VOL. 22 (1) (2025), 88-96-ISSN: 693-7554, e-ISSN:2654-3990

The Application of Geographic Information System (GIS) in Food Distribution Across Indonesia

Abdus Syakur[1*], **Budi Setiawan**[2]

1,2 Information System, Computer Science & Information Technology, Gunadarma University, West Java, 16424, Indonesia

Abstract

Food distribution and the food supply chain are major issues in achieving food security in Indonesia. Geographical disparities, poor transportation systems, and social differences in Indonesia cause high complexity challenges in implementing a perfect distribution system that suits Indonesia's characteristics. The objective of this study is to build an application for a food distribution using a Geographic Information System (GIS) that can be implemented in Indonesia. The research method is the SDLC (System Development Life Cycle) approach with a Prototyping Model. The data collected consisted of spatial data in the form of Indonesian maps with the provinces as the mapping unit, and each province has a capital city that acts as a center point for food distribution. Attribute data consisted of province's profiles, food productivity for each commodity, food supply, food sources and food exports. GIS can visualize all data layers into maps that are easier to analyze. Indonesia consists of 38 provinces spread across many islands, and each has its specific geographic profiles and transportation problems. Building a food distribution application is part of developing a food distribution system that produces a system prototype. The prototyping approach is used to evaluate the results of the GIS design by analyzing the features of food distribution in Indonesia. The result of this study is an application that can be implemented into a food distribution system that can create stable food security in Indonesia for all provinces.

Keywords: *Food Distribution; Food Security; Geographic Information System; Food Distribution GIS Prototype*

1. Introduction

Food needs are basic human needs that are very important and must be met by the government and society together. Law No. 7 of 1996 mandates that the government be the party that organizes the regulation, development, control, and supervision of food needs, while the community is the party that collects the production and provision process, trade, distribution, and acts as a consumer. To meet food needs, a food management system is needed that can protect those who consume and produce food; a good food management system must be able to meet basic human needs that provide benefits somewhat, evenly and sustainably based on food sovereignty, food independence and food security. [1]

According to Law No. 18 of 2012 concerning food, the state has the freedom to determine its food policy independently, which cannot be dictated by any party, and food business actors have the freedom to decide and carry out their business according to the resources they have. To meet food consumption, 3 main things must be considered, namely: a). Food availability based on optimal utilization of local resources; b). Food affordability from physical and economic aspects by the entire community; and c). Utilization of food or consumption of Food and Nutrition for healthy, active, and productive living. [2]

Realizing food availability based on optimal use of local resources is carried out by diversifying food and prioritizing domestic food production. Realizing food affordability from physical and economic aspects is done by managing the stabilization of supplies and prices of staple foods, managing staple food reserves,

*Corresponding author. *E-mail address:* syakur@staff.gunadarma.ac.id
Received: 13 January 2025, Accepted: 20 January 2025 and available online 31 January 2025
DOI: https://doi.org/10.33751/komputasi.v19i2.5260

and distributing staple foods. In realizing food availability, based on Law No. 18 of 2012 concerning food, the government and regional governments must implement government policies in distribution, marketing, trade, and stabilization of supply and prices of Staple Food and Food Assistance. [3]

Food distribution is necessary to distribute food commodity products from producers so that they reach consumers on time and in sufficient quantities and are affordable for people's purchasing power. Based on Law No. 18 of 2012, food distribution is carried out to ensure equal distribution of food availability throughout the territory of the Unitary State of the Republic of Indonesia sustainably. Food distribution is carried out so individuals can obtain sufficient, safe, quality, diverse, nutritious, affordable food. The government and regional governments are responsible for food distribution by their authority.

The law on food states that food distribution is carried out by developing a food distribution system that reaches all territories of the Unitary State of the Republic of Indonesia effectively and efficiently. Management of a Food distribution system that can maintain safety, quality, and nutrition and does not conflict with the community's religion, beliefs and culture is also carried out to realize the smooth and safe distribution of Food. Delivering food commodity products from the producer level often has to go through a chain of food distribution actors to reach the final consumer. In this case, the distribution aspect plays a very important role in the stability of national food prices.

Food distribution problems often occur due to differences that create gaps between production and consumption, between demand and supply, and, among other things, geographical gaps, time gaps, and communication and information gaps. The availability of food distribution data and information that is valid, updated and easily accessible is one effort to anticipate distribution problems caused by this gap. Data analysis can be carried out as an anticipatory step and as a material for making price stabilization policies and food supply policies. However, the availability of valid, updated, accurate, integrated and consistent data from each region regarding food distribution is still inadequate, so it isn't easy to realize effective and efficient food distribution to realize equal distribution of food throughout the territory of the Republic of Indonesia. [4]

Other researchers have used GIS for mapping food distribution. The main aim of this research is to evaluate the performance of the Integrated Food Distribution Network in Sweden. Location and route analysis was conducted using data from 11 manufacturers, 149 manufacturers, and one distribution centre. GIS is used in this research for site analysis [5]. GIS has also been used in Kenya to handle food emergencies. This study was conducted by Moturi and Benjamin Otieno (2013), who presented a framework for food emergency response and demonstrated using GIS as a solution for planning and managing food emergencies. This is especially important in certain countries, such as Kenya, where there is no unified communications framework to facilitate the management of food emergencies. [6]

Charlianto, Edi Purnomo Putra and Mikha Mangudu (2015) designed a database to support a data warehouse prototype at the Food Distribution and Reserve Center, Ministry of Agriculture, as an integrated historical data storage medium originating from several data sources. The data warehouse is used as a support to help upper-level management make the right decisions in an agency with the help of an interface in the form of a pivot table and/or a flexible report where you can view reports from various points of view and drill down. The Warehouse data produced still requires additional tools to analyze gaps arising from distribution problems. These tools can analyze geographic gaps where food distribution can be studied more validly and accurately by analyzing the layers in the geographic information system. [7]

Based on the literatures, it can be formulated that the food distribution problem really requires a geographic information system for food distribution network maps that can collect valid, updated, accurate, integrated and consistent data. Where the data obtained comes from all distribution activities in each region which functions to assist the government in making decisions and/or creating new policies.

Developing a geographic information system for food distribution network maps can be optimized through data collection in stages at the central and regional levels. Apart from that, presenting food distribution data as a network map is very helpful in analyzing the system more effectively because the location conditions in Indonesia are very large and have various constraining factors. By studying food distribution network maps, location information, distance between locations, and geographic conditions can be more easily identified. To get more complete, valid and integrated analysis results, Geographic Information Systems (GIS) are the most appropriate solution to the above-mentioned problems.

Generally, this research aims to develop a Geographic Information System (GIS) for food distribution analysis so that a food distribution database and application can be used to analyze, manage and present data as a Food Distribution Network Map. So that a food distribution database and application can be used to analyze, manage and present data as a Food Distribution Network Map.

Specifically, Information that will be processed will include the food commodities to be analyzed are taken from the 2015 – 2019 Food Security Agency Strategic Plan: Rice, Red Chilies and Shallots.

This research is significant to carry out to support the achievements of the Higher Education Research Strategic Plan, especially in the superior fields of information and communication technology.

2. Methods

Methodology is the method or technique used in preparing the grand design by the activities to be carried out. Thus, this implementation method is attached to each activity planned in developing a Geographic Information System for Food Distribution Analysis.

The methodological approach used in developing a Geographic Information System for Food Distribution Analysis is the SDLC (System Development Life Cycle) approach with a Prototyping Model as shown in Figure 1. This SDLC consists of planning, analysis, design, implementation, and system testing using a prototype system.

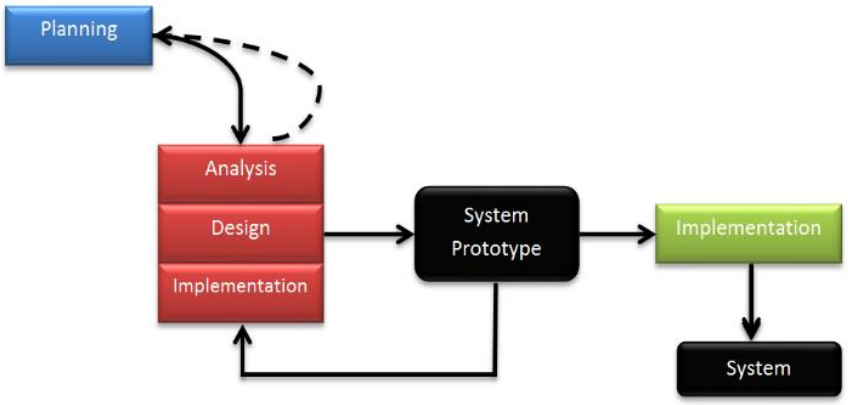

Figure 1. SDLC Diagram

2.1 Method of collecting data

The method or method of obtaining data greatly determines the accuracy of the data produced. This is useful for preventing imbalances between the conditions in the field and the resulting planned products. Determining how to collect data depends on the data needed.

a. Data Collection.
   Based on the data type, data collection activities through surveys are carried out through Institutional Data Surveys, namely survey activities aimed at obtaining secondary data. This survey activity was carried out at several agencies/institutions through written data requests.
b. Data Requirements.
   Secondary data is collected through policy documents and other written data. The data sources used in selecting indicators and variables in the development of this Geographic Information System for Food Distribution Analysis are:
   1. Updated Spatial Database (Map) of Indonesia with provinces and their capital cities as distribution point
   2. Attribute database obtained from related agencies such as the Department of Agriculture and the Central Statistics Agency (BPS): province's profiles, food productivity for each commodity, food supply, food sources and food exports
c. Data Processing and Analysis Activities.
   Data is a collection of values that reflect the characteristics of objects in a population. Data can be numbers, letters, sounds or images. From this data, it is hoped that as much information as possible will be obtained about the population. Thus, knowledge and mastery of analytical methods are required to extract the information in the data held. Statistics, as a branch of science that provides various techniques and methods of analysis, has provided multiple methods with different uses. Knowing the uses of these various techniques is necessary to avoid inappropriate use.

As with other activities, there must be preparation to move on to the next stage. Every analysis method must begin with a data preparation stage. This data preparation stage is carried out with the aim of:

1. Know the general characteristics of the data you have, for example, what variables you have, the data types of each variable and so on. This knowledge is needed to determine what methods can be used later.
2. Filter the data to be used in the analysis. Before carrying out further analysis, we must be able to filter the existing data. Not all the data may be used, but only some.
3. Correct data errors. It is not uncommon for errors in existing data to occur. So, at the data preparation stage, it must be ensured that errors like this do not happen.

In each stage of data analysis, it will always be cross-tested with other stages. Cross-testing is intended to maintain the completeness and consistency of the data. Meanwhile, for data objectivity, triangulation will be carried out between data sources. All data obtained will be presented as is. Then, categorization is carried out based on the validation model that has been developed, and reproduction is carried out to find the ideal approach pattern in program development.

Preparation and data analysis, which include:

1. Data Preparation includes the main steps that must be taken, including preparation of infrastructure and facilities for data processing, data entry and editing, calculating sampling weight, cleaning data and creating files, archiving data and working on tabulations.
2. Data Analysis includes understanding data categorization, descriptive and multivariate analysis approaches and calculations of various statistics.

This discussion formulates matters related to the development of a Web-Based Geographic Information System for Food Distribution Network Maps, namely existing policies related to food distribution. It is hoped that the final result will be the Grand Design of a Geographic Information System for Food Distribution Analysis.

3. Result and Discussion

Stages of Making a GIS-based food distribution application prototype using the SDLC (System Development Life Cycle) methodology. The main stages of SDLC are planning, analysis, design and implementation, with the following descriptions:

3.1 Planning

The planning stage of making a GIS-based food distribution application is carried out to formulate short-term and long-term goals of GIS-based food distribution application. In addition, the needs of this activity are identified so that all stages can run well. The details of the planning stages are as follows:

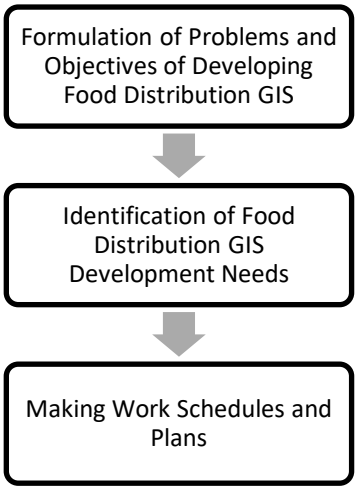

Figure 2. Planning Stages

The planning stage begins with formulating the problems of food distribution in Indonesia which are (i) availability; (ii) access; and (iii) affordability [ ].These problems specified the main objective for this research. Second stage prescribing the needs for all developing stages, from planning, analyzing, designing until implementation stages. The planning stage is closed with creating the work schedule and plan for getting the precise result.

3.2 Analysis and Design

After formulating the problem, identifying needs and making a schedule and work plan, the next stage is Analysis. At this stage, what

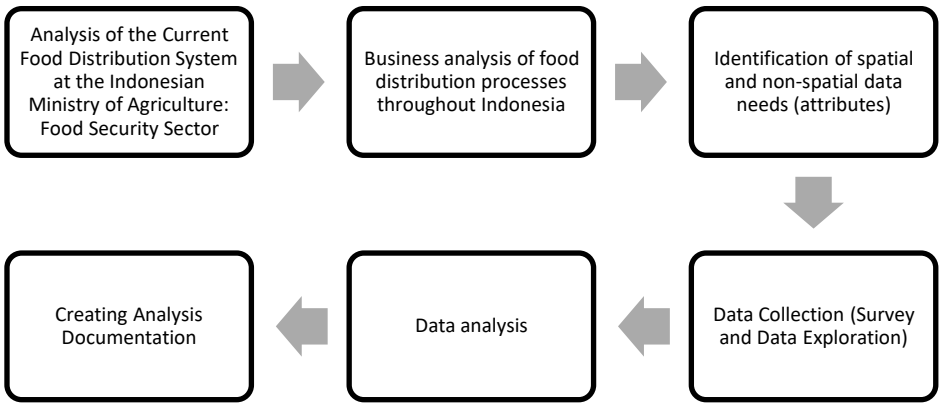

Figure 3. Analysis Stages

The method of obtaining data greatly determines its accuracy. This is useful for preventing imbalances between conditions in the field and the planned products produced. The method of data collection is very dependent on the data needed.

1. Data Collection Activities.
   Based on the data type, data collection activities through surveys are carried out through Institutional Data Surveys, namely survey activities aimed at obtaining secondary data. This survey activity is done through written data requests at several agencies/institutions.
2. Data Needs.
   The secondary data collected is data in the form of policy documents and other written data. Data sources used in selecting indicators and variables in the development of Geographic Information Systems for Food Distribution Analysis.

The data collected at this stage is spatial data in the form of a base map of Indonesia, maps of provinces throughout Indonesia and the coordinates of the capital city points of each province. Non-spatial data includes food distribution data from and to each province, along with the amount or volume. The image of the base map of Indonesia and its provinces can be seen below:

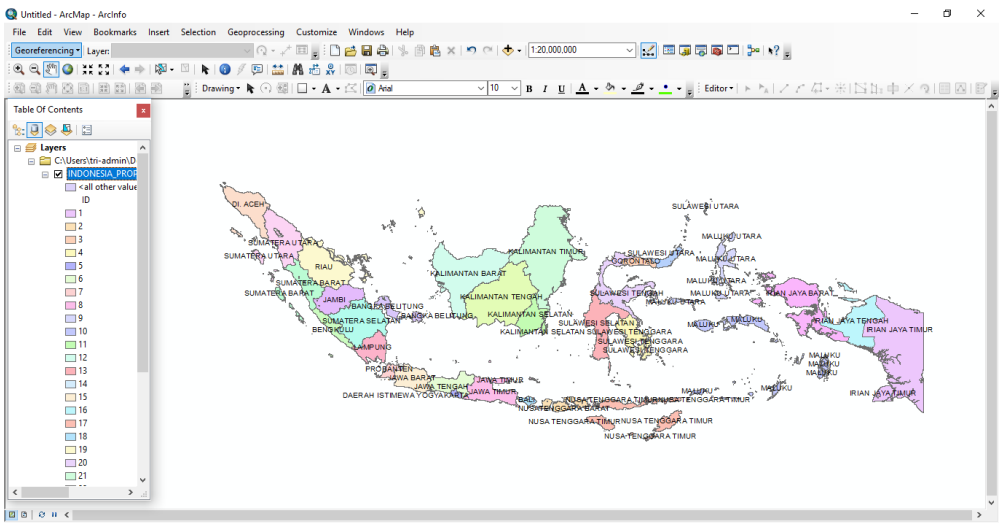

Figure 4. Design and Creation of GIS-Based Food Distribution Application Prototype

Each image (photos, graphs, and diagrams) in the article must be accompanied by a caption/image title and sequential image numbers, written below the image in the middle position. Images must be directly relevant to the article and are always referenced in the article referred toas Figure 1, where the capital letters are capitalized.

At this stage, a GIS-based food distribution application is designed based on the results of the previous analysis. At this stage, a prototype of the application is also made, which will be used as a model for the GIS-based food distribution application. The prototype was built using Java and JFlowMap. The stages are:

1. Coding using Java
2. Inputting the map that has been processed in ArcMap10 in JFlowMap
3. Inputting attribute data in CSV file format
4. Compiling

The initial appearance of the prototype is as follows:

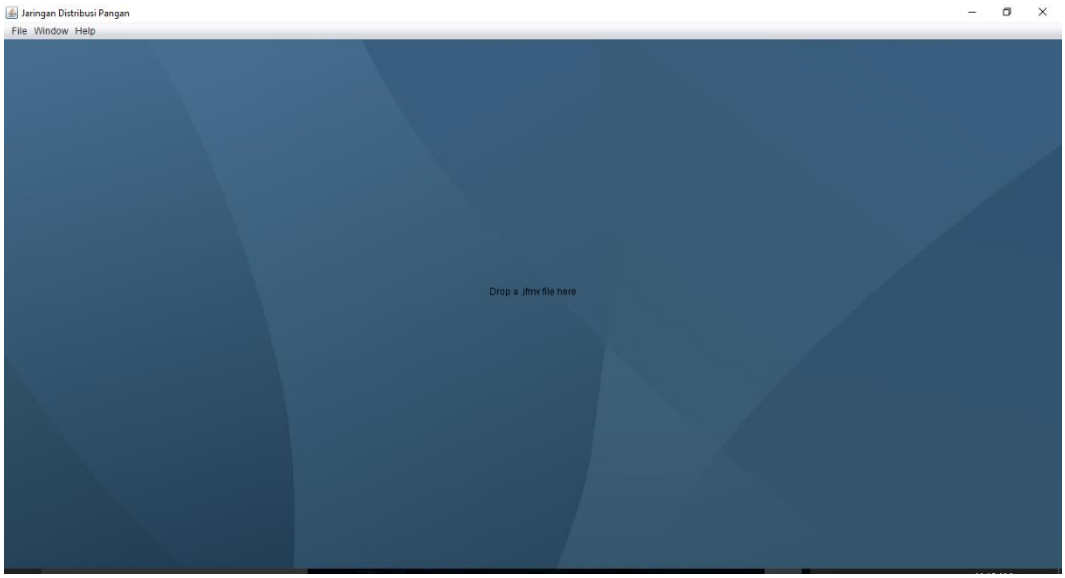

Figure 5. The initial appearance of the prototype

Then select the file to display the commodity map (rice, red chili or onion); if you select the rice file, the following will appear:

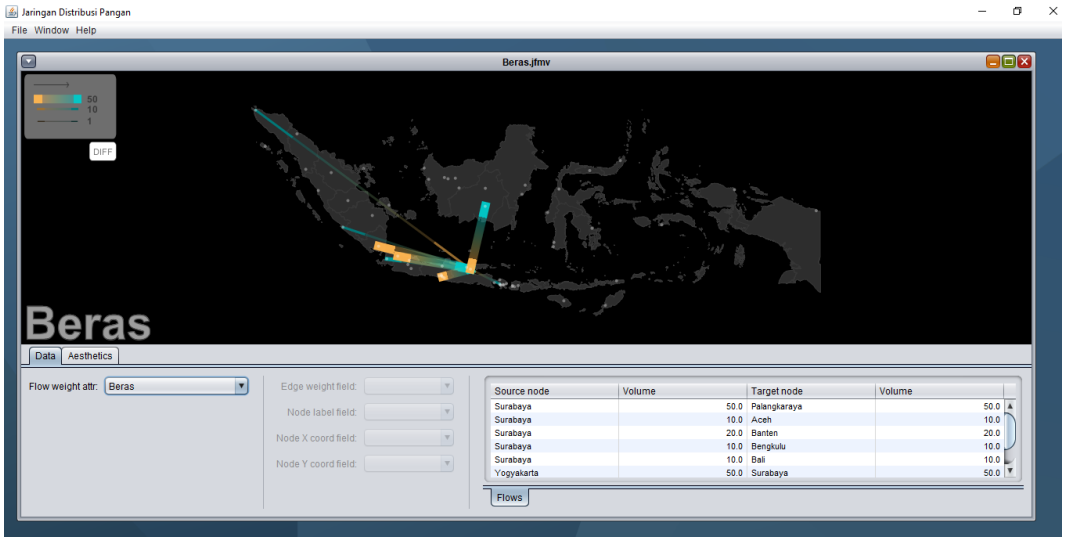

Figure 6. Display the commodity map

The above view is a map of rice distribution in Indonesia; the top view is the map, and the bottom panel is the data. In the bottom panel, there are Aesthetics to change the background color and schemes of the application, for example:

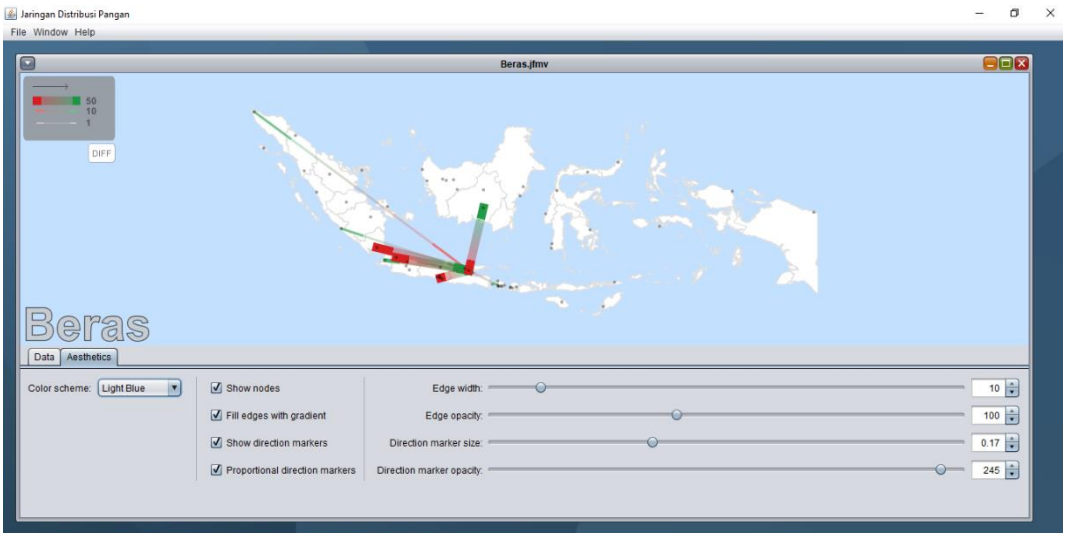

Figure 6. Scheme Options

Scheme color identified the commodities; each color can be assigned to one type of commodity. All options are: Dark, Light, Black on White, Light Blue, Inverted and Grey Red Green. The same thing can be done to display other commodities.

3.3 Implementation

Implementation stage is finalizing all the stages in the developing the GIS-based Food Distribution Application. This stage converts the prototype to the build-in application which being construct with web based developing tools. The displays of the application are shown in these pictures:

Figure 7. Welcoming Page

Welcoming page is opening the GIS-based food distribution application with information about the application. It also shows the main menu that available in application, which are: Home, Data Searching, Food Distribution and Login. The food distribution feature can be shown in Figure 8.

Figure 8. Food Distribution Map

Food distribution map shows the map and distribution arrows that source and destination of the commodities. The page consists of 2 frames, the map and the attributes options. The attributes options are the tools to personalize the map. The user can analyse the map for many purposes.

4. Conclusion

The GIS-based Food Distribution Application was developed to address the food distribution problem caused by many factors affecting distribution channels and food reserves in each region. GIS has several thematic map layers that can be used to analyse food distribution. The GIS Food Distribution Network Map was deliberately built web-based to make it easier for users to use this GIS Food Distribution Network Map; in addition to not requiring special skills in the computer field, users can also perform better analysis because it is easy to use.

Hopefully, this application will add to the treasury and alternative methods and techniques for food distribution planning. In Indonesia, it is currently very complex, and using a geographical information system is expected to be the most effective solution. In addition, the application can provide solutions based on the results of food distribution analysis using a geographic information system that combines spatial data and attribute data so that the geographical gap problem will not be an obstacle.

5. Acknowledgement

This research is part of a superior university grant funded by the Ministry of Research, Technology and Higher Education. Thanks to the Food Security Agency of the Indonesian Ministry of Agriculture for the data and information.

References

[1] Y. Syafiullah, "Kebijakan Pangan Di Indonesia : Antara Swasembada Pangan dan Kecukupan Pangan," *Jurnal Ilmiah Bestari Edisi No 38/XXI*, 2008.

[2] Rusastra, I Wayan, Thompson, Geoff, Bottema, J.W. Taco,Baldwin, Robert,, "Food security and poverty in the era of decentralization in Indonesia," *CAPSA Working and Discussion Paper*, p. 199, 2008.

[3] P. Hariyadi, "INDUSTRI PANGAN: Menjawab Tantangan Ketahanan Pangan Mandiri dan Berdaulat," *FOODREVIEW Indonesia*, vol. IX, pp. 22-24, 2014.

[4] "Pusat Distribusi dan Cadangan Pangan Badan Ketahanan Pangan, 2015, Panduan AnalisisJaringan Distribusi, Kementerian Pertanian Republik Indonesia," 2015.

[5] Techane Bosona, Ingrid Nordmark, Girma Gebresenbet, David Ljungberg. "GIS-Based Analysis of

Integrated Food Distribution Network in Local Food Supply Chain," *International Journal of Business and Management*, vol. 8, no. 17, 2013.

[6] Moturi, Christopher A. and Benjamin Otieno, "ICT and Food Security : Case of GIS in Food Emergency Response," *International Journal of Applied Information Systems (IJAIS) – Foundation of Computer Science FCS*, vol. 6, no. 1, 2013.

[7] Charlianto, Edi Purnomo Putra, Mikha Mangudu, Harisno, "Perancangan Database UntukMendukung Prototype Data Warehouse Pada Pusat Distribusi Dan Cadangan Pangan," *Kementerian Pertanian, ComTech*, vol. 6, no. 3, 2015.

[8] D. WIDIYANTO, Geographical Study on Local Food Activities in Indonesia, Nagoya, Japan: Nagoya Repository, 2020.

[9] I. Ketut Sardiana, "Application of Geographical Information Systems (GIS) for Mapping Food Vulnerability in Denpasar, Bali," IOP Conference Series: Earth and Environmental Science, vol. 755, no. 1, p. 012020, 2021.

[10] G. T. D. O. P. Andi Syah Putra, "Food Security Challenges in Rapidly Urbanizing," Sustainability, vol. 12, no. 22, pp. 35-38, 2020.

[11] A. S. Putra, T. Guangji and O. P. Didit, "Food Security Challenges in Rapidly Urbanizing Developing Countries: Insight from Indonesia," Sustainability, vol. 12, no. 22, 2020.

[12] N. Hermita, A. T. Sumantri, R. A. Riyanto and A. Mulyaningsih, "Distribution Mapping of Rice, Corn, and Soybean Production Based on Geographic Information ystems in Pandeglang Regency," IOP Conference Series: Earth and Environmental Science, vol. 715, no. 1, p. 012006, 2021.

[13] A. H. M. Khalid, K. Mohamed and h. S. A. Aziz, "Geographical Indications In Malaysia And Indonesia: Enhancing Protections For Economic Growth And Cultural Heritage," ASEAN Legal Insights, vol. 1, no. September, pp. 33-53, 2024.

[14] I. S. Anugrah, J. Hestina, E. Suryani, S. Wahyuni and H. , "Kinerja E-Commerce Toko Tani Indonesia Dalam Pengembangan Distribusi Pangan," Analisis Kebijakan Pertanian, vol. 20, no. 1, pp. 49-71, 2022.

[15] B. R. Yulianti, S. and R. Priyono, "Master Plan Development And Others Supporting: Integrated Food Crop Commodities," AL-AMWAL: JURNAL EKONOMI DAN PERBANKAN SYARI'AH, vol. 15, pp. 35-46, 2023.

[16] A. R. Salasa, "Paradigma dan Dimensi Strategi Ketahanan Pangan Indonesia," Jejaring Administrasi Publik, vol. 13, no. 1, 2021.

[17] N. I. Fawzi and V. N. Husna, "Pemanfaatan Informasi Geospasial Untuk Ketahanan," Seminar Nasional Geomatika 2020: Informasi Geospasial untuk Inovasi Percepatan Pembangunan Berkelanjutan, vol. 1, 2020.