MOBILE APPLICATION FOR MONITORING THE GROWTH OF DONATED KIRAY TREES ON THE CISADANE RIVERBANK

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ABSTRACT

The riverbank of the Cisadane in South Tangerang, Indonesia, is experiencing erosion issues due to significant fluctuations in water levels and currents. Planting trees with deep and dense root, such as Kiray trees, on the riverbank slopes can help slow down the erosion. Many institutions/individuals have planted trees in the area; however, the survival rate of the tree saplings is rarely monitored. The monitoring of 50 Kiray trees planted by Binus University in June 2024 shows that only 50% of the saplings survive after 2 months. In order to improve the survival rate, it is necessary to monitor the growth of the trees in more detail. This study proposed to develop a mobile application that can be used by many people to register and monitor the growth of the planted trees. The mobile application have been designed based-on the discussion with the riverbank community, to allow multiple users to register and update the data of the trees, including their height and location from time to time.

Keywords: mobile application, empowerment, river conservation, environment sustainability, eco system

INTRODUCTION

Cisadane is a 138 kilometers long river that flow through the provinces of West Java and Banten in the island of Java, Indonesia. The main upstream of the river is located at mount Pangrango and mount Salak, and it passes through the city of Bogor and Bogor Regency in the province of West Java, and various cities in the provinces of Banten, before ending at the Java Sea. It is one of the main rivers in the two provinces, with a water catchment area reaching 1500 square kilometers. The river plays important roles for more than 3 million people in the surrounding areas, such as to prevent flood by collecting rainwater, and to be processed as drinking water for the population of the areas (Kharisma et al., 2022).

Because of the position of the river, its water level and flow rate at the downstream of the river in the province of Banten, depends highly on the amount of rain in Bogor. During the rainy season, the water level at the downstream can rise as high as 5 meters over its normal level, causing flood and erosion of the riverbank in Tangerang. Moreover, the lack of awareness from the population regarding the importance of the river and the impact of their interaction with the river leave the river with various kind of industrial, agriculture and household waste (Damoza, 2015).

The erosion process involves the detachment of topsoil from the ground, the relocation of the topsoil by water and wind, and the and the deposition of topsoil in a new location. The rate of the erosion process is caused by various factors, such as the water current, wind speed, slope of the soil, number of vegetation, and human activities. In case of Cisadane, researchers have noted that human activities, such as the expansion of agriculture, housing, and farming areas around the river have reduced the absorption rate in the water catchment areas. In return, more rainwater flows directly into the river causing high fluctuation of water level and current in the river, mainly during the rainy season (Fattah & Hidayat, 2022), (Ambarwulan et al., 2023).

One possible solution to slow erosion is by planting trees with deep and dense root on the riverbank slopes. Not only that the tree roots can prevent the soil from detaching, but they can also become an ecosystem for the fishes. Moreover, the tree can also become the ecosystem for birds in the area and help absorb carbon dioxide and produce oxygen (Ulfah, 2015).

The solution to the erosion problem involves various stakeholders of Cisadane and cannot be solved all at once. At the downstream in the province of Banten, there is a community of people, called BankSaSuCi or *Bank Sampah Sungai Cisadane*, which is translated into *Waste Bank of Cisadane River*, that devotes their time to watch over the river. They help clean the river from floating waste, educate the surrounding population about the importance of maintaining the river, and collaborate with various institution to recycle the waste, plan trees on the riverbank, build gabions, and other activities to preserve the river. One of the institutions that collaborate with BankSaSuCi is Binus University, which brought their students to help plant trees and clean the river from waste. In June 2024, students and lecturers from Binus University have planted 50 Kiray tree on the downstream riverbank of Cisadane, in the city of South Tangerang, province of Banten, together with the BankSaSuCi community. It was a part of many tree planting activities by various institutions around the area, usually as a part of their community service activities.

Kiray tree or *metroxylon sagu* is a palm species native to the tropical regions of Southeast Asia, particularly in Papua New Guinea and Indonesia. This versatile tree is best known for its starchy pith, which is harvested to produce sago, a vital staple food in many local diets. The Kiray tree can reach heights of up to 30 meters and features large, feathery fronds. Kiray tree plays a significant ecological role, providing habitat and sustenance for various wildlife species in its native environment. One of its key properties to prevent erosion is its dense root system, which anchors the soil and helps maintain the soil structure. The extensive network of roots grows horizontally and vertically, effectively holding the soil in place and reducing the risk of landslides. The presence of Kiray trees in riparian zones also contributes to stabilizing riverbanks, further protecting these areas from erosion Click or tap here to enter text..

The survival rate of the Kiray tree when transplanted to a new location can vary based on several factors, including the tree's age, health, and the environmental conditions at the new site. Based on the observation by BankSaSuCi community, the Kiray tree sapling that can survive a relocation to the riverbank should be at least 2 meters high and the tree's root must be conditioned prior to the relocation. Smaller tree sapling usually got carried away by water when the water level of the river increase. Based on observation, 50% of the 50 Kiray trees planted by Binus University on the riverbank of Cisadane in June 2024 do not survive after 2 months. The remaining half of the Kiray trees manage to grow new core.

This study aims to develop a mobile application to monitor the growth of the Kiray trees. It is necessary to monitor the growth of the planted Kiray trees on the riverbank in order to learn how to plant the trees effectively, hence protect the riverbank in the long run. By recording and analysing the history of the tree samplings from the time to time, we can learn about the survival and growth of the trees and revise the next planting strategy to improve survival rate. And since most of the Kiray trees are donated from various institutions, the information about the survival and growth of the planted trees are beneficial for those institutions.

DATA STRUCTURE OF THE MOBILE APPLICATION

The necessary information for each Kiray tree includes some fixed data that does not changed after the registration of the tree, and some historical data that can change over time as updated. The fixed data are its unique Tree ID, type of plant, its date of planting, and the donor institution/individual, as described in Table 1. The historical data are the height, picture, location, date of update and the user that updated the data, as described in Table 2. Other than the tree data, the mobile application also record the user data that can update the fixed and historical data of the tree, as described in Table 3.

Table 1. Fixed Data of Each Tree

Data Name	Remarks
Tree ID	Unique ID of each tree
Type of plant	Kiray or other plant that is planted
Date of planting	Estimated date of planting
Donor	Individual or institution that provide the plant
Date of registration	Date of the registration of the new plant
User that registered	User that registered the new plant

Table 2. Historical Data of Each Tree

Data Name	Remarks
Height	Height of the plant at the time of monitoring
Picture	Picture of the plant at the time of monitoring
Location	Latitude and longitude at the time of monitoring
Date of update	Date of the data update
User that updated	The user that updated the data

Table 3. User Data

Data Name	Remarks
Email address	Email address of the user
Date created	Date of the user registration
Last signed in	Date of the last log-in for the user
User ID	Unique user identification code

The fixed data are recorded only at the time of registration of the tree, while the historical data are recorded first during the registration, and then updated periodically without deleting the previous historical data. With this way, we can monitor the growth of each tree from time to time, including the location, in case the tree is relocated from its original planting location.

USER INTERFACE OF THE MOBILE APPLICATION

Mobile application is a small application that can be installed in multiple mobile phones that have compatible phone operating system. As the mobile phones are used by almost all people in Indonesia, it means that the tree monitoring mobile application can be used by many people, hence a lot of people can help monitor the trees.

Currently the two most popular phone operating systems are Android and IOS, which are developed and maintained by Google and Apple respectively. In Indonesia, Android is more widely used, therefore, the mobile application developed in this study is aimed to be used on Android phones only. All the installed mobile applications are connected to one database through the internet, which allow the synchronization of all data that are registered and updated by multiple persons on multiple mobile phones. This database can also be accessed from a web application.

There are four main functions in the mobile application, which are: user management (log-in, sign-up and password recovery), tree registration, tree update and tree QR label creation. Tree registration function is used to add new tree to be monitored, where the user will be asked to fill the fixed data of a new tree, including its picture. Tree update function is used to record new observation of the tree, where the user will be asked to fill the historical data of a registered tree. The QR label creation function is used to generate the QR codes that will be printed to label the trees. The mobile application is designed to be simple, where all the pages and the flows are shown in Figure 1, implementing the above stated four basic functionalities.

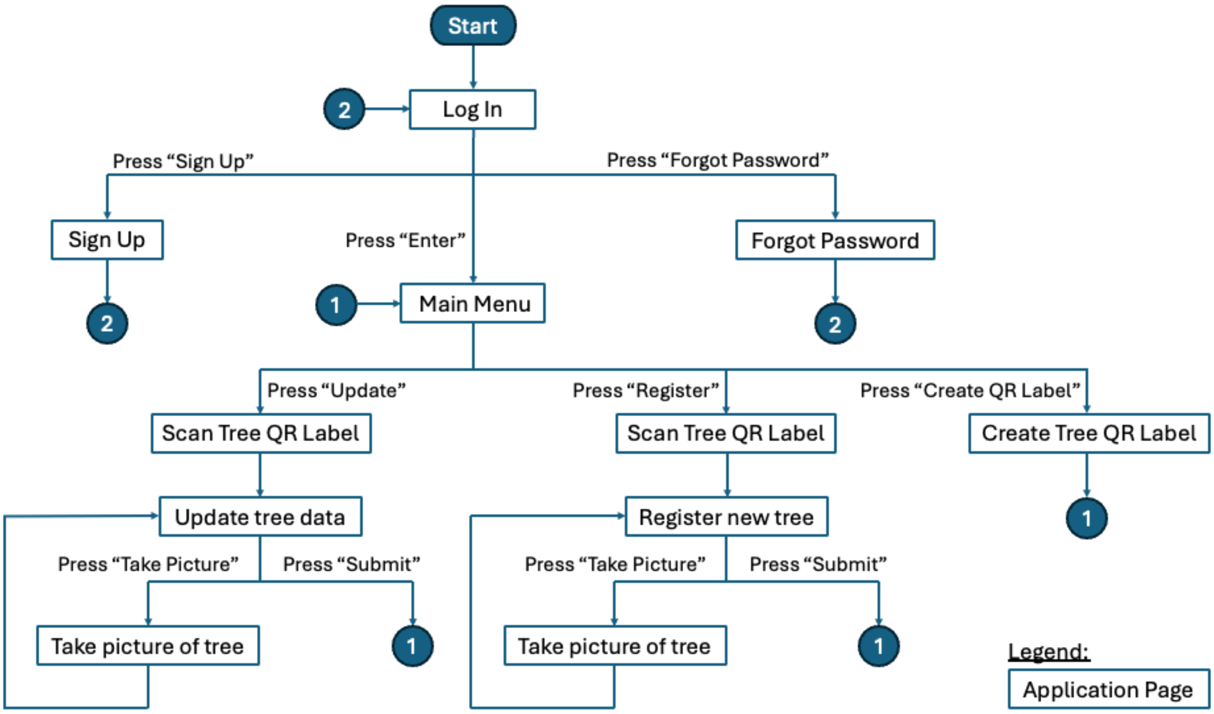

Figure 1. Page Flow Design of the Mobile Application

The basic user management function allows creation of new user (sign-up), recovery of forgotten password through the registered user email, and log-in into the main functions of the mobile application. The three main functions of the application require a log-in with a registered email address and a password. The basic user management function requires a connection to the internet to securely access the user database. The log-in and sign-up pages can be seen in Figure 2(a) and (b).

After log-in, the user will enter the main menu page, as shown in Figure 2(c), to choose one of the three main functions (tree registration, data update and QR label generation). Both the tree registration and tree data update functions will access the phone camera to scan the QR code on the label that is placed close to a tree. All the tree labels are unique and one-to-one related to the tree IDs. The label's material is polyvinyl chloride (PVC), usually used for banner that can withstand outdoor condition for years. Multiple QR labels can be created using the QR label generation function in the mobile application, as shown in Figure 3(a).

(a) (b) (c)

Figure 2. The (a) Log-In, (b) Sign-Up and (c) Main Menu pages.

(a) (b) (c)

Figure 3. The (a) QR Label Generation, (b) Tree Registration, and (c) Tree Update Pages.

Each tree needs to be registered before its data can be recorded in the mobile application. It is a one-time process where the QR code on the tree label will be scanned, assigned a tree ID, and then placed in the database. During the tree registration process, the user will be asked to type in the fixed data, which are: the type of plant, date of planting, and name of the donor institution/individual, and also the first historical data, containing: the height and picture of the tree, as shown in Figure 3(b). The date of registration, user that register the tree and the location of the tree are recorded into the database automatically by the mobile application when the user submits the tree registration.

Historical data of each tree can be updated from time to time using the tree data update function in the mobile application, as shown in Figure 3(c). The tree data update function will require the user to scan the QR code on the tree label, enter the height and take picture of the tree. The location of the tree, date of update and user that update the data are recorded into the database automatically when the user submit the tree data update.

DISCUSSION

The mobile application is still in its initial iteration, and while its functionality has been designed in collaboration with the BankSaSuci community, it has not yet undergone field testing. This is due to the need for further preparation, including setting up poles and signboards to attach the QR label near each tree, to enable on-site data collection and updates. Instead of jumping into a complicated or high-cost development approach from scratch, the authors decided to start with a mobile application development framework that can be used to quickly build the simple application for functional testing purpose.

The application requires a robust framework for building the functional user interfaces and a reliable database for storing and managing tree-related data. Thus, the Kodular development framework was chosen, a visual development platform that simplifies app creation through drag-and-drop blocks, making it ideal for developing the app's framework and features. For data storage, it uses the Firebase Realtime Database, which allows it to efficiently store and organize vital information about the planted trees, such as tree height, location, and other details. It also uses free Firebase web hosting for the simple web application.

A web application was also developed to facilitate public access to the tree database, allowing users to easily view and explore the data. By accessing the webpage, others can see the data of tree planted, type of tree, date of planting, donor name, tree height, and even the picture of the tree without having to download an application.

CONCLUSION

The survival rate of Kiray trees planted on the riverbank of Cisadane can be improved with better monitoring efforts. The developed mobile application as functions for registering and monitoring the growth of Kiray and other trees. This mobile application will facilitate the monitoring process by many people simultaneously, and the collected data can be used to analyze and enhance the survival rate of Kiray tress donated by various institutions and individuals along the riverbank of Cisadane. A web application is also developed to make it easy to see information of the tree without having to install the mobile application.

The mobile application will be tested in the near future in collaboration with the BankSaSuCi community for a small number of Kiray trees previously planted by Binus University to get more feedback to improve the mobile application at the next iteration. The future usability improvement of the mobile application is important so that the application can be widely used by BankSaSuCi community, donor institutions and individuals to monitor the planted Kiray trees. By knowing the survival rate and growth of the Kiray trees they have planted, they will be encouraged to plant more trees and seek better planting and tree care strategies. This is very beneficial in slowing the erosion of the Cisadane riverbank in the long run.

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