Interdisciplinary Description of Complex Systems 8(1), 34-48, 2010

COMPLEXITY IN ORGANIZATIONS AND ENVIRONMENT - ADAPTIVE CHANGES AND ADAPTIVE DECISION-MAKING

Robert Fabac*

Faculty of Organization and Informatics, University of Zagreb
Varaždin, Croatia

Regular article *Received:* 14. May 2010. *Accepted:* 30. June 2010.

ABSTRACT

The features of complexity are ever more present in modern organizations and in environments in which they operate, trying to survive and be as competitive as possible.) In the processes of, the so-called emergence, the formal organizational structure, designed purposefully and with a plan, is going through a change due to complexity and the need for adaptation. As a result, there is a variety of new informal groups. At the same time, the intended structural changes and business process changes occur because of the perception that the leadership and senior organizational management have of the strategic situation. Managers in modern organizations often use business intelligence (BI) systems when making important business decisions. These systems offer support to the decision-making by gathering and processing relevant data and information about the company performance, but also about the data on conditions in close and remote environment. A modern company is characterized by the complex adaptive system, but the environment in which it operates together with other business subjects (agents) is also complex. Consequently, the requirements for appropriate or optimal decisions and successfully completed activities are hard to meet. Given that expected future events and circumstances often occur in nonlinear mechanisms, the decisions made by following the models of traditional predicting and planning are not satisfactory. This calls for new approaches to decision making and acting.

KEY WORDS

complexity, complex adaptive systems, business intelligence, decision-making

CLASSIFICATION

JEL: D21, D73, L22

*Corresponding author, η: robert.fabac@foi.hr; +385 (0)42 390 870;
Faculty of Organization and Informatics, Pavlinska 2, HR - 42 000 Varaždin, Croatia

INTRODUCTION

Organizations are social entities oriented to certain goals. They are characterized by a designed structure and coordinated activities, and are open in terms of closeness with their environment. Organizations contain collection of resources, categorized as human and material resources that can be coordinated and managed to perform certain tasks. Processes and activities are determined in order to execute tasks, which enable organizations to continuously realize their goals.

One of the most prominent metaphors in the treatment of organization stems from the so-called system approach. It has been well known for many years and has origins in cybernetics and application to complex technical systems. People make efforts to apply certain rules of behaviour of technical systems to organizations. First of all, there is the concept of the systems management, at which efforts were made to apply certain characteristic concepts of control, feedback, measurement of system's performance, etc., to organizations as primary social systems.

ORGANIZATIONS AS COMPLEX SYSTEMS

In view of organization, the system approach extends to the theory of complexity, which, in terms of social systems, primarily affirms the important concept of the so-called complex adaptive systems (CAS). The idea of the complex system denotes presence of many independent entities, agents that behave in accordance with their objectives, and perform mutual interactions. At that it is important to observe that the complex system does not allow simple reduction, as is the case with a multitude of unconnected elements. That is why it is sometimes difficult to understand the behaviour rules of the complex system since it is not possible to set up a simple and yet satisfactory model. This issue is an important task for the managers as they are faced with concrete challenges in their organizations on a daily basis. CAS are characterized by several key attributes that can be concisely described by terms reflecting the behaviour of these systems: complexity, agents, emergence self-organizing, adaptability, nonlinearity.

Complexity as a characteristic feature occurs and grows when interdependence of the elements within the system becomes relevant. In such systems each part or agent has significance of its own, and removal of certain element from the system leads toward destruction of the existing system's behaviour [1; p.9]. CAS are open systems whose components are firmly interrelated and have the ability of self-organizing and dynamics. There are also certain local rules that apply to these components or agents. The dynamics is present because of interrelations, interactions and influences of numerous agents. As a result, CAS are subject to constant and discontinuous changes [2].

The aforementioned interactions among system's elements may result in occurrence of certain higher levels of organization, cores of new structures, and this phenomenon is called emergence. Elements or agents in organizations are individuals, organizational units, groups and so on. The occurrence of well-known informal organizational groups that significantly distort the structure defined by the purposeful design of organization, can be explained by the complexity conditions. Agents connect in accordance with their specific goals and interests. However, in real organizations they often connect at the expense of real, declared organizational goals. One desired scenario is the situation when self-organizing is motivated by learning within the organizations with a purpose of adapting the structure to external challenges and thus improving performances of the system itself.

Organizational adaptation to environment with the option of changing its structure is an important phenomenon in both theory and practice of the organizational design and organizational changes.

According to the system theory, the effects of the process balancing in the traditional control paradigm are achieved by means of negative feedback (Fig. 1). The behaviour of the system can be controlled by sending the output results relative to certain desired values back to the input segment of the process development. Such mechanism may serve to control the behaviour of social systems and it represents a contribution to the organizational theory studies.

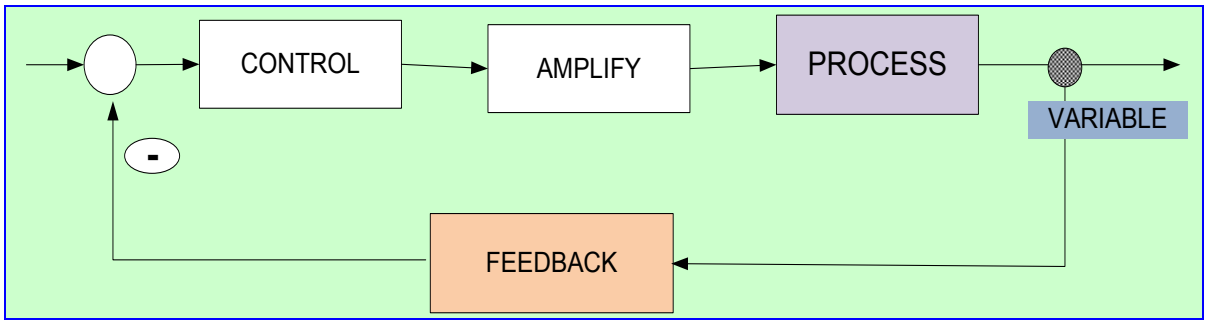

Figure 1. Negative feedback (an example).

While the negative feedback acts as a stabilizer of the system, the positive feedback activates the process of amplifying that may lead toward instability after a certain time. Nonlinearity is a phenomenon that can be explained in different ways. Due to numerous connections and interactions in CAS, the outcomes of processes and events are nonlinear with regard to the values of input variables. In the environment of organizational activities nonlinear processes are mainly unwanted because they decrease the possibility of control and adequate responses to impacts and events in the environment. Nonlinear occurrences imply circumstances of disproportional relative changes in the input-output states of the processes, for example, if some company is successfully increased their production but this phenomena does not have consequences in proportional growth of their profit, due to the saturation of markets.

However, when applied to the creation of responses to the challenges of environment, nonlinearity may be useful and desirable. Organizations represent adaptive and intelligent

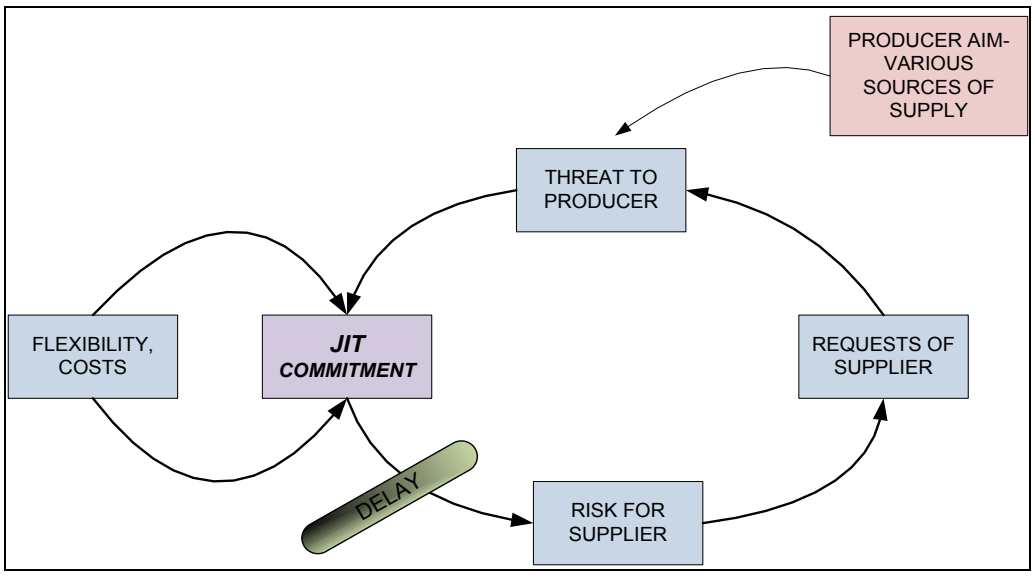

Figure 2. Commitment to „Just in time“ system – influences [5, p.105].

entities since they can take actions that were not pre-planned, and the final outcome is not just a simple sum of isolated individual efforts. The actual performance is also a result of the included nonlinear processes [3, 4]. The systems that possess distinctive CAS attributes demonstrate emergent rather than deterministic behaviors. The type of control in these systems is self-organizing and, to a lesser extent, centralized and hierarchical control.

The amplifying mechanism in the case of CAS is often joined with the stabilizing process that includes conditions of limitation and, consequently, keeps the growth inside certain regular boundaries. Such pattern for CAS was illustrated by Senge in the example of introduction of Just in Time System in business (Fig. 2).

Improvements achieved by implementing the JIT system, such as lower costs and other benefits, stimulate the manufacturers to commit themselves to this approach. However, the demands for a prompt reaction to the needs for supplies urge suppliers to fight for their exclusive position. This scenario exposes the manufacturer to risks because he would prefer the option of having multiple sources of supply [5]. As a result of the second loop, commitment toward the JIT is undermined. In the end, the commitment is expected to remain on certain reasonable, but no too high levels.

The complexity within organizations and in their environments, with the described phenomena included, leads to reluctance to organizational changes. In order to maintain competitiveness and survive in a potentially worst-case scenario, organization must change. There is a variety of theories dealing with organizational changes, and analyses are being made of the factors that influence changes, of the type and comprehensiveness of changes, of the effects and tasks of the strategic leadership, impacts of the changes on employees, etc.

ORGANIZATIONAL CHANGES

Organizational design is the activity through which managers and other responsible authorities select and manage structure, processes and culture as main organizational aspects. An organization should select a design that will enable it to successfully control activities that are essential for achievement of its goals.

Organizational changes are relatively frequent, which is not the case with strategic changes, because the latter are about organizational design, and they encroach upon the domains of structure, strategy, key processes and culture. Organizational change is a process used by organizations to redesign their structure, processes and culture with an aim to move from the current state toward a future desired state in order to increase their effectiveness and efficiency [6; pp.10-11]. Organizations effect changes because they want to see their mission accomplished, focusing on objectives that range from survival to dominance. Aware of the process of changes initiated by the management, through formal channels, they are encouraged by certain factors from within the company and the business environment. Common internal factors of changes for the companies fall into the categories of: strategy changes, organizational growth process, life-cycle of the organization. The main external drives of organizational changes are within the domains of the market dynamics, new technologies, and socio-economic trends.

Organizational changes can be observed with respect to five key elements of organizational design. Mismatches between and within these key elements of the organizational architecture result in occurrence of distorted performance (Fig. 3). These circumstances in turn require the intervention and changes in the domain of key elements and their relationships.

Organizational changes in the domain of structure are particularly important. According to one definition, organizational structure represents a system of mutual relationships and

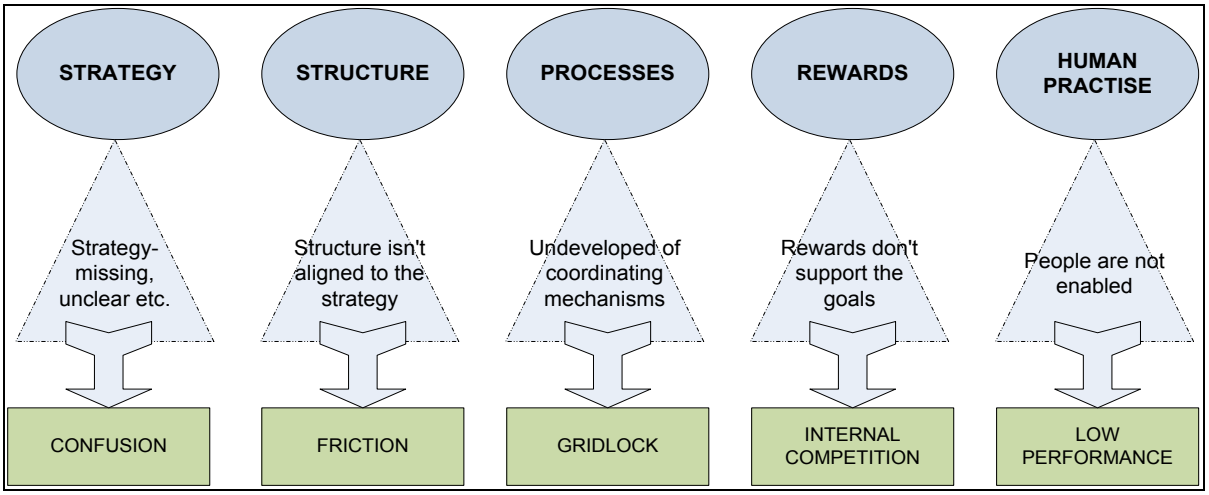

Figure 3. Effects of mismatch of organizational design elements [7; pp. 4-5].

connections in the company (organization). Structuring of an organization involves distribution of power (authority) as well as responsibility to existing organizational units and individuals. Suitable organizational structure provides support to the successful implementation of strategy and strategic plans, whereas unsuitable structure obstructs it [8; p.107].

There is a variety of types of structure, and most common versions are: simple structure, functional structure, divisional, project structure, matrix, and so on. When selecting and analyzing a suitable structure it is important to take into account the so-called dimensions of organizational structure, such as: complexity, centralization, formalization. When selecting a suitable design and organizational structure one can choose among a number of possible combinations of types and characteristics of the structure dimensions. In reality, inside the organizational structure, apart from the one formally declared and implemented, there also exists the informal structure. This formation usually emerges over the time, as a result of interests and interactions between agents, and it promotes their specific goals and aspirations.

Self-organization is a process typical of the complex adaptive systems in which components of the system communicate with each other in a way that can be described as spontaneous. These phenomena occur in practice in real organizations. Parts of the system are adapted and coordinated to produce certain common behavior. Creative organizations are developed through the crisis and no-stability phases and they create a new, more complex form of inside order in an unexpected way. In this context, new strategic directions to a greater extent emerge and to a lesser extent are planned [9; pp.240-241]. So in addition to changes in the organizational structure the process of self-organization is also responsible for changes in the field of strategy.

The changes that are due to the complexity phenomena do not always produce positive effects. Organizational adaptation i.e. structural learning result in the changes of the organizational structure and these changes are generally for the better. However, due to the new distribution of agents with empirical and other knowledge, certain negative patterns occur so that the agents in new environments do not have satisfactory interactions and responses in relation to their knowledge [2, 3]. So the process of knowledge management is definitely degraded to a certain extent, due to organizational adaptation.

With an aim to maintain successful performance CAS are able to change their structure, strategy and processes. That is why different types of organizational flexibility are recognized and required [10, 11]:

1. flexibility of processing (related to business processes improvement),

2. flexibility of planning (enables fast reaction to unexpected events, addressed to the adaptation of organizational strategy),
3. flexibility of resource allocation,
4. hierarchical flexibility (regarding the relations of power and decision-making, along with allocating resources is addressed in the adaptation of the structure of the organization).

From the listed organizational flexibility types it is obvious that flexibility covers main elements of the organizational design (Fig. 3). The changes of organizational strategy, the purpose of which is adaptation to the requirements imposed by environment, occur by analogy with the changes in the structure, thanks to mutual interactions of interconnected agents. Casual ingredients of strategy then emerge, something that is not proclaimed or defined as a method, but in reality they emerge, crystallize and act. In modern paradigms of strategic management and organizational theory increasing attention has been focused on business processes, so its changes are particularly important for the organizations. Range of changes goes from those incremental, often related to automatization and implementation of information technology, toward the reengineering of business processes (BPR). Radical operation using the full range of techniques and tools as well as with cross-functional characteristics makes BPR demanding performance that however often gives dramatically improvements. BPR is the creation of entirely new and more effective business processes, without regard for what has gone before [12; pp.4].

In addition to affecting the structure within the limits of organizational borders, contemporary environment and business conditions influence creation of new possibilities for expanding boundaries. Business processes can go across the number of organizations and in this they support connections of diverse systems. In the view of market as a broader environment with complexity attributes, agents present here are in fact different organizations with their specific goals and interrelations. Self-organizing and new structures are created in the form of strategic alliances, clusters, networks, virtual organizations.

Different organizational changes of the strategic levels mentioned above represent to a large extent adaptation to new and different circumstances. We consider adaptation as a process or state of changing, aimed at fitting in and adjusting to a new environment, or to different conditions and the resulting changes. Adaptation of a system sometimes requires modifications.

ADAPTATION AND LEARNING

As for adaptation of an organization to its environment, and the changes that occur as a consequence of that adaptation, it needs to be noted that there are several approaches covering this area. They have roots in the fields ranging from psychology to cybernetics. In that respect Senge mentions learning organizations, Stacey elaborates dynamism and non-linearity of behavior, Forrester et al. successfully applied the theory of systems several decades ago. Apart from them, there is a whole range of authors who were investigating the near domain of knowledge management.

Argyris considers types of learning and organizational learning. In his view, adaptation is connected with learning in the way that it is close to the so-called ‘single-loop learning’ [13; pp. 115-124]. According to Zack [14], the ability of an organization to learn, accumulate knowledge from its experiences, and reapply that knowledge is in itself a skill or competence that may provide strategic advantage.

The *organizational leadership* in the learning organizations must institutionalize and improve the process of *knowledge collection*. Knowledge collection involves the process of observing the external environment and the internal process of performance measurement. It also

involves various initiatives, such as launching of programs in the domain of development of technology, science and so forth. The cumulative *modification of the process*, which results in the growth of organizational competences ensures promising responses to future crises caused by environmental phenomena. This is the second key ability of successful learning organization. In the context of strategic decision-making organizations can also be considered as *interpretation systems*. Organizational interpretation is defined as a process of understanding events and creating mutual understanding and conceptual schemes among members of senior management.

Changes within an organization call for learning of something new, adjusting to a new way of carrying out operative activities. Changes demand application of the newly learned knowledge and performance in a new way. In that sense learning is not just a process of acquiring knowledge based on experience. It also implies a component of action taking. Kolb provides a well-known model of experimental learning, which includes four stages closed in the learning cycle [15; pp.9-14, 16]:

a) concrete experience,
b) reflective observation,
c) theoretical concepts,
d) practical experimentation.

Adaptive organizational changes manifest themselves over time in reduced magnitude of effect of destabilizing events that occur in the environment, and also in the accelerated and successful restoration of the system to the good state [17]. The requirements for successful adaptive organizational changes can be summarized within the following five categories [18; p.536]:

1) distinctive features of organization in the process of system changes must be in line with the company's strategy,
2) in most of the cases the process of changes must be iterative and dynamic because adaptive changes occur under the circumstances of uncertainty and external conditions that are also subject to changes,
3) adaptive changes call for learning about the ways of achieving the required structure, processes and organizational behaviour,
4) the support to organizational changes must be provided by as many stakeholders as possible (owners, managers, employees, clients),
5) adaptive changes must be effected on all organizational levels, but most of the responsibility lies on the management.

The leadership and top managers have a specific role in organizational changes. When observing the organizational metaphor of the so-called ‘flux and transformation’ as opposed to, for example, the metaphor of ‘political system’, one can notice a significant difference in the expected roles of leaders and required traits of leaders. Traditional metaphors saw leader as the main designer, the one that implement changes, a skilled orator. It used to be a person with a vision, someone who is familiar with project management, who supervises and controls. In recent metaphors, those close to the theory of complexity, the leader is “facilitator of emergent change”, he makes connecting possible, amplifies issues [15; pp.122-123]. So, leaders appear as particularly relevant agents within organization that are complex adaptive systems in which various interactions take place.

When we talk about successful adaptable changes we need to mention the concept of “adaptive cycle” that promotes three properties important for the development of the system in the future [19] . They include wealth, controllability and adaptation potentials. Wealth

implies the system potentials that determine the range of possible options in the future. Thus are determined the limits of the possible. The inner controllability of the system relates to the degree of interconnection between the process and control variables, and indicates the degree of flexibility (or rigidity) of the control. At the same time, controllability indicates the maximum level at which the system is capable of controlling its own fate. As opposed to the vulnerability of the system, the adaptive capacity is determined as a measure of elasticity in response to unexpected disorders or shocks. Such unexpected external impacts can also change the level of internal control [20].

The concept of complexity imposes and identifies new principles in the organizational design and in the behavior of the system, both its parts and its wholeness. It also incites the building of preconditions for successful responses of the organization to potential atypical events and impacts. As seen by a number of prominent theoreticians, complexity and its dynamics represent a barrier to the learning as we perceive it within a traditional organizational theory. Numerous entities with their interactions, positive and negative feedbacks, create non-linearities and unexpected phenomena, when it is hard to make conclusions following certain rules in force. Complexity slows down agents' learning (individuals and organization) because the feedback on the effects of decisions and actions taken also includes delays, errors, limited perception. Some processes that occurred are irreversible; new rules apply to new circumstances. Variables simultaneously change, and it is hard to decide what their mutual relationship is.

Given that the learning of decision-makers in the conditions of complexity is slowed down and made difficult, the decision-making is growingly demanding, and the mistakes made in that process are likely to be more frequent and more serious. As a result, more attention is being paid to the structuring and implementation of a system that provides support to decision-making.

DECISION-MAKING IN ORGANIZATIONS – BUSINESS INTELLIGENCE SYSTEM

Modern business environment implies complexity, which cannot be reduced in a simple way; therefore there are a number of factors to be considered in order to make appropriate decisions. To make sure that decision-makers have the required and correct information when deciding, it is necessary to build support systems that are called business intelligence systems (BI). They are tasked to collect and structure information and ensure targeted service for decision-makers in terms of providing them with information, processing of relevant parameters, variables and factors in the domain of business activities and environment of an organization.

Among numerous definitions we have singled out the one by Moss and Atre [21] who claim that business intelligence is primarily architecture and collection of integrated operative applications and applications to support decision-making, as well as the database that provides businesspeople with an easier access to relevant data. From the technical point of view, business intelligence is a system that automatizes collection of data from different sources, processes them, transforms them and delivers them to end users. Business intelligence is a response to the growing need for information and analytical tools indispensable for [22]:

- transformation of data into information,
- better management of daily operations by using relevant and updated business data,
- faster decison-making, based on relevant and updated information.

Collecting of information is a demanding job that requires time and engagement of resources. On occasions it is necessary to make decisions very fast, because a timely decision is worth more than a quality decision made too late. According to some authors, modern organizations spend as much as 80 % of time in collecting information and 20 % in analyses and decision-making [23]. Special value of a good business intelligence system is in that it may reduce both the time for decision-making and the time for data collection.

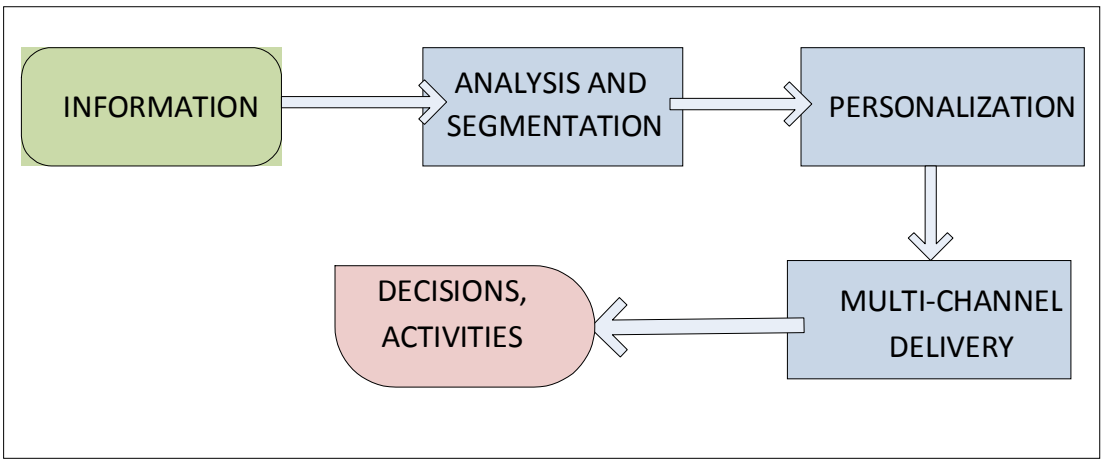

Figure 4. Components of the business intelligence model (modification from [24; p.26]).

Business intelligence helps transforming collected data into quality information needed in decision-making. While traditional systems that provide support to decision-making tended to ignore personalization of information, business intelligence takes it into account (Fig. 4). Through analysis and segmentation these systems direct data at individual employees by using, in general, a larger number of channels. Once he received information, the manager, as the entity that is in interaction with other components of the system, takes certain actions or makes appropriate decisions.

People who come from military circles, intelligence community, diplomacy, but also a large part of non-professionals equate business intelligence with espionage-related activities. For this particular part of the entire field of BI it can be said that it is close to the sub-category called competitive intelligence. Prescott and Miller [25] define the concept of business intelligence that comprises five types of intelligence: *Competitive intelligence*, *Customer intelligence*, *Market intelligence*, *Technical intelligence* and *Partners intelligence*.

Nowadays the requirements of complexity are more and more prevalent, and they impose the need for modernization of the concept of BI. Obstacles to learning and decision-making are also largely present in the classical BI systems. That is why more suitable solutions are being sought to support decision-making. One of the promising concepts that provides support to adaptation and modified decision-making is the so-called *adaptive system of business intelligence* [26]. This system is designed to meet the needs of complex conditions found in the environment.

ADAPTIVE BUSINESS INTELLIGENCE

Strategic decision-making and consideration must always take into account the future, and work out possible scenarios that will dominate the world of tomorrow. Consequently, it is necessary to anticipate expected changes and states of certain factors, variables and parameters by means of different methods. Particularly valuable scenario includes analysis because it opens the way to the estimation of discontinuity and the results of nonlinearity, which encompasses the effects of the presence of complex circumstances. Scenarios are

actually prudent, but also speculative stories intended to incorporate the concrete world of today into the envisaged set of future circumstances [27; p.45].

Organizational decisions that need to be implemented through operative actions are predominantly made on the basis of the current data or, at best, on the basis of linear predictions for situation in a short-term period. Due to the complexity of the environment and nonlinearity, those decisions are likely to be far from optimal. One of the ways of providing support to decision-making that meets the needs of new demands is the so-called system of adaptive business intelligence. The whole concept is based on the system of classical business intelligence. It employs the same infrastructure and techniques, but it is upgraded with specific new modules. These are system components that make possible *prediction*, *optimization* and *adaptation*.

Adaptive BI system (ABIS) includes the adaptation mechanism in the form of a sub-module, and it should be structured so that it can [26]:

- perform data search (avilable data are prepared and analyzed in detail),
- use prediction models, at which prediction module is built on the basis of results of data search,
- contain optimization module based on prediction modules,
- upgrade prediction module and thus contribute to more precise prediction of changes in environment, etc.

The structure of the aggregate model is such that it contains certain modules that are intended for specific purposes. The prediction module within the system may contain several sub-models and its basic function, depending on input data, is to generate the output, i.e. provide prediction with certain accuracy. The prediction model needs to be „trained“ first, and this is done by employing historical data [26]. For this activity of prediction various approaches, methods and tools can be used (forecasting, regressive analysis, neuronic networks, decision-making trees, etc.). The purpose of optimization, which is performed in a separate module of adaptive BI, is to detect the best solution of all potential and accessible solutions. Sometimes we restrict ourselves to the search for a set of satisfactory solutions. Of course, we can test sensitivity of the solutions. Optimization methods that are suitable for use can be found in the category of “classical” methods (linear programming, dynamic programming, etc.) and/or the category of “contemporary” methods (genetic algorithms, neural networks, etc.). Optimization module must be capable of recommending the best solution that is based on the outputs of prediction modules.

Adaptive business intelligence system has to be adjustable in the way that it is capable of learning and adapting to the changes that occur in the environment. At that the adaptation sub-model has the leading role (Fig. 5). The higher level of adaptation implies the learning from data, but also from own predictions and errors. To detect discrepancies between the

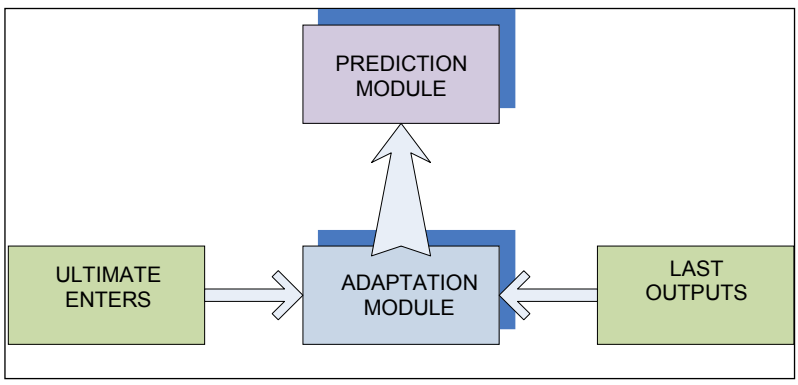

Figure 5. Adaptive part of the ABIS [26; p.44].

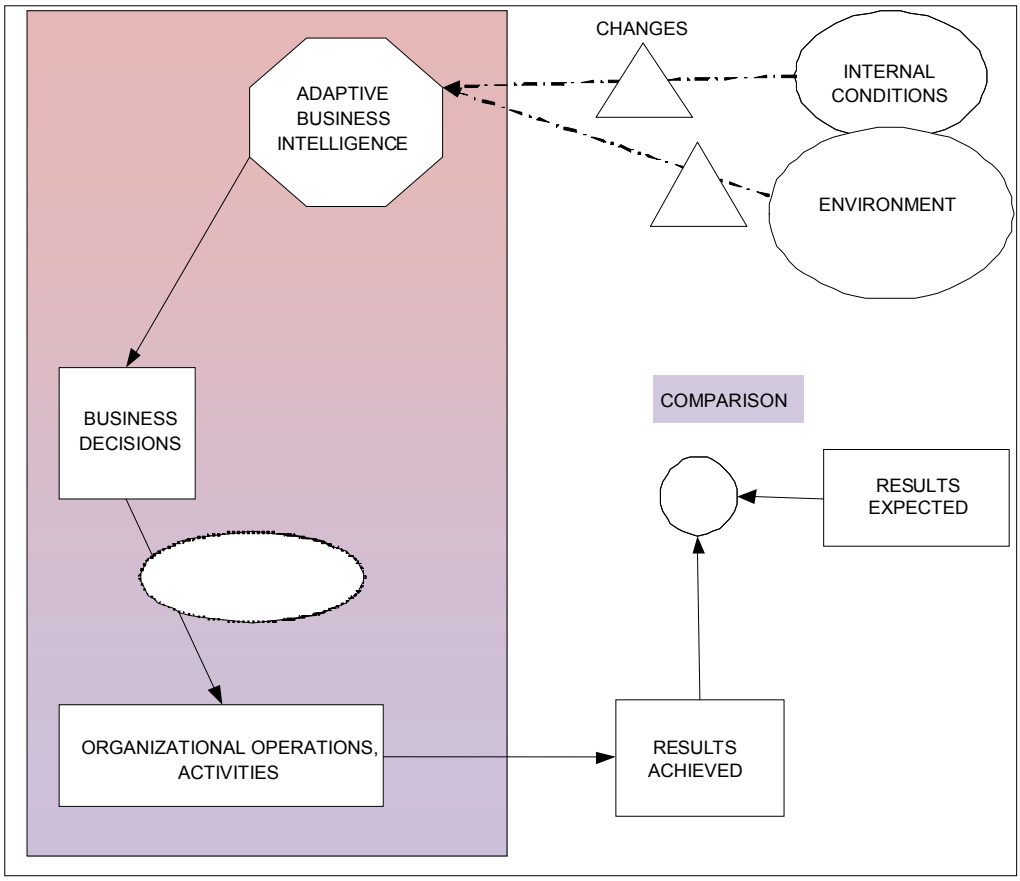

Figure 6. Framework of functioning of adaptive organization with adaptive BI system.

predicted results and the real results adaption module compares certain predicted and real values. If there is an error, adaptation module must be modified (adapted) so that it can be reduced. Adaptation module can be „adjusted“ to the changes in the environment by changing certain rules in the process of concluding [26]. It is possible to build it so that it is constantly adapteds through measuring and monitoring of own errors in predicting.

In reality adaptive organization that implements adaptive business intelligence system functions in effect as described in Fig. 6. The cyclic development of adaptations within an organization in a range of time iterations results in occurrence of interpretations, decisions, implementations of decisions, and evaluations of achievements. Decisions, their quality and the subsequent achievements come back in the form of feedback to the adaptability module. The BI system delivers the requested information accordingly, and creates knowledge. Data on environmental factors, business results, situation in the organization, and data on expected changes (prediction), initiate the decision-making system and activities in the way that is corresponds more with the condition of complexity. That is why the responses and behavior of this system are sometimes non-standard, because it operates in the process of adaptation.

As regards the functioning cycle, what follows after managers' decision are actions. A trend in the contemporary organization theory that has become growingly relevant is known as "action perspective", and this stream represents the analytical option that needs to be taken into consideration in addition to the already recognized realistic decision-making perspective [28; p.258]. At that one can start from the viewpoint that organizations are best understood as action generators [29].

It is particularly important to establish if such learning and adaptive framework function properly. Here we will focus on less formal considerations. In fact, such system of activities inevitably implies the generating of errors at more than one place, and then they propagate in iterative points of time in the process. Errors occur due to:

- inaccuracy of perception and interpretation of internal data, external environment, and data on changes,
- (im)precisions of prediction (forecasting) of the model in the BI system,
- limited rationales of decision-makers,
- interpretations of decisions on what actions should involve,
- (im)precisions of actions relative to implementation of decisions, etc.

Table 1. Errors in the organization.

Time	t_1	t_2	t_3
Event	data, information	decisions	Actions
Output		$f_1(data)$	$f_2(decisions)$
Errors	Er(data)	Er (decisions)	Er (actions)

Errors that occur as a result of imperfection of decision-makers, i.e. their limited rationality, are well known to all those who act in practice, or study issues of decision- making. It can be said that decision-makers are bounded rational in that they are only partially aware of the information available and are not able to fully analyze it [30; p.26]. What is common to the majority of errors is that they propagate through the system and if they occur in the initial parts and phases, their size is likely to assume other, usually larger dimensions.

$$er(data) \rightarrow er(data) + er(BI) + er(\text{interpretation}(data)) + er(\text{decision making}) \rightarrow \\ er(data) + er(\text{B}I) + er(\text{decision making}) + er(\text{interpretation}(\text{decisions})) + er(\text{actions}) \quad (1)$$

Errors (Table 1.) also occur in the correction-related activities (optimization, adaptation) since the functioning of the adaptive BI system itself is not quite precise. Of course, the intention is to reduce all errors, especially those that are likely to be serious and which occur at the onset of the functioning of the cycle. The approximate equation (1) illustrates how initial errors assume new dimensions and summarize with them.

Throughout this cycle (*perception – decision-making – action*) errors occur in different phases, and through propagation they generally initiate their own growth. The system of the so-called adaptive business intelligence should provide support and enhanced recommendations for decision-making in general. This will contribute to the better and more adaptive decision-making. In order to enhance its properties in general, the organization such as CAS must build up its flexibility, especially in the domain of processing, hierarchy, and planning. The adaptive BI system only partly supports the overall adaptability. Errors that we analyze eventually result in non-optimal *organizational behaviour*, less perfect *actions* and business operations. Therefore, to enhance organizational adaptations even more, improvements must encompass the whole "learning and doing" cycle rather than just the decision-making phase. Mental maps changes are essential to occur through the whole organization [5], in all relevant processes.

There is another circumstance present here that contributes to enhanced adaptability. The interaction of a large number of agents involved in the making of modified decisions gives an impulse to the enhancement of adaptability. That will stimulate additional processes of self-organizing of the higher levels that are characteristic for CAS.

CONCLUSION

If we look at an organization in terms of the metaphor of the complexity theory, we perceive it as a complex adaptive system (CAS). It contains a great number of independent entities, agents that behave in accordance with its goals, and their relationship is that of mutual interaction. Due to connections and interactions there occur higher levels of organizing, cores of new structures, self-organization, and emergence.

The complexity in organizations and their environments call for organizational adaptation in the form of well designed and yet spontaneous changes of structure, process, and strategy. The conditions of complexity require a different design, new leadership, and more advanced decision-making. Adaptation of an organization to its environment is linked with the practice of organizational changes. Generally, *organizational change* is motivated the move the ongoing situation towards certain desired situation in the future that is aimed at increased efficiency and competitiveness. Organizational changes call for learning of new knowledge. However, in operative terms, they call for adaptation to new ways of performing operative activities.

Learning is a prerequisite for organizational changes, whereas complexity is a barrier to learning as perceived by the traditional organization theory. Numerous entities with their interactions, and processes of positive and negative feedbacks incite emergence of nonlinearity and unexpected outcomes. At that adoption of regularity and legality is slowed down and rendered more difficult. Leaders have a significant role in the launching and implementation of complex organizational changes. They must be successful in scanning and interpreting of environment, and they must motivate people to accept adaptive changes. For the better adaptation organization must develop flexibility, especially in the domain of structure, execution of processes, planning and allocation of resources.

Decision-making, as one of the crucial phases in the cycle of adaptive learning is raised to a higher level by means of support system that reduces the burden of complexity. The widely adopted support is provided by means of the business intelligence (BI) systems, which collect information, structure them and provide decision-makers in organizations with relevant information. To ensure quality decisions and higher adaptability more advanced concepts are structured, such as the so-called adaptive business intelligence. This system is based on the classical business intelligence that is upgraded with specific new modules intended for *prediction*, *optimization* and *adaptation*. Although this approach ensures better conditions for decision-making and better chances of success, it is not easy to minimize the problem of propagation of errors through the decision-making system and acting upon those decisions.

To enhance the ability of adapt in general, organization such as CAS must work on its flexibility in terms of design solution. The adaptive BI system partly steps up the level of overall adaptability. Errors occurring here in the cycle from perception to action eventually result in non-optimal *organizational behaviour*. Therefore, adaptation elements present only in the stage of decision-making, by means of the BI system, are not enough. For a more successful organizational adaptation improvements must encompass the entire organizational *learning and doing* cycle and all segments and levels – all the way to the action itself – operative, tactical and strategic.

REFERENCES

[1] Miller, J.H. and Page, S.E.: *Complex Adaptive Systems*.
Princeton University Press, 2007,

[2] Eoyang, G.H. and Berkas, T.H.: *Evaluation in a Complex Adaptive System*.
http://www.chaos-limited.com,

[3] Carley, K.M.: *Adaptive Organizations and Emergent Forms*.
http://www.heinz.cmu.edu/research/86full.pdf,

[4] Carley, K.M.;Gasser, L.: *Computational Organization Theory*.
In Weiss, G., ed.: Distributed Artificial Intelligence. MIT Press, Cambridge, Ch. 7, 1999,

[5] Senge, P.M.: *The Fifth Discipline- The Art and Practice of the Learning Organization*. In Croatian.
Mozaik knjiga, Zagreb 2003, 1990,

[6] Jones, G.R.: *Organizational Theory, Design and Change*.
Pearson Education, Inc., New Jersey, 2004,

[7] Galbraith, J.; Downey, D. and Kates, A.: *Designing Dynamic Organizations – A Hands-On Guide for Leaders at All Levels*.
AMACOM, USA, 2002,

[8] Beitler, M.A.: *Strategic Organizational Change – A Practitioner's Guide for Managers and Consultants*.
Practitioner Press International, USA, 2006,

[9] Stacey, R.D.: *Strategic Management and Organisational Dynamics*.
MATE d.o.o., Zagreb, 1993,

[10] Tsourveloudis, N.C. and Phillis, Y.A.: *Manufacturing flexibility measurement: a fuzzy logic framework*.
IEEE Transactions on Robotics and Automation **14**(4), 513-524, 1998,

[11] Levchuk, G.M. et al.: *Design and Analysis of Robust and Adaptive Organizations*.
Command and Control Research and Technology Symposium (A2C2 session), Annapolis, 2001,
ieeexplore.ieee.org/iel5/7658/20944/00972954.pdf?arnumber=972954,

[12] Robson, M. and Ullah, P.: *A Practical Guide to Business Process Re-Engineering*.
Gower Publishing Limited, 1996,

[13] Argyris, C.: *Double Loop Learning in Organizations.*
Harvard Business Review, September-October 1977,
http://hbr.org/1977/09/double-loop-learning-in-organizations/ar/1,

[14] Zack, M.H.: *Developing a knowledge strategy.*
California Management Review **41**(3), 125-146, 1999,

[15] Cameron, E. and Green, M.: *Making Sense of Change Management.*
Kogan Page Limited, 2004,

[16] Kolb, D.: *Experiential Learning.*
Prentice Hall, New York, 1984,

[17] Mase, C.: The *Adaptive Organization.*
Shift: At the Frontiers of Consciousness **22**, 26-31, 2009,
http://hbr.org/1977/09/double-loop-learning-in-organizations/ar/1,

[18] Cummings, T.G. and Worley, C.G.: *Organization Development &Change.* 9th edition.
South-Western College Publishing, Cincinnati, 2009,

[19] Holling, C.S.: *Resilience of ecosystems; local surprise and global change.*
In Clark, W.C. and Munn, R.E., eds.: *Sustainable development of the biosphere*. Cambridge University Press, Cambridge, pp. 292–317, 1986,

[20] Holling, C.S.: *Understanding the Complexity of Economic, Ecological, and Social Systems.*
Ecosystems **4**, 390–405, 2001,
http://www.tsa.gov/assets/pdf/PanarchyorComplexity.pdf,

[21] Moss, L. and Atre, S.: *Business Intelligence Roadmap.*
Addison-Wesley, Boston, 2003,

[22] Williams, S. and Williams, N.: *The profit impact of business intelligence.*
Elsevier Inc., San Francisco, 2003,

[23] Liautaud, B. and Hammond: M.: *E-business Intelligence.* In Croatian.
Prudens Consilium, Varaždin, 2006,

[24] Panian, Ž. and Klepac, G.: *Business Intelligence.* In Croatian.
Masmedia, Zagreb, 2003,

[25] Prescott, J.E. and Miller, S.H.: *Proven strategies in competitive intelligence.*
John Willey & Sons Inc., New York, 2001,

[26] Michalewicz, Z. et al.: *Adaptive Business Intelligence.*
Springer-Verlag, Berlin, 2007,

[27] Perrottet, C.M.: *Scenarios for the Future*.
Management Review **85**(1), 43-46, 1996,

[28] Graeme Salaman, ed.: *Decision Making for Business.*
SAGE Publications, 2002,

[29] Starbuck, W.H.: *Acting first and thinking later. Theory versus reality in strategic change*.
In Pennings, J.M., ed.: Organizational Strategy and Change. Jossey Bass, San Francisco, 1985,

[30] Trefor, J.: *Business Economics and Managerial Decision Making.*
Manchester School of Management, John Wiley& Sons, 2004.

KOMPLEKSNOST U ORGANIZACIJAMA I OKOLINI – ADAPTIVNE PROMJENE I ADAPTIVNO ODLUČIVANJE

R. Fabac

Fakultet organizacije i informatike – Sveučilište u Zagrebu
Varaždin, Hrvatska

SAŽETAK

Obilježja kompleksnosti sve su prisutnija u suvremenim organizacijama kao i u okolini unutar koje organizacije djeluju, nastoje opstati i biti konkurentne. U procesima tzv. emergencije (eng. emergency) formalna organizacijska struktura oblikovana svrhovito i planirano, uslijed kompleksnosti i potreba adaptacije mijenja se te nastaju različiti oblici neformalnih grupa i novog ponašanja. Paralelno se događaju namjeravane strukturalne promjene i promjene poslovnih procesa uslijed percepcije lidera i glavnih menadžera organizacije u vezi strateške situacije. Pri donošenju značajnijih poslovnih odluka menadžeri suvremenih organizacija koriste sustave poslovne inteligencije, a koji pružaju potporu odlučivanju putem pribavljanja i obrade relevantnih podataka i informacija u vezi performansi kompanije, ali se također odnose i na stanje bliske i udaljene vanjske okoline. Suvremena kompanija ima obilježja kompleksnog adaptivnog sustava ali je kompleksna i okolina u kojoj djeluju i drugi poslovni subjekti (tzv. agenti) te stoga zahtjevi za dobrim odlukama i uspješnim aktivnostima nisu jednostavni za ispuniti. Očekivani budući događaji i okolnosti nastaju nerijetko po nelinearnim mehanizmima i zato odluke donesene sukladno modelima tradicionalnog predviđanja i planiranja ne zadovoljavaju. Potrebni su novi pristupi u odlučivanju i djelovanju.

KLJUČNE RIJEČI

kompleksnost, kompleksni adaptivni sustavi, poslovna inteligencija, odlučivanje