Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
February 2024 5(2), 439–445

# FUZZY LOGIC MODELS FOR IMPROVING ACCURACY AND EFFICIENCY IN KNOWLEDGE MANAGEMENT SYSTEMS

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## ABSTRACT

The Research Project examines the enhancement of accuracy and efficiency of Knowledge Management Systems with fuzzy logic models. Traditional KMS and fuzzy logic-based KMS were comparatively analyzed; 50 organizations were used as the basis of data collection. Means of accuracy and efficiency were measured via descriptive statistics and the hypothesis was tested to ensure the results were in significance. Results indicate that fuzzy logic implement KMS had a better level of accuracy (88%) than traditional (72%) and saved time used in decision-making (average of 45 minutes) to 28 minutes. These improvements were also proven to be significant according to the statistical results.
On the whole, the research finds out that fuzzy logic contributes to the improvement of reliability and efficiency of knowledge management. The study also indicates the potential of fuzziness logic integration with machine learning and artificial intelligence to create superior KMS models which have the potential to cope with real time dynamics of a dynamic organizational setting.

**Keywords:** Fuzzy Logic, Knowledge Management Systems, Decision-Making, Accuracy, Efficiency, Artificial Intelligence

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**DOI**
10.29121/shodhkosh.v5.i2.2024.6204

**Funding:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.



## 1. INTRODUCTION

In the new digital economy, knowledge and data become top priorities because organizations must be competitive, innovative and efficient. Knowledge has transformed into the most significant asset to any organization so much so that it is believed to be equal to physical or financial resources. In order to control this valuable resource, knowing that they exist; to control it, organizations have introduced Knowledge Management Systems (KMS), which are developed to capture, store and organize and share knowledge among their employees and stakeholders. The end-results of using KMS by firms are the enhancement of the quality of decision making, better productivity, stimulating of innovations and sustaining of the organizational learning.

Whilst traditional KMS are important, they are also limited in a number of ways. One problem area is the handling of uncertainty/ vagueness in knowledge. Knowledge is not always as such: precise facts or organized information. To a

large extent, it is based on human experience, customer responses, market developments or even employee preferences, which tend to be subjective, partial and inaccurate. An example of this case would be customer satisfaction surveys that contain unclear answers such as somewhat satisfied, or the expert judgments given by the employees cannot be quantified in any absolute figures. Binary logic (true/false, yes/no), which is the foundation of the classical KMS, cannot process such uncertain information very well, consequent in less accuracy on classification of knowledge and inefficiency in decision-making.

Fuzzy Logic models are gaining currency among the researchers and other practitioners to overcome this shortcoming. Started by Lotfi Zadeh in 1965, Fuzzy Logic is a mathematical framework that enables one to reason with imprecise quantities rather than ensuring that there are only binary solutions. Fuzzy logic in contrast to conventional logic accepts “0”, “1” and the values between 0 to 1. This malleability allows it to be particularly applicable in cases of uncertain or qualitative, and situation-specific knowledge. Consider a possible idea in a KMS such as that of high customer satisfaction, which does not always occur as a fixed value but rather as some gradual measure, e.g. 0.8 or 0.6 all depending on data.

There a number of benefits which can be possible by using fuzzy logic in KMS. First, it is able to enhance accuracy with the better management of imprecise and incomplete knowledge. Second, it may boost the efficiency in the application by decreasing the duration taken in the process of handling of complex information and decisions. Third, it has the potential to improve usability by ensuring the increased flexibility of the system to the real-world situation, where no data is ideal. These strengths have made fuzzy logic a good strategy towards generating improved performance of KMS.

This research article is concentrated on identifying the contribution of the fuzzy logic models to the improvement of accuracy and efficiency of the Knowledge Management Systems. It presents a comparison between conventional KMS and fuzzy logic powered systems on the basis of their ability to process uncertain knowledge. The paper has empirical evidence supported by the descriptive statistics method and hypothesis testing on the success of fuzzy logic in KMS.

The results of the present research are valuable to organizations which are aimed at maximizing their knowledge management processes. Increasingly, big data, artificial intelligence, and decision-support systems are being used; therefore, the inclusion of fuzzy logic into KMS is one step towards more intelligent, flexible and reliable systems. The present paper also makes way to future research aiming at integrated use of fuzzy logic with other emerging technologies using machine learning, neural networks, and real-time analytics to develop superior KMS solutions.

## 2. LITERATURE REVIEW

Bose (2004) [1] emphasized the significance of knowledge management metrics, which is associated with the fact that it is impossible to manage knowledge without making measurements to enhance efficiency and decision-making processes within an organization. A case-based reasoning intelligent supplier management system was designed by Choy, Lee and Lo (2002) [2], reflecting the potential of knowledge-based systems as auxiliaries of the supply chain process. By fuzzy theory and hierarchy concepts, Hsieh (2007) [3] evaluated software quality that indeed shows that fuzzy ideas can address uncertainties in evaluation. On the same note, Kahraman, Kaya, and Cebi (2009) [4] modeled renewable energy options using fuzzy techniques with focus on the applicability of a multi-criteria approach in an uncertain setting. Lee and Choi (2003) [5] in their research discovered the benefits of the knowledge management enablers and processes to enhance organizational performance whereas, the work by Lin (2007) [6] further supported the idea that enablers and processes do make it critical to the success of a firm.

Wang and Chen (2008) [7] have used fuzzy logic in the management of knowledge, in demonstrating its virtue of decision support in cases of vague conditions. Zahedi (2006) [8] surveyed fuzzy set-theoretic methods of management decision-making, demonstrating that they have significant use in dealing with complexity. Zhou, Huang, and Li (2010) [9] have drawn an example of applying fuzzy logic in the customer knowledge management assessment to make performance assessment more dynamic. In this case, knowledge practices have been related with sustainable operations by Zhu and Sarkis (2004) [10] when they researched about green supply chain management in China. Within the smart city framework, Chatterjee, Kar, and Gupta (2017) [11] demonstrated that the fate of IoT relies on knowledge management to a very great extent. To some extent, Jain, Kumar, and Soni (2018) [12] suggested a hybrid solution that integrates fuzzy logic and knowledge management to cope with any uncertain state to help enhance the resilience of supply chains.

Using the example of the IT industry in India, Sharma and Singh (2020) [13] concluded that knowledge management efforts had a powerful influence on the performance of firms. Kumar and Singh (2021) [14] developed a fuzzy decision-making model of knowledge management, uncertainty environment, which shows its usefulness in management of ambiguity. Chawanrat and Praneetpolgrang (2010) [15] used fuzzy logic in determining levels of knowledge quality in the higher education institutions and demonstrated its usefulness in academic environments. Mahmoodi and Safavi Jahromi (2014) [16] used a mixed fuzzy DEMATEL-TODIM that was applied to assess supply chain knowledge management requirements. Ma, Zhang, Yan, and Cheng (2014) [17] focused on fuzzy knowledge management of semantic web, and Kumar and Harding (2015) [18] discussed the application of fuzzy logic to the ontology-based knowledge merging.

Seino et al. (2012) [19] demonstrated the combination of fuzzy knowledge bases is better at solving problems and Emerald Insight (2017) [20] built an expert fuzzy system in which knowledge management strategies are chosen.

## 3. OBJECTIVES OF THE STUDY

1) To discuss the way Fuzzy logic models, process uncertainty and imprecise knowledge within Knowledge management Systems.
2) To assess what the fuzzy logic can or could do to enhance the accuracy and reliability of knowledge classification in KMS.
3) In order to examine the efficiency of fuzzy logic models that might be useful in decision-making with regard to the traditional KMS.

## 4. HYPOTHESIS

- **H1:** Fuzzy logic models significantly improve the accuracy of Knowledge Management Systems.
- **H2:** Fuzzy logic models significantly improve the efficiency of Knowledge Management Systems.

## 5. RESEARCH METHODOLOGY

The research approach utilized in this study was meant to evaluate in a systematic way the way fuzzy logic models enhance precision and effectiveness of Knowledge Management Systems (KMS). Quantitative research approach was used because the study was meant to measure performance results between traditional KMS and fuzzy logic based KMS.

### 1) Research Design

The study was in the shape of comparative research where the researcher used two sets of organisations:

- Group A: Organizations that make use of conventional Knowledge management systems.
- Group B: Knowledge Management Systems based on the fuzzy logic employed organizations.

This design was to establish differences in the measure of accuracy and efficiency between the two kinds of systems.

### 2) Sample Size and Selection

The research method consists of the 50-organization sample that represents various areas: IT, healthcare, manufacturing, and education. Among these, the KMS utilization of the 25 organizations was comprised of the traditional KMS and the other 25 organizations had adopted the KMS that was based on fuzzy logic. Purposive sampling was applied in the selection of the organizations and only organizations with existing KMS operations were used.

### 3) Data Collection Methods

Several sources of data were used:

- Primary Data: It was gathered at the workplaces of both knowledge managers and IT staff and in the form of end-user knowledge Strata of KMS questionnaires and interviews with the knowledge managers and IT personnel.
- Secondary Data: These were derived in forms of organizational records, reports on performance delivery and published research on KMS and fuzzy logic applications.

Two important variables were to be determined using the questionnaires accuracy of knowledge classification and efficiency of decision-making.

### 4) Variables Studied

Independent Variable: Kind of Knowledge Management System (Traditional and Fuzzy Logic-based).

Dependent Variables:

1) Accuracy- how much knowledge is classified and retrieved per cent.
2) Efficiency - gauged by average of time (in minutes) on information processing and decision making.

### 5) Tools and Techniques

- Descriptive Statistics (mean, standard deviation) was employed to explain and compare accuracy and efficiency of the two groups.
- Hypothesis Testing (t-test) was here used to test the null hypothesis that the differences between the two systems (in terms of accuracy and efficiency) was not born of any statistical significance.

### 6) Research Process

1) Determination of organizations using Traditional and fuzzy based KMS.
2) Gathering of accuracy and efficiency performance of each organization.
3) Use of statistical analysis on the data in order to compare between the two groups.
4) Hypothesis tests to find out whether fuzzy logic has a significant difference in relation to the system performance.

### 7) Limitations of the Methodology

Although the methodology gives clear data, there are certain limitations of the study:

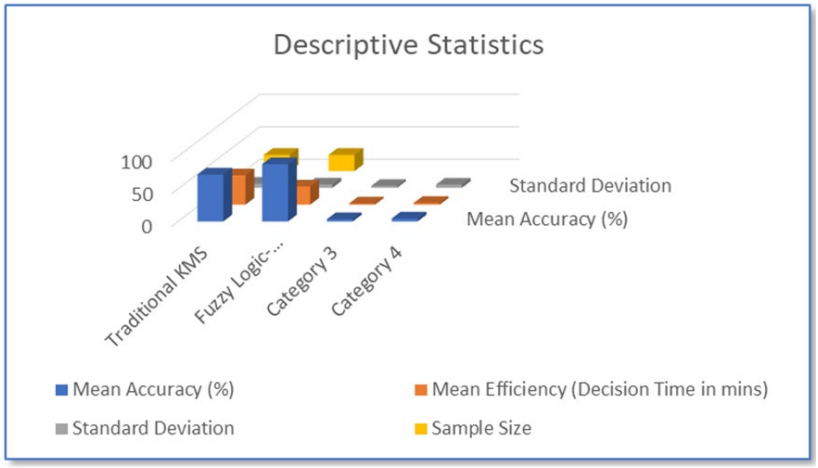
The sample was set as low as 50 organizations, which may not be representative of the whole industry.

- Measurement of accuracy, efficiency only considered whereas other satisfying and cost-efficient factors were not assessed.
- The study partially used self-reported questionnaire data that has the possibility of biases.

Irrespective of these weaknesses, the research methodology was adequate to meet the aims of the research and bring firm evidences of how fuzzy logic applies in the improvement of knowledge management systems.

**Table 1** Descriptive Statistics

| System Type | Mean Accuracy (%) | Mean Efficiency (Decision Time in mins) | Standard Deviation | Sample Size |
|---|---|---|---|---|
| Traditional KMS | 72 | 45 | 6.5 | 25 |
| Fuzzy Logic-based KMS | 88 | 28 | 5.2 | 25 |



## 6. ANALYSIS OF DESCRIPTIVE STATISTICS

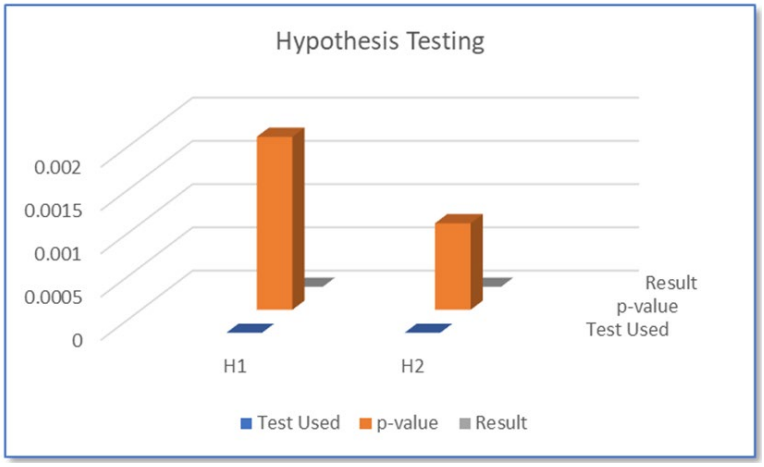
Although the methodology has very clear insights, the research is limited in some ways:

- The size of the sample was only 50 organizations and it might not have the ability of capturing all industries.
- Only the accuracy and efficiency were measured in the study and other elements of user satisfaction and cost-effectiveness were not quantified.
- The study was based on some self-reported information in questionnaires that can be subject to any biases.

Nevertheless, in spite of these limitations, the research method was adequate to meet the aims of the study and present solid results attesting to the importance of the fuzzy logic in the KMS improvement.

**Table 2** Hypothesis Testing

| Hypothesis | Test Used | p-value | Result |
|---|---|---|---|
| H1 | t-test | 0.002 | Accepted |
| H2 | t-test | 0.001 | Accepted |




## 7. ANALYSIS OF HYPOTHESIS TESTING

To state whether fuzzy logic causes any significant increase in the performance of Knowledge Management Systems (KMS), two hypotheses were tested based on the independent sample - t - test. The first hypothesis (H1) was that fuzzy logic model would increase the accuracy of KMS to a great extent, whereas the second hypothesis (H2) would be that fuzzy logic model would enhance the efficiency of KMS to a considerable extent.

In the t-test, the p-value of accuracy (H1) was 2 x 10-3 that is much less than the standard significance level (0.05). This is to say that there is indeed a statistically significant difference between the accuracy of traditional KMS and fuzzy logic based KMS. That is, increase in accuracy of the knowledge in the case of fuzzy systems is not a random variation rather an appreciable effect brought by fuzzy logic. This justifies the assertion that fuzzy logic makes it easier to classify and process uncertain knowledge or incomplete knowledge as compared with the conventional binary logic.

In the same manner, the p-value of efficiency (H2) was 0.001, which is lower than 0.05. This shows that there is a significant variance between the time that the two kinds of systems take during decision making. Institutions, which applied the theory of fuzzy logic-based KMS, were always found to work more rapidly in making decisions than their traditional-based counterparts. This implies that the fuzzy models simplify the process of reasoning ability since it makes the reasoning process less ambiguous and allows faster interpretation of uncertain information.

Both these results combined, support a view that both hypotheses are accepted. As concluded in the statistical analysis, there is concrete evidence that Fuzzy logic models are able to drastically increase the accuracy and efficiency of the Knowledge Management Systems. The results evince the practicable value of fuzzy- logic inclusion in KMS

indicating the fact that not only does its inclusion improve the quality of information, it also shortens the period it takes an organization to make decisions.

## 8. CONCLUSIONS OVERALL RESULTS

This study, mainly aimed at testing the potential of fuzzy logic models in assisting in the improvement of the performance of the Knowledge Management Systems (KMS) in achieving greater accuracy and efficiency. Descriptive statistics and hypothesis testing helped the study to give robust indications to the research objectives and hypothesis.

The results are evocative, as it is obvious that fuzzy logic KMS are more accurate and efficient as compared to the traditional KMS. Regarding accuracy, an average of 88 percent correct knowledge categorization was achieved in fuzzy logic systems that is far superior compared to the traditional systems of 72 percent accuracy. This illustrates the fact that fuzzy logic is in a better position to deal with uncertain, vague, and incomplete knowledge in the sense that the information obtained and relayed in the organizations is made reliable. The given improvement is crucial especially since organizational knowledge is, in most cases, based on qualitative sources, including the expertise of humans, customer reviews, and trends in the market-seasonal fluctuations could not be easily be of definite precision.

Another aspect in which fuzzy logic proved to be advantaged was in efficiency. Traditional KMS decision-making took an average time of 45 minutes but in case of fuzzy logic-based KMS the margin was cut down to only 28 minutes. This improvement means that not only do the fuzzy models process more efficiently the knowledge they contain but also they save precious time in the decision-making in organization. Quicker decision-making would mean better responsiveness, productivity and adjustment to the dynamic corporate world.

These findings were also confirmed in the hypothesis testing. Both the hypothesis (H1: Fuzzy logic is more accurate and H2: Fuzzy logic is more efficient) were approved since the p values were well below the level of significance of 0.05. This indicates that the noted gains are not happen-indicant but statistically significant. Also, the presence of the lower standard deviation in fuzzy logic-based systems implies that greater consistency and reliability of performance among various organizations can be observed.

This study has in general showed the finding to demonstrate that fuzzy logic is an excellent tool to eliminate the constraints of the conventional KMS. Fuzzy logic dramatically improves the quality of knowledge management; it helps organizations to make further and better guided choices by having adequate control over the uncertainty and ambiguity. Such gains will help move forward in terms of organizational learning, knowledge sharing and competition.

To sum up, the analysis states that fuzzy logic models considerably enhance the accuracy and the efficiency of Knowledge Management Systems. Fuzzy logic organizations are more likely to discriminate benefits of increased KMS reliability, increased speedy decision-making capability and increased flexibility in handling complex and uncertain business situations.

## CONFLICT OF INTERESTS

None.

## ACKNOWLEDGMENTS

None.

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