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Design and Development of an Intelligent Decision Support System for HR Recruitment

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Abstract **- In the current era of globalized business environments, the effective management of human resources (HRM) plays a critical role in attracting and retaining skilled employees as companies expand into international markets. This study aims to tackle the challenges encountered in the HR recruitment process by designing and developing an intelligent decision support system based on the Mamdani fuzzy inference system. The proposed system harnesses the capabilities of fuzzy logic and advanced analytics to enhance the efficiency, accuracy, and efficacy of candidate selection. By automating tasks, the system streamlines the recruitment process and enhances candidate-job matching through the utilization of linguistic variables such as Technical Skillset, Experience, Certifications, Qualification, and Projects completed. The Mamdani fuzzy inference system facilitates adaptable decision-making based on imprecise or uncertain inputs, capturing expert knowledge and domain-specific heuristics. This approach optimizes the candidate ranking process, contributing to the successful acquisition of talented individuals and fostering organizational growth. By adopting this technology-driven HRM approach, organizations can surmount the limitations of manual methods, elevate their recruitment processes, and make more well-informed hiring decisions. The proposed Mamdani fuzzy inference system presents a robust and efficient solution that capitalizes on the potential of information technology to augment human resource management practices and gain a competitive edge in talent acquisition.**
Keywords: **Intelligent Decision Support System, Fuzzy Inference System, Recruitment Process Improvement**

I. INTRODUCTION

With the expansion of the job market and an increasing number of job seekers, recruiters are faced with the daunting task of sifting through a large volume of resumes to find the right candidate for a given position. Resumes play a crucial role in the decision-making process during the recruitment phase, providing valuable information for evaluating candidates. However, this process becomes more challenging when there are numerous resumes to review.

To overcome this challenge, organizations require a system that can automate repetitive tasks involved in resume screening, allowing recruiters to focus on making informed decisions. This system can be replaced by a resume ranking method, utilizing data retrieval techniques to assess resumes based on various criteria. However, it is important to note that each company has unique attributes that contribute to employee performance. These attributes can be used to match candidates to specific employment profiles defined by the company. By employing a matching and ranking methodology, candidates who do not meet the qualifications can be efficiently filtered out. In recent decades, the advancement of information and communication technologies has transformed the landscape of job opportunities, and the way companies identify the most suitable candidates for specific positions. This raises the question of whether there is an effective way to leverage these technological advancements and individuals' online presence to achieve recruitment goals. In this project, we present a system that streamlines the entire recruitment process. Our system models candidates' CVs and ranks them based on various attributes such as skills, education, experience, and project work. The system then presents the results to the recruiter, who evaluates the top candidates and makes the final decision.

Overall, our system aims to optimize the recruitment process, taking advantage of technological advances and individuals' online profiles to facilitate more efficient candidate assessment and selection. By automating resume screening and implementing a comprehensive ranking methodology, organizations can enhance their recruitment practices and make more informed decisions when identifying the most suitable candidates for employment opportunities. The primary objective is to design and develop a robust and intelligent system that assists HR professionals in making informed decisions during the recruitment process. The system should leverage advanced technologies, such as artificial intelligence, machine learning, to provide valuable insights and support to recruiters.

II. LITERATURE REVIEW AND PROBLEM DEFINITION

The challenge of decision-making arises in numerous domains, including the process of recruiting new employees.

Recruitment encompasses a series of activities that commence when an organization or enterprise seeks to acquire labor and hire individuals who meet the qualifications for the available position(s). The Human Resource Department bears the responsibility of selecting suitable candidates for available job positions. This undertaking is particularly challenging due to the need to make difficult decisions amidst uncertainty.

To maintain the ongoing success of human resource selection (HRS), the adoption of a Decision Support System (DSS) is essential throughout different phases of the selection process. There are several decision analysis techniques available, each with its distinctive characteristics, requiring careful selection based on specific situations. In a previous study [1], a rule-based technique was implemented to shortlist applicants using a predefined set of criteria. The process of shortlisting resumes typically involves a panel of HR managers and field experts in the relevant job field. They assess individuals' specific skills and collectively make decisions to select or score candidates. However, automating this process introduces a considerable level of uncertainty. Soft computation techniques, such as Fuzzy Logic, are well-suited for handling such uncertainty. Additionally, Neural networks can be employed to assign weights and score CVs for ranking purposes. By implementing a hybrid system that incorporates these concepts, organizations can greatly benefit by selecting high-quality employees based on their characteristics. The system only requires specified requirements, which it can then use to automate the ranking process [2]. The Smart Applicant Ranker, presented by [3], is a resume ranking and recommendation system aimed at assisting IT companies in their recruitment procedures. This system employs Ontology to identify and categorize the connections, both implicit and explicit, between candidate profiles and job requirements.

The authors introduced a recommendation system that suggests relevant resumes based on the employer's inquiry [4]. The system primarily relies on the Vector Space Model (VSM). Two databases, namely the skill DB and candidate DB, are utilized to store the terms extracted from the documents. In the IT sector, [5] proposed a resume classifier application that assigns candidate profiles to the most suitable domain based on the resume information. The application utilizes an ensemble learning approach called the voting classifier, which comprises five individual classifiers. In [6], a resume matching system was introduced, consisting of a parser with four main phases. The system segments the extracted text based on attributes like Name and Phone to organize similar information. In their work [7], a system for classifying and matching resumes to specific job positions was proposed. The system aims to select the top ten candidates from a pool of applicants.

In the present circumstances, numerous organizations utilize online platforms to advertise job vacancies, effectively reaching a wider pool of job seekers. However, when it comes to initiating the hiring process, HR managers face multiple stages and tasks. Prior to this, job applicants submit their applications through online portals. In cases where the number of applicants surpasses the available job vacancies, HR managers encounter significant challenges in manually filtering and identifying the most suitable candidates for further processing. The sheer volume of applications makes it impractical for a single individual to review each one, leading to a time-consuming process. Automating this procedure would greatly reduce the time required for candidate screening and selection. The current system lacks flexibility, efficiency, and time-saving capabilities. HR managers are burdened with the manual task of analyzing all the job applicants. This becomes particularly challenging when there are limited job vacancies and a large number of candidates have applied. It becomes difficult for HR managers to manually shortlist candidates for further processing. Our candidate selection support system addresses this problem by offering a solution that saves time for HR managers. The system provides a ranked list of candidates for specific job profiles based on their resumes.

The sub-objectives are as listed below.

1. Determine the optimal list of candidates based on specific constraints and requirements for a particular vacancy.
2. Identify the crucial parameters necessary for ranking resumes effectively.
3. Develop a dataset that encompasses the relevant parameters needed for the ranking process.
4. Construct a robust model for ranking resumes using machine learning techniques, including Fuzzy Logic and Weighted methods.

III. PAGE ST PROPOSED DECISION MANAGEMENT SYSTEM

The system architecture diagram provides a comprehensive overview of the proposed system's structure. It illustrates how the system is designed, highlighting the internal connections between various components to ensure smooth functioning. The system utilizes a database for storing the data collected from users through the graphical user interface (GUI). The database is linked to the main processing system for internal operations. Users exclusively interact with the system through the GUI, which serves as the interface for inputting data and accessing results. The system architecture for the ranking system based on technical skillset, experience, certifications, qualifications, and projects completed can be outlined as follows.

1. *User Interface (UI):* Provides an interactive graphical user interface for users to input candidate data and access the ranking results. Allows users to input candidate information such as technical skills, experience, certifications, qualifications, and project details.
2. *Data Storage:* Utilizes a database to store the candidate data collected through the UI. Stores information such

as candidate profiles, technical skillsets, experience, certifications, qualifications, and project details.

3. *Ranking Engine:* Analyzes the candidate data to calculate individual rankings based on the specified criteria. Applies appropriate algorithms, statistical models, or machine learning techniques to assign scores or ranks to each candidate.
4. *Ranking Factors:* Technical Skillset Evaluation: Utilizes algorithms to assess the proficiency and relevance of candidates' technical skillsets. Experience Assessment: Considers the candidates' work experience, evaluating factors such as years of experience, roles, responsibilities, and project involvement. Certification Analysis: Takes into account the certifications obtained by candidates and their relevance to the desired skillset. Qualification Review: Considers educational qualifications and their alignment with the required qualifications for the position. Project Evaluation: Analyzes the complexity, relevance, and success of past projects completed by candidates.
5. *Scoring and Ranking:* Assigns scores or ranks to candidates based on their performance in each ranking factor. Applies weighting factors to different criteria based on their importance for the specific job position or organizational requirements. Calculates an overall ranking score by aggregating the individual rankings from each factor.

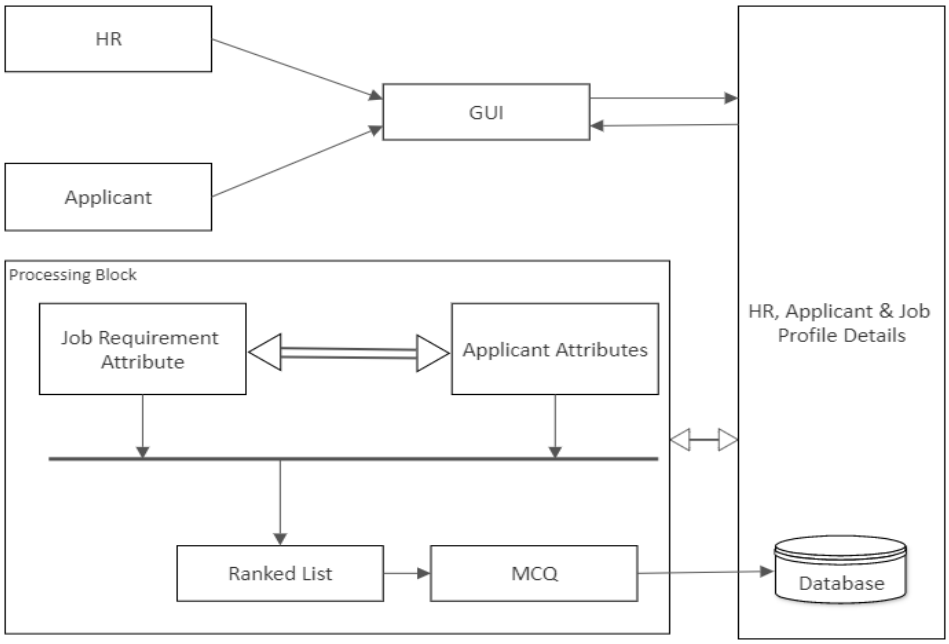

Fig. 1 Proposed System

The ranking system we have developed utilizes Fuzzy Logic to assign weights to criteria such as experience and applies a weighted method to rank candidates according to job requirements. Candidates are required to fill in the database using the web interface specifically created for collecting valuable information. This acquired knowledge is then stored in the knowledge base. The ranking attributes considered are as follows.

1. Technical Skillset
2. Experience
3. Certifications
4. Qualification
5. Projects completed.

IV. EXPERIMENTAL DETAILS AND RESULTS

To design fuzzy systems for the Intelligent Decision Support System for HR Recruitment based on the mentioned attributes, we can use fuzzy logic techniques to handle the inherent uncertainty and vagueness in these attributes.

The Mamdani inference system consists of several key components.

1. *Fuzzification:* This process involves converting crisp (numerical) inputs into fuzzy variables by mapping them to appropriate membership functions. Fuzzification allows for the representation of uncertainty or vagueness in the input values.
2. *Rule Base:* The rule base defines a set of fuzzy rules that link the fuzzy inputs to fuzzy outputs. Each rule consists of an antecedent (input conditions) and a consequent (output action). The antecedent uses linguistic variables and fuzzy logic operators (e.g., AND, OR) to express fuzzy conditions.
3. *Inference Engine:* The inference engine applies the fuzzy rules to determine the appropriate fuzzy outputs. It evaluates the degree of membership of each input in the fuzzy sets defined by the antecedents and determines the degree of support for each rule.
4. *Rule Aggregation:* The rule aggregation step combines the fuzzy outputs from different rules to obtain a single

fuzzy set for each output variable. Various methods can be used, such as the max, min, or average aggregation.

5. *Defuzzification:* Defuzzification converts the fuzzy output set into a crisp (numerical) value that represents the final decision or action. This process involves determining a representative value from the fuzzy set, often using methods like centroid calculation, weighted average, or maximum membership.

A. Fuzzification

1. *Technical Skillset:* The fuzzy system for evaluating technical skillset can include linguistic variables such as "low," "medium," and "high" to represent the level of expertise in different skills. Membership functions can be defined for each linguistic variable based on the required proficiency levels for the job. Fuzzy rules can be created to assess the skillset based on the candidate's declared skills and their proficiency levels.
2. *Experience:* The fuzzy system for evaluating experience can utilize linguistic variables such as "novice," "intermediate," and "expert" to represent different levels of experience. Membership functions can be defined for each linguistic variable based on the required years of experience for the position. Fuzzy rules can be designed to assess the candidate's experience level based on the declared years of experience.
3. *Certifications:* The fuzzy system for evaluating certifications can use linguistic variables such as "none," "basic," "intermediate," and "advanced" to represent the level of certification achieved by the candidate. Membership functions can be defined for each linguistic variable based on the importance and relevance of specific certifications for the job role. Fuzzy rules can be created to assess the candidate's certifications based on the presence or absence of relevant certifications.
4. *Qualification:* The fuzzy system for evaluating qualification can incorporate linguistic variables such as "low," "medium," and "high" to represent the level of qualification attained by the candidate. Membership functions can be defined for each linguistic variable based on the required educational qualifications for the job position. Fuzzy rules can be established to assess the candidate's qualification based on their educational background.
5. *Projects Completed:* The fuzzy system for evaluating projects completed can include linguistic variables such as "few," "moderate," and "many" to represent the quantity of projects completed by the candidate. Membership functions can be defined for each linguistic variable based on the desired level of project experience for the position. Fuzzy rules can be designed to assess the candidate's project experience based on the number of projects they have completed.

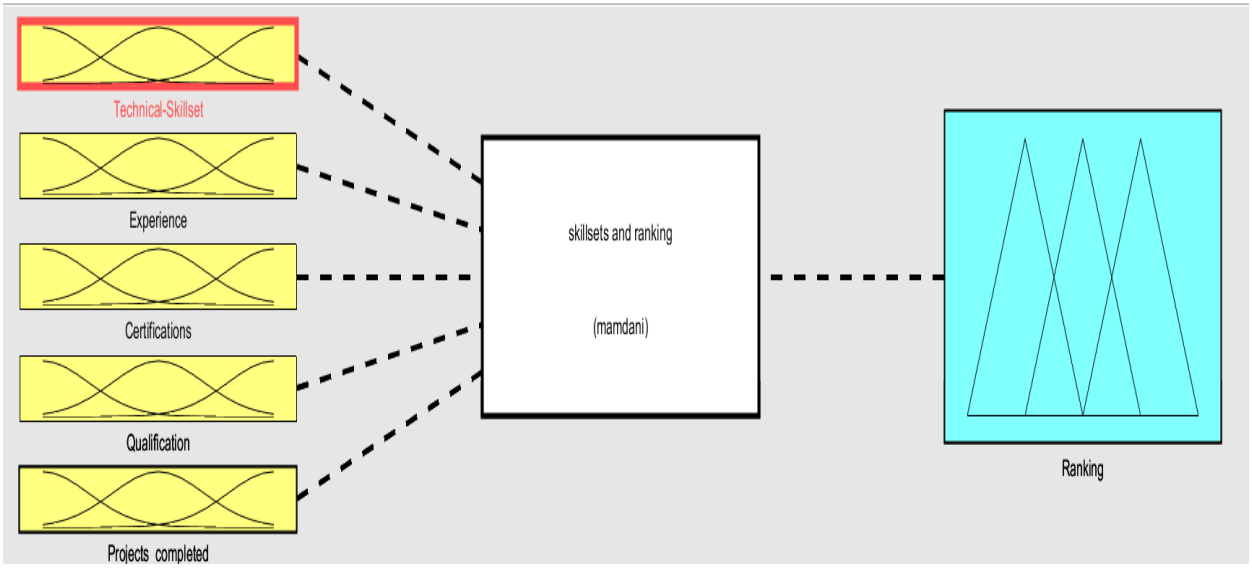

Fig. 2 Proposed Fuzzy System

B. Membership Functions

1. *Technical Skillset:* Linguistic variables: Low, Medium, High.
   Low: Triangular membership function with values ranging from 0 to 0.5.
   Medium: Triangular membership function with values ranging from 0.25 to 0.75.
   High: Triangular membership function with values ranging from 0.5 to 1.
2. *Experience:* Linguistic variables: Novice, Intermediate, Expert.
   Novice: Triangular membership function with values ranging from 0 to 0.5.
   Intermediate: Triangular membership function with values ranging from 0.25 to 0.75.
   Expert: Triangular membership function with values ranging from 0.5 to 1.

3. *Certifications:* Linguistic variables: None, Basic, Intermediate, Advanced.
   None: Trapezoidal membership function with values ranging from 0 to 0.25.
   Basic: Triangular membership function with values ranging from 0.125 to 0.5.
   Intermediate: Triangular membership function with values ranging from 0.375 to 0.75.
   Advanced: Triangular membership function with values ranging from 0.625 to 1.

4. *Qualification:* Linguistic variables: Low, Medium, High.
   Low: Triangular membership function with values ranging from 0 to 0.5.
   Medium: Triangular membership function with values ranging from 0.25 to 0.75.
   High: Triangular membership function with values ranging from 0.5 to 1.

5. *Projects Completed:* Linguistic variables: Few, Moderate, Many.
   Few: Triangular membership function with values ranging from 0 to 0.5.
   Moderate: Triangular membership function with values ranging from 0.25 to 0.75.
   Many: Triangular membership function with values ranging from 0.5 to 1.

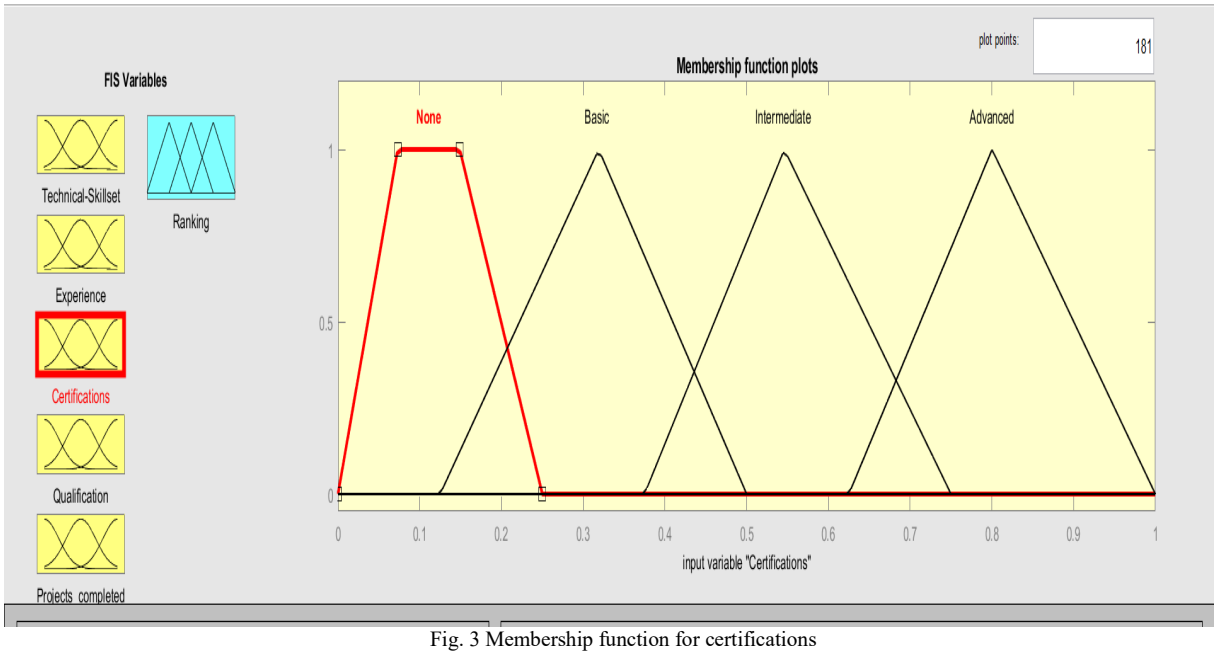

Fig. 3 Membership function for certifications

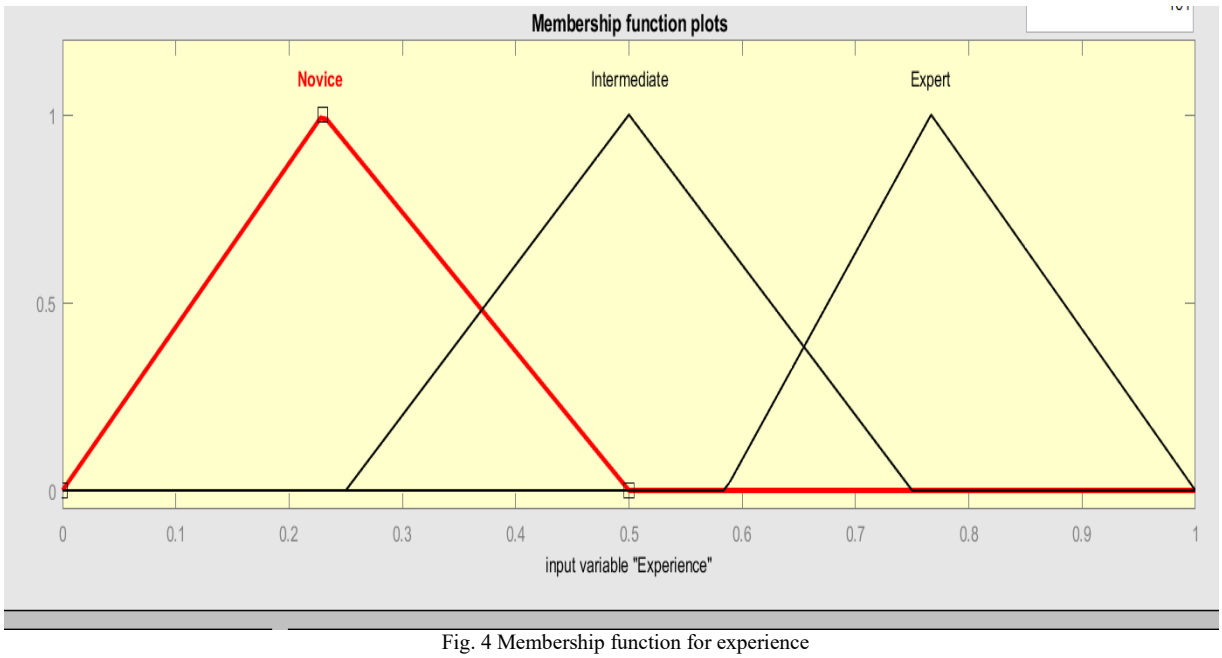

Fig. 4 Membership function for experience

C. If Then Rules

1. If Technical Skillset is High and Experience is Expert and Certifications is Advanced and Qualification is High and Projects completed is Many, then Candidate Ranking is High.
2. If Technical Skillset is Medium and Experience is Intermediate and Certifications is Intermediate or Advanced and Qualification is Medium or High and Projects completed is Moderate or Many, then Candidate Ranking is Medium.
3. If Technical Skillset is Low or Medium and Experience is Novice or Intermediate and Certifications is None or Basic and Qualification is Low or Medium and Projects completed is Few or Moderate, then Candidate Ranking is Low.
4. If Technical Skillset is High or Medium and Experience is Expert or Intermediate and Certifications is Intermediate or Advanced and Qualification is High or Medium and Projects completed is Many or Moderate, then Candidate Ranking is High or Medium.
5. If Technical Skillset is Low and Experience is Novice and Certifications is None and Qualification is Low and Projects completed is Few, then Candidate Ranking is Low.
6. If Technical Skillset is High and Experience is Expert and Certifications is Advanced and Qualification is High and Projects completed is Many, then Candidate Ranking is High.

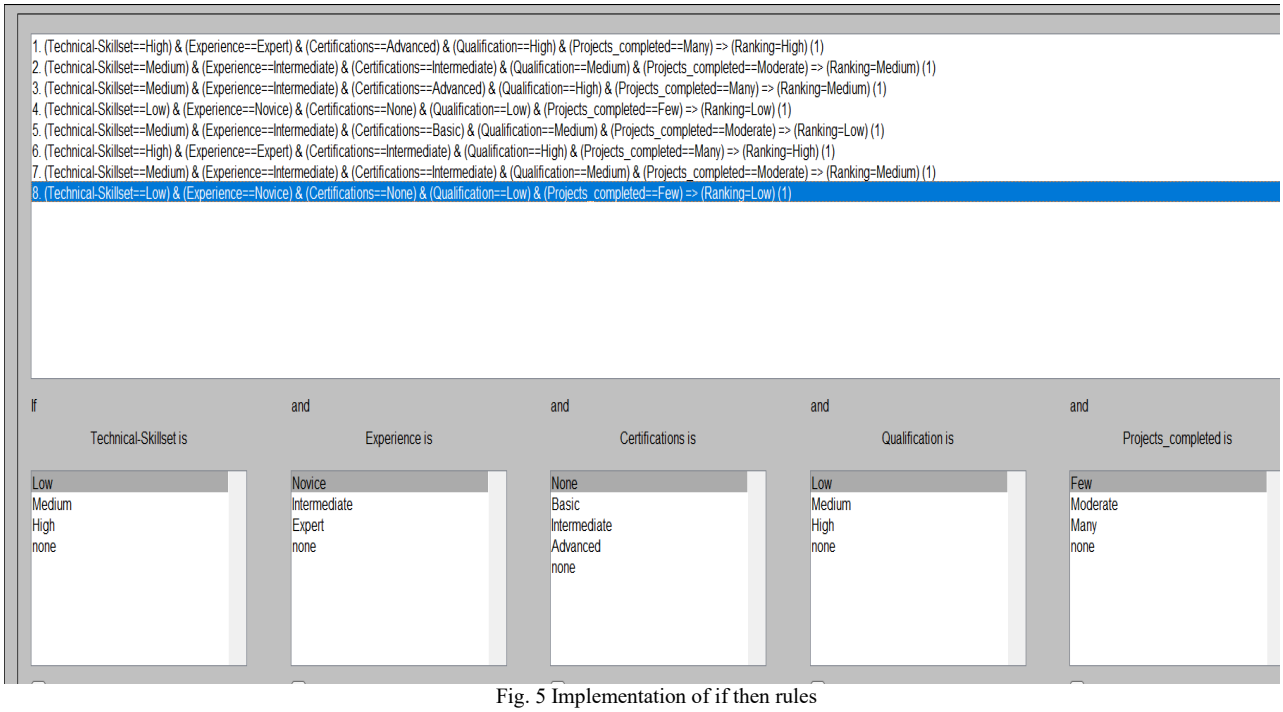

Fig. 5 Implementation of if then rules

Fig. 6 Results using Mamdani Inference Systems

These fuzzy systems can be integrated into the Intelligent Decision Support System for HR Recruitment, where they will evaluate candidates based on the respective attributes using fuzzy logic principles. By aggregating the results from these fuzzy systems, the decision support system can provide a comprehensive evaluation of candidates, facilitating the HR recruitment process. Through the utilization of fuzzy logic, the DSS has enabled HR professionals to overcome the limitations of traditional binary decision-making models. It has provided a more flexible and nuanced approach to candidate assessment, taking into account the inherent ambiguity and imprecision in evaluating human attributes and qualifications. The successful implementation of the fuzzy DSS for HR recruitment has not only improved the efficiency of the recruitment process but also enhanced the overall quality of candidate-job matching. Organizations utilizing this system have experienced reduced recruitment time, increased success rates in hiring suitable candidates, and minimized the risk of incorrect selection decisions.

V. CONCLUSION

The development and implementation of a Fuzzy Decision Support System (DSS) for HR recruitment have proven to be a valuable and effective approach in enhancing the efficiency and accuracy of the recruitment process. In conclusion, the proposed Mamdani fuzzy system, which includes variables such as Technical Skillset, Experience, Certifications, Qualification, and Projects completed, provides a framework for decision-making in a specific domain. By employing fuzzy membership functions and fuzzy rules, the system effectively handles imprecise or uncertain information related to these variables. The linguistic variables and fuzzy logic operators used in the system allow for the representation of vague or subjective concepts in a structured manner.

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