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General theory of systems, cybernetics and evaluation of human competence by solving present crisis problems of civilisation

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Abstract

Present crisis problems of civilisation create the opportunity and need to analyse the possibilities of use of knowledge from system theory of cybernetics and evaluation of human competence, which has been accumulated and published up to now. Use of this knowledge should help, among other non-elaborated scientific knowledge to stop the impact of the global crisis and to ensure sustainable development of human civilization. Uses of this knowledge allude to several facts. Primarily, use of knowledge of cybernetics is in practice frequently connected with natural and scientific problems and their solving. Use of knowledge of the general theory of systems, however not all, collides with notional problems. Nevertheless, this knowledge can be used in wider scope of activities. And in expertise, even if knowledge is oriented mainly on evaluation of "non-living objects" and intellectual property, the evaluations of working competence occur more and more.

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Keywords: object, system, holism, unit, parts, relations between parts, homeostasis, equifinality, feedback, variety, repertory, holistic competence

1. Holism of the system – definition

The sickness of today's world is directly related to our inability to see it as a single unit (Senge, 1995). Systemic management is considered as a discipline of the perception of units through their parts and structures or it is the

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ability to perceive very fine interactions (relationships and links) which provide live, dynamic systems with the unique character of a unit.

Holism as a subsystem has a unique characteristics which is not common in any other part of a unit. It is something new, emergent, being created from the mutual interaction of elements (parts) and is considered as a holistic management competence. The competent manager is not and cannot be a manager, who is only professionally skilled, or a worker with enormous knowledge, but who is practically unable to apply.

A manager's competence is a holistic quality and emergent feature which is attributed a person due to his or her professional ability, social maturity, and practical skills in order to prevail over egoism and ignorance. On the one hand, the human being is the most perfect creature in the nature; on the other hand, they must continuously learn to be competent in relation to nature and to other people.

Systemic thinking is a discipline that teaches us to see structures, the relationships between competence elements and between the personal maturity, expert knowledge and practical skills which are not obvious all the time – but which are a basis for the understanding of competence as the holistic manifestation of a personality. If we succeed in perceiving competence as a whole, holism or emergent, we are able to "care for its health"; we can denominate and identify where to increase the level of our knowledge, skills or maturity by means of education – upbringing, study and training.

Ross Ashby (1954) presented real determination of aims for the unit and its parts, which is a basis of the function of planning in management by results of the research so-called homeostat (homeostasis). He came to the conclusion that the basic condition of homeostat (and thus of determining of aim of the unit and its parts) is an equality of all parts of the unit and use of relations of equality between them.

In the structures of the unit, individual parts have different hierarchical positions resulting from subordination of differentiated tasks of differentiated task of the unit. It is called the equifinality and was elaborated by L. Bertalanffy. Hierarchy of the parts in the unit is usually multilevel one. Equifinal organization of parts in the unit is oriented on securing of the fulfilment of set objectives by means of organizing function for particular hierarchically arranged parts and the unit, while using the relations of superiority and subordination for fulfilment of the aim. If for example the smallest part of the unit doesn't reach the objective resulting from its differentiated task, the objective is not reached by the part into which it belongs to, and thus the whole unit can't reach the objective (the example of the Greece and other states of the European Union).

N. Wiener (1960) suggested to divide all parts of the unit into two parts, in order to ensure the stability and equilibrium state. These two parts can be in a simplified way called the subject of the management and object of the management, among which vertical relationships are developed.

The subject of management monitors (checks) outputs (results) of the object of management through the feedback. By this, it monitors the activity of the unit as well as reaching the set objectives. Connection through the feedback in a vertical hierarchical unit composed of several parts passes through several subjects and objects of management in the given unit.

2. The links and relationships (their types) between the parts and units in a system's structure

The basis of the building of any unit structure is to specify the differentiated task – or usefulness of every element or part and to look for such ordering by means of identifying the links and relationships which are most convenient for them all – element, part and unit.

In practice, however, the question of building the structures or networks of a unit's arrangement is done simultaneously in both ways:

a) from the unit to its parts and elements
b) from the elements and parts to the unit

The term interaction – mutual action of units, parts and elements in a system, doesn't determine the material, quantitative or contents aspect of interaction more closely. The orderliness of the units, parts and elements in the structure of systems, or the level of their orderliness depends on the knowledge and use of both aspects of interactions, i.e. the material, quantitative (formal). In this case we speak about the relationships between structural components.

Links and relationships stand for two different views on interactions, where our knowledge is used to lead to a higher level of orderliness in the systems and to their longer-term sustainable development. The cognition of the character of interactions helps us understand the behaviour system as a unit. The structure of interactions between elements, parts and units causes certain behaviours and in cases where the structures and the character of interactions change, this can cause changes in their way of behaving.

Systemic thinking is based on the search for substantial changes in the links and relationships of elements, parts and units, i.e. on the changes of structures that sustainable development is achieved by. Systemic thinking means knowing how to identify ever-more complex and ever less discernible (less noticeable) interactions, i.e. structures in the flood of details, under varying pressures, and faced by contradictory tendencies wherever management acts.

Basically, if we can distinguish the links and relationships in an organisation's structure and describe their character and changes, then we can predict their behaviour. Every particular structure causes a certain type of behaviour and changes in structure lead to changes in the way of behaving.

The links between the elements in the structure of organisations are broken up – based on the way of passage (the routing of links), into the input and output element. We can distinguish two main groups according to the routing of their links:

- open (serial, parallel) links
- feed-back (closed) links

The interaction relationships result from the mechanism of the functioning of a unit, they have an objective character and their division into groups corresponds to the forms and manners of control. They exist in parallel and nobody can remove them by force. Only the organisation's systems are built on the principle of prevailing relationships and this way, they consciously suppress for example functional relationships by linear ones and vice versa. The types and sorts of interaction relationships change with regard to the changes made in the unit. This automatically assumes that one must follow this movement, otherwise, this can lead to the wrong choice of the form and way they are controlled.

The interaction relationships resulting from the control of units – organisations, can be divided as follows:

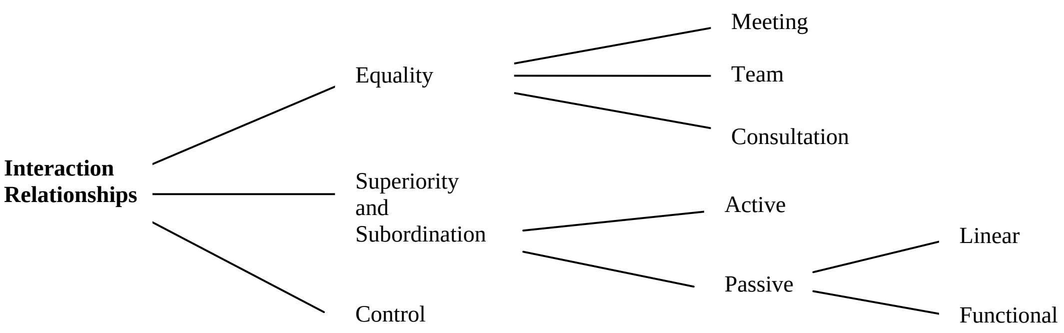


Fig. 1: The classification of interaction relationships in organisations

The division of interaction relationship results from the determination of the characteristic of these relationships by hierarchical degree. This is due to the fact that in the overall hierarchical construction of an object and system, all types and ways of relationships exist in parallel and it is not possible to assess the unit by one and only one selected characteristic.

3. Stability and equilibrium in the functioning (behaviour) of systems

By their actions, competent managers are able to influence the sustainable development and dynamics of development of their organisations. We say that such organisations are stable.

Through the functioning and fulfilment of specified usefulness, each unit goes through different changes, carries out different activities and acquires certain new states in which it stays for different lengths of time. All its states, activities or changes are limited by so-called invariable states, which represent the boundary points of its existence. All positive states are designated as the stability of a unit.

On the other hand, the invariable states and other states behind them represent the states of unstableness, which don't allow an object to fulfil its usefulness and so they lead to the cessation of the unit.

It is schematically shown on fig. 2.

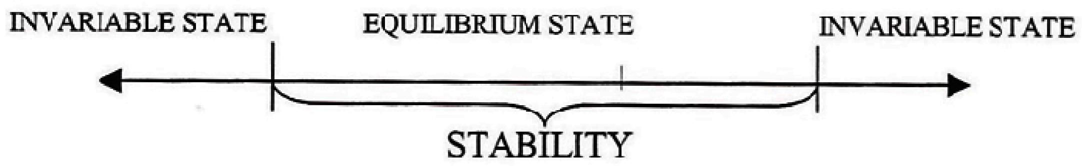


Fig. 2 Equilibrium state and borders of stability of an economical object's behaviour

By invariable states we understand those states where a system stops being a system and stops functioning if they are exceeded. The effort to control any unit is to find a state within the boundaries of the invariable states and which represents the limits of stability. We call this state the "Equilibrium State".

With regard to developments in technology, due increases in work productivity and changes in the need for products, man-made organisations and units are in continuous development. Their balance in the dynamics of development can be specified provided that there is a development contradiction in its usefulness. This means that the requirement on the required usefulness is higher than the existing usefulness. If the existing usefulness of the unit was higher than required, we would have to examine if the social consumption doesn't drop, if it is not replaced by other types of products. The most frequent problem in practice is to specify a new required usefulness (a new equilibrium state).

The equilibrium state represents the most favourable state in which a system can survive for a long time. If a certain unit achieves an equilibrium state, it achieves the best results of its activities. Any displacement of the unit from this state to one or another side – to the invariable states, leads to the deterioration of the results. The most convenient state of a system can't be determined as an average, or only as a state in the middle of the overall system's movement between the interfaces of the invariable states. The equilibrium state is a dynamic value†.

The behaviour of systems within the boundaries of stability or beyond, using feedback, can be illustrated in the example of a linear system. The scheme is shown in Fig. 3.

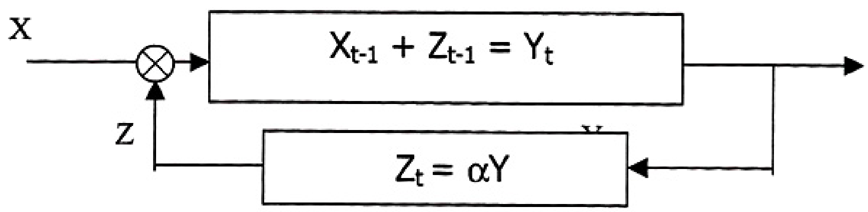


Fig. 3: Linear system whose elements are linked by feedback

The initial movement of the given block-scheme of the system description of a complex unit is given by a certain input – X and its transformation into an output – Y. This initial movement can either express the beginning of activity in a certain unit, or simply the former state of its functioning. The transformation process is realised by means of change of an input into an output which enables us to determine the coefficient and to modify the output in a way to be able to evoke a certain equilibrium state.

Thus, the transfer function of an entire block scheme of a system unit description is:

$$Y_t = \alpha\, Y_{t-1} + X_{t-1}$$

It follows that in addition to input value Xt-1, the output trajectory Y is also characterised by the output value shifted by one time unit. The block scheme shows that the output value is multiplied by a specified constant and after modification; it comes back to the system in the form of an input. This leads to a certain output value circulation, the consequence of which is the subtraction of a time delay. If, for Yt, we want to know Yt-1, Xt-1, then for Yt-1, we want to know Yt-2, Xt-2, etc.; at Yt-t =Y0, Y, X will equal Y0 X0, which means they remain constant. Then provided that X is constant regardless of time, the system description scheme will be in an equilibrium state. Its transfer function is:

$\bar{Y} = \alpha\, \bar{Y} + X$. The first phase of the equilibrium state's determination was determined in this way.

If we modify the transfer function $\bar{Y} = \alpha\, \bar{Y} + X$, we will get the following equilibrium state formula:

$$\bar{Y} - \alpha\, \bar{Y} = X$$
$$\bar{Y}\,(1 - \alpha) = X$$
$$\bar{Y} = \frac{1}{1-\alpha}\, X$$

The complex unit will be in equilibrium when the output $\frac{1}{1-\alpha}$ will be a multiple of the input, with a fixed input.

The problem of the proper functioning of complex units doesn't end with the determination of the equilibrium state. Various disturbing influences can deviate the unit from its equilibrium state. The complex unit develops maximum efforts to remove these disturbing influences and to overcome them by means of the internal forces of adaptation and development. If disturbing influences act on the functioning of a certain unit, deviation from the equilibrium state occurs. The deviation of the output from the equilibrium state can be defined as follows:

$$y_t = Y_t - \bar{Y}$$

The deviation takes place in a certain time and is determined on the basis of the comparison of the indicated formulas. If we assume a constant input X, we will get:

$$Y_t - \bar{Y} = \alpha\, Y_{t-1} - \alpha\, \bar{Y} + X_{t-1} - \bar{X}$$
$$Y_t = \alpha\, (Y_{t-1} - \bar{Y})$$
$$y_t = \alpha y_{t-1}$$

The deviation from the equilibrium state in time t is α-multiple of the deviation in time t-1. Through the step-by-step use of this deviation from the equilibrium state, the deviation assumes a geometrically progressive form (for linear dependencies):

$$y_t = \alpha y_{t-1} = \alpha^2\, y_{t-2} = \ldots = \alpha_t\, y_0$$

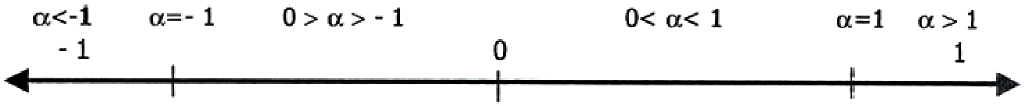
So that it applies that:

$$y_t = \alpha^t\, y_0$$

Where y_0 is an initial deviation from the equilibrium state. The development of a deviation from the equilibrium state assumes two constants – namely α and y_0. Then the total functioning of a complex unit can be expressed by the relation where the deviation from the equilibrium state in time is added to the required equilibrium state:

$$Y_t - \bar{Y} + y_t = \frac{1}{1-\alpha}\, X + \alpha^t\, y_0$$

Five basic types of unit functioning can originate, depending on the coefficient α_t over time. This means that 0, 1, 2, 3… and up to a certain final time: t will be introduced step-by-step into the deviation from the equilibrium state. The coefficient can acquire various values, as follows:



Since α = 0 and α = 1 don't create a real characteristic of functioning, there are five ways of functioning in total:

a) Functioning from the state α - 1 will be defined by a trajectory, receding in sharp oscillations from the equilibrium state. (Fig. 4)

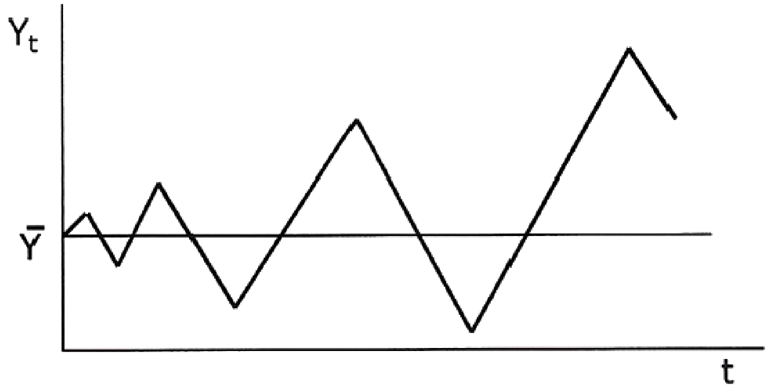


Fig. 4: Graphical representation of the behaviour of an unstable system (α - 1)

The above case characterises the unstable object where the development discrepancy between required usefulness and existing usefulness doesn't operate.

b) The second way of functioning is in the state where α = - 1, and is defined by a trajectory that will oscillate around state to either side with identical oscillations (Fig. 5)

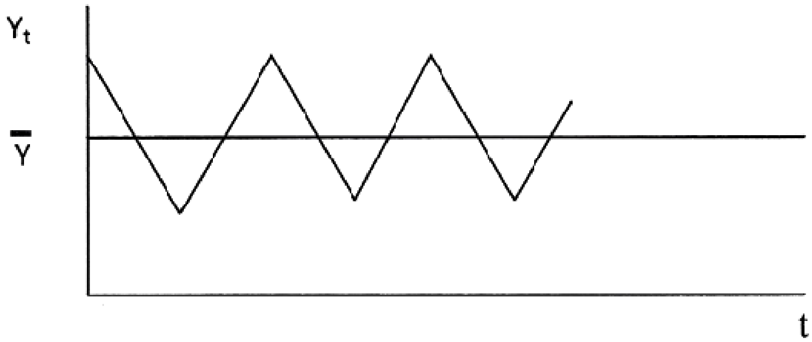


Fig. 5 Graphical representation of the behaviour of a neutral stable system (α = - 1)

This example represents a neutral stable state.

From the indicated ways of unit functioning of a complex unit represents a systemic perception of the content and the qualitative aspects thereof. It is a rather ideological view of this complex issue. At this level of dealing with the issue of the internal functioning of a mechanism, it is not possible to satisfactorily identify the ways in which units are directed towards equilibrium and it is hard to elaborate the methods and ways of controlling them. The biggest problems arise from the quantification of the factors of this process. The common interacting and conditioning of the individual characteristics causes that we are unable to determine the importance of their operation in a given unit.

There are no methods or ways of totally describing and quantifying usefulness and its links in structural allegiance to the unit and its surroundings.

4. Systemic definition and cybernetic mechanism of the concept management functions

The need to elaborate the management functions is urgent. The decisive contribution of scientists to the examination of the contents of management probably doesn't consist in elaborating and use of relevant means and methods in the organization of the management process, but in much deeper elaboration and understanding of this process and its valuation.

The decisive task of the management functions in solving structural issues of management points out that there is a need to define them more or less unambiguously, to determine a mechanism of their gradual performance, but first of all to elaborate the scope of the contents of each production.

The management functions contain the most general principles of creating management systems, including their computer parts.

The mechanism of assertion of the management functions can be explained by use of the system approach in the most general form. Let us see its schematic illustration first.

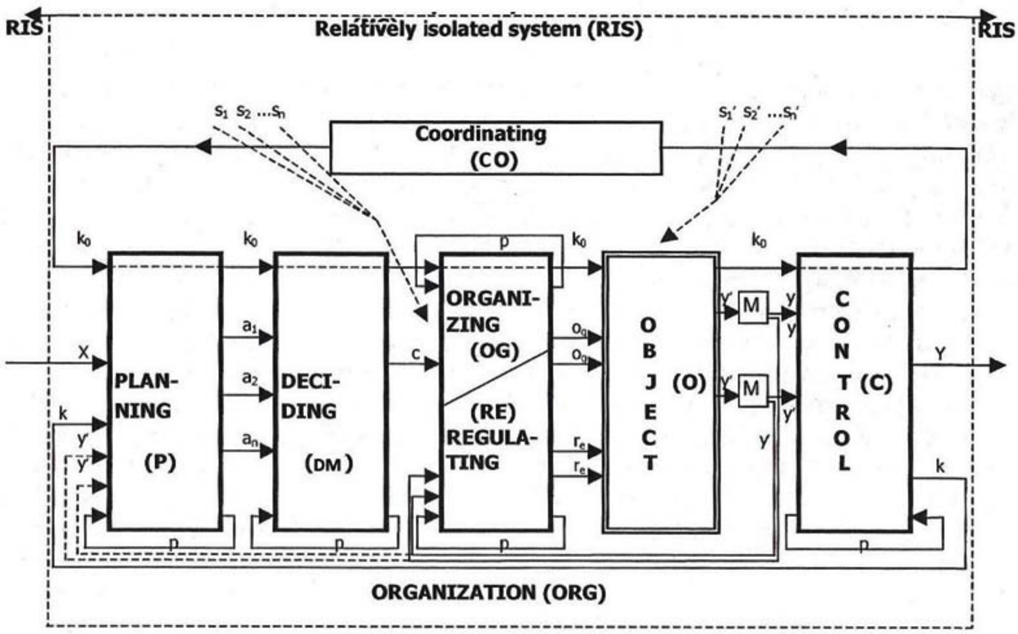


Fig. 6: Model of assertion of control function in the organisation

The exchange of information with the surrounding is shown in the scheme as information input "x" and output "y". The input quantity "x" is not "one-dimensional", it represents a multidimensional vector expressed according to the rules of algebra of vectors as follows: $x = (x_1, x_2 \ldots x_n)$. The same applies to the input quantity $y = (y_1, y_2 \ldots y_n)$. We could consider the input quantity "x" as bi-dimensional vector if it represented information relations with the superior system (SS) and with the systems in its surrounding. In fact, the bi-dimensional vector "x" is the only one representing a very small level of resolution level needed for the required investigation of the system input.

The first block, connected with the surroundings through the system is a block (function) of planning (P). As it results from the schematic illustration, the following inputs share in the fulfilment of the planning function contents: the input "x", expressed by the vector and representing information from the surroundings, the input "y", representing information about changes on the object (O) during the period of achieving the objective in the previous working process in view of the changes in estimated internal and external factors; the input “c” represents the control information about the realisation and evaluation of the previous working process; “c_0” is the information and the coordination function; the self-link “p” can represent the information about internal (and external) conditions (situations) of the system, information about the way (methods) of determining the alternatives of the objective, either for the system vision, system strategy or system plan, etc. The result of transformation of the information inputs “x”, “y”, “c”, “c_0”, “p” in planning (P) are information outputs characterizing the individual alternatives of the objective (a_1, a_2…a_n).

The block of decision making (DM) accepts information about the objective alternatives a_1, a_2…a_n and has the information “c_0”and “p”at disposal. In this case, the “p” information may express the necessary information about the required maximum revenues and minimum risks to be taken into account when selecting one of the alternatives of the objective. The result of activities in the decision making block (DM) is the selected objective’s alternative “c”, representing the system’s objective.

The selected objective “c” is transformed into the block of organization (OG) and knowing ways how to realize the objective (shown in the scheme by self-link “p” into the OG block) and based on the coordination information “k_0” it is carried out by transforming the organizational quantities “o_g” into the object (O). The quantities “o_g”, transformed into the object (O) are modified with regard to the assumed operation factors s_1, s_2…s_n.

Operating of the quantities “o_g” on the object (O) resulted in the “y” quantities measured with measuring devices (M). However, the object carrying out the objective is influenced by real operation factors s_1, s_2…s_n, due to which the measured quantities “y” are not identical with the required output quantity “y”. Due to that fact, the quantities “y” are a loop of the feedback returned into the regulation block (RE). The real operation factors require a second correction of the organizational quantities. The way of corrections is in the regulation block (RE) expressed by the self-link “p”. The organizational quantities modified with regard to real operation factors are from the regulation block (RE) transformed back to the object (O). This transformation is expressed on the scheme by information values “r_e”.

The above description makes it obvious that the organizational quantities passing into the object (O) for the first time, represent the expression of the objective. Then, in the following feedback circles in the regulation block (RE), they are modified until the required objective value “y” is achieved. If the regulation function (RE) can’t regulate organizational values as far as to the required quantity “y”, the feedback loop “y” from the measuring devices (M) is extended to the planning block (P), where a correction of the objective if carried out, the resulting parameters “y” are transformed into the control block (C), and then, having finished the whole working process through the feedback loop “k”, they again transform the information results of their activity into the planning block (P). The coordination block (CO) realizes its function by coordinating the activity in the individual blocks P, DM, OG, RE, O, C, OO through the link channel “k_0”.

5. Conclusion

Globalization activities in the worldwide environment cause unpredictable crisis problems, which can’t be sustainably secured in a long-term by the subjects of management (politicians, enterprise owners and managers). Developing holistic management is beginning to solve the global tasks and problems of the environment. Knowledge about the behaviour of management of the units is already elaborated in the general theory of systems, on which holistic management relies in several aspects. The use of scientific knowledge about conditions of stability and equilibrium state of specific kinds of unit, synergies, and emergency arising during mutual interaction of parts, about principles of homeostasis, equifinality, feedback and many more, would serve to develop ways out of present crisis problems not only in Europe, but in the whole world. European Union as a community would be more viable if it had synergic (holistic) or central management of foreign policy, fiscal, commercial, legislative or budgetary policy. If stability in Europe is to be preserved, social system should be unified or harmonized. This is the only way to give rise to Europe as a world power, which can cooperate or compete with the USA and more and more aggressive Asian countries, mainly with China and India on the principles of equality. Only holistically educated representatives of European countries are qualified and can find solutions to return our continent to outstanding position.

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