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Review Article

The Bases, Principles, and Methods of Decision-Making: A Review of Literature

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Abstract

Introduction: Decision-making, one of the most important conscious processes, is a cognitive process which ends up in choosing an action between several alternatives. The present paper studies the theoretical literature with the aim of forming an integrated concept of decision-making.

Methods: In the present review, "Decision, Decision-making, types of decision-making, methods of decision-making, classification of decision-making, decision-making reinforcement, decision-making facilitation, decision-making reduction, decision-making deficiencies, decision-making optimization, decision-making assessment, and decision-making evaluation" were the keywords which were searched in "PubMed, ScienceDirect, Google Scholar, Google Patent, MagIran, Taylor and Francis, SID, Proquest, Ebsco, Springer, IEEE, Kolwer, & IranDoc" search engines. With respect to the relation of the study parts, academic publishes after 2000 and the relevant Jadad system sources were selected. The manuscripts then were finalized by the evaluation of five experts in decision-making studies via the Delphi method.

Results: 9 definitions in 3 classes, 4 involved factors, 5 types of decision-making, processes and steps of decision-making, 11 techniques of individual and participatory decision-making, 3 groupings of steps of decision-making, 5 related theories, 7related constructs, MCDM, biopsychological bases, military decision-making, medical decision-making, and Islamic decision-making were found.

Conclusion: Teaching correct ways of decision-making, appending decision-making courses to syllabi of university majors, and the development of databases in varied domains, especially in medical services, are among the effective strategies to improve decision-making and reduce the costs of decision-making mistakes.

Keywords: Decision, Decision-making, Decision-making methods, Jadad Method, Delphi Method

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Introduction

In information processing systems, selection is one of the most important involved processes in consciousness and decision-making and are considered as a vital activity throughout day-to-day life. Decision-making could be considered as a mental (cognitive) process which results in practical choosing among varied options. Each decision-making process ends in a final choice. The output is weather an action or an idea [1, 2, 3].

Decision-making is a problem-solving process which ends when a satisfying solution is reached. Therefore, decision-making could be considered as an argumentative or emotional process which could be (ir)rationally based on implicit/explicit assumptions. In general, decision-making is a mental process that all humankinds are involved in throughout their lives. The process of decision-making is done on the bases of culture, perceptions, belief systems, values, attitudes, personality, knowledge, and the insight of the decider(s) [4, 5].

It is assumed that most of the time decision-making is a rational process. However, when it comes to personal issues, the process comprises less rationality. The bases of most of our decisions are our behaviors and actions. Our selections, preferences, and decisions are influenced by information that have their impacts through unconscious paths and apparently have no direct link to our ongoing decision-making [6].

The significance of choosing and decision-making in cognitive processes is high, so that the process of decision-making is together with executive and managerial functions of the neocortex. Decision-making is a process in the brain which takes responsibility of monitoring planning, cognitive flexibility, abstract thinking, role acquisition, initiation of proper action, inhibition of inappropriate actions, and helps attentional processes in order to select related sensory information [7].

Decision-making, according to rational, logical and principal bases, is an important part of all scientific decisions and specialists are trying to present their knowledge to domains in which decisions are structured. For instance, in medical sciences, clinical and therapeutic decisions are made when diagnostic steps of a certain patient are passed and then a suited therapy shall be administered [8].

Human performance in the time of decision-making has been subject in many studies in varied domains of knowledge. In some perspectives about decision-making, the act of decision-making is considered to be accomplished only when a satisfying solution is reached. In this essence, decision-making might be rational/emotional, logical/illogical, and explicit/implicit [9].

Rational and logical decision-making is part of many science-based professions in which experts use their knowledge in a certain domain to make conscious decisions. However, in situations of time limits, risks, and high ambiguity, most of the experts use intuitive, rather than structured, methods to decide. It shall be noted that decision-making, as an inevitable responsibility of human everyday life, causes distress and negative feelings, so that in mood disorders (especially major depressive disorder, MDD) inability to deciding becomes one of the diagnostic criteria of the disorder [10-12].

Decision-making about affective and emotional values of a stimulus may occur after reward presentation and might involve some varied regions of the brain in deciding about certain stimulus. These regions are different in other emotional stimuli and sometimes might be just hyper/hypo activity of a certain brain region. This is important in emotional processing which are related to decision-making, because it shows a wide range of different processes involved in decision-making,, especially its related emotional processing, and suggests that varied stimuli are been processed in the time of decision-making [13].

In spite of the importance of decision-making in all aspects of everyday life, especially in mid- and high-levels of management, an integrative viewpoint which can incorporate the knowledge aspects of decision-making altogether is not established yet. Therefore, the aim of the present study is to present a base for theoretical consensus about decision and decision-making in order to lay the foundation for future multi-disciplinary studies in this domain of knowledge.

Methods

The population of the present literature review was comprised of all the published journal papers and book (chapter)s in Persian and/or English which were related to bases, principles, and methods of decision-making. The entrance criteria of documents consisted of subjective relation to the research key words (Decision, Decision-making, types of decision-making, methods of decision-making, classification of decision-making, decision-making reinforcement, decision-making facilitation, decision-making reduction, decision-making deficiencies, decision-making optimization, decision-making assessment, and decision-making evaluation), their relation to theoretical bases of the study, being published by academic resources, and the newness of publishing (preferably being published after year 2000). In addition, other indices were the title of the published documents, and the relevance of the documents which were indicated by search engines. The aforementioned criteria were necessary to achieve optimum results in literature reviews [14, 15].

Moreover, the Jadad Scale was used to investigate and rate the selected papers. The Jadad scale which is also known as Jadad Scoring Method, and Oxford Quality scoring System, is a process to independently evaluate the quality of the methodology in a given research. Up to now, this method is of high application, so that in year 2008, more than 3000 scientific studies have cited this method from its original reference [16]. with this regard, in the final stage of screening, out of 810 found documents, 343 Persian and English reference were selected (Table 1).

Resources	Books	Research Articles	Reviews		Meta-Analysis	Dissertation
			review	systematic		
Persian	12	2	1	0	0	0
English	74	179	57	9	1	0
Sum	86	181	58	9	1	0
Total Sum	Persian= 23		English= 320		Total 343	Sum=

Study keywords (both in Persian and English) were applied to the scientific search engines including Simorgh, sciencedirect, PubMed, magiran, SID, Proquest, Kolwer, IEEE, Springer, Taylor and Francis, Google Scholar, Google Patent, Ebsco, and IranDoc and documents related to the study were selected from the search results. In addition, related English academic and university books were searched in www.amazon.com. Afterwards, via using Simorgh, their presence and location in the country's libraries were checked in order to use them in the study. After preparing the documents, the related contents to the bases, principles, and methods of decision-making were indicated and classified according to the entrance criteria. As the present study is considered as a review and has neither experimental/control groups nor survey questionnaires, the results were analyzed by content analysis and the rate of citations were calculated via different methods.

Moreover, with the aim of increasing the validity of results and reducing the biases of final analysis, the Delphi method was implemented. In order to find the best content for the bases, principles, and methods of decision-making, the title was sent to three Psychologists (PhD, expert in methods of decision-making), and two industrial engineers (PhD, Expert in Decision-making systems and analysis) separately, and asked to write down their ideas about such contents and its components. Their ideas formed the first round headlines. In the second round, the combination of these five referees were sent to each of them again, so that they read and write down their ideas about such headlines and give back feedback separately. Their second time feedbacks were combined and listed again and in the third round sent back to them all to give their ideas about these manipulated headlines. The third round ideas, were sent to the referees again to make changes, if there would be a need. In this step, all five referees agreed with all the headlines and it shaped the final headlines of the study results (Table 2).

Delphi Rounds	Referees confirmed Headlines
First Round	Decision-making, judgment, choice, decision theory, MCDA/MCDM, psychology of decision-making, neurology of decision-making, cognitive impairments in decision-making, decision tree, decision engineering, tyranny of small decisions, military decision-making, methods of decision-making in industrial engineering, operation research, social decision-making system, medical decision-making, business decision-making.

Second Round	Definition of decision-making, classification of decision-making, bases of decision-making, techniques of decision-making, decision theory, decision analysis, MCDA/MCDM, judgment, choice, social selection, rational choice, neuropsychology of decision-making, analysis paralysis, tyranny of small decisions, military decision-making, methods of decision-making (decision engineering, difficult decision making, expert systems, clinical decision support).
Third Round	Definition of decision-making, typology of decision-making, processes involved in decision-making, techniques of decision-making, stages of decision-making, decision analysis, decision theory, optimum decision, information gap theory in decision-making, MCDA/MCDM, choice, architecture of choice, social choice, rational choice, choice overload, neuropsychology of decision-making, distraction, sensitivity to reinforcement and decision-making, analysis paralysis, analysis overload, tyranny of small decisions, bias in decision-making, military decision-making, therapeutic decision-making, Islamic decision-making.

The major aspect of ethics in the present study was considering the copyright of all authors of papers and book (chapters) in the final report which had been carefully observed throughput all the procedure.

Results

1. Definition of decision-making

It appears that all the activities and actions of humankind in all aspects of life is a result of decision-making. Today, decision-making is a process that relates to problem-solving and hence, often decision-making is addressed as advanced problem solving. In other words, from mind's point of view, a problem reveals when a desired situation is formed which is different from the current situation. First, the individual tries to achieve the ideal situation via manipulating the current situation in her/his mind, and then, eagers to change the surrounding environment to achieve her/his desired goals [17].

In general, there are two fundamental factors in any decision-making; one is the value of the results of the deciding and applying it (expected value), and the other is the chance and probability of the desirable results if one acts according to that decision. Therefore, to decide a desired and optimum decision, one shall be able to predict the value of all the probable results of deciding and comparing these values with a kind of quantitative scale and inspecting the success probability, implicitly. This process would never be that simple [18-20]. According to these issues, there are nine major definitions of decision-making in the main fields of science which can be divided into three domains (Table 3).

Domain of definitions	Comments	Examples
Psychological viewpoints	In psychological studies of decision-making, assessment of personal decisions are regarded in the context of needs, functions, performances, and current or desired values of individuals.	[5, 21, 22]
Cognitive-science viewpoints	In cognitive perspectives, decision-making is considered as an ongoing process of interaction which has an important surrounding environment and underlying processing mechanisms.	[23, 24, 25, 26]
Normative viewpoints	These approaches analyze the personal and organizational decisions according to logics of decision-making, rationality, and constant choice selection. This domain is mostly built on mathematics, statistics, and operation research.	[4, 27]

2. Factors involved in decision-making

Varied factors are involved in decision-making. Some authors suggest to consider most decisions as unconscious. According to these authors, human beings simply decide without thinking about it too much. In controlled environments, such as classrooms, instructors may try to persuade students to weigh cons and pros before deciding. This strategy is called Franklin's rule. However, with respect to the need of enough time, cognitive resources, and a full access to related information about decision subject, this rule is not able to describe deciding mechanisms of individuals, well [28].

In a general manner, the influencing factors on decision-making could be classified as follows [29]:

1. Rational factors: quantitative factors such as price, time, predictions, etc. People usually tend to consider such factors and forget non-quantitative ones.
2. Psychological factors: Human participation in decision-making is obvious. Factors such as personality of the decider, her/hic capabilities, experiences, perceptions, values, goals, and roles are important factors in decision-making.
3. Social factors: Others' agreement, especially those who influence decider, is a matter of importance. Considering these issues reduces others' resistance against the decision.
4. Cultural factors: Surrounding environment has varied layers which are called culture of the region, culture of the country, and culture of the universe. Also, the culture of the decider's organization should be also considered. These cultures influence individual/organization decisions in the form of socially accepted values, trends, and common values.

3. Typology of decision-making

Decision-making is a process of ongoing risk of losing something in return for the chance of attaining other things, and occur in varied situations, such as cockpit, important business meetings, and even daily routines (e.g., shopping). Different situations have different influences and consequences on decision-making. The decider has to adapt her/his decision domains and decision-making processes with occurred demands and limits in the environment [30]. Typology of decision-making is based on the combination of dimensions of proximity to danger and levels of authority comprised by operation, business administration, executive

Administration and technical support, political arena, and crisis management (diagram 1; 31, 32).

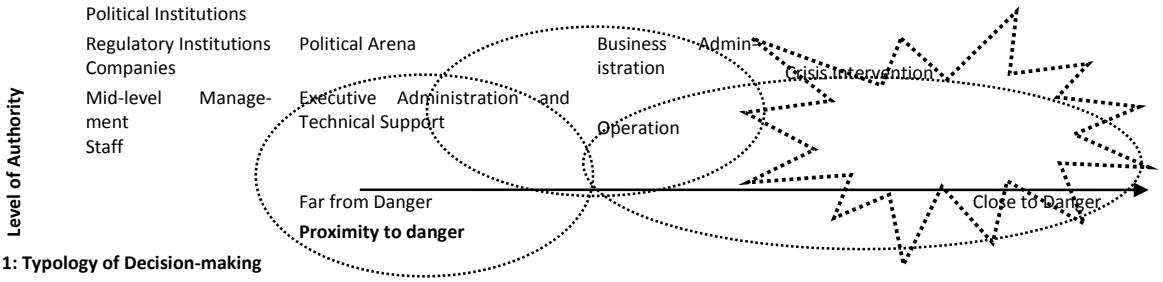

Diagram 1: Typology of Decision-making

4. Processes involved in decision-making

Classification, systematization, and structuralization of various topics and transforming them to a common language, as well as standardization are among important goals of science-based approaches to issues. In many activities, understanding the current situation is considered as the very first and even the most important stage. If a problem is not recognized well, all the other stages and finally decided decision might be ineffective. Whenever an individual makes an incorrect decision and achieves the wrong goal, she/he commits two major errors of destructive effectiveness and destructive efficacy, although efficacy indices show a proper efficacy [33, 34]. Main involved processes in decision-making consists of situation identification, option generation, evaluation and choice, follow-up and execution. It shall be noted that in the process of decision-making, the closer the decision authority is to the origin of the problem, the better decision she/he/it can take [diagram 2].

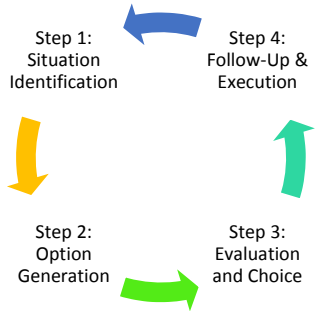

Diagram 2: Involved processes in decision-making

5. Planning in decision-making

It shall be noted that decision-making is part of a higher cortical function and one of most brilliant representations of individual and collective cognitive functions. Therefore, decision-making must have methods, so that the best and most accurate results are achieved for individual/organization. This is because the decisions can have vital and determinative roles in future and can be the next steps of the individual/organization's life. One of the major components of decision-making is planning. Decision-making without planning is common, though would not end up in good results. Planning for decisions can be taken in a simple and intellectual manner. Planning makes decision-making easier than it appears [35].

Benefits of planning in decision-making could be classified in four groups [36, 37]:

1. Planning can help the development of independent goals. In fact, planning consists of conscious and guided sequences of choices.
2. Planning provides some standards for measurement. Planning could be considered as a scale of how individual/organization progresses in line of determined goals.
3. Planning transforms values to actions. Individuals/organizations think about their plan and design and decide what can help them advance their programs, twice as much.
4. Planning helps to devote limited resources effectively and in a systematic hierarchy. In general, planning helps individuals/organizations to better manage their limited resources in all situations.

6. Techniques of decision-making

There are several techniques for decision-making in individual and group (cooperative) levels. In individual decision-making, the responsibility is up to one decider and usually the subject of deciding is not about collective affairs. It shall be noted that sometimes, when the total authority of decision-making is assigned to an individual which is head of an institution or organization (military commandership, CEO of private organization, etc.), an individual decision-making may affect collective destiny. However, individual decision-making is referred to the method of decision-making and involves people in the process, and hence, the techniques are not divided according to the inclusion of the results on individual(s) [38].

It is noteworthy that techniques for individual decision-making are applicable to collective and group decision-making. There is an increasing need for decision support softwares to assist decision-making processes in individuals, as well as collective and business, aspects, due to the day-to-day advances of knowledge and increasing complexity of components, categories, elements, and other involved factors [39]. Authors have introduced eight individual and three collective (group) techniques of decision-making [20; table 4].

Classification of techniques	Techniques
Individual Decision-Making Techniques	Cons and pros estimation Simple prioritization Examination of all options to determine the satisfaction level of each option Elimination by aspects Preference trees Opportunity cost estimation Participative decision-making (PDM) Non-scientific methods include, authority obedience (expert, boss, religious leader, …), coin throw, draw cards, play dice, praying, augury, , tarot cards, astrology, soothsaying, taking decisions completely against unreliable authorities, etc.
Group (Collective, participatory) Decision-making Techniques	Consensus decision-making Voting-based methods Democratic decision-making

7. Steps of decision-making

In all processes of decision-making, each step can comprise individual, motivational, cognitive, situational, and social components, elements, and obstacles which should cope with them by constructive negotiations. It is suggested that the more conscious the process of decision-making and its obstacles become, the better help for individual cope would be provided. Different steps are described for the process of decision-making [table 5; 20].

Method	Steps
Arkansas Program [40]	1. **Creation of common space:** Development, reinforcement, and nutrition of relationships, values, norms, and processes that influence problem understanding and exchange. This step is occurred before or concurrent to the confrontation with a decision-making situation 2. **Perception:** Understanding and recognition of the presence of a problem which makes decision-making necessary. 3. **Interpretation:** Identification of conflicting and counter explanation of the problem, and evaluation of underlying drives of these interpretations. 4. **Judgment:** Inspection and choosing between varied actions or responses and identification the more justifiable ones. 5. **Motivation:** Examining different alternatives which can affect the results of decision-making, prioritization, and commitment to values that are beyond individual, organizational, or social values. 6. **Action:** Taking a decision and going forth with the more supported, and/or better justifiable action. Integrity would be achieved by the ability to cope with distractions and obstacles, development of executive skills, and ego strength. 7. **Reflection in action:** Execution of decided decisions in actions after to the decision-making. 8. **Reflection on action:** influence on impressions, imaginations, and future decision-making actions.
Seven Steps of Decision-Making [41]	1. Specification and clarification of goals and consequences 2. Data gathering 3. Search and development of alternatives (e.g, using brain storming) 4. Listing cons and pros of each alternative 5. Taking decision 6. immediate action for execution of decided choices 7. Learning from gained experiences of current deciding process in order to reflect and use them in future decision-makings.
OCER Method [42]	1. Orientation (O): The members of decision-making group meet each other for the first time and announce their viewpoints with other members. 2. Conflicts (C): After announcing with their points of views with each other, debates, incongruences, controversies, and tangles are common which will be gradually solved. 3. Emergence (E): The group starts to identify ambiguous viewpoints and members discuss about them. Then, priorities of decision-making and consensus will be clarified. 4. Reinforcement (R): Finally, group members decide and provide their choices with explanations.

8. Decision theory

Decision Theory is a multidisciplinary theory which uses Game Theory, as the delineator of interactions between agents that have the least conflict with each other, to explain how decisions act as consecutive sequences of choices. Most of the Decision Theory is normative and prescriptive. This theory deals with better identifications of the decision that would be taken and assumes that the ideal decider which is fully informed can estimate accurately and act fully rational. One domain in the decision theory is decision-making in uncertainty. Another domain in the decision theory are intertemporal choices. This domain deals with the kind of choice which varied the actions result in consequences which are understood in different temporal points. The third dimension in the decision theory is about rivalry among the deciders. A branch of decision theory has become a distinct domain which is called Signal Detection Theory with the goal of the quantification of the ability to distinguish between patterns of information transmission and random patterns which result in derangement of information delivery. The fifth domain of the decision theory concerns about robust decision-making (RDM). Another field of study in the decision theory is the compromise effect. One the common problems in decision-making occurs whenever deciders must choose among options some of which contain extremist or immoderate issues [43- 46].

9. Decision analysis

Decision analysis is a domain of decision-making that includes philosophy, theory, methodology, and practice which are needed to study decision. Decision analysis com-

prises a wide range of trends, methods, and tools to identification, clear representation, and assessment of formal aspects and prescriptions of a set of actions. All of these actions are needed to help a decider reach the maximum expected profitability and transform a formal representation of a decision and its related issues to a simple and tangible representation for the decider. Graphical representations of decision problems in decision analysis are usually in the form of influence diagrams and decision trees. Both of these tools show available options, uncertainty, incertitude, and assessment of scales that show to which extent deciders can reach their goals in the final output. Uncertainty and incertitude of each available option are presented by likelihood and probability distribution. Studies have shown the utility of decision analysis in the development of decision algorithms and its advances to intuition without aid. The phrase "decision analysis" often addresses to decisions that do not rely on mathematical optimization methods. However, methods, such as applied information economics, are trying to make more accurate ways for even such decisions in order to minimize human errors. Decision analysis is implemented by using decision analysis cycle. In general, decision analysis cycle consists of four phases of development of bases, algebraic sensitivity analysis, probability analysis, and fundamental evaluation [47- 49].

10. Multi-criteria decision making (Multi-Criteria Decision Analysis)

Multi-Criteria Decision Making (MCDM) or Multi-Criteria Decision Analysis (MCDA), as a subordinate of operational research, is specifically studying varied quantitative and qualitative criteria. In all aspects of social and personal life, whether ordinary of special affairs, there are usually varied and conflicting criteria which shall be resolved and fixed before taking any decision [50-52].

One common important criterion is the price or cost of each decision. Another complexity and controversy in decision-making is finding criteria for quality assessment. In everyday life, people usually do multi-criteria estimations implicitly and might be satisfied of such intuition-based decisions. On the other hand, when the capital involved in decision-making is high, sound and accurate structuring of the problem and explicit evaluation of varied criteria are considered as important issues. Proper structuring and constructing of complex decisions and explicitly take into view criteria, results in better and more conscious decisions [53].

There are many advances in MCDA/MCDM and many of the current approaches and methods are administered by using super-complex tools and software. However, the main point in MCDM is the presence of easy-to-use software. Almost everyone can use it in their decision-makings and optimize their decisions just by knowing the bases of MCDM. In practice, MCDM deals with structuring, decision-making, and planning in domains with several criteria and its goal is supporting the decision in dealing with such situations. In General, there is not only one optimum solution to such problems and in these situations deciders' preferences should be considered in order to distinguish between options [54, 55].

Problem solving is addressed to varied processes in decision-making. In one approach, problem solving is seen as finding and choosing the best option out from a set of available options. In another approach, problem-solving means to choose a small set of good options, or grouping of options to sets with different preferences. Another form of problem-solving is to find all non-dominant reliable. The robustness of the problems is mostly because of the presence of more than one criterion for decision-making. There is no one optimum solution for MCDM problems without the insertion and use of information related to preferences. Today, the concept of "one optimum solution" is substituted with the concept of "a set of non-dominant solutions". A non-dominant solution has the feature of being eliminated from the set of solutions without sacrificing and loosing at least one criterion. Therefore, it is better for deciders to choose between a set of non-dominant solutions. Several models have been developed to solve the problems of MCDM which have super advanced mathematical bases and complex calculations [56].

Today, with the use of computer, all these calculations and estimations are done automatically. In general, MCDM models include multi-objective mathematical programming models, objective programming models, fuzzy set models, multi-criteria utility models, French models (ELECTRE), evolutionary multi-objective optimization models, and hierarchical analysis models. On the basis of these models, several MCDM methods have been developed which are used in the development of decision-support software [57, 44, 27].

11. Choice and choice architecture

The phrase choice comprises a mental decision of a judgment between options of multiple alternatives and selecting one or more of them. Choices could be from several imaginary/real alternatives as well as consequent actions. Factors such as personal motive, cognition, instinct, wills, desires, and sentiments are involved in choosing. Choices usually comprise from command, delegated, shunning, push (mandatory), and participatory choices [58, 59].

The explanation of the method by which decisions may change according to the way of presentation of choices, is a category in decision-making that is called decision architecture. The construct of decision architecture tries to show the influence of presentation methods of an individual/organization to a decider. In addition, decision architecture addresses presentation methods of one choice to a decider so that she/he can easily understand the benefits of a certain choice. Studies on decision architecture show that there are two main methods in this field including structuring to decision in a specific manner, and presenting alternatives to the decider in a certain pattern. The construct of decision architecture exists in varied contexts and domains and is used commonly. The field of computer science uses decision architecture in its highest level. In this field, manufacturers of computer hardware always strive to suggest the need of computer in all aspects of life, inspire the continuous hardware and software updates, etc. [60-62].

12. Theories related to decision-making

Info-Gap Decision Theory (IGDT) is a non-probabilistic theory of decision in which optimization of robustness for failure or unexpected opportunities under extreme uncertainty situation is studied. IGDT focuses on the sensitivity analysis of the stability radius for perturbations of a given quantity of a parameter of interest. IGDT is a useful theory in sever uncertainty situations of decision-making. In other words, this theory uses proof by contradiction in decision-making. IGDT is a decision theory and tries to help decision making in uncertainty. Therefore, it uses three models namely, uncertainty, decision-making, and robustness/opportuneness models [63- 65].

Social choice theory (SCT) is a theoretical framework to analyze the combination of opinions, preferences, interests, and personal welfare to achieve a group decision and/or social welfare. SCT comprises from components of the voting theory and welfare economics and has ideographical methodology to combine preferences and actions of mass from the individual's point of view. Analysis starts by formal logic and from a social choice presumption in order to form social welfare functions. Furthermore, subjects such as rivalries, behavioral compensation mechanisms, justice, freedom, civil rights, limits in exertion of preferences of social agents, variables population, confirmation of functioning strategies of social choice, available natural resources, capabilities, functions, welfare, juridical justice, and poverty are other agents and factors of investigation in this analytical function. SCT is based on an accumulation of personal preferences to make a social welfare function. Social preferences could also be modeled in economic utility functions. The ability to sum the utility of functions of different people depends to the extent of comparability of their functions. This means that the preferences of different people should be evaluated by the same measures. In addition, the ability to generate social choice function depends to the comparability of utility functions (interpersonal utility comparison) [65-67].

Rational Choice Theory (RCT) or Rational Action Theory (RAT) is a framework to understand and modeling of behavioral and economic behaviors and actions of people. If the phrase "rational" is interpreted as a demand more instead of less, it could be used as a behavioral presumption in microeconomic models and their related analyses. With respect to this definition, authors in social sciences, political sciences, and philosophy also have used RCT to study human behaviors and actions in varied domains. In fact, demand could be more defined as instrumental rationality which includes searching for instruments that have the most advantage of reaching specific goals, without considering the value of the goal. The main idea of RCT is that the behavioral features in any given society reflects the choices of people when maximizing their benefits and minimizing their losses. In other words, people compare the cons and pros of different actions and decide how to act. As a result, current behavioral figures are the outputs of such choices. The idea of rational choices, wherever people compare cons and pros of actions of interest, is obvious in economic theories [68-70].

13. Neuropsychological bases of decision-making

It appears that emotion facilitates decision-making in varied ways. Often decision-making occurs in dealing with uncertainty about whether decision results in benefit or loss. Somatic Marker Hypothesis, which is a neuropsychological theory, suggests that how human beings decide in uncertainty. This theory argues that these decisions are taken with the aid of emotions which are aroused in the time of thinking about the future consequences and results in distinguishing different alternatives for behaviors, as useful or useless. This process includes interactions between responsible nervous systems for planning and guiding such somatoemotive states. Although, the extent of generalizing these results are unclear yet, it is commonly accepted that unconscious processes are involved in initiation of voluntary and conscious actions and behaviors [71-73].

In neuropsychological approaches, decision-making is a core executive functioning mechanism (EFMs). EFMs are underlying brain processes which are completely involved in dealing with new subjects and situations which need new solutions. Regarding to their reliance on conscious mechanisms, EFMs actively needs attention span for their special cognitive processing. Therefore, any activated factor that uses attention span, can influence and reduce executive functioning. Such tasks which are combined with the original one and reduce higher cortical function yields are called distractions. Distraction is known as the major external factor that influences decision-making. Distraction could be defined as an alteration of attention from the subject of attention to a source of distraction. Many factors can result in distractions, including inability to attend, inability to get interested in the subject of attention, or more intensity, novelty, and/or attraction of the distraction source comparing to the subject of attention. Most of the time, distraction occurs by external sources [74-76].

One of the most influential endogenous factors on decision-making are Brain/Behavioral Systems (BBSs) which is also known as the Reinforcement Sensitivity Theory (RST). In fact, RST is a modern method in personality studies based on physiology and fundamental processes of the central nervous system (CNS). BBS is a biopsychological theory of personality which has been proposed by Gray in 1970s. RST is based on the description of the states of nervous systems and emotions, in relatively short time, and their dependent behaviors which, according to the theory, are bases of trait tendencies of emotion and behavior in people. According to the theory, personality factors are sources of constant changes in behavior, thought, and cognitive processing of individuals, and are invariable throughout time. These personality factors are stemmed in basic and underlying biological and genetic features of people, and hence, environmental changes cannot result in alteration in personality traits and their behavioral representations, unless they can change phenotypic and biological impressions in individuals. According to RST, even individual differences in behavior are invariable throughout the time. Therefore, it appears that differences in BBS activities in individuals lead to differences in cognitive processing of decision-making. In addition, with respect to variations in the activity of BBS in individuals, different people may have disparate resistance against distractions [77, 27, 78].

14. Constructs related to decision-making

Analysis paralysis is an anti-pattern and a mode of over-analysis about a situation that one cannot decide and/or react, and therefore, there would be no outcome. In such situations, decision-making is described both as a hyper-complex activity and has lots of detailed alternatives and as a result, no decision is taken. This situation is in contrast with when an individual/group is inspecting and examining different alternatives to find a solution to a major problem. Decider(s) may seek an optimum of perfect solutions and worries to decide in the time of searching for the best solution which results in wrong outcomes. Analysis paralysis describes a situation in which the cost of decision analysis is more than executing that decision. Moreover, paralysis analysis represents an uncertain situation in which the pure quantity of analysis are in excess of decision-making process and hence, prevents decision-making. Analysis paralysis is attributed to any situation that analysis may be used to aid decision-making and at the same time increases to the extent which becomes a malfunctioning element of organizational behavior. Often, in alike situations, this is called paralysis by analysis that is in contrast with the situation called extinction by instinct (taking lethal decision according to a hasty judgment or naïve decision-making) [79-81].

Information overloud which is also known as infobesity or infoxication, is derived from cognitive psychology and gradually becomes a rich metaphor in other aspects of human life. In general, information overload addresses the difficulty of understanding a subject and decision-making by individuals which is caused by high amounts of information in the environment. Information overload occurs whenever the information input of a given system is more than its processing capacity. In decision-making, deciders have relatively limited cognitive processing capacity. Therefore, whenever information overload occurs the probability of quality reduction of decision-making would be high. In other words, Information overload is a gap between information volume and human required instruments to absorb them completely. In varied studies, it has been revealed that the more the information overload is, the worse the decision quality becomes. Several factors contribute to information overload including personal information agents, information properties, tasks and processes options, organizational design, and information technology [82-84].

Tyranny of small decisions indicates a phenomenon in which several decisions, that are small in size and temporal aspects per se, accumulatively result in a consequence that is neither optimum nor desired. This situation, is a condition in which a set of decisions, that are rational per se, could negatively alter the next decisions and even end up in a condition in which the decider destroys the desired alternatives [85-87].

Bias to its general meaning in methodology, is any factor that has the ability to change the results of a process of interest, potential or de facto. Usually, bias influences decision-making in a subtle and precise way. Many studies on decision-making have shown that many people have variedly decided about the same problem and etiological investigations have revealed the personal and cognitive biases as the underlying causes of this choice diversity [88- 90].

A routine situation for consumers and clients in markets, especially in postindustrial countries, is too many choices to decide on which is called choice overload. Choice overload is known as a result of technology advances. From the industrial revolution up to now, every year producers have provided markets with more and more products. Consumers and clients have gained more cash income to spend, in addition, producers are now able to provide markets with varied products simpler and at lower costs [91-94].

An optimum decision is a decision that no other alternative in the given situation can have a better result. In order to compare the consequences of varied decisions with each other, it is common to evaluate the relative utilities of each alternative. If there is uncertainty about the consequences of one or more alternative, optimum decision maximizes the expected utility (average utility within all consequences of a decision). The problem of finding optimum decisions, is a mathematical optimization problem. In practice, there are a few deciders who use optimization for their decision-making and instead of implementing heuristic ways of decision making which are "good enough", are engaged in the process of satisfaction [95, 96].

15. Decision-making in military and martial environments

In complex martial situations, such as the state of war or combats, military decisions should be based on the moment, relevant, and on-time information. Failure in gaining such information, would highly reduce the probability of triumphs. Large amounts of information, if not managed and controlled, can result in a burnout and exhaustion of the military personnel. In addition, confusion and chaos of information can reduce the utility of taken decisions by the military commanders and leaders and unduly keep a large bandwidth of human and machinery connections busy. It appears that these days, taking righteous military decisions, without accurate classification of information and application of optimum decision-making methods, is rather hard and illogical. If the workload of a military decider increases by information overload, she/he would face blockages, according to the limitations of human cognitive processing, and have difficulties in decision-making. Therefore, the primary requirement of military decision-making of the contemporary date is decision support in a way that varied levels of deciders can reach a suited conclusion of the current situation and the upcoming choices with accurate investigation and distinguish different alternatives from each other [97, 98].

Understanding combat and operational environments together with issues related to decision-making and operational goals, requires some specific methodologies which are beyond ordinary military decision-making processes. Typically, the most important factor of determining success in military operations is the degree of advancement of commands and decisions of commandership in a given operation. Military operation occurs in a complex framework of environmental factors that is shaped by the nature and influences the consequences. Military operations require commandants who well understand strategic and operational environments and their relevance to each mission. This understanding comprises special traits of operation-specific environment for any mission and the degree of importance of

key element of each environment in shaping the mode of operation of military staff. Operational environment is a combination of situations, conditions, and influences that affect the application of capabilities of military personnel and continuation of administration of commandant's decisions. Operation Environment comprises insider, enemy, and neutral systems, as well as an understanding of environmental conditions, government status, technology, local resources and the culture of local population. Operational environment is shaped by information and decisions taken by commandership, commandants, commanding officers, deciders, individuals, and organizations. In addition, media advertisements and propaganda can influence the decision-making processes of commandants. Several factors are involved in the conflicts and problems of military operation execution, such as globalization, technology, demographic changes, urbanization, resource demands, climate change, natural disasters, failed or failing situations, use of mass destruction weapons, and more important, issues related to decision-making and/or administration of commandership decisions in varied levels [99, 100].

Studies have shown several factors to reduce uncertainty, incidence, chance, and disagreement in military decision-making. Good leadership, proper and flexible organizations, training related to decision-making strategies, and the use of reliable technologies of decision support can reduce uncertainty. Accurate and momentarily information can reduce the influence of incidence and chance. Simple operational programming with the use of decision support systems and continual coordination would reduce the effect of disagreement. However, even when operations progress well, commandants might decide according to incomplete, inaccurate, and conflicting information in unfavorable situations. Indestructible determination is one of the required tools to cope with disagreements, as well as experience. High moral, rational and sound organization, effective commandership networks and systems of mission, and well-trained staff help a lot to deal with problems. In order to reach strategic and tactical victories, commandants shall attain a correct understanding of environment and take effective decisions with proper flexibility, regardless of all obstacles and problems of operation. Moreover, a commander should not let his fear of consequences of decision to intervene decision-making processes and choosing correct operational alternatives [101, 102].

16. Decision-making in therapeutic environments

Clinical environments are among the most important environments of decision-making. In these environments, many cases need therapeutic professionals' decision-making including hospitalization, choosing therapeutic methods, choosing medication, deciding for surgery, prioritization in the treatment of clients, and prioritization in handling patients' problems. Participatory decision-making methods are used in some cases of decision-making, in clinics and hospitals. Recently, the use of clinical decision-support systems (CDSS) are increasing in health service systems. CDSS is an interactive expert system software which aids doctors, and other health-care staff in decision-making (e.g., determining diagnosis according to patients' data). CDSS integrates medical observation with medical knowledge to improve clinical decision. CDSS epitomizes application of artificial intelligence in medical and clinical systems. CDSS is considered as an active knowledge system which takes advantage of two or more classifications of patients' data to generate case-specific clinical suggestions. This implies that, in fact, CDSS is a DSS concentrated on knowledge management in medical affairs, which uses available patient's data to reach a medical advice. In addition, CDSS reduces the need to consult with professionals, and therefore, would reduce consulting rates and costs of treatment [103, 104, 105].

17. Islamic decision-making

In Islamic systems, decision-making is formed on the basis of the thoughts of savants (Olul-albab) with regard to the past experiences and current facts of future and not only uses rationale, but also takes advantage of superior thoughts of the origin of the being (Allah). Islamic decision-making mostly deals with the bases and principles of deciding rather than its techniques and methods, and therefore, is a fundamental discussion about all the levels and dimensions of human individual and social life including leadership, government managers, authorities, economic organizations managers, service organizations managers, universities, schools, and families. Islamic decision-making comprises decision-making to enforce Allah's rules and orders, decision-making at the level of prophecy, imamate, and vilayate, as well as decision-making of the members of Islamic society. Several factors contribute to Islamic decision-making which include trust in Allah and asking for his help; participation and consulting in decision-making; punctuality, tactfulness, and foresight in decision-making; stability, endurance, and decisiveness in decision-making; mental health and mindfulness in decision-making; and fairness, equity, and being attentive to inferiors in the time of the decision-making [106-108].

Discussion

Decision-making is one of the most important aspects of human lives, so that no dimension is free from decision-making. In spite of the complexity of mental process of decision-making, individuals determine the problem and imagine their desired results. According to the main goal of the present study to find a theoretical consensus, it appears that the best definition of decision making is considering it as a problem-solving process which ends whenever a desirable solution is reached. Accordingly, decision-making is a reasoning of emotional process which could be rational or irrational and could be based on explicit or implicit assumptions [4].

Decision-making is rather a complex process and many biological, physiological, psychological, and environmental (social, and cultural) factors influence it. In addition, the level of authority and danger in any given situation of decision-making, in combination with other factors increases the complexity of decision-making. The strategies of the analysis of decision-making processes and its current trends, depend on the level of interpretation and domain of decision-making.

Today, using mathematical equations, computer hardware and software facilities, and various theories of different branches (such as mathematics, statistics, economics, sociology, etc.) in decision-making has improved a lot. In this manner, advances in decision-making processes gradually end up in revision in decision-making in varied domains of human society and significant improvements would be obtained. One of the most accurate domains in this way is MCDM which has made a revolution in decision-making science.

Varied aspects of human life such as medical services, military, transport systems, energy transport and distribution networks, and managerial sectors are increasingly using modern techniques of decision-making. Medical and military sectors have tended to administer MCDM techniques to reduce national per capita in their related sectors. Specially, in medical services, using CDSS has resulted in the optimization of medical information management, reduction in treatment expenses, and a reduction in medical deciding mistakes [103, 104].

Considering the wide scope of decision-making science, it is not a simple act of analysis, describe, and/or advice strategies to improve. It appears that a sound solution to facilitate the administration of decision-making science is to teach the correct ways of decision-making to various sectors of the society. Appending decision-making courses to the syllabi of university majors would result in a more familiarity to decision science in the society and highlights its importance in different domains. Moreover, it seems that the development of medical databases of patients, as well as general training for medical staff to use a coordinated medical decision system, would increase the quality of medical services in the society.

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