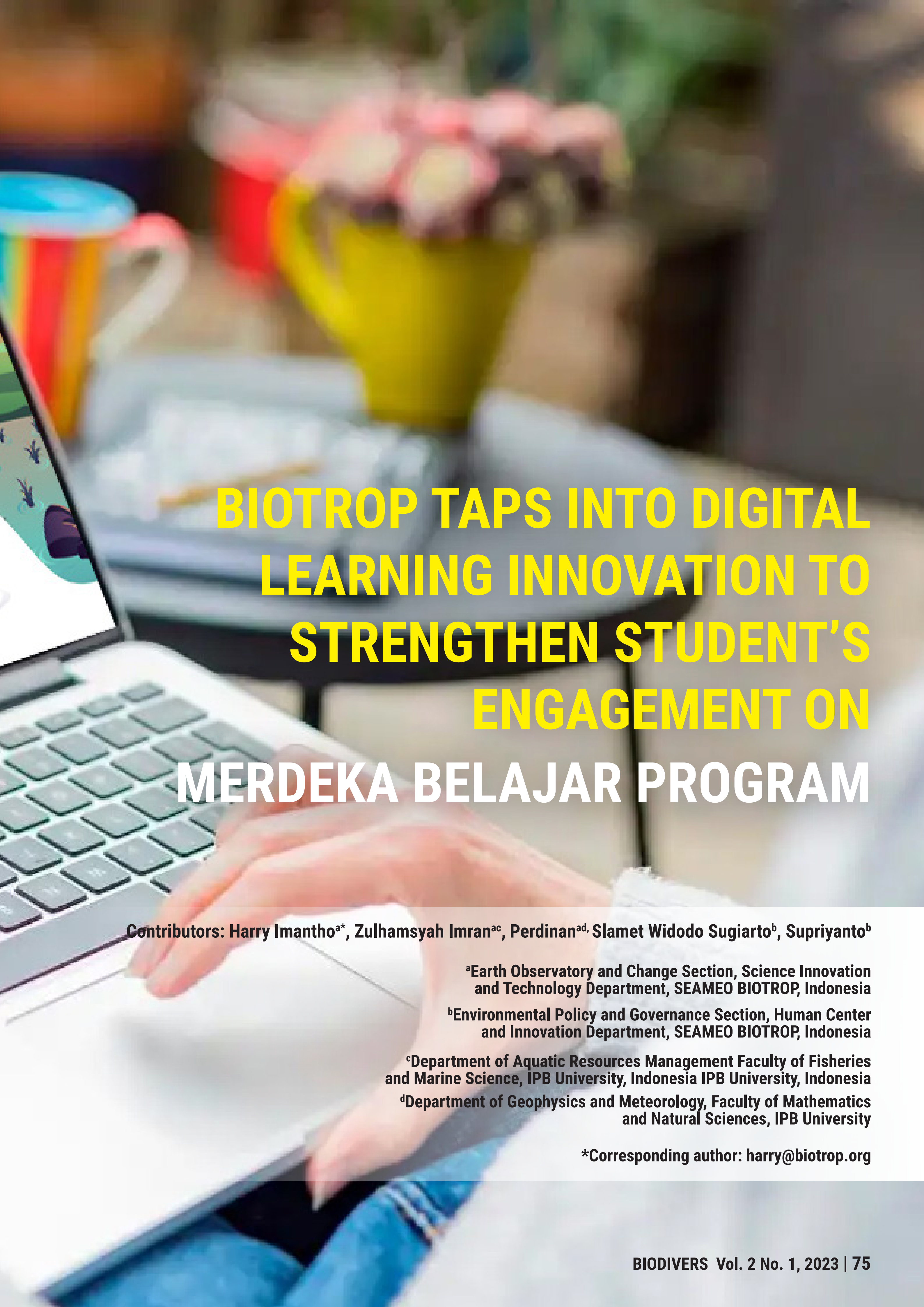

BIOTROP TAPS INTO DIGITAL LEARNING INNOVATION TO STRENGTHEN STUDENT'S ENGAGEMENT ON MERDEKA BELAJAR PROGRAM

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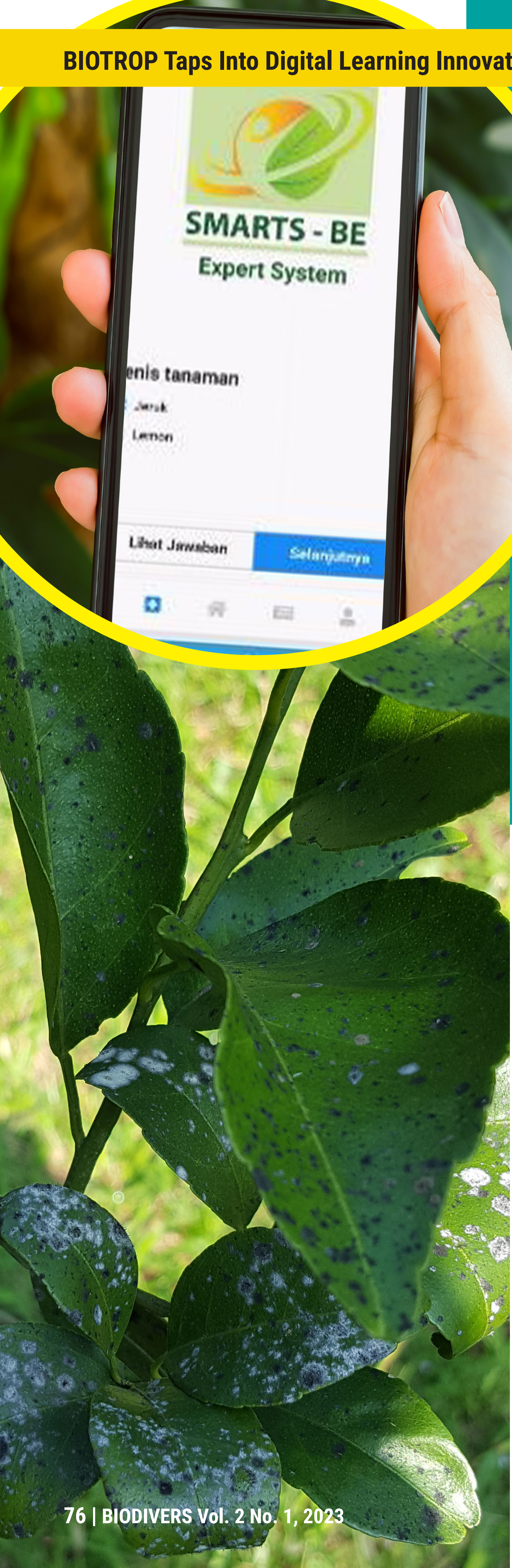

ABSTRACT

The COVID-19 pandemic has suddenly forced the world of education to carry out a more massive digital transformation that should meet student's requirements and strengthen their knowledge, skills and competencies. The digital media developed should facilitate student's self-learning and freedom to learn (Merdeka Belajar) amidst physical and social interaction limitations. Vocational high school students have special requirements compared to upper secondary school students in terms of soft skills and hard skills education. It is very interesting to provide digital educational media which fits their needs. This study aims to develop an online digital platform in responding to the demand of vocational schools that have joined the SEAMEO BIOTROP SMARTS-BE program since 2015 in applied tropical biology. Since 2015, SEAMEO BIOTROP has provided face-to-face mentoring to vocational high schools spread across 10 provinces in Indonesia. The Expert System for Identifying Pest and Disease on lemon orchard is a digital transformation in the mentoring method while demonstrating a new learning experience educational materials into a web-based digital platform and Android application. This expert system demonstrates the implementation of problem base learning (ProBL) concepts to enrich online learning materials for vocational schools in the age of digital science and education.

Keyword: expert system, merdeka belajar, SMARTS-BE

INTRODUCTION

In early 2020, the Minister of Education and Culture of the Republic of Indonesia launched the "Merdeka Belajar" (Freedom to Learn) program to give teachers more autonomy to control what happens in the classroom. This program is designed to improve student's literacy and numeracy skills following Indonesia's subpar achievement in the global education assessment. The essence of "Merdeka Belajar" is to unlock the full potential of teachers and students to innovate and improve their learning quality independently. A few months later, the COVID-19 pandemic made all activities, including the education sector, helpless. Countries worldwide need help accelerating the digital transformation of the education sector and getting out of the deadlock situation so that educational activities can recover immediately. The Ministry of Education, Culture, Research and Technology of The Republic of Indonesia published guidance and technical assistance to maximize the effectiveness of the "Merdeka Belajar" program by tapping into digital learning innovation, for example, the online distance learning model.

The World Bank, in collaboration with EdTech, conducted studies in several countries to assess the effectiveness of distance learning solutions. The study concluded that there are 5 (five) focus components for the effectiveness of distance learning solutions, namely institutional capacity and multi-strategy; training and changing the role of teachers; remedial learning; curriculum adjustments and monitoring; and assessment of learning outcomes (WorldBank, 2021). Several countries with adequate experience, infrastructure, and qualified human resources can quickly adapt to the distance learning system. A total of 93.58% of educators in India have switched to e-learning mode in a very short time with good confidence (Rajhans et al., 2020). However, developing countries that have yet to experience implementing distance learning have exposed some inequalities and challenges regarding systems, infrastructure, and human resources (Oyedotun, 2020).

Indonesia also faces various challenges in integrating the "Merdeka Belajar" program into the distance learning system. The main obstacles are geographical conditions related to distance learning infrastructure, institutional capacity, education providers, and human resources (teachers). However, Indonesia has great potential to implement a distance learning system. From the results of a survey conducted in 2019, there are 150 million active internet users in Indonesia, or about 56% of the total population of Indonesia (Lestari, 2019). It shows that internet usage has high penetration in Indonesia. However, this number is not proportional to the infrastructure of the distance learning system. The adaptation level to distance learning methods should be improved. The condition of distance learning infrastructure which is not uniform for all regions in Indonesia, is another challenge.

This study aims to develop an online digital platform through developing Android Apps of an expert system for identifying pests and diseases in lemon orchards. The platform was developed in response to the demand of vocational schools that have joined the SEAMEO BIOTROP SMARTS-BE program since 2015 in applied tropical biology. The expert system is a digital learning innovation that can be applied in lemon orchard management. This expert system also serves as a learning system to increase teacher and student competency in SMARTS-BE member schools and to support the "Merdeka Belajar" program. It also adopts the Problem Base Learning (ProBL) concepts (Savery, 2006) to enrich the distance learning model and content.

METHODOLOGY

2.1 Time and location

The development of Android Apps of the expert system for identifying pests and diseases in lemon orchards was carried in March until November 2021. Data and information on pests and disease attacks on lemon orchards were gathered through field observation. At the same time, the development of Androids Apps of expert systems was done in the Remote Sensing and Ecology Laboratory, SEAMEO BIOTROP, Jalan Raya Tajur Km. 6 Bogor. Testing and knowledge transfer were done using online media (such as zoom and google meet) and face-to-face at selected vocational schools in Jakarta, West Java, Central Java and East Java.

2.2 Tools and material

Several data processing and programming software were used to develop an expert system for identifying the pests and diseases in the lemon orchard, as presented in Table 1.

Tabel 1. Softwares used in the study

No	Name	Function
1	ArcGIS Desktop	Spatial data processing including data preparation, editing and updating
2	Cloud Server	Hosted geodatabase, backend application and provide API services
3	Native ReactJS	Programming language to develop mobile and backend application.
4	PHP and MySQL	Programming language to develop web-based application

The drone was used during field observation to map the orchard area, and GNSS (Global Navigation Satellite System) receiver was used to record coordinate positions where pests or diseases were found.

2.3 Method

a Framework of the expert system for identifying pests and diseases in the lemon orchard

Android Apps of the expert system for identifying pests and diseases in the lemon orchard was developed in this study, indeed a continuous development of the geolocation-based monitoring system of the lemon orchard that was developed in 2019. Figure 1 shows the framework of the expert system. The Inference engine is an important part of an expert system. The question-based forward chaining method was chosen and used in the system to generate a decision, presented in Figure 2. Experts validated the list of questions and question-based diagnostic method through focus group discussion (FGD).

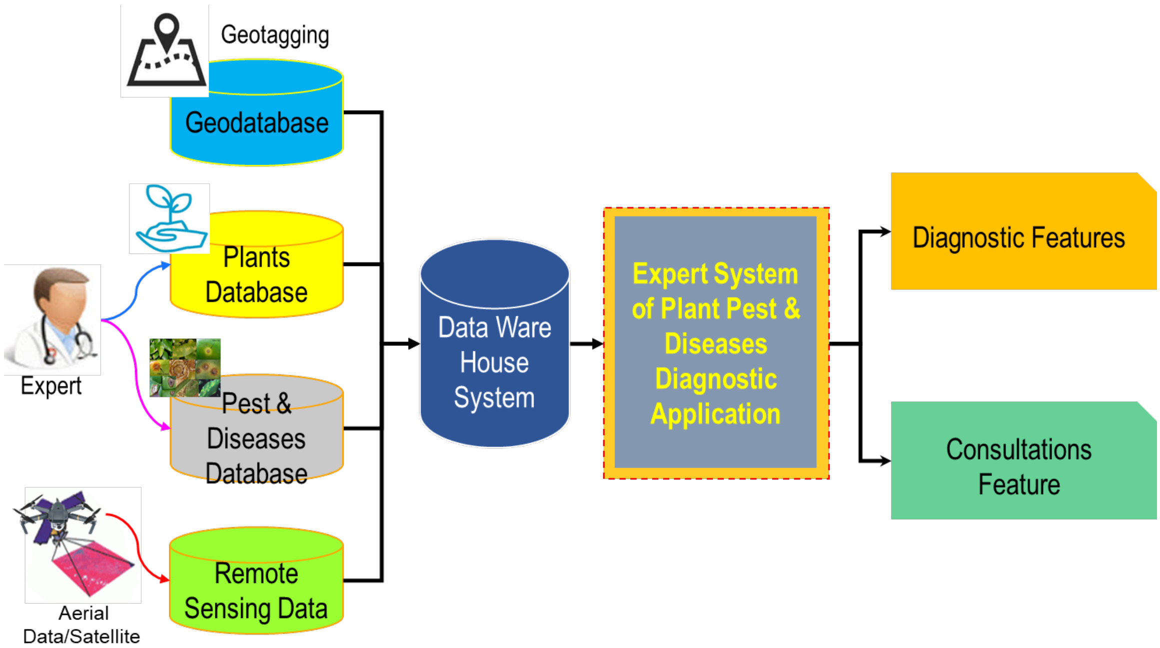

Figure 1. The framework of pests and diseases diagnostic system

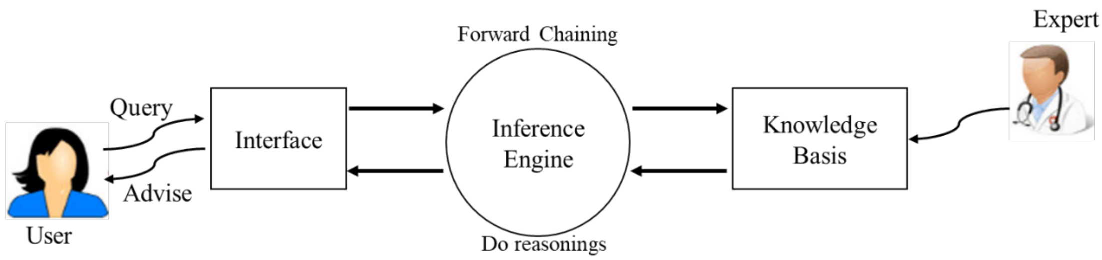

Figure 2. Method of generating diagnostic or decision

b Development of the expert system for identifying pests and diseases in the lemon orchard

The waterfall development method has been used in designing expert system for identifying peast and desease in lemon orchad. The Waterfall method has the following stages (Sommerville, 2011):

1. System Requirements Analysis; system requirements, constraints, and objectives were determined through consultation with users. These were becoming the basis for system specifications.
2. System design and software requirements; system requirements, both hardware and software, were identified and allocated and were formed into the system architecture. Software design involves assessing and describing system abstractions and the relationships between components within them.
3. system test; the software design was realized as a program or program unit at this stage. Testing ensured that each unit met the system specifications.
4. System integration; the sub-programs or programs were combined and tested as a complete system to ensure compliance with the requirements defined in the first and second stages. The user can implement the system that has passed this stage.
5. System implementation and evaluation; real users installed and operated the system. System maintenance involved resolving program code errors (bugs), improving the implementation of the system unit, and improving system services as new requirements.

The advantage of the waterfall method was that it allowed the design control process to be carried out sequentially, step by step, thereby minimizing errors that might occur. The design starts with concept, i.e., requirements identification, logic design, implementation, testing, installation, and problem-solving, and ends up with operation and maintenance.

c System testing and evaluation

Application testing was carried out before the user implemented the application system. System testing was carried out based on the initial purpose of the system being built. Users tested the system from a technical point of view, the system's functionality (the system runs well without errors) and the suitability of the features to the user's needs for the system.

The initial stage of system testing was errors/bugs testing on the coding used in the development of the system, whether there were still errors/bugs in the application program structure by tracing each menu and sub-menu on the system. If there were still errors/bugs on the menu page or in certain sub-menus, the system should be refined by the developer. The system testing process is shown in Figure 3. The installation and implementation were carried out on the backend server, and the Android Apps of the expert system for identifying pests and diseases were also distributed to selected vocational schools under the SMARTS-BE program.

d Knowledge Transfer

To encourage the utilization of the developed system by vocational schools under the SMARTS BE program, it was necessary to disseminate knowledge (knowledge transfer) regarding the operational guidelines of the system and basic knowledge that supported the optimization and updating of the information knowledge database. The knowledge transfer has been carried out through 2 (two) activities, namely workshops and training. The face-to-face workshop has been held for 5 (five) selected schools, and training of trainer (ToT) has been conducted online for all SMARTS BE member schools.

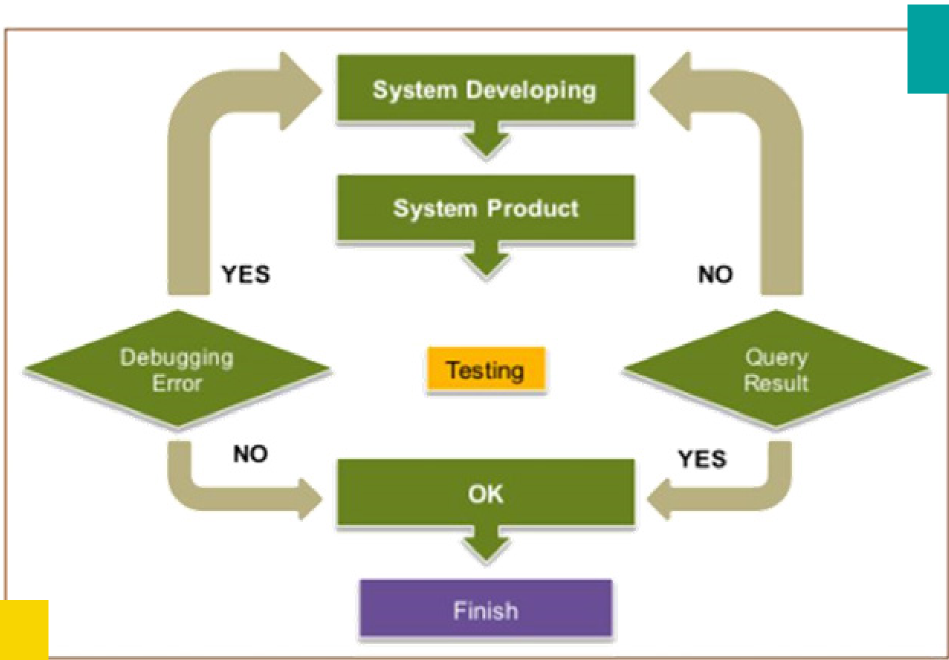

Figure 3. Framework of system testing and evaluation

RESULT AND DISCUSSION

An expert system has been developed in this study. It captured experts' knowledge and then transformed it into a computer system. Thus, computers can mimic an expert to solve certain problems. There are 3 components in the expert system, namely the interface, knowledge database and inference engine. Knowledge databases store knowledge data for understanding, formulation, and problem-solving, representing knowledge experts. The Inference engine contained a methodology for reasoning about information based on a knowledge database. Then it generated conclusions and recommendations like the mindset and reasoning used by experts in solving a problem.

The system architecture of the expert system for identifying pest and disease in lemon orchad was divided into two, namely the frontend and backend components. The frontend component was designed as a mobile application (Android). In contrast, the backend component served as the main engine processor, placed on a cloud server, and supported by the mobile backend process and API (Figure 4). This system enhanced the capability of the geolocation-based monitoring system by adding the diagnostic system's function. This App is one of the digital learning innovation of SMARTS-BE program.

The user architecture of the expert system for identifying plant pests and diseases is designed with the Project Base Learning (PBL), and Problem Base Learning (ProBL) approaches. This system facilitated students to learn systematic methods for identifying plant pests and diseases through a question-based problem-solving process. Figure 5 describes plant pest and disease diagnostic models and flows.

The reasoning model developed in the inference engine was designed dynamically. The users can also be actively involved in updating plant data such as plant physiology, indications or symptoms, and decisions or diagnostic results. Recommendations were generated by the expert system, as a result of diagnostics processes, which was a combination of the user's visual exploration and the knowledge database stored in the expert system. Process details are shown in Figure 6.

The expert system for plant pest and disease identification was developed in a mobile application environment, currently available for the Android platform. The question-based forward chaining method was a good example and demonstrated that a problem-based learning approach could be used on plant pest and disease identification. The developed expert system introduced vocational students to a systematic process of identifying pest and desease through attractive and interesting media. This expert system is a digital learning innovation that encourages and strengthens vocational students' engagement on "Merdeka Belajar Program". Since student's active engagement in the learning system is one of the key factors that impact education quality.

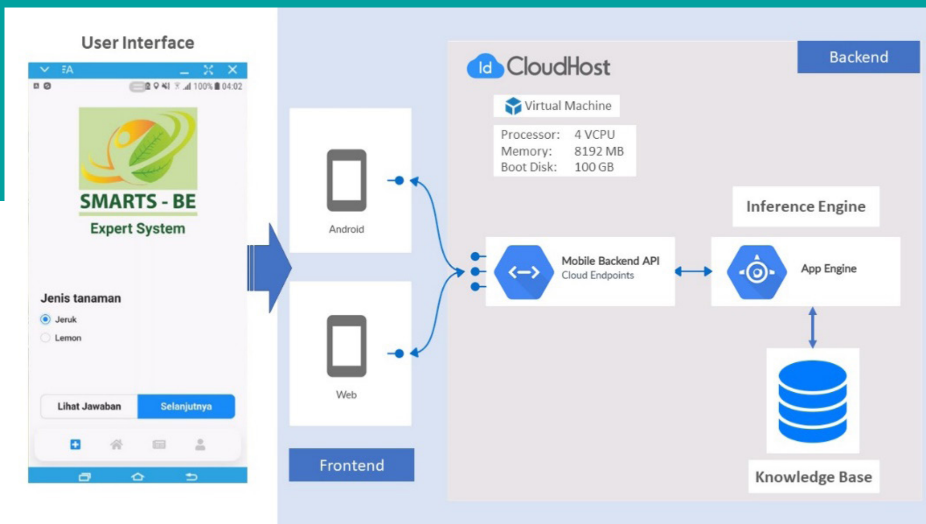

Figure 4. The system architecture of the expert system

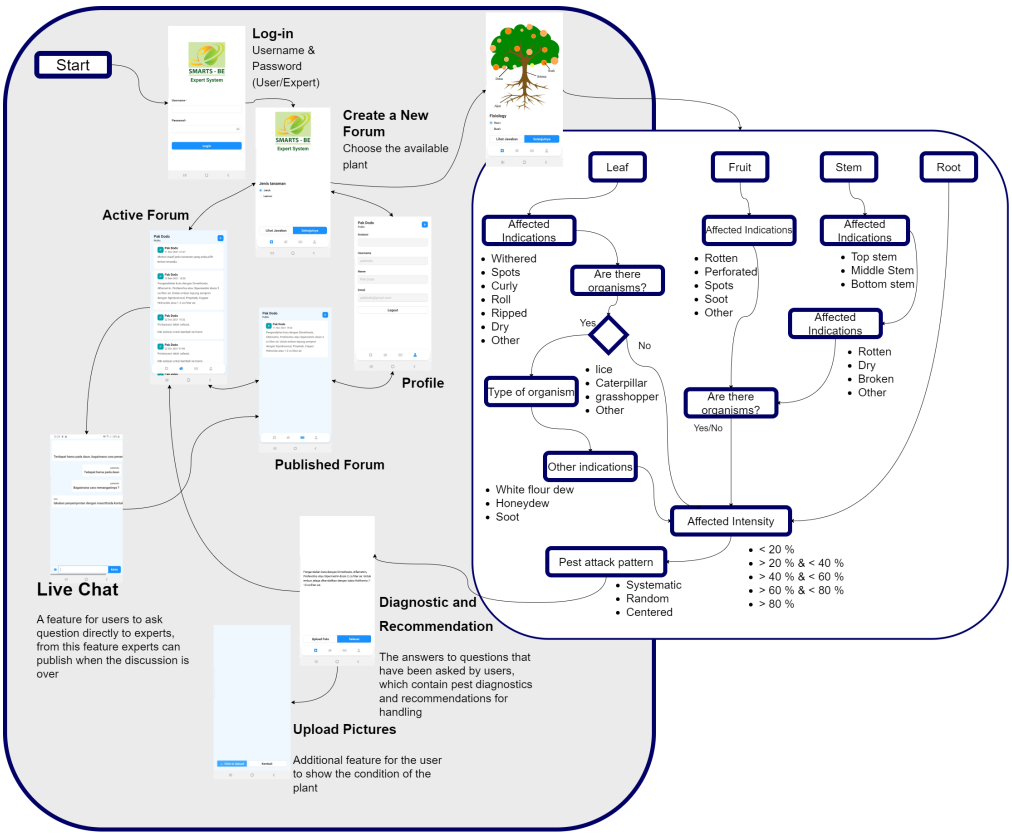

Figure 5. Flowchart diagram of the expert system

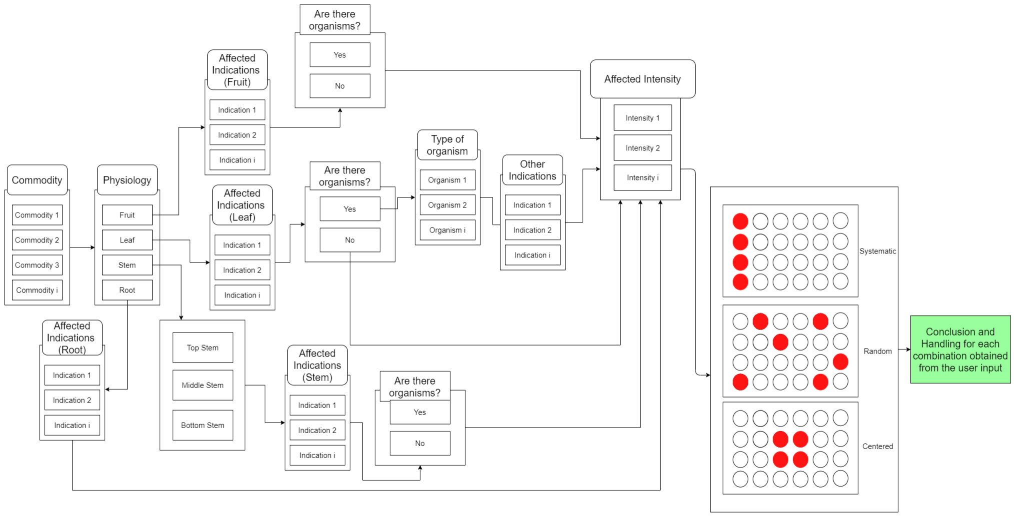

Figure 6. Model diagram on identifying pest and desease

CONCLUSION

Digital learning innovation is a form of digital transformation in education and learning systems that runs faster due to the impact of the COVID-19 pandemic. Digital learning innovation improves the skills of teachers and students and strengthens their involvement in creating an effective, creative, innovative, and inclusive educational process. Digital learning innovation supports the spirit of quality and equity in education, and every student has the same chance to receive quality learning and education.

The study has successfully developed an expert system for identifying pest and diseases in lemon orchard to support achieving those goals. This expert system can be an effective learning media for practices in identifying plant pest and diseases in lemon orchard. The expert system also demonstrates the application of a problem-based learning approach in a concrete form and uses friendly media. The expert system is available to students and teachers; indeed, this supports the concept of a borderless school and in line with the "Merdeka Belajar" program launched by the Minister of Education and Culture of the Republic of Indonesia.

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