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ARTICLE

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Revealing Halal Certification Oversight Gaps for MSEs through ArcGIS Dashboard Integration

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Abstract: *The Indonesian government has developed a comprehensive halal certification program through the Halal Product Assurance Organizing Body (BPJPH). However, the halal certification recording application requires enhancements due to its lack of data elements pertaining to micro and small enterprises (MSEs) with geographical or location references. Geographic Information System (GIS) technology can serve as a solution for data management in the halal industry, encompassing the management, monitoring and analysis of spatial-temporal and real-time data. This research is aimed at developing geospatial technology for industrial halal management within the scope of MSEs. Methods for developing geospatial technology-based management of halal industry applications use analysis, design, development and evaluation through the ArcGIS online platform developed by Environmental Systems Research Institute (Esri). The findings of this research highlight the potential of geospatial technology in the halal industry. It can be effectively utilized to integrate and comprehensively manage halal industry data on a spatial basis, enabling performance monitoring of MSEs, halal product process assistance and the BPJPH. This technology allows for quick analysis of patterns, distributions, trends, associations and regional comparisons, providing valuable insights. Consequently, geospatial technology can support policy recommendations aimed at accelerating the halal certification process by mapping and analyzing relevant data based on geographic locations, facilitating a better understanding of spatial distribution and relationships within the halal industry. This research successfully develops geospatial technology for managing halal industries within MSEs, enabling comprehensive data integration and spatial analysis. The findings highlight its potential to enhance monitoring, support policy recommendations and accelerate the halal certification process.*
Keywords: *geographic information system, geospatial, halal certification*

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1. Introduction

Indonesia has the largest Muslim population in the world. Religious consumers with high religiosity tend to have different consumption patterns and prefer halal products and services (El-Bassiouny, 2014; Kurniawati & Cakravastia, 2023). Therefore, the halal food/ product sector is a crucial industry that not only fulfils religious requirements to feed around 87% of the Muslim population in Indonesia but also serves as an economic force both domestically and globally (Aslan, 2023; Pribadi et al., 2023).

In Indonesia, the Halal Product Assurance Organizing Body (BPJPH) issues halal certificates under the Indonesian Ministry of Religious Affairs. The process of certifying products or services in accordance with Sharia law is known as halal certification. The halal certification and verification system are considered a crucial component in assuring Muslim consumers regarding the quality of halal products. In Indonesia, there are two halal certification schemes carried out by two different institutions, namely the Halal Inspection Agency (LPH) for regular schemes and the Halal Product Process Assistance Agency (LP3H) for self-declaration scheme.

Furthermore, the utilization of halal certification in procurement encourages stronger partnerships with suppliers and the implementation of various strategies to ensure continuity of supply, which significantly impacts the purchasing process (Ali et al., 2021; Mahbubi et al., 2019; Rejeb et al., 2021). The largest proportion of the variance in product preference is explained by consumers' trust in halal certification from different Muslim and non-Muslim countries, followed by the interaction between country preference and country of origin brand name (Rios et al., 2014; Saville & Mahbubi, 2021).

The data directory management standards of LPHs and LP3Hs in Indonesia still require performance improvement. The current system does not meet the needs of managers since it lacks geo-referenced or location-based Micro and Small Enterprise (MSE) data elements. Additionally, no monitoring tools are available for MSEs, assistants, and auditors that are spatial-temporal and real-time. Furthermore, there is no tool to analyze the distribution patterns of MSEs that are close to halal certification assistants for time and cost efficiency. Integration of location data can support the acceleration of halal certification. Geographic Information System (GIS) technology can be a solution to integrate the spatial-based data needed by the BPJPH (Drackett et al., 2023). GIS technology can be used to record halal certification for MSEs, helping to manage, monitor, and analyze data in real time.

Nowadays, Geographic Information Systems (GIS) are widely used in various fields, including business (Anand & Deb, 2023; Ni et al., 2024), health (Biswas et al., 2023; Mobaied, 2020), government tasks (Higgs et al., 2013; Truden et al., 2022), politics (Isaksson & Gren, 2024; Sui & Hugill, 2002), and education (Austin et al., 2017; Dias, 2004). For instance, GIS can be used to evaluate and analyze the merger of ANZ and the National Bank of New Zealand into one brand. GIS helped ANZ bank to identify optimal branch locations, resulting in a reduction of the bank's cost-to-income ratio from 42.7% to 38.9%. Additionally, loans grew by 5%, and customer deposits increased by 8% (FinTech Futures, 2015). Bank of America (BoA) also utilized GIS to model its asset network and streamline its complex operations by determining which bank outlets to retain during the global crisis. By utilizing GIS, BoA's Retail distribution team was able to reduce the bank's annual expenses by $800 million and increase the stock price by approximately $1. Additionally, BoA also developed a predictive model for the bank's business development and mapped the value of each location against the bank's asset network. BoA used GIS to analyze the relationship between business locations and customer demographics, enabling them to offer appropriate products (Esri Malaysia, 2015).

The use of GIS for directory data management at the Halal Inspection Agency is beneficial for viewing various aspects, including the distribution of spatially-based MSE data, the distance between the assistant's home address and the location of MSEs, which can optimize assistance and cost efficiency, real-time data visualization, expansion or equalization of MSE targets to be certified, measurement of assistant and auditor performances, monitoring the validity period of spatially-based certification, and marketing campaigns related to halal certification (Manesha et al., 2021). GIS can be combined with statistical analysis to generate new values, such as clustering, hypothesis testing, modeling, or prediction. This can support the manager of the Halal Inspection Agency in determining the right policy to improve performance in MSE certification.

Professionals in related fields highly seek GIS due to its ability to efficiently manage, analyze, and visualize spatial data, aiding in decision-making and strategy development. Dashboard development can improve community services by providing real-time cross-agency links and serving as a basis for evidence-based decision-making (Kitchin, 2016). ArcGIS Dashboard can present, assess, and interpret location-based analysis using intuitive and interactive data visualization (Newman et al., 2023).

Research on GIS Story Maps includes the didactic application of cultural heritage and storytelling in Trieste, as presented in the article by Mauro et al. (2021). The use of ArcGIS Story Maps can increase students' interest in recognizing cultural heritage. The article titled 'Teaching Tourism: Urban Route Design Using GIS Story Map' demonstrates the usefulness of story maps in designing tourist travel routes. The article highlights the innovative nature of this approach and its potential to assist tourists in determining their travel routes (Mínguez, 2021).

Research by Antoniou et al. (2018) demonstrates the use of Story Maps as an interactive medium for communication and information dissemination to explore the Methana Peninsula. The purpose of developing the Story Maps was to highlight the characteristics of the Methana Peninsula, provide users with maps, texts, videos, and images, and inform both professional and non-professional users about certain aspects of the volcanic area. Although not a new sector, the halal industry has not fully utilized GIS technology yet. GIS has been widely adopted in several business sectors to support the halal industry. It is important to start by identifying the long chain of halal industry management to build a perspective on the use of GIS for the halal industry.

The objective of this research is to develop geospatial technology that integrates and manages halal industry data in a comprehensive spatial-based manner, analyzes the performance of micro and small enterprises, assistants, and the Halal Product Assurance Organizing Body, as well as provides policy recommendations to accelerate halal certification. Hence, the development of GIS technology is expected to make a major contribution to the equalization and acceleration of halal certification in Indonesia.

2. Materials and Methods

The method of this research considers various variables, including data from the Sihalal platform of LPH Sutha's account and LP3H's account of Islamic State University (UIN) Jambi. There are three LPHs and seven LP3Hs in Jambi Province. The data was collected specifically from the LPH and LP3H of UIN Jambi, which are relatively new and owned by the state university. This data was processed, integrated, and visualized on the ArcGIS Dashboard and combined in the ArcGIS HUB. Additionally, the data was analyzed to identify any shortcomings or weaknesses in the performance of halal inspection agencies in different locations.

This research was designed using the Research and Development (R&D) methodology. The following section presents a four-step process for integrating data related to the halal industry into the ArcGIS Dashboard, as described by Newman et al. (2023) and Shi et al. (2022). The process includes collecting data, editing data attributes, displaying the data on ArcGIS Online, and integrating it into the ArcGIS Dashboard. The following section provides a detailed description of the workflow.

2.1. Collecting Data

The initial step is to collect data related to the halal industry. This data encompasses information on halal product process assistants, micro and small enterprises, and the BPJPH. The research data was taken from the official website of the BPJPH of the Ministry of Religious Affairs (https://bpjph.halal.go.id/), as well as from the LPH and LP3H in Jambi Province. The data was presented in a tabular format without geo-referencing. The data was then processed, corrected, and transformed into spatial data. In addition to data related to the halal industry, the researchers also included sub-district boundary data as supporting information to show the distribution of halal product process assistants and MSEs in each sub-district. The sub-district boundaries were used as a recommended area for the BPJPH and local governments to accelerate halal product certification.

2.2. Editing Data Attributes

The data collected was formatted into CSV and combined with information on the location points of the distribution of halal assistants and MSEs obtained through tracking and collecting on Google Maps. Each piece of data is entered into the ArcGIS Pro application separately. Researchers then joined tables between location data and the halal industry attribute data. The data was integrated and stored in shapefile format, serving as the basis for creating data visualizations on the ArcGIS dashboard. The procedural model for integrating halal industry data into the ArcGIS Dashboard analysis platform is shown in Figure 1.

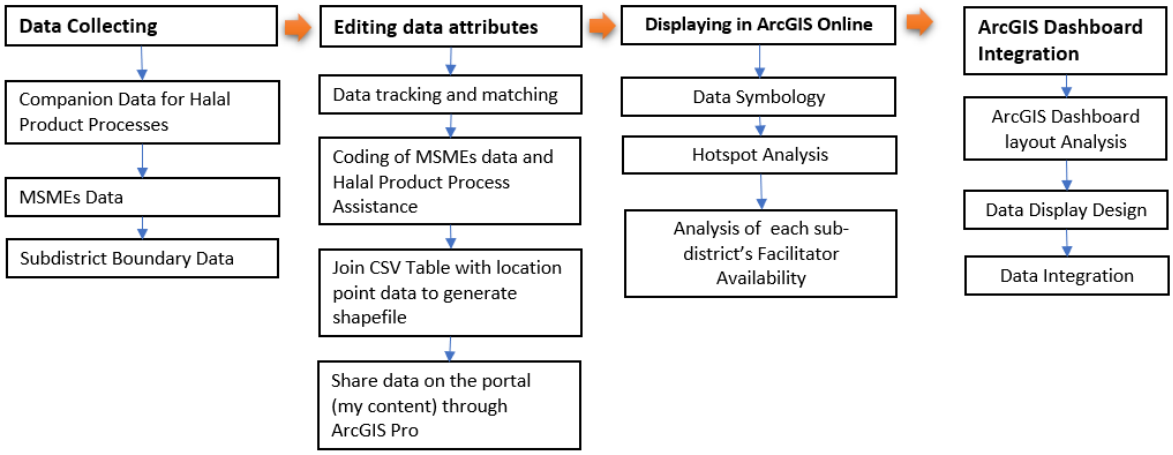

Figure 1. The procedural model for integrating halal industry data into the ArcGIS Dashboard

2.3. Displaying the Data on ArcGIS Online

Data shared through ArcGIS Pro was displayed on ArcGIS Online or New Map Viewer and symbolized according to cartographic rules. Two analyses were conducted, including Hotspot analysis of the distribution data of halal product process assistants and Overlay analysis to determine the vacancy of assistants in each sub-district. These analyses served as a guideline to provide recommendations to related institutions.

The analysis results are used to create an attractive visualization on the ArcGIS Dashboard (Praharaj et al., 2023). Hotspot analysis provides an overview of concentrations of the distribution of halal product process assistants. Hotspot analysis can quickly provide related parties with an understanding of how to accelerate the distribution of partners in the halal certification process in several regions. This distribution is part of accelerating the ownership of halal certificates for MSEs. Additionally, a legend will display information on the significance level of the hotspots, while sub-districts without assistants will be visualized separately with the primary data. It will facilitate readers in analyzing and making decisions. Figure 2 shows the data displayed on ArcGIS Online.

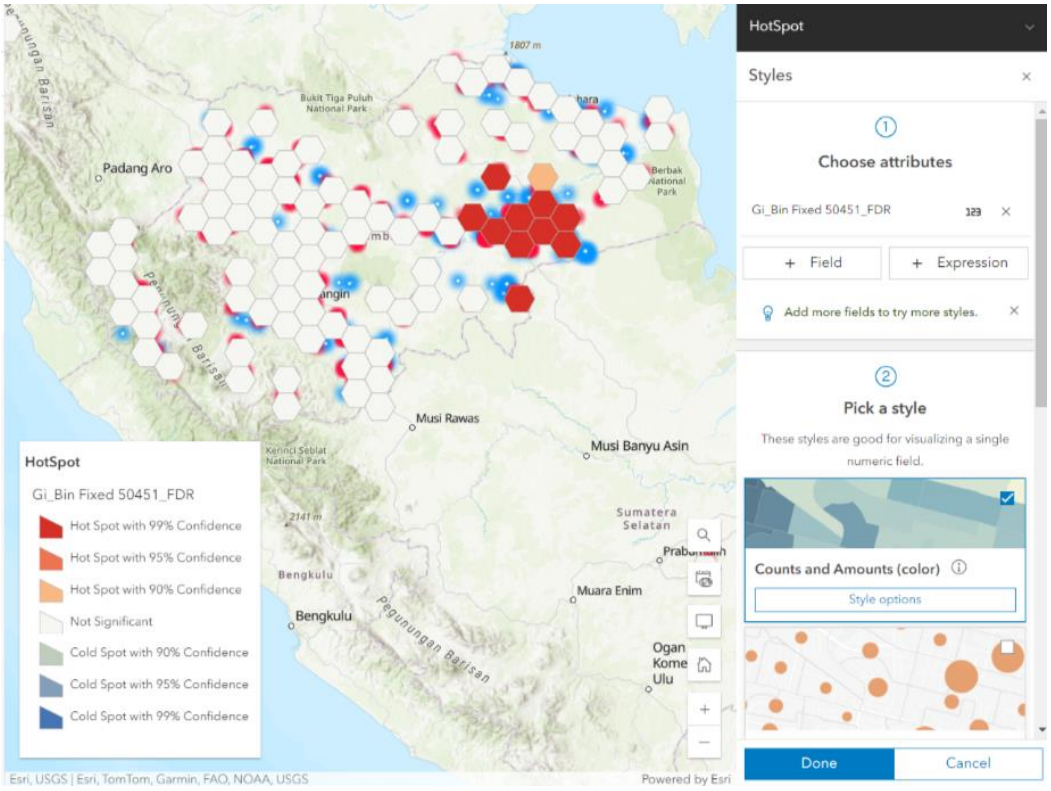

Figure 2. The data displayed and analyzed on ArcGIS Online

2.4. Integrating the Data in the ArcGIS Dashboard

The data processed in the map viewer can be integrated into a visualization display in the ArcGIS Dashboard platform. ArcGIS Dashboard can present dynamic data and visualize multiple data sets in various formats, including maps, tables, and graphs (Newman et al., 2023). ArcGIS Dashboard can be used to measure space and time to visualize patterns of relationships (Bachechi et al., 2022). The features displayed on the ArcGIS Dashboard are shown in the following Figure 3. The ArcGIS Dashboard menu includes main options such as map, map legend, serial chart, pie chart, indicator, gauge, list, table, details, and rich text. This tool is ideal for displaying dynamic data, such as the development of halal industry data. The real-time recording system can be integrated with Survey123 as a data entry form that includes location elements. Survey123 data can be easily integrated into the ArcGIS Dashboard, allowing for quick recording and display of information (Hennig et al., 2023).

Each data point will be equipped with zoom, pan, and flash actions to enhance its informative power. Upon selection, the corresponding cluster or personalized data coverage will be immediately displayed. Additionally, the total number of indicator elements will adjust to the selected data, facilitating quick and accurate information retrieval.

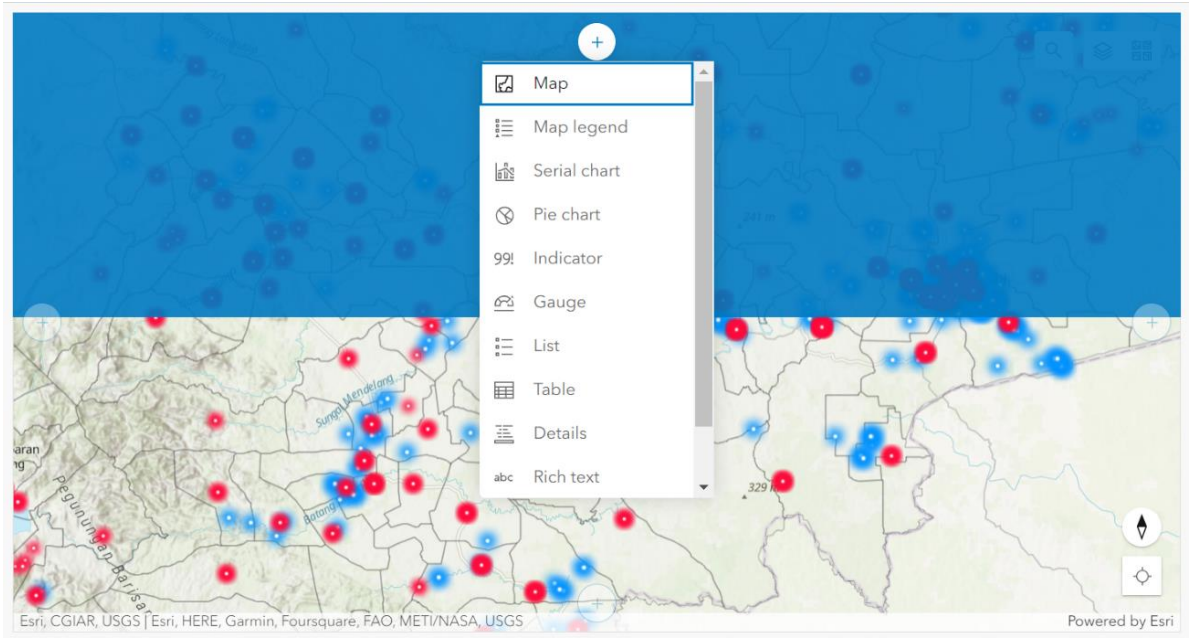

Figure 3. Menu view on ArcGIS Online

The main focus of the data visualization for halal product process assistants and MSEs distribution is the map display. Additional information, such as the total number of halal product process assistants, the performance of several BPJPH Halal Task Forces in various regions, and the performance of each assistant are also provided. Each element of information in the ArcGIS Dashboard is connected to map data to provide a more comprehensive understanding (Hamrock & Marchenko, 2023; Stupen et al., 2023).

3. Results and Discussion

GIS is a software that manages, analyzes, and visualizes geographic data. It integrates location data with descriptive information to help users understand geographic patterns, relationships, and contexts. The benefits of GIS include improved communication and efficiency, as well as better management and decision-making. Information that contains aspects of location in the form of maps can be used to find patterns, assess trends or make decisions. This process is called spatial analysis. Spatial analysis is the most interesting and remarkable aspect of GIS (Afnarius et al., 2023).

Spatial analysis can combine information from many independent sources and use sophisticated spatial analysis tools to derive new sets of information. GIS is able to help answer complex spatial questions, such as Determining Relationships, Understanding and Describing Locations and Events, Detecting and Measuring Patterns, Making Predictions, as well as Finding the Best Locations and Paths (Esri, 2018). In the context of the Halal Industry, GIS can analyze the distribution patterns of halal-certified MSEs or any patterns of MSEs that refuse halal certification, analyze or detect changes over

time, recommend the closest location between assistants and business actors, and recommend targets to be achieved. Locations are not only about static objects but also about targets or development strategies. It is called location awareness. For example, related to premises, asset tracking and finding the nearest restaurant or MSEs, one can imagine similar applications in homeland security and international border management (Dasgupra, 2018). Geospatial Technology-Based Management of Halal Industry is carried out through the following stages.

3.1. Integration and Management of Halal Industry Data in a Comprehensive and Spatial-Based Approach

In recent years, the Halal Industry has no longer been under the authority of a single institution. It is important to develop data integration that brings together governance stakeholders to ensure the successful implementation of halal assurance. Governance is a main requirement in policy implementation (Saadah, 2021). The government facilitates the free halal certification program through the Sihalal platform. This platform integrates all government actors into a cohesive business process flow. However, several areas still require improvement, such as the insufficient emphasis on location.

Additionally, the location aspect is crucial to the successful implementation of the halal certification program. The Sihalal system can enhance its performance by integrating spatial data and loading geographic information systems with halal certification aspects. This can be achieved by utilizing GIS technology that enables data search, visualization, and analysis (Bührdel et al., 2020). It is important to note that the text already adheres to the desired characteristics and language; therefore, no changes were made. Figure 1 shows the procedural model for integrating data from the halal industry into the ArcGIS Dashboard analysis platform.

ArcGIS Pro makes it easy to convert non-spatial data to spatial data (Szubert et al., 2024). ArcGIS Pro software is used to integrate table data and distribute it to the assistant locations and MSEs. The software can merge CSV or Excel data into shapefile data using the ‘join’ table tool. Data can also be updated automatically using the overwrite tool in ArcGIS Pro (Harder & Brown, 2017). This process is the starting point for comprehensive data analysis and visualization, as shown in Figure 4.

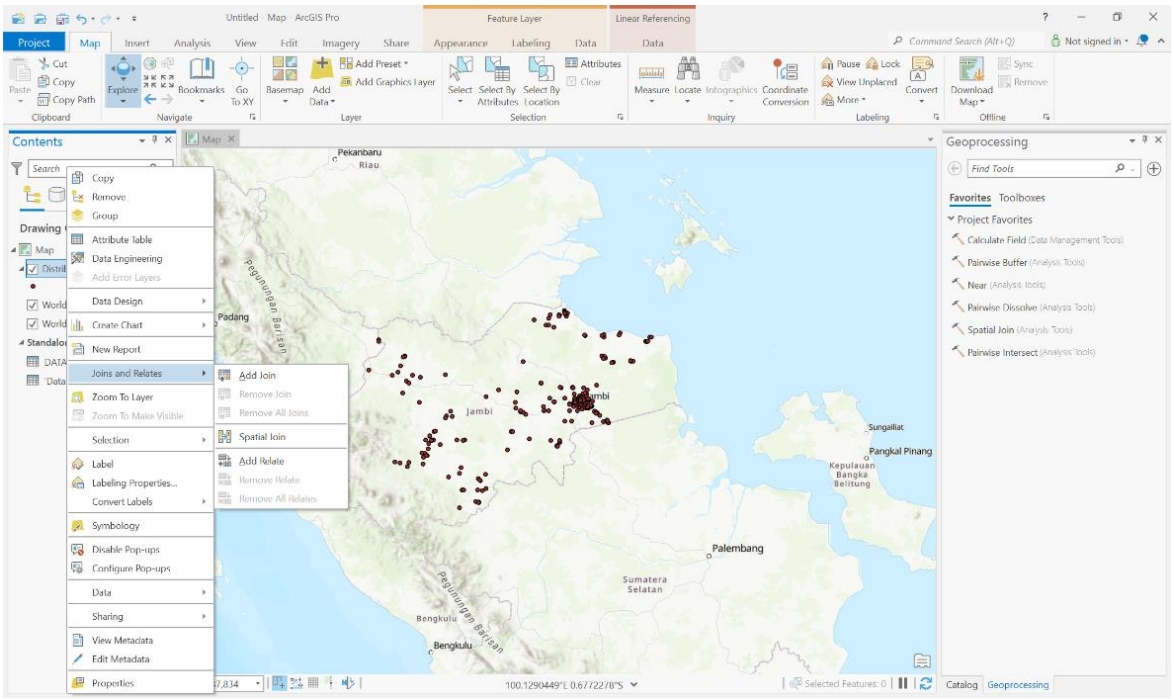

Figure 4. Data integration process in ArcGIS Pro

Integrated and managed Halal industry data can provide added value and impact for the MSEs. Based on this data visualization, local governments, as MSE mentors, can make more efficient and effective policies. Spatial data can be a reference for understanding market dynamics, consumer behavior, and demand patterns in the halal ecosystem. As the largest Muslim country, relevant government stakeholders need to continue to understand halal certification trends and their relationship to these three things. In the process of maintaining the maturity of the halal industry that has been built, relevant government stakeholders need to identify geographical hotspots for Halal product demand, especially with the possibility of an unstable supply chain of raw materials in Indonesia.

3.2. Integration and Management of Halal Industry Data in a Comprehensive and Spatial-Based Approach

The next stage of the policy cycle is monitoring. GIS can be used to store, process, and monitor special data, which produces high-precision digital maps (Ganguly & Bhan, 2023). ArcGIS Dashboard can be used to monitor data in real-time (Polineni et al., 2022). The halal certification program involves multiple actors from various levels, both central and regional. In the ArcGIS Dashboard display, the visualization of the data distribution accompanying halal certification can be seen clearly in the appearance of red dots. Furthermore, the visualization of the distribution of certified MSEs is displayed in the appearance of blue dots (Figure 5). Halal assistants must be present in all villages and sub-districts in Indonesia; thus, monitoring becomes a challenge. Monitoring the performance of assistants and institutions involved in halal certification is crucial to achieving the target number of halal-certified MSEs. Monitoring is closely related to location, specifically the location of MSEs that do not have halal certification, as well as assistants and LPHs that perform poorly. The integration of spatial technology makes it easier to answer these questions.

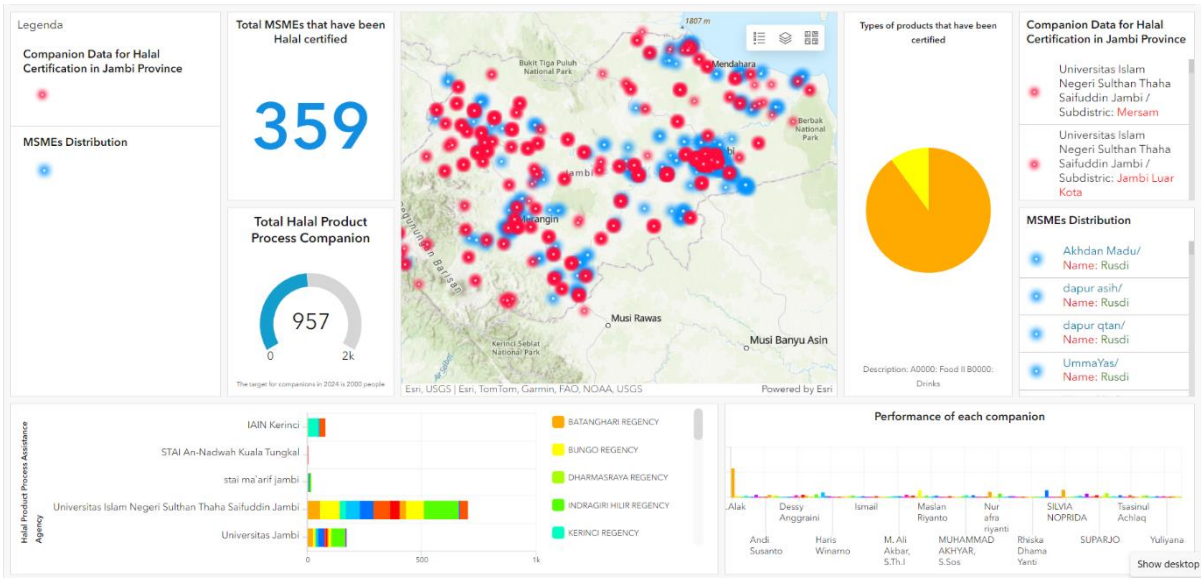

Figure 5. Visualization of companion and BPJPH performance through ArcGIS Dashboard

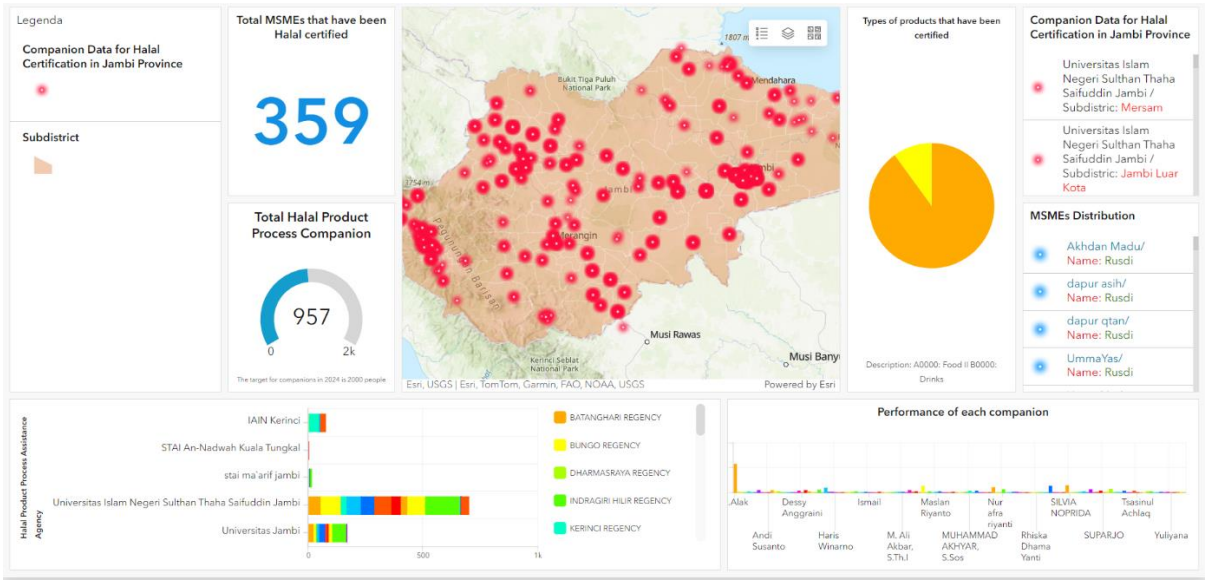

Figure 6. GIS Distribution of halal product process assistants in Jambi Province

Figure 6 depicts the performance of the parties involved in the halal certification process in Jambi Province. The ArcGIS dashboard provides visualizations of various information elements, including the spatial distribution of assistants and certified MSEs in each sub-district, diagrams illustrating the percentage of certified product types, and performance graphs of each assistant and LP3H. Visualization on the ArcGIS Dashboard creates interest in users and makes it easier to understand data content (Windra et al., 2024). This integration can be a crucial component in formulating policies quickly and accurately.

Monitoring is a critical stage in the policy cycle, where the implementation and performance of halal facilitation and LPHs are tracked. Thus, as an instrumental technology that stores, processes, and monitors spatial data, GIS provides high-precision digital maps, which is essential for effective facilitation and LPH monitoring. The Halal Task Force is the executor of BPJPH's duties to monitor the halal certification performance, but it has not yet shown significant performance. Effective monitoring of the performances of halal assistants and institutions involved in the certification process, including LPHs and Facilitators, is vital.

This platform can assist because monitoring needs to be focused on specific locations. Data is required on MSEs that have not obtained halal certification to socialize or promote awareness of halal obligations, as well as on MSEs that have obtained halal certification to monitor the implementation of halal criteria policies. Finally, currently, BPJPH routinely evaluates LPHs that have not maximized their performance using the Sihalal database temporally. However, this data still needs to be provided for spatial-based analysis and visualization. Spatial data on LPH performance can provide BPJPH with a new perspective on performance evaluation based on regional conditions, such as socio-cultural conditions and organizational behavior.

3.3. Providing Direction for Policy Recommendations to Accelerate Halal Certification

GIS plays a significant role in providing policy recommendations to accelerate the achievement of halal certification targets. The ArcGIS Dashboard can simplify business processes through its powerful features (Molefi et al., 2021). To accelerate the target of achieving halal certification, some recommendations include providing guidance for areas that have not yet reached the halal certification target. The task involves analyzing the success or socialization level of programs that have not been implemented based on regional clusters. Additionally, recommendations must be provided for parties to be invited to collaborate based on their proximity to business actors (Shaffer et al., 2023).

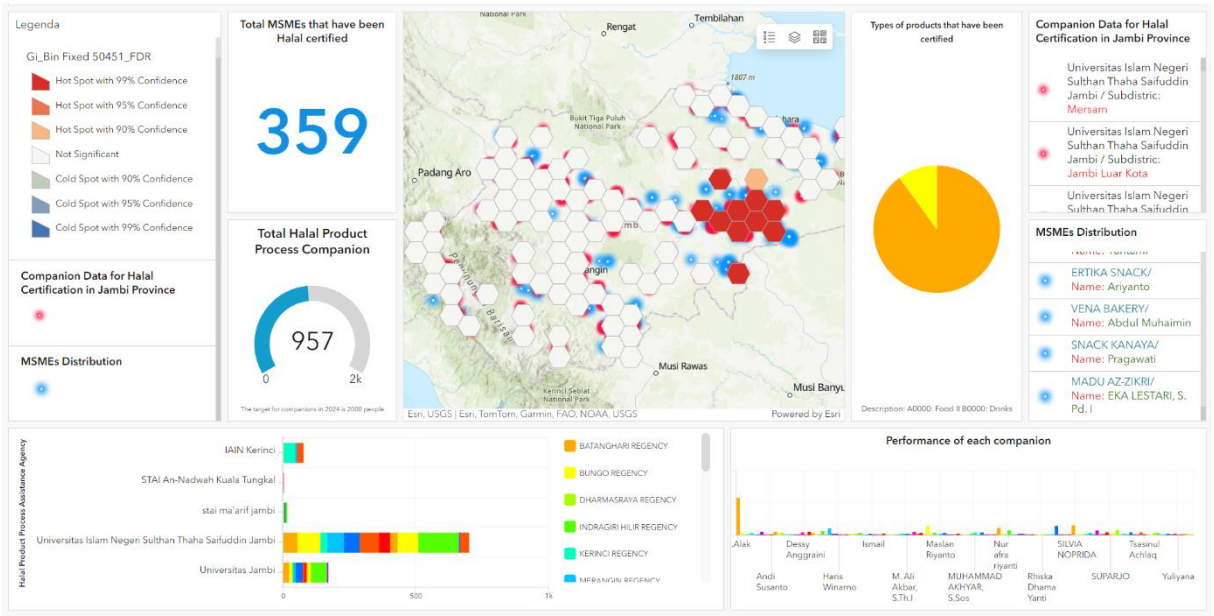

Figure 7. The results of the hotspot analysis of the Halal Product Process (PPH) assistants

The distribution of halal product process assistants in Jambi Province is concentrated in the Jambi City area, indicating that most of the halal certification assistants for MSEs are located in Jambi City. Figure 7 illustrates the significant disparity in the availability of halal product process assistants across regions. Even within sub-district boundaries, there are still nine sub-districts without a single halal product process assistant, as shown in Figure 8. Targeted socialization is necessary to recruit and

increase the number of assistants in each region. On the other hand, evaluating the performance of each BPJPH Halal Task Force can strengthen its performance in each region of Jambi Province. This highlights the importance of strong cooperation between BPJPH and local government to ensure even expansion of the halal product certification program. In the end, this display can facilitate policymakers to monitor the distribution of existing disparities (Newman et al., 2023). In another example, using dashboards can also create a user-friendly dashboard interface. Data showing a collection of maritime accidents as well as rescue drills is displayed and can be filtered and searched to understand more details about each specific case (Hamrock & Marchenko, 2023).

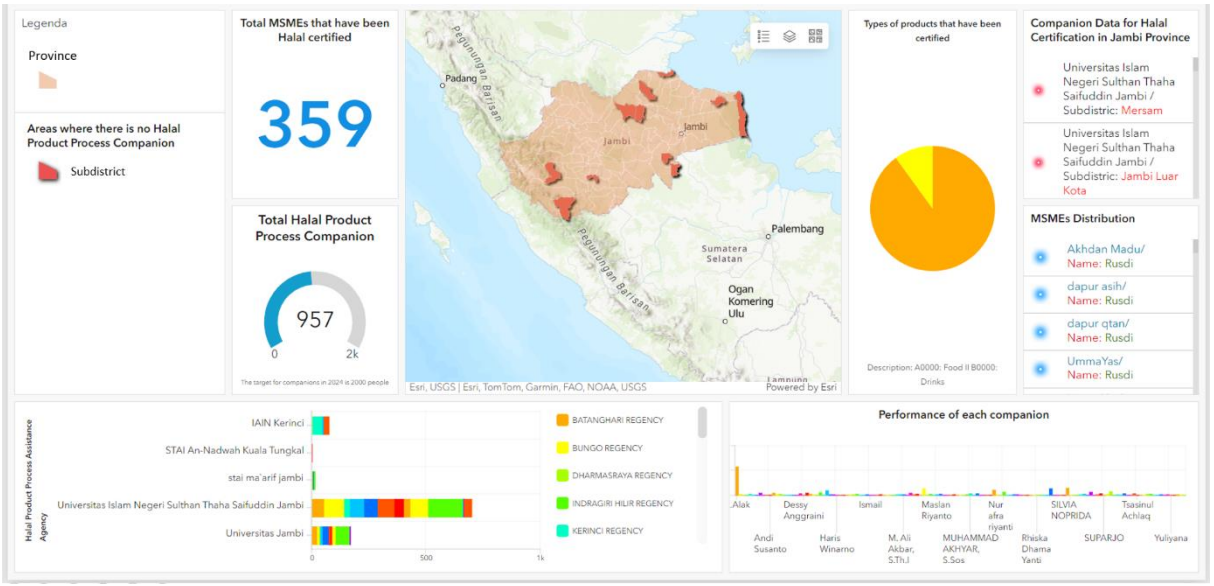

Figure 8. Analysis of sub-districts without a single Halal Product Process (PPH) assistant in Jambi Province

Based on Figure 8, using the ArcGIS Dashboard can easily reveal performance gaps in the halal certification process for MSE products. This convenience can be seen from the analysis of the overlapping distribution of the halal certification process with various data, such as boundary data on administrative areas, type of business, assistant performances, and certified MSEs or other data. Monitoring through the ArcGIS Dashboard can provide quick information on areas where institutions assisting the halal certification process are performing poorly. This condition can provide input for relevant institutions to intervene quickly in areas that are low-performing or have insufficient support. Apart from that, the ArcGIS Dashboard can also help plan the placement of resources appropriately, while ensuring that support is directed to the areas that actually have very low MSE halal certification records. Ultimately, this integration can help make the halal certification process more effective and efficient and can support equitable achievement of halal certification in various regions.

4. Conclusion

The results of this research indicate that geospatial technology plays an important role in the management and acceleration of halal certification in several ways. First, it integrates and manages halal industry data comprehensively and spatially. Second, it monitors the performance of micro and small enterprises, assistants, and the BPJPH. It also can be used quickly to analyze patterns, distribution, trends, associations, and comparisons between regions. Third, it provides policy recommendations to accelerate halal certification. The development of GIS technology has made a significant contribution to the equalization and acceleration of certification.

Using GIS, stakeholders can quickly assess their performance across regions. This capability enhances understanding of the dynamics of the halal industry, making it easier to identify trends and make data-driven decisions. The insights gained from the use of geospatial technology can inform policy recommendations. These recommendations can be aimed at accelerating the process of halal certification, ensuring that it is done more efficiently and effectively across regions.

The breadth and rapidity of practical developments in this industry support optimism for future halal industry studies. The digitalization of halal certification is a widespread phenomenon, especially in Indonesia; improvements from various aspects are needed to increase the efficiency, transparency, and reliability of the process. This locus requires attention from researchers, especially in the field of

application development, which is integrated, user-friendly, and ensures data security. Sihalal, as a very well-developed platform, needs to be integrated with various related databases, such as licensing databases that identify business classifications and food safety databases, for efficiency at the pre-audit stage. At the post-audit stage, Sihalal must also be integrated with the auction platform for service providers used in local government agencies. GIS mapping makes this condition possible, thus halal certificates can boost MSEs' income. On the other hand, further studies can analyze the policies and regulations needed to integrate halal industry data with geospatial technology. This research can help design policy recommendations for accelerating halal certification.

CRediT Authorship Contribution Statement

Imam Arifa'illah Syaiful Huda: Conceptualization, Methodology, Validation, Analysis, Writing – Original Draft Preparation, Writing – Review. **Maratun Saadah:** Conceptualization, Writing –Original Draft, Analysis, Writing – Review. **Agus Sugiarto:** Writing – Original Draft, Visualization. **Mohd Hairy Bin Ibrahim:** Methodology, Writing – Review. **Ravinesh Rohit Prasad:** Methodology, Writing – Review. **Alfyananda Kurnia Putra:** Validation, Analysis, Visualization, Methodology. **Achyat Budianto:** Conceptualization, Writing – Original Draft Preparation.

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