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Geographic Information System for Mapping Agricultural Technology Dissemination

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ABSTRACT

Indonesia, with its wealth of natural resources and strategic position, is still lagging behind in several areas. Differences in topography, such as high and low plains, slopes and mountains, as well as geographic locations between seas, islands and mountains, trigger difficulties in accessing information for farmers. Other factors such as culture, level of education, culture, economy, low quality of human resources, and limited facilities and infrastructure also play a role in the low level of adoption of agricultural technology. This shows the need for changes in development and dissemination approaches that are adapted to the characteristics of the local community and region. The relatively low socio-economic conditions of farmers spread throughout the archipelago and their diverse cultures also influence their accessibility to agricultural technology information. The Ministry of Agriculture's centralized and uniform programs, with the same dissemination patterns for all regions, have proven to be ineffective. This results in the loss of introduced technology after the program ends and farmers return to old ways. A special approach is needed so that agricultural technology information can be accepted and applied in everyday life. This approach must take into account the uniqueness and diversity of culture, social, political, work ethic and economy in each region. The development of a communication method for disseminating agricultural cultivation technology based on user mapping is a solution to overcome this problem. This method can function as initial information and guidance in carrying out socialization and dissemination in the future. Geographic Information Systems (GIS) can be used as a tool in user mapping methods. GIS enables the collection, storage, and analysis of geographic information related to agricultural technology users. This can help in seeing the development of users over time, increasing their understanding, attitudes, skills and behavior regarding cultivation technology disseminated by extension workers/researchers. By using dissemination communication methods based on user mapping and utilizing GIS, it is hoped that agricultural technology information can be conveyed effectively and on target, so as to increase technology adoption and encourage progress in the agricultural sector in Indonesia. The approach used in working on this system is Predictive Software Development Life Cycle (SDLC), this is based on the assumption that human resources, costs and flexibility are sufficient. Using a predictive SDLC approach can also save costs and time in returning to the previous phase..

Keywords:

Agricultural Technology Dissemination, Mapping, Geographic Information Systems (GIS), Agricultural Technology Adoption, Farmer Well-being, Sustainable Agricultural Development

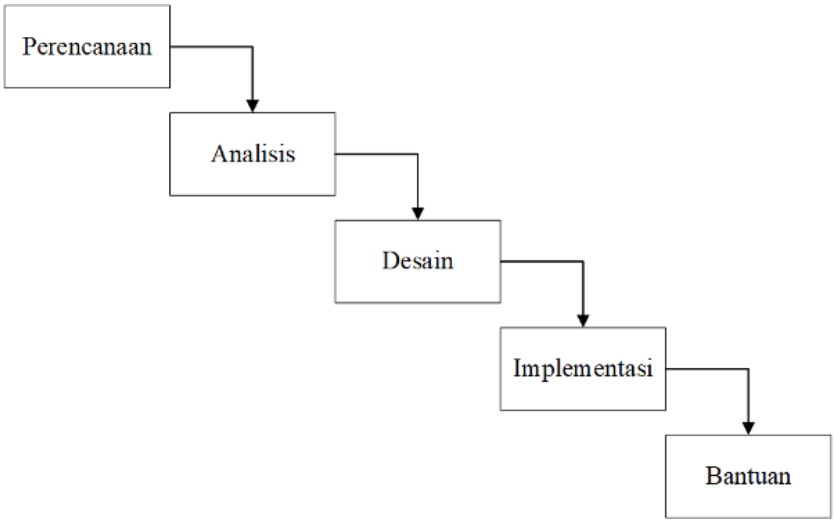
INTRODUCTION

Indonesia is a country that is rich in natural resources and has a very strategic position, but some regions are still lagging behind, considering the differences in topography of several regions such as high and low topography, sloping or hilly, as well as between the sea, islands and mountains resulting in it is difficult for farmers to access adequate information for their needs. Apart from natural conditions, culture, level of education, culture, economy, low quality of human resources, and limited facilities and infrastructure are very different from one district to another. This situation plays a real role in the high and low adoption rates. Therefore, it is necessary to change the development approach (change to the dissemination approach) differently, according to the characteristics of the local community and area.

The socio-economic status of farming communities spread across the archipelago is relatively low, making it difficult to purchase technological inputs in a timely manner. Very diverse cultures also influence the work ethic of farmers, this situation influences farmers' accessibility to agricultural technology information. Of the many forms of programs carried out by the Ministry of Agriculture, basically it adheres to one pattern, namely a centralized dissemination system, which means one for all regions. The same treatment in clearly different recipient conditions. As a result, it was found that almost all locations that had received assistance had disappeared without a trace along with the end of the project. Technology that was used during a Ministry of Agriculture program, after the program or project ended, farmers returned to using old methods. It is deemed necessary to have a special approach so that agricultural technology information can be accepted and implemented in everyday life. Cultural, social, political, work ethic and economic diversity are very different from one district to another and even adapt to the characteristics of the local community and region. From the explanation above, it is deemed necessary to develop a communication method for disseminating agricultural cultivation technology based on user mapping, which can function as initial information and as a guide in carrying out socialization and dissemination in the future.
Geographic Information Systems (GIS) are computer-based systems used to store and manipulate geographic information. GIS is designed to collect, store and analyze objects and phenomena where geographic location is an important or critical characteristic to be analyzed. Thus, GIS is a computer system that has the following four capabilities in handling geographically referenced data: input, data management (data storage and retrieval), data analysis and manipulation, output. Based on these capabilities, GIS can be used to see the development of users over time, increasing their understanding, attitudes, skills and behavior regarding cultivation technology disseminated by extension workers/researchers.

METHOD

The approach used in working on this system is Predictive Software Development Life Cycle (SDLC), this is based on the assumption that human resources, costs and flexibility are sufficient. Using a predictive SDLC approach can also save costs and time in returning to the previous phase. The flow diagram of the GIS development stages is shown in Figure 1.



The steps for developing a geographic information system in Figure 1 are explained as follows:

Planning

At this stage, planning is carried out for system development. The planning carried out is scheduling and paying attention to risks that must be anticipated in order to reduce errors at the next stage.

Analysis

At this stage, the needs and scope of system development are defined. The features that will be developed will focus more on system functionality, in the form of:

Information/data on the dissemination of agricultural technology

Interactive map display that can be updated when there are changes by agricultural technology dissemination researchers/researchers

Recommendations for improving the dissemination of agricultural technology in an area

Filtering the features/data you want to display

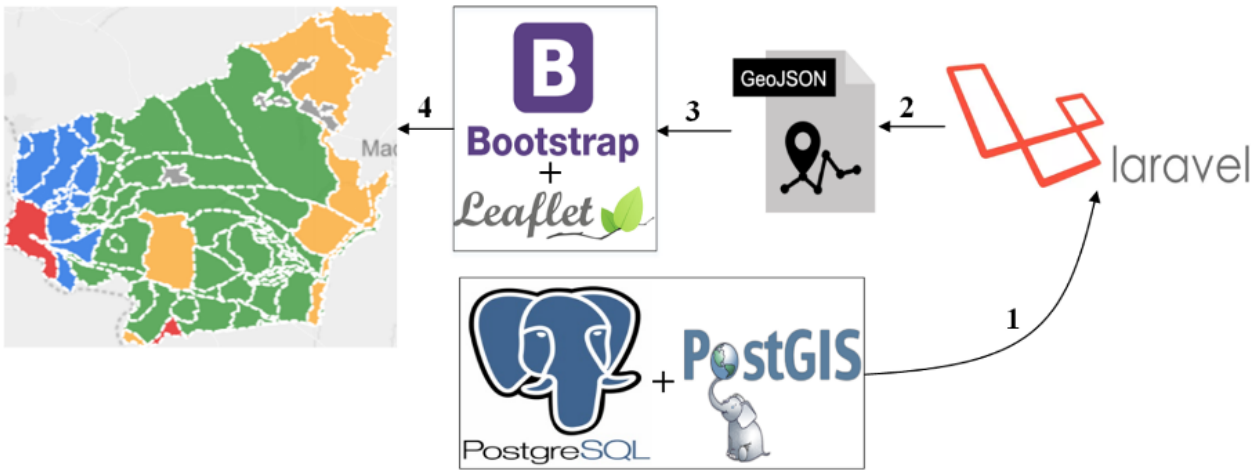
Design

After carrying out the analysis, the next step is to create a system design based on the data obtained from the analysis. The system design will be created using flowcharts, use case diagrams, class diagrams, and sequence diagrams to represent the process flow in the system.

Implementation
At this stage, construction of the system is carried out based on the model that was created at the analysis and design stage. The implementation stage includes:
Creating a database based on a design that has been created on the PostgreSQL DBMS with the PostGIS extension
Creating a web-based system interface
Implementation of the model on a web-based system
After construction is complete, black box testing will be carried out on the system that has been developed. Testing using the black box method includes:
Incorrect or missing functions
Interface error
Errors in data structures or external database access
Performance error
Initialization and termination errors

Help
This stage is the final stage of improvements that may need to be made, so that the system will have the best performance. This stage is carried out by perfecting the system until it is ready to be used in the form of a web-based GIS for agricultural technology dissemination.

RESULTS AND DISCUSSION
In this paper, we will focus more on developing interactive maps based on analysis of existing agricultural technology dissemination. Visualization of agricultural technology dissemination maps is carried out by building a Geographic Information System (GIS) in the form of a web base with the help of the Laravel framework and leaflets. The creation of a GIS is expected to help users map agricultural technology that still needs to be improved based on five factors, namely farmer characteristics, innovation characteristics, physical environment, social environment, quality of institutional services. The GIS architecture for agricultural technology dissemination that will be built can be seen in Figure 2.



The stages of the land suitability GIS architecture in Figure 2 are explained as follows:

Stage 1, perform a spatial query (request) from Laravel to access using the Query Bulider feature in Laravel.
Stage 2, converting the spatial data resulting from the request into Geographic Javascript Object Notation (GeoJSON) spatial data using the ST_AsGeoJSON function.
Stage 3, converting GeoJSON spatial data into Javascript Object Notation (JSON) data using the json_encode feature in Laravel.

Stage 4, visualization of the spatial map in JSON form using the help of leaflets wrapped in a web base display by bootstrap.

Dissemination Information map

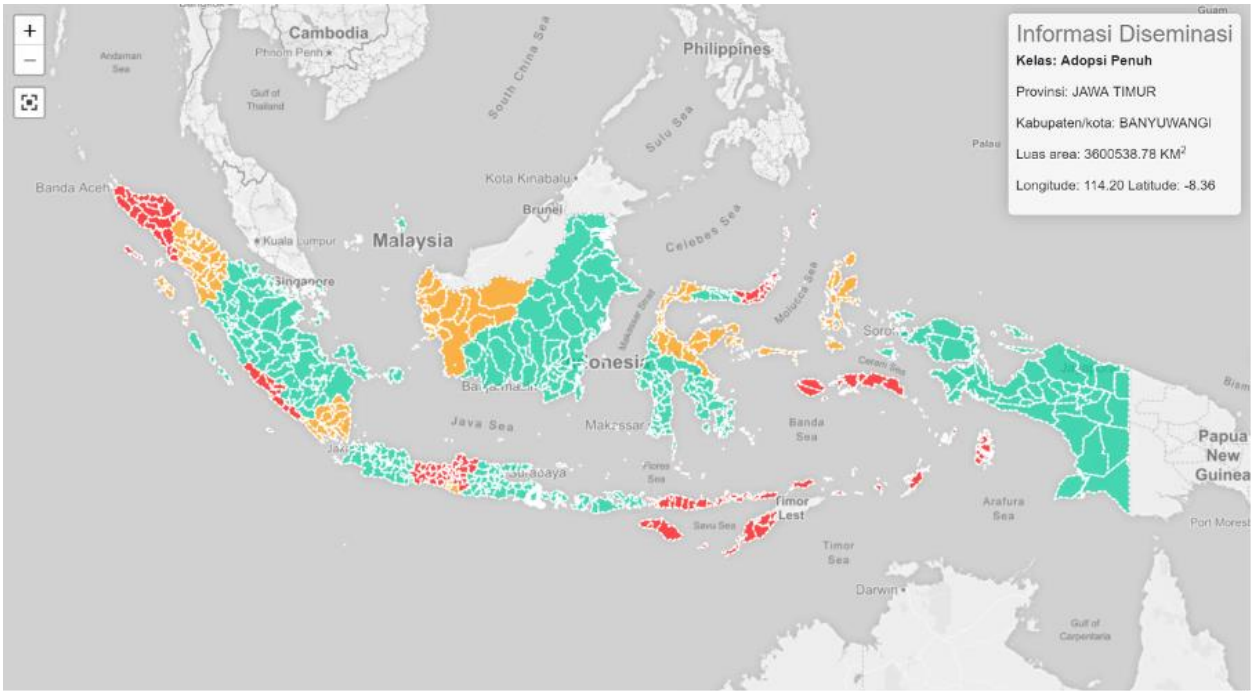


Figure 3 shows the Information Dissemination map

for the red map it shows the percentage of rejection dissemination, for the green map the percentage of full Adoption dissemination, for the yellow map the percentage of partial Adoption dissemination in Banyuwangi Regency the dissemination percentage shows full Adoption.

Maps page design

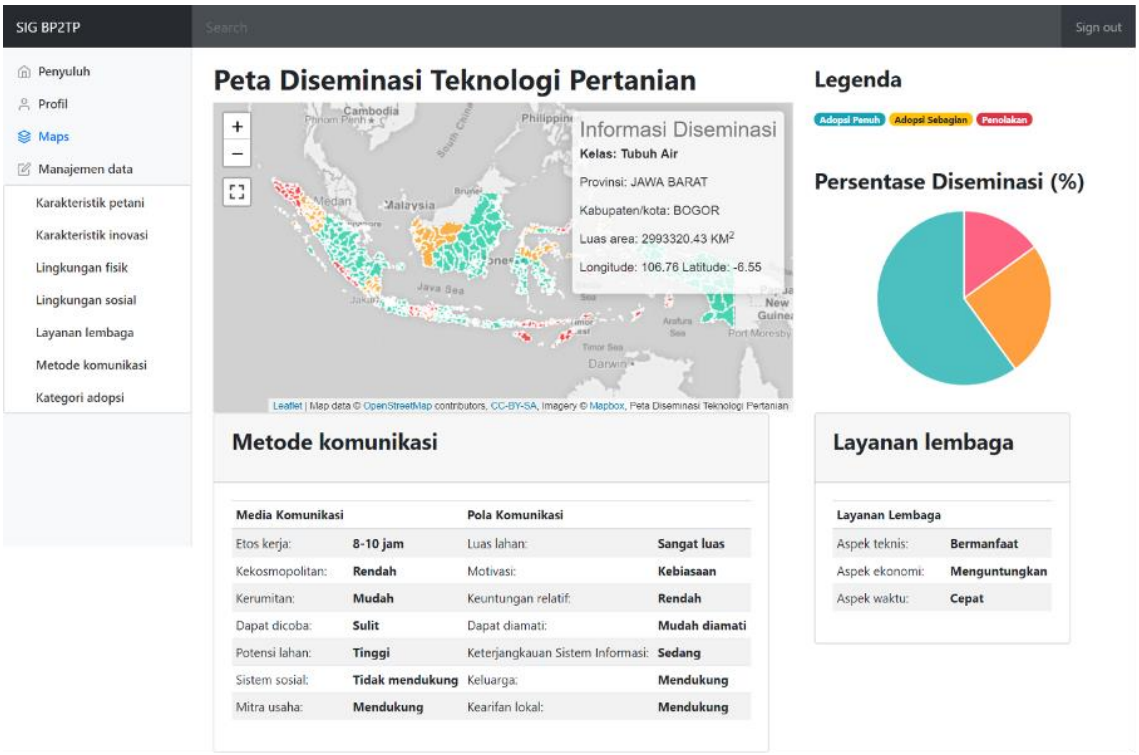


Figure 4 Maps page design

Maps page design This page is designed to make it easier to display data, the data contains maps of agricultural equipment technology dissemination. The information displayed is in the form of class, province, district, area, longitude. On the page there is a pie chart showing the dissemination presentation, the green diagram shows full adoption, the orange diagram shows partial adoption while the pink one shows rejection. This page displays data on communication methods and institutional services.

Design a data management page that displays farmer characteristics

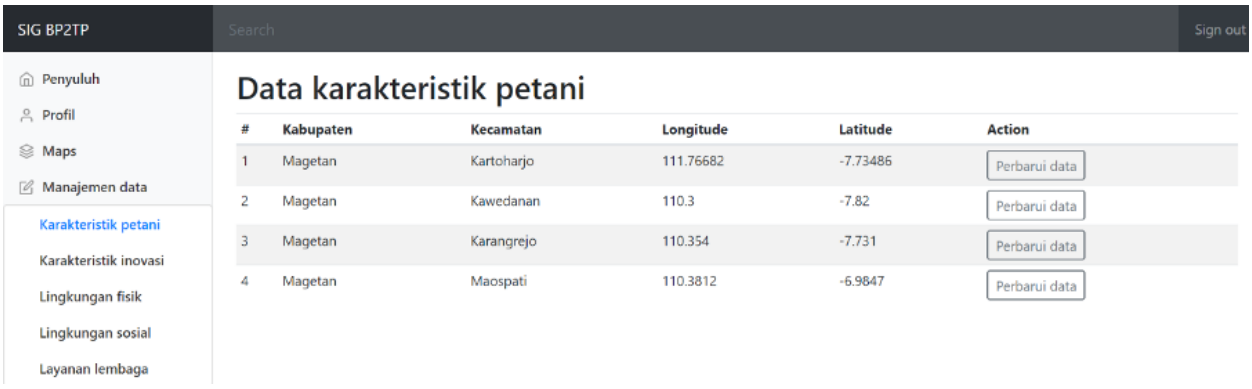


Figure 5 Design a data management page that displays farmer characteristics

Design a data management page that displays farmer characteristics in table form containing district, sub-district, longitude and latitude data. On this page the data can be updated according to the owner

Design a update farmer characteristics data

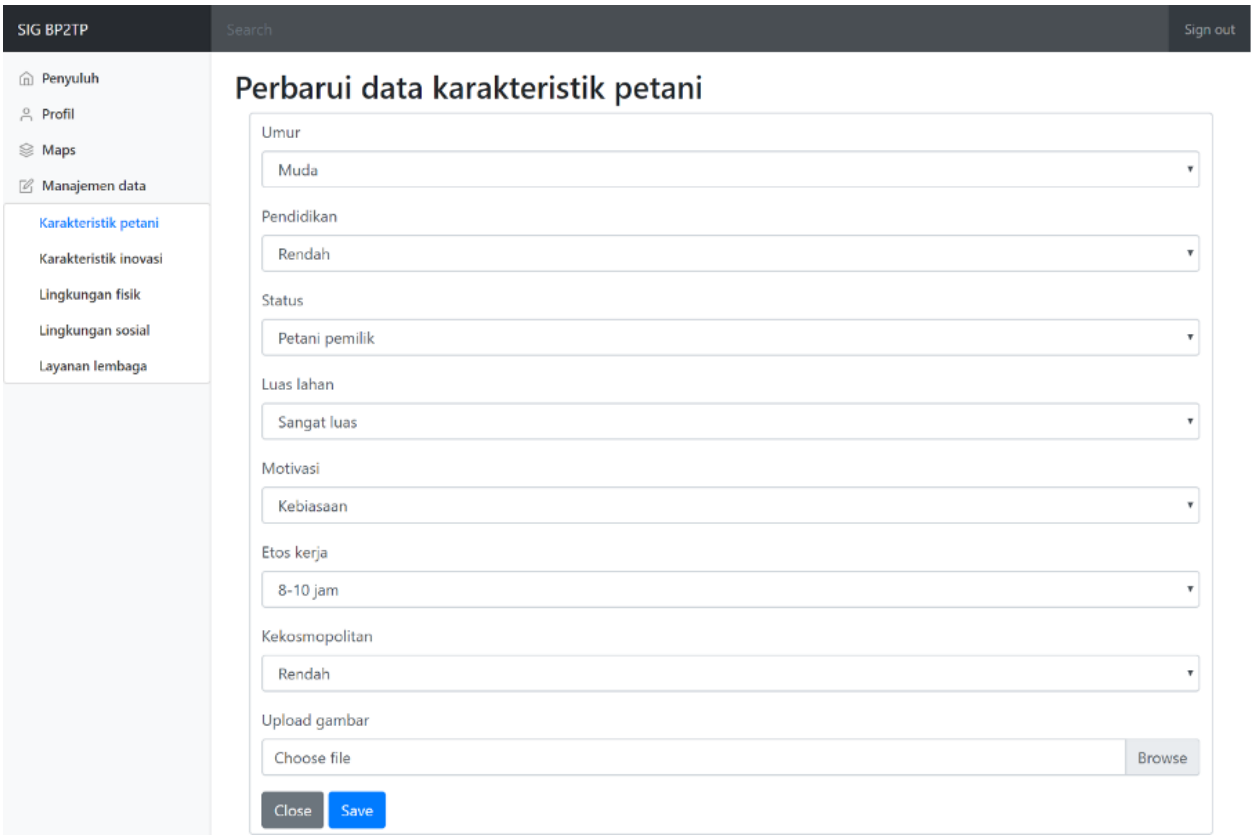


Figure 6 update farmer characteristics data

Design a data management page that displays farmer characteristics in table form containing district, sub-district, longitude and latitude data. On this page the data can be updated according to the owner

CONCLUSION

The socio-economic status of farmers scattered throughout the archipelago is relatively low, leading to difficulties in accessing agricultural technology inputs in a timely manner.

The diverse culture also influences the work ethic of farmers, which in turn affects their accessibility to agricultural technology information.

Programs implemented by the Ministry of Agriculture tend to follow a centralized dissemination system, which may not always be effective due to the diverse conditions of the recipients.

A change in dissemination approach is necessary to align with the characteristics of local communities and regions to enhance the adoption rate of agricultural technology.

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REFERENCES

Smith, J. D., & Johnson, A. B. (2017). The impact of agricultural technology on small-scale farmers in developing countries. Journal of Agricultural Economics, 65(3), 789-802.

Brown, C., & Miller, P. (2015). Enhancing agricultural extension services through geographic information systems. Journal of Extension, 53(2), 1-10.

Nguyen, T. H., & Tran, L. T. (2013). Adoption of agricultural technology among smallholder farmers in Vietnam: A case study. Agricultural Economics, 47(4), 521-535.

Li, W., & Wang, H. (2012). Geographic information systems for sustainable agriculture development: A review. Computers and Electronics in Agriculture, 85, 1-10.

Garcia, R., & Martinez, E. (2011). The role of culture in agricultural technology adoption: A case study in

Latin America. Journal of Agricultural and Resource Economics, 36(2), 345-358.
Kim, S., & Lee, J. (2010). Spatial analysis of agricultural technology dissemination in South Korea. Applied Geography, 30(4), 567-578.
Jones, M., & Smith, R. (2009). The impact of social and economic factors on agricultural technology adoption in sub-Saharan Africa. World Development, 37(10), 1634-1642.
Wang, Y., & Zhang, L. (2008). Geographic information systems and their applications in agriculture: A review. Journal of Agricultural Science and Technology, 10(3), 123-136.

BIOGRAPHIES OF AUTHORS

Tegar Karangga has a strong interest in web creation and is currently working on a research paper entitled "Geographic Information System for Mapping Agricultural Technology Dissemination".