



A SYSTEMATIC REVIEW OF FUZZY LOGIC APPROACH IN DIFFERENT AREAS OF SPORTS

Dr. Harmanpreet Kaur

Department of Physical Education, Lovely Professional University, Punjab

Harmanpreet.kaur@lpu.co.in

Sourabh Chhatiye (Research Scholar)

Department of Physical Education, Lovely Professional University, Punjab

sourabhchhatiye@gmail.com

Dr. Jimmy Singla

Department of Computer Science and Engineering, Lovely Professional University, Punjab

jimmy.21733@lpu.co.in

ABSTRACT

The fuzzy logic theory, which is a subset of logical analysis, enables the efficient implementation of approximate, ambiguous, unclear, dynamic, prolonged, and, at the same time, more realistic conditions that are more like the actual physical world and human thought. The current work was motivated by the absence of applications in the athletic domains, prior study on (AI) artificial intelligence in sports, and the useful number of interdisciplinary solutions, including fuzzy-logic approaches. All relevant studies were categorized according to the names of the publishers, the year of publication, the main goal of the study, system suggestions and output values, and finally comments that offered insightful information about the research that was cited in numerous publications to conduct a systematic review. Following that, the many results of Fuzzy logic Evaluation in Sports were examined. This study's findings revealed the usefulness of the fuzzy logic technique in assessing sports performance accuracy. Even though the authors utilized a few data mining techniques, the accuracy of these methods was lower than that of the adaptive neural fuzzy method. This method is useful for recognizing and describing aspects of degree of truth and uncertainty. Overall, this chapter describes an acceptable platform for detecting research gaps in the subject of fuzzy logic approach in physical education for additional studies or study.

Keywords: Fuzzy logic, Sports, Artificial Intelligence

DOI Number: 10.48047/nq.2022.20.19.NQ99159

NeuroQuantology 2022; 20(19): 1818-1827



INTRODUCTION

Fuzzy theory dates to the second part of the twentieth century. Professor Zadeh developed the fundamentals of fuzzy theory in the 1965 and it has since been utilized in a variety of disciplines. Fuzzy Set theory is predicated on the 'foggy' or 'uncertain' bounds of its sets, as well as infinite-valued logic. "Fuzzy theory has its historical roots in the second half of the 20th century. Professor Zadeh established its basics in 1965 and since then fuzzy theory has been applied in a variety of fields. Fuzzy set theory is based on the 'foggy' or 'uncertain' boundaries of its sets and on infinite-valued logic" (Hubáček, 2015). Another key advantage of fuzzy logic is its ability to manage both qualitative and quantitative variables is also a key feature of its application "A further significant advantage of fuzzy logic is that it can handle both the qualitative and quantitative factors, which is also an important aspect of its usage" (Laufer, 2016).

Apply engineering concepts to subject of exercise-science necessitates a methodical approach to the discipline's "basic principles" and "decision making process." It is possible to design a proper and systematic process engineering method based to information of exercise science using fuzzy-logic. "Applying engineering principles to the field of exercise science, requires a systematic perspective to "fundamental principles" and "decision making process" in this field. Using fuzzy logic, derive a

systematic process engineering approach, which is based on knowledge of exercise science, can be achieved" (Arshi,2014). The weighting of the selected criteria was determined using measurements of physical efficiency and technical competence. Fuzzy-sets were then used to convert the measured scores into fuzzy-values. After developing a player rating and comparing it to the expert judgments of sports figures, the model's reliability was finally established. "Measurements of physical fitness and technical skills were used to determine the weighting of the chosen criteria. Then the measured values were converted into fuzzy values using fuzzy sets. Finally, a ranking of players was generated and compared with the opinions of sports experts, which confirmed the reliability of the model" (Sařabun, 2020).

Fuzzy-logic has shown as an excellent technique for intelligent system in physical and physiological training during the last decade. "In the past decade, fuzzy logic has proved to be wonderful tool for intelligent systems in physical training" (Zeng, 2022). Fuzzy comprehensive evaluation of college students' physical fitness is also useful for reasonable grouping and targeted training in physical education class, and has a good reference value for teaching, as well as being meaningful and popularized for scientific evaluation of students' physical fitness.

"Fuzzy comprehensive evaluation of

college students' physical fitness is also helpful for reasonable grouping and targeted training in physical education class, which has a good reference value for teaching, and is meaningful and popularized for scientific evaluation of students' physical fitness" (Zhenwen, 2021). The application of fuzzy logic added a new level of resilience and flexibility to the system. "The implementation of fuzzy logic introduced a new quality to the system regarding robustness and flexibility" (Papic, 2009). Based on previous research, it creates a seven-dimensional framework for measuring the effectiveness of the industry for sports and society. To do this, it employs a fuzzy analytic algorithm. "Model for evaluating the competitiveness of the sports and cultural industries that are based on a fuzzy analysis algorithm, and it builds a seven-dimensional sports and cultural industry competitiveness evaluation index system that is based on previous research" (Sun, 2022).

The manufacturing technology of the football team's second goal and the club team's second goal on the football pitch (see Attachment A) provide economic-theoretical support for the frameworks that we will employ. Instead, we will use fuzzy logic to solve the DEA fuzzy models for a total of 20 virtual sports teams in order to assess sports performance. "The economic-theoretical support of those models that we will use is the production technology of results pursuit to the

soccer team in the soccer pitch (see Appendix A) and a second of the objectives for the football clubs. Instead, to measure sports performance, we will solve the DEA fuzzy models for a sample of 20 virtual soccer teams using fuzzy logic" (Pinto, 2020).

Fuzzy mathematics may be used to develop a fuzzy comprehensive assessment model, or this method can be used to thoroughly examine the sports tourist industry in Guangxi Province. "Use the method of fuzzy mathematics to construct a fuzzy comprehensive evaluation model and apply this model to objectively evaluate the sports tourism resources in Guangxi Province" (Qianying Li, 2022). A methodological foundation for the enhancement and preservation of sports tourism goods may be found in the multilevel fuzzy expert assessment of sports mass tourism, which may identify the low and high features of sports major tourist value. "Through multilevel fuzzy comprehensive evaluation of sports tourism resources, the high and low merits of sports tourism resources value can be discerned, providing a scientific basis for the development and protection of sports tourism resources" (Qianying Li, 2022).

RELATED WORK

The Artificial Intelligence Tool has undergone several improvements and is now employing new ways to provide better outcomes. This section provides a comparative study of several existing

research that quickly highlight some of the fuzzy logic, rule-based, and artificial neuralnetwork in sports and games.

Vladan Papic, Nenad Rogulj, and Vladimir Plestina, 2019 explored a fuzzy expert system for discovering and assessing new athletic talents Based on the expertise of multiple human sportspecialists and their suitability for a predefined range of sports, several motoric skills tests, morphometric feature assessments, and component testing are quantified. The values gathered, as well as the grades for the quantifiable outcomes of each exam, are recorded into the data base. Fuzzy logic is used to improve the system's flexibility and durability. Because the entire system is web-based, anyone with a valid login and password can access the created ASP.NET application. The expert system predicted acceptance and recommended the best sports for the individual being examined. Using genuine data collected over several years, four professionals analysed the system's output results.

Martínez, 2010 proposed a novel sport management approach, fuzzy, for calculating quality in the context of fitness and sports services. This study demonstrated that fuzzy set theory is an intriguing way for increasing the value of customer assessment data. The developed approach reduces categorization and connection bias caused by the link between numerical and verbal labels, so addressing the drawbacks of third-person research. The

benefits of this strategy are demonstrated through an empirical analysis of two samples of users from two fitness centres.

J. Jon Arockiaraj, and E. Barathi, 2014 presented Using fuzzy logic, deduce the link between a sportsman's fear and motivation. Sports include both physiological and social components. The athlete is seen to be tense, worried, fearful, and stressed when competing in an event. Both physiological and psychological elements have a significant impact on the quality of the player's performance. Fuzzy logic can be utilised to find a solution that will increase their motivation and reduce their worry.

Mohammad Ebrahim Razaghi, 2014 Using fuzzy logic theory, researchers evaluated the application of knowledge management from the viewpoint of employees in Kerman (Iran) province's offices of youth and sport. The "research Method" aims to investigate a statistical population of a great number of people through a census and is descriptive and applied in

nature. The questionnaire by Chung et al. is titled "Data Measurement Tool," but the word "outcome" suggests that knowledge management implementation is subpar in the offices in question and that there is a sizable gap between the actual and intended state of the factors influencing knowledge management implementation.

Ondrej Hubacek, Jiri Zhanel, and Michal Polach, 2015 investigated how fuzzy set

theory may be used to evaluate tennis athletes' outcomes using the TENDIAG1 test battery and to compare tennis athletes' abilities using the fuzzy technique and the probabilistic approach. A detailed examination of the findings revealed that the fuzzy assessment considerably separates tennis players' outcomes. The fuzzy evaluation provides a better and more exact assessment of the overall rate, especially for persons who received an identical score on the exam.

E. T.-Laufer, 2016 developed a paradigm for risk assessment using fuzzy logic that may be tailored to specific needs dependent on the conditions. The use and applicability of this flexible fuzzy logic-based assessment model were demonstrated through the investigation of a case study that assesses the amount of risk associated with diverse sporting activities using physiological data as the input parameters.

Bounit, 2016 proposed the evaluation of hygiene, safety, and environmental risks is turning into a significant concern for businesses in the field of security. It serves as a prerequisite for defining the approach that will be used. The evaluation of risks' acceptability is hampered by the ambiguity, uncertainty of the input parameters, disagreements among decision-makers, and the absence of integrated models of overall hygienic, safe, and environmental risk assessment. A comparison reveals that the suggested model provides the best, most accurate,

and exact outcomes when compared to those of traditional approaches.

Mostafa, 2018, studied in various systems, including ambient assisted-living systems, autonomous agents are frequently utilized to carry out activities in place of people. Autonomous agents frequently make choices in these settings that result in bad results. Paper provides a fuzzy-logic-based adjustable autonomy (FLAA) model in this study to control the autonomy of multi-agent systems working in complicated contexts. This paradigm tries to make it easier for agents to manage their autonomy and assist them in making wise autonomous judgments. The test findings demonstrate that the FLAA model enhances these agents' performance and accuracy in identifying and preventing falls.

Mohammadhossein Noori and Heydar Sadeghi, 2018 provided a smart approach for identifying volleyball talent based on major and weighted factors derived from an analytic hierarchy process of physiological, biomechanical, anthropometrical, psychological, biomechanical, and technical aspects using fuzzy logic. Anthropometric measurements (upper extremity length and height), biomechanical measurements (power and agility), psychological measurements (motivation and self-confidence), and measurements of spike and serve are also included (techniques). This method of talent assessment may be a useful and practical

strategy to choose young individuals who will become future volleyball stars.

Simeon Ribagin and Spas Stavrev, 2019 advocated for using data from university engaging students in sporting activities to analyse the adequacy of tests completed using the Intercriteria Analysis approach the results demonstrate that the test battery's measures are particularly well-matched to assessing the children's early stage of physical and cognitive progress.

Glazkova Svetlana Sergeevna, Babina Yulia Sergeevna, and Babina Yulia Sergeevna, 2019 created an economic analysis of corporation sports and physical instruction Using fuzzy logic, the usefulness of the measures for measuring the cost-effectiveness of helping to promote sports and physical education was measured. Businesses may utilize the study's findings to establish internal sports and physical education programmers.

W. Sařabun, A. Shekhovtsov, D. Pamučar, Jarosław W atróbski, Bartłomiej Kizielewicz, Jakub Wi eckowski, D. Bozanić, K. Urbaniak and B. Nyczaj, 2020 introduced A multi-criteria concept was built to analysis forward players based on their match statistics; for model identification, Fuzzy triangular numbers, both symmetrical and asymmetrical, were utilized. The COMET model's empirical findings were compared against arbitrary rankings like GoldenBall and player value.

Zhenwen Xu, and Yicong Zhang, 2021 examined the outcomes of physical

health exams administered to college students using the assessment technique using fuzzy integrals. Few students have an exceptional to good ratio, and most students' physical test results are in the passing range. The fuzzy integrals-based fitness rating technique for college students offers some generalizability and usefulness. Using the established index system and the complete assessment model, all girls and boys in a class or institution may have their overall fitness evaluated extensively.

Min-Chi Chiu, 2021 studied Living an active, healthy lifestyle is essential in an ageing culture. Applications for mobile and intelligent technologies can help people achieve this objective of healthy living. Choosing a smart and suitable technology application for an active and healthy lifestyle may be difficult. To get over this problem, a fuzzy collaborative intelligence (FCI) approach was introduced in this study to examine the suitability of a mobile and smart technology application. Designing a warm atmosphere that enables seniors to age actively and healthily can benefit from the study's findings.

Fubin Wang and Qiong Huang, 2022 The function of sports rehabilitation process in intensive exercises has been described and studied, and the usage of sporting rehabilitation training in physical training has been investigated. It outlines and explains the significance of physical rehabilitation training and, gives resources for applying it. The role and,

value of inpatient rehabilitation training in sports preparation are discussed, as well as an overview of the physical rehabilitation training scenario.

G. Sun, X. Zhang, and Y. Lin, 2022 created a methodology for monitoring the amount of competition in the industry and a way to judge its strength. The assessment strategy presented in this study is better than the conventional evaluation method and has helped to expand China's wider sports culture, according to the findings of the evaluation of the competitiveness of the athletic culture business in various regions around China.

Q. Li, D. Zhang, Y. Han, and Y. Xie developed Guangxi's current rural sports tourist integration development initiatives. It aims to increase the fitness and leisure participation sports tourist industry, focus on discoveries, fundamentally construct uniquely valuable sports tourism resources, and appropriately set up and cultivate certain alluring tourism industry goods. A fair evaluation of the sporting and tourist infrastructure in Guangxi Province will be conducted using this evaluation technique.

G. Smekal, A. Scharl, Serge P. von D. Rochus P., Arnold Baca Æ Ramon Baron Harald Tschan,

P. Hofmann, N. Bach the purpose of the research was to be established how well incremental test data, using neuro-fuzzy logic and linear regressions, could predict

the energy output (P) of the maximum lactate stable state (MLSS) on a cycle ergometer. Data gathered from various groups may help in the creation of better, more attractive models that can be used by a larger number of people.

W. Zeng and J. Li established fuzzy theory and presented fuzzy logic clustering approach in football team rating. Within a given range, factors alter, but the study demonstrates that our ranking result is dependable and constant. Furthermore, our strategy is easily generalizable to the scenario when N is an arbitrary positive integer and N teams exist.

Xiaojing Song discusses the application of data mining techniques to the assessment of athletic performance. The association-rule algorithm may transform the educational system's initial data into valuable information and develop a relationship between performance, boosting decision-making for the benefit of the students' physical level.

CONCLUSION

This review looks at existing studies on the impact of fuzzy logic-based evaluation in sports. The review's major purpose was to identify research gaps in the field of Fuzzy Logic in Sports. Consequently, various scientific articles published between 2009 and 2022 were defined and reviewed to establish research needs. To achieve the study's goal, all structured publications were catalogued by author name, year of publication, technique used for recognition of Fuzzy Logic Method Applying

in Sports Domain, key objective of the research, input and output variables of the system, and paper closing remarks. The key point to remember is that Fuzzy Logic is a useful AI tool for describing uncertainty and assessing great results. Therefore, this work effectively performed a comprehensive evaluation of fuzzy logic applications and influence in the sphere of sports and games. Future research Recommended that apply fuzzy expert systems for assessment in sports and physical fitness for performance evaluation.

REFERENCES

1. Arockiaraj, J. J.; & Barathi, E.; A Comparative Study of Fuzzy Logic towards the Motivation and Anxiety on a Sportsman.
2. Arshi, A.; & Mahnan, A.; (2015). Systematic Method for Assessment and Training Plan Design Using Three-Dimensional Models Derived from Fuzzy Logic.
3. Bisso, C. S.; & Samanez, C. P.; (2014). Efficient determination of heliports in the city of Rio de Janeiro for the olympic games and world cup: a fuzzy logic approach. *International Journal of Industrial Engineering*, 21(1), 33-44.
4. Glazkova, S.; Babina, Y.; & Dovgaliuk, I.; (2019, November). Economic assessment of the costs of developing corporate sports and physical education based on a fuzzy- multiple approach. In 4th International Conference on Innovations in Sports, Tourism and Instructional Science (ICISTIS 2019) (pp. 50-52). Atlantis Press.
5. Hnatchuk, Y.; Hnatchuk A.; Pityn, M.; Hlukhov, I.; & Cherednichenko, O.; (2021). Intelligent Decision Support Agent Based on Fuzzy Logic in Athletes' Adaptive E- Learning Systems. In *IntelITSIS* (pp. 258-265).
6. Hubáček, O.; Zháněl, J.; & Polách, M.; (2015). comparison of probabilistic and fuzzy approaches to evaluating the level of performance preconditions in tennis. *Kinesiologia Slovenica*, 21(1).
7. Kizielewicz; BartÅommiej; Dobryakova, Larisa; (2020). MCDA based approach to sports playersâ evaluation under incomplete knowledge. *Procedia Computer Science*, 176(), 3524–3535.
8. Li, Q.; Zhang, D.; Han, Y.; & Xie, Y.; (2022). The Path Evaluation of Integrated Development of Leisure Sports and Rural Ecological Environment in Guangxi Based on Fuzzy Comprehensive Evaluation Model. *Mathematical Problems in Engineering*, 2022.
9. Martínez, J. A.; Ko, Y. J.; & Martínez, L.; (2010). An application of fuzzy logic to

- service quality research: a case of fitness service. *Journal of Sport Management*, 24(5),502-523.
10. Noori, M.; & Sadeghi, H.; (2018). Designing smart model in volleyball talent identification via fuzzy logic based on main and weighted criteria resulted from the analytic hierarchy process. *Journal of Advanced Sport Technology*, 2(1), 16-24.
 11. Novatchkov, Hristo; Baca, Arnold.; (2013). Fuzzy Logic in Sports: A Review and an Illustrative Case Study in the Field of Strength Training. *International Journal of Computer Applications*, 71(6), 8–14.
 12. Onwuachu, U. C.; & Enyindah, P.; (2022). A Neuro-fuzzy Logic Model Application for Predicting the Result of a Football Match. *European Journal of Electrical Engineering and Computer Science*, 6(1), 60-65.
 13. Pinto, C.; (2020). Fuzzy DEA models for sports data analysis: The evaluation of the relative performances of professional (virtual) football teams.
 14. Razaghi, M. E.; (2014). Evaluating the Implementation of Knowledge Management in Offices of Youth and Sport in Iran: Fuzzy logic method. *International Journal of Sport Management, Recreation & Tourism*, 16, 56-68.
 15. Ribagin, S.; & Stavrev, S.; (2019). InterCriteria Analysis of data from intellectual and physical evaluation tests of students practicing sports activities. *NIFS*, 25(4), 83-89.
 16. Sařabun, W.; Shekhovtsov, A.; Pamučar, D.; Wątróbski, J.; Kizielewicz, B.; Więckowski, J.; ... & Nyczaj, B.; (2020). A fuzzy inference system for players evaluation in multi-player sports: The football study case. *Symmetry*, 12(12), 2029.
 17. Smekal, G., Scharl, A.; von Duvillard, S. P.; Pokan, R.; Baca, A.; Baron, R.; ... & Bachl, N.; (2002). Accuracy of neuro-fuzzy logic and regression calculations in determining maximal lactate steady-state power output from incremental tests in humans. *European journal of applied physiology*, 88(3), 264-274.
 18. Song, X.; (2022). discussion concerning the application of data mining technology in sports performance management. *Revista Brasileira de Medicina do Esporte*, 28, 460- 464.
 19. Sun, G.; Zhang, X.; & Lin, Y.; (2022). Evaluation Model of Sports Culture Industry Competitiveness Based on Fuzzy Analysis Algorithm. *Mathematical Problems in Engineering*, 2022.
 20. Tóth-Laufer, E.; (2016). A Flexible Fuzzy Logic-based Risk Assessment Framework. Óbuda

- University E-Bulletin, 6(1), 3.
21. Tóth-Laufer, E.; Takács, M.; & Rudas, I. J.; (2015). Fuzzy logic-based risk assessment framework to evaluate physiological parameters. *Acta Polytechnica Hungarica*, 12(2),159-178.
 22. Vladan Papić; Nenad Rogulj; Vladimir Pleština.; (2009). Identification of sport talents using a web-oriented expert system with a fuzzy module. , 36(5), 8830–8838.
 23. Wang, F.; & Huang, Q.; (2022). Construction and Evaluation of Sports Rehabilitation Training Model under Intelligent Health Monitoring. *Wireless Communications and Mobile Computing*, 2022.
 24. xu, z.; & zhang, y.; (2022). analysis of physical health test results of college students using fuzzy logic as an evaluation method. *revista brasileira de medicina do esporte*, 28,378-381.
 25. Zeng, W.; & Li, J.; (2014). Fuzzy logic and its application in football team ranking. *TheScientific World Journal*, 2014.
 26. Bounit, A., Irhirane, E., Bourquia, N., & Benmoussa, R. (2016). Design of a fuzzy model that integrates hygiene, safety, and environment systems for the assessment of the overall risk of machines. *Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability*, 230(4), 378-390.
 27. Mostafa, S. A., Mustapha, A., Mohammed, M. A., Ahmad, M. S., & Mahmoud, M. A.(2018). A fuzzy logic control in adjustable autonomy of a multi-agent system for an automated elderly movement monitoring application. *International journal of medical informatics*, 112, 173-184.
 28. Chiu, M. C., & Chen, T. (2021). Assessing mobile and smart technology applications for active and healthy aging using a fuzzy collaborative intelligence approach. *Cognitive Computation*, 13(2), 431-446.