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Identification of Key Factors in the Implementation of Geographic Information Systems for Public Administration

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Abstract

This study aims to identify key factors in the implementation of Geographic Information System (GIS) in public administration in Sibolangit Sub-district Office, Deli Serdang Regency. GIS plays an important role in improving efficiency, transparency, and accuracy in the management of geographic data. The method used in this study is a qualitative approach with data collection techniques through interviews, observations, and document analysis. The results show that GIS has improved time efficiency and data accuracy in public administration, but its effectiveness is still affected by several factors. The main obstacles found include unstable technological infrastructure, limited technical training for staff, and lack of policies that support the use of GIS in a structured manner. Technical, organizational, and human resource factors are the keys to the successful implementation of GIS. This study concludes that to maximize the effectiveness of GIS, it is necessary to make improvements to technological infrastructure, increase human resource capacity, and develop policies that support the implementation of GIS in public administration.

Introduction

Advances in information technology have had a significant impact on various sectors of life, including public administration. One of the innovations that has great potential is the Geographic Information System (GIS). GIS is a technology that enables more effective and efficient management, analysis, and visualization of location-based data (Erkamim et al., 2023). In the context of public administration, GIS can be used to support more informed decision-making, regional planning, and optimal public services (Bailey & Grossardt, 2010; Tao, 2013; Kahila-Tani et al., 2019).

The implementation of GIS at the local government level, especially at the sub-district, presents an opportunity to improve the quality of public administration (Ramli, 2017). With GIS, regional data management can be carried out in a more integrated manner, thereby providing relevant information for the community and interested parties. However, the effectiveness of GIS implementation depends on a variety of key factors that affect its successful use (Budić & Godschalk, 1994).

Sibolangit District, Deli Serdang Regency, is one of the areas with high needs for geographic data management. The geographical characteristics of this area, which includes highlands and tourism areas, make regional data management very important. Therefore, the implementation of GIS in Sibolangit District can provide a solution to improve the efficiency of public administration. While GIS has many benefits, its implementation often faces various challenges. Some of them are the limitation of competent human resources, inadequate technological infrastructure, and lack of understanding of the benefits of GIS at the decision-

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making level. Identifying the key factors in the implementation of GIS is an important step to ensure its success (Sieber, 2000; Taleai et al., 2009).

There is a need to understand the factors that affect the effective implementation of GIS in public administration. Some of the questions that arise include: What are the key factors that affect the success of GIS implementation in Sibolangit District? How can these factors be optimized to support regional data management? This study seeks to answer this question by identifying the key factors that affect the implementation of GIS. By understanding these factors, a strategy can be formulated to optimize the implementation of GIS in Sibolangit District, thereby supporting the efficiency of public administration.

The main objective of this study is to identify and analyze the key factors that affect the successful implementation of GIS in public administration in Sibolangit District. This research also aims to provide strategic recommendations for the sub-district government in utilizing GIS more effectively. The results of this research are expected to contribute both academically and practically. Academically, this research can be a reference for similar studies in the future. Practically, the results of this research are expected to be a guide for the Sibolangit District government in developing GIS as an administrative tool and public services. The implementation of GIS is influenced by various factors, including technical, organizational, and human resource aspects. Technical factors include the technological infrastructure, software, and hardware used (Nanda & Agus, 2024). Organizational factors include management support, policy, and coordination between agencies. Meanwhile, human resource factors include competence, training, and staff understanding of the use of GIS (Ismail et al., 2022; Leuhery et al., 2023; Pasae et al., 2021).

This research uses a theoretical approach that refers to the concept of information technology implementation in public organizations. This framework helps in understanding the dynamics of the interaction between these factors and their impact on the effectiveness of GIS implementation. Sibolangit District has a strategic role in public administration in Deli Serdang Regency. Apart from being a rapidly growing tourist area, this region also faces challenges in managing geographic data, such as zoning mapping and regional asset management. The successful implementation of GIS in this sub-district can be a model for other regions with similar characteristics.

This study uses a qualitative approach with a case study method. Data was collected through in-depth interviews with related parties, field observations, and document analysis. The focus of the research is on the identification of factors that affect the implementation of GIS in Sibolangit District. The results of this study are expected to reveal various key factors that affect the implementation of GIS. In addition, this research is also expected to be able to provide an overview of the challenges and opportunities faced by the Sibolangit District government in utilizing GIS. This research has high relevance in supporting the government's efforts to improve the quality of public administration. With the growing need for location-based data, GIS is becoming an indispensable tool to support evidence-based decision-making.

Methods

This study uses a qualitative approach to deeply understand the key factors that affect the implementation of Geographic Information Systems (GIS) in public administration in Sibolangit District. The qualitative approach was chosen because it is able to explore contextual and in-depth information about complex phenomena, especially related to the interaction between technology, organizations, and human resources in the implementation of GIS.

This study uses a case study design (Assyakurrohim et al., 2023). The case study was chosen to allow an in-depth analysis of the implementation of GIS in Sibolangit District as a single

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unit of analysis. This design is relevant because GIS is a phenomenon that has a special context, and its implementation is influenced by unique local conditions.

The research was conducted in Sibolangit District, Deli Serdang Regency. The selection of this location is based on the characteristics of the region that require optimal geographical data management to support public administration, as well as the existence of GIS implementation initiatives in this region.

The research subjects include individuals and groups that are directly involved or have an important role in the implementation of GIS in Sibolangit District. Key subjects include: 1) District Government: Sub-district Head, administrative staff, and GIS operators; 2) Technical Parties: Technology service providers or consultants involved in the development of GIS; 3) Other Stakeholders: Community representatives or users of geographic data from GIS.

Data Collection Techniques

Interviews were conducted with key informants, such as sub-district heads, technical staff, and GIS operators. The interviews are semi-structured to allow for a more in-depth exploration of the key factors in the implementation of the GIS. Observations are made to understand the process of using GIS directly in the work environment. This includes observation of GIS software usage, coordination between staff, and public administration workflows. Relevant documents, such as GIS implementation reports, local policies, and technical guidance, are analyzed to get a comprehensive picture of the implementation process and the obstacles encountered (Miles & Huberman, 1992).

Data Analysis Techniques

The collected data was analyzed using thematic analysis methods. The steps of data analysis include (Saleh, 2017): 1) Data Reduction: Organize data from interviews, observations, and documents to find key themes; 2) Categorization: Identifying recurring factors and grouping data according to relevant themes, such as technical, organizational, and human resource aspects; 3) Drawing Conclusions: Interpreting the results of the analysis to understand the relationship between key factors in the implementation of GIS.

Data Validity

To ensure the validity of the data, this study uses data triangulation, namely by comparing the results of interviews, observations, and document analysis. In addition, the member checking technique is used by asking the main informant for confirmation regarding the results of the interview and data interpretation.

Results and Discussion

Effectiveness of Geographic Information Systems in Public Administration at the Sibolangit Sub-district Office

Based on the results of interviews, observations, and document analysis, the implementation of the Geographic Information System (GIS) at the Sibolangit Sub-district Office shows that the effectiveness is still at an intermediate stage. Some of the GIS effectiveness indicators analyzed are:

Ease of Use

Most administrative staff stated that GIS is quite easy to use, especially for basic purposes such as territory mapping and asset data management. However, there are limitations in the more complex analytical features due to the lack of technical training.

Time and Cost Savings

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GIS helps speed up the process of mapping and searching for regional data. This can be seen from the reduced data processing time by up to 40% compared to manual methods. However, the cost of software and hardware maintenance is still a challenge.

Increased Transparency and Data Accuracy

GIS provides better transparency in the presentation of location-based data, such as regional zoning data and village assets. Data accuracy is increased because processing is carried out digitally and standardized.

Response to Community Requests

Although GIS helps in responding to public requests for geographic information, such as boundary data or road mapping, the system often experiences technical obstacles that cause delays.

The ease of use of GIS is one of the main indicators in measuring its effectiveness. Based on interviews, most staff are able to use GIS for basic tasks, such as territory mapping and asset data management. This is in line with the Technology Acceptance Model (TAM) theory put forward by (Davis, 1989), where perceived ease of use is an important factor that determines the acceptance of technology by users. However, training limitations have caused staff to experience difficulties in utilizing advanced features of GIS, which hinders the optimization potential of this technology (Attah et al., 2024; Krichen et al., 2024).

GIS has helped speed up the process of managing geographic data, which contributes to time efficiency. Research by (Brown & Brudney, 1998) It also shows that the application of GIS is able to significantly reduce data processing time compared to manual methods. However, constraints related to software and hardware maintenance costs have become obstacles. This reflects previous findings by Kumar et al. (2019), who stated that limited budgets are often an inhibiting factor in the implementation of information technology in the public sector.

One of the main advantages of GIS is the increased transparency and accuracy of data. The geographic data presented through GIS allows users to view information visually and in a standardized manner, which minimizes human error (Nygren et al., 2024; Ki et al., 2023). These findings are supported by research (Goodchild, 2007), which states that GIS can improve the accuracy and validity of data, especially in the management of public territories and assets.

GIS helps improve government responsiveness to requests for geographic information from the public. However, technical obstacles such as internet network disruptions are still an obstacle. According to research by (Norris & Moon, 2005), inadequate technological infrastructure is often one of the main causes of the low effectiveness of GIS in public services

Table 1. GIS Effectiveness Indicators

Indicators	Valuation	Information
Ease of Use	Intermediate	It can be used for basic tasks, but advanced features are less than optimal.
Time and Cost Savings	High (time) / Low (cost)	The process is faster, but the maintenance cost is high.
Data Transparency and Accuracy	Tall	The data is more transparent and accurate than manual methods.
Response to the Community	Intermediate	The response is faster, but it is often interrupted by technical constraints.

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Factors Affecting the Effectiveness of the Implementation of Geographic Information Systems in Public Administration at the Sibolangit Sub-district Office

From the results of the data analysis, several key factors were found that affect the effectiveness of GIS implementation. These factors are grouped into three main categories: technical, organizational, and human resources.

The availability of GIS hardware and software is quite adequate. However, there are often internet network disruptions that hinder real-time data access. The lack of budget allocation for software and hardware maintenance causes some features to not function optimally. The support from the sub-district head and the management is quite good, but coordination between agencies still needs to be improved to maximize the benefits of GIS. The absence of specific policies regarding the use of GIS makes its implementation less structured and consistent. Most staff do not have adequate technical training on the use of GIS, so their ability to utilize the system is limited.

Motivation and Understanding

The level of staff understanding of the benefits of GIS in public administration is still low, which has an impact on low motivation to make optimal use of the system.

Table 2. The following summarizes the factors that affect the effectiveness of GIS implementation

Category	Factor	Information
Technical Factors	Technology Infrastructure	Hardware and software are adequate, but the internet network is less stable.
	System Maintenance	Limited budget for software maintenance.
Organizational Factors	Management Support	quite good, but coordination between agencies is weak.
	Policies and Regulations	There are no specific policies governing the use of GIS
Resource Factor	Staff Competencies	Staff have not been optimally trained to operate the GIS.
	Motivation and Understanding	Staff understanding of GIS benefits is still low

The availability of technological infrastructure, such as hardware and software, at the Sibolangit Sub-district Office is quite adequate. However, internet network disruptions and lack of budget allocation for software maintenance are the main obstacles. This is in line with the view (Heeks, 2002) in the Theory of Design-Reality Gap, which explains that the gap between system design and infrastructure reality often results in the failure of technology implementation in the public sector.

Good management support is an important asset in the implementation of GIS. However, the lack of specific policies and regulations related to the use of GIS leads to a less structured implementation process. Research by (Gil-García & Pardo, 2005) shows that supportive policies and coordination between agencies are key factors for the successful implementation of information technology in the government.

Limited staff competence and low understanding of the benefits of GIS are the main obstacles. Suboptimal technical training makes it difficult for staff to harness the full potential of GIS.

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Research by (Rajabifard et al., 2002) emphasizing the importance of developing human resource capacity in supporting the successful implementation of GIS, especially in complex organizational environments.

Contextual Analysis

Sibolangit District has complex geographical characteristics, such as hilly topography and tourism areas, which require efficient management of geographic data. The implementation of GIS in the region has a great opportunity to improve the quality of public administration, but its success depends on the holistic management of technical, organizational and human resource factors.

The results of this study show that there is a gap between the potential of the technology and its implementation in the field. To overcome these obstacles, the Sibolangit District government needs to strengthen technological infrastructure, provide intensive training for staff, and develop policies that support the implementation of GIS.

Conclusion

This study shows that the implementation of the Geographic Information System (GIS) in public administration at the Sibolangit Sub-district Office has quite good effectiveness, although there are still several obstacles. GIS has proven to be able to improve time efficiency, transparency, and data accuracy in the management of geographic information, which is an important aspect in supporting public administration needs. However, its success is still influenced by technical, organizational, and human resource constraints. From a technical point of view, although GIS hardware and software are adequate, internet network disruption and lack of budget allocation for system maintenance are major obstacles. This highlights the importance of optimal technology infrastructure management to support the sustainable performance of GIS. From an organizational perspective, existing management support provides a good initial impetus for GIS implementation. However, the absence of specific policies governing the use of GIS causes the implementation of this system to be less directed and structured. Coordination between agencies also still needs to be strengthened to maximize the benefits that GIS can provide. Human resources are one of the key factors that affect the effectiveness of GIS implementation. The low competence of staff in operating GIS, due to the lack of technical training, and lack of understanding of the benefits of GIS, has caused this system to not be optimally utilized. The results of this study confirm the importance of synergy between technology, organizations, and people in the implementation of GIS. To increase the effectiveness of GIS, it is necessary to improve technological infrastructure, develop staff competencies through intensive training, and formulate policies that support the consistent use of GIS. By overcoming these obstacles, GIS has the potential to be a very effective tool to improve the quality of public administration in Sibolangit District, as well as provide significant benefits to the community through more efficient, transparent, and accurate services.

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