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Uncertainty and Cybernetics

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Abstract

Cybernetics is an interdisciplinary science that explores the way of control and relation in machines and animals. The relation is the largest and most key element in cybernetic systems without which monitoring and feedback will be meaningless. Information is the key element of relation. Thus, addressing the concept of information, information flow, and its influencing factors are the most important issues in cybernetics. This study aims to investigate the lack and deficiency in the information or the uncertainty from the perspective of cybernetics. It should be noted that risk increases positive entropy, system instability, leads it towards the maximum chaos and destruction. To avoid it, it needs to use the negative entropy or adding information to the network.

Keywords: cybernetics, uncertainty, relations, information, control, system

1. Introduction

The term cybernetics stems from Cybernetic "steersman, governor, pilot, or rudder". The word cybernetics was first used in the context of "the study of self-governance" by Plato (Schoderbek, Schoderbek, & Kefalas, 2006). The prevalence and use of it as an interdisciplinary science that explores the way of control and relation in machines and animals has a lifetime of about seventy years. The human need is the origin and the source of all inventions and innovations, and cybernetics has emerged based on the human need. During World War II, how to deal with the German war planes aroused scientists and thinkers. In the meantime, the American mathematician, Norbert Wiener, could find a solution. He managed to predict German aircraft trajectory in space using solutions in mathematics in spite of the limitations of the machine in an immediate change of directions. Weiner published a book in 1948 and used the term "cybernetics" as a new interdisciplinary science for the first time.

Given the relative youth of this discipline and its interdisciplinary nature, many and varied definitions have been suggested by experts in this field. However, it is necessary to provide a relatively comprehensive description related to the area of information and communications. "Cybernetics is the science, on the one hand, investigating the relatively open systems regarding the mutual exchange of information between them and their environment. On the contrary, deals with the structure of these systems from the perspective of mutual sharing of information between their various elements" (Lerner, 1987). According to this definition, cybernetics addresses the system behavior. In this study, the relation between systems and their components is critical. Therefore, communications and information are major issues in cybernetics.

Uncertainty is one of the common phrases that include topics related to information and communications. According to published works on information and communications and the relationship between them in various fields, most of the issues always take a look at uncertainty. Hence, this research is aimed to address this issue and determine its relationship with cybernetics.

2. Definition of Uncertainty

Uncertainty or lack of confidence is a term in the opposite of the word "faith". Uncertainty means having a complete lack of awareness about something. When we fully understand something, we think that we have gained a thorough understanding of it and had a sense of peace and comfort about it. In this case, we are certain and sure. To the contrary, when we have the lack of information, we are not relaxed and always have a concern; In this case, we have uncertainty. So, what is important in this context is the existence or non-existence or lack of information.

Uncertainty means the state of being uncertain, doubt, and hesitancy. Uncertainty provides the necessary ground for indeterminism. A closer look at these two words indicates that semantically one takes precedence over another. In other words, indeterminism results from uncertainty. The word “uncertainty” is a so-called concept like many other words in the sciences. A review of the scientific literature shows that this term is common in sciences such as philosophy, physics, mathematics, engineering, economics, sociology, psychology, management, cybernetics and so forth. Reviewing various sources indicated that there is no common definition for the term “uncertainty”. But in general it can be defined as follows: situations where information and knowledge are limited, and the description of the current situation is not possible or difficult to predict. According to this definition, there are two essential points: first, the “uncertainty” is created due to a lack of or limited knowledge; second, the indeterminacy is created from change and predicting the future will be impossible precisely. This issue happened in quantum physics and led some of the physics scientists to consider uncertainty in the entire universe. Thus, they rejected the law of causality.

2.1 Indeterminism and Causality

As stated earlier, the indeterminacy is created from uncertainty. Certainty and determinacy are rooted in causation and are based on the belief that any event is related to the previous events. The law of causality is a great and old philosophy laws that its origin is not clearly understood. Every human being on the face of any event discovers the causes. According to the law, every phenomenon and, in fact, any effect has a cause. Therefore, the cause is something based on which something else exists (Tabatabai, 1995). Also, causes have some types. The necessity and authenticity of cause and effect are the components of the law of causality. The Necessary is the law derived from the law of causality and accordingly it is not possible to distinguish between cause and effect. According to this law, there is a causal relation between the two phenomena so that the realization of one leads to the realization of another one (Mahdavi Azadboni, 2006). When the complete cause happens, the existence of effect will be imperative. Effect exists when there is the whole purpose. According to authenticity principle, each effect has its cause. In other words, an individual effect has a particular reason (Motahari, 1995). The review of the different philosophical kinds of literature shows that there are various categories of objects. In this study, the type proposed by Aristotle is presented. Aristotle’s very ancient metaphysics focused on the four causes of being. They are the material, formal, efficient, and final causes. “Four causes” refers to a critical system in Aristotelian thought whereby explanations of change or movement are classified into four fundamental types of answer to the issue “why?” Aristotle wrote that “we do not have experience of a thing until we have grasped its why, that is to say, its explanation”. While there are cases where classifying an account is difficult, or in which classes of explanation might merge, Aristotle was convinced that his four categories of explanation provided an analytical scheme of general applicability.

• Change or act’s material explanation is the aspect of the change or movement which is determined by the material that composes the moving or changing things. For a table, that might be wood; for a statue that might be bronze or marble.

• Change or action’s formal statement is a change or alteration caused by the arrangement, shape or appearance of the thing shifting or moving. Aristotle states for example that the ratio 2:1, and number in general, is the explanation of the octave.

• Change or movement’s adequate or moving information consists of things apart from the thing being modified or moved, which interact so as to be an agency within the change or movement. For example, the adequate explanation of a table is a carpenter, or a person working as one, and according to Aristotle, the appropriate description of a boy is a father.

• An event’s final statement is the end toward which it directs. That for the sake of which a thing is what it is. For roots, it might be a grown-up plant. For a sailboat, its sway is sailing. For a ball above of a ramp, it might be coming to rest at the bottom. For a person’s action, it is the goal (Mahdavi Azadboni, 2006).

As mentioned, there are also two types of causes, including complete and incomplete. According to the whole reason, the existence of the effect depends on the cause. In other words, an individual effect has a particular purpose. In the incomplete object, it is necessary but not enough to realize the effect (Mesbah Yazdi, 1998).

Believing and accepting the law of causality will lead to finality and certainty. Across the world, every effect has a cause which is necessary for the presence of an effect. Thus, the presence of them will be final and inevitable. The requirement for the law of causation is that the incident of events is definite regarding location and time. Sciences owe their certainty to this law (Motahari, 1993). Thus, physics and existing phenomena are inevitable and irrevocable, and their occurrence can be predicted.

Before the twentieth century, the general paradigm governing all scientific theories in the scientific world was by the law of causality. The world has a mechanical and predictable nature that can be used to understand the logic of relations. Newtonian physics were accepted with certainty according to the three assumptions: realism (the quality or fact of representing a person or thing in a way that is accurate and true to life). Reductionism which refers to several related but different philosophical positions regarding the connections between phenomena, or theories, “reducing” one to another, usually considered “simpler” or more “essential”; determinism which is the philosophical position that for every event there exist conditions that could cause no other event.

“There is much determinism, depending on what pre-conditions are considered to be determinative of an event or action”. The problem of these discrepancies among computations and observations remained open until the end of the 18th century when Lagrange and Laplace correctly formulated the equations of motion. Laplace and Lagrange, whose work converged on this point, calculated secular variations, in other words, long-term changes in the planets’ semi-major axes under the consequences of perturbations by the other asteroids. Their computations revealed that, up to first order in the masses of the planets, these variations disappear. Laplace thus showed that Newton’s law was in itself sufficient to explain the movement of the planets throughout known history, and this exploit no doubt partly accounted for Laplace’s determinism. Laplace’s demon still makes a substantial impact on contemporary science, in spite of the fact that Logical Mathematics outcomes, Quantum Physics advent and more recently Complexity Science have pointed out the crucial role of uncertainty in the World’s descriptions. While the very essence of Laplace’s observer—with its capacity to measure the initial status of all the bits in the Universe, to enter them in the Newtonian equating. So to measure any trajectory—patently emerges as very dangerous, the interesting side is the implicit understanding that such a program is unfeasible, and yet apparently pleasant! In other reports, there is no difference in thinking it out, and it agrees with our knowledge of the physical world. The Quantum Physics undermined the Laplace-inspired computability of the World. So, we have to come to terms with the idea that a mathematical model of a complex system is just a “picture” of a single side of the scheme that has been taken from one of the several possible perspectives among the organizational behaviors. Risk and incommensurability among a variety and another one are here natural elements of the knowledge process and are placed in the interstices of any theoretical description.

However, in the late nineteenth, scientists were faced with phenomena which were not justified by the existing paradigm and its assumptions. By the beginning of the twentieth century, quantum physics emerged by scientists, notably physicist. Thus, the tiny world could not be explained according to classical physics (Bohm, 1957).

3. Quantum Theory

According to this theory, understanding the whole can be done by dividing it into its components and then identifying and examining each of these elements and the relationships between them. In the late nineteenth century, physics scientists, like many of their colleagues in other sciences, tried to gain an understanding of the components of atoms. This effort led to the emergence of a new theory called “quantum theory” which investigated components of atoms and phenomena related to them called “quantum phenomena”. “Quantum in physics describes particles as components of matter and how they interact with each other and the way they interact with the energy” (Horri, 2008, p. 47). Concepts and issues in quantum physics are not so straightforward and understandable so that the Niels Bohr, one of the original founders of quantum theory, stated that “If someone is not shocked after reading quantum theory, he/she has not understood this theory” (Bohr, 1958, p. 32).

There are five concepts or principles in quantum theory: wave/particle duality, Uncertainty principle, Quantum entanglement, Wholeness, Non-locality. Many years ago, it was thought that the structure of the atom is like the solar system in a way that the central core is located in the middle of atoms, and particles orbit around it. Sub-atomic physics experiments showed that this assumption is not correct. Quantum theory says that subatomic particles do not move in a fixed direction, and the exact determination of their location is impossible. Thus, they are in a mode of non-locality. According to quantum theory, subatomic particles have this feature that can have two unique features at the same time. In other words, objects have complementary properties which cannot be observed or measured at all at the same time. In physics, it is referred as the principle of complementarity (Bohr, 1958).

For a better understanding and recognition of the wave-particle behavior of subatomic particles, we can refer to Young’s experiment: In this experiment, a light source is located on the screen with two adjacent narrow grooves (Figure 1). A light beam shines on the screen. The light beam passes through the slots on the second page which are in front of the first display. If the light is considered as particle nature, two grooves will be like the above Figure. According to Young’s experiment, the formation of multiple lights and dark bands in parallel results from the interference of two waves (Barbour, 1995). Similar experiments on subatomic particles such as electrons and protons showed a similar behavior (Figure 2). In Newtonian mechanics, objects are within the limits of time and space and their interaction is realized through time and space. In quantum mechanics, two particles, which are adjacent to each other and are mutually influenced, maintain a mutual relationship when they are far apart. This issue is called Quantum entanglement. Quantum entanglement is a physical phenomenon that occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently. Instead, a quantum state must be defined for the system as a whole. An entangled system is defined to be one whose quantum state cannot be factored as a product of states of its local constituents, that is to say, they are not individual particles but are an inseparable whole. If entangled, one part cannot be fully described without considering the others. The counterintuitive prophecies of quantum mechanics about strongly correlated systems were first discussed by Albert Einstein in 1935, in a joint paper with Boris Podolsky and Nathan Rosen. They formulated the EPR paradox (Einstein, Podolsky, Rosen paradox), a thought experiment that attempted to show that quantum mechanical theory was incomplete. They wrote: “We are thus forced to conclude that the quantum-mechanical description of physical reality given by wave functions is not complete.” The reality of the paradox is that particles can associate in such a way that it is possible to estimate both their position and their momentum more accurately than Heisenberg’s uncertainty principle. Except measuring one particle instantaneously affects the other to prevent it, which would involve information being transmitted faster than light as forbidden by the theory of relativity. According to Bohr, We cannot consider the world as independent components, but the world must be considered as a “unit” which its components are dependent on each other (Bub, 2006). According to many precise experiments, Bohr’s views were confirmed, which verified the foundations of quantum theory.

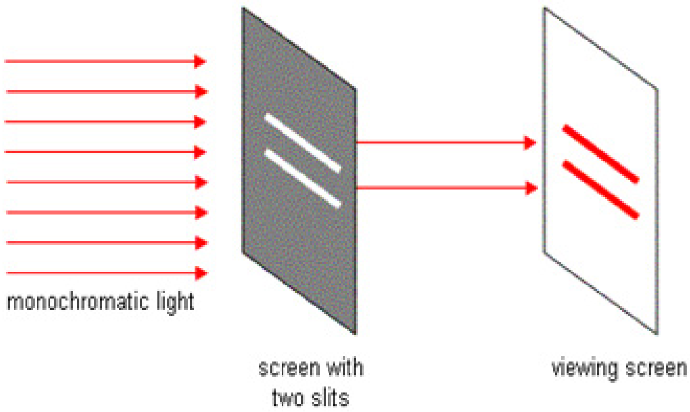

Figure 1. Light as a particle (little particles they will make a pattern of two exact lines on the viewing screen)

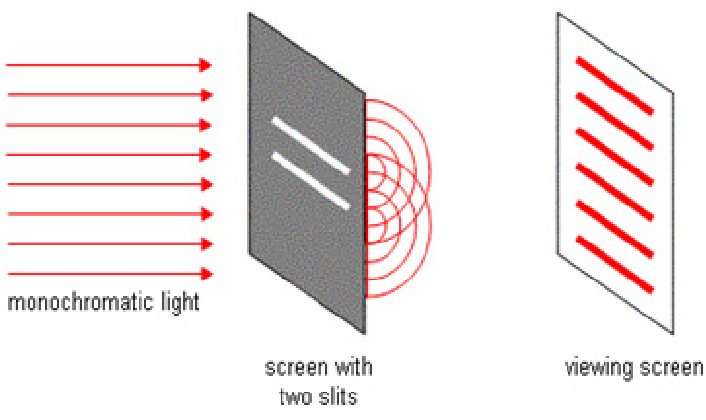

Figure 2. Light as a wave

Werner Heisenberg's simple idea tells us why atoms don't implode, how the sun manages to shine and, strangely, that the vacuum of space is not empty. One way to think about the risk principle is an extension of how we see and measure things in the everyday world. Heisenberg was working through the implications of quantum theory; a strange new way of explaining how atoms behaved that had been developed by physicists, including Niels Bohr, over the previous decade. You can read these words because particles of radiation, photons, have bounced off the cover or paper and transferred to your eyes.

Each photon on that way takes with it some data about the surface it has bounced from, at the speed of light. According to quantum theory, subatomic particles and the microscopic world exist when they can be seen. However, the reality of daily life shows us the opposite (Hanson, 1963). According to what mentioned about Heisenberg's uncertainty principle, the uncertainty regarding the exact determination of the position and momentum characteristics of subatomic particles is an integral part of atoms. In Newtonian physics, the atom is considered as a nucleus around which discrete particles would be spinning. According to Newtonian physics, the components of atoms can be clearly distinguished and the laws governing its behavior can be gained from analyzing the behavior of its parts. But in quantum theory, the atom is considered as a total and complete pattern whose components cannot be distinguished. Therefore, properties of atoms will be analyzed as a "whole" by the new rules (De Broglie, 1955).

What is clear is that the uncertainty is the core foundation of quantum theory, and quantum phenomena are unpredictable because of this uncertainty. Scientists, especially physicists have different perceptions and definitions of it. Thus, this section discusses the reasons for the rejection of the law of causality. For example, some cannot believe that the existence of event (A) is because of the existence of event (B) because there can be an effect without a cause in the quantum world. In other words, the issue of "cause and effect" has no place in the quantum world. However, it seems that no discipline should govern the world of atoms. Albert Einstein expressed his contempt for the notion that the universe is governed by probability and said "God does not play dice" (Gulshani, 2001). On the other hand, Bohr deeply believed in the validity of the quantum theory and expressed a view in contrary to Einstein's. Bohr said, "The atomic world is dominated by a certain discipline, but we're not used to it." Thus, criticisms of the law of causality emerged. A small number of physicists such as Einstein and Max Planck believed that the uncertainty of quantum theory could then be attributed to ignorance of the human (Ramin, 2012). In other words, our knowledge and science are not enough to recognize the laws of quantum mechanics and subatomic particles and determine cause and effect. According to this interpretation, uncertainty about the subatomic phenomena is not because of anything specific in nature, but because of lack of adequate information. This deficiency is eliminated with the advancement of science and human knowledge and the rules governing them will be discovered. Einstein states "... It is my firm belief that human beings can eventually achieve theory in which concrete examples of rules that have been associated with each other are real and perceived" (Ramin, 2012). Accepting such an explanation does not violate a law of general causation; however, some people believe that in practice they have not achieved a better alternative theory; it is appropriate to maintain the probabilistic theory and not to feel a yearning for the past (Barbour, 1995). Some other scientists believe that human empirical and conceptual limitations are the reasons for the unpredictability of quantum phenomena and uncertainty about them. According to the first part of the interpretation of the experimental limitations, the observer does not interfere in the process of the system when observing quantum phenomena due to limitations in the measurement tools of the human. Thus, it causes the particles not to perform their normal behavior. For example, we enter the classroom as a researcher to observe and investigate students' behavior we observed. Although some experiments have also proved the contrary; in other words, the presence of observers has no effect on the behavior of particles and has not decreased uncertainty; for example, the issue of radioactive substances decomposition that is an unpredictable process. This means that when we consider a radioactive atom (e.g., uranium), we cannot predict with certainty the exact time of its decomposition because it may happen a second or a year later. Interestingly, when we consider a set composed of a large number of radioactive atoms, the process of decomposition can be explained with the help of the possibilities with high accuracy. But we are never able to say which of the atoms will be broken down. The second part of the interpretation on the limitations refers to the principle that human beings are not able to understand the reality of objects. Thus, people with sensory tools will only be able to identify and understand some aspects of phenomena and objects. Therefore, mankind has no way to recognize the ultimate reality of phenomena. Also, the human cannot investigate all aspects of a phenomenon by a scientific method. Atomic structure of the universe is in a way that we should choose a causal description (taking advantage of the functions that are likely to evolve determinism) or spatial descriptions (i.e., separate observations that are only statistically tied together), and we cannot select both of them at the same time. Scientific theories and probability functions are useful computational tools for alignment of observations, not representing the real world (Frank, 1957).

The third argument is that non-physical presence is useful in creating of quantum phenomena, and the non-physical factors are God's providences. So in such phenomena that we are not able to determine the causes, there are non-physical causes that we are unaware of them, or we have neglected them. According to the absence of a physical cause, we cannot conclude that this phenomenon is spontaneous, and there is no cause for it. John Bayl, the Canadian mathematician, states that "Suppose that one can prove the absence of a physical cause in nuclear accidents"; there is still the possibility of non-physical causes; it can be human minds, incorporeal beings such as angels and demons and even the direct action of God Himself. The non-physical factors, by definition, are beyond the scientific inquiry. So, we are not theoretically allowed to claim that the absence of a physical cause is the lack of any cause (Bayl, 2003).

4. Probability Theory

Probability is rooted in lotteries from ancient times, and thinkers did not seriously consider them until the seventeenth century. From the perspective of mathematics, probability theory is the study of possible events. In other words, probability theory is a branch of mathematics that deals with the analysis of random events. The core of probability theory includes random variables and random processes and events. In addition to random phenomena, probability theory investigates random events that are not necessarily random. But the results follow a pattern with a high repetition frequency of testing. For instance, when a person tosses a coin, he can guess the probability of occurrence of different phenomena (probability theory, n.d.). Thus, there are different interpretations in different contexts to correct any defects in previous definitions of probability.

The majority of the founders of probability theory, especially Laplace, considered the classical interpretation of probability and defined the probability as the ratio of favorable conditions to possible conditions. According to this interpretation, possibilities to express our ignorance, because the possibility of the equality of events indicates that there is not a compelling reason to choose one of the modes. This interpretation is based on the principle of indifference (Psillos, 2007). The second one is the frequency analysis based on the incidence of happens of an event. Frequency analyses posit the most intimate connection of all: identity. Thus, we might identify the probability of "heads" on an individual coin with the frequency of heads in a suitable sequence of tosses of the coin, divided by the total number of tosses. A simple version of frequentism, which we will call finite frequentism, attaches probabilities to events or attributes in a restricted reference class in such a straightforward manner: the likelihood of an attribute A in a finite reference class B is the relative frequency of actual occurrences of A within B (Psillos, 2007). The shortcoming of this investigation is that it is not useful for the phenomena that occur only once. The third one is subjectivism (also known as subjective Bayesianism) with the slogan: "Probability is a degree of belief". We identify probabilities with degrees of confidence, or credence, or "partial" opinions of suitable agents. In this way, even if we achieve the correct result, it cannot meet our needs until the outside world may not be objective (Shafer, Gillett, & Scherl, 2003). The fourth one is propensity interpretation. Like the frequency analyses, propensity analyses locate probability "in the world" rather than in our heads or logical abstractions. Probability is thought of as a physical propensity or disposition, or tendency of a given type of physical situation to yield an outcome of a particular kind, or to yield a long run relative frequency of such a result (Popper, 1959). The challenging point about this interpretation is that given that an event can be analyzed in many different situations, the tendency will be different depending on the circumstances. According to what was said, perceptions and interpretations about possibilities are different. Thus, the interpretations should be considered when using probability theory.

As previously mentioned, when we have sufficient and accurate information about the phenomenon, we can predict with certainty the future events. However, when we have uncertainty and insufficient information about the phenomenon, we can inevitably consider the probabilities about it. In fact, probability theory is associated with random events and is useful only in situations of uncertainty in which uncertain conditions are caused by random aspects of a system or a process. Also, we can use the probability theory as follows: when the lack of trend in changes or the complexity and diversity of factors cannot be considered separately; when there is no inclination to explore the factors influencing the outcome of events due to limitations of the study and decision-making. The randomness of a fundamental kind of uncertainty and probability theory is a branch of mathematics that deals with the behavior of random phenomena (Liu, 2008). The point that should be noted is that the uncertainty is not only for random events and incidents but also for the ambiguity of information or the existence of insufficient information in many situations. Therefore, it should be noted one of the ways to manage and reduce uncertainty is using probability theory. In conditions of uncertainty, it is necessary to determine the type. It was long thought that the change is caused by the coincidence of the events, and it is possible to formulate a theory, but now there are theories which hold that all uncertainty is due by the coincidence of the event. Risk indices are classified into four methods: crisp sets theory, probability theory, possibility theory, and evidence theory (cited from Azar & Elahi, 1999).

5. Fuzzy Logic and Probability Theory

In Aristotelian logic, we are always faced with two values. In such a system, propositions are evaluated by two values: "right" or "wrong", the "good" or "bad", "white" or "black" and so forth. According to Aristotelian logic, the life affairs should be valued in the context of such a system, while paying attention to everyday affairs of people shows that many propositions are not in full compliance with any of the two values. For example, is a yellow apple with red streaks a yellow apple or a red apple? Is 60 km/h fast or slow? What is certain is that in this case and other similar cases we cannot be decisive and should choose one of two options. Thus, we require a multivalued system in a way that we can share our values.

The term fuzzy logic was introduced with the 1965 proposal of fuzzy set theory by Lotfi Zadeh. Fuzzy logic is a kind of many-valued logic in which the accuracy states of variables may be any real number between 0 and 1, considered to be "fuzzy". By contrast, in Boolean logic, the accuracy amounts of variables may only be 0 or 1, usually named "crisp" values. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false (Zadeh, 1965). Therefore, concepts such as "to some extent" or "somewhat" or statements like "glass is almost empty" are fuzzy phrases because the terms are vague and inaccurate. The difference between fuzzy logic and Aristotelian logic suggests that fuzzy logic is not compatible with probability theory, and it needs to be a new theory.

Possibility theory is a mathematical theory for dealing with certain types of uncertainty and is an alternative to probability theory. Professor Lotfi Zadeh first introduced possibility theory in 1978 as an extension of his theory of fuzzy sets and fuzzy logic. According to this theory, in the analysis of the events and environmental conditions, we are not only looking for possible events but also we are looking for possible events in the uncertain structures. Thus, we do not consider events and controversies mutually exclusive (Zadeh, 1999). For example, there is a glass of water, and we can drink or not drink it. Thus, there are two conflicting events related to drinking water. If the probability of drinking water is 0.3, the possibility of not drinking water is 0.7. In other words, we can sum the value of the possibilities. It should be noted that a high degree of the contingency does not mean a high level of probability and vice versa. However, if an event is impossible, it will not be possible (Dwivedi, Mishra, & Kalra, 2006).

What is certain is that the possibility and probability are various aspects of uncertainty. Opportunity follows the compatibility of an event which is attributed to its nature. The probability refers to occurrence or non-occurrence. Furthermore, the Total amount for the probability (probability distribution) in the entire analyzed space is one. There is no limitation on the possibility and Total number for the potential in the entire analyzed area can be higher than one.

6. Uncertainty and Cybernetics

As was mentioned in the introduction, cybernetics is the science that deals with systems, especially open systems, and these systems are considered based on the mutual exchange of information between components and elements and between the elements and environment. In general, it can be said that cybernetics identifies and controls the information on the relationship between the phenomena and performs operations of storage, processing and transmission of information to keep these findings if necessary (Azad & Hassan Zadeh, 2003). What is certain is that communication, control, and feedback are essential elements in any cybernetic system.

Cybernetics as a useful tool for evaluation purposes, combines the different bodies of knowledge of the various stakeholders, including the professional evaluator, resulting in a coherent body of knowledge created mainly by those internal to the process, owned by them, and relevant to all. The science of cybernetics deals with non-linear exchanges and the processes of change and stability within non-linear systems. Communication is one of the keys and most basic components in any cybernetic system. According to the definition of cybernetics, the relationship between elements of a system with each other and with the surrounding environment is critical. Transmission of information within and outside of a system is vital and can be carried out through communication. The two basic elements of any cybernetic system are control and feedback. They are dependent on communication and can never play a role without it. Many aspects of cybernetic systems are associated with communication. We can investigate physical components of these systems by taking into account the differences and the way of relationships between different components of the system (Zahedi, Asadpoor, & Hajinoori, 2011). Cybernetics investigates how the concepts are manifested in a variety of various systems using concepts such as the level of organization, complexity, hierarchy, structure, information and controlling (Meyers, 2001). Dimensions, such as discrimination of components, and variety and restriction of a system, are associated with the element of communication (Variability and limitations of the system are calculated based on the number of distinct and diverse components as well as the quantity; they are called complexity). In each system, there are factors called entropy which act against the system order and would ultimately collapse and weaken the system. Entropy is divided into two types: positive entropy whose performance is against the system order and negative entropy whose performance is in the opposite direction of positive entropy. In other words, they act to make changes and adjustments for correcting deviations and sustainability in the environment (Zahedi, 2007). Thus, we can see their role in uncertainty. The complexity of the system increases by increasing the number of components and their diversity. Naturally, the communication between them increases in these conditions. So, uncertainty will naturally increase for reasons such as lack of information, defects or other causes. A cybernetic system tries to use the theory of probability and possibility to complete the information and reduce uncertainty. Restrictions or lack of diversity decreases our risk in the system and allow us to make necessary predictions (Meyers, 2001). With the increasing of diversity and complexity, disorder increases, resulting in increasing positive entropy and uncertainty (lack or absence of detailed information). The system tries to maintain the survival and sustainability by obtaining information with different mechanisms or the negative entropy. The received information will reduce the uncertainty in the system.

Control is one of the essential elements of a system, especially cybernetic systems, and aimed at maximum efficiency and minimum material and energy consumption. Cybernetics is understood as the science of effective organization. Organizations have goals and try to achieve them. The most significant innovation of cybernetics is its explanation about the goal-directedness (Beer, 2000). An independent system like an organism can resist against environmental barriers. At the highest level, the goal of an independent system is survival and is a natural choice for all living systems. Targeting can be understood to prevent the diversion of a fixed target. But the system is always faced with disturbances that exist both outside and inside to achieve goals. Cybernetics prevents possible disorders within the system by controlling disturbances (Meyers, 2001). Apparently, if the targeting is not done and there is no target, the philosophy of control is questioned. The control in a system is a factor to maintain stability and prevent the deterioration of the system. Also, it reacts in the face of disorder and entropy reduction. Thus, information is considered as a prerequisite for successful control. In fact, uncertainty resulted from absence or deficiency of information enhances disease and deviations of the system. Uncertainty can be prevented by feedback. Deficiency will be transferred to the control system, and it will be removed there. Feedback is a relation circuit that determines the performance of the system and the deviations. The system receives feedback through the available information and applies the necessary reforms based on the circumstances of time and place (Zahedi, 2007). Negative feedback in the system is a sign of its deviation from the target of the system and moving towards disorder. Thus, the control system creates changes and activates the system. This activation can be defined in the form of obtaining information and reducing uncertainty. If the output of the system is good, the feedback will be positive within the system, and thus the cycle continues.

7. Conclusion

Cybernetics is the science related to communication and control within systems, and these systems can be natural or man-made. What is important is how the components are connected to each other within a system and how they interact with their external environment. Monitoring and controlling the system components and their relationship is considered by cybernetics. The core and center of the cybernetics are communication without which there will be no control and feedback. The communication cannot occur without the transfer of information. The uncertainty must be addressed whenever the information is considered. Therefore, investigating the concept of information, along with the risk in this area, is essential. It should be noted that the lack of information, deficiency in the system or the uncertainty will increase positive entropy and inconstancy of the system, and leads the system towards maximum disorder and destruction. Hence, negative entropy or information must be added to the system to avoid the damage.

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