ISSN 1392 – 2785 ***Inzinerine Ekonomika-Engineering Economics*(5). 2009**
ECONOMICS OF ENGINEERING DECISIONS

Constructing Abstract (Theoretical) Models of Actual (Material) Systems

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The world around us is a global system, therefore, it can be said that all its elements are interconnected. The strength of the connections between the system's elements and their groups is not uniform. In some cases, we can observe the links very clearly, in other cases, we assume that they exist, while, sometimes, we are not even aware of their existence. The existence of the connections of various strength shows that the particular elements are of different nature and possess some specific features and capacity allowing them to interact with others and form the particular structures when the same goal is pursued. These structures differ from others and make the systems of a particular level. Therefore, the elements relevant for the considered problem should be identified (or formed if an artificial system is considered). In other words, we should identify or form a system for solving an arising problem.

Another important aspect of investigating an existing or specially formed system is associated with its reflection. To change or to manage a social economic system, for example, the state of an enterprise should be measured. This may be achieved only if all major aspects of its performance are described by the particular criteria. The values of the criteria allow us to plan the measures to be taken for improving enterprise performance.

The analysis of the literature shows that we can hardly find a generally accepted concept and definition of the word 'system'. However, a lot of various definitions are suggested. This may be explained by the fact that either various features of the system are emphasized, or not all relevant features are considered. In some cases, a definition includes too many features, often duplicating each other. Some researchers base themselves on a very wide 'system's' definition, while others prefer a short one, embracing its essential features. Various approaches depend on the research objective, 'system's' perception, and, finally, the researcher's ability to see the essential features and understand the nature of the considered phenomenon. In terms of the research objective, investigators usually search for a versatile 'system's' definition, while others prefer a short one, embracing its essential features. Various approaches depend on the research objective, 'system's' perception, and, finally, on the researcher's ability to see the essential features and understand the nature of the considered phenomenon. In terms of the research objective, investigators usually search for a versatile system's definition suitable for studying any phenomenon at any investigation level. However, they also may try to find a multifunctional approach, giving the priority to general features of the system, rather than to its basic, principal characteristics, thereby restricting themselves to a 'narrow' definition suitable for solving a particular problem and achieving a particular goal. The latter approach makes sense only if it does not contradict a universal system's concept and definition. This means that a universal concept and definition of the word 'system', which could be used as a basis for possible interpretations should be developed. The analysis of the available 'system's' definitions allows us to suggest the following basic definition – a system is the structured whole of interacting elements.

A basic category of the theory of systems is structure, which marks the beginning of system's stabilization. However, we can see that a generally accepted definition of the concept 'structure' is also lacking. On the other hand, all definitions emphasize the same, probably, most essential, structure's feature – the connections between the elements. In addition, the existence of the system and structure representing it is closely connected to the aim (purpose) of the system. It is the structure that orients the system to pursuing a particular aim. In mathematical terms, the establishing of invariable relations between the elements is necessary but insufficient for system formation. These relations should be properly directed, i.e. oriented to achieving the system's aim. This may be obtained only by establishing hierarchical relations between the interacting elements, i.e. by structuring the elements according to the type of their subordination. It is the process of structuring of a set of interacting elements that gives them a particular orientation and turns them into a system. The analysis of various 'structure's' definitions allows us to define it as a whole of constant relations between the elements oriented to achieving the system's aim.

Now, when the concepts of system and structure are clear, it is possible to investigate them. Classification, i.e. their subdivision into separate groups, is an efficient tool in this process. The analysis of the literature on the problem shows that, in various system's classifications, various attributes are considered. For the case investigated in the present paper, system's classification into actual (material) and theoretical (abstract) systems is relevant. The first class embraces the systems of organic and inorganic nature, while the second includes hypotheses, theories, formalized models, etc. In fact, the latter may be deduced from the former. Therefore, they are aimed at reflecting actual (material) systems. Thus, it may be stated that theoretical (abstract) systems are the models of actual (material) systems.

The following steps may be identified in the process of reflecting actual (material) systems by theoretical (abstract) models. First, the problem situation associated with the actual (material) system is described, then, the problem and the aim of its solution are stated. The existence of the reflected system's problem situation, the problem and the aim of its solution determine the problem situation, the problem and the aim of the reflecting model.

Keywords: *systems, socio-economic systems, definition of a system, definition of a structure, classification of systems, actual (material) and theoretical (abstract) systems*.

Introduction

In many investigations, systems are considered from various perspectives, therefore, the question arises: what is the purpose of the system's study? The answer may be given if we know what is reflected by a particular system. When a social system is considered, it reflects groups of interacting people, i.e. families, enterprise staff members, religious communities, political parties, etc. Socio-economic systems reflect a certain amount of materials, mechanisms, information or other resources integrated into a social system (Ginevicius, 2009; Zavadskas, Turskis, 2008; Brauers *et al*, 2007; Burinskiene, 2009; Sarka *et al*, 2008; Siskina *et al*, 2009). They also embrace all organizations, various forms of economic, financial, quality management, sets of rules, beliefs, positions, evaluation and behaviour, directly or indirectly influencing economic performance and results (Zukovskis, 2007; Vanagas, Vilkas, 2008; Ruzevicius, 2000; Marsan, 2009; Nobre, Ferreira, 2009; Makstutiene, 2008). According to their nature, all these systems are dynamic, implying that they are constantly changing (improving) their state. Therefore, their definition and study are aimed at searching for the possibilities of managing (controlling) these processes.

The world around us is a global system, therefore, it can be said that all its elements are connected. The strength of the connections between the system's elements and their groups is not uniform. In some cases, we can observe the links very clearly, in other cases, we assume that they exist, while, in some other cases, we are not even aware of their existence. The existence of the connections of various strength shows that particular elements are of different nature and possess some specific features and capacity allowing them to interact with others and form the particular structures when the same goal is pursued. These structures differ from others and make the systems of a particular level. Therefore, the elements relevant for the considered problem should be identified (or formed if an artificial system is considered). In other words, we should identify or form a system for solving an arising problem.

Another important aspect of investigating the objectively existing or artificially created system is associated with its reflection. In order to be able to change, i.e. to control (or manage) the performance (state) of a socio-economic system, e.g. an enterprise, it should be measured. This may be achieved only if all major aspects of its performance are described by the particular criteria. The values of the criteria allow us to plan the measures to be taken for improving enterprise performance.

The process of getting knowledge about a system for the purpose of controlling (managing) is presented in Figure 1.

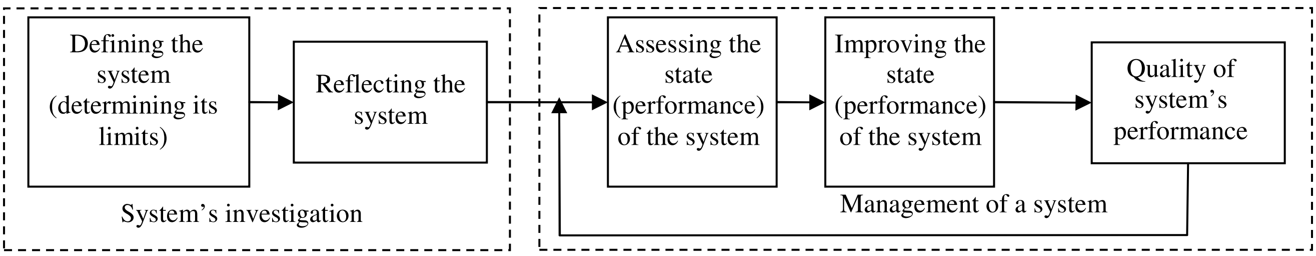

Figure 1. Getting knowledge about the system required for its management

As shown in Fig 1, one of the major conditions of achieving effective system's management control, is getting more knowledge about it, and reflecting the existing (natural) and artificial systems. Therefore, the aim of the present paper is to provide a universal system's definition and to demonstrate how a real (material) system may be described by a theoretical (abstract) model for quantitative evaluation of its state.

To achieve this aim, we should fulfill the following tasks:

1. To analyse the concept of the system.
2. To analyse the available definitions of the system's concept.
3. To offer a generalized definition of the system's concept.
4. To analyse the available definitions of the structure's concept.
5. To offer a generalized definition of the structure's concept.
6. To analyse the classification of systems.
7. To determine the relationship between the real (material) and theoretical (abstract) systems.
8. To offer a theoretical (abstract) model describing a real (material) system for quantitative evaluation of its state.

To solve the above problems, a comparative analysis and systematization methods are used.

The concept and definition of the term 'system'

The world around us is getting more complicated, dynamic and overburden with information. In this environment, it is difficult to take proper decisions. Efforts were being made both in research and practice to simplify the reflection of the reality and complex problem solution. To achieve this, systems theory, allowing system approaches to be applied to the analysis of complex structures, phenomena, processes, problems, etc., may be used. This theory takes into account interrelations between the constituent parts of an object (Martin 2008; Mulej 2007; Bailey 2006; Troncale 2006; Samuelson 2006; Rapoport 1978; Mlakar, Mulej 2008; Schwaninger 2007). The research based on the above principles is being conducted in many fields of science and practical application, however, tools and methods of analysis that would be generally accepted have not been developed yet.

Not only the development of methods of system's analysis presents a problem, but the very concept of the term 'system' has not been defined yet (Staciokas, Rimas, 2004). It is stated that the proper definition of this term cannot be found in the literature.

Therefore, a definition of the term 'system' is the essential problem in the systems theory. As mentioned above, a generally accepted concept and definition of the term 'system' cannot be found in the literature. It is usually described in terms of 'element', 'relation' or 'interaction', 'the whole', 'structure', 'aim', 'environment', 'order', 'arrangement', etc. (Table 1).

Table 1

Definitions of the concept of 'system'

No	Definition	Author
1.	A system is a set of interacting elements.	Bertalanffy. 1968
2.	A system is a regular arrangement of its components as well as principles, making the basis of a particular science, the whole of the components of the systems with a common function and a form of social elements.	Dictionary of modern Lithuanian language, 1972
3.	A system is the whole of interacting elements arranged in the appropriate order, which, as the integral whole, possess the properties, not found in separate elements.	Kravchenko, Skripka, 1974
4.	A system is a set of elements connected with each other and making an integral whole.	Plečkaitis, 1975
5.	A system is an object made of at least two or, in practice, much more interrelated constituent parts (elements). The elements of the same location, which are not connected with each other with the same type of relation do not make the system.	Jasinavicius, 1981
6.	A system is a means of achieving a particular goal.	Peregrudov, Tarasenko, 1989
7.	A system is the whole of interrelated elements separated from the surrounding world and interacting with it as a unit.	Peregrudov, Tarasenko, 1989
8.	A system is a regular arrangement, organization or connection of the phenomena, which distinguishes it from the surrounding objects as an independent uniform formation; the whole of the connected units performing the same function, social order; the whole of the connected enterprises and institutions.	Leonavicius, 1993
9.	A system is a structured whole of the connected elements and other things.	Simanauskas, 1997
10.	A system is the respective whole of interrelated elements.	Simanauskas, 1997
11.	A system is a set of objects possessing some particular properties and connections existing between the properties of those objects.	Gudas 2000
12.	A system is a set of interconnected elements which aims to achieve the pursued goals based on the existing connections between the elements. A system with no aim is just a set of the connected elements. The connections between the elements determine their behaviour. A set of unconnected elements cannot perform any action.	Gudas, 2000
13.	A system is the integrated whole of various things, which, as the constituent parts, are both independent and connected. Since the antiquity and stoics' times, a concept of 'system' has been used in the sense of cosmos, pilot formation (polis), animal's organism and scientific areas and research jointly.	Halder, 2002
14.	A system is a sort of the required order or process.	Halder, 2002
15.	A system is an object made of at least two or, actually, much more interrelated constituent parts (elements). The elements of the same location, which are not connected with each other, with the same type of relation do not make the system.	Zakarevicius, 2002
16.	A system is the whole of the connected components, objects, elements, processes, phenomena, etc., possessing the features not inherent in its components.	Damasiene, 2002
17.	A system is a set of phenomena (processes) and physical components, connected and arranged so that to make the integral whole and/or to perform as an integral whole.	Janusevicius, 2003
18.	A system is a thing, phenomenon or process, consisting of a qualitatively described set of elements, which being interconnected, make an organic whole, and, under the action of the external forces, may change their structure.	Guscinskiene, 2004
19.	A system is a set of interconnected elements, arranged in some way into an integral system.	System, 2005
20.	A system is a set of elements connected with each other more closely than with other elements surrounding the system. Though any element of the system should not be necessarily connected with all other elements, however, an element, not connected with any other element, is usually not considered a part of the system.	System, 2005
21.	A system is the whole of interconnected things and phenomena in nature and society. Therefore, a system is characterized by its content and structure, i.e. the connection between its elements and subelements (hierarchy).	Tertiary sector, 2005
22.	A system is a set of elements connected for achieving a common goal.	Zukovskis, 2007
23.	A system is a purposeful whole of interconnected elements.	Zukovskis, 2007

There are various opinions about the diversity of system's definitions provided by various authors. For example, this is explained by the effort of researchers to integrate too different things at the same level (Peregrudov, Tarasenko, 1989). It is hardly possible to agree with this explanation, given that fundamental essential properties of a system as a phenomenon are retained in a system of any type at any level. If there were no this 'common denominator', a unified systems theory would not exist. On the other hand, one can agree that 'the emphasis placed on formal and intuitively perceived properties of the whole and its elements, and the ignorance of the more important profound properties determining the origin and existence of the system' (Lydeka, 1999) complicates system's definition.

The analysis of system's definitions presented in Table 1 has revealed the causes for their diversity. First, various features of the system as a phenomenon are emphasized. Second, not all aspects of a system are considered, i.e. a definition is not complete. Third, a definition, on the contrary, is overburden with insignificant, auxiliary properties duplicating each other.

The term 'system' originated from the Greek language and is objectively defined in it as the whole, consisting of parts, a structure, a combination.

This explanation provides a methodological basis for approaching system's definition.

It may be noted that some researchers rely on a wide multifaceted 'system's' definition, while others prefer a concise definition based on the essential properties of the considered phenomenon. These different approaches depend on various factors, including the research aim, interpretation of the term 'system', the character of its use for the solution of a particular problem and, finally, on the ability of a researcher to see and identify the essence of the 'system' as a phenomenon and its major properties. Depending on the purpose, the author may search for a versatile 'system's' definition suitable for studying any type of problem at any level, or for multifunctional description emphasizing system's properties corresponding to a particular aim of investigating a particular problem, rather than its general or essential features. The latter approach also makes sense only if it does not contradict a universal system's concept and definition. Therefore, it implies that a universal concept and definition of a 'system', which could be used as a means for further interpretation should be outlined first.

Searching for a generally accepted definition, essential system's properties should be revised once again. Some questions associated with defining a system as a whole consisting of parts arise: what parts are meant? what relations do they have? what is meant by stating that they make a whole?, etc.

A general systems theory states that the system's element which is the smallest and indivisible unit *in this approach* makes its major part (Simanauskas, 1997; Lydeka, 1998, 1999). On the one hand, it performs a specific function in a system, allowing this element to be combined with other elements. On the other hand, it possesses the property of contributing directly or through functioning as part of a particular formation to a common aim for which the system is created. Based on the above-mentioned general properties, the elements or their formations may be combined into the integral whole. Both general and specific features of the elements determine the nature of their relations, which are oriented to achieving a common aim of the system. The relations between the elements or their formations may be oriented only when the latter are properly arranged, i.e. structured.

Taking into consideration the above statements, the most suitable 'system's' definition in terms of versatility would be as follows: 'a system is the structured whole of particular interconnected elements or their formations' (Simanauskas, 1997). Omitting some less significant words (e.g. 'structured' includes elements' formations, while the expression 'the connected elements' eliminates the words 'particular' and 'inter-' from the definition), the following system's definition could be suggested: 'a system is *the structured whole of interacting elements*'. The concept of 'the whole' differentiates a set of elements from the surrounding objects or a higher-level system, thereby defining its limits, while the concept of 'interacting' means that a set is made of interconnected elements. In its turn, the concept of 'structured' shows that systems and elements may be grouped into formations based on their properties so that the formations would be hierarchically arranged, and their interaction would be oriented to achieving a common goal for which a system is created.

L. Bertalanffy, the founder of the systems theory, provides even a simpler system's definition: *a system is a set of interacting components* (Bertalanffy, 1968). This definition satisfies two out of three system's conditions as a phenomenon. First, a set has a determined number of elements which seems to be sufficient to reflect the considered object from various perspectives. Second, the above elements are directly connected with each other. These conditions, satisfying a combination of elements, may be presented as shown in Figure 2.

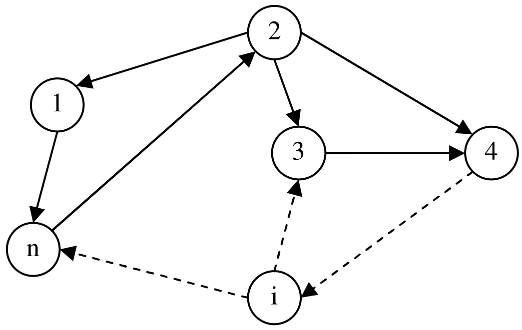

Figure 2. The whole of interacting elements

There are some doubts about the third, structuring system's condition. Does the graph given in Figure 2 satisfy it? It is not clear from the interconnections between the elements shown in it, how they contribute to achieving the common system's aim. In fact, it is not yet a structured whole of the elements, which could be referred to as a system.

A concept and definition of a system's structure

To describe the structuring process in more detail, the term 'structure' should be defined. This word of Latin origin (structura) means the arrangement, or lining up the parts of something complex. There is a great number of different definitions of this term (see Table 2).

Table 2

Definition of the term 'structure'

No	Definition	Author
1.	A structure is a formation of the system of objects or phenomena, not connected with their origin, functions and properties of the elements. In other words, the structure may be defined as the arrangement of people, perceived as not connected with their functions or hierarchy.	A dictionary of international words, 1985
2.	A structure presents relatively constant relations between the elements collectively, which are independent of the element substrate to some extent and describe the nature of the system.	Vengrys, 1988
3.	A structure presents the relations between the parts, which are not of casual nature and which help to integrate these parts into a whole. Any part of a system also has internal and external properties. Internal properties depend on their nature, while external properties – on their function (purpose).	Vengrys, 1988
4.	A structure embraces all relatively permanent relations in a system.	Gudas, 1988
5.	A structure means relatively permanent relations between the system's elements, ensuring its integrity and invariability, i.e. retaining its major properties under the action of internal and external changes.	Vengrys, 1988.
6.	A structure embraces the relations between the elements necessary and sufficient for achieving the goal pursued.	Peregrudov, Tarasenko, 1989
7.	A structure embraces permanent relations between the system's elements, ensuring its integrity and invariability, i.e. retaining its major properties under the action of internal and external changes.	Lydeka, 1998
8.	A structure means regular arrangement of elements in a coherent whole.	Halder, 2002
9.	A structure is the whole of the relations between the system's elements, ensuring its integrity and invariability.	Staciokas, Rimas, 2004

As one can see, definitions of structure given in Figure 2 emphasize a general property of structure – the existence of permanent relations between the elements. On the other hand, a system and its structures are closely connected to the aim for which the system is intended. It is the structure that orients the system to pursuing a particular aim. In mathematical terms, the establishing of invariable relations between the elements is necessary but insufficient for system formation. These relations should be properly directed, i.e. oriented to achieving the system's aim. This may be obtained only by establishing hierarchical relations between the interacting elements, i.e. by structuring the elements according to the type of their subordination. It is the process of structuring a set of interacting elements that gives them a particular orientation and turns them into a system.

Taking into consideration the above statements, definition No 6 from Table 2 (Peregrudov, Tarasenko, 1989) could be considered the most accurate description of the term 'structure'. We may only omit the word *sufficient* because, if not all necessary interconnected elements are included, a system, which could achieve the required aim, cannot be formed. Therefore, a structure of the system can be defined as *the whole of permanent connections between the elements of the system oriented to achieving the required aim*.

The definitions of the system and its structure, as well as their concepts, show the ways for its investigation and reflection, using some particular values.

Problems of systems' classification

In getting more knowledge about systems, their classification or grouping according to common properties plays an important role. The analysis of the literature on the problem shows that a lot of essentially different classifications can be found. This may be attributed to the fact that various properties are taken for classification. Some classifications are based on the system's origin or ways of management (Peregrudov, Tarasenko, 1989), while others rely on the elements of the system, their relations and properties as well as the system's properties (Zakarevicius, 2002; Kucinskas, Kucinskiene, 2002; Mann 2000; Stoskus, Berzinskiene, 2005). They may also be based on the method and purpose of system's creation, its composition, ability to change, implementation, links with the environment (Stoskus, Berzinskiene, 2005), mathematical model used to describe it, physical properties and applicability, level of organization and the properties of seven sets describing a system (Jasinavicius, 1981). The above diversity indicates that the authors use different bases for classifying the systems. A question arises if it is reasonable to search for some unified, generally accepted system, or the current state, when plenty of classifications are available, may be considered acceptable. To answer this question, the purpose of classifying the systems should be known. Everything associated with systems' analysis is aimed at getting more knowledge about them for their effective management. Systems are large, complex and complicated formations. Researchers have not created comprehensive methods of their analysis yet, therefore, each investigator tries to classify systems according to the aspect which seems to be most important for him/her, e.g. system's size, purpose, links with the environment, etc. In this case, the availability of systems' classifications based on various properties allows researchers to select one which is best suited for investigating the problem of their choice.

The relation between actual (material) and theoretical (abstract) systems

From the perspective of the present investigation, systems' classification into actual (material) and theoretical (abstract) is significant. The first group includes inorganic (physical, geological, chemical, etc.) and organic (biological, social, economic, etc.) systems. Theoretical (abstract) systems are hypotheses, theories, formalized models, etc. (Lydeka, 1998). In other words, they present the investigation of the state of actual (material) systems. The above division is important in terms of evaluating this state. This becomes clear in considering the relation between the actual (material) and theoretical (abstract) systems. In fact, the latter can be deduced from the former, implying that the purpose of theoretical (abstract) systems is to reflect actual (material) systems. Therefore, it is said that theoretical (abstract) systems are actually formalized models. In other terms, they are formalized models of actual (material) systems.

Let us, for example, consider an actual (material) system, an enterprise. It embraces equipment, workers and other staff distributed in workplaces, shops, etc. and administrative departments.

Under the conditions of growing competition, an enterprise may face a problem situation, which may be described, for instance, as the decreasing market share of this enterprise. When the consequences of this become clear, the problem is stated. In its turn, when the necessity of solving the outlined problem becomes evident, the *aim* of its solution is defined. It may be expressed as the subjective reflection (abstract model) of the desired environmental conditions, which would help to solve the problem faced by an enterprise (Peregrudov, Tarasenko, 1989).

To evaluate the performance of the material system, an abstract formalized model should be constructed. The existing problem situation, problem and goal of an enterprise determine the problem situation, problem and goal of the model reflecting the considered enterprise (Figure 3).

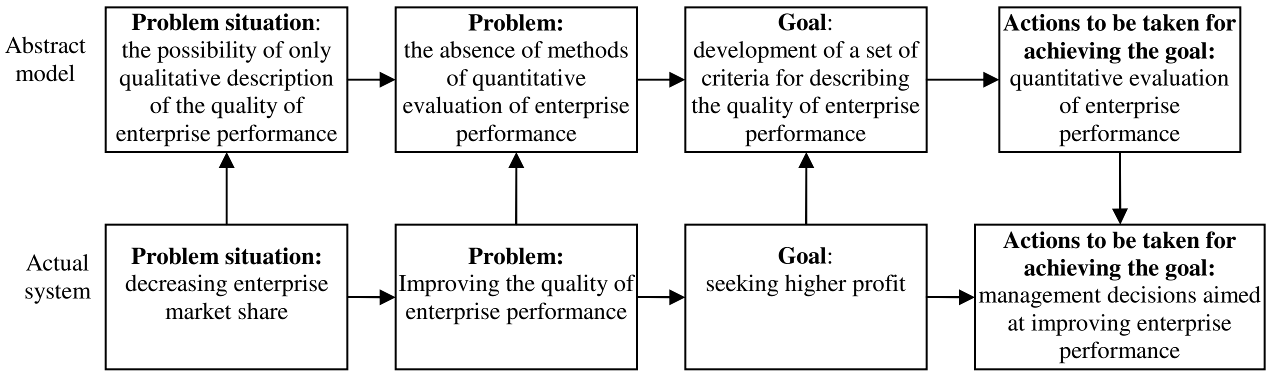

Figure 3. The development of theoretical (abstract) model, reflecting the real (material) system (an enterprise)

The model shown in Fig 3 is versatile because it can reflect any actual (material) system. A description of this system by a set of criteria allows us to evaluate its performance (state) quantitatively, which, in its turn, provides a basis for making effective management decisions.

Conclusions

It is hardly possible to manage naturally existing or man-made systems without having profound knowledge about them. Effective system's management is based on quantitative description of system's performance (state).

Interpretation and definition of the term 'system' play a decisive role in reflecting the system as a phenomenon. The analysis of various interpretations allows us to suggest the following definition: 'a system is a structured whole of interacting elements'. It follows that a description of an actual system requires the analysis of all its major aspects and their relationships.

Classification of systems helps us to get a deeper insight into them. This process is based on various criteria. A division of systems into actual (material) and theoretical (abstract) is also important for their adequate description. The second group includes formalized models, reflecting actual (material) systems, among others.

The sequence of operations used in describing real (material) systems by theoretical (abstract) models is as follows. First, *the problem situation* associated with a real (material) system is defined. Then, *the problem* and *the aim* of its solution are formulated. The existence of the described system, the problem situation, the problem and the aim of its solution referring to the described system determine the problem situation, the problem and the aim of the describing model.

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Romualdas Ginevičius

Realių (materialių) sistemų teorinių (abstrakčių) modelių sudarymas

Santrauka

Aktualumas ir problema. Mus supantis pasaulis darosi vis sudėtingesnis, dinamiškesnis, skęstame informacijos srautuose. Tokioje nevienareikšmiškoje situacijoje vis sunkiau priimti teisingus sprendimus. Visą laiką buvo ieškoma būdų, kaip paprasčiau, tačiau kiek galima adekvačiai pavaizduoti tikrovę, sumažinti sprendžiamų problemų kompleksiškumą. Išeitį pasiūlė sistemų teorija, kuri leido sudėtingus reiškinius nagrinėti sistemiškai, t. y. įvertinant jų sudėtinių dalių tarpusavio ryšius. Sisteminiu požiūriu sisteminiai tyrimai plėtojami jau daugelį metų, tačiau iki šiol taip ir nėra bendros metodologijos, bendrų analizės metodų ir būdų. Iki šiol aktualia moksline problema lieka taip pat ir pati sistemos samprata.

Sąsajos tarp mus supančio pasaulio kaip globalios sistemos, elementų ar elementų grupių yra nevienodo stiprumo – vienais atvejais jos juntamos

akivaizdžiai, kitais – silpniau, dar kitais – iš viso nejaučiamos. Tai yra pagrindas elementams jungtis į tam tikrus darinius siekiant bendro tikslo. Tokie dariniai gali būti išskirti iš kitų ir gali suformuoti atitinkamo lygio sistemas. Dėl to reikia išskirti ar suformuoti tuos elementus, kurie tikslingi nagrinėjamos problemos prasme. Kitaip tariant, reikia suformuoti sistemą iškilusiai problemai spręsti.

Problemą galima spręsti daugiau ar mažiau efektyviai, todėl ją atspindinčią suformuotą sistemą reikia pateikti taip, kad jos padėtis kokybiškai ar kiekybiškai būtų įvertinta. Tik tokiu atveju galima šią būklę keisti kryptingai, t. y. ją valdyti.

Straipsnio tikslas – pateikti universalų sistemos, jos struktūros apibrėžimą, taip pat realių (materialių) sistemų atspindėjimo modelį, norint kiekybiškai įvertinti jos padėtį.

Uždaviniai:

1. Išanalizuoti sistemos sampratą.
2. Aptarti siūlomų sąvokos „sistema“ apibrėžimus.
3. Pateikti apibendrintą sąvokos „sistema“ apibrėžimą.
4. Aptarti siūlomų sąvokos „struktūra“ apibrėžimus.
5. Pateikti apibendrintą sąvokos „struktūra“ apibrėžimą.
6. Išanalizuoti sistemų klasifikacijas.
7. Nustatyti realių (materialių) ir teorinių (abstrakčių) sistemų santykį.
8. Pasiūlyti realią (materialią) sistemą atspindintį teorinį (abstraktų) modelį, norint kiekybiškai įvertinti jos padėtį.

Tyrimo metodai. Lyginamosios analizės ir sisteminimo metodai.

Straipsnio struktūra. Straipsnį sudaro įvadas, keturios dalys ir išvados. Įvade aptariama: sistemų pažinimo tikslas, sistemų prigimtis, savybės, pirmapradės priežastys, dėl kurių atsiranda ar suformuojamos sistemos, jų pažinimo galimybės. Pirmoje dalyje nagrinėjama sistemos samprata, analizuojami siūlomi sąvokos „sistema“ apibrėžimai ir tuo pagrindu pateikiamas apibendrintas sistemos apibrėžimas. Antroje dalyje aptariama sistemos struktūros samprata, analizuojami siūlomi sąvokos „struktūra“ apibrėžimai ir tuo pagrindu pateikiamas apibendrintas struktūros apibrėžimas. Trečioje dalyje aptariamos sistemų klasifikacijos pagal įvairius požymius. Ketvirtoje dalyje nagrinėjamas realių (materialių) ir teorinių (abstrakčių) sistemų santykis ir tuo pagrindu sudarytas realias (materialias) sistemas atspindintis teorinis (abstraktus) modelis.

Mus supantis pasaulis yra globali sistema. Neatsitiktinai sakoma, kad joje viskas susiję. Sąsajos tarp atskirų jos elementų ar jų grupių yra nevienodo stiprumo – vienais atvejais mes jas matome akivaizdžiai, kitais – jas tik numatome, trečiais – jų nejaučiame iš viso. Įvairaus stiprumo ryšiai nusistovi neatsitiktinai – tai liudija apie tam tikrų elementų specifines savybes, prigimtį, sąveiką, kuri leidžia jiems jungtis į tam tikrus darinius siekiant bendro tikslo. Tokie dariniai išsiskiria iš kitų ir suformuoja atitinkamo lygio sistemas. Dėl to reikia išskirti (jeigu tai dirbtinė sistema, suformuoti) tuos elementus, kurie tikslingi mūsų nagrinėjamos problemos prasme. Kitaip tariant, reikia išskirti ar suformuoti sistemą iškilusiai problemai spręsti.

Kitas svarbus objektyviai egzistuojančios ar dirbtinai suformuotos sistemos pažinimo aspektas – jų atspindėjimas. Norint kryptingai keisti, t. y. valdyti, socialinė-ekonominės sistemos, pavyzdžiui, įmonės padėtį, ją reikia įvertinti. Tai padaryti galima tik visas esmines jos veiklos puses išreiškus tam tikrais kriterijais. Jų reikšmės leidžia numatyti padėties gerinimo priemones.

Literatūros šaltinių analizė rodo, kad nėra bendro sąvokos „sistema“ tiek suvokimo, tiek ir apibrėžimo. Apie tai liudija siūlymų gausa. Taip yra dėl to, kad akcentuojami arba skirtingi sistemos bruožai, arba įvertinami ne visi ją apibūdinantys aspektai, arba apibrėžimas „apkraunamas“ nereikalingais išvestiniais, vienas kitą dubliuojančiais požymiais. Dalis tyrėjų orientuojasi į platų, visa apimantį sąvokos „sistema“ apibrėžimą, kita dalis – į trumpą, pabrėžiantį tik esminius šio fenomeno prigimties bruožus. Toks skirtingas požiūris priklauso nuo keleto priežasčių – tyrimo tikslo, sąvokos „sistema“ suvokimo, panaudojimo nagrinėjamai problemai spręsti pobūdžio, galų gale nuo sugebėjimo matyti ir suprasti „sistemos“ kaip fenomeno esmę, giluminius jos prigimties požymius. Tyrimo tikslas gali būti arba universalaus „sistemos“ apibrėžimo, tinkančio bet kokio pobūdžio ir bet kokio lygio reiškiniams pažinti, paieška arba daugiafunkcinio jos supratimo, paieška, kai pirmiausia iškeliamos ir akcentuojamos ne principinės, pamatinės ar bendrosios sistemos savybės, o tos, kurios siauriau suprantamos, apribotos tik konkrečia problema, konkrečiu tikslu. Ko gero tam tikrą prasmę turi ir antras požiūris, tačiau tik tiek, kiek jis neprieštarauja universaliam sistemos supratimui ir apibrėžimui. Taigi visų pirma reikia universaliai suvokti ir apibrėžti sistemą. Šis apibrėžimas būtų galimų interpretacijų pagrindas.

Ieškant sistemos apibrėžimo, dar kartą reikia įvardyti esmines sistemos savybes. Sistemos samprata, kad tai yra visuma, sudaryta iš dalių, kelia daugelį klausimų: kokios tai per dalys? kokie jų santykiai? ką reiškia teigiamos, kad jos sudaro visumą? Kyla ir kitų klausimų.

Remiantis bendrąją sistemų teorija, pagrindinė sistemos dalis yra jos elementas, kuris yra mažiausias ir *nagrinėjamu požiūriu* nedalomas (Simanauskas, 1997; Lydeka, 1998, 1999). Sistemoje, viena vertus, jis atlieka specifinę funkciją, kuri leidžia jam jungtis į elementų darinius, antra vertus, turi bendrą savybę, kuri leidžia jam tiesiogiai arba funkcionuojant minėtų darinių sudėtyje prisidėti siekiant bendro sistemos tikslo. Remiantis šiomis bendrosiomis savybėmis, elementus ar jų darinius galima jungti į vieną visumą. Tiek iš specifinių, tiek iš bendrųjų elementų savybių išplaukia jų sąveikos pobūdis. Sistema yra kryptinga, nukreipta bendram sistemos tikslui siekti. Sąveikos kryptingumas užtikrinamas tik atitinkamai sutvarkius elementų ar jų darinių tarpusavio santykius, t. y. struktūrizuojant.

Įvertinus visa tai universalumo prasme geriausias gali būti šis „sistemos“ apibrėžimas – „tai struktūrizuota tam tikrų tarpusavyje susietų elementų ar jų darinių visuma“ (Simanauskas, 1997). Išmetus kai kuriuos perteklinius žodžius (pavyzdžiui, sąvoka „struktūrizuota“ apima ir elementų darinių sudarymą, sąvoka „susietų elementų“ iš apibrėžimo eliminuoja žodžius „tam tikrų“ ir „tarpusavyje“), galima būtų pasiūlyti tokį „sistemos“ apibrėžimą: tai „struktūrizuota sąveikaujančių elementų visuma“. Sąvoka „visuma“ elementų aibę išskiria iš supančios aplinkos arba aukštesnio lygio sistemos ir drauge nubrėžia nagrinėjamos sistemos ribas; sąvoka „sąveikaujančių“ reiškia, kad šią aibę sudaro tik tarpusavyje susiję elementai; sąvoka „struktūrizuota“ parodo, kad sistemos ir elementai gali būti sugrupuoti į jų darinius pagal tam tikrus požymius, kad šie dariniai vienas kito atžvilgiu išsidėsto hierarchiškai ir kad jų sąveika yra nukreipta bendram sistemos tikslui siekti.

Esminė kategorija sistemų teorijoje – struktūra, kuri yra sistemos stabilizavimo pradžia. Vėlgi matome, kad nėra visuotinai pripažinto sąvokos „struktūra“ apibrėžimo. Antra vertus, visi jie išryškina tą pačią ir todėl esminę struktūros savybę – pastovius ryšius tarp elementų. Antra vertus, sistemos ir ją išreiškiančios struktūros buvimas yra neatsiejamas nuo šios sistemos tikslo. Sistemos orientaciją į tikslą suteikia būtent jos struktūra. Pastovių ryšių nustatymas tarp elementų, matematikų terminais kalbant, yra būtina, bet nepakankama sistemos sudarymo sąlyga. Šių ryšių visumai dar reikia suteikti kryptingumą, t. y. orientaciją pasiekti sistemos bendrą tikslą. Tai pasiekti galima tik nustačius pavaldumo ryšius tarp sąveikaujančių elementų, t. y. atlikus šių elementų hierarchinį struktūrizavimą. Būtent sąveikaujančių elementų sąrankos struktūrizavimas suteikia jai kryptingumą ir paverčia sistema.

Visa tai įvertinus tinkamiausias yra 2 lentelės šeštasis struktūros apibrėžimas (Перегудов, Тарасенко, 1989). Šiame apibrėžime galima atsisakyti žodžio *pakankamas*, nes jeigu į sistemos sudėtį nebus įtraukti visi būtini tiesiogiai sąveikaujantys elementai, tai bus negalima suformuoti sistemos, kuri pasiektų jai keliamą tikslą. Tokiu atveju sistemos struktūrą galima apibrėžti taip: *tai orientuota pasiekti sistemos tikslą pastovių ryšių tarp elementų visuma*.

Suvokus sistemos ir jos struktūros esmę, galima kalbėti apie jų pažinimą. Čia svarbi jų klasifikacija, t. y. skirstymas į grupes pagal bendrus požymius. Literatūros šaltinių analizė rodo, kad, klasifikuojant sistemas, daugeliu atveju imami vis kiti požymiai. Mūsų nagrinėjamu atveju aktualus yra sistemų klasifikavimas į realias (materialias) ir teorines (abstrakčias). Pirmosioms priklauso negyvosios gamtos ir gyvosios sistemos, antrosios – tai hipotezės, teorijos, formalizuoti modeliai ir pan. Iš esmės jos yra išvestinės iš pirmųjų. Taigi jų paskirtis – atspindėti realias (materialias) sistemas. Galima formuluoti, kad teorinės (abstrakčios) sistemos – tai formalizuoti realių (materialių) sistemų modeliai.

Realių (materialių) sistemų atspindėjimo teoriniais (abstrakčiais) modeliais seka atrodo taip. Visų pirma įvardijama realios (materialios) sistemos *probleminė situacija*, po to suformuluojama *problema*, toliau – sprendimo *tikslas*. Atspindimos sistemos probleminė situacija, problema ir jos sprendimo tikslas sąlygoja atspindinčio modelio probleminę situaciją, problemą ir tikslą.

Pavyzdžiui, jeigu reali (materiali) sistema yra įmonė, tai ją atspindinčio abstraktaus modelio tikslas gali būti įmonės funkcionavimo kokybę atspindinčių rodiklių sistemos sudarymas ir padėties kokybės kiekybinis įvertinimas.

Raktažodžiai: *sistemos, socialinės-ekonominės sistemos, sistemos apibrėžimas, struktūros apibrėžimas, sistemų klasifikavimas, realios (materialios) ir teorinės (abstrakčios) sistemos*.

The article has been reviewed.

Received in September, 2009; accepted in December, 2009.