the organization to effectively respond to information from the global environment and ensure optimal decision-making. Analysis of human resource management discourse, a review of biological organization theory, and a detailed examination of reflex arc theory using elements of human body analogy such as neurons, allowed us to model a system that examines the basis of decision-making of information coming from the global environment in an organization, and the conducted research allowed to discover how to improve organizational abilities to respond to external stimuli. Theoretical modeling techniques revealed connections between the organization and various systems, and computer simulation allowed to examine these connections in different situations using Spyder (Python 3.8 environment based on SciPy, NumPy, etc.), with all the necessary functions to perform calculations and visualize the results. In order to gain a deeper understanding of decision-making in the organization, a model has been developed that is able to effectively make a decision from the perspective of the organization's biological approach. A computer simulation conducted in the course of the study indicated: (1) that according to the interests of the organization the model selected (20%) of information of interest, from which, according to the ability of the created model, (95%) was directed to form a routine response and (5%) was directed to a creative response; (2) the time efficiency of the routine response may be more effective than that of the creative response from (63.6%) to (90.7%); (3) the efficiency of the realistic scenario of the model's performance is inferior (about 21%) than that of the optimistic scenario, but more effective (about 17%) than that of the pessimistic scenario, this means that the realistic scenario works better than predicted in the pessimistic scenario, making it positive for the suitability of the model. These findings provide valuable insights into an organization's ability to respond quickly and make decisions in a competitive environment, which may have practical implications for organization management and strategies to improve the ability to respond to external factors.

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Introduction

An ongoing intensive globalization and international integration lead to changes in the organization, which depend in part on the organization itself but are also strongly influenced by the effects of the external environment (Lei and Jia, 2007; Dowling et al., 2008). Therefore, it is likely that in the course of environmental transformation, the organization also undergoes evolutionary changes from a biological perspective, which in one way or another affects the organization's structure and initiates transformation in its management systems, including human resource management (Milne, 1970; Morgan, 1998; Kreitner and Kinicki, 2012). According to the researchers, the organization must be seen as a system of interconnected parts similar to the human body, since each part of the body depends on the others (Henning, 2018), so the biological foundations of organizational behavior have been analyzed in detail (Arvey and Zhang, 2015).

The analysis of human resource management discourse (Da Silva et al., 2022; Stone and Deadrick, 2015) sheds light on the intricate interplay between technological advancements and the evolving landscape of HR practices. Specifically, these studies illuminate how organizations navigate the challenges and opportunities presented by Industry 4.0, emphasizing the need for HRM to adapt to a digitalized and technologically driven environment. In their exploration of HR's future, Stone and Deadrick (2015) contribute valuable insights into the multifaceted dynamics of organizational change, providing a comprehensive overview of the challenges posed by shifts in the economy, globalization, domestic diversity, and technology. Building upon the insights from biological organization theory (Niman, 1994; Morgan, 1980; Penrose, 1952), the study explores the organizational context. Niman (1994) delves into the limited use of biological metaphors in economic theory. Morgan (1980) takes a radical humanist critique, suggesting that organization theory is confined by its metaphors and trying to free organization theory from metaphorical imprisonment. Penrose (1952) challenges the appropriateness of biological analogies in economics, arguing that neo-Darwinian theories of evolution exclude deliberate human action in the economic field. The researchers trying to comprehensively understand the role, challenges, and potential value of incorporating biological analogies into economic theories of the organization. Furthermore, a comprehensive examination of reflex arc theory (Phillips, 1971) provides a theoretical foundation for understanding By tracing the historical development of the reflex arc concept, particularly its roots in Descartes' mechanistic theories, the study sheds light on how foundational ideas in physiology have influenced contemporary perspectives. By elucidating the contributions of these scholars and theories, this research establishes meaningful links to an established body of knowledge, reinforcing the relevance of our study within the broader academic discourse.

Analysis of the organization's response to information coming from the global environment and its response to the activity of the system indicated that the functioning of the organization is very similar to the functioning of the human reflex arc. This insight made it possible to recognize the structure of the human nervous system as an integral part of the organization's decision-making system.

According to Dewey (1896), the ordinary reflex arc theory proceeds upon the assumption that the outcome of the response is a totally new experience. Laycock (1840, 1845, 1876) discovered human behavior that is initiated by various stimuli, and the resulting actions are described as reflexes. Pavlov (1960) supplemented the reflex theory with teaching on conditioned reflexes and higher nervous activity by introducing the concept of conditioned and unconditioned reflexes. Conditioned reflexes help the body adapt to changing environmental conditions, unconditioned reflexes help adapt to partially constant conditions, therefore, the organizational reflex is used as a factor to achieve the result. Skinner (1935) argues that a conditioned reflection is said to be conditioned in the sense of being dependent for its existence or state upon the occurrence of a certain kind of event, having to do the presentation of a reinforcing stimulus, therefore, conditioned reflexes can be temporary, since without the stimulus repeating, the conditioned reflex is no longer formed.

After delving into the theoretical statements about human resource management from the perspective of biological organization, it becomes clear that the organizational reflex hypothetically plays an active role in the process of receiving information from the environment and forming a response (Vaitkevicius and Papsiene, 2023; Vaitkevicius et al., 2021; Papšienė and Vaitkevičius, 2015). The organizational reflex in relation to the organization is considered to be an instinctive reaction of its employees to the emerging external stimulus or, in other words, the ability of the employee to spontaneously generate a competitive response to the organization based on information received from the global environment (Vaitkevicius et al., 2023). The organizational reflex can play an important role in the reactivity system of organizations and the ability to make effective decisions.

To understand what the organizational reflex is, we should first refer to the concept of reflex action. A reflex action is a movement in response to a specific stimulus. Huxley (1915) realized that the spinal cord, an independent nerve center, is capable of initiating actions upon the reception of a sensory impulse. „By the help of the brain we may acquire an infinity of *artificial* reflex actions, that is to say, an action may require all our attention and all our volition for its first, or second, or third performance, but by frequent repetition it becomes, in a manner, part of our organization, and is performed without volition, or even consciousness" (Huxley, 1866, p. 286).

The collected relevant information on the functioning of the reflex arc and its comparison with the principles of the functioning of the organization's reactivity system made it possible to see that the information received from the global environment until it becomes the response of the organization is processed by human resources capable of making an effective decision.

Therefore, the main problem of the study is the readiness of human resources in the organization to respond adequately to the information received from the global environment in order to ensure effective decision-making. Organizations can undergo evolutionary changes and be influenced by external environmental factors, so it may be important to understand how organizations adapt information from the environment and how their employees respond to external stimuli.

Objective of the study: to compare conditioned and unconditioned reflex responses in effective decision-making.

During the research, two hypotheses were formulated. H_0: less time is required when making a routine decision; H_A: less time is required when making a creative decision. The hypotheses were tested during the modeling process.

This research can influence human resource management in organizations from a biological perspective and help to understand how organizations can better respond to information from the global environment and adapt to changing conditions. For more accurate results, other factors should be taken into account, which can also affect the competitiveness of organizations.

Literature review

Knowledge of human resource management as an organizational function. The scientific literature pays much attention to the knowledge of human resource management as an organizational function (Torrington et al., 2007; Sims, 2010). Much has been done in the fields of human resources, retention and improvement of competencies, career planning, compensation, and other areas that are strategically important for the development of the organization (Dowling et al., 2008). A discourse on the topics of these and other analogous fields has made it possible to know human resource management as a function that consists of functions with a narrower definition and is particularly important in establishing human resources as an important prerequisite for organizational development and increasing organizational competitiveness (Bratton and Gold, 2012; Torrington et al., 2007; Birdi et al., 2008).

Human resource management and personnel management. Scientific discourse on the topic of the definition of human resource management has not only revealed the complexity of the definition of human resource management but also indicated that many concepts have been formed that deal with the differences between human resource management and personnel management. Although some authors stated that the function of personnel management was to represent management to employees, and employees to management (Mabey et al., 1998; Analoui and Karami, 2003). Other authors have sought to attribute the same functions to human resource management (Guest, 1990; Analoui and Karami, 2003). Thus, they described human resource management as a management discipline that sought to ensure the recruitment, training, motivation, and management of employees in such a way as to maximize their benefits for management. Thus, human resource management, although renewed and expanded in comparison with personnel management, eventually included all personnel management functions (Bae & Rowley, 2003; Torrington et al., 2007). During this discourse, it becomes clear that the phenomenon of human resource management is no longer only interested in science from the perspective of ontological cognition, but it also becomes relevant in the perspectives of axiology and praxeology, which creates additional prerequisites for observing the evolution of human resource management as an organizational function. This can mean not only seeking to understand what human resources are but also assessing the added value they can bring to the organization.

Soft and hard human resource management. Since human resource management is a relatively young scientific field, therefore, and in the scientific literature, the treatment of the same properties of an object differs in terms of terminology. For example, the scientific literature presents “hard” and “soft” theories of human resource management, where the former embodies a resource paradigm and the latter embodies a systemic one. This is because, according to the authors, the hard theory emphasizes the term “resource” and represents a “rational” approach to employee management, i.e., performs the function of unifying business and human resource strategies. The soft version of management emphasizes the term “human” and thus identifies such functions of human resource management as an investment in training and education and the development of a “commitment” strategy that ensures that having good skills and loyal employees gives the organization a competitive advantage (Walker, 1992; Bratton and Gold, 2012). For some, hard theory symbolizes a peculiar attitude to the organization of labor and to the management of labor relations, where it corresponds to the new economic order (Beer et al., 1984; Betcherman et al., 1994).

Comparing the human resource functions named by Armstrong (2006), it was observed that according to their characteristics, they provide a clear view of how human resource management can play a strategic role, manage organizational processes, integrate employees, and stimulate their development. In addition, it is important to notice how these functions relate to the goals of the organization and how they contribute to the decision-making process within the organization.

Human resource management mediator and/or moderator. After the analysis, it becomes clear that human resources management in the organization does not function as an antecedent, it is seen more as a mediator and/or moderator from the point of view of the organization’s implementation, which inevitably receives an external impulse, as a result of which the function of ensuring the efficiency of the organization’s activities is activated, which can still be treated as an essential motive for the application of human resources management in the organization when making decisions. The external impulse activates the function of ensuring the effectiveness of the organization’s activities by determining that human resources management can act as a mediator. This means that factors from the organization’s environment, perhaps market changes or competition, can have a direct impact on human resource management, which in turn affects the effectiveness of the organization’s activities. The function of ensuring the effectiveness of the organization’s activities can be treated as a motive for the application of human resource management, emphasizing the possible role of the moderator. Human resource management can act as a tool that enables an organization to achieve efficiency goals, as well as motivate and orient employees towards these goals. Human resource management, acting as a mediator or moderator, can be perceived as a tool that helps an organization make decisions effectively in response to external changes (see Fig. 1).

The function of ensuring the effectiveness of the organization’s activities is more defined by the purpose of human resources management or in other words the directionality of human resources management, while Armstrong’s (2006) functions are more focused on the description of the purpose of human resources management and the set of human resources management competencies in the organization. Still, other authors (Walker, 1992; Wright and Snell, 1998) identify the function of increasing the competitiveness of the organization, which can be associated with ensuring the effectiveness of the organization’s activities, since it is also a function that expresses motivation, which partly answers the question of who needs to increase the superiority of the organization.

In addition, the above authors name the functions of enhancing employee competence, capacity building, motivation, role awareness, and human resource management formation and strategic management (Guest, 1990; Analoui and Karami, 2003). All of them are repeated, which suggests that from a functional point of view, the authors equally understand and describe the purpose of human resource management in the organization.

Organizational activity model using the human reflex arc. This perspective makes it possible to perceive an organization that responds to external information and applies different responses depending on the situation. The conditioned reflex, equivalent to the creative response, and the unconditioned reflex, corresponding to the routine responses, reflect the organization’s ability to adapt to new information or use routine decisions.

Organizational reflex: from the human nervous system to the functioning of the organization. Analysis of the organization’s response to information coming from the global environment and its response to the activity of the system indicated that the functioning of the organization is very similar to the functioning

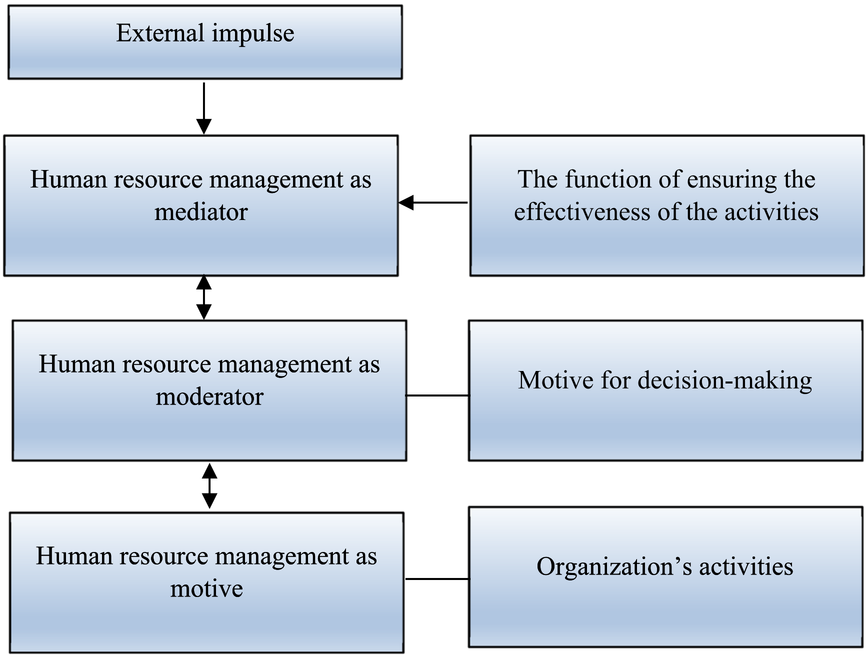

Fig. 1 The role of human resource management as a mediator or moderator in the organization's activities.

of the human reflex arc. This insight made it possible to recognize the structure of the human nervous system as an integral part of the organization's decision-making system. By evaluating the organization from the perspective of a biological approach, the organization can be perceived as a human organism, where decision-making acts as a human reflex arc.

In the organization, the organizational reflex is defined by two responses that are manifested from the recognition of the information received from the global environment, i.e., (1) a conditioned reflex, which is equated to a creative response in the organization, as a result of the interaction of specific knowledge and skills, where a competitive response to incoming information from the global environment is formed, and (2) an unconditional reflex, which corresponds to a routine response in the organization, as a competitive response formed by standard decisions to incoming information from the global environment.

Organizational decision-making system from a biological perspective. In the organization, operational processes come in two different stages, which are manifested depending on the information received from the global environment. The information received from the global environment in the organization is processed by human resources that make a decision. If the information is known, then there is a routine process—a way of acting according to established rules, provisions, and standards, and if the information is not known to human resources, then there is a creative process—purposeful creative thinking of a person using the level of learning, during which purposeful and conscious work is carried out to create an added value. The knowledge of employees accumulated in the organization is collected in the organization, which is defined as an experiential database—the skills and knowledge acquired by employees of the organization. According to Kritz (2014), the organization is also closely intertwined with information. Any organization can receive, and transmit information, or the organization can mean something to someone.

Application of the organizational reflex in the construction of the organizational activity model in the context of the biological approach. Based on the analysis of literature sources, when

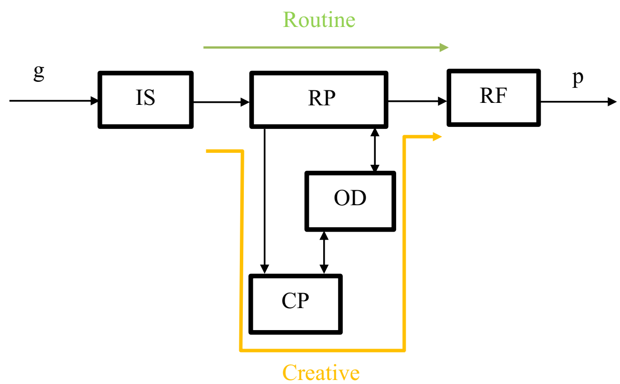

Fig. 2 Model of organizational performance from a biological approach using organizational reflexivity.

constructing the organizational activity model of the biological approach by applying the organizational reflex (Fig. 2), it was observed that the operating principles of the organizational reactivity system could be explained with the help of the human reflex arc.

Model description. g—information from the Global Environment;

IS—Selection of information // selects information of interest to the organization from the set of accepted information according to the criteria assigned by the advance and rejects/does not omit information of no interest;

CP—Creative process // analyzing newly received / incomplete information for optimal response formation/creating a pattern;

RP—Routine process // routine work, according to pre-known responses;

OD—Organization database // the organization's knowledge base, which is based on the experience employees have or acquired in the course of work, with the possibility of accumulating/updating information;

RF—Forming a response // forms the responses received from RP according to the protocols for submission of answers established by the organization's internal rules

p—Formed response

Description of the model algorithm.

1. input g; // enters information from the global environment
2. if IS(g)=TRUE then; // checks if information *g* corresponds to the company's interests
3. if RP(g)=TRUE then; // checks if there is *OD* response pattern
4. p(g) goto9; // response is provided according to the protocol
5. else IS(g)=FALSE goto2; // information *g* does not correspond to the company's interests (rejected) the following is checked
6. else RP(g)=FALSE; // there is no response pattern in *OD* base
7. CP(g); // creating a response pattern
8. OD = OD + 1 goto3; // *OD* is supplemented with the generated response pattern
9. end.

The organization's response to global information: from selection to the formation of a competitive response. Information from the global environment (g) falls into the structural-functional unit of the organization (IS), where employees familiarize themselves with the information received. The assessment of the nature of the received information according to the characteristics of the information that meets the interests of the organization takes place. If the information does not have signs of information of interest to the organization, it is rejected and transferred to the assessment of other information received from the global environment. When information shows signs of the organization's interest, it is transferred to a routine process (RP), where information is evaluated quantitatively and qualitatively:

If, by the nature of the information received, it is decided that the information received is complete, the competitive rebuff will not create difficulties, (RP) is carried out, where a competitive response is formed to incoming information from the global environment and transmitted to (RF).

When the received information is of a non-routine nature, the response requires specific knowledge and skills and is transferred to the (CP) response formation stage, where a competitive response to incoming information from the global environment is formed. Employees are introduced to the formed variant of the competitive response. In this way, their knowledge is supplemented and their qualifications are raised.

Summing up the results, it can be stated that it was possible to apply the reflex arc in the processes of the organization and form a model that explains how the information transmitted from the global environment to the organization becomes the organization's competitive response to the global environment.

Stages of the process of creating a model and its application.

1. Application of fuzzy logic. Fuzzy logic was chosen because it is suitable for logical reasoning with imprecise data.

    11. Fuzzy terms objects are created and their values are determined. Objects of fuzzy terms are designed to manage the purpose in the fuzzy logic model. Objects of fuzzy terms are important because they represent undefined concepts or rules in the model. By determining the values of fuzzy terms, it is possible to regulate how these concepts are interpreted in the model. By changing the values of the fuzzy terms, it is possible to change the performance of the model and its adaptation to different conditions or data. Therefore, this stage is necessary in order to properly configure the fuzzy logic model to meet the specific needs or situations in which it will be used.
    12. Fuzzy logic rules are included. The created rules define the relationship between the input parameters and the output result, i.e., the rules define how to respond to different input values. Adding new rules) can improve the decision-making system by adding more logic and taking into account new factors.
    13. To create a control system and simulation object. Parts of the system are created that are responsible for the decision-making process (RP) and the execution of the simulation. This may include algorithms, control logic, and a rule system. In this case, the control system includes fuzzy logic rules. A simulation of the model is created, for which data from the control system is transmitted and calculated according to fuzzy logic. The simulation object can be a great tool to understand how different solutions would work in different situations. This allows the organization to test various scenarios without real consequences and learn from possible mistakes. In addition, it can improve the general understanding of human resources about the activities of the organization and its interaction with the outside world.
    14. Parameters for sensitivity analysis and Monte Carlo simulation are specified. Sensitivity analysis is included in Monte Carlo simulations by changing input parameters and observing how this affects values, i.e., how the system responds to various changes in parameters, which allows the identification of critical factors that can have a significant impact on the operation of the system. Monte Carlo simulation is a statistical methodology for modeling uncertainties and random events. By specifying the selected parameters, it is possible to perform simulations with different scenarios of events and evaluate the performance of the system under various conditions. By changing these values, it is observed how this affects the selected variable, which may be the main parameter in the analyzed system. It can be an improvement in the decision-making process, including fuzzy logic and simulations to better assess and manage uncertainties within the organization.

2. Random sample creation and model application. An array is created, which denotes whether a particular event is included in the sample. A function random.choice is used to generate a random sample and mark corresponding events with a value. When various arrays and variable structures are created, iteration is initiated through model execution cycles, where additional logic is executed with a fuzzy logic model and Monte Carlo simulation and the model is applied to the sample.

    21. Generate a random value. For each event, a random value is generated to be used as input in the fuzzy logic model.
    22. Execute additional fuzzy logic model logic: Executes additional logic of the fuzzy logic model, such as replacing random input values and measuring the output of the model.
    23. Implement Monte Carlo simulation: Monte Carlo simulation actions are performed, with additional actions of fuzzy logic analytics for each event. This allows observing how different combinations of events affect the results of the model.
    24. Create result lists and store information: Result lists/arrays are created and stored to be used in further analysis or visualization.

3. Different scenarios of Monte Carlo simulations. Expanded Monte Carlo simulation in which the performance of the model is evaluated in different scenarios. Scenarios include optimistic (80% of normal duration), realistic, and pessimistic (120% of normal duration) scenarios. For each scenario, a separate histogram and a list of results are created.

   31. Optimistic, realistic, and pessimistic scenarios were created. Three different scenarios are created that can reflect optimistic, realistic, and pessimistic system operation options.
   32. Perform relevant Monte Carlo simulations. For each scenario, corresponding Monte Carlo simulations are performed that allow different results to be obtained according to different scenarios of assumptions. Each scenario is based on a different duration.

4. Data saving. The obtained simulation results, sensitivity analysis data, and other important parameters are saved in the corresponding files. This allows the organization to have documentation and the ability to conduct retrospective analyses.

   41. Store results and information. The results and information are saved in the corresponding files.

5. Graph mapping

   51. Create charts. Diagrams are created to represent the results of sensitivity analysis and Monte Carlo simulation. This helps to visually assess the performance of the model and the distribution of results.
   52. Save in image files. Save the created graphs in image files to easily share and present the results to the employees of the organization.

Each of the steps in the process of applying the model is important to understand how an organization can adapt to different conditions and how the decision-making process can change.

Summing up the results, we can say that it was possible to apply the reflex arc in the processes of the organization and form a model that explains how the information transmitted from the global environment to the organization becomes the organization's competitive response to the global environment.

Research design: participants and procedure

The strategic combination of selected methods. Theoretical modeling and computer simulation were chosen to achieve the goal of the study.

Theoretical modeling was carried out using the following methods: (1) the model of the global environment communication system with the organization was chosen as the analogy method, and the human nervous system anatomy model was chosen as the basis of comparison; (2) the method of comparison is chosen for the purpose of knowing the relationship between objects because comparison is understood as a thinking operation and is related to analysis and synthesis operations. When comparing, the object is divided into parts, their peculiarities are distinguished. Their juxtaposition implies the association of elements. The change of gradually deepening analysis and synthesis allows for revealing the relations of identity and similarity of objects through comparison. During the comparison, the essential elements of the nervous system: sensors, effectors, spinal nerves, and the brain as a system are extrapolated into the model of the global environment. As a result of this extrapolation, a model of the global environment was created, where the receptor and effector implement the competitive response of the organization, which acts as a receiver and transmitter of signals from the global environment. The functioning of the spinal cord is described as a routine process, while the brain describes the data processing and decisions taken in the organization and the response signal sent to the global environment; (3) deduction is chosen because new knowledge, and conclusions are obtained from more general knowledge, statements. Deductive reasoning assumes that the organization acts as a reflex arc, this conclusion corresponds to the assumption; (4) extrapolation allows observing one part of the phenomenon, expanding the other part of it, to predict the course of events, while transferring the resulting conclusions to the organization.

Computer simulation performed by using methods: (1) fuzzy logic chosen because it allows the processing of the uncertainty of the situation, useful for interpreting the model in the organization and explaining decision-making to stakeholders; (2) sensitivity analysis selected to assess the sensitivity of the model to various values of the input parameters. Sensitivity analysis is performed by observing how changing input parameters affect "Time" values; (3) the method of Monte Carlo simulations is chosen because it allows to generation of various scenarios, changing the input parameters each time. It reflects the organization's decision-making in different situations; (4) Monte Carlo simulation with scenarios is chosen where the performance of the model is evaluated in different scenarios. Scenarios include optimistic (80% of normal duration), realistic, and pessimistic (120% of normal duration) scenarios.

Theoretical modeling techniques have revealed relationships between the organization and various systems, and computer simulation has made it possible to examine these relationships in different situations.

The methods of analogy, comparison, deduction, and extrapolation were used to develop a theoretical model, taking into account the model of the anatomy of the nervous system. This helped to create an abstract structure that was applied to the model of organization, and deductive reasoning allowed deriving new knowledge from more general statements.

Computer simulation included fuzzy logic, which is perfect for processing uncertainty in the organizational model, especially in decision-making situations. Sensitivity analysis helped to estimate the sensitivity of the model to various values of the input parameters, while Monte Carlo simulation with scenarios made it possible to take into account various situations and predict the functioning of the organization in different conditions.

All these methods were combined to create a more complete and accurate model of the organization and to understand how different factors can affect its performance. Theoretical modeling methods and computer simulation complemented each other for a deeper understanding of decision-making in an organization.

Reason for choosing fuzzy logic. Fuzzy logic is a mathematical concept that allows for the inclusion of uncertainty and subjectivity in decision-making models (Marín Díaz and Carrasco González, 2023). The model uses model data describing uncertain situations and their multiple evaluations simultaneously. Input (Neighbors and Symmetry) and output (Time) parameters are modeled on the basis of fuzzyfication. The created rules define the relationship between the input parameters and the output result. Depending on the values of Neighbors and Symmetry the decision system decides whether Time should be small, medium, or high. A fuzzy logic control system was created, which includes fuzzy logic rules, which allow for more flexible adaptation of the model to the needs of the organization, so it is possible to experiment with different rules and observe how they change decision-making.

Sample size selection motive. Monte Carlo simulation is a statistical methodology often used in model analysis and verification, used to analyze systems or model uncertainty. Generating a sample using the Monte Carlo method (Mondal and Mandal, 2020) can provide a variety of results that help understand the model's performance and sensitivity to various variables, help assess the model's reliability, and reveal potential weaknesses. By generating a sample, it is possible to measure how well the model works in various situations. It is an important tool for the analysis of complex systems and the decision-making process. Small sample size for Monte Carlo simulation, will affect the uncertainty of the data, can increase the variance of the results, and make them more sensitive to random event fluctuations. A higher sensitivity to change due to a smaller sample model will have a higher sensitivity, therefore each random event will have a greater impact on the results, and we will have a greater fluctuation between different simulations. Monte Carlo simulation is a stochastic process, therefore, executing it with one size, we get one result, and the next time, with another size, we get different results. The stochasticity property of the Monte Carlo simulation makes it possible to evaluate the performance of the model in various situations, so a sample size of 10000 was chosen since a larger data set can help reduce the influence of random effects.

Description of fuzzy logic rules. It should be noted that the computer simulation of real processes is accurate enough. According to Valiulis (2005), fuzzy logic is currently more and more widely used for the management of dynamic processes due to the nonlinearity of their systems and the volatility of parameters. Fuzzy logic was chosen to describe the power of fuzzy logic principles to generate complex behavior from a compact, intuitive set of expert rules by applying semantic variable selection according to established rules (Mendel, 1995; Kacprzyk and Pedrycz 2015).

A fuzzy set is an extended classical set. If X is an input space, and x—is the elements of that space, then fuzzy set A in space X:

$$A = \{x, \mu_A(x) | x \in X\} \quad (1)$$

where μ_A—a function of the dependence of x on the set A (Fig. 3).

This triangle would be useful when we define the fuzzy relationship between information segments of the input (g) and output (p). Below we present three rules: (see Tables 1–3).

The design of a fuzzy logic control system begins by defining the input information from (g) (Figs. 4–6).

Rule 1:

If the information meets the condition *high fitness*, this information is complete and unconditionally suitable for use.

Rule 2:

If information meets the condition *suitable*, and information position meets the condition *no information*, then the information is created using 7 of each information segment from both right and left, and thus we get the information to solve a specific issue.

This rule was applied for the most accurate information for the creation of new information.

Rule 3:

If information meets the condition *high fitness*, and the information processing time is (76 to 100) seconds, *then* the information is complete and unconditionally suitable for use.

Formulating the correct answer in less time indicates the effectiveness of the organization.

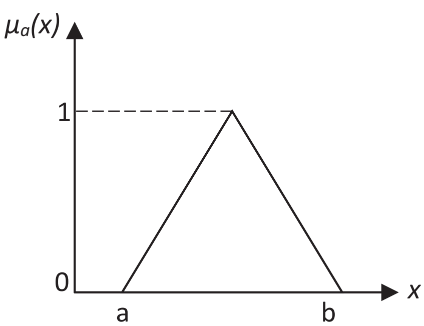

Fig. 3 Dependency function for set A.

Table 1 Rules of fuzzy logic control system (information in relation to *neighbors*).

Neighbors	Left	Center	Right
Information	**0 ÷ 7**	**8 ÷ 22**	**23 ÷ 30**
Low fitness	Yes	No	No
Mediocrely appropriate	No	Yes	No
High fitness	No	No	Yes

Table 2 Rules of fuzzy logic control system (with respect to information *symmetry*).

Symmetry	Left	Center	Right
Information	**−15 ÷ −8**	**−7 ÷ 7**	**8 ÷ 15**
Invalid (left)	Yes	No	No
Suitable	No	Yes	No
Invalid (right)	No	No	Yes

Table 3 Rules of fuzzy logic control system (*time-based* information).

Time	Left	Center	Right
Information	**−0 ÷ 25**	**26 ÷ 75**	**76 ÷ 100**
Low fitness	Yes	No	No
Moderate suitability	No	Yes	No
High fitness	No	No	Yes

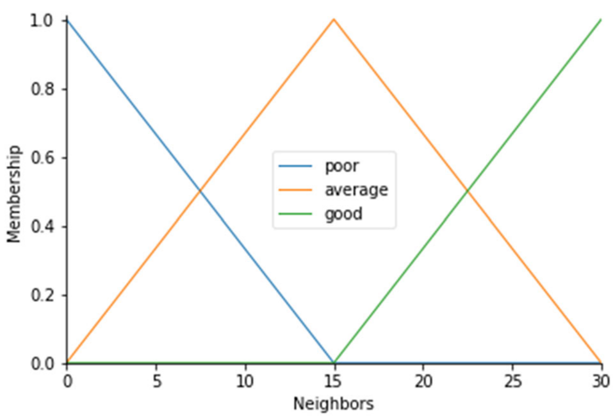

Fig. 4 Fuzzy logic system definitions. The figure illustrates the defined fuzzy logic system with antecedents (Neighbors and Symmetry) and the consequent (Time). Each linguistic variable is divided into membership functions, and the rules for the system are represented. Membership functions for 'Neighbors' with three categories: 'poor,' 'average,' and 'good'.

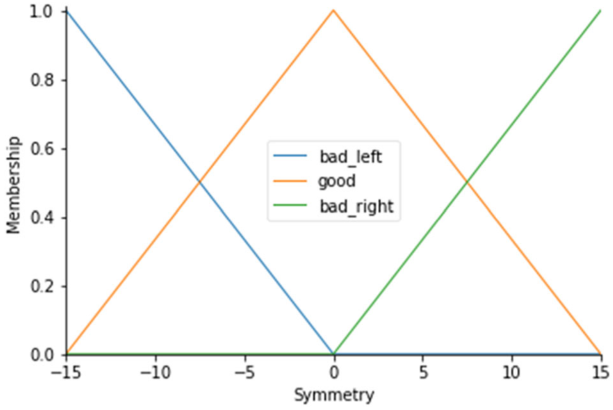

Fig. 5 Fuzzy logic system definitions. The figure illustrates the defined fuzzy logic system with antecedents (Neighbors and Symmetry) and the consequent (Time). Each linguistic variable is divided into membership functions, and the rules for the system are represented. Membership functions for 'Symmetry' with categories: 'bad_left,' 'good,' and 'bad_right'.

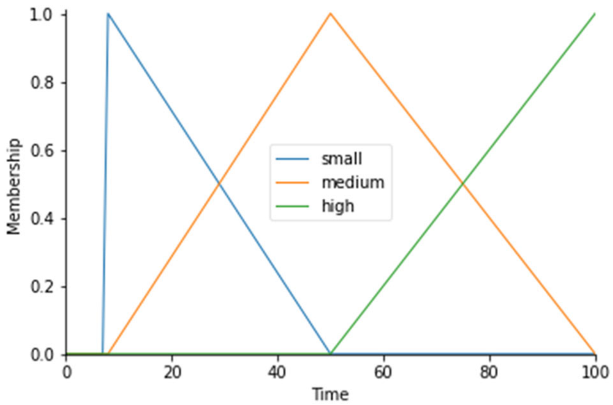

Fig. 6 Fuzzy logic system definitions. The figure illustrates the defined fuzzy logic system with antecedents (Neighbors and Symmetry) and the consequent (Time). Each linguistic variable is divided into membership functions, and the rules for the system are represented. Membership functions for 'Time' with categories: 'small,' 'medium,' and 'high'.

The developed research methodology made it possible to discover the phenomenon of the global environment communication system with the organization, which replicates the model of the anatomy of the human nervous system. In addition, this methodology made it possible to describe the principles of functioning of this phenomenon based on empirical data and theoretical modeling.

The practical applicability of the developed model is checked by computer simulation. To carry out the study, a computer simulator was created to check the operation of the compiled model using Anaconda Distribution program packages and concepts according to the structural scheme (see Fig. 2).

Data analysis and results

Results of the model's computer simulation. After performing a computer simulation in order to determine the performance of the created model, the obtained results are presented in Figs. 7–9 (see Fig. 7–9). In a simulated flow of information from the global environment, 10,000 different segments of information are sent. During the computer simulation, the reaction of the created model is observed, which is presented as a graphic expression in separate stages.

Figure 7 indicates that during the initial information processing, the system (IS) recognized 10000 segments of various information from the incoming information from (g) according to the available information. According to the available information, from the accepted 10000 information segments, the system

variant (a): separated 8000 information segments as not currently in the organization's interest, and 2000 information segments passed (IS) stage and entered the information management system (RP), whose function is to redistribute information from (IS) (see Fig. 7a).

variant (b): separated 9000 information segments as not currently in the organization's interest, and 1000 information segments passed (IS) stage and entered the information management system (RP), whose function is to redistribute information from (IS) (see. Fig. 7b).

This system helps the flow of collected information to become more sustainable and more accurate in the interests of the organization.

The graph shows how the model-sorting system (RP) is triggered, based on available internal information from selected

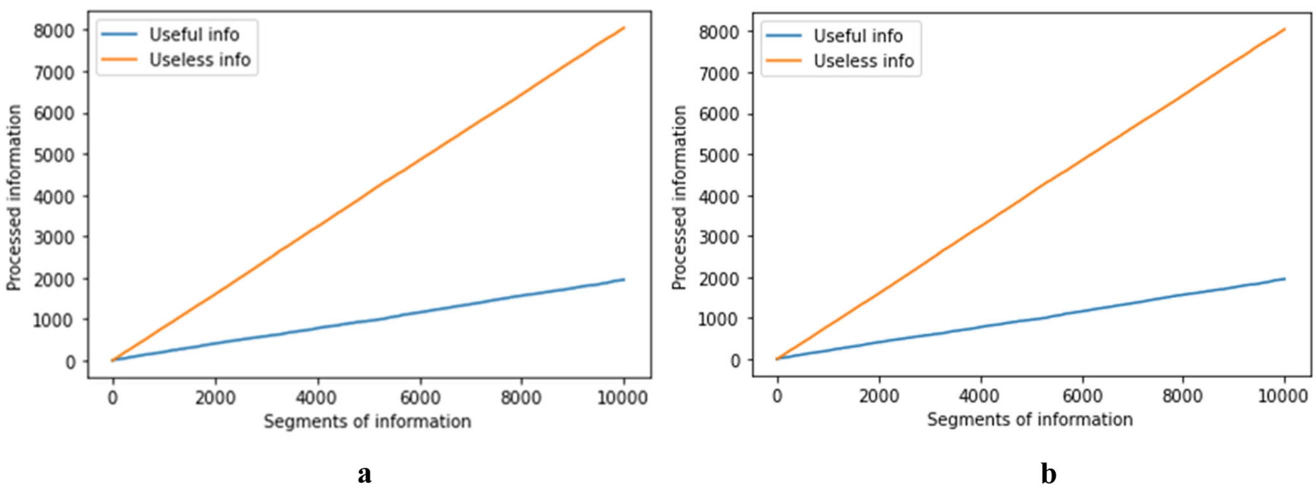

Fig. 7 The primary result of (IS) processing of received information. a The spectrum of the organization's interests is planned during the simulation. **b** The spectrum of the organization's interests is reduced, and the model restarted.

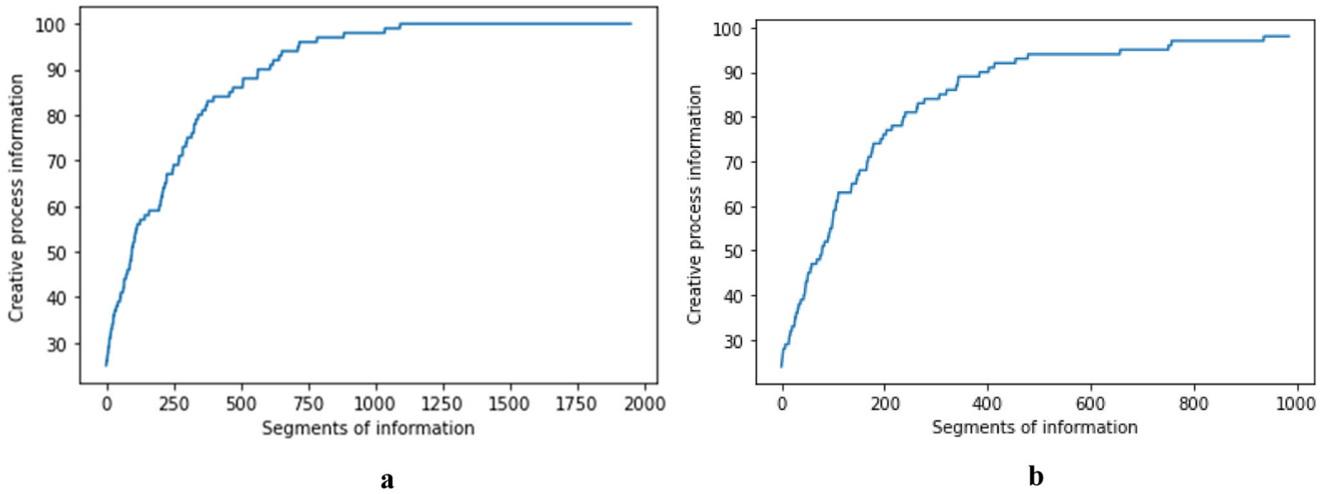

Fig. 8 Information management system's (RP) sorting information segments. a The spectrum of the organization's interests is planned during the simulation. **b** The spectrum of the organization's interests is reduced, and the model restarted.

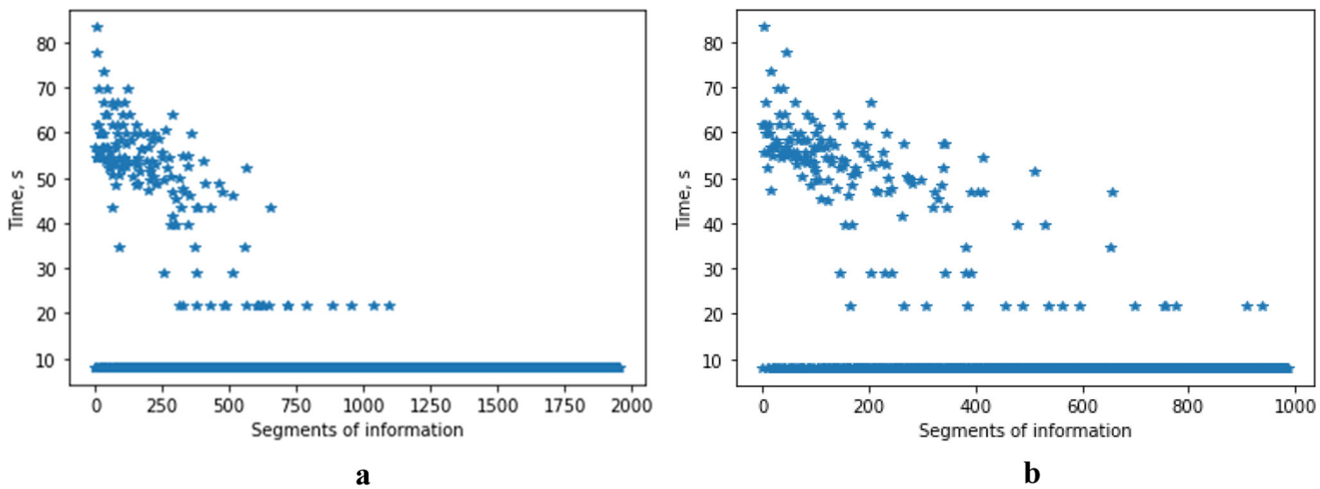

Fig. 9 Result of high-speed management of received segmental information in the case of routine response and creative response. a The spectrum of the organization's interests is planned during the simulation. **b** The spectrum of the organization's interests is reduced, and the model is restarted.

variant a: of the 2000 information segments extracted by (IS) the control system (RP) found 1900 cases suitable for a routine response, and 100 cases for a creative one, that is, the model did not have an answer of its own (OD), they were created artificially on the platform (CP) based on the available information (see Fig. 8a).

variant b: of the 1000 information segments extracted by (IS), the control system (RP) found 900 cases suitable for a routine response, and 100 cases for a creative one, that is, the model did not have an answer to its own (OD), they were created artificially on the (CP) platform based on the available information (see Fig. 8b).

The formation of the response of the computer simulation of the model in the *routine* and in the *creative* case is presented in Fig. 9 (see Fig. 9a, b), where the time spent by the information management system in responding to the information received from (IS) is shown. A routine response to a segment of information from IS is generated in the case when the response (pattern) information management system finds (OD). In this case, the response time to information from (IS) is fixed in all cases within 8 sec during computer simulation. The creative response to the information segment from the (IS) is generated in the case when the control system does not find the information for the response (OD). In this case, the information management system automatically transfers the process to (CP), which creates a response variant based on the information available to (OD). The creative response time is fixed in a time interval from 22 to 87 s. The time interval for the creation of a new response depends on the characteristics of the available (OD) information segments, which are mentioned earlier (used for the creative response). The repeated information segment to which the creative response was given sometimes is generated as a routine response to the information received.

The model uses fuzzy logic, which, according to the established rules, forms a response using the database of the organization. The response time interval of 22s–87s in this case depends on the complexity of the information received, the information available in the organization's database, and established response formation rules.

Sensitivity analysis for identification of determining factors. Sensitivity analysis is an important step in assessing the sensitivity of a system to various values of input parameters, taking into account randomly selected input values. By changing these values,

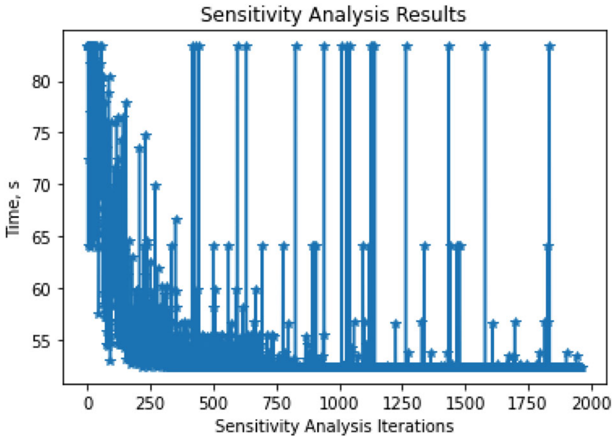

Fig. 10 Sensitivity analysis results. This figure presents the results of sensitivity analysis iterations, highlighting the responsiveness of the fuzzy logic system to variations in input parameters. Each point represents an iteration, reflecting changes in the system's output (Time).

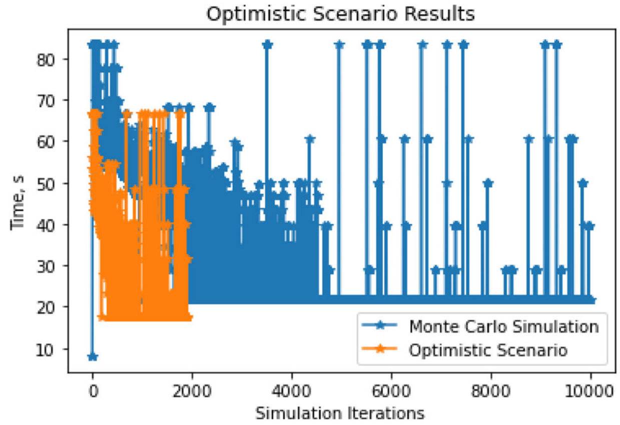

Fig. 12 Optimistic scenario results. This figure illustrates the results of Monte Carlo simulations conducted under an optimistic scenario. Each data point represents a simulation iteration, showing the Time values over the course of the simulation.

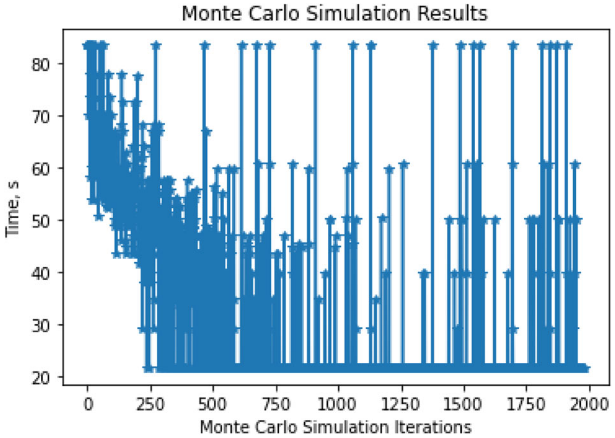

Fig. 11 Monte Carlo simulation results. The figure showcases the outcomes of Monte Carlo simulations, providing an overview of the distribution and variation in Time values across simulation iterations.

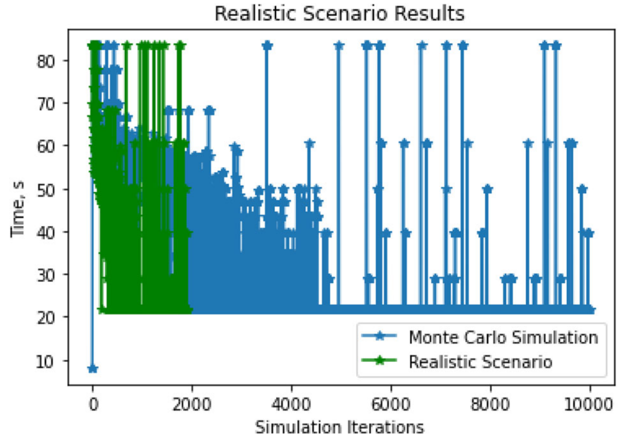

Fig. 13 Realistic scenario results. The figure displays Monte Carlo simulation results for a realistic scenario. Each data point represents a simulation iteration, illustrating the Time values and their variation throughout the simulation.

it is observed how it affects "Time" variable, which is the main parameter in the analyzed system. The results of the sensitivity analysis presented in the figure (see Fig. 10) allow a visual assessment of which input parameters have the greatest influence on the behavior of the system. Each point represents the result of a single iteration of sensitivity analysis, allowing us to see how time changes depending on different input scenarios. This provides a more detailed understanding of how changing factors can affect decision-making within an organization, and in particular, how these factors can influence the values of "Time".

Monte Carlo simulation. Monte Carlo simulation is performed with random input values. These values are used to execute the model and accumulate results. Monte Carlo simulation, the purpose of which is to estimate the operational time of the organization under different conditions. Different input values (such as Neighbors and Symmetry) affect the operating time of the organization Time. By identifying critical factors, strategies can be formulated to manage and adapt to these factors more optimally in the decision-making process. In this case, only selected information that corresponds to the interests of the organization is of interest (see Fig. 11).

Monte Carlo simulation in decision-making scenarios. Monte Carlo simulation results are presented in Figs. 12–14, where different simulation scenarios reflect organizational dynamics and influence on organizational behavior.

The (X) axis contains the simulation iterations covering the entire volume of input information (g), and the (Y) axis contains the time. The points correspond to the result of each iteration of the simulation. It allows seeing how the system works in different scenarios, that is optimistic, realist, and pessimistic scenarios, which are generated only in a spectrum of selected information (that is, information that is in the interests of the organization).

The results can be useful for decision-making in the organization. They can be interpreted as follows.

Optimistic scenario: the shortest time, it can indicate what the duration of the system can be if all the conditions for making a decision are favorable. This scenario demonstrates a situation in which the time for decision-making activities is shorter by 20% than the duration of the compiled model. This could mean that the system works better than expected and is quite efficient. The organization can use this information to plan resources or optimize processes. It can also provide an opportunity to exploit existing opportunities and resources more efficiently.

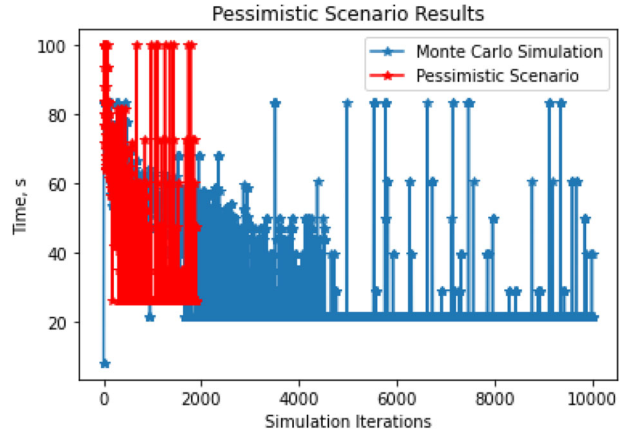

Fig. 14 Pessimistic scenario results. This figure presents the outcomes of Monte Carlo simulations under a pessimistic scenario. Each data point reflects the Time values over simulation iterations, highlighting the impact of pessimistic conditions on the system's performance.

Realistic scenario: the time shows a scenario of possible reality based on established rules and logic. The realistic scenario should reflect the operational time of the compiled model as calculated by Monte Carlo simulation. This is the main forecast that the organization can use to plan its activities. This scenario is based on Monte Carlo simulation outputs and reflects the expected duration of system activity.

Pessimistic scenario: the longer duration, possible risks, or unforeseen difficulties in decision-making can be envisioned. The pessimistic scenario is longer by 20% than the usual duration, this scenario reflects a situation in which the activity takes longer than usual. It can be interpreted as a reserve designed to take into account unpredictable problems or risks. The organization can use this scenario as a protection against unexpected interference or as a precautionary measure.

The final decision depends on the organization's goals, strategy, and risk tolerance. It is necessary to take into account how these scenarios can affect the ability of the organization to operate under different conditions and how they can be integrated into the decision-making process. When comparing a realistic (Monte Carlo) scenario and the one simulated with (fuzzy logic), they coincide.

It can be stated that the compiled model has positivity. This suggests that the model is capable of realistically replicating the behavior of the system in terms of random input values. This compatibility between a realistic situation and a simulated situation may indicate that the use of fuzzy logic is appropriate and effective in reflecting the dynamics of the system. This is a positive result since models that fit well into the real situation in the organization can be useful for decision-making and predictive of the situation. This allows expectations that the model can be a reliable tool for analyzing or planning real-world situations in an organization.

Discussion and conclusion

The main research results include the use of theoretical modeling and computer simulation to understand organizational decision-making. To achieve this aim, this simulation can be applied to the analogy of the global environmental communication system and organization, based on the human nervous system anatomy model. The review aims to explain how theoretical modeling techniques and computer simulations can interact to gain a deeper understanding of organizational decision-making. Analyzing how different modeling methods were combined and how they contributed to the development of a detailed organizational model highlighted how fuzzy logic and Monte Carlo simulation were applied to study organizational behavior in different scenarios. These results can be applied to real-world situations and their application is meaningful to organizations. Büyüközkan and Feyzıoğlu, (2004) research develops and applies ideas related to decision-making in organizational hierarchies and specifically in the field of New Product Development in order to improve the accuracy of decision-making under conditions of uncertainty.

In this research study, using fuzzy logic and Monte Carlo simulation, a model framework was developed for the analysis of organizational behavior and decision-making. An important contribution is the fuzzy Logic Model, where the structure of the model is created to evaluate yours, taking into account variables such as Neighborhood interaction, Symmetry, and Time, and Monte Carlo Simulation realized simulation that allows you to observe the scenarios caused by the organization's struggle and the factors caused by the factors, giving a realistic picture of the possible results. An analysis was carried out in which the variables with the greatest sensitive effect on the results were identified. This helps the organization to better understand the determinants and make informed decisions. For Future Research Suggestions are made for further research areas such as dynamic behavior modeling, uncertainty tolerance, and individual behavior modeling. Practical Implications It shows how organizations can apply these insights in areas such as decision-making, efficiency, driving innovation, human resource management, risk management, and energy conservation. Limitations such as data volume and model complexity are acknowledged and strategies to address study limitations in future research are suggested. The research results can serve as a basis for further research or practical implementation in the activities of organizations.

In the context of our organizational model, reflexes play a crucial role in shaping responses to various stimuli. Timely decision-making: the organizational reflex arc facilitates quick responses to external changes. Example: in a rapidly changing market, the reflexive response mechanism allows the organization to adapt swiftly to emerging trends, ensuring timely decision-making in product development or strategy adjustments. Innovation and creative solutions: creative reflex responses are triggered in situations where routine responses may not suffice. Example: faced with a unique challenge, the organization's reflexive creative response mechanism encourages innovative problem-solving. This could involve brainstorming sessions or cross-functional collaborations to generate novel solutions.

In the context of organizational model, reflexes play a crucial role in shaping responses to various stimuli. Timely decision-making: the organizational reflex arc facilitates quick responses to external changes. Example: in a rapidly changing market, the reflexive response mechanism allows the organization to adapt swiftly to emerging trends, ensuring timely decision-making in product development or strategy adjustments.

The organizational model introduces a paradigm shift in the field of organizational management and decision-making by seamlessly integrating theoretical modeling with advanced computer simulation techniques. Unlike conventional methods, our approach draws inspiration from the intricate workings of the human nervous system, employing analogies, comparisons, and deductions to create a robust theoretical foundation. The innovative use of fuzzy logic in the model further distinguishes it from traditional decision-making frameworks. Fuzzy logic allows us to navigate the inherent uncertainty in organizational environments, providing a more adaptable and flexible system. By incorporating fuzzy logic, our model excels in processing complex and dynamic situations, offering a nuanced understanding of decision-making under uncertainty. Additionally, the integration of Monte Carlo simulation with scenario analysis enhances the predictive capabilities of our model. This combination allows us to explore a spectrum of potential outcomes, providing organizations with valuable insights into their operational dynamics across various scenarios.

Extending the practical implications of the findings, we note, that the organization can apply the model to improve decision-making, efficiency, and innovation promotion, e.g.: (1) the financial sector organization can use the results of the model to improve investment decision-making. By including variables related to risk and profit, the organization can optimize its portfolio and increase return on investment, and (2) the manufacturing company can use model forecasts for employee efficiency, taking into account variables such as employee interaction and working time distribution. By applying these insights, the organization can optimize work processes and reduce production time, and (3) the technology sector company can use model forecasts for the development time of new products, taking into account variables such as innovation history and employee engagement. These insights can help the organization plan for new product development more effectively.

By exploring the application of the model to specific industries, a deeper and more consistent understanding of organizational behavior and decision-making can be obtained, and the use of innovative technologies such as artificial intelligence or machine learning could better predict organizational behavior, and the integration of new modeling tools would allow organizations to adopt more effectively decisions based on rules and behavior.

This research provides a new perspective for understanding organizational behavior, complementing and expanding this field (Vaitkevicius et al., 2023).

Recognizing the limitations of the study, including the quantity and quality of the data and the complexity of the model, we understand that further research in this area should be carried out with greater attention to data collection and its quality in order to create a reliable and accurate model. It is also important to assess the complexity of the model and the possibility of applying it in practice. As the model continues to improve, new variables or specific scenarios can be added to improve its accuracy by reflecting the real context of the organization.

To eliminate the limitations of strategies in future research, it is proposed to constantly collect new data and update the model, follow strict model versioning practices, consult with experts in the field, involve their opinion in the development and improvement of the model, and regularly check the accuracy of the model with new data through detailed inspections.

It is important to understand that the variant of routine response and creative response in the organization is a critical factor, because each of them has its own unique advantages and influences on the success and adaptation of the organization, because they are responsible for the competitive response and decision-making in time, because they have the ability to form a response to signals coming from outside (Papšienė and Vaitkevičius, 2015; Vaitkevicius et al., 2021, 2023).

Using fuzzy logic and Monte Carlo simulation in this study, the model structure developed allowed evaluation of the behavior of the organization and prediction outcomes in different scenarios. Sensitivity analysis identified critical factors that may have the greatest impact on the functioning of the organization. The results of the study gave the organization a realistic view of possible scenarios and helped make better-informed decisions. Further research is recommended to explore aspects of dynamic behavior modeling, uncertainty tolerance, and individual behavior modeling to improve the accuracy and applicability of the model in the organizational context.

Computer simulation indicated the ability of the model to receive information from the global environment, select the necessary information according to pre-known parameters, and perform certain responses. The model can create and store new information, enriching the organization's experiential database. Initial information processing identified 10000 information segments of which: in the first case (see Fig. 9a.) 80% was rejected as useless information for the organization, and 20% was significant. Performed 95% of routine responses (i.e., unconditioned reflex) to receive information from the global environment and 5% of creative responses (i.e., conditioned reflex) and supplemented the organization's experiential database, and, in the second case (see Fig. 9b) 90% was rejected as useless information for the organization, and 10% was significant. Performed 90% of routine responses (i.e., unconditioned reflex) to the information received from the global environment and 10% of creative responses (i.e., conditioned reflex) and supplemented the organization's experiential database.

Comparing realistic scenario results (Monte Carlo) and (fuzzy logic) information processing was the same in the case of creative response 22–87 s and 8 s in the case of routine response. In addition, a computer simulation indicated that routine response time efficiency is more efficient than creative response from 63.6 to 90.7%.

Simulated performance scenarios (see Figs. 12–14.) indicate the model's work prospects. In the graphs presented, it can be seen that in a realistic scenario efficiency is ~21% worse than in an optimistic scenario, this may mean that an optimistic scenario in which input variables are chosen to be more favorable is not a likely situation in the context of the organization. But a realistic scenario is more effective by ~17% than a pessimistic scenario, this can be a positive message because the organization that prepared the realistic scenario works better than predicted in the pessimistic scenario. This result may indicate that the organization is capable of adapting to challenges and operating effectively, even under adverse conditions.

The study indicated that the model can be successfully applied in the organization for the effectiveness of decision-making because the organization can use the results of the model in the decision-making process, which is valuable for forming a routine and creative response.

Data availability

The datasets analyzed during the current study are available in the Dataverse repository: https://doi.org/10.7910/DVN/DBEAFH.

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Author contributions

The author is solely responsible for conducting the research, analyzing the data, writing the manuscript, and all other tasks.

Competing interests

The author declares no competing interests.

Ethical approval

Ethical approval was not required as the study did not involve human participants.

Informed consent

This article does not contain any studies with human participants performed by the author.

Additional information

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