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University system as a complex adaptive system

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Abstract
The systems theory represent that human societies as complex systems. The highest system-level, complex systems are v by Adaptation. The purpose of this study, the coherence properties of a complex adaptive system in a variety of research related to this field. In this regard research questions include: What are the characteristics of the adaptive complex systems? Are there any features adaptive systems can be theoretical framework for the management of universities as a complex system offer? In this context, the present study all the articles of the Google homepage, site Shahid Beheshti University, Central Library and scholarly journals available in the library Shahid Beheshti University in complex adaptive systems. The book (Sporn, Barbara, 1999) as well as Latin was used as a source document. 54 abstracts and books related to complex adaptive systems were received. Of those, 21 papers received and examined thoroughly. Selected passages from eleven papers related to research and the translation of other texts was not used. After reviewing the terms, key concepts extracted from the convergence of concepts, research directed towards a category the extracted concepts with analysis, classification (categorization) was content analysis. Article key phrases in the five main categories as of 1 interaction and the environment, (2) the control (relative independence elements), 3-changing and constantly evolving, 4 Self-organization (self-regulation, to choose, to decision-making, feedback) 5. Complexity (number of factors, interacting factors, uncertainties and dynamism, respectively. the framework was presented to the University of adaptive complex.

Keywords: intravenous injection, contrast media, radiographers

1. Introduction

Community, because of its social, human and cognitive identity, is among the open and complex systems in which information are permanent (Andriani & Passiante, 2001, Simon, 1962) [1]. The word "complexity" represents a dynamic system located between order (in which nothing changes like crystalline structure) and total disorder state (like dispersion of smoke). The behavior of these systems change as the time elapses and these systems are so sensitive to in initial conditions of their occasions, speed and so on, such that slight deviations in their causes bring about great differences in their impact. So predicting performance of these systems beyond time would have multi-behavior that is impossible. Because of that, it seems they obey no rules and mostly they act upon happening. With this description, dynamic systems in these conditions indicate regular collective structures, although it is not possible to detect the individual behavior of each of their elements (Morin, 1990) [18]. They have used practical and theoretical systemic thought of social phenomena. Since the systematic thought was represented as a way to deal with phenomena and issues, so for so many studies have been performed that among the main concepts of systemic approach (interaction, communicating with environment, organizing and complexity totality), the concept of "complexity" has attracted the attention of natural and human science scientists (Duran, 1983) [5]. Authors Le Thanh Khoi (1991) [14] says about the relation between the concepts of complexity with the issues of social systems: inconsistencies and probabilities extant in political, economic, social and cultural systems is related to the concept of complexity. The basic challenges of systemic approach is more precise understanding of complexity of occasions and phenomena in sporadic manner. For example education that is a general phenomenon meanwhile simultaneously is one of the elements of more general phenomenon called society. One of the defects of studies and historical and sociological examinations of education is that discuss it just from the perspective of formal institution and consider training thoughts without the relationship with political, economic and social text i.e. independently. This precise perspective makes impossible any deep understanding of education and society (Khoi, 1991) [14]. So the higher education system like education and any social and human system, is related to the concept of complexity and the most important of the complex systems' assumption is that in the case of decreasing complexity and variety of its behaviors, the system will be sentenced to deterioration (Morin, Domingo and Sybvrna, 2000; Peng Long, 2006) [18]. It is the case the programming

for social and human systems like higher education and education is performed according to environment simplification. An environment which have the feature of complexity and complexity is its identity. Among the reasons of non-success of college plans, having plans appropriate with environments has been facilitated which is not matched with a complex environment. On this basis, planning based on simplification of complex environment of university can be so useful and requires plans proportional with truth of complex system if university (Ka In Shivonne, 2006; Mcclellan, 2010, Mcclellan, 2006) [12, 15]. But what is the feature of the complex environment, so that we can plan the features by knowing that? Yamani (2003) states about the complexity of system features, complex system has the feedback mechanism, complexity of university system is related to the number of different elements and was of communicating among related components. Class is especially run by student-based method and the feature of this class is that among the emergence of new information, there are so many dynamic varieties. The variety of behaviors is the same as organization complexity. This variety of behaviors is general which is not detectable before happening or emergence. Each organization comprises a number of humans with vast behavioral capabilities, a general set with potential and numerous variation. Aside from interaction and complexity, university system has totality in complexes whatever makes the totality, is two concepts of interaction and complexity. Among other features of university complex system, is organizing. Organizing of university complex system is not static. And the concepts of interactive communication, complexity and totality do not hinder organizing. Embedded in organizing, we should consider order and disorder concepts. Disorder is generator of self-organizing. Also Sporn (1999, p 74) [22] states: university has been recognized a disordered system having organizational chaos with low rules and control mechanisms. This definition is related to partial self-organizing units like colleges and departments so, complexity theory is originated from system thought and represents new conceptual tools for planning in universities. Integration of order and disorder in complex and probable systems, organizing and behavioral totality are among these conceptual tools have been examined in general systems theory so far (Khoi, 1991; Innes & Booher, 2000; Jayan, 2013' Fenwick; 2010, James Murray, 2012) [14, 9, 10, 6, 11]. But the most important concept in complement with features related to complex systems is adaptive. Adaptive of complex systems as a concept tool can propose a new look for increasing university system capability (Chan, 2001, London health foundation, 2010, McCarthy, 2003) [3, 8]. Adaptive indicates system capacity for alter or change and change is ability of learning from experiences (Begun, Zimmerman and Dooley, 2003, p 255) [2]. Adaptive complex systems are prevalent everywhere like stock market, human body, figures and cells, tress, schools, universities (ibid). Sporn (1999, p 74) [22] states: universities have been mostly recognized as disorganized systems with organizational chaos with low rule or control mechanisms. This definition is related to partial self-running of units like colleges and departments. He believes that university is also a complex adaptive system. In the present study, theoretical achievements of adaptive and complex context from 2000 to 2012 will be discussed and a framework will be proposed for examining university as an adaptive complex system and in this case following questions will be answered.

The keywords of articles were classified in 5 components 1- system and environment interaction, 2- control issue (partial independence of elements), 3- continuous alter and change, 4- self-organizing (self-regulating, able to choose, able to decide, feedback), 5- complexity (numerous factors, interaction of factors and probability and dynamism) (table 1).

Table 1: main categories extracted from sample articles

1	university and environment interaction
2	control issue (partial independence of elements)
3	continuous alter and change
4	continuous alter and change
5	continuous alter and change

In the first category, one of the most important features of the adaptive systems has been considered interaction between environment and system (table 2). The studied articles which discussed different systems, has considered the first and prominent feature of complex adaptive systems bilingual interaction of environment and system. The discussed expression and the extracted concepts from them has been proposed as interaction with environment in the following table.

Table2: the category of interaction with environment in complex adaptive systems

Even that system after passing time may be similar to its previous configuration. The context for each adaptive system is unique as any adaptive system is dependent on its own context (Begun, Zimmerman, Dooley, 2003, p 256) [2].
The feedback obtained from different environments, causes learning and change. In mechanic system, the change should be applied but in the adaptive systems, change can occur in the suitable conditions intrinsically (Plsek, 2001, p 313) [20].
Context and embeddedness: systems are located inside other systems also affect other systems and this matters (ibid). For example, decrease of money in Thailand affects stock market in America. In machine and mechanical systems, some part can be motivated and predict the detected response of other parts (Plsek, 2001, 314) [20].
Although some parts of complex adaptive system can be studied but its context is also important (ibid).
The general basis of these systems is the change structure in them (Holland, 1992, p 18) [7]. The change structures means that these systems change and reorganize their components along with their adaptiveness with problems surrounded them (Holland, 1992, p 18) [7].
A dynamic system changes by the input energy while a static and invariant system is decreased and remains in this state and cannot grow and develop and reorganize itself (Johnson, 2009, p 13, 14) [24]
The world is full of systems. Weather, body immunity, social and so many similar systems increasingly adapt with their environment (London health organization, 2010, p 6). Organizational adaptive requires structural modification or alteration

for responding to external environment changes (sporn, 1999, p 75) [22]. There is a stable and consistent search between organization and its environment (sporn, 1999, p 75) [22].
According to a new perspective, adaptiveness is falling in imbalance between on organization and its environment (sporn, 1999, p 75) [22]. Studies of critical organizations in commercial systems indicates that the existence of a crisis, is the main organizer of adaptiveness (sporn, 1999, p 75) [22]. Organization in both cases seems reaction able (sporn, 1999, p 75) [22].
Adaptiveness is search proportional with external restrictions. Two adaptive responses help this objective: changing environment t for harmonizing with organization or changing organization for harmonizing with environment (sporn, 1999, p 75) [22]. The context of higher education includes governance and university level factors pressured from the environment and in some cases present hurdles for teaching (Lea and Callaghan, 2008, p 177) [23]. These occurred pressures originate from context, and economic, political and social conditions affecting the performance of higher education (Lea and Callaghan, 2008, p 177) [23]. For understanding higher education, interaction with education context is also important which is related to dynamic process with environment (Lea and Callaghan, 2008, p 177) [23].

As we can observe, all of these concepts point to a concept and that is interaction of system and environment. The second category is "the problem of control" or "partial independency of elements". The selected expressions from sample articles related to control problem has been proposed in table 3.

Table 3: the control category (partial independency of elements) in complex adaptive systems

A system is set of links and things dependencies. In a complex adaptive system, all the things are independent factors. A factor can be a person, molecule, a version or an organization among many factors. These factors act upon local or conditions and environmental knowledge (Begun, Zimmerman, Dooley, 2003, p 255) [2].
A core body, senior Norn or CEO cannot control the individual movements of factors. Complex adaptive system has communicative network of factors full of connections each act upon its scheme or local knowledge (Begun, Zimmerman, Dooley, 2003, p 255) [2]. In complex adaptive systems, it is required that different parts of system or its various elements, have the freedom and ability to respond to the drive from different and unpredictable ways (Plsek, 2001, p 310) [20].
The thought of mechanical systems requires exact schemes and high control along with certainty and high level of assurance (Plsek, 2001, p 311) [20].
Inherent order: systems can be regulatory even without border control, self-organizing is the key idea of complexity sciences (Plsek, 2001, p 313) [20].
In complex adaptive systems control is dispersive and non-concentrated (Johnson, 2009, p 13) [24].
In adaptive complex systems we cannot use control method of up to down and in turn the role of management is: creating conditions for flexibility, self-organizing response and emerging inherent dynamisms fluctuations by enabling elements in having correct judgment and by using so many impacts of diffraction phenomenon (Clark, 1999, p 17) [4]. This process is called system self-organizing along with learning to reach objective and walk-in learning (Clark, 1999, p 12) [4]. Learning and feedback in movement brings about self-organizing and bringing about controllability of adaptive complex systems (Clark, 1999, p 12, 13) [4].
In adaptive complex system, control is inclined to dispersion and dis-concentration. The total system behavior is the result of so many persistent adopted decisions by factors (London Health Organization, 2010, p 6).
Adaptive complex system, has comprised of active elements which are independent factors. These factors are decision maker institutions. It means that they can be decision making entities that receive and process the information related to their local and range for creating change, outputs and intra-system dynamisms (McCarthy, 2003, p 730) [8].
In fact, universities often have been recognized as disorganized systems having organized chaos with less rule and control mechanisms. This challenge is related to partial self-regulating state of units like colleges and departments (sporn, 1999, p 74) [22].

As we can observe, all of these concepts point to a concept and that is partial independence of adaptive complex system.

The third category chosen for the concept of adaptive system is change and evolution of system. The expressions of author has been presented in table 4.

Table 4: category of change and evolution for so many complex adaptive systems

Complex adaptive systems are recognized with dynamic state. The numerous factors in these systems, connections between factors and the effect of external factors. All result in consistent and incessant change in complex adaptive systems (Begun, Zimmerman, Dooley, 2003, p 256) [2].
Adaptation: indicates system capacity for alter or change (ibid) and change is ability of learning from experiences.
Small changes in variables can have small effects and in other conditions can have great effects. In turn, the effects of great changes in variables can be different with so slight to so great depending on other variables (Begun, Zimmerman, Dooley, 2003, p 256) [2].
Small changes in initial conditions of an adaptive system is so important as a slight difference in start manner of system may cause great differences in results. This phenomenon is sometimes called butterfly effect (Begun, Zimmerman, Dooley, 2003, p 257) [2].
In mechanic system, change should be applied but under complex adaptive systems change can happen intrinsically under appropriate conditions (Plesk, 2001, p 313) [20]. Corporation evolution or correlation evolution: evolution or change of complex adaptive system is performed through balance and constant states (Plesk, 2001, p 314) [20].
Balance and constant state is permanent and balance is created through inside constant and constant is created though inside balance. The general foundation of these systems is change structure in them (Holland, 1992, p 18) [7]. Change structure means that these systems change and reorganize their components along with adaptation with surrounded issues (Holland, 1992, p 18) [7]. These systems have moving target (Holland, 1992, p 18) [7]. Elements in adaptive systems follow Darwinian change and growth and their aim of improvement

and advancement is survival in actions and interaction with surrounded parts (Holland, 1992, p 18) [7]. and this means element's ability for adaptation and learning which is basis of adaptive complex systems identity (Holland, 1992, p 18) [7].
Features of complex adaptive systems (Johnson, 2009, p 13, 14) [24]; simple rules of governance are used for correct behavior. The principle of growth and evolution has high rate of change. Balance states are temporal. CASs are always changing and reorganizing. CAS evolved with balance periods. A dynamic system changes by input energy.
Complex adaptive systems approach are in nature in evolutionary manner (McCarthy, 2003, p 743) [8].
Organizations which are adaptive complex systems create variability, select and maintain innovation technologies and lead the evolutionary change (McCarthy, 2003, p 743) [8].
These systems have decision capacity for awareness evolution in responding special objectives and destinations (McCarthy, 2003, p 743) [8].
Adaptive complex system have the ability of knowingly change of configuration and affect its survival in present and future (McCarthy, 2003, p 743) [8].
Complex systems like nature and social-economic systems cannot be static issue and are changing (Miller, 2012, p 9) [16].
College structure has important role in producing and regulating with environmental changes (or important role in producing and setting environmental changes) (Sporn, 1999, p 75) [22].
Functions inside structure, government, management and leadership that lead the behavior of people, groups or units in college or university (Sporn, 1999, p 75) [22].
Organization adaptation requires structural modifications or alteration for responding to external environment changes (Sporn, 1999, p 75) [22]. Adaptiveness is search proportional with external restrictions. Two adaptive responses help this objective: changing environment t for harmonizing with organization or changing organization for harmonizing with environment (Sporn, 1999, p 279) [22].
An important index is that most of adaptiveness (adaptation) includes change in financial structure of university (Sporn, 1999, p 279) [22].

As we can observe, all of these concepts point to a concept and that is change and evolution of system.

Fourth category is self-organizing. The extracted statements about the category of self-organizing has been presented in table 5.

Table 5: the category of self-organizing in various complex adaption systems

A factor can be a person, molecule, a version or an organization among many factors. These factors act upon local or conditions and environmental knowledge (Begun, Zimmerman, Dooley, 2003, p 255) [2].
A factor can be a person, molecule, a version or an organization among many factors. These factors act upon local or conditions and environmental knowledge (Begun, Zimmerman, Dooley, 2003, p 255) [2].
In adaptive complex systems we cannot use control method of up to down and in turn the role of management is: creating conditions for flexibility, self-organizing response (Clark, 1999, p 17) [4].
These systems have decision capacity for awareness evolution in responding special objectives and destinations (McCarthy, 2003, p 743) [8].
Adaptive complex system, has comprised of active elements which are independent factors. These factors are decision maker institutions (McCarthy, 2003, p 730) [8].
In adaptive complex system, control is inclined to dispersion and dis-concentration (London Health Organization, 2010, p 6).
Adaptive complex system have the ability of knowingly change of configuration and affect its survival in present and future (McCarthy, 2003, p 730) [8].
Adaptive complex systems have common features that we state four kinds related to organizations (Begun, Zimmerman, Dooley, 2003, p 255) [2]. 1-dynamic, massively entangled, emergent, 4- robust
Complex adaptive system indicates emergent or self-organizing aspect. (Begun, Zimmerman, Dooley, 2003, p 256) [2].
Emergent, surprising and creative behavior are three features for adaptive system (Plsek, 2001, p 310).
What we want to appreciate and modify in adaptive complex systems is aggregate or total behavior of system (Holland, 1992, p 20) [7].
In adaptive complex system, control is inclined to dispersion and dis-concentration. The total system behavior is the result of so many persistent adopted decisions by factors (London Health Organization, 2010, p 6).
Adaptive complex system is a model for study of relation between elements leading to general behavior of system and model for examining how to elements interact with each other and their environment (London Health Organization, 2010, p 6).
Factors of an adaptive system in their interaction with other factors also change and alter other factors and feedback looms can create change or constancy in system (Begun, Zimmerman, Dooley, 2003, p 256) [2].
Complex adaptive systems are powerful. They indicate their ability in changing themselves in response to feedback (Begun, Zimmerman, Dooley, 2003, p 257) [2].
In complex adaptive systems, it is required that different parts of system or its various elements, have the freedom and ability to respond to the drive from different and unpredictable ways (Plsek, 2001, p 310) [20].
Feedback coming from interaction with different environments cause learning and change (Plsek, 2001, p 310) [20].
In adaptive complex systems we cannot use control method of up to down and in turn the role of management is: creating conditions for flexibility, self-organizing response and emerging inherent dynamisms fluctuations by enabling elements in

having correct judgment and by using so many impacts of diffraction phenomenon (Clark, 1999, p 17) [4]. This process is called system self-organizing along with learning to reach objective and walk-in learning (Clark, 1999, p 12) [4]. Learning and feedback in movement brings about self-organizing and bringing about controllability of adaptive complex systems (Clark, 1999, p 12, 13) [4].
In big systems by networks with complex chain of interactions allows system to be self-order (Begun, Zimmerman, Dooley, 2003, p 257) [2].
In complex adaptive systems, system elements have the capability of self-order that can change themselves like human being constantly changing in life and learning (Plsek, 2001, p313) [20].

As we can observe, all of these concepts point to a concept and that is self-organizing of system.

According to the concepts in table 5 the self-organizing category has these four categories self-order, ability to choose, ability to decide and feedback.

The fifth category for complex adaptive systems is the concept of complexity (table 6). This category includes these four sub-categories numerous elements dimensions, elements interaction, probability and dynamism. These expressions have been proposed in the following.

Table 6: complexity category in complex adaptive systems

Among the adaptive complex features are unpredictability and contextualized (Peter, 2010, p 1).
Emergent, surprising and creative behavior are three features for adaptive system (Plsek, 2001, p 310) [20].
Small changes can have great effects for example great program in an organization may have low real effect (ibid), complex adaptive system in details, is unpredictable. Predicting is inherently incorrect art unless in restricted manner. For example, structural rules about pressure and gas temperatures is non-linear for this reason although there are mega computers and collecting information, still it is not possible to forecast weather for long-term and precisely. However with time and place restrictions we can have predictions for weather (ibid).
Parts of adaptive complex system are always modifying and reviewing their roles for interaction as every part is surrounded by variable behavior of other parts, for this reason, the total behavior of phenomena is unpredictable and unpleasant (Holland, 1992, p 20) [7].
Slight differences in particular parameters lead to fuzzy transfers (quality differences). Some slight differences of phenotypic between human and other mammals (like difference in memory capacity, voice machines control, sociability scale and …) because of integration and interaction leads to general different identity (Johnson, 2009, p 13 and 14) [24].
In a complex adaptive system, objective and result is beyond performed predictions and the future is unpredictable (London Health Organization, 2010, p 6).
Adaptive complex systems have common features that we state four kinds related to organizations (Begun, Zimmerman, Dooley, 2003, p 255) [2]. 1-dynamic, massively entangled, emergent, 4- robust
Adaptive complex systems are recognized by their dynamic state (ibid0.
Are dynamic network of different factors (Johnson, 2009, p 13, 14) [24]
Adaptive complex systems are recognized by their dynamic state (Begun, Zimmerman, Dooley, 2003, p 255) [2]. Complexity indicates the number of elements (Begun, Zimmerman, Dooley, 2003, p 255) [2].
So many factors in these systems all of connections and the effect of external factors lead to continuous and discontinuous change in complex adaptive systems. Relations in complex adaptive systems are combined and means they are massively entangled. Complex adaptive systems have been comprised of different parts and influenced by interdependent forces. In addition to interdependent parts, they have nonlinear and discontinues relations (Begun, Zimmerman, Dooley, 2003, p 255) [2]. The behavior of machine and mechanical system is predictable for this reason that it has not so many elements and interaction (Plsek, 2001) [20]
Complex adaptive system to large extent is self-organizing (Clark, 1999, p 11) [4], meaning that systems are product of innovation of emergent and multiple ones and created by heterogeneity and uncontrolled forces and actions (Clark, 1999, p 11) [4]

As we can observe, all of these concepts point to a concept and that is complexity of system. According to the concepts in table 6 the complexity category has these four categories, probability, dynamism and the numerous factors and interaction between elements.

2. Conclusion

The concept of adaptive, after the concept of complexity was proposed in completing smart system features. The most important feature of this concepts is considering independence of each element or factor in system such that each factor is a complex adaptive system having decisions and control power. Decision ability allows each factor step along with crises and imbalances originated from interaction between environment and system and total self-regulation of system. Increasing freedom scale of a system and its internal factors contributes self-organizing of total system. This system is complex having so many factors and it is hard to recognize interactions between these factors. Such system has the potential of self-regulation and can get the ability to control inside and it does not need planning and external absolute control and even external planning and control eliminates system, recedes it and makes it non-dynamic. But self-recognizing system is effective to increase its abilities as the adaptive complex systems are called smart systems. These systems are continuously controlling external and internal information only manage and lead the system but each element considered collecting internal and external information to appraise external factors and internal growth. This self-assessment causes elements feedback to each other and system feedback to environment. Humans and all of social systems like universities, school, and classroom are CAS systems require knowing themselves and their environment for emerging their capabilities. On the other hand, if smart and adaptive systems in the main identity of self-regulation do not have the ability to choose and decide (whether knowing or not knowing their abilities) recede and die. As grow and evolution is one of the most important

features of adaptive systems for survival. This systems use imbalance between environment and system for their own evolution and use incessant balance states for evolution route. There for the most survival requirement of these systems is reciprocal interaction between system and environment. By examining and defining features proposed in studied articles 5 features were detected: interaction of system and environment, partial independence of internal factors of system, continuous change and alteration, self-regulation (self-order, ability to choose, ability to decide and feedback) and complexity (probability, dynamism and the numerous factors and elements). Discovering these features has the primary point for training humans, social systems managers like teacher in classroom, university principal, and school principal to become aware of their abilities, these abilities ate: all of the system elements have ability to decide, choose, feedback power, ability to self-organize and self-order. Features of adaptive complex features bring about this knowing for human psychologists, trainers, and teachers, social system managers that CAS system has smartness and independence inherently. CAS system gets along with its evolution among imbalance states between itself and environment. Imbalance states for moving in the path of evolution track is necessary. Therefore. Trainer, teacher and management no only as complementary element but are observer and convergent. Management is an element that transfer information and feedback among elements and wait for feedbacks of each parts of system and such that by getting these comprehensive information of elements operate harmonizing between members and elements. Therefore university elements as adaptive complex system should have partial independence. Managers of CAS systems should permanently control the change as grow and evolution is among the identity of CAS system.

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