

Development of Digital Learning Application to Support Smallholder Dairy Farmers in Indonesia

Yuni Resti^{1*}, Sofiyanti Indriasari², and Bayu Widodo²

¹Livestock Management and Technology Study Program, College of Vocational Studies, IPB University, Indonesia

²Informatic Management Study Program, College of Vocational Studies, IPB University, Indonesia

Abstract. The Indonesian government has facilitated farmers through the role of agricultural extensionists (AE). One of the agricultural businesses that have a high interaction with AE is dairy farmers. AE have the responsibility to connect regularly with dairy farmers. However, since the Covid-19 pandemic, AE have limitations in coordinating with farmers directly. Therefore, a strategy is needed to overcome so farmers can continue to receive counselling and AE can still carry out their duties. In addition, several routine training activities carried out to improve the ability of farmers in practical management have also been delayed. The study aimed to develop an online application in collaboration with the triple helix concept through the interaction of multiple sectors from government, education, and business. The study used the collaboration between farmers and cooperatives as partners who cooperate with government agencies through agricultural extensionists and knowledge institutions to share information related to livestock business development. The application was built using the Extreme Programming (XP) methodology. The research was held by conducting independent interviews with relevant stakeholders such as dairy farmers, cooperative boards, AE, the Ministry of Agriculture, and academicians. The study facilitated dairy farmers and AE to interact online with specific features and discussions about dairy farming. Moreover, educators such as livestock teachers, lecturers, and trainers can also take advantage of this digital application, especially the updated information related to livestock farming practices.

1 Introduction

1.1 Background

The Indonesian Government has made various improvements in strengthening the agricultural business, particularly for smallholder farmers. One of which is by facilitating farmers through the role of agricultural extensionists (AE) to increase farmers' productivity. AE play a significant role in the growth of livestock business [1] due to their responsibility to guide in solving problems to the community. Dairy farming is one of the agricultural

* Corresponding author: yuni.resti@apps.ipb.ac.id

businesses that have a high interaction with AE. The supervision given by AE is expected to help farmers in improving the performance of their farms. Generally, AE are divided into private and government extensionists. Private extensionists are mostly part of private companies as a supporter of the limited number of governments extensionists [2]. According to [3] some of the extension methods that have been implemented to the farmers are observing farmers groups; delivering information through resource persons/facilitators; demonstration by providing examples on a farm; field study by inviting farmers to visit other farms to exchange information with other farmers; field school extension (SL) by conducting short education to farmers such as training or short courses; and interview counselling by holding two-ways meetings between AE and farmer groups to discuss related issues.

Although many methods have been used in agricultural extension, there are still many obstacles that occurred during its implementation in the field. The study results of [4] concluded that distance is one of the main problems for AE in carrying out their duties. AE need to cover around 3 – 18 km to reach the farmer's house and 15 – 30 km to be at their farm location. The other thing is the facilities used during their fieldwork are sometimes not very attractive to farmers. Farming activities require lots of time which often overlap with the schedule of the visit. Therefore, AE must deliver interesting tools to support the farmers by applying various application-based technologies.

Many applications have been supported for extension activities through application-based technologies. According to [5], several extension applications have been developed by the Research and Development Agency of the Ministry of Agriculture for example Cyber Extension which is initiated by Agency for Agricultural Extension and Human Resources Development. It consists of extension materials and information that can be accessed by farmers in facilitating their agricultural business; Integrated Planting Calendar, an application that contains information about the right rice planting time, supported by the Indonesian Rice Consultation Service. It is a website-based application settled to assist farmers in rice cultivation designed by the International Rice Research Institute Indonesia and Indonesian Agency for Agricultural Research and Development; MyAgri is established by the Vegetable Research Institute and Wageningen University & Research through an android-based vegetable cultivation information system; Takesi is a technology founded by Indonesian Agency for Agricultural Research and Development, the Centre for Veterinary Research, to control cow health; and Coffee Experts introduced by Indonesia Research Institute for Industrial and Beverages Crops to provide information about coffee farming.

AE have the responsibility to interact regularly with farmers directly in their working areas which leads to high mobility. Since the implementation of working from home activities, several technical problems occurred. It is limiting the capacity of AE to visit farmers. A special strategy is needed to overcome this so that farmers can continue to receive counselling. Hence, the use of the internet can be one of the solutions so AE can carry out their duties which are in line with the current condition of Covid-19. One way that can be done is by promoting an online extension application specifically for dairy farmers. The development of this online extension application provides a prototype that facilitates farmers with a conversation menu where registered farmers can directly choose their AE. Farmers can discuss and improve their knowledge and practical skills through interactive learning. This application is expected to be a medium of learning and digital consultation for farmers during the Covid-19 pandemic.

According to [6], there is a positive relationship between the dynamics of the triple helix model in terms of the type and purpose of innovation, introducing new products and ecological innovations and their efforts to improve communication. The triple helix concept can be realized through interaction between farmers and cooperatives as partners who work with government - agricultural extensionists and educational institutions to share information related to the principle of "good farming practices" in assisting the development of farmers'

businesses. Henceforth, the study objective was to develop an online application in collaboration with the triple helix concept that involves users from farmers, government, and educational institutions. The application was built to facilitate online consultation and education activities.

2. Method

The research was conducted by taking a case study of dairy farmers in Cisarua, Bogor District. Dairy farmers in Cisarua are organized as independent farmers and some are formed in farmers groups under the coordination of dairy cooperatives. The study focused on cooperative farmers. Farmers who are members of the cooperative were chosen with consideration because the average cooperative members are small farmers who need more support. The methodology used was extreme programming (XP), one of the iterative and agile software development methodologies to deal with change [7]. The research was also held by conducting independent interviews with relevant stakeholders such as dairy farmers, cooperative boards, the Ministry of Agriculture, and academicians. The XP methodology aimed to produce software with higher quality and help in providing optimal solutions [8]. The methodology had some very good practices such as paired programming and unit tests [9].

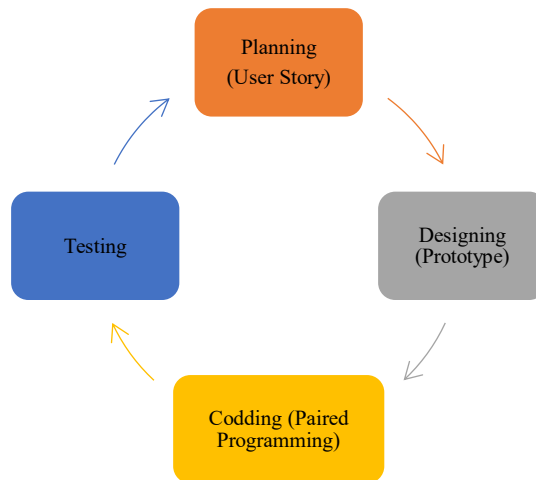


Fig. 1. Extreme Programming Method

The stages passed during the study: Planning, Designing, Coding, and Testing. Figure 1 shows the stages of research carried out using the XP approach. The planning stage was done by collecting data to create a user story. User stories are sourced from users and are used to create time estimation for the planned release [9]. Techniques in collecting data for making user stories were interviews and brainstorming. Therefore, the application feature design was made as quickly as possible so it could be immediately used as a basis for implementation.

The design stage that had to be done was to make a prototype. A prototype is an image that resembles the original product to visually describe the flow of application functionality. It will make the implementation process easier. The next process was an implementation called coding. Coding is the implementation stage of creating program code based on the design results. The implementation reference used a prototype. Programming code was done in pairs (pair programming). Paired programming was done to speed up production and control product quality.

The final stage was testing. It was done to ensure quality. The test was done in two stages. The first test was a unit test conducted by the development team to ensure the program code that needed to be delivered had minimal bugs and errors. The second test was managed with the application together with the users. This second stage of testing was held based on a predetermined acceptance test scenario. The user acceptance test is the phase where the client validates the software to find out whether the solution provided is suitable or not for their use and meets their business needs. According to [10], the user acceptance test was a testing process by users which was intended to produce documents that were used as evidence that the application developed has been accepted by the users.

3. Results and Discussions

3.1 Planning

Planning is making procedures about application development activities based on the needs. Application requirements were collected from prospective application users which were then presented through user stories. Making user stories was done by collecting data during interviews and brainstorming techniques. Direct interviews with dairy farmers, ranging from experienced farmers who have started farming since the 1990s to young farmers. Along with this, data collection for user stories was done by brainstorming. The brainstorming aimed to dig deeper into the application needs of the experts. The brainstorming was attended by representatives of AE, educators from universities, and representatives from cooperative boards. User stories that had been formed were analysed to take values.

Visualization of the analysis results is needed to make it easier to understand the selected features, so they can be explained to users for approval. The visualization used to display the results of the requirement feature application analysis was a use case diagram. The use case describes the function provided by the system as units that exchange messages between units with actors expressed by using verbs [11]. The results of functional visualization of applications using use case diagrams can be seen in Figure 2. The main features of this application are related to education to farmers. The educational features included chats for farmers and AE; management of educational materials; displaying educational materials; managing livestock data; and accounts. In addition, prospective application users who register as users are verified by the admin through the activation and user management features. Table 1 shows the description of each feature.

There are 4 types of users in the application, namely, admins, extensionists, farmers, and educators. Admin is an administrator user who is only responsible for managing users' applications such as activating users who have just registered, refusing activation of unidentified accounts, deactivating users who are already in the application, and deleting registered users. AE are representatives of the government who carry out the task of providing consulting services to farmers. Farmers are users who are dairy farmers who must be verified by the cooperative. Educators are those who have the right to provide learning materials that can be posted as articles, documents, or videos. Educators consist of teachers from Animal Husbandry Vocational Schools, university lecturers, and researchers or animal husbandry experts who are experienced in the field of dairy farming. The four users have access to each feature in the application. Figure 2 shows the features that can be accessed by the user according to the specified access rights.



Fig. 2. Use case diagram

Table 1. Features description

No	Features name	Users	Descriptions
1	User activation	admin	The feature is designed to enable users who create new accounts to operate the app
2	User management	admin	It is established for user account management that has been registered. Admin can determine whether users will be activated or deactivated
3	Account registration	Users' candidate	Account registration is used for potential application users. Application users who have not registered can only view articles without being able to interact (as readers). If the user registers an account, they can choose which access rights are required. Whether as a farmer, PPL, or as an admin Edu. The account registration will be verified for activation by admin as the owner
4	Login	All registered and active users	Login is created for all users who have an active account and status. This feature is used to enter the application with access rights and interactivity according to the type of account.

No	Features name	Users	Descriptions
5	Update Password	All registered and active users	A feature is developed for users who have an active account and status to change the password to access the application.
6	Displaying dairy Edu menu	All users	A feature displays educational materials that have been uploaded to the application. Educational materials can be articles and attachments in which can be downloaded in pdf files, as well as learning video links
7	Managing dairy Edu data	Admin Edu	A feature shows all educational materials that can be uploaded by educators. In addition, educators can also improve existing content, and delete content that is no longer relevant
8	Activating extensionists status	Extensionists/AE	The feature is used by AE for activation. Activation of the AE will affect their access to receive the consultation. If they choose to activate the status, the farmers can send a message. On the other hand, if AE choose to be inactive, the farmers cannot send any messages.
9	Consultation	Farmers	The feature can be a media for farmers to send messages (chat) to AE in consultation activities.
10	Managing livestock data	Farmers	The feature is planned to enter livestock data owned by each farmer. Data includes the number of livestock, age, and livestock categories. Farmers can also change the latest data if there is a change in the condition of their farm

3.2 Designing

Application design is an activity to visualize the flow of application functional requirements in more detail and more technically. The functional requirements of the application summarized in the use case diagram are detailed in its flow and visualized more technically. The flow of each application function is visualized by creating a prototype. The prototype is made by considering the function flow and then describing the layout of the application interface according to the needs and business processes described in the user story. The prototype provides an easier description for implementation reference. An example of a prototype showing the application page design can be seen in Figure 3.

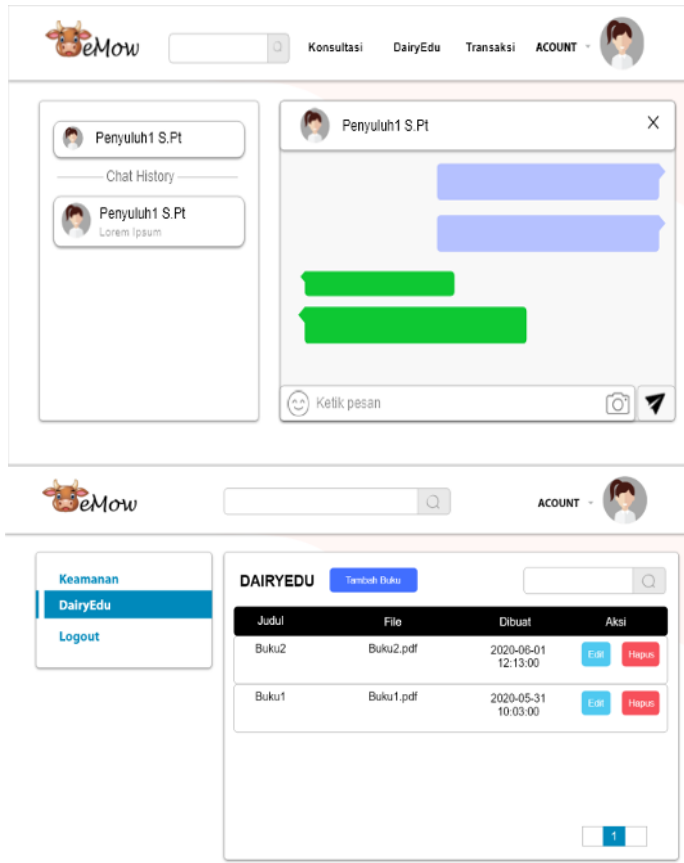


Fig. 3. Application prototype

3.3 Coding

The implementation stage is to create program code to form the application. This application development process uses a paired programming approach which is the hallmark of the Extreme Programming methodology. Pair programming is one of the software development practices in which two programmers work together in partnership using one computer, cooperating on the same problem. Paired programming shows a positive impact on the quality of the resulting product on the attitudes and feelings of the team [12]. Additionally, paired programming has a positive influence on the quality and duration of application completion [13]. The application was built in a web-based application. Implementation was referred to the design that has been made previously. The results of the application that have been established then were hosted on the IPB Vocational School server. The application could be accessed at the link <http://klik.sv.ipb.ac.id/emoww>. Screenshots of the application can be seen in Figure 4 and Figure 5.

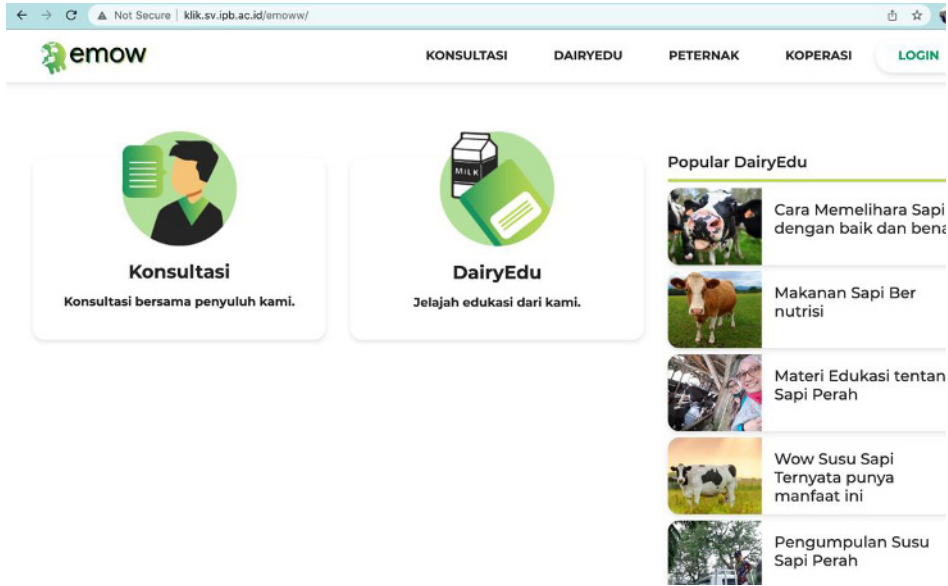


Fig. 4. Main page

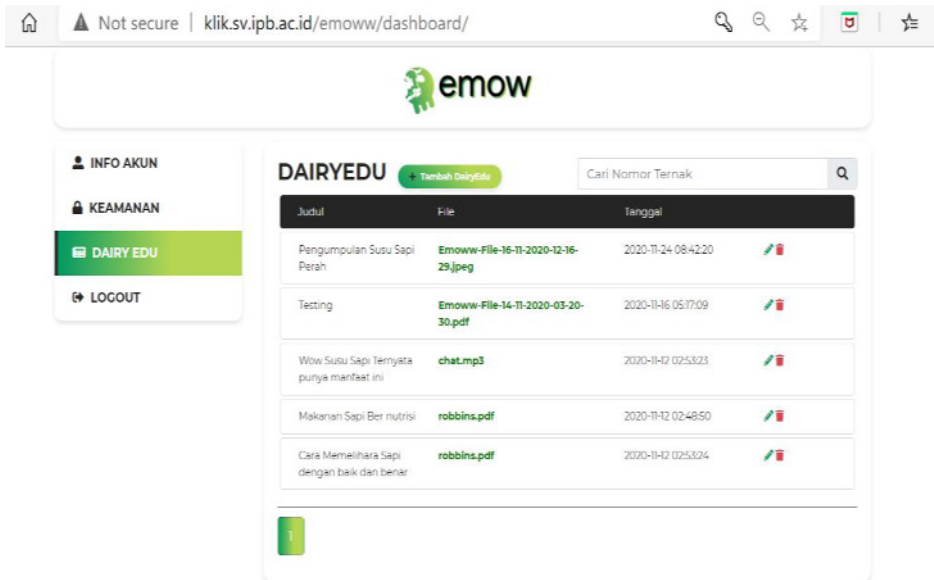


Fig. 5. Education data page

3.4 Testing

Testing was done to ensure the running process of application functions. The black box testing technique was used to test this application. Testing was conducted through the application system interface using a black box. The points were to check the functions in the application and evaluate the suitability of the application to user needs [14]. Examiners, in black box testing activities only need to know about the required inputs and outputs, or in other words, the examiners do not need to understand the internal system [15]. Test scenarios were designed based on experiments with various inputs. If the input was correct, then the application would display the correct response or information. If the input test case was wrong, then it would show how did the system respond to the wrong input. Table 2 presents the results of the application testing.

Table 2. Application features testing

No	Features Name	Testing Scenario	Testing results description
1	User activation	<ol style="list-style-type: none"> 1. Admin displays a list of new users who have registered 2. Admin selects the accept button which means the new account is approved to be activated 3. Admin selects the reject button which means the new account is not approved to be activated and registration is rejected 	<ol style="list-style-type: none"> 1. The screen displays a list of registered users 2. A new user has an active account. A user can login and access features according to their access rights 3. The user gets a registration rejected message and cannot login to the application
2	User Management	<ol style="list-style-type: none"> 1. Admin shows a list of users who already have an application account 2. Admin selects the activate button on users whose status is inactive 3. Admin selects the inactive button on users whose status is active 	<ol style="list-style-type: none"> 1. The screen displays a list of users who already have an account to access the application 2. Users whose accounts are inactive become active can enter the application and can access application features in accordance with the access rights granted 3. Users whose status is active become inactive and cannot access application features for interactivity
3	Account registration	<ol style="list-style-type: none"> 1. The user registers an account by entering the required identity: full name, email, selecting access rights (farmer, extension worker, or admin Edu), username, and password in accordance with the 	<ol style="list-style-type: none"> 1. Account data is stored and will appear on the admin page for the new user list, to be accepted or rejected. 2. The new user account data is not saved, and an error message appears informing that the field is not complete or other

No	Features Name	Testing Scenario	Testing results description
		<p>provisions. All parameters are required.</p> <p>2. The user registers an account by filling out a wrong form or do not filling in the parameters</p>	<p>messages such as the wrong email format.</p>
4	Login	<p>1. Users who have an account log in by entering the correct username and password</p> <p>2. Users who have an account log in by entering the wrong username and password or leaving it blank</p> <p>3. Users who do not have an account try to login with any account</p> <p>4. Users who successfully login then log out and try to return to the page link when logging in</p>	<p>1. The user has successfully entered the application and can access the application features in accordance with the access rights granted</p> <p>2. A message appears on the screen that the username and or password fields and or is still empty</p> <p>3. A message appears on the screen that the username and or password fields and or is still empty</p> <p>4. The user cannot return to the account page after logging out even though pressing the back button on the browser. Session on the application works properly</p>
5	Update Password	<p>1. The user changes the password by entering the old password correctly and entering the new password and re-confirming the new password</p> <p>2. The user changes the password by entering the wrong old password and or entering a new password but when re-confirming the new password entered is not the same</p>	<p>1. Password has been changed successfully and the user can login with her/his new password</p> <p>2. Password failed to change; a message appears that the entry is not correct</p>
6	Displaying dairy Edu menu	<p>1. The educational material appears on the homepage of the application and when clicked, the details of the selected educational material appeared</p> <p>2. Educational materials in files format can be downloaded by pressing the</p>	<p>1. The home page runs appropriately. It shows the educational materials according to the latest uploaded material</p> <p>2. The feature for downloading materials works well</p>

No	Features Name	Testing Scenario	Testing results description
		download button on the application 3. Video links on educational materials can be clicked and display videos of learning materials	3. All learning video links can operate properly and display videos that are relevant to the material
7	Managing dairy Edu data	1. Entering dairy Edu data by filling in the title, uploading images, materials, and uploading files 2. Updating dairy Edu data by changing one of the elements: the title, uploading images, materials, or uploading files 3. Deleting dairy Edu data by selecting the data to be deleted and clicking delete 4. Selecting dairy edu menu to display dairy Edu data	1. The new dairy Edu data has been successfully saved and displayed on the education page 2. Dairy Edu data has been successfully updated and displayed 3. The selected dairy Edu data has been deleted successfully 4. The application shows the dairy Edu page and its educational materials
8	Activating extensionists status	1. The AE select an active status on his account page 2. The AE select an inactive status on her/his account page	1. The farmers can send a message for consultation with the AE. 2. The farmer cannot send messages to the AE because they are inactive
9	Consultation	1. The farmer selects an active extension agent and sends a message 2. Farmers choose inactive extension workers 3. Extension workers reply to incoming messages from farmers	1. Message received by selected extensionists 2. The extension button is inactive and cannot send messages to inactive AE. 3. Farmers receive a message from the AE
10	Managing livestock data	1. Farmers enter new livestock data correctly 2. Livestock data is updated by replacing certain selected livestock data 3. Selecting the livestock data to be deleted and press the delete button 4. Selecting the livestock menu to display livestock data	1. New livestock data has been successfully saved and displayed 2. The livestock data has been successfully updated and displayed 3. The selected livestock data has been successfully deleted 4. The Livestock menu displays the livestock data

Based on the test results described in Table 2, it is shown that the application runs very well. Besides testing using the black box method, brainstorming sessions with users who have tried the application was also conducted. The brainstorming results indicated that there were features that were not yet needed, really needed and had just been revealed. After trying the application and having a discussion with farmers, it led to a suggestion to add forum features in the application. Users said that a forum can be a useful tool to share knowledge to solve problems faced by other farmers. This is related to a study conducted by [16] in the development of mobile learning applications for farmers in Tanzania which allows farmers to communicate and share the latest technology and innovations. Currently, many digital applications have been developed to facilitate farmers with extension services, agricultural information, and financial services. Several studies show a positive impact on the use of this technology that can improve livelihoods, especially in the global south. For example, m-Agri Service in Africa. Several educational and extension applications developed through m-Agri Service for farmers include iCow, Vet Africa, Agro-Hub, Modisar, uLima, and Agtag. The existence of this service was able to increase access to information for farmers. Particularly, sharing of information and knowledge can support the practical skills of farmers, which can increase their productivity [16].

4. Conclusion

AE have a responsibility to continue interaction regularly with farmers which cause high mobility. Since the outbreak of the Covid-19 and the enactment of working from home activities, it has limited the capacity of AE to provide counselling to farmers. The use of the internet is one solution to support AE in their duties. The application of this study can facilitate AE and farmers in interacting online with specific features and discussions. Moreover, this application can also maximize the role of educators by providing topics related to farming practices.

The application produced in this study has been tested by the technical side of the development team as well as tested by users to confirm the suitability of the features with their needs. The results showed that the application run properly. Besides, testing it, using the black box method, brainstorming sessions with users were also conducted. Direct consultation with AE was indeed very helpful. However, this application still needs further development. one of them is by adding a forum feature in counselling activities to share information and strengthen the relationship between farmers.

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