Development of mobile-based apps for oil palm fresh fruit bunch transport monitoring system

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Abstract. After being harvested, the oil palm fresh fruit bunch (FFB) has to be evacuated from the field and transported to the oil palm mill. In most cases, it transported using the trucks. FFB transportation should be optimized in order to achieve the best FFB quality and minimum cost. This research was aimed to develop tools to monitor trucks as FFB transport equipment, due to some deviations in the field. The Development of the application using these method: business process analysis, system analysis, system design, and implementation and functional test. The application software run as an Android-based application, as a map-based application, and using location-based service. The system also runs as a web-based application and has been tested on FFB logistic system in private plantation company. It monitored the truck route and FFB loading and transporting activities in the field, as well as gave instruction to the truck driver in order to avoid the heavy queue in an oil palm mill.

1. Introduction

Ministry of Agriculture, Rep of Indonesia noted that Fresh Fruit Bunch (FFB) production in 2011 was 23.096.541 tons, increase as much as 1.84%, to 23.521.071 in 2012 [1]. Indonesia’s oil palm export at semester I 2012 valued US$9.95 million [2]. Even there was a fluctuation within 5 years recently, oil palm is predicted to have good prospect due to the good economic growth of some big population countries like India and China. Lubis [3] stated that in order to maintain FFB quality, fruit’s bruise should be minimized within harvesting, loading, evacuation, and transportation. The bruise an injury cause fast increment of FFB’s free fatty acid (FFA) content. FFA content is one of CPO quality major criteria and should be as low as possible, usually sought no more than 2% when FFB enter the mill [4]. Research conducted by Krisdiarto [5, 6] showed that field transportation contributed pretty much bruise/injury to the fruit, which caused higher FFA content when FFB reach the mill loading ramp. Krisdiarto et al. [7], using dynamic modeling also found that bruised FFB suffered higher FFA content increment when it was in a long time in queue. Currently, the FFB evacuation and transportation from oil palm field is manually controlled based on the real-time capacity of the palm oil mill (POM). Sometimes there is no coordination between mill capacity and farmer’s FFB shipment. Meanwhile, the POM capacity is not stable, due to many reasons. On the other hand, there are also fluctuations in harvesting volume, due to field condition and the climate [8]. The long queue caused by those factors results in FFB quality degradation and higher cost of processing. Krisdiarto et al. [7] recommended the truck start to transport the FFB when there was a spare capacity, in order to minimize the queue. Due to
the harvesting-evacuation-transportation-processing is a continuous process, the coordination and control of the system should be real time. This can be done applying mobile based application on computer/gadget. This research aimed to build a mobile-based application which refers to FFB harvesting and transportation business system. The apps would work on internet connection and give real-time information, so it could be used as a tool in a decision support system.

2. Methodology
The study was conducted at Information Technology Laboratory, Atma Jaya Yogyakarta University, Pilot plan of Stiper Agricultural University, and PT Mamuang, an oil palm plantation at West Sulawesi, from June to September 2018. The research steps are depicted in figure 1.

![Flowchart of research steps](image)

2.1 Business Process Analysis
2.1.1 Business Process of OP plantation management
2.1.2 Business Process of FFB transportation Monitoring
2.2 System Analysis
2.2.1 Product perspective
2.2.2 Product Function
2.2.3 Software need analysis
2.2.4 Data Relationship Entity
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2.3.2 Interface Design description
2.4 System Implementation
2.4.1 Software definition
2.4.2 System Implementation
2.5 Evaluation
2.5.1 Functional evaluation
2.5.2 User evaluation

3. Results and Discussion

3.1 Business process analysis
The system was developed with the name of LogTranSawit, and the aim of the system is to facilitating FFB harvesting management and transportation monitoring. FFB transportation is expected to be carried out by remote orders using mobile-based applications, and FFB transportation trips can be monitored in real time. The application built for two main business processes. The first business process is the management of oil palm harvesting, including: defining field for plantation, harvest prediction, and manage harvesting data. The second business process is the FFB transportation monitoring. Details of those two business processes are illustrated in figure 2 and 3.
3.2 System analysis

3.2.1 Product perspective
The system works at internet application environment, and could be accessed using web browser and mobile application in Android OS. This application connected to the internet to get data from database server via web server. The user interacts with Graphical User Interface (GUI). Information system architecture of this system refers to [9] illustrated in figure 4.

The LogTranSawit used by head of field assistant, mill manager, plantation manager, field assistant, and plantation clerk using web browser to handle some functionalities such as: employee and staff
management, field mapping, truck and field capacity, and FFB harvesting and prediction management. Plantation manager role could draw location and field map, manage oil palm prediction data, calculate FFB harvested and estimate transportation time. The LogTransawit also could be used by driver and field assistant for giving an transporting order to truck driver, and monitor itinerary of the truck. Further, field assistant or field manager could make a decision based on realtime transport condition and map which has been drawn. Mill and plantation manager can monitor the FFB transportation from web-based application from the computer at the office.

3.2.2 Feature and function
To fulfill the purpose of application objectives, refering to on site practices [4,10], the following features and functions of software were designed:

1. Login: this function used by user every time he entered the system, according to his rule.
2. Account admin: this function used by a system administrator to manage employee accounts, such as add, edit, delete, find, and display the data.
3. Afdeling management: this function used by a system administrator to manage field on map, such as draw the afdeling or block and their information.
4. Block management: this function used by a system administrator to manage plantation block on map.
5. FCP management: this function used by a system administrator to manage FCP in the block, such as pointing the FCP position, draw FCP, and their information.
6. Harvesting prediction management: this function used by a farmer assistant and head of assistant to give harvesting prediction of every block. The prediction was done periodically, i.e. yearly, monthly, weekly, and daily.
7. Reporting function: this function used by a mill manager to display some report related to FFB transportation from every block.
8. Work shift function: this function used by a mill manager to manage work shift. This function related to mill processing capacity.
9. Mill capacity function: this function used by a mill manager to manage processing capacity adjusted to work shift.
10. Harvesting distribution function: this function used by a FFB truck driver to set FFB transportation from field to the POM.
11. Harvesting management: this function used by an assistant to manage the number of harvesting in block.
12. Transportation order to driver and monitoring: this function used by driver and field assistant.
3.2.3 **Entity Relationship Data (ERD)**
There were many data involved in the system. Relationships among database are depicted in figure 5.

![Entity Relationship Data (ERD)](image)

**Figure 5.** Entity Relationship Data (ERD) of the application

3.2.4 **Interface design**
Based on the software concept and function needed, the interface built was to ease the interaction between users and application. Some designed interface are depicted in figure 6 and figure 7.

![Interface design](image)

**Figure 6.** a. Interface : landing space, b. Interface : “home” page
3.3 Implementation

3.3.1 Definition and coding

The LogTranSawit application was a system that developed to help oil palm plantation company in optimizing FFB transportation. Using the application, users can manage field aspects (harvesting and evacuation) in relation with POM capacity in real time manner. The application was developed in Laravel framework, employing PHP and Java language programming. While for mobile-based program employing Java programming language and using Android Studio tool for development enviroment. The application used API web service that connect directly to database server. Coding list of program listed in table 1 and table 2.

Table 1. Coding list of Entity LogTranSawit.

| Class name    | Size (KB) | Update date       | Information                                           |
|---------------|-----------|-------------------|-------------------------------------------------------|
| Afdeling.php  | 0.350     | 20 / 06 / 2018    | Entity class for object afdeling                      |
| Blok.php      | 0.308     | 12 / 07 / 2018    | Entity class for object field block                   |
| Distribusi    | 0.232     | 03 / 10 / 2018    | Entity class for object harvesting distribution       |
| Panen.php     | 0.257     | 03 / 08 / 2018    | Entity class for object capacity                      |
| Kapasitas.php | 0.240     | 03 / 10 / 2018    | Entity class for object distribution coordinats      |
| Koordinat     | 0.249     | 25 / 07 / 2018    | Entity class for object clerk                         |
| Distribusi.php| 0.257     | 20 / 06 / 2018    | Entity class for object role                          |
| Shift.php     | 0.249     | 03 / 08 / 2018    | Entity class for object shift                         |
| Taksasi.php   | 0.269     | 13 / 07 / 2018    | Entity class for object harvesting prediction         |
| TPH.php       | 0.313     | 25 / 08 / 2018    | Entity class for object FCP                          |
| Truk.php      | 0.257     | 02 / 09 / 2018    | Entity class for object truck                         |
| TrukSopir.php | 0.258     | 02 / 07 / 2018    | Entity class for object truck driver                  |
| User.php      | 0.544     | 15 / 06 / 2018    | Entity class for object user                          |
Table 2. Coding list of LogTranSawit Controller.

| Class name                  | Size (KB) | Update date  | Information                                      |
|-----------------------------|-----------|--------------|--------------------------------------------------|
| Afdeling Controller.php     | 8.48      | 15/09/2018   | controller class for afdeling management         |
| Akun Controller.php         | 4.1       | 15/09/2018   | controller class for account management          |
| Dashboard Controller.php    | 0.455     | 15/06/2018   | controller class for home page management        |
| Krani Controller.php        | 0.430     | 15/09/2018   | controller class for clerk function management   |
| Laporan Controller.php      | 5.03      | 20/05/2018   | controller class for reporting management        |
| Login Controller.php        | 4.04      | 12/08/2018   | controller class for login management            |
| Manpabrik Controller.php    | 4.66      | 05/10/2018   | controller class for POM manager function        |
| Sopir Controller.php        | 0.690     | 15/09/2018   | controller class for driver function management  |
| Warning Controller.php      | 0.376     | 15/06/2018   | controller class for error warning function      |
| Direction Parser.java       | 4         | 10/10/2018   | controller class for map direction management    |
| Main Activity.java          | 6         | 09/10/2018   | controller class for mobile login function       |
| Maps Activity.java          | 21        | 17/10/2018   | controller class for mobile map function         |
| Maps Activity2.java         | 35        | 19/10/2018   | controller class for 2nd mobile map              |
| Option Activity.java        | 12        | 19/10/2018   | controller class for harvesting data input       |
| Profil Activity.java        | 6         | 10/10/2018   | controller class for profile function management |
| Request Handler.java        | 2         | 03/10/2018   | controller class for request handler management  |
| SharedPref Manager.java     | 3         | 03/10/2018   | controller class for shared preference manager   |

3.3.2 System implementation

Figure 8 showed the login page at web-based application, which can be accessed from a computer. This is the first page the user should pass in. Figure 8 b illustrates the employee data page, this was used by the administrator to input, edit, and display the employee data in the system. The employee data were a name, an email, a phone number, and his role in the system. There were some button and menu in this page, i.e. refresh, edit, role, and password. Menu “Kebun/Afdeling” used to display block, afdeling, and
FCP management. There was also textbox “Pencarian” which can be used by the admin to find employee account.

![Figure 9. Display of map menu page and transportation capacity report](image)

Two displays in figure 9 are the display of the manager’s account. Map menu can be used by the manager to explore information about field block and harvesting, while transportation capacity report gives ease and instant information of time to time FFB transported from the field and received in POM. These are the tools that help the manager in taking the decisions regarding harvesting-transportation-mill process optimization [11]

![Figure 10. Display in mobile application: a. map of the plantation, b. Information of FCP](image)

On the side of FFB transportation operator, user, i.e. driver and assistant (supervisor) used mobile-based application that installed in smartphone. Two main menus depicted in figure 10. After the user pass login page, he will see the menu with field map. The driver should operate this menu when he starts the transportation route, then push “angkut TBS (load FFB)” when he loads FFB at FCP, and push “selesai (Finish)” when he unloads the FFB at POM loading ramp. In this movement, truck can be observed real time by manager or supervisor who has an authority to do that. The application will be equipped with a communication feature in order to facilitate the manager instruct the driver directly.
Figure 11. Display for transportation monitoring

Figure 11 shows truck monitoring feature, that used by plantation manager to view the itinerary of truck. The effectiveness of the trip could be seen as a drawing line that could help manager to make a technical decision about the transportation.

3.4. Evaluation from user
In order to figure out the response from users, the users were asked some questions and should answer these options:
   a. Strongly Disagree (1)
   b. Disagree (2)
   c. Fairly (3)
   d. Agree (4)
   e. Strongly agree (5)

There were two type of users observed, i.e. mill manager and driver. The number of respondents involved was 4 managers and 23 drivers.

Figure 12. Users respons for application usage.
4. Conclusions
It can be concluded that the application developed functions according to the intended purpose. It can be used to manage transportation data as well as monitor and control truck movement appropriately and easily. The main requirement of the system to give real-time performance was the availability of internet access.

5. Acknowledgment
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