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Implementation of Forward Chaining in a Web-Based Expert System for Passport Services

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ABSTRACT

In the digital era, technology has become a crucial component in public services. The Class I Immigration Office TPI Yogyakarta is experiencing an increase in passport applicants, necessitating more efficient service delivery. An Expert System, which simulates the knowledge of a human expert, can enhance the efficiency of passport services by gathering and organizing knowledge within a database. Expert Systems, which have been widely applied in the healthcare sector, also hold significant potential in passport services. Many passport applicants lack a clear understanding of the required information, leading to confusion and delays. An Expert System helps applicants access accurate information regarding passport types and provides recommendations for the most suitable option. It also improves service quality by reducing errors and saving time. The selection of an Expert System is based on its ability to effectively store and manage expert knowledge, while offering accurate and fast solutions and recommendations. This system benefits passport applicants, immigration officers, and the government by improving the efficiency and effectiveness of public services and increasing public satisfaction. Additionally, the Expert System is designed to be flexible and adaptable to changes in regulations or procedures.

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1. Introduction

In today's digital era, technology plays a vital role across various sectors, including public services. At the Class I Immigration Office TPI Yogyakarta, the increasing number of passport applicants demands more efficient service delivery. One promising solution is the implementation of an Expert System—a computer-based system designed to emulate the knowledge and expertise of a human expert in solving specific problems [1].

An Expert System can collect and organize information from experts into a knowledge base that users can access effectively and efficiently [2]. Although this technology has been widely applied in the healthcare sector, its benefits are also highly relevant to passport services. The system can provide applicants with information on passport types, required documents, and the application process flow, thereby reducing confusion and delays..

For immigration officers, the Expert System helps reduce workload by allowing applicants to obtain basic information without needing to ask directly. This improves time efficiency, minimizes errors, and enables officers to focus on core services [3]. For the government, the system supports increased effectiveness and public satisfaction with immigration services.

The Expert System also enhances the efficiency of human resource utilization, as information can be accessed directly without intermediaries. Additionally, the system is designed to be flexible and can be updated in line with changes in regulations or procedures, ensuring the information remains accurate and relevant.

With its ability to store expert knowledge, provide rapid solutions, and adapt to change, the Expert System is expected to be an innovation that supports better, more modern, and responsive passport services tailored to the needs of the public..

2. Research Method

This study outlines the methodology applied to provide a comprehensive view of the research subject and procedures. The researcher employed the Waterfall development method as a guideline to organize the research steps and approaches, with the aim of achieving structured and efficient results [4]. This step-by-step approach assists the researcher in detailing the research subject and systematically and structurally designing the procedures to be implemented..

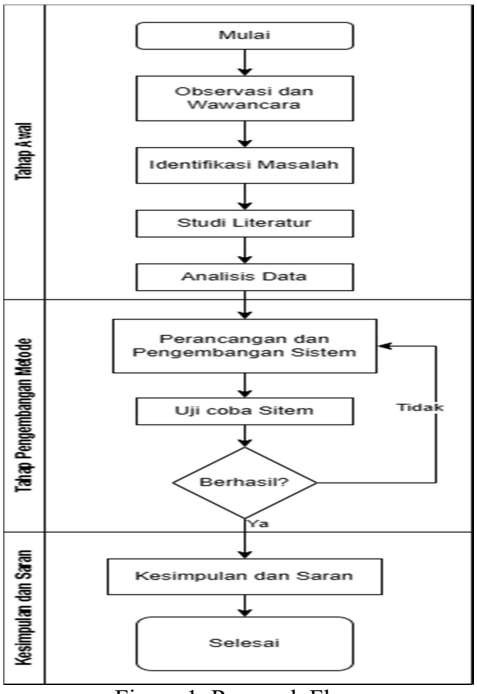

Figure 1. Research Flow

1. Initial Stage

The initial stage consists of a series of steps to determine the research problem. Observation and interviews involve collecting data through direct observation and interviews with staff at the Class I Immigration Office TPI Yogyakarta. The collected data is then used for Problem Identification, where existing problems are identified based on the gathered information. Literature Review involves in-depth research on relevant topics to gain a deeper understanding of the issues and how similar problems have been addressed using traditional methods. In the Data Analysis phase, the data that has been collected and identified is analyzed to gain further insights into the problem and how it can be resolved.

2. Method Development Stage

The development stage thoroughly discusses the process of designing and developing the system, as well as the implementation of trials to ensure that the system operates according to the established specifications. This process is carried out gradually and systematically, following the principles of traditional

system development methods. In the System Design and Development phase, the system is identified, designed, and developed. This may include prototype creation, algorithm development, or the implementation of specific technologies such as Unified Modeling Language (UML). Unified Modeling Language (UML) is a standard modeling language used for the design and documentation of software systems and other business structures [5]. UML is not limited to software but can also be used in the development process of various systems. It helps developers visualize, design, and document various aspects of a system in a systematic and organized manner [6]. After the system is designed and developed, it enters the Testing Phase. The developed system is tested to ensure that it works as expected and can address the identified problems. If the system fails, the process returns to the System Design and Development phase for necessary improvements and adjustments before proceeding to the next stage [7].

3. Conclusion and Recommendations

In the conclusion and recommendations stage, the researcher presents all findings obtained in the field. The Conclusion provides a summary of the research results and answers to the research questions. Meanwhile, the Recommendations include suggestions for future research and practical implementations of the study's findings.

3. Results and Discussion

The Expert System is designed to provide accurate and relevant information, including the type of passport that best suits the applicant's needs—such as an ordinary passport or an electronic passport. For instance, an applicant who frequently travels abroad for business purposes would be recommended to use an electronic passport. In addition, the system can also provide specific information, such as the requirements for issuing a passport for a child with limited dual citizenship. Thus, this Expert System supports a smarter, more efficient, and responsive passport service at the Class I Immigration Office TPI Yogyakarta. The results of the conducted research include identifying input variables in the form of coded applicant condition data, and output variables in the form of applicant recommendation codes, which are used to generate solutions, as shown in the table below:

1. System Design

Table 1. Applicant Condition Data

Kode	Applicant Conditions
A01	ID card (KTP) data does not match
A02	Family Card (Kartu Keluarga) data does not match
A03	Birth certificate data is incorrect or missing
A04	Educational certificate (elementary, junior high, senior high school) data is incorrect or missing
A05	Marriage certificate or marriage document data does not match
A06	Health documents are invalid or not available
A07	Passport data does not match
A08	Passport was issued before the year 2000
A09	Baptism certificate is incorrect or missing
A10	Recommendation letter for Indonesian Migrant Workers (CPMI) from BP2MI is invalid or not available
A11	Purpose is Umrah or Hajj but name consists of only one word
B01	Frequently crosses international borders (Transit)
B02	Frequently travels abroad (within less than 6 months)
B03	Age above 17 years or already has an ID card (KTP)
B04	Travels abroad more than once a year
B05	Travels for tourism abroad more than once a year
B06	Child under 17 years old
B07	Prioritizes convenience in immigration checking process

B08	Visiting multiple countries for business purposes
B09	Passport application is solely for religious purposes (Umrah or Hajj)
C01	Child from a legal marriage between an Indonesian father (WNI) and a foreign mother (WNA)
C02	Child from a legal marriage between a foreign father (WNA) and an Indonesian mother (WNI)
C03	Child born out of wedlock to a foreign mother (WNA), legally acknowledged by an Indonesian father (WNI) before the child reaches 18 years old or before marriage
C04	Child born outside Indonesia to both Indonesian parents (WNI), provided that the country of birth grants citizenship to the child
C05	Child born out of wedlock, under 18 years old, unmarried, and legally acknowledged by a foreign father (WNA)
C06	Indonesian child under 5 years old who has been legally adopted by a foreign national (WNA) through a court decision
C07	Child born from a marriage between a foreign father and a foreign mother (both WNA)
C08	Child born outside Indonesia to both foreign parents (WNA)
C09	Child born out of wedlock to a foreign mother (WNA) and not acknowledged by an Indonesian father (WNI)
C10	Child born out of wedlock, under 18 years old, unmarried, and not legally acknowledged by a foreign father (WNA)
C11	Indonesian child adopted by a foreign national (WNA) without a court decision
C12	Child who has chosen a foreign nationality after reaching the age of 18

Table 2. Applicant Recommendation Data

Kode	**Recommendations**
T01	Correct ID card (KTP) or Family Card (KK) data at the Civil Registry Office (Dukcapil)
T02	Replace supporting documents such as birth certificate, school certificates (elementary, junior high, senior high), marriage book, marriage certificate, or baptism certificate
T03	Submit a statement report (BAP) related to passport data changes
T04	Obtain a recommendation letter for prospective migrant workers (CPMI) from BP2MI
T05	Obtain a health certificate from a hospital or other healthcare service unit
T06	Attach Family Card/Birth Certificate/School Certificates (elementary, junior high, senior high) showing the biological father's name
T07	Correct or request a duplicate birth certificate at the Civil Registry Office (Dukcapil)
T08	Renew passport by bringing complete documents (ID card, Family Card, Birth Certificate/School Certificate/Marriage Certificate/Marriage Book)
P01	Electronic Passport
P02	Regular Passport
Q01	Eligible for Indonesian Passport (Paspor RI)
Q02	Not eligible for Indonesian Passport (Paspor RI)

After assigning condition codes for applicant data and corresponding recommendation codes, the next step involves the development of a rule base, which serves as the core of the decision-making mechanism within the Expert System. A rule base is used to systematically represent expert knowledge and apply it in evaluating specific conditions or situations encountered during passport service processes.

The rules in an Expert System are typically structured into two fundamental components: conditions (IF) and actions (THEN). These IF-THEN statements allow the system to simulate the reasoning process of a human expert by evaluating input data (such as inconsistencies in applicant documents or specific travel purposes) and producing appropriate recommendations or decisions.

This rule-based approach not only enhances the system's ability to make consistent and logical conclusions, but also ensures transparency and traceability in the decision-making process. Moreover, the use of a rule base allows for easy updates and modifications as regulations evolve or new scenarios emerge.

The implementation of these rules transforms raw applicant data into actionable insights that support efficient, accurate, and responsive passport services. The structure and content of these rules are presented in the following table.:

Table 3. Expert System Rule Base

No	Rules	
	IF	THEN
1	A01 OR A02	T01
2	A03 OR A04 OR A05 OR A09	T02
3	A07	T03
4	A10	T04
5	A06	T05
6	A11	T06
7	A03	T07
8	A08	T08
9	B01 OR BO2 OR BO3 OR BO7 OR BO8	P01
10	B04 OR BO5 OR B06 OR BO9	P02
11	C01 OR C02 OR C03 OR C04 OR C05 OR C06	Q01
12	C07 OR C08 OR C09 OR C10 OR C11 OR C12	Q02

2. System Design

This stage involves the system design process, which includes the creation of use case diagrams, activity diagrams, class diagrams, and the user interface design of the system to be developed. The use case diagram is a technique used to capture the functional requirements of a system, illustrating the expected functionalities that the system should perform.

a. Use Case Diagram

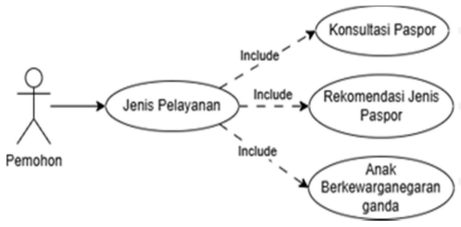

Figure 2. Applicant Use Case Diagram

The use case diagram above illustrates the interactions between the applicant (user) and the expert system for passport services. The applicant is depicted as the primary actor who interacts with the system to perform several key functions. These functions include entering personal data, selecting the purpose of passport application, receiving recommendations on the appropriate type of passport (e.g., regular or electronic), and obtaining information regarding the required supporting documents. This diagram helps to visualize the system's functional requirements from the user's perspective and clarifies how the system responds to various inputs. By modeling the interactions in this way, the diagram supports a better

understanding of system behavior, guides interface design, and ensures that the system aligns with user needs and expectations. The use case approach also facilitates communication between developers and stakeholders during the development process.

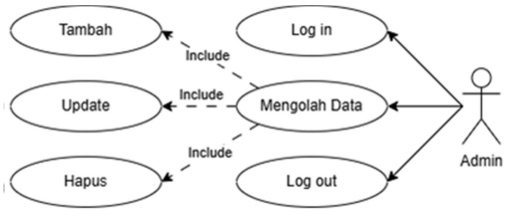

Figure 3. Admin Use Case Diagram

a. Activity Diagram

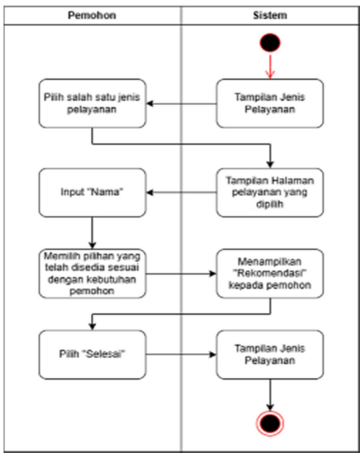

Figure 4. Applicant Activity Diagram

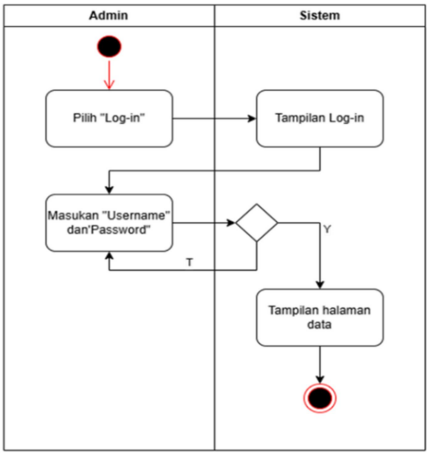

Figure 5. Admin Activity Diagram

Figures 4 and 5 illustrate the activity diagrams for the types of services provided by the system interface. The system will display the type of service previously selected by the applicant. The applicant then inputs their name and selects the condition that matches their current situation.

In Figure 5, the Admin Activity Diagram shows the login process flow. The admin selects the login option, and the system displays the login interface. The admin then enters their username and password according to their access rights. If the credentials are valid, the system grants access and displays the appropriate interface based on the user's access level. If the credentials are incorrect, the admin will be prompted to re-enter the username and password.

b. Class Diagram

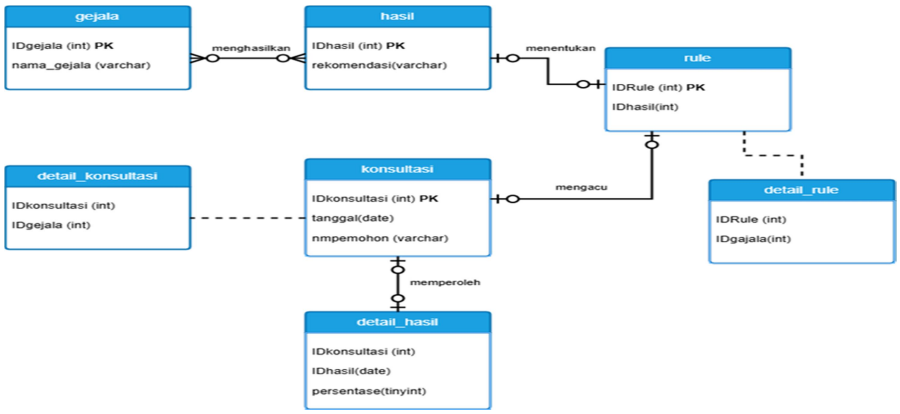

Figure 6. Expert System Class Diagram

Figure 6 shows a total of seven (7) entities, which include the following:Symptom entity: IDgejala (Primary Key), nama_gejala Result entity: IDhasil (Primary Key), rekomendasi Rule entity: IDRule (Primary Key), IDhasil Detail Rule entity: IDRule, IDgejala Consultation entity: IDkonsultasi (Primary Key), tanggal, nmpemohon Consultation Detail entity: IDkonsultasi, IDgejala Result Detail entity: IDkonsultasi, IDhasil, persentase These entities collectively represent the core components of the expert system's database structure, facilitating the process of knowledge representation, rule association, user consultation, and result output.

c. Deployment Diagram

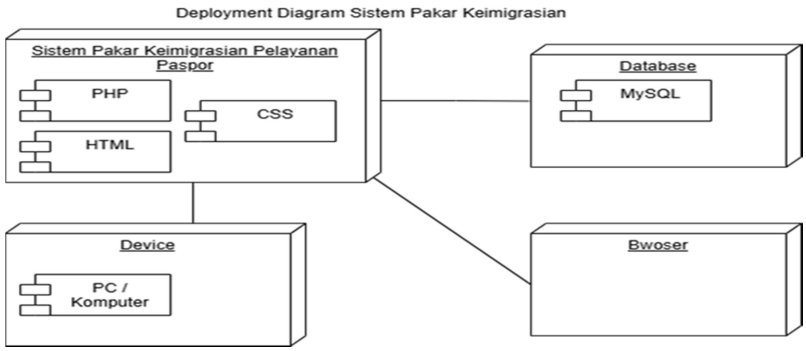

Figure 7. Expert System Deployment Diagram

The deployment diagram illustrates the software and hardware components required for the application developed by the researcher. It also depicts the processes involved in the Expert System and the relationships within the system.

The deployment diagram in Figure 7 consists of four (4) nodes. The Immigration Expert System for Passport Services Node includes two main components: programming languages (HTML, PHP, CSS). The Database Node contains a MySQL database. The Device Node represents PCs or computers, which are not specific in brand or type, as the system can be accessed through any standard web browser.

2. Implementation

a. Application Home Page (Login)

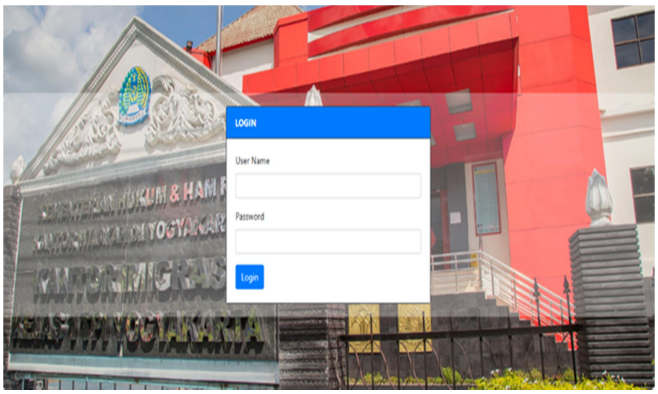

Figure 8. Login Page

The login page displays fields for Username and Password, which are used to determine the access rights—either as Admin or Applicant.

b. Home Dashboard

Figure 9. Home Dashboard Page

The dashboard page includes menu options such as Passport Issues, Passport Type Recommendations, Children with Dual Citizenship, and Log Out. Additionally, the dashboard features a welcome message to greet the officer after successfully logging in.

c. Applicant Conditions

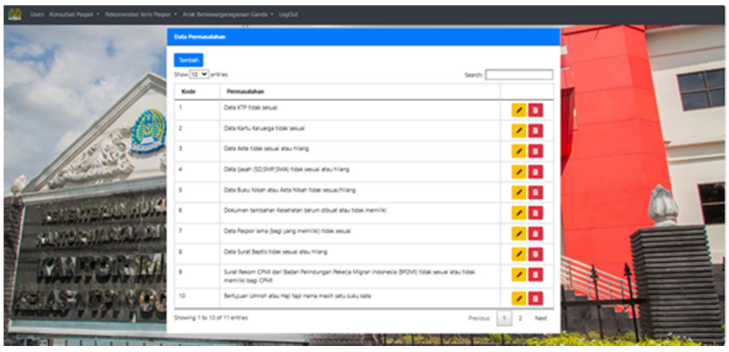

Figure 10. Applicant Condition Page

On the Applicant Condition page, there is an Add function to input new applicant condition data. Additionally, each condition entry includes Edit and Delete functions, which allow the user to update or remove existing condition data.

d. Recommendation Page Based on Applicant Conditions

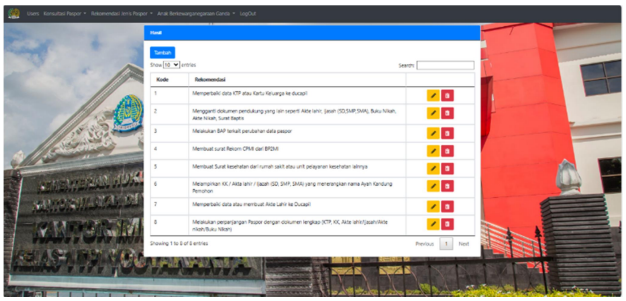

Figure 11. Recommendation Page Based on Applicant Conditions

On the Recommendation Page, users can utilize the Add function to input recommendations corresponding to specific applicant conditions. Each recommendation entry also features Edit and Delete functions, allowing users to modify or remove the recommendation data as needed.

e. Rule Base Page

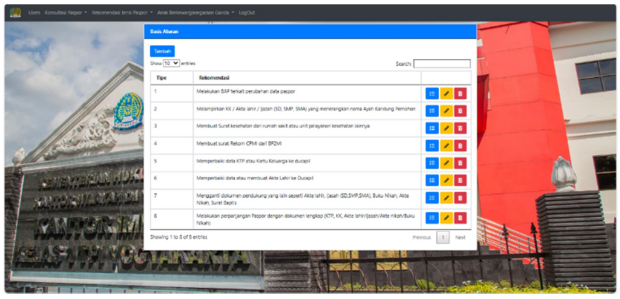

Figure 12. Rule Base Page

The Rule Base Page displays the rules (IF) that have been created based on the applicant's condition data, along with the corresponding recommendation results (THEN).

f. Expert System Consultation Result Page

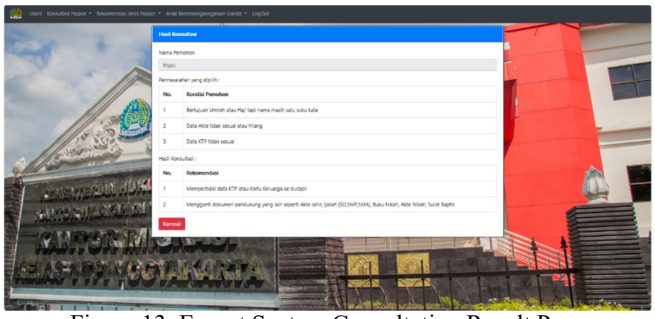

Figure 13. Expert System Consultation Result Page

On the Expert System Consultation Result Page, the user is required to enter their name, after which the system displays the applicant's condition data along with the recommended result based on the selected conditions, including the percentage of the recommendation outcome.

4. Conclusion

Based on the research findings, the process of providing passport service information at the Class I Immigration Office TPI Yogyakarta is still conducted conventionally. Applicants must take a queue number,

wait for their turn, and consult directly with an officer. This often results in long queues at the front office and repeated questions from applicants on a daily basis.

With the development of a web-based Expert System for Passport Services using the forward chaining method, the information delivery process becomes more efficient. This system allows applicants to access information independently without having to queue, and it also helps reduce the workload of immigration officers, enabling them to focus more on other essential tasks.

5. Recommendations

To improve the quality of passport services at the Class I Immigration Office TPI Yogyakarta, it is recommended to conduct regular applicant satisfaction surveys and provide an easily accessible complaint system. This is essential for gathering feedback, addressing complaints, and continuously improving service quality. Regarding the implementation of the Expert System for Passport Services, regular system maintenance and updates are necessary to ensure optimal performance. The system should also be aligned with the latest regulations and further developed to be accessible online, making it easier for the public to obtain passport service information.

References

[1] Jarot Dian Susatyono, *Kecerdasan Buatan : Kajian Konsep dan Penerapan*. Semarang: Yayasan Prima Agus Teknik, 2021.

[2] Fenilinas Adi Artanto, "Perancangan Sistem Informasi Perpustakaan Negeri Pelangi Berbasis Website," *SATESI: Jurnal Sains Teknologi dan Sistem Informasi*, vol. 3, no. 2, Oct. 2023, doi: 10.54259/satesi.v3i2.2111.

[3] R. Muhidin, N. F. Kharie, and M. Kubais, "ANALISIS DAN PERANCANGAN SISTEM INFORMASI PADA SMA NEGERI 18 HALMAHERA SELATAN SEBAGAI MEDIA PROMOSI BERBASIS WEB," *IJIS - Indonesian Journal On Information System*, vol. 2, no. 2, p. 91, Sep. 2017, doi: 10.36549/ijis.v2i2.31.

[4] Muhammad Rehan Anwar, "Analysis of Expert System Implementationin Computer Damage Diagnosis with Forward Chaining Method," *International Transactionson Artificial Intelligence (ITALIC)*, Mar. 2023, doi: 10.34306.

[5] A. Mubarak, J. J. Metro, and K. T. Selatan, "RANCANG BANGUN APLIKASI WEB SEKOLAH MENGGUNAKAN UML (UNIFIED MODELING LANGUAGE) DAN BAHASA PEMROGRAMAN PHP (PHP HYPERTEXT PREPROCESSOR) BERORIENTASI OBJEK," 2019.

[6] M. T. Hafizal *et al.*, "Implementation of expert systems in potassium deficiency in cocoa plants using forward chaining method," in *Procedia Computer Science*, Elsevier B.V., 2022, pp. 136–143. doi: 10.1016/j.procs.2022.12.120.

[7] Agung Noviantoroa, Amelia Belinda Silvianab, Risma Rahmalia Fitrianic, and Hanum Putri Permatasari, "RANCANGAN DAN IMPLEMENTASI APLIKASI SEWA LAPANGAN BADMINTON WILAYAH DEPOK BERBASIS WEB," *Jurnal Teknik dan Science*, pp. 88–103, Jun. 2022.

[8] Jursak Irawan, "BUKU PEGANGAN SISTEM PAKAR," *Researchgate*, Jul. 2019.

[9] F. N. Hasanah and R. S. Untari, *Rekayasa Perangkat Lunak*. Sidoarjo: UMSIDA Press, 2020.

[10] Restu Adji Saputra, "MODUL REKAYASA PERANGKAT LUNAK DIAGRAM KOMPONEN & DIAGRAM DEPLOYMENT," Apr. 2018.

[11] M. Fowler, "Microservices," *MartinFowler.com*, 2014. [Online]. Available: https://martinfowler.com/articles/microservices.html

[12] S. Newman, *Building Microservices*, O'Reilly Media, 2021.

[13] Nofri Wandi Al-Hafiz, Helpi Nopriandi, and Harianja, "Design of Rainfall Intensity Measuring Instrument Using IoT-Based Microcontroller", *JTOS*, vol. 7, no. 2, pp. 202 - 211, Dec. 2024.

[14] N. W. Al-Hafiz and H. Harianja, "Design of an Internet of Things-Based automatic cat feeding control device (IoT)", *Mandiri*, vol. 13, no. 1, pp. 161–169, Jul. 2024.

[15] PutriD. and Al-HafizN., "SISTEM INFORMASI SURAT KETERANGAN GANTI RUGI TANAH PADA KECAMATAN KUANTAN TENGAH MENGGUNAKAN WEBGIS", *Biner : Jurnal Ilmiah Informatika dan Komputer*, vol. 2, no. 2, pp. 112-121, Jul. 2023.

[16] H. Harianja, N. W. Al-Hafiz, and J. Jasri, "Data Analysis of Informatics Engineering Students of Islamic University of Kuantan Singingi", *JTOS*, vol. 6, no. 1, pp. 23 - 30, Jan. 2023.

[17] Siregar, M., and N. Al-Hafiz. "Design of Cloud Computer to Support Independent Information System Servers Universitas Islam Kuantan Singingi." *Journal of Information System Research (JOSH)* 3.2 (2022)

[18] A. Apri Denta, H. Nopriandi, and E. Erlinda, "Information System Design Realization and Performance Achievements of the Manpower Office of Kuantan Singingi District", *JTOS*, vol. 7, no. 1, pp. 01 - 09, Nov. 2024.

[19] A. AP Putra, E. Erlinda, and M. Yusfahmi, "Sales System in the Endocell Mobile Phone Business Using the CRM (Customer Relationship Management) Method) in Kompe Berangin Village, Cerenti District", *JTOS*, vol. 7, no. 1, pp. 10 - 21, Nov. 2024.

[20] D. Setiawan, F. Haswan, and J. Jasri, "Design of School Bell Scheduling Application Based on Arduino Uno on MTs Babussalam Simandolak", *JTOS*, vol. 7, no. 1, pp. 22 - 30, Jul. 2024.

[21] D. Juniarti, A. Aprizal, and S. Chairani, "Information System for Analyzing Disease Trends in the Region Cerenti Health UPTD", *JTOS*, vol. 7, no. 1, pp. 31 - 43, Jun. 2024.

[22] F. Restuadi, H. Nopriandi, and A. Aprizal, "ANALISIS QOS JARINGAN INTERNET FAKULTAS TEKNIK UNIVERSITAS ISLAM KUANTAN SINGINGI MENGGUNAKAN WIRESHARK 4.0.3", *JTOS*, vol. 7, no. 1, pp. 44 - 54, Jun. 2024.

[23] J. Jasri and N. W. Al-hafiz, "Designing a mobile-based infaq application markazul quran wassunnah foundation (MQS)Kuantan Singingi", *J. Teknik Informatika CIT Medicom*, vol. 15, no. 5, pp. 247–254, Nov. 2023.

[24] R. Nazli, A. Amrizal, H. Hendra, and S. Syukriadi, "Modeling User Interface Design E-Business Applications for Marketing Umkm Products in Payakumbuh City Using Pieces Framework", *JTOS*, vol. 7, no. 2, pp. 55 - 66, Nov. 2024.

[25] Siti Saniah and Mhd. Furqan, "Classification Of Rice Plant Diseases Using K-Nearest Neighbor Algorithm Based On Hue Saturation Value Color Extraction And Gray Level Co-Occurrence Matrix Features", *JTOS*, vol. 7, no. 2, pp. 212 - 223, Dec. 2024.