International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 2, January-February 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Soft Computing in Management: An Introduction

Matthew N. O. Sadiku[1], Uwakwe C. Chukwu[2], Abayomi Ajayi-Majebi[3], Sarhan M. Musa[1]

[1]Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA
[2]Department of Engineering Technology, South Carolina State University, Orangeburg, SC, USA
[3]Department of Manufacturing Engineering, Central State University, Wilberforce, OH, USA

ABSTRACT

Soft computing can be regarded as a collection of techniques that will enable dealing with practical situations in the same way as humans deal with them, i.e. on the basis of intelligence, common sense, experience, etc. One of such demanding problems is the management of companies. To be successful, managers need to support their decision-making process with available state of the art tools and techniques that allow managing data in the most effective way. There are various soft computing methods used in management. These methods include fuzzy logic, neural networks, machine learning, probabilistic reasoning, and evolutionary algorithms. These techniques have been used in practical applications in several management processes. This paper is an introduction on the applications of soft computing in healthcare.

KEYWORDS: *soft computing, hard computing, computer science, management*

How to cite this paper: Matthew N. O. Sadiku | Uwakwe C. Chukwu | Abayomi Ajayi-Majebi | Sarhan M. Musa "Soft Computing in Management: An Introduction" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-2, February 2022, pp.677-682, URL: www.ijtsrd.com/papers/ijtsrd49288.pdf

IJTSRD49288

INTRODUCTION

Managing an organization and its resources is an uphill task. Managers need to make multiple decisions under conditions of uncertainty. The process of making decisions in management is difficult because it involves factors that are political, social, psychological, economic, financial, environment, educational, etc. The factors may be endogenous and exogenous and may be characterized by imprecision, uncertainty, vagueness, semi-truth, approximations, and so forth. A serious problem is to find a suitable methodology for modeling the management processes presented in real systems. Soft computing methods have had successful applications in management, supporting the decision-making process in view of a crisis. The methods help managers in their decision-making functions and also in decentralization of decision-making processes to be standardized, reproduced, and documented [1].

The field of soft computing has been around since the 1990s. The term "soft computing" was coined by Lofti A. Zadeh in 1991. Since then, the area has experienced rapid development. Soft computing became a discipline within computer science in the early 1990s. The terms "machine intelligence" and "computational intelligence" have been used to have close meaning as soft computing. The principal premise of soft computing (SC) is that we live in a world that is imprecise and uncertain. Soft computing refers to the use of "inexact" solutions to computationally hard tasks [2].

OVERVIEW OF SOFT COMPUTING

Soft computing, as distinct from hard computing, is an emerging field of computer science. It simulates the human's cognitive ability of reasoning, learning, and analyzing imprecise and uncertain information. The main idea underlying the SC techniques is related to the modelling of the behavior of the human mind. Unlike hard computing techniques, soft computing techniques tolerate imprecision, uncertainty, and approximate values.

Soft computing refers to a collection of computational techniques in computer science, artificial intelligence,

and machine learning. The techniques aim to exploit the tolerance of imprecision and uncertainty to achieve tractability, robustness, and low solution cost. Its principle components include:

- Expert systems
- Neural networks,
- Machine learning
- Probabilistic reasoning
- Evolutionary algorithms
- Artificial neural networks
- Fuzzy logic
- Swarm intelligence
- Interactive computational models

These computation methods or technologies provide information processing capabilities to solve complex practical problems. Some of these techniques are illustrated in Figure 1

[3]. Although the soft computing tools have several advantages when used individually, a good combination of the techniques into hybrid models is useful in the development of practical and efficient intelligent systems.

APPLICATIONS OF SC IN MANAGEMENT

Soft computing is used for solving real-life problems and can be applied in different fields such as education, healthcare, business, industry, engineering, power systems, transportation, communication systems, wireless communications, data mining, home appliances, robotics, etc. [4]. Typical applications of soft computing in management include the following:

- **Risk Management:** A project often involves the presence of risk and hence risk analysis is required. A risk is the potential of gaining or losing something of value. It denotes the possibility of suffering harm or loss. Risks may be regarded as the effects of uncertainty of objectives followed by the coordinated and economical application of resources to minimize, monitor, and control the impact of unfortunate events. Risk management is the identification, assessment, and prioritization of risks. It is a complex, multi-criteria and multi-parametrical system full of uncertainties and vagueness. A risk management system can be built up as a hierarchical system of risk factors (inputs), risk management actions (decision making system) and direction for the next level of risk situation solving algorithm. Disaster event monitoring is one of the steps in risk and crisis management. Natural disasters arise without direct human involvement. The risk and disaster factors can be human-based or nature-based. Expert engineer's experiences are suited for modeling operational risks in the engineering sciences and other applications. The use of fuzzy sets to describe the risk factors and fuzzy-based decision techniques to help incorporate inherent imprecision, uncertainties, and subjectivity of available data [5].

- **Health Management:** Health is often regarded as the absence of disease in the body. The risk factor in health diagnostics is anything that increases chance of illness, or other negative events. Stroke is one of the most important health issues. It occurs when the brain's blood flow stops or when blood leaks into brain tissue. This implies that some parts of the body may not be able to function. Risk factors may include medical history, genetic make-up, personal habits, and life style of the patient. The relationship between healthcare expenditure and health outcomes is of interest to policy makers in most industrialized countries. Social security, tranquility, safety, and welfare could be increased by increasing of the healthcare expenditure, which could also help people to recover and return to work quickly. Serious concern has been raised about the sustainability of public healthcare systems as a result of the economic crisis. To overcome the forecasting difficulties of the gross domestic product (GDP) growth rate, soft computing approach has been applied since a bilateral relationship exists between healthcare expenditure and GDP [5,6].

- **Supply Chain Management:** This includes all the activities an enterprise employs to keep its products flowing, from sourcing raw materials, to delivering finished goods at the point of purchase. As typically shown in Figure 2, supply chain management (SCM) includes the manufacturers, suppliers, transporters, warehouses, retailers, and customers [7]. It is widely and globally known that effective SCM is a necessity for organizations to compete in the global marketplace. Organizations need to invest their time and resources to improve their SCM processes in order to gain and sustain strategic competitive advantage. They seek to improve customer service and reduce operational costs in order to maintain profit margins. Performance evaluation of supply chain has attracted researcher's attention. Researchers have developed interest in improving and optimizing SCM performance and decision making capability. A variety of soft computing techniques including fuzzy logic and genetic algorithms have been used to improve effectiveness and efficiency

in different areas of supply chain management. SC tools are used for multiple criteria decision making as well as forecasting problems [8].

- **Infrastructure Management:** Increasing demands, shrinking financial and human resources, environmental pollution, and infrastructure deterioration have made the task of maintaining the infrastructure systems quite challenging. For example, transportation systems play a vital role in facilitating a productive and competitive national economy. They provide mobility, access, opportunity, and comfort for people. America's transportation infrastructure consists of 8,315,121 lane-miles of roadway, 593,813 bridges, 19,820 airports, and more than 12,000 miles of inland waterways. Infrastructure management decisions are often based on data that is uncertain, ambiguous, and incomplete. Conventional tools cannot practically and effectively utilize expert knowledge and handle ambiguous uncertainties. Soft computing techniques are particularly appropriate to support these types of decisions because these techniques are very efficient at handling imprecise, uncertain, ambiguous, incomplete, and subjective data. The three most used soft computing techniques in infrastructure management are artificial neural networks, fuzzy systems, and genetic algorithms. The techniques provide appealing alternatives for supporting many infrastructure management functions. They employ available "real-world" information to support infrastructure management decisions [9,10].
- **Business Management:** A majority of the problems in organizational sciences and business management usually do not have a clearly defined structure. Activities and decisions are under the influence of people whose behavior is not deterministic. Such behavior cannot be adequately solved through hard computing, but it is necessary to take into account the uncertainty and ambiguity whose presence is evident. Soft computing techniques constitute powerful tools in the decision making process in situations where it is not possible to accurately determine all the factors. They are widely used in various segments of business management for processing a large amount of data in order to make decisions. Such techniques often take into account both internal and external factors [11].
- **Water Resources Management:** Water is vital for living and supporting human activities. Billions of people worldwide have no access to safe drinking water. Water resources are becoming scarce and polluted due to environmental changes, rapid population growth, agriculture, industrialization, and urbanization. Water resource management is the development and use of different techniques for water system planning, development, and operation to overcome problems related to quality and quantity of water. Given the complexity of the problems associated with water resource management, efficient numerical techniques are required. Different SC techniques (such as neural networks, support vector machines, fuzzy regression, fuzzy expert, etc.) have been combined in a fusion technique to save time and calculation efforts during water source management evaluations [12].
- **Project Management:** A project may be regarded as the entire process required to produce a new product, new plant, new system, or other specific results. For example, effective software project management focuses on the four P's: people, product, process, and project. The goal of project management is to manage issues such as resource allocation, scheduling, and customer communications. Project management is widely known as a concept for organizing, innovative as well as strategic endeavors. Since the project management team is responsible for producing the project output , they must be constantly aware of the project goal, project purpose, and project management efficiency. Project managers play a key role in successful project completion. The major project management processes are initiating, planning, executing, controlling, and closing. Project management is being increasingly recognized as an important area of study for computing programs. Some projects have failed due to mismanagement by the project leaders, including poor planning, poor communication within the team and stakeholders, and inability to follow a stick timeline. Soft computing comes into picture in such situation since it gives the project manager a simple yet powerful tool that helps him/her to quickly accept or discard the project before any complex analysis. The efficiency of project management can be increased using a soft computing tool based on fuzzy logic, giving it the ability to solve complex problems plagued with uncertainty and vagueness [13].
- **Crisis Management:** Crisis or disaster management is very important today.. It may be viewed as the organization and management of resources and responsibilities for dealing with all

humanitarian aspects of emergencies. Crisis management and effective decision making in a multiple uncertainty environment are important elements in international relations. Various soft computing techniques are proving to be a suitable tool for crisis management since the inputs and outputs of crisis events cannot be sharply defined. Fuzzy cognitive maps is used as a technique for modeling political and strategic issues situations and supporting the decision making process in view of an imminent crisis. Its object domain is soft computing using as its basic elements different methods from the areas of fuzzy logic, cognitive maps, neural networks, and genetic algorithms. Combining the SC tools to form a hybrid system can simulate political situation successfully and produce results which is descriptive of the actual events that lead to the defusion of the crisis [14].

- **Environmental Management:** Manufacturing industry is a critical component of any economy because the industry produces various kinds of products we use every day. Since manufacturing production has environmental adverse effects such as air pollution, excessive energy consumption, and waste production, it has become challenging to manage. Some environmental factors have a major impact on the stability of energy prices, such as customer expectations, and waste management. World population is increasing significantly and is having an impact on energy prices. A fuzzy multi-criteria decision-making model has been used to analyze environmental management systems for sustainable energy price [15].
- **Oil Exploration Management:** Oil exploration management can reduce risk and save cost. Recognizing oil-bearing formation implies recognizing the characters of each layer in the well. These characters include dry layer, water layer, inferior layer, and oil layer. With the development of oil exploration, the information to handle becomes more and more complicated. There are much raw data in the procedure of oil exploration, which covers certain information that could become knowledge and even be formed to if–then fuzzy rules. Artificial neural networks (ANNs) and genetic algorithms (GA) can be combined to provide a soft computing fusion model for extracting fuzzy rules in the oil exploration. Two major goals should be considered in extracting fuzzy rules: one is the maximizing accuracy; and the other is the minimizing complexity [16,17].
- **Human Resource Management:** Organizations and individuals frequently require making various decisions to function optimally. A decision may involve the issues that are in conflict and need to be considered simultaneously. The final decision may not be unique, and may be necessary to select it from a set of possible alternative solutions. Making the right decisions about human resources policies can determine success in companies. In real-world systems related to human resource management, decision making problems are often uncertain or vague, and because of the lack of information, the future state of these systems cannot be known completely. Mathematical models can help decision-making. Such models take into account the uncertainty and subjectivity associated with real-life problems and can provide a more accurate and practical modeling. Fuzzy logic does not increase the difficulty of traditional mathematics and it is closer to human thinking. Scenarios, such as hiring, training, promotion, etc., can also be modeled by means of fuzzy sets [18].

Other applications of SC in management includes human resource management, power management, education management, information management, industrial management, waste management, financial decision making, intelligent location management, fault management, sensor management, business document management, congestion management, and disaster management.

BENEFITS

Soft computing is the use of approximate calculations to provide imprecise but usable solutions to complex computational problems. It is the study of the science of logic, thinking, analysis, and research that combines real-world problems with biologically inspired methods. The main benefit of using SC tools is the capability to deal with real world uncertainty, imprecision, ambiguity, and partial truth in order to achieve human like decision making behavior. SC techniques offer technological advantages over conventional models for decision-making and management. They can adapt quickly to the changes in the environment. Due to their tolerance of imprecision and uncertainty, soft computing techniques are increasingly used in solving various management problems. They do not require a precisely formulated analytical model and often do not require huge computation time. They offer numerous possibilities for an enterprise in the design of processes, products, and services.

CONCLUSION

By seamless integration of intelligence and decision technologies, soft computing has been completely changing various aspects of management such as the way we manage our factories, logistics, education, healthcare, energy, and supply chain networks. More information about soft computing in management can be found in the books in [19-27] and the following related journals:

- Soft Computing
- Applied Soft Computing
- Applied Computational Intelligence and Soft Computing
- Engineering Management and Soft Computing
- Southeast Europe Journal of Soft Computing
- Managing Software Processes Using Soft Computing Techniques
- Soft Computing Techniques and Applications
- Journal of Soft Computing and Decision Support Systems
- International Journal on Soft Computing
- International Journal of Soft Computing, Mathematics and Control
- Journal of Soft Computing Exploration

REFERENCES

[1] P. Dostál, "The use of soft computing in management," in P.M. Vasant, *Handbook of Research on Novel Soft Computing Intelligent Algorithms: Theory and Practical Applications.* Information Science Reference, volume 2, 2014.

[2] M. N. O. Sadiku, Y. Wang, S. Cui, S. M. Musa, "Soft computing: An introduction," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. 8, no. 6, June 2018, pp. 63-65.

[3] M. Devi et al., "A survey of soft computing approaches in biomedical imaging," *Journal of Healthcare Engineering,* 2021.

[4] M. Dahiya, "Applications of soft computing in various areas," *International Journal of Engineering Sciences & Research Technology*, vol. 6, no. 5, May 2017, pp. 712-716.

[5] M. Takács, "Soft computing based risk management," https://www.intechopen.com/chapters/17361

[6] G. Maksimović et al., "Management of health care expenditure by soft computing methodology," *Physica A: Statistical Mechanics and its Applications,* vol. 465, January 2017, pp. 370-373.

[7] S. M. A. Burney, S. M. Ali, and S. Burney, "A survey of soft computing applications for decision making in supply chain management," *Proceedings of the IEEE 3rd International Conference on Engineering Technologies and Social Sciences,* August 2017.

[8] M. Ko, A. Tiwari, and J. Mehnen, "A review of soft computing applications in supply chain management," *Applied Soft Computing,* vol. 10, no. 3, June 2010, pp. 661-674.

[9] G. W. Flintsch and C. Chen, "Soft computing applications in infrastructure management," *Journal of Infrastructure Systems*, vol. 10, no. 4, December 2004, pp. 157-166.

[10] C. Chen, "Soft computing-based life-cycle cost analysis tools for transportation infrastructure management," *Doctoral Dissertation,* Virginia Polytechnic Institute and State University, 2007.

[11] N. Vojtek, "Managing business processes using soft computing techniques – A literature review," *Journal of Sustainable Business and Management Solutions in Emerging Economies,* vol. 23, no. 1, 2018, pp. 63-71.

[12] Y. A. Hamaamin, "Applications of soft computing and statistical methods in water yesources management," *Doctoral Dissertation,* Michigan State University, 2014.

[13] V. Kumar and S. K. Yadav, "Project management efficiency using soft computing and risk analysis," *International Journal of Computer Applications*, vol. 50, no. l6, July 2012, pp. 17-22.

[14] A. S. Andreou et al., "Soft computing for crisis management and political decision making: the use of genetically evolved fuzzy cognitive maps," https://af.booksc.eu/book/7675096/70094c

[15] Z. Ding, S. Yükse, and H. Dinçer, "An integrated Pythagorean fuzzy soft computing approach to environmental management systems for sustainable energy pricing ," *Energy Reports,* vol. 7, November 2021, pp. 5575-5588.

[16] H. X. Guo, "Extracting fuzzy rules based on fusion of soft computing in oil exploration management," *Expert Systems with Applications*, vol. 36, 2009, pp. 2081–2087.

[17] G. Haixiang et al., "Optimizing reservoir features in oil exploration management based on fusion of soft computing," *Applied Soft Computing,* vol. 11, no.1, January 2011, pp. 1144-1155.

[18] L. Canos and V. Liern, "Soft computing-based aggregation methods for human resource management," *European Journal of Operational Research,* vol. 189, 2008, pp. 669–681.

[19] J. Casillas and F. J. M. López (eds.), *Marketing intelligent systems using soft computing: Managerial and Research Applications.* Springer, 2010.

[20] R. R. Karri, R. Gobinath, and M. H. Dehghani (eds.), *Soft Computing Techniques in Solid Waste and Wastewater Management*. Elsevier, 2021.

[21] M. Gui et al., *Computational Intelligence and Soft Computing Applications in Healthcare Management Science*. IGI Global, 2020.

[22] S. Borah and R. Panigrahi (eds.), *Applied Soft Computing: Techniques and Applications.* Apple Academic Press, 2022.

[23] N. H. Shah and M. Mittal (eds.), *Soft Computing in Inventory Management.* Springer 2021.

[24] A. M. Gil-Lafuente, J. Gil-Lafuente, and J. M. Merigó-Lindahl, *Soft Computing in Management and Business Economics*. Berlin, Springer, volume 1, 2012

[25] P.M. Vasant, *Handbook of Research on Novel Soft Computing Intelligent Algorithms: Theory and Practical Applications.* Information Science Reference, volumes 1 & 2, 2014.

[26] R. R. Karri, R. Gobinath, and M. H. Dehghani (eds.), *Soft Computing Techniques in Solid Waste and Wastewater Management*. Elsevier, 2021.

[27] K. Kumar, S. Roy, and J. P. Davim, *Soft Computing Techniques for Engineering Optimization.* Boca Raton, FL: CRC Press, 2019.

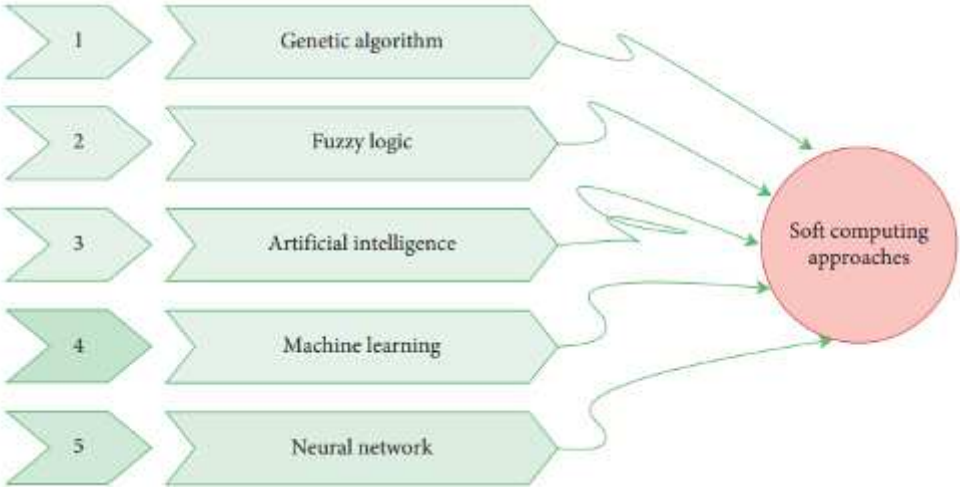

Figure 1 Soft computing approaches [3].

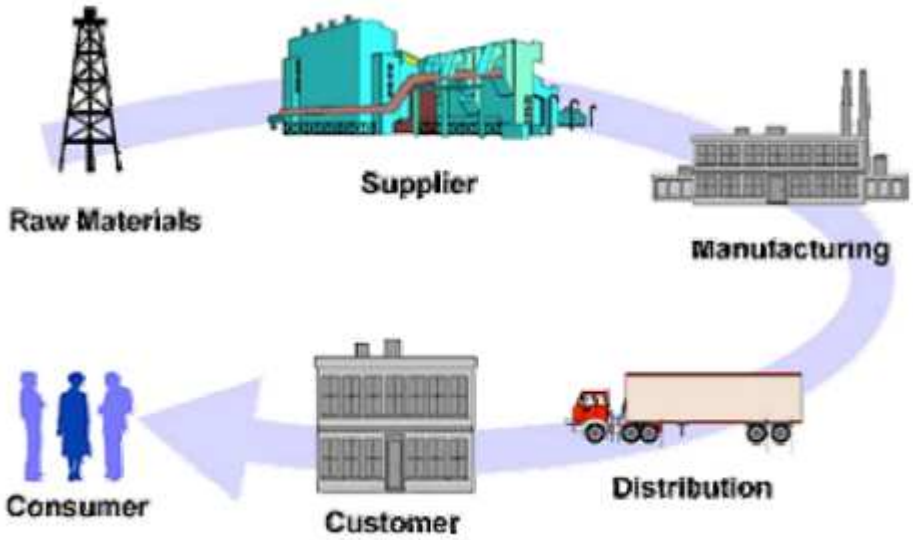

Figure 2 A typical supply chain [7].