Web Service Integration: Data Exchange among Area Sampling Framework, Paddy Sampling, and CAPI Cropping Systems

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Abstract— Statistics Indonesia (BPS) is responsible for providing agriculture data. BPS collects statistics on paddy paddy production by performing a survey that involves sampling paddy plots using the Area Sampling Framework (ASF). The ASF survey is conducted monthly. The ASF System receives information from the Paddy Commodity Cropping Sampling System to prepare the sample frame and withdraw samples. This is done by the Sub-Directorate of Sample Frame Development (PKS Sub-Directorate). The existing system requires human processing of ASF results to modify the paddy observation code. This processing is carried out by the Sub-Directorate of Food Crops and the data is prepared by the Sub-Directorate of Sample Frame Development (PKS) before being uploaded into the Paddy Commodity Cropping Sampling System. The findings of sample retrieval by the Paddy Commodity Cropping Sampling System will be transmitted to the Sub-Directorate of Data Processing Integration (Sub-Directorate of IPD) and thereafter uploaded into the CAPI System for Paddy Cropping. The PKS Sub Directorate has identified many processes in the existing system that are deemed to be less efficient. The current inefficiency of the business process is caused by the manual execution of various tasks in the ASF system, such as sending data via email, modifying the paddy observation code, and sending the modified code results. Additionally, the data preparation process relies on additional applications, and sample documents from the Paddy Crop Sampling System are manually sent to the CAPI Cropping Sampling System. Hence, there is a requirement for enhancing the process flow of paddy harvesting sample. The lack of integration across systems necessitates manual execution of the process. This research proposes enhancing the Paddy Commodity Crop Sampling System by introducing new functionalities for modifying the paddy observation code and data preparation. Additionally, it suggests utilizing web services to integrate the ASF System, Paddy Commodity Crop Sampling System, and CAPI Cropping System.

Keywords— Integration System, Area Sampling Framework, Web Service, Cropping Sampling

I. INTRODUCTION

Statistics Indonesia (BPS) has an important role in agricultural data in Indonesia. One type of agricultural data produced by BPS is the data of the Paddy Commodity Cropping Survey. The Cross-Cutting Survey is a survey conducted by BPS routinely by recording part of the harvest of paddy plants to estimate the yield of the entire paddy harvest in paddy fields. In 2018 (September-December), the ubinan survey no longer used a household approach, but used an area approach with the Area Sampling Framework (ASF) method. In the ASF method, the sample of ubinan plots is calculated based on the location of paddy fields, not the location of farm households [1].

In 2017, five state institutions collaborated to improve the country's rice data by implementing the Area Sampling Frame (ASF) method which led by Badan Pusat Statistik (BPS) dan Badan Pengkajian dan Penerapan Teknologi (BPPT) [2]. This method was developed in early 1990s by BPPT and European Union [3]. ASF method has been awarded by Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia/LIPI) in 2017 [4]. The method has been enhanced through the internet, GPS (Global Positioning System), and GIS (Geographic Information System) which are available from Android smartphones. Since 2018, ASF is now fully operational with high accuracy in measuring and calculating the rice harvest area [5].

The process of processing the data of the paddy commodity Cropping Survey was assisted by several related systems, namely the ASF system, the Paddy Commodity

Cropping Sampling System, and the CAPI Cropping system. The ASF system served as a data processing system for the results of the enumeration of ASF activities and was managed by the Sub-Directorate of Food Crops. The Paddy Commodity Cropping Sampling System acts as a data processing system for compiling sample frames and conducting the withdrawal of Cropping samples, the system is managed by the Subdirectorate for Sample Frame Development (PKS Subdirectorate). The CAPI-Cuban system acts as a management system that manages the data of ubinan samples and is managed by the Subdirectorate of Data Processing Integration (Subdirectorate of IPD).

Routine paddy seedling survey activities are carried out every month. After the ASF system releases the data, the Sub-Directorate of Food Crops conducts the process of changing the paddy observation code using a csv-extension document with the Microsoft Excel application. The process of changing the paddy observation code compares the observed value of paddy plants in the generative phase. In changing the code of paddy observations, the generative phase will be changed into two phases, namely the early generative phase and the late generative phase.

After the ASF data is processed to change the paddy observation code, the data is then sent by the Sub-Directorate of Food Crops via email to the Sub-Directorate of PKS. Sub Directorate of PKS then prepares the data using Microsoft Excel application and produces segment and subsegment data. After the segment and subsegment data were formed, the PKS Sub-Directorate uploaded the two data in the form of csv documents into the Paddy Commodity Cropping Sampling System.

In the current Paddy Commodity Cropping Sampling System, segment and subsegment data are formed into a sample frame and a sample is drawn. After the sample is selected, the PKS Sub-Directorate then downloads the sample data and uploads it to the BPS cloud and sends an email notification to the Sub-Directorate for Data Processing Integration (IPD Sub-Directorate) [4].

Based on interviews conducted with the PKS Sub-Directorate, it has been determined that the movement of data results from the ASF system to the Paddy Commodity Cropping Sampling System is deemed inefficient. The current business process is inefficient due to the manual procedures involved in sending output files from the ASF system via email, manually changing the paddy observation code by the Sub Directorate of Food Crops, manually sending the results of code changes via email, manually preparing data, and manually uploading documents into the Paddy Commodity Cropping Sampling System and the CAPI Cropping System.

Given the current issues, the ASF data flow necessitates a system that may enhance the efficiency of the activities involved in the current business process. An integrated system between the ASF system, the Paddy Commodity Cropping Sampling System, and the CAPI Cropping system can enhance the efficiency of the process. Furthermore, a system is required to facilitate the modification of the paddy observation code and the automation of data preparation, which is now being carried out manually. This is an effort to enhance the efficacy of the procedure that is currently being performed manually.

Web services technology has shown promising utility and capacity in creating user-friendly applications for business-to-business interaction [6], [7]. Web services are designed to construct a web server that accommodates to the needs of a website or any other application [8], [9]. Another description of a web service refers to a software system specifically created to facilitate machine-to-machine interaction within a network [10], [11].

The client software implements the Application Programming Interface (API) to establish communication with the web service. Representational State Transfer (REST) is a distinct type of web architecture. Web API that utilize the REST architectural style are commonly referred to as REST API. This architecture employs one of the HTTP methods to request data from a specific resource identified by a URL namely GET method [12], [13]. In the literature (1), the utilization of Restful API in the Laravel framework involves the implementation of Jason Web Token (JWT) [14], [15]. The server's key is used to sign tokens for secure verification on both the client and server side. JSON Web Tokens (JWTs) are utilized to authenticate subsequent client requests without the need for repeated connections to the resource server or database [16], [17].

This research will design a system using a RESTful API web service to integrate all the system so that data between systems can be exchanged.

II. METHODOLOGY

The research steps employed in this subject leverage the SDLC waterfall system development paradigm, which comprises five distinct stages as outlined below [18], [19]

1. Requirement Analysis: The first stage carried out is a needs collection analysis with the research subject matter. In this research, the subject treated as a subject matter is the Subdit PKS BPS.
2. Design: In building a system design, researchers define the problems and needs that occur then carry out a system design that will be built.
3. Code Writing: This stage represents the actualization of the design for system development. This phase of writing computer code concentrates on technical aspects, where the outcomes of the system design will be converted into programming language.
4. Testing: Module testing aims to find out whether the software is in accordance with the design, and the functionality of the system whether it runs well or not.
5. Implementation and Maintenance: The last stage is program implementation and maintenance. Systems that have passed the system testing stage can then be used by the subject matter. System maintenance also includes fixing errors, upgrading, and customizing the system according to usage needs.

III. RESULT AND DISCUSSION

A. Current System Analysis

The process of segment and subsegment data from the ASF system to the Paddy Commodity Cropping Sampling System in the current system is shown in Figure 1. The activities of the process flow of ASF-based paddy field survey data begin with the ASF system releasing ASF data until the activity is ended by the Paddy Commodity Cropping Sampling System successfully displaying the sample frame data.

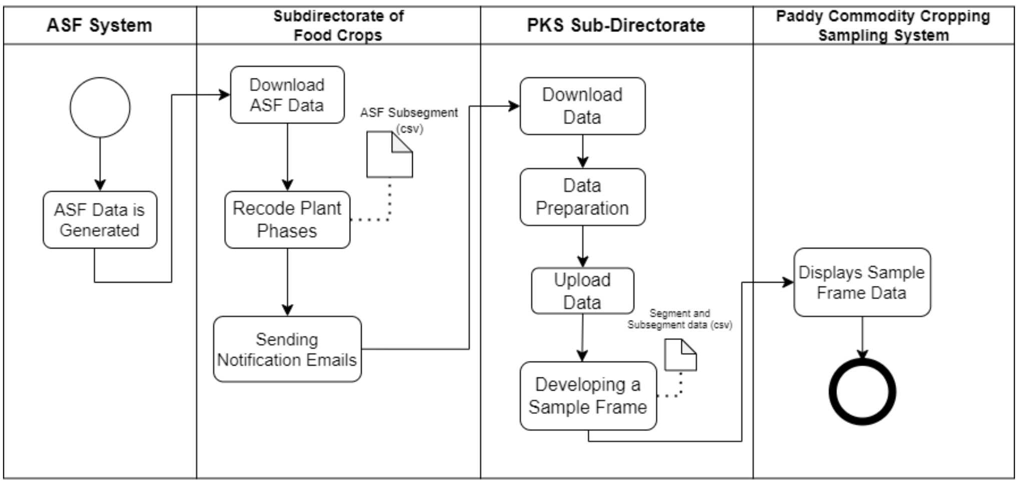

Figure 1. Business process flow of ASF system to the Paddy Commodity Cropping Sampling System in the current system

The next process is that the Paddy Commodity Cropping Sampling System releases the sample data until the CAPI Cropping system successfully displays the sample data. The current business process is shown in Figure 2.

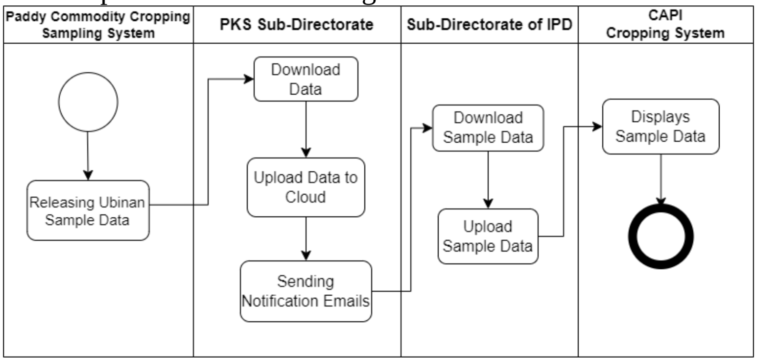

Figure 2. Business process flow of the Paddy Commodity Cropping Sampling System to the CAPI Cropping system in the current system

B. System Requirements Analysis

The following is a requirement analysis on the functional system.

1) *Requirements for the ASF system*
   - The system provides an API that can be used as a medium for sending data between systems.
   - The system can create API tokens that are used as access in requesting other systems data to the ASF system.
2) *Requirements for the Paddy Commodity Cropping Sampling System*
   - The system can perform the process of changing the observation code of paddy plants
   - The system can check and change inappropriate strati values
   - The system can request data to the ASF system using a web service.
   - The system can arrange the sample frame using ASF data.

C. Proposed System Design

1) *Proposed Business Process*

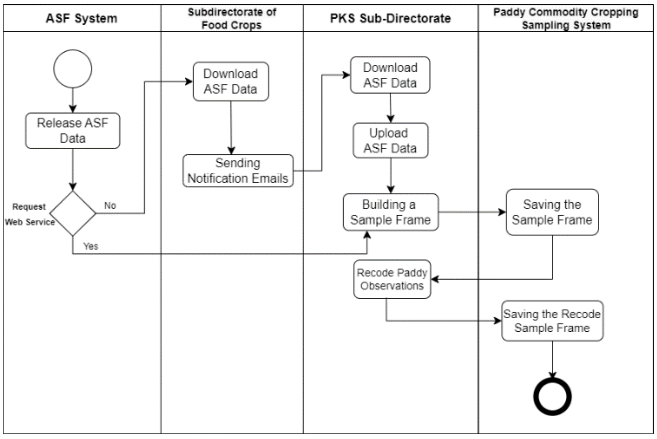

Figure 3. Business process flow of ASF system to Cropping Sampling System of Paddy Commodities in the proposed system

The process of changing the paddy observation code is carried out by the PKS Sub-Directorate and there is an alternative flow in the process of sending ASF data to the sampling system using web services as shown in Figure 3. As for Figure 4, the proposed business process is in the form of adding alternative flows in the process of sending selected sample data using web services from the Paddy Commodity Cropping Sampling System to the CAPI Cropping system.

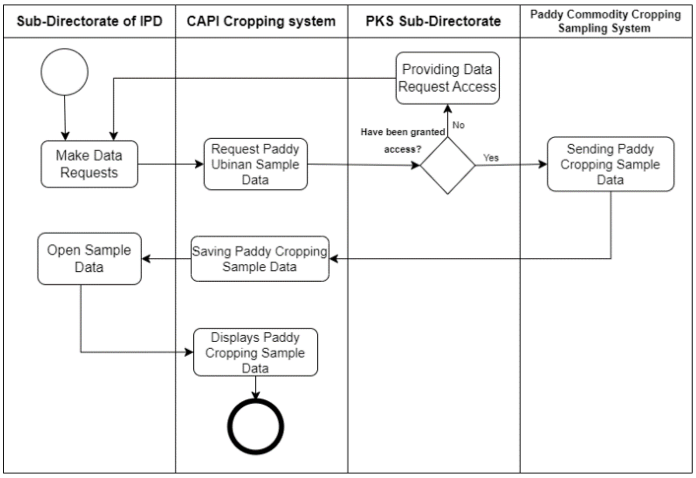

Figure 4. The business process flow of the Paddy Commodity Cropping Sampling System to the CAPI Cropping System in the proposed system.

2) Proposed System Integration Architecture

The proposed system integration architecture is shown in Figure 5. The system consists of ASF system, Paddy Commodity Cropping Sampling System, and CAPI Cropping system. There is an additional web service as a link between systems with a data exchange format using JavaScript Object Notation (JSON) [20], [21]. In this research, the web service that will be created applies the REST architecture. This is also often done to integrate between systems to make it more efficient as in previous studies [22]–[25]. This study used the ASF dummy system and the CAPI Cropping dummy system due to limited access by BPS RI.

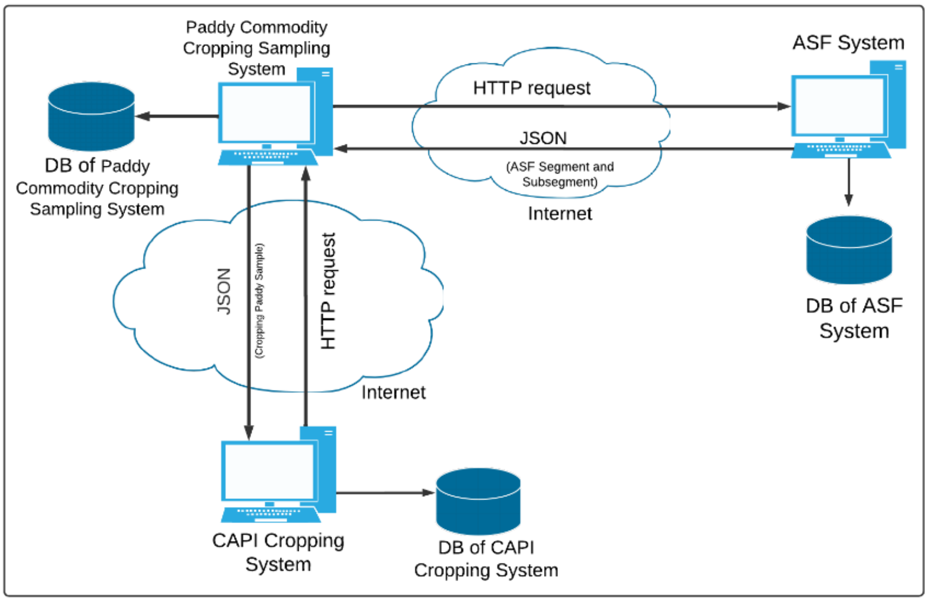

Figure 5. System integration architecture

3) Use Case Diagram of Proposed System

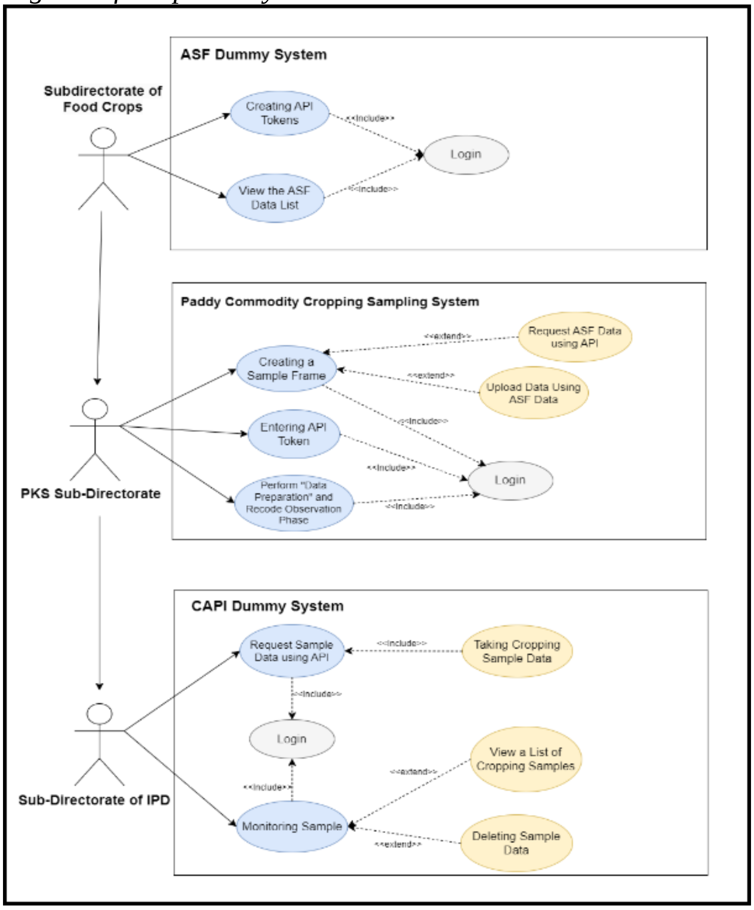

Figure 6. Use case diagram of proposed system

Use case diagrams can describe an interaction between actors and processes that occur [26]. The use case diagram in this research is shown in Figure 6, there are three business actors and three systems related to this research.

4) Diagram of Proposed System

Activity to Create API Token on ASF Dummy System can be seen in Figure 7. The process begins with the system loading the API page then users can view API information or can add API tokens to the system. If the user wants to add an API token, it is necessary to fill in the system name then the system will generate the token and the API token is successfully formed.

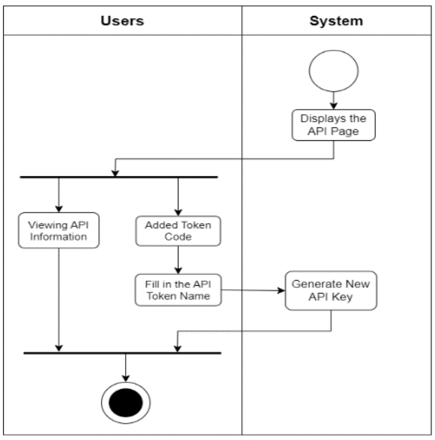

Figure 7. ASF Activity diagram of creating an API token on the ASF Dummy system

API Activity to Develop a Sample Framework with API is shown in Figure 8. The process of compiling the sample frame begins with the user selecting the method of compiling the sample frame using the API. Then the user can set the year and month according to the current month. Then the system will display the segment and subsegment paths according to the month that has been adjusted to send data requests to the ASF dummy system.

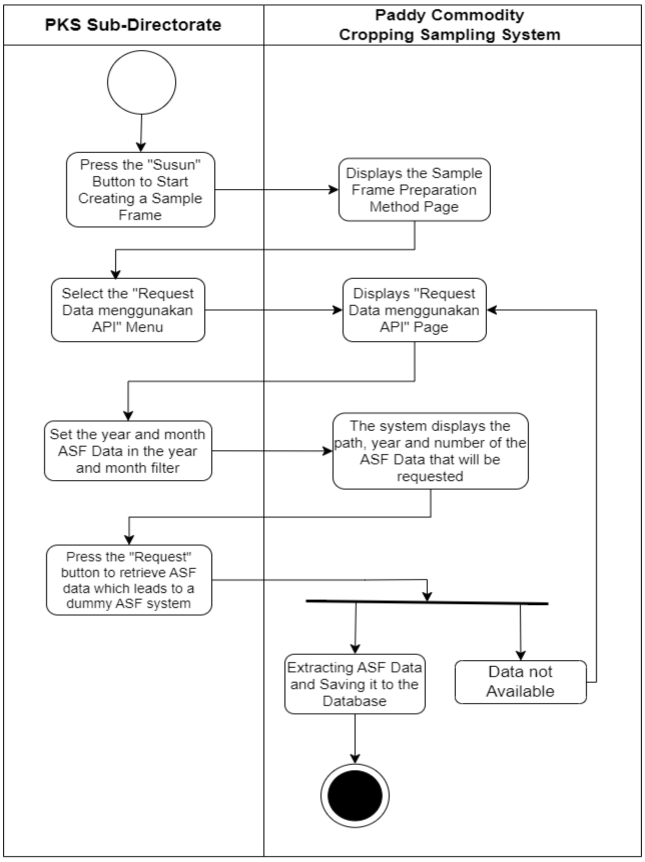

Figure 8. API Activity diagram of compiling a sample frame with API

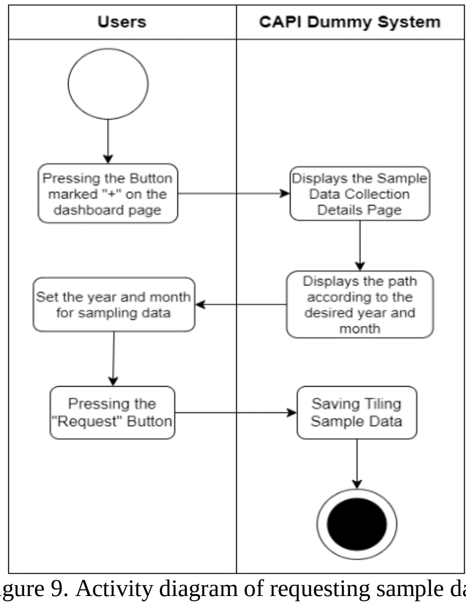

Figure 9. Activity diagram of requesting sample data

Activity Requesting Cropping Sample Data is shown in Figure 9. The process begins with the user pressing the button with the plus logo (+) on the dashboard page. Then the system will display the data request page. On that page, the user can set the month and year that the data will be taken from the Paddy Commodity Cropping Sampling System. After the user finishes setting the month and year, the system will display the sample path that will be requested. Next, the user presses the "Request" button and the system will search for sample data according to the user's settings using the get method. After the sample data is obtained, the CAPI dummy system stores the sample data into the database.

5) Database Design of Proposed System

Database design is needed as information that contains specific user needs in a system. In this research, there are three database designs that use the Physical Entity Relationship Diagram shown in Figure 10 to Figure 12.

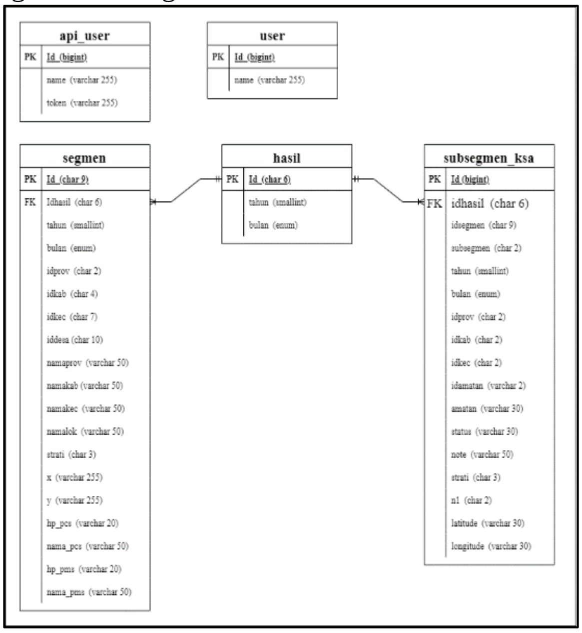

Figure 10. ERD sistem dummy ASF

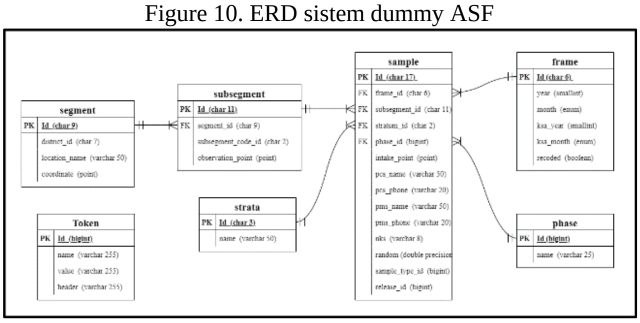

Figure 11. ERD of Paddy Commodity Cropping Sampling System development

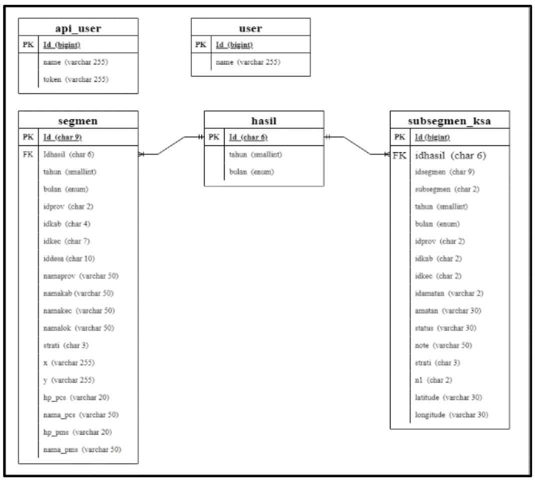

Figure 12. . ERD of CAPI ubinan dummy system

6) *Implementation of the System*

The implementation of the API information page on the ASF dummy system can be seen in Figure 13.

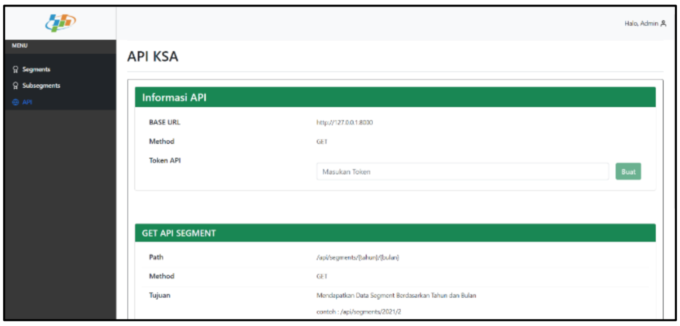

Figure 13. API information page on the ASF dummy system

Implementation of the data request page on the Paddy Commodity Cropping Sampling System can be seen in Figure 14.

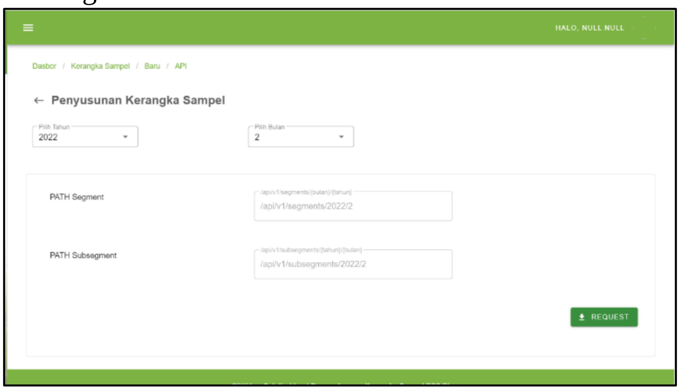

Figure 14. Data request page on the Paddy Commodity Cropping Sampling System

Implementation of data request page on CAPI Cropping dummy system is shown in Figure 15.

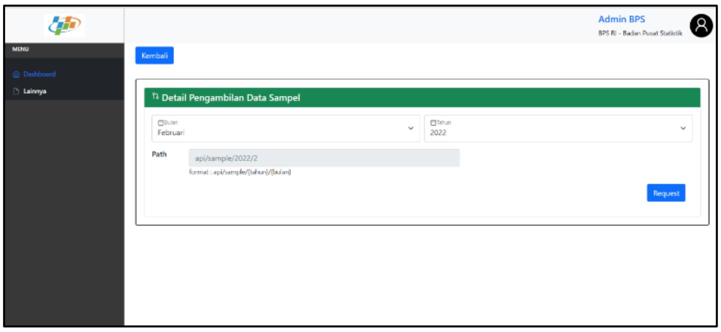

Figure 15. Data request page on CAPI ubinan dummy system

Implementation of Button Flow in the Cropping System can be seen in Figure 16.

Figure 16. Button flow to change the paddy observation code

Based on Figure 16, the flow of the button to change the observation code is the first user to arrange a pre-existing sample frame on the Paddy Commodity Cropping Sampling System then the button will change to change the observation code. The process of changing the observation code is carried out in accordance with the flowchart of the proposed process. After that, the button will change to view and can be used to view data on the results of the preparation of the sample frame and the results of changing the paddy observation code.

The results of the implementation of changing the code of paddy observations before and after are shown in Figure 17 and Figure 18. In Figure 17, it can be seen that in the strata column there is still a value of S12 and in the phase column the value of paddy observations is 3. The experiment was carried out using the same data, the process of changing the code of paddy observations in the ubinan system successfully changed the value of subsegments in phase 3 to phase 9 and changed the value of strata S12 to S1 as shown in Figure 18.

NKS	Kode Provinsi	Kode Kabupaten	Kode Kecamatan	Provinsi	Kabupaten	Kecamatan	Lokasi	Kode Segmen	Strata	Fase
1110011	11	01	010	ACEH	KABUPATEN SIMEULUE	TEUPAH SELATAN	LABUHAN JAYA	01	S12	3
1110012	11	01	010	ACEH	KABUPATEN SIMEULUE	TEUPAH SELATAN	LABUHAN JAYA	01	S12	3

Figure 17. Before changing the paddy observation code

NKS	Kode Provinsi	Kode Kabupaten	Kode Kecamatan	Provinsi	Kabupaten	Kecamatan	Lokasi	Kode Segmen	Strata	Fase
2110011	11	01	010	ACEH	KABUPATEN SIMEULUE	TEUPAH SELATAN	LABUHAN JAYA	01	S1	9
2110012	11	01	010	ACEH	KABUPATEN SIMEULUE	TEUPAH SELATAN	LABUHAN JAYA	01	S1	9

Figure 18. After changing the paddy observation code

7) System Testing and Evaluation

Testing and evaluation of the system built in this study was carried out using the black box testing method and the System Usability Scale (SUS). Black box method testing is done to see the success of each function in the system [27]. In this study, the black box testing method was carried out by two students majoring in Statistical Computing at the STIS Statistical Polytechnic. The conclusion that can be drawn is that each scenario in black box testing has run as expected.

This research system testing process uses System Usability Scale (SUS) testing. The SUS questionnaire filling process was carried out on June 28-29, 2022 with the results shown in Table 1.

Table 1. SUS test results

Respondents	Question-										Score
	1	2	3	4	5	6	7	8	9	10	
1	5	1	5	5	5	2	5	1	5	2	32
2	4	3	3	4	4	2	4	2	4	4	24
3	4	2	4	2	4	1	4	2	5	2	35
4	4	2	5	2	3	2	4	2	4	1	31
5	4	2	5	3	3	3	5	2	5	3	29

Based on Table 3, the average SUS score for five respondents from the Central Bureau of Statistics (BPS) employees was 75.5. According to the U.S. General Services Administration [28], SUS scores that have values above 68 can be considered as above average scores. Therefore, the proposed system developed is feasible to accept and use because the average SUS score obtained is above 68.

IV. CONCLUSION

Based on the research that has been done, the following conclusions are obtained. The addition of features to change the paddy observation code and data preparation in the Paddy Commodity Cropping Sampling System can assist officers in carrying out these activities. The system provides architectural design recommendations on the ASF System to the Paddy Commodity Cropping Sampling System using a web service where the ASF System has an API that can send segment and subsegment data with JSON data format and has an API security using API tokens and the Paddy Commodity Cropping Sampling System requests data from the ASF system using the GET method then stored in the system database in the form of a sample frame.

The system also provides recommendations on the architectural design of the Paddy Commodity Cropping Sampling System to the CAPI Cropping System using a web service where the Paddy Commodity Cropping Sampling System provides an API that can send sample data in JSON data format with system security using API tokens and the CAPI Cropping System requests data from the Paddy Commodity Cropping Sampling System using the GET method then the CAPI Cropping system stores sample data into the database.

The black box test results obtained are the system can run as expected. The test results using SUS with a score of 75.5 resulted in a score above the average and it was concluded that the system could be accepted by the subject matter.

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