The design of fresh fruit bunch palm oil purchase system from independent smallholders to support Indonesia’s biodiesel development program

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Abstract. Miniplants established by the independent smallholder’s secondary cooperative is one of the efforts to get rid from monopsony market and mill. By the existence of miniplants, Fresh Fruit Bunch (FFB) sales channel will not only end at mill, but also at the miniplant in spite of in limited capacity. Each channel of FFB sales should be supported by the credible price information and the integrated purchase system. To fulfill the need of real-time & transparent price information and the integrated FFB purchase system can be realized by developing mobile application Software as a Service (SaaS) of FFB’s purchase based on a cloud platform. The method used to develop the mobile application is a system approach following the stages in SDLC (System Development Life Cycle) starting from the ideas, user requirements, system requirements, designing, deployment and maintenance. This study is restricted until the stage of designing and generating Business Process Diagram, Use Case Diagram, Data Conceptual Model and Mock up only. Both diagram and model generated in this study aids develop FFB purchase mobile application. The large number of independent smallholders has the opportunity to get a large number of mobile application users. The application will generate a large amount of data. These data can be used to develop various tools as part of the FFB e-procurement system to ensure the supply of independent smallholders’ FFB can be used for biodiesel development programs as expected by the government of Indonesia.

1. Introduction

The sale of Fresh Fruit Bunch (FFB) from the independent smallholders highly depends on the mills. Their dependency on mills forms monopsony market [1]. On the monopsony market, the sale channel only goes toward to one party. This condition causes the independent smallholders will not possess the sale bargaining. The independent smallholders are the significant element for palm oil industry, however their main role is only needed when the demand increased [2]. The mill only purchases FFB in particular months to optimize CPO (Crude Palm Oil) and PKO (Palm Kernel Oil) productions [3]. Otherwise, while the CPO demand decreased, the independent smallholders are difficult to sell FFB with the normal price.

To overcome that kind of condition stated above, the independent smallholder’s secondary cooperative in certain provinces as Bangka Belitung and South Kalimantan try to get rid of the monopsony market constructing people’s mills or miniplants. With the existence of the miniplant, the
mill will not be the only FFB purchaser and CPO producer. Miniplant also the hub for the CPO production, albeit in limited capacity.

Secondary cooperatives consist of several primary cooperatives, it receives FFB delivery orders directly from the mill. Meanwhile, the primary cooperative fosters independent smallholders and collects independent smallholder palm oil FFB, then the FFB is sent to secondary cooperative to fulfill mill orders. The innovation in establishing miniplant by the secondary cooperative is a process of transformation on CPO production. The transformation on CPO production is followed by the transformation on the system of the purchase in FFB the supply chain. One of the challenges in transforming the purchasing system in FFB supply chain of the independent smallholders is how to provide the update and transparent price information [2]. Price information is a key factor in the amount of supply and demand in trading a commodity [4]. The real time price information simplifies and fastens the purchase of FFB transaction. The Information Communication Technology (ICT) support enables the FFB purchase transaction more responsive.

The ICT functions to enhance the coordination among the various business entities in supply chain. The ICT is tool and technique which makes it possible to share information among the various business entities in supply chain by integrating both the internal business system and the external one [5]. With the ICT support, the price information system becomes so centralized that aids the independent smallholders obtain the real time and credible price information. The real time price information can be used for developing the FFB purchase application of the independent smallholders. The cloud platform can integrate the business process on FFB buyer and seller entities in a platform as a service. The buyers within FFB supply chain of the independent smallholders include middleman, cooperative and Peron. The FFB purchase application that is powered by cloud service can ensure the increase of transaction volume of various buyers and sellers within the centralized system. The effective FFB purchase can support the continuity of FFB delivery to the mill and miniplant with the accurate quantity, accurate time and good quality.

The price information system and the independent smallholders’ FFB purchase system based on cloud is an essential part of digital transformation of FFB procurement. Nowadays FBB allocation is highly used to develop biodiesel. Indonesian could produce biodiesel production 4.7 Million KL, within two years, the production reached 9.6 Million KL in 2019. The statement released by the Indonesia Palm Oil Fund Management Agency (Badan Pengelola Dana Perkebunan Kelapa Sawit/BPDPKS) states that the land owned by the independent smallholders is relied to supply FFB to support the biodiesel development program [6] but the mechanism and the regulations do not exist. Without both, the independent smallholders will not benefit from the biodiesel development program. BPDPKS as a government institution funds biodiesel development programs concerns more on the distribution process of B20 and B30 upstream. The system of biodiesel distribution has been supported by the information system to supervise and control the subsidized biodiesel payment [6]. BPDPKS pays more attention to the biodiesel distribution system, while the FFB and CPO procurement are on the contrary. Meanwhile at the downstream, procurement of FFB and CPO to develop biodiesel are managed by the mill. Hence, the source of FFB and CPO cannot be traced. No mechanism can ensure FFB and CPO of the independent smallholders are part of biodiesel supply chain. The independent smallholders will not benefit from the biodiesel development program. We can learn from the biodiesel development program in Thailand. Biodiesel development program increases farmers’ income, but it doesn’t imply much on palm oil price [7]. One of the ways how the independent smallholders to gain more benefit from biodiesel development is by making their FFB and CPO as a part of FFB procurement system for biodiesel.

E-Procurement Service can be applied in procurement system of FFB and CPO for biodiesel. E-procurement is one of the promising tools of operation to construct digital supply chain of the independent smallholders FFB. However, in order to establish the digital supply chain of FFB, then, all the challenges, business, technical and policy should be handled well. The development of the FFB purchase system based on cloud service solves one of the technical challenges faced, established E-procurement of FBB and CPO for the biodiesel development program.
Based on previous studies, there are not many research topics that discuss ICT support for independent smallholders. One of the studies discusses about single FFB price reference is the government of Malaysian through the Malaysian Palm Oil Board (MPOB) that has transformed the determination of the price of a single FFB reference [9]. The single reference price will make a transparent FFB trading and ensure that the relationship among smallholders, FFB traders and mills remains in harmony. In Indonesia, the topic of research on independent smallholders focuses on strengthening the institutions of independent smallholders [2], Prioritize the use of the fund to clarify smallholders land tenure rights, so that they could get access to sustainable certification and financial institutions. [10]. Develop a model to improve the performance of independent smallholders [11], application of Good Agricultural Practice [12]. The study of the contribution of independent smallholder oil palm plantations to poverty alleviation in rural areas, but also independent smallholders also contributed to increase forest fires [13].

This study aims at analysing and designing the FBB purchase system of independent smallholders based on Cloud service. To analyse and design the FBB purchase system uses system approach. The first phase of the study determines components to construct the FBB purchase system. The analysis and design system follow the System Development Life Cycle (SDLC), starting from the ideas, user requirement, system requirement, designing, deployment and maintenance [8]. The second phase, create users’ requirement and system requirement model using UML. The model constructed is Use Case Diagrams, Conceptual Data Model and mock up interface FFB purchasing application. To capture the business process to fulfil the system requirement uses BPMN 2.0. The Next section provides research method. The third section presents result and discussion. The last section concludes by providing an answer of research objective.

2. Methodology

2.1. Requirement analysis and modelling system

The requirement analysis includes the first phase in designing using the system approach. In this stage, all components of independent smallholders’ FFB purchase system are analysing, starting from the actors involved as well as their roles. The input and output data, regulation, resources needed (Fig. 1).

![Figure 1. Components of Independent Smallholders’ FFB Purchase system [8].](image)

The analysis and design system follow the System Development Life Cycle (SDLC), starting from the ideas, user requirement, system requirement, designing, deployment and maintenance [8]. Based on research background there are two main ideas; 1) how to provide single price reference system and 2) how to provide FFB purchase system for two channels of FFB Sales. The Users’ requirement analysis is process to gather all the information like what the customer wants to build. This research captures user requirement based on SOP for harvesting and FFB sales published by the Oil Palm
Farmers Union (Serikat petani Kelapa Sawit/SPKS) [14]. System requirement specification or software requirements specification is a document or set of documentation that describes the features and behaviour of a system or software application. The user requirement of FFB's purchase system modelled by Use case diagram and The system requirement of independent smallholders’ FFB purchase system modelled by Business Process Model and Notation (BPMN) 2.0. There are two output of design stage, Conceptual Data Model and the interface design. SDLC is restricted until the stage of designing and generating Business Process Diagram, Use Case Diagram, Data Conceptual Model and the interface of mobile app. All of diagram and model are made using power design software from SAP.

2.2. Research object

Research object includes several cooperatives of the independent smallholders in Bangka Belitung. The system of FFB purchase is made to answer the cooperative needs of price information system and the integrated FFB purchase system in Bangka Belitung province. Prototype of the independent smallholders’ FFB purchases application to be examined in several cooperatives in Bangka-Belitung province.

3. Results and discussions

3.1. User Requirement Analysis

The manual FFB purchase system of the independent smallholders will be transformed by constructing an application of FFB purchase based on Cloud service. In order to use the service, the actors involved should register and then after it is done, followed by the process of authentication. The actors involved: the independent smallholders whose harvest FFB and the buyers, categorized as middleman, cooperatives and Peron. CPO producers include: mill and miniplant. User_DB and SaaS are entities in FFB purchasing service. After register and successfully log in, the independent smallholders register their farms by inputting data the farm they manage. Then, the independent smallholders note the harvest time forecast based on the previous harvest time in the farm registered. Referring to the recapitulation of the harvest time forecast of the cooperative members, the cooperative can forecast the number of FFB to be allocated to fulfilling delivery order of FFB from the mill. For the mill itself, the harvest time forecast is required to determine the production planning of CPO. The purchase price of FFB in the mill fits the price set by the local government. The buyer based on their category determines the purchase price of FFB based on the price set by the mill. Each actor notes the transaction of the FFB purchase through mobile application. The transaction is then saved in a centralized system with a support from SaaS service. The relation among entities or actors in the system of FFB purchase of the independent smallholders captured in Use Case Diagram as shown in fig 2.
3.2. System Requirement Analysis

The independent smallholder FFB purchase system consists of two main business processes, FFB Harvests and FFB purchases. System requirement analysis change the ‘as-is’ business process into a ‘to-be’ business process. To-be business process described in fig. 3 & 4. The independent smallholders require FFB price as set by the local government and stakeholders. At harvest they already get price information. Besides, the service required in harvesting process include: the farm registration service and the harvest time forecast. The farm registration service is used to get all data regarding the land such as the size, location and GPS coordinate point. After the farm registered, the independent smallholders note the harvest time forecasting the farm.

Buyers are also required to register by inputting the identity of the business owner including contact number, location, etc. The cooperative lists their membership including farmers who have registered their farm in the FFB purchase system. The cooperative can see the recapitulation of farm, the recap. Of harvest time forecast. There are two kinds of cooperatives: 1) Primary cooperative that is related directly with the farmers and actively buys FFB of the independent smallholders. 2) Secondary cooperative that is related directly with the mill and actively fulfils delivery order of FFB based on the contract signed. Several secondary cooperatives initiate to establish miniplant. Middleman can also list their membership, namely the non-cooperative member farmers. Middleman can also see the farm registration and the harvest time forecast. Peron’s gather middleman to be their members.
In the process of FBB purchase, the independent smallholders require their FBB recapitulations including FBB quantity, FBB weigh and weigh of overripe FBB. After the harvest time, farmers sort their harvest, input data including their harvest time and the number of FBB. The sale of FBB is through two channels. The first channel ends at the mill, while the second channel ends at miniplant. For the first channel, the non-cooperative members are banned to sell to the mill directly. They must pass through middleman and Peron. The cooperative member farmers sell FBB to the cooperative. The process of FBB purchase by the cooperative and middleman is not similar. Middleman must pick up to grab the FBB in the farms and weigh at their places. Then, the farmers can have their cash directly. For the cooperative members, the farmers can weigh their FBB on location but the farmers must wait the payment from the mill before they can have their cash. The second channel, in certain location, farmers can sell FBB and overripe straight to the miniplant.

### 3.3 Conceptual Data Model

Data requirements for system development are obtained during the process of user requirements analysis and system requirements analysis. Data requirements are described in the conceptual data model (fig. 5.).

![Conceptual Data Model of FFB Purchase System](image-url)
3.4. *The Interface Design of Mobile Application for FBB Purchase*

Homepage is an initial page that is firstly displayed while farmers open the application (see appendix). This page contains FFB reference prices in Bangka Belitung. This page also displays prices set by collectors, cooperatives and Peron. The other services are restricted because the users are only as guests. In order to have an access, a farmer must register themselves. Farmers must provide all data such as username, password, email. The farmers can access home user page with a menu. after they get their registration confirmation through email. User’s menu consist of; profile, farm, harvest time forecast, buyer, harvesting and news. In the registration form, farmers fill in farm data. The system will display 11-digit farm id after the farmer inputs the farm status, STDB (Surat Tanda Daftar Budidaya), farm address and GPS coordinates. The 11 digits follow the regional format standard based on data from globalforestwatch.com. The first two digits are the province code, the next two digits district code and the next three digits the sub-district code and finally the land number.

The farm page contains data that has been filled by farmers. Previously the farmer entered the data by filling in the location of the GPS coordinates, farm address and farm administrative data. Each farm consists of one or more fields. Fields are added when farmers expand their oil palm farms. The time to plant oil palm is different in each field, therefore the harvest time forecast is also different. The harvest time forecast is filled by farmers based on previous harvest data. On the harvest time forecast page, farmers offer crops to buyers by pressing the inquiry button.

The buyer’s recapitulation of harvest time forecast page (see appendix) contains information on the forecast of harvest time input by the farmer in his mobile application. Inquiry is accepted when the buyer presses the accept button. This means that the buyer agrees to buy FFB when it is harvested, the Tri Tungal cooperative as a buyer receives inquiry from independent smallholder Suhardi and Herman. During the harvest, Suhardi recorded the weight, quantity and price of FFB. The Tri Tungal cooperative received FFB and ripe palm oil purchases records on its mobile app purchase page in accordance with the FFB sales data inputted by Suhardi.

The design of mobile applications for purchasing FFB focuses on the seller’s side. The mock up feature discusses the independent farmer cellular app because farmland and harvest data are needed for future development. Recording farmland and harvest data is the first step in digitizing the independent smallholder FFB supply chain. With the support of digital supply chains, the industry is able to identify and mitigate risks because the flow of information in money, and goods in more detail and real time [15]. The sustainability of biodiesel development will be ensured by the ability of digital supply chains to identify and reduce risks in the flow of money, goods and information.

4. **Conclusion**

This FFB purchase application design to build a better FFB trading system. An integrated FFB’s reference price in Bangka Belitung will make a transparent FFB trading and ensure that the relationship among smallholders, FFB traders and millers remains in harmony. The FFB purchase system using a mobile application is the initial stage of the digital transformation in independent smallholder FFB supply chains. The large number of independent smallholders has the opportunity to get a large number of mobile application users. The application will generate a large amount of data. These data can be used to develop various tools as part of the FFB e-procurement system for biodiesel development program. GPS coordinate point of smallholders’ farm, mills and miniplants data can be used to build FFB delivery order systems with location-based service technology. Data on the age and size of independent smallholder oil palm plantations can be used to support the rejuvenation of smallholders oil palm program (Peremajaan Sawit Rakyat/PSR). Data of cooperative and middleman as collectors can be used as a database to build FFB and CPO Supplier Management System.
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Appendix
The buyer’s recapitulation of harvest time forecast page

Buyer purchase page