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A knowledge-based expert system for campus helpdesk request processing

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Abstract

Help desks play a crucial function in the information technology department by acting as the main point of solution to customers' issues. The speed and efficiency of agent-centric help desks are diminished by the inability of a help desk agents to share their knowledge when they leave and the inability of agents applying past cases to solve present problem. In this study, a knowledge-based expert system for campus helpdesk request processing was presented. The presented system consists of a fusion of expert system and fuzzy inference system for campus helpdesk request processing. The fuzzy inference system is responsible for the rules while the expert system provided the interface for the user interactions. The presented system takes input queries from students through the interface of the expert system. The input queries are converted into fuzzy variables and the inference engine is then used to compare the fuzzy variables with the fuzzy rules in the knowledge base of the expert system. The database base of the expert system contains the solutions to past queries while the rule base is made up of the set of IF-THEN rules depicting the domain expert knowledge. The expert system will fire the rules that matches the input queries and deliver the answers to the queries through the expert system output interface. The evaluation results of the presented system when compared with previous research showed a better accuracy of 95.36767% in term of its efficiency in providing solutions to requests relating to complaints from campus students.

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1. Introduction

Help Desk has worked with numerous businesses, academic institutions, and other organizations to offer technical support to their staff members and students. Networking, operating systems, printer configurations, internet connections, computer security, and any other hardware/software issues are just a few of the things that support can cover. The Information Technology (IT) help desk representative needs to be adequately knowledgeable about both diagnosing and fixing specific issues in order to offer this kind of service. Help desks play a crucial function in the information technology department by acting as the main point of contact for customers to speak with analysts about any issues pertaining to networks, hardware, and software [1, 2]. Help desk analysts need to be knowledgeable about the information technologies that the help desk supports in order to address the IT issues that callers report [3]. The product of the help desk is knowledge which increases an individual's capacity to take effective action [4, 5, 6]. According to different surveys, the use of Artificial Intelligence (AI) has been employed to automate request processing in most sectors [7, 8]. One reason for the increase in the use of AI is the proliferation and distribution of information technology such as different personal computers, software applications, printers, and servers throughout the organization.

Depending on whether the clients are supported by an internal or external help desk, there are two different kinds of help desks [9, 10, 11]. Typically, internal help desks are arranged under the IT Department. Since the internal help desk resolves issues that could prevent, postpone, or otherwise affect the accomplishment of daily business activities, it has been noted that the help desk has a significant impact on the productivity of the organization. External help desks are maintained by enterprise for customers who have paid service agreements for technical support. It is a significant value-added service offered to the client in the case of the external help desk. The quickness and caliber of the solutions offered affect client happiness and, consequently, the company's reputation [12, 13].

In a traditional help desk, the agent answers call and uses a variety of expertise and information sources to solve issues [14]. This type of support desk is known as agent-centric. The agent-centric approach has at least two drawbacks. The first challenge is identifying recurring issues as such. According to help desk staff, resolving common issues takes up between 60 and 70 percent of their work [7, 15]. On the other hand, an agent who hasn't handled this kind of issue before can be assigned to handle a problem call that comes through the help desk [16, 17]. The information that an agent has about how to handle a certain scenario is not recorded by the agent-centric help desk in a manner that allows it to be searched, examined, shared, and updated by others. As a result, because the agent-centric help desk's structure makes knowledge sharing difficult, learning's benefits are not completely realized. The second issue is the high rate of employee turnover in the modern workplace, particularly for technical staff. This is an issue for the help desk because the knowledge, abilities, and prompt problem-solving skills of the help desk agents greatly influence the help desk's performance. When help desk agents leave, their knowledge frequently follows them, as they possess extensive knowledge about the systems, business procedures, and technology [18, 19]. The efficacy and efficiency of support desks are diminished by these two issues.

Numerous expert systems have been created to address diagnostic issues [20]. The most often used method of representing the knowledge base in an expert system is through rules. Rules are obtained through two sorts of methods: automated (machine learning) and manual (interviewing, for example) [21]. The rule-based approach creates a knowledge base that analyzes the issue and offers solutions, regardless of the technique employed. While knowledge base rules can be a useful tool for users, they are not the same as a collection of documents utilized in an information retrieval system. For the purpose of handling helpdesk requests on campus, this study proposes a knowledge-based expert system. The proposed knowledge-based expert system bases its solution of the user's problem on rules that have been obtained from experts.

The rest of this study is designed as follows: Section 2 presents related work. Materials and method are presented in Section 3. The results and discussion are presented in Section 4. Section 5 concludes the work with future work.

2. Related work

Abraham et al. [22] at the University of Pittsburgh created Expertech, a help desk system, for a small computer services company. Expertech is a rule-based solution that aims to diagnose seven commonly occurring issues in the telecom network faster and with greater assistance to the help desk operator. Information obtained by listening to the help desk professional explain things out loud, by watching the expert work through a problem and reading some documentation. The system was able to provide the solution for 66 out of 147 cases, or 44.8%, according to both quantitative and qualitative evaluation methods.

Gonzalez et al. [23] discussed the differences between a centric call center and a standard agent-centric call center's knowledge management system (KMS) and how they affect employee performance. The system functions as a mediator between the agent call center and different knowledge resources, enabling the agent call center to have access to a multitude of knowledge resources. The system was successful in demonstrating that a technician with less experience can fix an issue more quickly than a call center support worker. Another benefit of this study is that the system performed well enough to allow the agent call center to take advantage of the organization's knowledge and address problems more quickly than they would have otherwise.

Delic & Hoellmer [24] presented a relationship analysis between the knowledge-based system (KBS) and help desk. Problems with software, hardware, and the environment are among the various knowledge categories that the KBS offers. By providing answers to a predetermined number of questions, the KBS can improve problem solving by deriving solutions faster. As a result of utilizing KBS in conjunction with helpdesk, several benefits have been observed, including: the analyst can now handle a wider range of problems and fix them in less time when using KBS. In addition, the study pointed up a few drawbacks for the same relationship use, including the high initial cost and high maintenance costs of a knowledge base system.

Chan et al. [25] introduced the case-based help desk (CBHD) system, which aims to enhance call centers and customer service by utilizing the case-based reasoning (CBR) method to quickly diagnose issues and discover appropriate solutions. Being an automated decision-making system, the CBHD system has the advantage of offering the call center assistance by automatically diagnosing issues and quickly finding and suggesting suitable solutions.

Clarin [26] develops a Priority-Based Scheduling Algorithm-based Help Desk Support System to automate technical support processes, including ticket automation and request queuing for technical issues and inquiries. A knowledge-based system was created to offer details on typical help desk problems. In order to guarantee equitable and balanced processing, it offers a novel way to handle ticket requests utilizing the Priority-Based Scheduling Algorithm. The software development process, which involves multiple stages, was carried out using an object-oriented systems development paradigm. These are the specifications for problem analysis, systems design, data collection, and implementation. The Domain and IT Expert assessed the system based on ISO 25010 Software Development Criteria to ascertain its quality and performance. Functional suitability, performance efficiency, usability, reliability, security, maintainability, and portability were all assessed as excellent by both the domain and IT experts, while compatibility received a very good rating. The evaluation's overall result was outstanding, indicating that the system satisfies the requirements set forth during its development and that its deployment is advised.

Cheung et al. [27] presented a multi-perspective knowledge-based approach for a customer service management system. Knowledge repositories (KR), a knowledge-based system (KBS), a perceptual training module (PTM), a performance measurement and monitoring module (PMMM), and a business automation module (BAM) are the five components that make up the suggested system. To support the other modules, the KR is made up of databases, case libraries, and dynamic data. Both the KBS and PTM are responsible for assimilating and disseminating the knowledge of the various customer service activities. In order to automate client services, the BAM uses the knowledge that the KBS has assimilated. The PMMM collects and tracks employee customer service quality on a regular basis. A variety of artificial intelligence technologies, including case-based reasoning (CBR) and adaptive time-series modeling, which are utilized for decision analysis, performance evaluation, and monitoring, are integrated into the multi-perspective knowledge-based model. Based on the multi-perspective knowledge-based paradigm, a prototype customer service portal was developed and successfully implemented in a consulting firm.

Alcober et al. [28] presented a Web-based Helpdesk Support System that utilizes Time Series Methods for Ticket Forecasting and Knowledge-based Management for Tertiary Institutions. The project created a web-based helpdesk support system for postsecondary institutions that incorporates multiple time series analysis techniques to forecast the estimated number of tickets to be filed by the stakeholders based on historical records. The aim of the project is to assist students, teachers, and even non-teaching staff in managing technological inquiries and maintaining communication to perform academic-related transactions. In particular, it investigates how creating a specialized ticket management system that combines analytics and improved user experience might benefit users, particularly in higher education. Purposive sampling was used to choose 62 respondents in total. Using the ISO/IEC 25010 software quality model, these respondents assisted in assessing the overall quality of the system. The system passed the requirements-based testing since the respondents gave the system's overall quality an above-average rating. According to the survey results, 95.2% of participants concur that using data visualization to inform strategic business decisions provides insightful information. Furthermore, the system's user experience rating had the highest mean score—4.82—among its evaluations. The study's methods appear to be dependable based on the findings of the exponential smoothing, linear regression, basic moving techniques, and weighted moving average, which produced accuracy rates of 88%, 80%, 85%, and 84%, respectively.

Govindan et al. [29] used a knowledge-based fuzzy inference system (FIS) to develop a decision support system that will aid in demand management in the healthcare supply chain, community stress reduction, breaking down the COVID-19 propagation chain, and, overall, mitigating epidemic outbreaks for disruptions in the healthcare supply chain. The developed approach first classifies community members into four groups: very sensitive, sensitive, slightly sensitive, and normal. It also classifies residents based on two indicators of age and pre-existing diseases, such as high blood pressure, diabetes, or heart problems. After then, these people are categorized and made to abide by the rules of their class. Ultimately, the usefulness and accuracy of the suggested approach were demonstrated when the efficiency of the approach was evaluated in the actual world utilizing data from four users.

Deveci et al. [30] presented a hybrid decision-making framework for ranking sustainable public transportation priorities in the Metaverse using q-rung orthopair fuzzy sets (q-ROFS). To aggregate the q-ROF information in this regard, first q-rung orthopair fuzzy (q-ROF) generalized Dombi weighted aggregation operators (AOs) and their characteristics are devised. Second, to determine the objective and subjective weights of criteria, respectively, a q-ROF information-based method utilizing the removal effects of criteria (MEREC) and stepwise weight assessment ratio analysis (SWARA) models is suggested. The final weights of the criteria are then determined by using a combined weighting model. Third, by taking into account the integrated weighting model, suggested operators, and double normalization processes, the weighted sum product (WISP) approach is expanded to the q-ROFS context. Using weighted sum and weighted product models, the study leverages the benefits of two normalization procedures and four utility measures to validate the impact of benefit and cost criteria. Next, a case study of sustainable public transportation in the metaverse is presented in the context of q-ROFSs to illustrate the usefulness and efficacy of the method that has been presented. The study demonstrates that the suggested model can deliver more practical performance in the face of several influencing factors and input uncertainties, which opens up a greater range of potential applications.

Banik et al. [31] proposes a LSTM-based decision support system for swing trading in the stock market. In order to help swing traders effectively examine and forecast future stock values, the study implemented a Long Short-Term Memory mandated Decision Support System. In addition to other technical indicators like MFI, relative RSI, the stock price's support and resistance, five Fibonacci retracement levels, the company's MACD and SIGNAL LINE analysis, and the average stock price of the NIFTY industry, the decision support system generates a report that includes the expected values of the company's stock for the next 30 days. The trader's decision-making process can be enhanced by utilizing the report's investment success score. In comparison to state-of-the-art methodologies, the proposed model's outcomes in terms of Root Mean Square Error, Mean Absolute Error, and Mean Absolute Percentage Error are 4.13, 3.24, and 1.21%, respectively.

Psarommatis & Kiritsis [32] proposes a hybrid Decision Support System for automating decision making in the event of defects in the era of Zero-Defect Manufacturing (ZDM). The study focuses on detection and repair-based ZDM strategies. It implements a newly developed, hybrid Decision Support System (DSS) that uses data-driven and knowledge-based approaches to detect defects and then automate the necessary decision-making processes. The system uses an ontology-based approach in order to describe the production domain and enrich the available data with contextual information. The authors used real time production data and past knowledge to analyse defects, identify their type and severity, and suggest alternative repair plans. The authors also evaluated possible repair plans using a dynamic multi-criteria approach that determines the plan most suited to production conditions at the time of defect detection. The proposed method was integrated with a dynamic scheduling tool and was also used in an industrial application in the semiconductor domain in order to test the efficacy of their method. The simulations and the real-world implementation both showed that the proposed DSS system can efficiently detect defects and automate the post-detection decision-making process. The multi-criteria approach adopted by the study proves that the DSS can make well-adapted decisions, handle the dynamic nature of a production system, and help manufacturers move closer to Zero Defect Manufacturing.

Rosati et al. [33] proposes a Decision Support System (DSS) for solving a predictive maintenance (PdM) task. The proposed DSS comprised of data collection, feature extraction, predictive model, cloud storage, and data analysis. The suggested method is predicated on a machine learning prediction model and feature extraction strategy that are driven by certain themes gathered from both the lower and upper tiers of the production system. The experimental results showed that their approach is the best trade-off between computational effort (average latency of 2.353 s for learning from 400 new samples), predictive performance (MAE: 0.089, MSE: 0.018, R2: 0.868), and interpretability for the prediction of processing quality when compared to other state-of-the-art machine learning models. These unique characteristics, along with the incorporation of the machine learning approach under study into the suggested cloud-based architecture, enable the operator/maintainer to be directly supported in optimizing the machining quality procedures. By enabling manufacturers to lower service costs by optimizing uptime and increasing productivity, these benefits may have an impact on the optimization of maintenance schedules and the ability to receive real-time warnings regarding operational risks.

Vassilakopoulou et al. [34] developed an interface between humans and AI to provide chat-based client services. In order to provide insights into the action options that chatbots present to customer support representatives and the possibility of forming hybrid human/AI service teams, researchers and practitioners were collaborated together on this study. In addition, the study made service agents more aware of the affordances that they can find in real-world situations rather than only by using chatbots for predetermined purposes. The authors pointed out that practitioners creating and implementing chatbot-based services may find the various affordances they've uncovered to be helpful. According to the report, chatbots' action options give service agents and chatbots new ways to collaborate to meet the demands of the public. Three lessons on human/AI partnerships, theory-based interventions, and institutionalized collaborative research were provided by the study process, which can be helpful for researchers who wish to interact with practice and organizations that wish to advance their use of technology, foster innovation, and interact with research.

2.1 Help desk technology

The idea of a help desk system is to gather user questions, process them, and then respond to them [35, 36]. In order to answer a query, an agent consults a variety of knowledge and information sources. These resources include the agent's computer files, database access, agent-to-agent communications, and Internet access. Since the agent is ultimately responsible for locating and gathering the necessary data and expertise to resolve an issue, this kind of help desk technology is known as the agent-centric approach [37, 38]. A lot of people have concentrated on computer-telephony integration (CTI) in order to automate the agent-centric support desk. The integration of computers and phones to enable intelligent and seamless communication is the cornerstone of CTI. The following are the main hardware technologies: headsets, reader boundaries, predictive dialing, interactive voice response (IVR), voice response unit (VRU), automatic call distributor (ACD), and headsets. By decreasing idle time for agents and distributing agent workload equitably throughout the help desk, these technologies help to improve the efficiency of the current process. These technologies don't help with the issue of knowledge loss that occurs when agents go, nor do they give the agent information that can be used to solve issues. A number of writers have looked into using expert systems to enhance help desk operations. Expert systems record, store, and modify solutions to past issues so they can be applied to either a new or reoccurring problem. Knowledge is stored in the form of cases, each of which outlines a potential issue and a potential solution.

2.2 Expert systems

Expert systems are computer programs that mimic the decision-making and actions of a person or group with in-depth knowledge and experience in a given field by utilizing artificial intelligence technologies [39, 19]. Similar to people, these systems can perform better with time as they accumulate more experience. Expert systems gather information and facts in a knowledge base and combine them with an inference or rules engine, which is a collection of guidelines for using the knowledge base in scenarios that the program is given. Expert systems offer a self-adjusting capacity for obtaining, reusing, disseminating, and sharing customer service representatives' experience and expertise in interpreting and recommending responses to their inquiries.

2.3 Expert systems for help desk

The expert system acts as a go-between for all data, information, and knowledge sources and the help desk agent [16, 40]. This technique has two strengths. Firstly, it should make knowledge acquisition easier because it acts as a mediator for all information passing through the system. Acquiring knowledge is frequently a barrier since knowledgeable workers are too busy to remember to enter knowledge into the system, which would cause the expert system to become unresponsive. The expert-centric approach also has the benefit of providing a single, consistent interface via which the help desk agent can access a variety of information sources. Help desk agents must access a variety of information sources that are often located remotely, have different file formats, and are frequently arranged differently [16]. The knowledge from the other sources is disorganized because they are not part of the system, with the exception of the knowledge base. Instead, there is organization in the interface for finding knowledge. Where the knowledge can be found is indicated by the expert system. A pointer to connect the location to the entry in the expert system's knowledge base, for instance, is present if the information is included in a document on a file server.

3. Materials and method

The architecture of the proposed knowledge-based expert system for campus helpdesk request processing is presented in Figure 1. Figure 1 consists of a fusion of expert system and fuzzy inference system for campus helpdesk request processing. The architecture takes input queries from students through the interface of the expert system. The input queries are converted into fuzzy variables and the inference engine is then used to compare the fuzzy variables with the fuzzy rules in the knowledge base of the expert system. The Knowledge base comprises of the database and rule base. The database base of the expert system contains the solutions to past queries while the rule base is made up of the set of IF-THEN rules depicting the domain expert knowledge. The expert system will fire the rules that matches the input queries and deliver the answers to the queries through the expert system output interface.

3.1 input variables

Given an input queries X of users' complaints and solution Y of domain expert rules for the input queries respectively. Let Eqs. (1) and (2) represent input queries and answers to queries respectively;

$$X = x_1, x_2, \dots x_n \qquad (1)$$

$$Y = y_1, y_2, \dots x_n \qquad (2)$$

where n is the number of input queries and solutions.

3.2 Database

The database stores user's interaction with the system providing queries details. The database is a repository storing the solutions to past queries and domain expert knowledge. It receives as input solutions to past queries and the domain expert knowledge through the browser interface. Table 1 shows the sample complaints and solutions.

3.3 Rule base

The rule base for the developed expert system is composed of the input queries combined by a set of IF-THEN rules in which the IF-parts consist of the query variables combined by the AND operator while the THEN-parts involve the solution or answers to the queries. The rules that constitute the rule base were intelligently formulated with the knowledge of domain experts. The complaints and solutions from the database can also be combined by the IF-THEN rules to resolve multiple problems for a particular user.

3.4 Defuzzification

This part converts the rules into a decision output that can be easily interpreted by the users. Defuzzification is the process of turning fuzzy variables into precise values. By counting the overlapping region of the fuzzy output set as one, the resultant membership functions are generated in this manner, yielding more results. The union of the output of each rule is taken into consideration.

4. Results and discussion

The knowledge-based expert system for campus helpdesk request processing was developed using Visual Basic 6.0 as the Integrated Development Environment (IDE); Hypertext Markup Language (HTML), JavaScript and Cascading Style Sheet (CSS) as front-end design; Pre-Hypertext Process (PHP) as intermediary design; and MySQL as Backend design.

4.1 Implementation interface

Login Page

The interface takes data from administrator and check if it's a valid input for login. If the login is successful, the dashboard is displayed for the admin to use the software. If the login is not successful, an error message is prompted saying invalid username or password. Also, the forget password can also be used to reset the password. Figure 2 shows the login interface for the system.

Create Account Page

Create account page is a screen within the developed expert system software that allows individuals to create a new user account. It serves as the initial steps for users to gain access to the system by providing their personal information and creating login credentials. Figure 3 shows the create account interface.

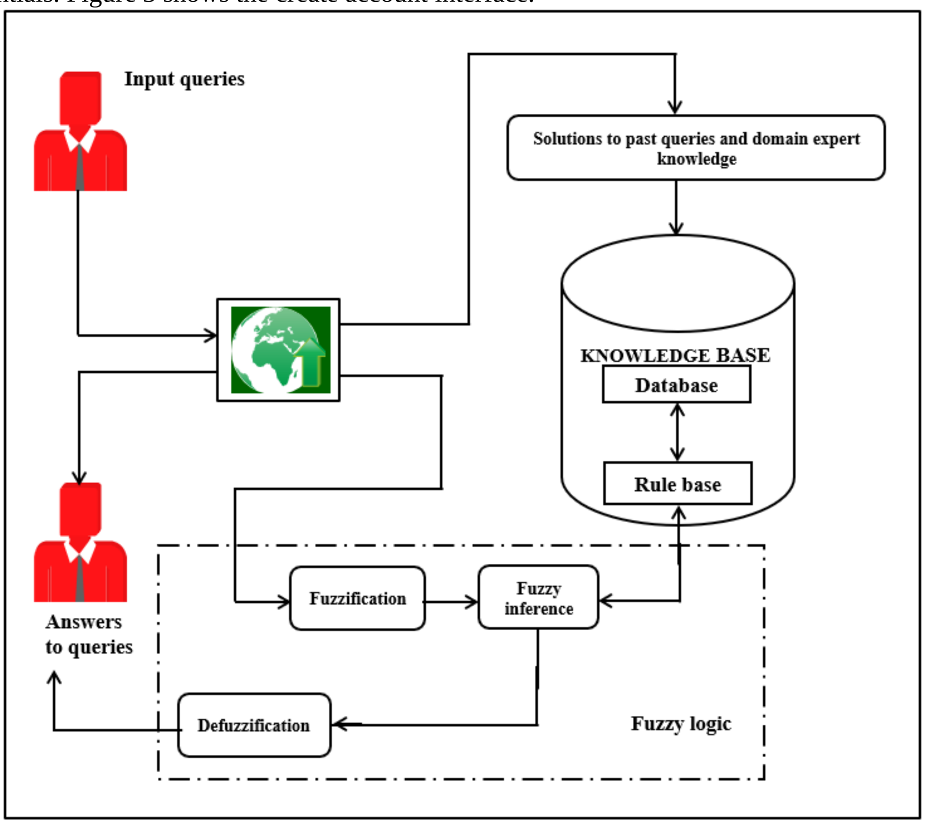

Figure 1. Architecture of the proposed knowledge-based expert system for campus helpdesk request processing

Table 1: Sample complaints and solutions

S/N	Complaint	Solution
1	Reset Learning Management System password	Enter the email account registered in the Portal, and the verification code. Click on Continue button
2	Reset portal password	Enter the email account registered in the Portal, and the verification code. Click on Continue button
3	Career counselling booking	Visit the career counselling portal. State the purpose of your request and you will be properly assigned to the right personnel.
4	Did not register a course	Go to your portal and register the course. If the portal is currently closed, ensure you write the exam for the course and register later before results are uploaded.
5	I cannot remove a course	Consult the ICT centre to remove or delete the course automatically.
6	A course I did not register but showing in the list of to do courses	Consult the HOD of your department to upload the correct curriculum
7.	A course I carry over is now bearing different course code	Register and write the course using the old course code
8.	A course I earlier passed is still showing as an outstanding course on my portal but did not affect my CGPA	Consult the ICT centre to remove or delete the course from your outstanding.
9.	My CGPA is incorrectly computed	Go to the ICT department to be sure the result processing software is working correctly or Go to your department to check the status of the courses on the course curriculum.
10.	How to pay for my acceptance fees	Go to the school acceptance fee portal, enter your registration number as username and surname as password to login. Proceed to make payment online
11.	How to pay for my school fees	Visit the admission portal, login with your registration number as username and surname as password and then make direct online payment.
12.	Transcript generation request	Visit the transcript portal. Fill in your details accurately including a valid email as required on the form. Then proceed to make payment and print your payment receipt.
13.	Call for exam script enrolment	Visit the Exam script enrolment portal. Login with your details and fill in your details accurately. Proceed to make payment and print your payment receipt. Take the receipt to your department for further processing.
14.	Request for live support to provide answers to predefined queries about students	Visit the live support portal. Request for a live support provide answers to predefined queries.

Admin Dashboard

This is the first page displayed after the login page. It is use to manage and monitor various aspects of the application. It's a centralized location for administrators to access and control the different features and settings of the software. Figure 4 shows the admin dashboard interface.

4.2 Results

In order to evaluate the performance of the proposed system with those obtained from the agent-centric method equivalent in terms of results accuracy, a performance analysis of thirty random system solutions for various input queries or complaints were compared. Table 2 shows the examined solutions cases. The table showed that the accuracy of the proposed system is 28.6103 as a result of the errors from the agent-centric method for campus helpdesk request processing. The mean accuracy was also computed by the summation of the three accuracies divided by the 30 data points.

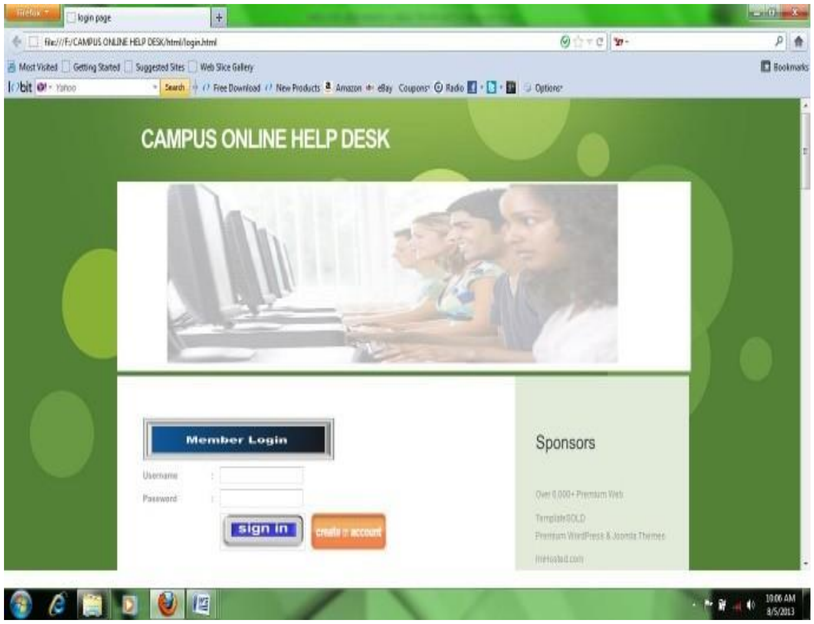

Figure 2. Login interface

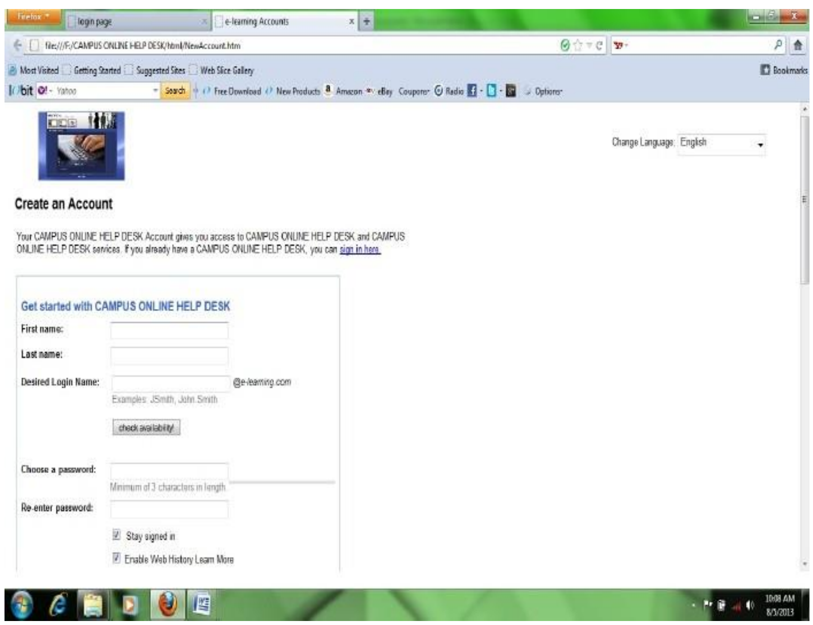

Figure 3. Create account interface

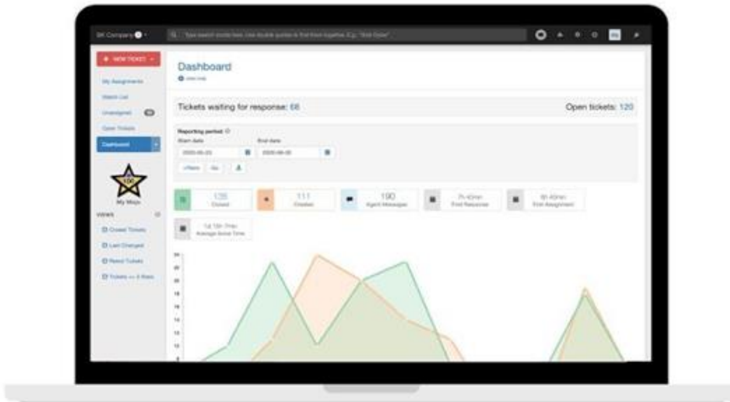

Figure 4. Admin dashboard interface

Table 2. Performance evaluation

User ID	ACA	ECA	e_i	$(1-e_i)$
1	0.7123	0.6642	0.0481	0.9519
2	0.6633	0.6054	0.0579	0.9421
3	0.6920	0.6642	0.0278	0.9722
4	0.7991	0.7819	0.0172	0.9828
5	0.8819	0.8407	0.0412	0.9588
6	0.8407	0.7740	0.0667	0.9333
7	0.7230	0.6859	0.0371	0.9629
8	0.7819	0.7226	0.0593	0.9407
9	0.6054	0.5937	0.0117	0.9883
10	0.7230	0.6859	0.0371	0.9629
11	0.6054	0.5937	0.0117	0.9883
12	0.7819	0.7226	0.0593	0.9407
13	0.6054	0.5937	0.0117	0.9883
14	0.7145	0.6828	0.0317	0.9683
15	0.7520	0.6809	0.0711	0.9289
16	0.7683	0.7129	0.0554	0.9446
17	0.7863	0.7108	0.0755	0.9245
18	0.6725	0.6020	0.0705	0.9295
19	0.7748	0.7222	0.0526	0.9474
20	0.5726	0.5216	0.051	0.949
21	0.6649	0.6238	0.0411	0.9589
22	0.8383	0.7262	0.1121	0.8879
23	0.8129	0.7539	0.059	0.941
24	0.6669	0.6210	0.0459	0.9541
25	0.6440	0.6082	0.0358	0.9642
26	0.7648	0.7257	0.0391	0.9609
27	0.7439	0.7040	0.0399	0.9601
28	0.7524	0.7148	0.0376	0.9624
29	0.6801	0.6229	0.0572	0.9428

30	0.6436	0.6162	0.0274	0.9726
Total			**1.3897**	**28.6103**

ACA= Agent-Centric Approach of the traditional method, ECA= Expert-Centric Approach of the proposed method, e_i = prediction error, and $(1- e_i)$ = accuracy of the proposed method.

Therefore, the mean accuracy of the proposed diagnosis system and its efficiency is computed as follows:

$$Mean\ Accuracy\ (MA) = \frac{\sum_{i=1}^{30}(1-e_i)}{n} = \frac{28.6103}{30} = 0.953677$$

$$Efficiency\ (E) = MA * 100 = 0.953677 * 100 = 95.36767\%$$

From the evaluation result, it can be concluded that the proposed expert system is most efficient at providing solutions for campus helpdesk request processing at 95% accuracy. In other word, the calculated MA and E values suggested that the proposed expert system for campus helpdesk request processing is 95% accurate.

4.3 Result evaluation

Table 3 displays the evaluation result of the proposed expert system for campus helpdesk request processing when compared with previous research. The previous studies were implemented and compared with the proposed expert system under the same system condition and configurations. The results showed that the majority of the methods attained good accuracy except Abraham et al. [22] with the lowest accuracy of 44.8% and highest error rate of 55.2%. The proposed expert system for campus helpdesk request processing showed better accuracy of 95.4% compared to the other most efficient methods of Sharmila et al. [43] and Alcober et al. [28] with 94.6% and 94.5% respectively. Additionally, the proposed method achieved the lowest error rate of 4.6% when compared with the other previous research. These results showed that the proposed method for campus helpdesk request processing is relatively efficient than the other previous research.

Table 3: Comparison with previous research

Method	Accuracy (%)	Error (%)
Abraham et al. [22]	44.8	55.2
Delic & Hoellmer [24]	71	29
Chan et al. [25]	80.3	19.7
Clarin [26]	88.2	11.8
Cheung et al. [27]	84.5	15.5
Alcober et al. [28]	94.5	5.5
Govindan et al. [29]	76.7	23.3
Al-Hawari & Barham [41]	81.4	18.6
Kamal et al. [42]	79.8	20.2
Sharmila et al. [43]	94.6	5.4
Expert-Centric Approach of the proposed method (ECA)	**95.4**	**4.6**

5. Conclusion and future work

In this study, a knowledge-based expert system for campus helpdesk request processing was presented. The presented system consists of a fusion of expert system and fuzzy inference system for campus helpdesk request processing. The fuzzy inference system is responsible for the rules while the expert system provided the interface for the user interactions. The presented system takes input queries from students through the interface of the expert system. The input queries are converted into fuzzy variables and the inference engine is then used to compare the fuzzy variables with the fuzzy rules in the knowledge base of the expert system. The Knowledge base comprises of the database and rule base. The database base of the expert system contains the solutions to past queries while the rule base is made up of the set of IF-THEN rules depicting the domain expert knowledge. The expert system will fire the rules that matches the input queries and deliver the answers to the queries through the expert system output interface. The evaluation results of the presented system showed a better accuracy of 95.36767% when compared to the other previous research in term of its efficiency in providing solutions to requests relating to complaints from campus students.

Conflict of Interest
The authors declare that there are no conflicts of interest regarding the publication and/or funding of this manuscript.

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نظام خبير ـ المعرفة لمعالجة طلبات مكتب المساعدة في الحرم الجامعي

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الخلاصة

تلعب مكاتب المساعدة دورًا حاسمًا في قسم تكنولوجيا المعلومات من خلال العمل كنقطة رئيسية لحل مشكلات العملاء. تتضاءل سرعة وكفاءة مكاتب المساعدة التي تركز على الوكلاء بسبب عدم قدرة وكلاء مكتب المساعدة على مشاركة معارفهم عند مغادرتهم وعدم قدرة الوكلاء الذين يطبقون الحالات السابقة على حل المشكلة الحالية. في هذه الدراسة، تم تقديم نظام خبير قائم على المعرفة لمعالجة طلبات مكتب المساعدة في الحرم الجامعي. يتكون النظام المقدم من مزيج من نظام الخبراء ونظام الاستدلال الغامض لمعالجة طلبات مكتب المساعدة في الحرم الجامعي. نظام الاستدلال الغامض هو المسؤول عن القواعد بينما يوفر النظام الخبير الواجهة لتفاعلات المستخدم. يأخذ النظام المقدم استعلامات المدخلات من الطلاب من خلال واجهة النظام الخبير. يتم تحويل استعلامات الإدخال إلى متغيرات غامضة ثم يتم استخدام محرك الاستدلال لمقارنة المتغيرات الغامضة مع القواعد الغامضة في قاعدة المعرفة للنظام الخبير. تحتوي قاعدة بيانات النظام الخبير على حلول للاستعلامات السابقة بينما تتكون قاعدة القاعدة من مجموعة قواعد IF-THEN التي تصور معرفة خبير المجال. سيقوم النظام الخبير بإطلاق القواعد التي تطابق استعلامات الإدخال وتقديم الإجابات على الاستعلامات من خلال واجهة إخراج النظام الخبير. أظهرت نتائج تقييم النظام المقدم بالمقارنة مع الأبحاث السابقة دقة أفضل بلغت 95.36767% من حيث كفاءته في تقديم الحلول للطلبات المتعلقة بالشكاوى المقدمة من طلاب الحرم الجامعي.