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Development Of A Digital Platform Prototype For The Sustainable Decision Support System On The Kenaf Fiber Agro-Industry Supply Chain

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ABSTRACT

Kenaf plants are able to absorb 21 to 89 tons of CO2 per hectare per year, depending on the agronomic management and environment. Kenaf plant-based fiber agro-industry in Indonesia serves as an upstream industry that has a potential to increase the export value contribution of kenaf dried fiber, while allowing domestic demand for kenaf dried fiber to be met through Indonesian production. This will have an impact on the reduced value of kenaf dried fiber import. The purpose of this study was to develop a digital platform prototype of a sustainable decision support system for kenaf fiber agro-industry supply chains. Development of this digital platform relied on an Android OS with Java language based decision support system framework, which was previously established using a system development life cycle (SDLC), Waterfall model. This research has succeeded in developing a digital platform decision support system for a sustainable kenaf fiber agro-industry supply chain using a waterfall model SDLC approach. This digital platform helps users to make decisions regarding alternative opportunities for cleaner production and increasing green productivity through measuring green productivity indexes with GVSM as the input. This research can be further developed for implementation of intelligent system-based DSS. Therefore, in future research, DSS can be developed with a model-based management system using an intelligent systems approach.

Keywords:

digital platform, green productivity index, clean production, kenaf fiber agro-industry supply chain, decision support system

Introduction

As a fiber-producing plant, kenaf (Hibiscus cannabinus L.) mainly relies on their bark and stems [1]. However, in order to obtain the higher economical value [2], an optimal processing of all kenaf plant parts is carried out [3]. Fiber is produced in a number of nations, including Indonesia, and has the potential to become a flagship product both domestically and globally. The plant known as kenaf (Hibiscus cannabinus L.), which is grown on just 3,000 Ha of arable land, is the source of the type of

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fiber under discussion. Nonetheless, 30,000 tonnes of dried fiber are consumed domestically each year [4]. Kenaf is a green or dry material that can be harvested in three to six months. Its composition is 60 to 75 percent core and 25 to 40 percent bast. Kenaf has mechanical qualities that are nearly identical to those of jute fiber, but it is more glossy and colorful [5]. Kenaf is non-woody plant that can grow until four meter height and can be harvested in four to five months [6].

Kenaf fiber has various benefits, including the ability to be renewed and biodegraded, both of which are necessary for producing goods that are beneficial to the environment [7]. Almost all the parts of Kenaf can be used for raw materials of various industries, but the reliable is the fiber of the barrel [8]. One of the commercial crops grown worldwide, kenaf is becoming a popular reinforcement material in the advanced composite manufacturing sectors [9]. Kenaf plants have a significant contribution in absorbing carbon dioxide. Some of carbon dioxide that is produced anthropogenically contribute to the largest greenhouse effect [10]. Kenaf plants are reported [10] to be able to absorb 21 to 89 tonnes of CO2 per hectare per year, depending on the agronomic management and surrounding environmental conditions.

Kenaf plant-based fiber agro-industry in Indonesia serves as an upstream industry that has a potential to increase the export value contribution of kenaf dried fiber, while allowing domestic demand for kenaf dried fiber to be met through Indonesian production. This will have an impact on the reduced value of kenaf dried fiber import. This condition is triggered by increasing productivity, quality, value added, consumer satisfaction, and good cooperation along the kenaf vegetable fiber supply chain network. This increase leads to a rise in the performance and income of each member in the kenaf vegetable fiber supply chain network. The purpose of this study was to develop a digital platform prototype of a sustainable decision support system for kenaf fiber agro-industry supply chains.

Environmental issues are prioritized in development of the global kenaf fiber industry, as kenaf fiber is considered as an environmentally friendly plant- based fiber raw material [10]. This was revealed from the process of retting [11], [12] as the main step in processing kenaf into dry kenaf fiber.

The goal of supply chain management as an integrated approach is to satisfy customers by fostering a collaboration and an ever-evolving process that facilitates the smooth transfer of goods and services from producers to consumers [13], in addition to associated information flows. In the supply chain, information and materials move both upstream and downstream [14]. The agro-industry that produces kenaf fiber appears to have a problem that could be solved with the help of sustainable supply chain management, or SSCM to achieve long-term success, SSCM incorporates the triple bottom line—which includes economic, social, and environmental aspects—into essential business activities [15].

This digital platform helps users to make decisions regarding alternative opportunities for cleaner production and increasing green productivity through measuring green productivity indexes with GVSM as the input. The focus of GVSM is green manufacturing. A diagnostic tool called GVSM offers insights into both environmental performance (also known as green performance) and production efficiency (also known as productivity) [16]. The purpose of this study was to develop a digital prototype of a sustainable decision support system platform for the kenaf fiber agro-industry supply chain. Decision support system tools are needed to provide decision alternatives related to clean production and green productivity index. It is important to develop this prototype in order to support actors in the upstream supply chain network in making decisions to increase supply chain efficiency and responsiveness. There has been no previous research regarding the development of SPK

specifically for kenaf in calculating GPI, so this research intends to develop an SPK for Kenaf to fill the research gap.

Methods

Development of this digital platform relied on an Android OS-based decision support system framework, which was previously established using a system development life cycle (SDLC), Waterfall model [17], [18]. The research framework is presented in Figure 1.

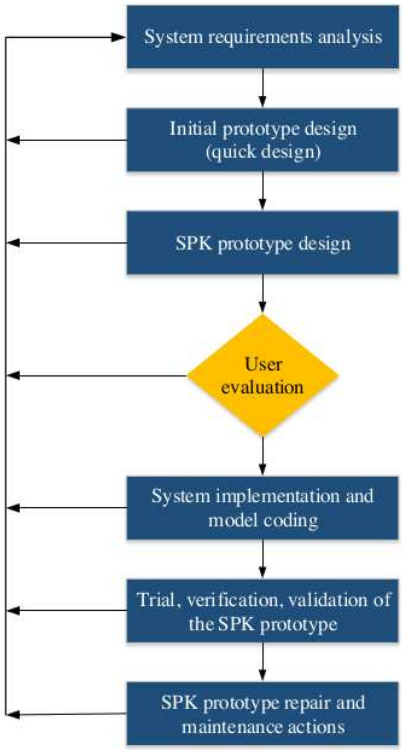

Figure 1. Waterfall model in SDLC

The process of system requirements analysis interviews with upstream agro-industry to obtain the data. The contents of the discussion related to waste, labor, and cultivation processes, as well as data associated with GPI, which included production costs and the selling price of kenaf. Meanwhile, the weights for gas, solid, and liquid were obtained through a literature study regarding the table of indicator weights in ESI 2005 [19]. The initial prototype design process is carried out by making the user interface graphics. An application's graphics user interface (GUI) acts as an interface between the program and its final user [20]. The SPK prototype design process is carried out by developing user interface graphics to become a digital platform prototype. Knowledge-based decision support systems are made to help the convergence industry make more accurate decisions by efficiently utilizing relevant and timely data, information, and knowledge management [21]. The user evaluation stage is carried out by giving a user acceptance test to the user. In this case, is the upstream agro-industry. At the system implementation and model coding stage, the development of a

clean production model, GVSM, and GPI is carried out through the Java programming language which functions to integrate into the Android operating system. In the trial, verification, and validation of the SPK prototype stage, the pre-existing prototype is given to the user as well as user manual instructions regarding the use of the digital platform prototype created. in the SPK process prototype repair and maintenance actions are carried out based on input from the user regarding the prototype that has been tried. There will be improvements to the prototype based on the user.

Results and Discussion

There will be major advantages from the potential to export raw kenaf fiber, particularly for Indonesia's agriculture industry [22]. Kenaf plant-based fiber agro-industry in Indonesia serves as an upstream enterprise that can grow the export price contribution of kenaf-dried fiber, at the same time allowing home demand for kenaf-dried fiber to be met via Indonesian production. This can have an impact at the reduced fee of kenaf dried fiber import. This condition is brought on through increasing productiveness, nice, fee brought, customer pride, and appropriate cooperation along the kenaf vegetable fiber deliver chain community. This growth leads to an upward thrust in the performance and earnings of every member within the kenaf vegetable fiber supply chain community. The reason of this look at become to broaden a digital platform prototype of a sustainable decision support system for kenaf fiber agro-enterprise deliver chains.

A. Implementation of the Digital Platform for the Decision Support System on the Sustainable Kenaf Fiber Agro-industry Supply Chain

The Decision Support System on Sustainable Kenaf Fiber agro-industry Supply Chain (Kenaf DSS) is a digital platform prototype developed as a software that is able to propose alternatives to clean production, green value stream mapping, and measure green productivity. The prototype implementation developed was designed in Java language software.

This prototype supports users in the sustainable kenaf fiber agro-industry supply chain network in using, updating, and managing data. The users include owners of the kenaf fiber agro-industry and academics as super admins. This digital platform prototype is installed on Android smartphones with minimum specifications as follow:

1. Operating system: Lollipop Android 5.0 API 21
2. RAM: 2GB
3. Processor: Snapdragon 450 1.8GHz max
4. Screen resolution: 720 x 1280 px – 2560 x 1600 px

The Kenaf DSS digital platform prototype was designed to be easy-to-use, enabling the users to take advantage of this application. The main page on the application, presented in Figure 2, shows the application name, i.e. the Decision Support System on the Sustainable Kenaf Fiber agro-industry Supply Chain and a plant icon. In order to facilitate decision making, user roles are identified as shown in Figure 3.

Figure 2. Main Page Display

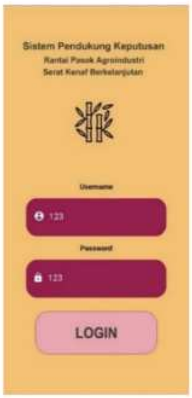

Figure 3. User Identity Page Display

This digital platform has a main menu display to view the supply chain of the sustainable kenaf fiber industry. Approaches of clean production and green productivity index will be used in the sustainability concept. The objective of this sustainability implementation is to suggest a recommendation strategy for decision making-related sustainability in order to increase efficiency and responsiveness in the supply chain network.

Figure 4. Main Menu Application Display

Figure 5. Cleaner Production Main Menu Display

Main menus provided in this application include Cleaner Production, Green Value Stream Mapping (GVSM), and Green Productivity Index (GPI). The application page view is presented in Figure 4. In Figure 5, the main display for Cleaner Production is presented in the upstream kenaf fiber supply chain network. The main menu presented is processes in cleaner production in the upstream kenaf fiber supply chain network.

In Figure 6, the main menu display is presented to see the Green Value Stream Mapping (GVSM) in the kenaf fiber supply chain network. There are several menus, including the current state, the current state with opportunities, and the future state. Figure 7 shows the main menu display to see the Green Productivity Index (GPI) in the kenaf fiber supply chain network. There are two menu options on the GPI, i.e. the current state and the future state.

Figure 6. GVSM main menu display

Figure 7. GPI main menu display

B. Digital Platform of Sustainable Decision Support System in the Kenaf Fiber Agro-industry Supply Chain

The digital platform prototype of sustainable decision support system (DSS) in the upstream Kenaf fiber supply chain network was built based on a database management system (DMS), model base management system (MBMS), and knowledge base management system (KBMS).

Database management system (DMS) as a technique to handle the increasing amount of data generated from modern import and export activities [23]. DMS on DSS was obtained from internal and external data. Internal data was data obtained from observation and documentation of kenaf fiber agroindustry. External data was obtained from data mining on various supporting sites, such as the website of the Statistics Indonesia (BPS) and the Ministry of Industry, as well as the results of literature studies from previous studies that have been successfully published.

The data inputted in this system was related to kenaf fiber cultivation, production costs, waste weights, body mass ratios, and by-product types and quantities. By-products in the upstream supply chain network of kenaf fiber agro-industry also show some value added for their selling power and benefits in production, and therefore being able to be an alternative to clean production in kenaf fiber agroindustry.

MBMS is a model used to represent situation and condition of kenaf fiber agro-industry in the upstream supply chain network in the real world system. This model is able to simplify problem solving in net production and productivity of kenaf fiber agroindustry.

Mass balance is one of tools which provides alternative opportunities and analyzes net production in this agroindustry. Results of mass balance become an input in building current state GVSM, current state GVSM with opportunities, and future state GVSM. Moreover, maps that has been successfully drawn through GSVM facilitates data processing through a GPI approach. The third management system in DSS was KBMS, which in this DSS performs knowledge acquisition, knowledge

conceptualization, and knowledge representation. DSS development diagram as described above is visualized in Figure 8.

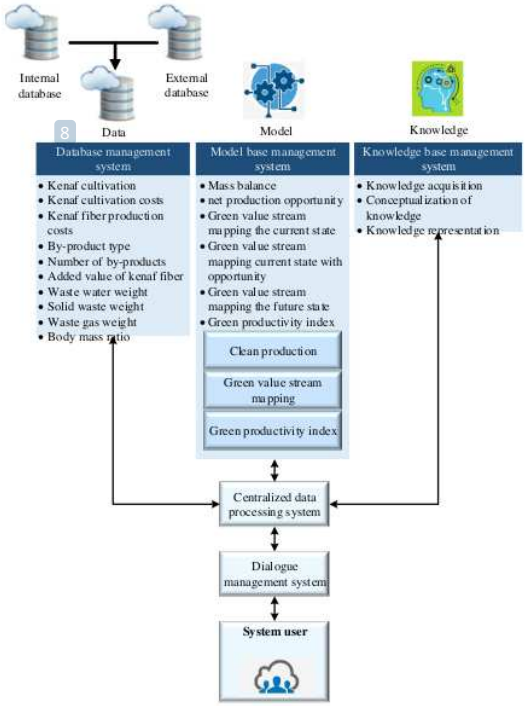

Figure 8. SPK Development Diagram

A 'Use case' diagram was designed to identify 'user' roles in this system. This diagram works by defining typical interactions between users on a system and a separate system. This diagram defines relationships and roles of each 'user', as well as interactions between them. Use case diagrams are employed during the software development process to analyze and gather requirements while taking both internal and external aspects into account. A system's actors and the use cases that go along with them are designed during the functional analysis phase [24]. In its application, 'user' can access some information on an Online-based Digital Platform for the Sustainable Decision Support System on the Kenaf Fiber agro-industry Supply Chain. The 'use case' diagram is presented in Figure 9.

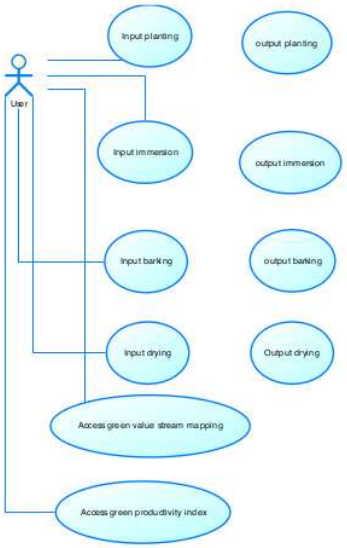

Figure 9. Use Case Diagram

The designed business process is described in the BPMN diagram presented in Figure 10. BPMN describes detailed activity flows in a business process model of the decision support system for each user on the sustainable kenaf fiber agro-industry supply chain. Because of its highly comprehensible notation for both business and technical professionals, BPMN is an ISO approved standard (ISO/IEC 19510:2013) for defining business process semantics [25].

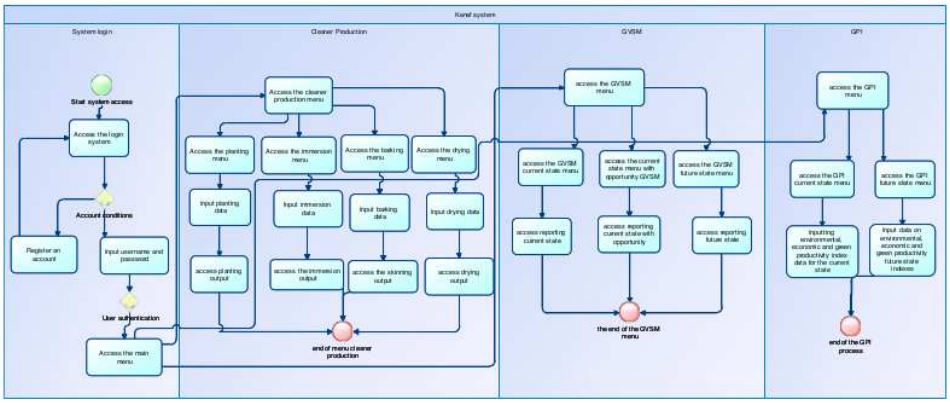

Figure 10. BPMN Diagram

Levels of data stored on the Digital Platform for the Decision Support System on the Sustainable Kenaf Fiber agro-industry Supply Chain are shown in a hierarchical diagram presented in Figure 11. The hierarchical diagram illustrates relationships between data and boundaries of the decision support system on the sustainable Kenaf Fiber agro-industry supply chain.

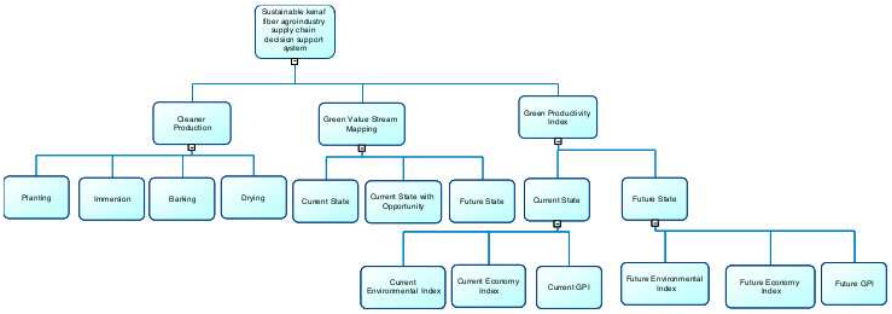

Figure 11. Hierarchy Diagram

This digital platform has several advantages including having a clear database system and being able to provide information regarding the results of agro-industry GPI values). On the prototype that has been developed, the tests carried out are still relatively limited because the test is only on one user, namely users in the upstream agro-industry. This digital platform helps users to make decisions regarding alternative opportunities for cleaner production and increasing green productivity through measuring green productivity indexes with GVSM as the input. This research can be further developed for implementation of intelligent system-based SPK. Therefore, in future research, SPK can be developed with a model-based management system using an intelligent systems approach.

Conclusion

This research has succeeded in developing a digital platform decision support system for the sustainable kenaf fiber agro-industry supply chain using a waterfall model SDLC approach. This digital platform is operated on the Android OS with Java language. This digital platform facilitates decision making regarding alternative opportunities for cleaner production and increasing green productivity through measuring green productivity indexes with GVSM as the input. This research can be further elaborated in implementation of intelligent system-based DSS. Therefore, in future research, DSS would be developed with a model base management system using an intelligent systems approach.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11