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SmartRecruit: A Fuzzy Rule-Based Expert System for Candidate Screening and Ranking

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Abstract - Human Resource (HR) management plays a pivotal role in organizational success, with recruitment being one of its most critical functions. In recent years, the integration of Artificial Intelligence (AI) into HR processes has gained significant attention, particularly in automating recruitment to enhance efficiency and reduce biases. While AI-driven systems have demonstrated advanced capabilities, many lack adaptability across diverse job roles and often fail to provide transparency in decision-making. This research addresses these limitations by proposing a novel fuzzy A Fuzzy Rule-Based Expert System for Candidate Screening and Ranking (SmartRecruit). The system evaluates candidates based on key parameters such as skills, educational qualifications (e.g., CGPA), and work experience, offering an efficient, unbiased and transparent approach to hiring.

Keywords: Smart Recruit, AI Recruitment, Expert System, Fuzzy Logic, Fuzzy Rule Based System.

I. INTRODUCTION

The world is evolving, and people have started to adopt technologies and especially AI in their day-to-day tasks. As the demand of skilled professionals are increasing day by day and with that the number of resumes is also increasing. This sometimes creates a quite chaotic and hectic situation for Human Resource Management. The traditional recruitment system is quite time-consuming, subjective and can be prone to bias. This inefficiency highlights the need for intelligent technology and automation in the resume vetting process of the candidates.

That's where the use of Artificial Intelligence comes into effect. Artificial Intelligence has significantly transformed the recruitment system. The introduction of the automated resume vetting process to evaluate candidates plays a vital role in the current world. Based on the candidate resume vetting the HR can select the best candidates for the interviews or call for the next hiring process. This may vary from company to company. In this context, we conducted an interview with Miss Isliana Ismail-Bonnifay, the HR representative of RIA International, to explore real-world scenarios of recruitment procedures, focusing on how automated recruitment systems can enhance the overall hiring process for both the company and HR professionals. Additionally, extensive research was carried out by reviewing numerous academic papers and journals to gain a comprehensive understanding of how automated resume screening processes, particularly those utilizing AI-driven solutions, can significantly improve hiring efficiency and effectiveness.

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The use of AI has been explored on the use of Artificial Intelligence in the recruitment process, showing its decision-making capability and minimizing the human biases [1]. AI-driven systems can calculate with large datasets and can make rank predictions of the suitable candidates [2]. Addition to that fuzzy logic AI model has the capability of reasoning like humans and is very flexible as well [3].

Although AI-driven recruitment solutions have demonstrated advanced capabilities, many existing systems still lack the adaptability required for diverse job roles and may fall short in ensuring transparency in their decision-making processes. The SmartRecruit system assesses candidates based on key criteria such as skills, educational qualifications (e.g., CGPA), and work experience, providing an efficient and unbiased approach to the hiring process.

This paper is structured in the following sections which represents as follows Section 2 presents related literature review. Section 3 presents the detailed methodology for developing Smart Recruit. Section 4 represents system design and implementation. Section 5 presents the analysis of the result and lastly the conclusion which is Section 6.

II. LITERATURE REVIEW

Ekuma has discussed the impact of artificial intelligence in human resource development and highlights the improvement of AI and automation in the HR functions [1]. It has also been highlighted how automation can reduce hiring biases and can increase efficiency by removing subjective decision making. The research also includes a very crucial factor about the AI powered recruitment tools that can offer transparency and accountability which aligns the unbiased hiring process by fuzzy logic

Samalia, Grumpy and Manga demonstrated the use of fuzzy decision-making ability to standardize candidate assessment by exploring the fuzzy logic in candidate vetting [2]. Their study also includes a more significant approach than a traditional Boolean method based on the fuzzy logic evaluation on multiple weighted criteria. The research further shows handling of uncertainties in skills, experience and academic qualifications by using fuzzy logic which supports the feasibility of its use in automated HR systems.

Afshari and Ćoćkalo have presented multiple fuzzy logic-based decision-making models for human resource selection [3]. Their key findings include the effective talent acquisition and the reduction of subjectivity in hiring by using the fuzzy logic system. The study also demonstrates the challenges of

defining appropriate fuzzy rules which is a crucial factor in the expert system implementation.

Kaur and Kaur have provided key insights about the AI powered HR system with their suggestions for talent acquisitions [4]. Their study has shown valuable factors like how AI based tools can improve efficiency in the recruitment process especially in dealing with large numbers of applications. On the other side they have also highlighted the risk factors like arithmetic biases and data privacy concerns. But their key findings mostly emphasize the importance of transparency and fairness. This study reinforced the objective of developing an automated fuzzy rule-based recruitment system.

Ivanov et al. focusses on fuzzy modeling in HR management and detailing the enhancements of recruitment by fuzzy logic [5]. It also includes the impact of a fuzzy logic system in employee performance evaluations. Their research has also explored the adaptation of fuzzy logic systems to handle diverse human resource tasks which include candidate vetting, and selection to different task planning. Lastly their findings provide the support of a fuzzy logic system that provides scalability and fairness in recruitment process arguments.

Demirel and Çubukçu shows their examination of the effective fuzzy logic in measuring employee performance in human resource contexts [6]. This study also provides that fuzzy logic can do multi criteria and decision-making tasks which allows the HR professionals to do qualitative and quantitative evaluation in candidate vetting and hiring process. This study helps to evaluate the approach to integrate skills, education (CGPA) and experience into a well-structured inference system.

Hellmann has introduced the fuzzy logic principles and offered foundational insights about the fuzzy rule-based system functions [7]. This work also provides the theory for backing the membership functions and inference mechanisms implementation for Smart Recruit.

AI has been on the rise and being used quite often in the recruitment process, which offers efficiency and can reduce human biases. Horodyski has examined the perception of applicants of AI in the hiring process [8]. This article also highlights its pros and cons. The study shows that most of the candidates find AI as a positive application in the hiring process. But at the same time, it is seen that candidates show concerns about the human interaction and transparency in AI driven candidate vetting decisions. These findings highlight the critical gap in AI driven candidate vetting process where

transparency and candidate experience remain a big challenge.

Meshram has explored the role of AI in the field of human resource management to enhance efficiency and reduce biases [9]. His study highlights the ability to streamline application experience and reduce the workload of the HR managers. His study shows that 24% of businesses globally have already started to use AI for the candidate vetting process and its importance of growing significance in modern HR. He has also stated about the challenges with transparency and maintaining human touch in recruitment.

The critical analysis of the existing literature puts a consistent emphasis on the efficiency and bias reduction using the capabilities of AI technology in recruitment. But there still might be several challenges which remain unaddressed like adaptability and candidate trust in automated AI based recruit systems. Meanwhile, prior study shows the success of fuzzy logic in handling candidate data and making multiple criteria-based decisions, but implementation of user-friendly interface or transparency might be lacked. That's where SmartRecruit addresses these issues and limitations by combining fuzzy logic and rule-based systems with an easy-to-use web interface. This allows the HR teams to create job specific requirements and at the same time they can maintain interpretability. The novelty aspect of the system lies in the ability to provide dynamic score-based ranking using linguistic variables like CGPA, experience, skills. Apart from that SmartRecruit provides transparency, fostering both ethical hiring and confidence in AI based recruit systems. This approach creates a bridge between human decision-making capabilities and AI based decision making.

III. METHODOLOGY

A. Data Collection for Smart Recruit

Data was collected through google form that was structured according to the demand of the HR of RIA International Money Transfer. The google form was distributed to 10 professionals ranging from fresh graduates to early career professionals. The form collected the following data such as full name, university, major, CGPA, experience, hard skills and soft skills. Accrual hiring data from the industry was not possible due to privacy concerns of the company.

Figure 1. CSV file of the collected data

B. Metrics for SmartRecruit Evaluation

The key performance metrics for evaluating the system include the following:

Matching accuracy: We compared the system generated results with the expectation of the expert which is our collaborator in this case.

Interpretability: The rules that are explained and the matching scores can be traced back to the fuzzy logic part.

Ranking clarity: The candidates have been ranked in descending order baked on the matching score which gives a decision making. Below is an output of the candidate ranking based on their resume

C. Fuzzy Logic System

Fuzzy Variables: The fuzzy variables represent the input and output values within the system. Skills-Represents the number of matched skills between the job requirements and candidate's skillset. The scoring ranges from 0 to 28 points (14 skills × 2 points each). CGPA: Represents the candidate's academic performance. The scoring is categorized into ranges of 5, 10, 15, and 20 based on CGPA brackets. Experience: Represents the candidate's professional experience, ranging from 0 to 22 months. Scores are categorized as either "low" or "high." Match Score: Represents the final evaluation score for a candidate, ranging from 0 to 100. It determines whether the candidate is a poor, average, or excellent match for the job.

Fuzzy Membership Functions: Membership functions define how input values are mapped to linguistic terms (e.g., "low," "medium," "high"). The system uses triangular membership functions (trimf) for simplicity: Skills: Divided into three terms: "low," "medium," and "high." CGPA: Categorized as "low," "medium," and "high." Experience: Categorized as "low" (0–10 months) and "high" (10–22 months). Match Score: Divided into three terms: "poor," "average," and "excellent." The triangular membership function is used because it provides a clear and linear representation of transitions between these categories.

Fuzzy Rules: The fuzzy rules define how the input variables (skills, CGPA, and experience) are combined to calculate the match score: Rule 1: High skills, high CGPA, and high experience result in an "excellent" match score. Rule 2: Medium skills, medium CGPA, and high experience result in an "average" match score. Rule 3: Low skills, low CGPA, or low experience result in a "poor" match score. Rule 4: Medium skills with high CGPA and high experience result in an "excellent" match score. These rules represent the logic for evaluating candidates and ensure that the system produces consistent and objective results.

D. Ranking clarity

Skills Score: Matches candidate qualifications with expertise required in the input form.

Gives 2 points for each skill matched.

CGPA Score: Gets the maximum CGPA limit for the candidates.

Compared with the minimum CGPA entered in the form.

Scores (5, 10, 15, 20) are assigned according to a predefined CGPA bracket.

If CGPA is below minimum level, candidates are automatically disqualified.

Experience Score: Verifies that candidate experience meets minimum qualifications.

0 months of experience: 21, 0 otherwise If experience is below minimum automatically disqualifies candidate.

IV. RESULTS AND DISCUSSION

A. System Evaluation

Smart Recruit expert system evaluates the candidates by using a fuzzy rule-based system based on the Skills, Education (CGPA) and Work Experience of the candidate. The admin has to provide the necessary keys like job requirements, minimum CGPA, required skills and experience level. These are the criteria for the candidate vetting process. The candidate data is collected by using the Google Forms and later the admin downloads the CSV file and uploads the csv file for the candidate vetting process. The skills are evaluated based on the job description, CGPA is categorized into fuzzy sets (like low, medium, high) to ensure flexible scoring. In a similar fashion experience is also evaluated to fuzzy levels (like entry level, intermediate and expert) to provide variations in the work. The system then calculates all the fuzzy weighted score rules and generates a score based on the matching criteria for each candidate. The results are displayed in the admin dashboard which allows the recruiters to identify the most suitable candidates efficiently.

Dynamic Result: Since the results shown are dynamic and it varies on the Required Skills, CGPA and Experience (In Months). Here are the samples of the output based on the input:

Matching Results

Candidate Name	Matching Score
Saima Zaman	62.32
Amirul Hakim	62.32
Hafiz Rahman	62.32
Farah Aisyah	55.07
Nur Hafiza	55.07
Daniel Ikhwan	28.99
Elham Haziq	24.64
Nur Alia	24.64
Mohammad Faisal	17.39
Aina Syuhada	14.49

Figure 2. Result 1

Here the inputs are Required Skills: Test case creation, Bug tracking, Automation testing, Quality standards compliance, Data analysis, Attention to detail, Communication, Problem-solving, Time management, Team collaboration, Power Bi Tools, Documentation, Jira, MS Office

Minimum Experience (months): 0 Minimum CGPA: 2.0

Matching Results

Candidate Name	Matching Score
Saima Zaman	62.32
Amirul Hakim	62.32
Hafiz Rahman	62.32
Farah Aisyah	55.07
Nur Hafiza	55.07
Daniel Ikhwan	28.99
Elham Haziq	24.64
Nur Alia	24.64
Mohammad Faisal	0
Aina Syuhada	0

Figure 3. Result 2

Here the inputs are Required Skills: Test case creation, Bug tracking, Automation testing, Quality standards compliance, Data analysis, Attention to detail, Communication, Problem-solving, Time management, Team collaboration, Power Bi Tools, Documentation, Jira, MS Office Minimum Experience (months): 0 Minimum CGPA: 3.0

Matching Results

Candidate Name	Matching Score
Amirul Hakim	62.32
Nur Hafiza	55.07
Saima Zaman	0
Elham Haziq	0
Farah Aisyah	0
Mohammad Faisal	0
Nur Alia	0
Hafiz Rahman	0
Aina Syuhada	0
Daniel Ikhwan	0

Figure 4. Result 3

Here the inputs are Required Skills: Test case creation, Bug tracking, Automation testing, Quality standards compliance, Data analysis, Attention to detail, Communication, Problem-solving, Time management, Team collaboration, Power Bi Tools, Documentation, Jira, MS Office Minimum Experience (months): 6 Minimum CGPA: 3.0

Matching Results

Candidate Name	Matching Score
Saima Zaman	62.32
Amirul Hakim	62.32
Hafiz Rahman	62.32
Farah Aisyah	55.07
Nur Hafiza	55.07
Elham Haziq	0
Mohammad Faisal	0
Nur Alia	0
Aina Syuhada	0
Daniel Ikhwan	0

Figure 5. Result 4

Here the inputs are Required Skills: Test case creation, Bug tracking, Automation testing, Quality standards compliance, Data analysis, Attention to detail, Communication, Problem-solving, Time management, Team collaboration, Power Bi Tools, Documentation, Jira, MS Office Minimum Experience (months): 12 Minimum CGPA: 3.

Across all scenarios, SmartRecruit dynamically adjusted candidate evaluations by applying fuzzy membership functions on CGPA, experience, and skills match. As stricter academic and professional requirements were introduced, the system proportionately tightened the qualification thresholds, demonstrating robust adaptability and transparency in candidate screening.

B. System Flow Chart

The flowchart provides a general description of function flow of Smart Recruit and clearly shows the role of Admin and Candidate and the order of operations.

- Start: First of all, the user has to use an Admin or a Candidate.
- Candidate Path: Redirection of the Candidate in the Google Form to submit the Job Application. This is a simple form that collects relevant candidate data like skills, CGPA, experience etc which will be utilized in the subsequent rounds normally in the recruitment drive.
- Admin Path: The user must login to the system with valid credentials if an Admin. She will then log in successfully.
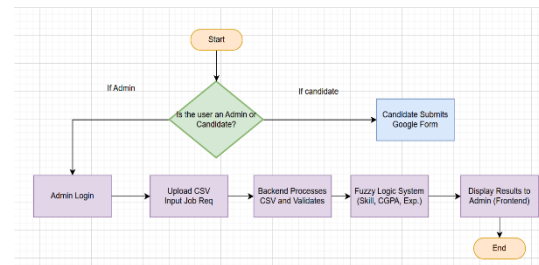- CSV File Upload and Job Requirement Input: The Admin uploads the CSV file with

Figure 6. System Flow Chart

C. System Architecture

a. Frontend UI (Netlify Hosted): Links these services with a user interaction for candidates and administrators. The user may host the candidate application link (Google Form) and the admin interaction panel.

b. Google Form (Candidates): This functions as a central collection point for candidates' data which can be pulled into CSV file.

c. CSV File Upload (admin interaction panel): Admins upload the candidate data CSV file and enter job requirements like skills, CGPA, and experience.

d. Backend (Render Hosted — Flask): Imports a CSV file, and processes it to validate the data and rank candidates using a fuzzy logic system. Houses the decision-making fuzzy rule-based system.

e. Fuzzy Logic System: Rates candidates on skills, CGPA, experience and gives a match score for each candidate

f. Results in JSON: The results are then sent from the backend to the frontend as a JSON response.

g. Display Results (Frontend): The frontend interprets the JSON response to present they ordered list of candidates to the admin in a table. It maintains beautiful data flow and integration between all components to create a seamless, powerful recruitment solution.
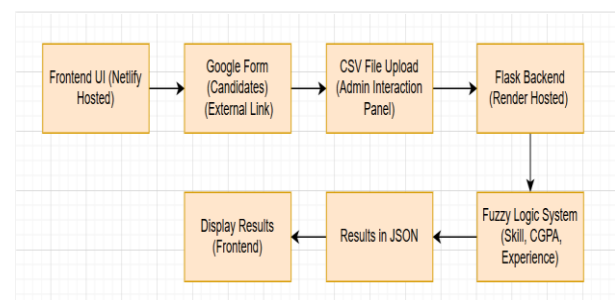

Figure 7. System Architecture

h. Frontend UI (Netlify Hosted): Links these services with a user interaction for candidates and administrators. The user may host the candidate application link (Google Form) and the admin interaction panel.

i. Google Form (Candidates): This functions as a central collection point for candidates' data which can be pulled into CSV file.

j. CSV File Upload (admin interaction panel): Admins upload the candidate data CSV file and enter job requirements like skills, CGPA, and experience.

k. Backend (Render Hosted — Flask): Imports a CSV file, and processes it to validate the data and rank candidates using a fuzzy logic system. Houses the decision-making fuzzy rule-based system.

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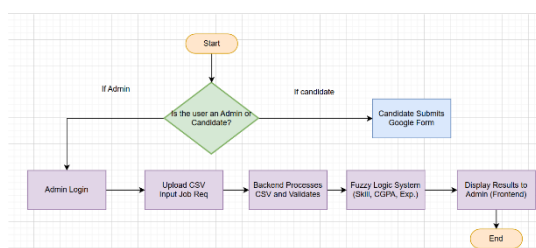
D. *System Flow Chart*

Figure 8. System Flow Chart

The flowchart provides a general description of function flow of Smart Recruit and clearly shows the role of Admin and Candidate and the order of operations.

● Start: First of all, the user has to use an Admin or a Candidate.

● Candidate Path: Redirection of the Candidate in the Google Form to submit the Job Application. This is a simple form that collects relevant candidate data like skills, CGPA, experience etc which will be utilized

in the subsequent rounds normally in the recruitment drive.

● Admin Path: The user must login to the system with valid credentials if an Admin. She will then log in successfully.

● CSV File Upload and Job Requirement Input: The Admin uploads the CSV file with the data of all candidates and adds job requirements, such as required skills, minimum CGPA, and experience.

● Data Validation: Backend Processing The uploaded data is validated and checked for compliance with required criteria. Data used to create the inputs is flagged for corrections.

● Fuzzy Logic System: The validated data is subjected to the fuzzy rule-based system, which rates and ranks candidates based on their qualifications, CGPA and experience, matching candidates to the job.

● Displays Result: The processed Result with candidates sorted according to the match score is sent to the frontend and displayed to the Admin in a comprehensible tabular format.

● End: This entire process goes on until the results are shown to the Admin, ensuring a complete recruitment workflow.

The flow chart demonstrates how the user types (Admin and Candidate) interact with the backend processes, highlighting the efficiency of the system.
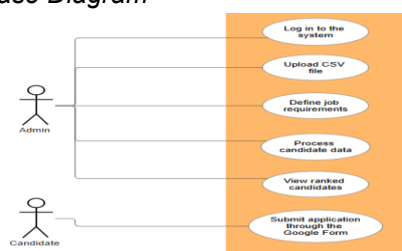
E. *Use Case Diagram*

Figure 9. Use Case Diagram

Use Case Diagram represents the relationship between the Smart Recruit and its two main actors, namely the Admin and the Candidate.

Admin:

The Admin uses the system via the following use cases:

● Login: Entering the admin panel.

● Upload CSV file: Uploads candidate data for processing.

● Define job requisition: Defines criteria like required skills, CGPA and experience.

● Candidate data processing: Starts the fuzzy logic-based evaluation of candidates.

- View ranked candidates: A review of the ranking of candidates according to the match score.

Candidate:

- The application is submitted to Google Form by Candidate the Admin then uploads this data and later it gets processed in a system.

System:

- Smart Recruit is the heart of the architecture that processes all the inputs and computations, and returns an output for the recruitment process.

It also creates a clear communication between user roles and functionalities that the system Offers.

V. LIMITATIONS AND CHALLENGES

This section discusses the potential of SmartRecruit, a recruitment tool based on fuzzy logic. However, it also highlights that there are several limitations and challenges to consider which may affect its scalability as well as effectiveness in real-world HR environments.

A. Data Limitations

The present solution is based on a tiny, simulated dataset acquired using Google Forms. Although this dataset is useful for system testing and prototyping, it may not reflect the diversity and complexity of real-world applicant profiles, especially in terms of employment experience, educational background, and skill variances. As Horodyski (2023) points out, application data in AI systems must represent the variety of human variability in order to be fair and successful. Small or unrepresentative datasets may distort evaluation results and restrict the system's generalizability.

B. Implementation Challenges

Adoption of AI techniques, particularly those utilizing fuzzy logic, may be resisted by HR workers who are inexperienced with such approaches. According to Meshram (2023), many organizations are still in the early phases of incorporating AI into their recruiting processes and may struggle with the interpretability of rule-based systems. The abstract nature of fuzzy sets and language rule combinations may be seen as complicated or opaque, particularly by HR personnel without technical backgrounds. To overcome this reluctance, we need better training, simpler interfaces, and explainable AI models.

C. Scope and Domain Limitations

While SmartRecruit works effectively in structured, criteria-driven tasks like Quality Assurance, Data Analysis, and IT Support, it may not be as successful in more creative or subjective job roles like content creation, UX design, or leadership. These professions frequently need intangible qualities such as creativity, emotional intelligence, or leadership potential, which are difficult to measure in a fuzzy rule-based framework. As Faugoo (2024) points out, adaptability and interpretability are critical for AI recruiting systems functioning in dynamic and developing employment markets.

SmartRecruit effectively addresses the challenges that include bias reduction, data diversity and transparency. This improves the system interpretability and expanding domain adaptability which are important for bigger adoption and long-term projects.

VI. IMPLICATIONS AND FUTURE WORK

A. Organizational Impact

The SmartRecruit can ease the workload of the Human Resource Management making it streamlined. It will minimize human error, handle large candidate data and enable data driven decisions.

B. Responsible AI

The SmartRecruit runs on the principles of transparency and accountability by using a fuzzy rule-based model. The decisions made by the system are traceable by membership functions and scoring logic. This system thus reduces biases and reinforces trust in the AI driven recruitment process.

C. Scalability

The SmartRecruit is highly scalable across all industries and levels. This includes internships to higher level experienced roles. In the future with the help of Machine Learning and Natural Language Processing this system can be made more reliable through any kind of application like pdfs, word file etc.

D. Future Work

Future enhancements could include integrating explainable AI (XAI), machine learning algorithms to optimize hiring processes and natural language processing (NLP) for resume parsing. This will enhance SmartRecruit to analyze CV letters, personal statements and resumes. Additional features like bias detection dashboard can provide a great feature. Real time analytics dashboard for HR can be a great addition too. These features will aim for fairness, transparency, better user experience and increase system intelligence. Additionally, user feedback can help improve the system's accuracy and transparency. By addressing identified gaps, SmartRecruit can become a more unique, diverse, efficient and ethical recruitment platform.

VII. CONCLUSION

The literature that has been reviewed highlights the role of AI and fuzzy logic in the recruitment process, the importance of efficiency, reduction of bias and transparency. AI powered systems particularly Fuzzy Logic can offer a clear structured and a well scalable approach to candidate evaluation but still there are some concerns or challenges in transparency and maintaining human touch in candidate evaluation. The gaps that were identified from the literature show a very crucial indication and suggestion that there is a need for improved explainability in AI based hiring processes to build trust among the candidates and the HR professionals.

Now let's take a look at our Fuzzy Rule based Smart Recruit System which aims to provide transparency in the decision-making process, to provide a clear image of the candidate vetting process and create a very simple and easy to use interface for both the candidate and the HR professionals. There is always room for improvements and enhancements. Future enhancements can include an integrating explanation which is also known as AI(XAI), a machine learning algorithm for adapting hiring, natural language processing (NLP) for resume parsing, creating a more versatile database to accommodate more diverse job roles and implementing a feedback system for continuous improvement. Apart from that we can use the feedback to improve the system's accuracy and transparency. Lastly by bridging the gap that has been identified, this system can be more unique, diverse, more efficient and a much more ethical recruitment system.

AUTHOR CONTRIBUTIONS

Azizar Mohammad Sadmam Sobhan: Methodology, investigation, software, validation, data curation, writing-original draft and writing-review and editing;

Siti-Soraya Abdul Rahman: Conceptualization, supervision and writing-edit and review.

CONFLICT OF INTERESTS

No conflict of interests were disclosed.

ETHICS STATEMENT

Ethical approval was not applicable to this research since it did not involve human participants, animals, or sensitive data.

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