A Model for Implementing the UN-IGIF in Geospatial Information Infrastructure Development for Indonesian Local Governments

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Abstract
Indonesia's Geospatial Information Infrastructure (GII) has evolved from the Spatial Data Infrastructure (SDI) and is now governed by Law No. 4/2011 on Geospatial Information. Its primary aim is to provide the necessary facilities and infrastructure to enhance geospatial information management across national and local government agencies. On the international stage, the United Nations adopted the Integrated Geospatial Information Framework (UN-IGIF) to improve the management of geospatial information for its member countries and support the achievement of the Sustainable Development Goals (SDGs). The UN-IGIF is designed for national-level implementation, making it essential to identify suitable indicators that can be applied at the local government level. This study evaluates the implementation of the nine strategic pathways of UN-IGIF for local governments in Indonesia. Data were obtained from questionnaires with 103 respondents and interviews with twelve local government officials. They were used to assess the importance of the indicators in the nine UN-IGIF strategic pathways in developing GII at the local government level. The insights from the questionnaires and interviews were then used to create a logic model for GII development in local governments in Indonesia based on UN-IGIF. To develop the logic model, twelve local governments were divided into five classes according to the problems they encountered to simplify the logic model's development. The findings highlight that three strategic pathways, governance and institutions, data, and capacity and education, showed a significant and positive impact when implemented in GII development. For less developed local governments, a cautious approach has to be taken since the adoption of UN-IGIF is influenced by local context and the state of geospatial information utilization. Nonetheless, the UN-IGIF, which was initially designed for implementation at the national level, can be adapted to support GII development in local government in Indonesia and potentially elsewhere. Successful adaptation of the UN-IGIF requires consideration of the local context and governmental settings, which can vary significantly between regions and countries.

Keywords: Geospatial Information Infrastructure, Indonesia, Local Government, Spatial Data Infrastructure, UN-IGIF

1. Introduction

Spatial Data Infrastructure (SDI) refers to the collection of technologies, policies and institutional arrangements that are useful in facilitating the availability and accessibility of geospatial data and information [1]. SDI is mainly developed to facilitate the availability and sharing of geospatial data and information among all relevant stakeholders through policy, data access, standards, human resources and data [2]. Nowadays, geospatial data and information are the important elements in planning and decision-making in both government and private sector.

Various institutions invest considerably in the provision of geospatial data and information, from data collection, storage, processing, analysis, and dissemination of geospatial information to fulfill their needs.

However, geospatial data and information are still expensive and time-consuming to produce. This situation becomes an issue as each institution demands a broader range of geospatial data and information than the funding available. The proposed solution to this problem is to use the principle of "create once, use many times" and share geospatial data and information among all relevant institutions [2][3] and [4]. Unfortunately, this principle cannot be implemented easily because developing SDI is not a straightforward process. The development requires the orchestration of technical and non-technical aspects of SDI. Therefore, the development in many countries varies.

Indonesia is one of the first eleven countries in the world to initiate the development of a National Spatial Data Infrastructure (NSDI) [5]. The development of SDI in Indonesia was initiated in 1993 by the initiation of SIGNas, the National Coordination Meeting on Geographic Information System[6]. Since 2011, SDI has been adapted into Geospatial Information Infrastructure (GII) following the enactment of Law 4/2011 on Geospatial Information. GII consists of five main elements: policies, institutional arrangements, technology, standards, and human resources as facilities and infrastructure used to facilitate the implementation of Geospatial Information (GI). Law on Geospatial Information is also the foundation for the transformation of the National Coordinating Agency for Survey and Mapping (Bakosurtanal) into the Geospatial Information Agency (BIG). BIG is responsible for organizing government affairs in the geospatial information provision and dissemination [7]. Geospatial data is disseminated through geoportals which serve as the technical implementation and essential tool for realizing geospatial data sharing, making it an indispensable element of any country's NSDI [8]. In Indonesia, all central government agencies and local governments are required to develop their own geoportal. At the national level, the data are integrated into the national geoportal called Ina-Geoportal. The national geoportal is managed by BIG. Since its launch in 2011 until 2024, only 441 central government agencies and local governments have geoportals connected to Ina-Geoportal out of 623 central government agencies and local governments.

The SDI concept was developed in an era when most production of geospatial data was still very expensive, so that only the government could afford the cost. The utilization was also limited in terms of sectoral elements and types of data. The advancement of technology has changed the geospatial ecosystem from focusing on acquisition, processing, storing, and disseminating data in a traditional method to develop services and shared utilization using advanced techniques. To respond to this new environment, it is necessary to develop new concepts beyond SDI to maintain the sustainability of the geospatial ecosystem in the future [9], which is also aligned with the ability of SDI to adapt as Complex Adaptive Systems (CAS) [10]. United Nations (UN) and the World Bank, through the Committee of Experts on Global Geospatial Information Management (UN-GGIM), developed the UN Integrated Geospatial Information Framework (UN-IGIF) to strengthen the institutional arrangements for geospatial information management for UN member countries, especially developing countries in supporting the implementation of the Sustainable Development Goals (SDGs) [11]. The implementation of UN-IGIF is guided by nine elements called strategic pathways: governance and institutions, policy and legal, financial, data, innovation, standards, partnerships, capacity, and education and communication and engagement. In comparison to the Indonesian GII elements, several strategic pathways of UN-IGIF are not covered explicitly in the Indonesian GII elements developed earlier. The differences are in the following elements: financial, partnerships, communication, and engagement.

Indonesia plans to adopt the UN Integrated Geospatial Information Framework (UN-IGIF) to accelerate the development of the Geospatial Information Infrastructure (GII) at the national level in 2024. This adoption will serve as one of the references for preparing the National Medium-Term Development Plan (RPJMN) for 2025-2029 and the National Long-Term Development Plan (RPJPN) for 2025-2045 [12]. This research focuses on how differences in this context affect the development of GII and how to address these differences so that UN-IGIF can be effectively implemented to optimize GII development in Indonesian local governments. There have been few studies on the implementation of UN-IGIF for developing National Spatial Data Infrastructure (NSDI) in various countries, particularly at the local government level. For example, Ali [13] conducted a study on the adaptation of UN-IGIF in determining barriers and measuring the extent of obstacles in developing NSDI in Pakistan.

From the point of view of data and standards, Lindgren [14] uses UN-IGIF Diagnostic tools to assess Liberia's Spatial Data Infrastructure. Both studies were conducted at the national level, which highlights the need to identify UN-IGIF indicators that are relevant at the local government level.

2. Method

The method employed in this study involves the development of a questionnaire designed to assess the significance of applying the indicators of the nine UN-IGIF strategic pathways for advancing Geographic Information Infrastructure (GII) in Indonesian local governments. To evaluate the data collected, Partial Least Squares Structural Equation Modeling (PLS-SEM) was utilized as the analytical framework. PLS-SEM was selected for its ability to predict relationships between latent variables, the nine UN-IGIF strategic pathways and GII data, even when working with a limited sample size from local governments [15]. PLS-SEM has also been used in research to assess the readiness of local governments to implement SDI [16] and in research on factors influencing SDI development in Pakistan [13]. By utilizing PLS-SEM, this study aims to prioritize the application of these strategic pathways in developing GII at the local government level.

Structured interviews were conducted with twelve local governments to determine the state of SDI development in their respective areas. The results of these interviews provide insight into the status of the development of the five elements of GII, the challenges faced, and solutions undertaken during the development of GI. Additionally, the expectations of local governments regarding the application of the United Nations Integrated Geospatial Information Framework (UN-IGIF) in developing GII are discussed. Utilizing nine strategic pathways, a strategic plan was created based on the findings from the questionnaires and interviews. This plan employs a logic model to assist local governments in addressing existing issues related to GII development. Logic models can systematically and visually present the relationship between available resources to accomplish a planned activity in achieving goals [17]. A logic model has also been utilized in research related to the Indonesian NSDI development [18]. The flow diagram of this research is presented in Figure 1.

2.1 Data Acquisition

This research uses two data sources: a questionnaire and an interview. The questionnaire assesses how important it is for the indicators of the nine UN-IGIF strategic pathways to be evaluated and used in GII development at local governments. The interview aimed to reveal the actual conditions of GII development at local governments. All participants were informed of the purpose of the study prior to participating in the survey or interviews. Participation was voluntary, and informed consent was obtained from all respondents. Anonymity and confidentiality were maintained throughout the data collection and analysis process. The data collected was used solely for academic research purposes and was stored securely to prevent unauthorized access.

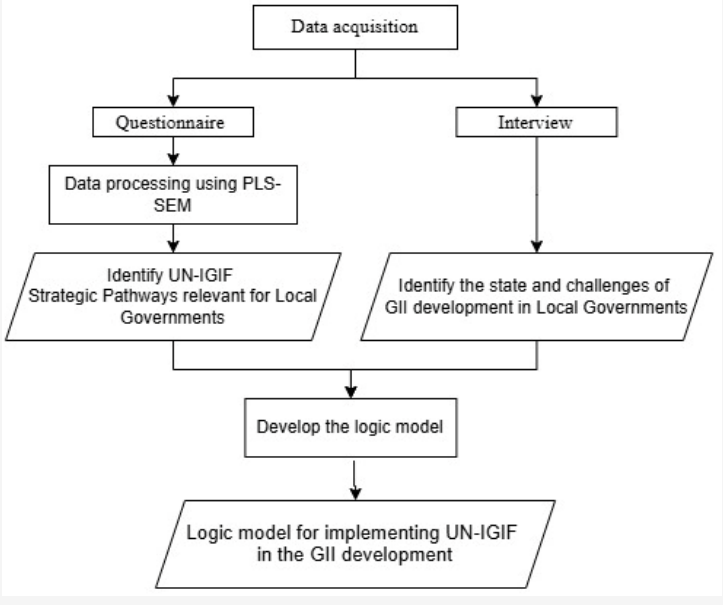

Figure 1: Research flow diagram

2.1.1 Questionnaire

Data collection through questionnaires was conducted to obtain information related to how important the indicators in the nine UN-IGIF strategic pathways are to be applied and evaluated in GII development in local governments. The respondents consist of local government employees (Province, Regency and City) working in relevant Local Government Agency (LGA), such as the Regional Planning and Development Agency (Bappeda), Agency for Communication and Informatics (Diskominfo), and Spatial Planning Agency. The questionnaire was developed based on official frameworks and policy documents. Although it was not piloted or statistically validated before data collection, its content was aligned with internationally and nationally recognized standards to ensure conceptual relevance. The questionnaire employed a Likert scale (1-5) to measure respondents' perceptions of the nine UN-IGIF strategic pathways. It consisted of two parts: the first part contains respondents' information, and the second part is related to respondents' opinions about indicators in UN-IGIF (Table 1).

Table 1: Questionnaire used to measure how important UN-IGIF indicators are in developing GII

No	Section	Items
1	Governance and institutions aim to gain political support, strengthen institutional mandates and establish a cooperative data-sharing environment. In your opinion, how important do you think these items are to be considered in the development of the governance and institutional component?	6
2	Policy and legal aim to solve existing problems by strengthening policies and laws related to geospatial information management. In your opinion, how important do you think these items are to be considered in the development of policy and legal components?	5
3	Financial aims to ensure the availability of routine and sustainable budget/finance required for the development and implementation of GII, as well as optimize the utilization of GI. In your opinion, how important do you think these items are to be considered in development for the financial component?	4
4	Data aims to ensure the availability of quality GI following the rules of interoperability so that it is ready to be shared and utilized by users. In your opinion, how important do you think these items are to be considered in development for the data component?	8
5	Innovation aims to ensure the implementation of GI using the latest cost-effective and innovative technology. In your opinion, how important do you think these items are to be considered in development for the innovation component?	6
6	Standards aim to raise awareness about the importance of implementing standards at every stage of GI implementation. In your opinion, how important do you think these items are to be considered in development for the standards component?	2
7	Partnerships aim to build cross-sectoral and interdisciplinary cooperation, coordination, and collaboration with all levels of government, the geospatial industry, the private sector, academia, the community, and international organisation. How important do you think these items are to be considered in the development of the partnerships component?	7
8	Capacity and education aim to ensure the availability of human resources for implementing Geospatial Information in each implementing unit in accordance with the needs. In your opinion, how important do you think these items are to be considered in development for capacity and education component?	6
9	Communication and engagement aim to help develop effective communication and engagement strategies to increase participation, and contributions from all stakeholders at all levels. How important do you think these items are to be considered in development for the communication and engagement component?	5
10	Geospatial Information Infrastructure is the facilities and infrastructure used to facilitate the implementation of GI through collecting, processing, storing and securing, disseminating and using GI. In your opinion, how important is the development of GII in local government to organizing the GI?	6

2.1.2 Interview

Data collection through interviews with local governments was conducted to obtain information on the current status of the development of the five GII elements at local governments, obstacles they face, and solutions implemented during GII development. Additionally, it was also aimed to gather local governments' expectations regarding the implementation of UN-IGIF in advancing GII. A structured interview consisting of five questions (see Table 2) was conducted with twelve local governments (refer to Table 3) on October 14 and 15, 2024. The local governments interviewed are finalists for the Bhumandala Award for GII in 2024, indicating that their GII status is above the average for local governments in Indonesia. This selection may introduce a positive bias, as the findings primarily reflect the conditions, experiences, and best practices of high-performing local governments. Consequently, the results may not adequately represent the challenges faced by less developed local governments. As a result, the findings may not entirely reflect the challenges or circumstances encountered by less developed local governments. Therefore, caution should be exercised when extrapolating these results to all local governments across Indonesia, particularly those with limited resources, lower institutional capacity, or less exposure to national geospatial initiatives. To achieve a more balanced and comprehensive understanding, broader studies involving a more diverse sample of regions, particularly those that are in the early stages of GII development, are necessary.

2.2 Identifying UN-IGIF Strategic Pathways which Local Governments Can Implement

The questionnaire data were processed using the PLS-SEM method with SmartPLS4 software. The first step involved developing a conceptual model that illustrates the relationships between latent variables and their corresponding measurement indicators and the relationships among the variables themselves, both exogenous and endogenous. The nine strategic pathways of the UN-IGIF were designated as exogenous latent variables (labelled SP-1 through SP-9).

Table 2: List of questions from the structured interview

No.	Question
1	Based on the five elements of GII, what is the progress of GII development in the implementation of NSDI in your local government?
2	What are the problems of GII development in your local government?
3	What actions have been taken, and what are the plans to solve these problems?
4	Have you ever heard about the UN-IGIF?
5	What are your expectations regarding the adoption of UN-IGIF in the development of GII in your local government in the future?

Table 3: List of interviewees

Local Government	Local Government Agency
Lampung Province	Regional Planning and Development Agency
East Java Province	Regional Planning and Development Agency
Central Java Province	Regional Public Works, Water Resources, and Spatial Planning Office
DKI Jakarta Province	Regional Public Works, Spatial Planning, and Land Affairs
South Sumatra Province	Regional Planning and Development Agency
Bandung City	Regional Public Works, Construction Development, and Spatial Planning
Palembang City	Regional Planning and Development Agency
Manado City	Regional Planning and Development Agency
Tangerang City	Regional Communication and Information Office
Bantul Regency	Regional Communication and Information Office
Kubu Raya Regency	Regional Planning and Development Agency
Purbalingga Regency	Regional Communication and Information Office

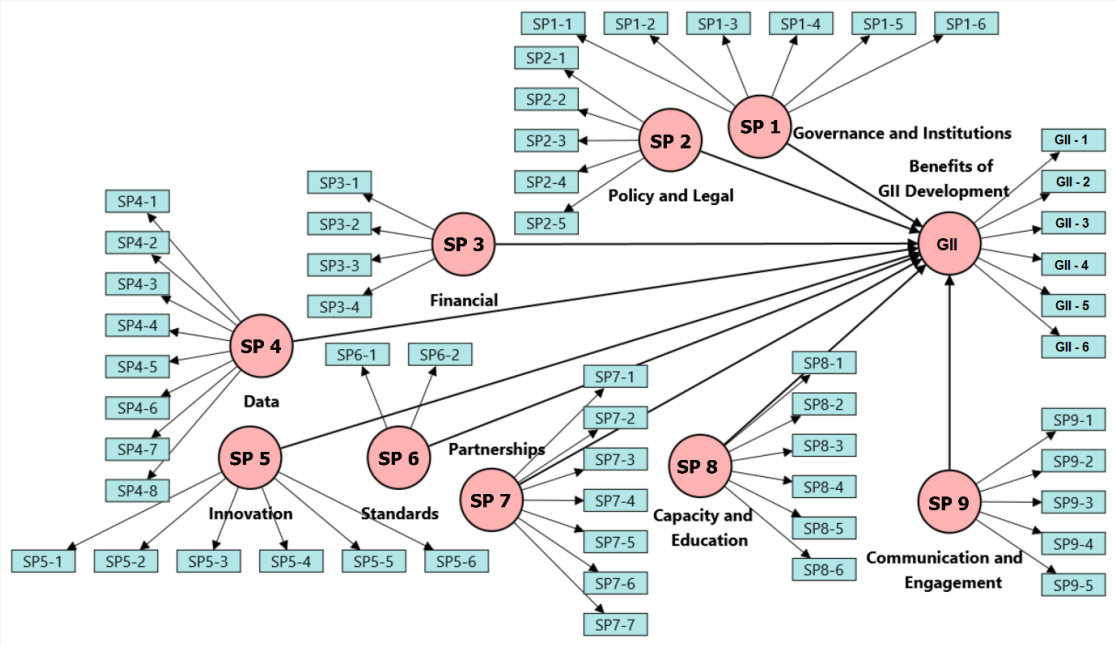

Figure 2: Conceptual model of this study

Figure 3: A basic program logic model [17]

The benefits of implementing UN-IGIF on GII development are improved collection, processing, storage and security, dissemination and use of geospatial data, and, lastly, the implementation of Regional Geospatial Information Network (RGIN), served as endogenous latent variables (GII-1 to GII-6). The questions in Table 1 were utilized as measurement indicators for each latent variable (for example, SP1-1 to SP1-6). These indicators and exogenous and endogenous variables were organized into a conceptual model for data processing using PLS-SEM, as illustrated in Figure 2.

The second step was to evaluate the measurement model. The criteria for evaluating the measurement model include the outer loading value of each measurement indicator, which should be ≥ 0.708. It is recommended to use loadings greater than 0.708. This is because such loadings show that the construct accounts for over 50% of the variation of the indicator. This results in suitable item reliability [15]. Additional criteria include internal consistency reliability, which should have a composite reliability of > 0.700. Convergent validity should also be assessed, with the Average Variance Extracted (AVE) needing to be ≥ 0.500. Lastly, discriminant validity should be verified, ensuring that the HTMT value is < 1.000 [19]. The final step was the evaluation of the structural model.

The structural model evaluation criteria check the absence of multicollinearity between variables with an inner VIF value <5 and model fit or R^2 [20]. The results of the T statistic and p-value are used to see the level of significance of each latent variable in the endogenous model (UN-IGIF strategic pathways) on the exogenous model (benefits to GII development).

2.3 Identifying the Actual Condition of GII Development in Local Government

The interview results were transcribed for each respondent. Each respondent's answer was categorized based on the transcripts. Questions related to the progress of GII development, obstacles faced, and solutions carried out are categorized based on the five elements of GII: policy, institutional arrangement, standards, technology, and human resources. The results of the interview data processing were used to verify the findings obtained in the questionnaire data processing.

2.4 Developing a Strategic Plan Using a Logic Model

The development of the logic model (Figure 3) begins by identifying the main objectives or impacts that the model aims to achieve (Impact). From this foundation, the expected results are outlined (Outcomes).

This tiered structure ensures that each outcome logically contributes to the overall impact and provides a clear pathway for monitoring progress over time. By structuring outcomes this way, stakeholders can better understand how incremental changes lead to systemic improvements in developing GII at the local government level. Next, specific activities are identified following the outcomes to support achieving those objectives (Activities). These activities are designed to address existing challenges in GII development across various regions and ensure a direct link between effort and impact. Each activity is accompanied by clear, measurable outputs that serve as performance indicators for implementation (Outputs). The final step involves mapping the required resources to implement each activity (Resources). These resources are aligned with the nine strategic pathways outlined in the UN-IGIF.

3. Results and discussion

3.1 Questionnaire Results

The questionnaire was distributed to 426 local government employees across 26 provinces, 158 regencies, and 43 cities. Participants completed the questionnaire online using Google Forms from September 18, 2024, to October 17, 2024. Out of the 426 questionnaires distributed, 103 local government employees responded, representing nine provincial governments, 27 regencies, and 14 cities. Although the number of respondents met the minimum sample size requirements for the study [21], the response rate of 24.2% (103 out of 426) indicates that only a portion of the targeted local governments participated. This low response rate may introduce non-response bias, as those who chose to respond could differ systematically from those who did not, potentially impacting the representativeness and generalizability of the findings.

3.1.1 Measurement model evaluation results

Outer loading was used to describe the relationship of measurement indicators to the latent variables they represent (Table 4). A high outer loading value indicates that the indicator significantly represents the latent variable. Each measurement indicator is considered valid if it has an outer loading value > 0.708. An outer loading value of < 0.708 can still be considered valid if it is between 0.400-0.708 and the latent variable has an AVE value of > 0.500 [20].

Governance and institutions (SP 1) were measured by six measurement indicators, SP1-1 to SP1-6. All measurement indicators have an outer loading value above 0.708. The outer loading value ranges from 0.735 to 0.876. The highest outer loading value is for indicator SP1-2 (0.876), which describes that the existence of a board/steering council tasked with overseeing the implementation of the Regional Geospatial Information Network (RGIN) in local governments has a significant impact in shaping good governance and institutions. On the other hand, the SP1-6 indicator, monitoring and evaluating activity implementation, has the lowest outer loading value (0.735), indicating that monitoring and evaluation of activity implementation has a relatively lower contribution to governance and institutions.

Five indicators, SP2-1 to SP2-5, measure policy and legal indicators (SP 2). Four of the five measurement indicators have an outer loading value >0.708, and one indicator, SP2-4, has an outer loading value < 0.708. The outer loading value ranges from 0.688 to 0.786. The indicator with the highest value is SP2-2 (0.786), which describes the importance of reviewing and analyzing needs in the formation of policies and legal products in producing good policies and legal products. Meanwhile, the indicator with the lowest value is SP2-4 (0.688), indicating that the licensing of each geospatial information product has a lower contribution than the other indicators.

Four indicators, SP3-1 to SP3-4, measure financial (SP 3). All measurement indicators have an outer loading value > 0.708. The outer loading value ranges from 0.739 to 0.864. The highest outer loading value is indicator SP3-2 (0.864), illustrating that the budget source for organizing activities is an important factor in supporting GII development. The lowest indicator value is SP3-4 (0.739), which indicates that the utilization of RGIN in supporting government activities has a relatively lower contribution to the financial component. Eight indicators, SP4-1 to SP4-8, measure data (SP 4). Seven of the eight measurement indicators have an outer loading value > 0.708, and one indicator, SP4-8, has an outer loading value < 0.708. The outer loading value ranges from 0.601 to 0.825. The highest value is indicator SP4-2 (0.825), which describes the availability of geospatial information lists produced by each Local Government Agency, which is very important in supporting GII development. The indicator with the lowest value is SP4-8 (0.601), indicating that the availability of data product specification documents on each geospatial information has a relatively low contribution. Innovation (SP 5) is measured by six indicators, SP5-1 to SP5-6. All measurement indicators have an outer loading value of > 0.708. The outer loading value ranges from 0.710 to 0.825. The indicator with the highest value is SP5-4 (0.825), which indicates that a geoportal connected to the national geoportal has an important impact in supporting innovation in the geospatial field.

Table 4: Outer loading values

Latent Variable	ID	Description of Measurement	Outer Loading
Governance and Institutions	SP1-1	Leadership	0.827
	SP1-2	Management board/steering committee overseeing the implementation of the Regional Geospatial Information Network (RGIN)	0.876
	SP1-3	Geospatial coordination unit	0.750
	SP1-4	Geospatial institutional governance	0.870
	SP1-5	GII development plan and implementation of RGIN	0.780
	SP1-6	Monitoring and evaluation of the implementation of activities	0.735
Policy and Legal	SP2-1	Legal and policy working group	0.705
	SP2-2	Review and needs analysis of policies and legal products	0.786
	SP2-3	Policies related to the sharing of geospatial information	0.772
	SP2-4	Geospatial information license	0.688
	SP2-5	Policies and regulations for the implementation of One Data Indonesia	0.724
Financial	SP3-1	Availability of routine and sustainable budget	0.833
	SP3-2	Budget source for organizing activities	0.864
	SP3-3	Utilization of Geospatial Information in increasing regional original revenues	0.765
	SP3-4	Utilization of RGIN to support government activities	0.739
Data	SP4-1	Identification of geospatial information needs	0.766
	SP4-2	List of Geospatial Information produced by each LGA	0.825
	SP4-3	Use of the national spatial reference system	0.756
	SP4-4	Completeness of metadata	0.776
	SP4-5	Technical guidelines for organizing geospatial information	0.761
	SP4-6	Implementation of quality management	0.818
	SP4-7	Structural arrangement of geospatial data and information	0.746
	SP4-8	Availability of data product specification documents	0.601
Innovation	SP5-1	Working groups related to geospatial innovation	0.710
	SP5-2	Geospatial innovation strategies and programs	0.757
	SP5-3	Availability of Information and Communication Technology (ICT) tools	0.819
	SP5-4	Geoportal connected to the national geoportal	0.825
	SP5-5	Availability of instruments or measuring tools for geospatial data collection.	0.772
	SP5-6	Utilization of geospatial data processing software	0.718
Standards	SP6-1	Programs related to increasing awareness of standards implementation	0.944
	SP6-2	Implementation and use of standards	0.961
Partnerships	SP7-1	Involvement of all Local Government Agencies	0.744
	SP7-2	Partnership programs with other government agencies	0.753
	SP7-3	Partnership programs with the private sector and NGO	0.766
	SP7-4	Partnership programs with universities and academics	0.787
	SP7-5	Partnership programs with foreign parties/institutions	0.768
	SP7-6	Community involvement	0.718
	SP7-7	Monitoring and supervision of partnerships	0.679
Capacity and Education	SP8-1	Working group on capacity building and education of human resources	0.787
	SP8-2	Availability of human resources	0.869
	SP8-3	Assessment and analysis of human resources needs	0.824
	SP8-4	Program plan for human resources capacity building through education	0.813
	SP8-5	Program plan for human resources capacity building through training	0.747
	SP8-6	The existence of geospatial majors in universities	0.729
Communication and Engagement	SP9-1	Working group related to communication with stakeholders	0.829
	SP9-2	Stakeholder analysis	0.825
	SP9-3	Communication and engagement strategy	0.847
	SP9-4	Stakeholder meetings or forums	0.769
	SP9-5	Utilization of geospatial information in the implementation of local action plans towards sustainable development goals	0.729
Benefits of GII Development	GII-1	Geospatial data collection	0.847
	GII-2	Geospatial data and information processing	0.886
	GII-3	Storage and security of geospatial data and information	0.874
	GII-4	Dissemination of geospatial data and information	0.783
	GII-5	Use of geospatial data and information	0.872
	GII-6	Implementation of RGIN	0.780

The indicator with the lowest value is SP5-1 (0.710), indicating that the existence of a working group in charge of conducting innovations in the geospatial field has a relatively low contribution compared to other indicators.

Standards (SP 6) are measured by two indicators, SP6-1 and SP6-2. All measurement indicators have outer loading values > 0.708. Both have high outer loading values, 0.944 for SP6-1 and 0.961 for SP6-2. These values indicate the importance of implementing and using standards in every stage of organizing geospatial information. Implementing activities to increase the awareness of all parties on the importance of standards, such as socialization and training, also has a positive impact on supporting GII development. Seven indicators, SP7-1 to SP7-7, measure partnerships (SP 7). Six of the seven measurement indicators have an outer loading value > 0.708, and one indicator, which is SP7-7, has an outer loading value < 0.708. The outer loading value ranges from 0.679 to 0.787. The highest value is indicator SP7-4 (0.787), which indicates that the existence of partnerships with universities and academics has the most significant contribution to supporting GII development. The indicator with the lowest value is SP7-7 (0.679), which indicates that monitoring and supervision of the partnership have relatively low contributions compared to other indicators.

Six indicators, SP8-1 to SP8-6, measure capacity and education (SP 8). All measurement indicators have an outer loading value > 0.708. The outer loading value ranges from 0.729 to 0.869. The indicator with the highest value is SP8-2 (0.869), which describes the availability of human resources related to the geospatial field in each Local Government Agency that significantly supports GII development. The indicator with the lowest value is SP8-6 (0.729), indicating that the existence of geospatial majors in universities in each local government has a relatively low contribution compared to other indicators. Communication and engagement (SP 9) is measured by five indicators, SP9-1 to SP9-5. All measurement indicators have an outer loading value > 0.708. The outer loading value ranges from 0.729 to 0.847. The highest outer loading value is SP9-3 (0.847), which describes a communication and engagement strategy with each stakeholder that helps establish good collaboration with each related party in supporting GII development. The indicator with the lowest value is SP9-5 (0.729), indicating that the utilization of geospatial information in the implementation of regional action plans towards sustainable development goals has a relatively low contribution compared to other indicators.

The benefits of GII development in supporting the implementation of geospatial information and RGIN are measured by six indicators, GII-1 to GII-6. All measurement indicators have an outer loading value> 0.708. The outer loading value ranges from 0.780 to 0.886. The highest outer loading value is GII-2 (0.886), which indicates that GII development significantly impacts the geospatial data and information processing steps. The indicator with the lowest value is GII-6 (0.780), indicating that GII development has a relatively low contribution to the implementation of RGIN compared to other indicators. Latent variables from SP 1 to SP 9 represent nine UN-IGIF strategic pathways that have an influence on GII development. Most measurement indicators can represent the latent variables appropriately measured with an outer loading value of > 0.708. Three measurement indicators that have an outer loading value < 0.708, namely SP2-4, SP4-8 and SP7-7, are still considered good and can be used to measure their respective latent variables because it has an outer loading value > 0.400 and an Average Variance Extracted (AVE) value > 0.500 (Table 5). Based on the AVE value of each latent variable in Table 5, all latent variables in the conceptual model have an AVE value > 0.500, so convergent validity for all variables has been met, and all measurement indicators can appropriately measure the relationship between latent variables in the conceptual model.

Table 5: AVE value of each latent variable

Variable Laten	AVE
SP 1 - Governance and Institutions	0.653
SP 2 - Policy and Legal	0.542
SP 3 - Financial	0.643
SP 4 - Data	0.576
SP 5 - Innovation	0.590
SP 6 - Standards	0.908
SP 7 - Partnerships	0.556
SP 8 - Capacity and Education	0.634
SP 9 - Communication and Engagement	0.641
GII - Benefits of GII Development	0.708

3.1.2 Structural model evaluation results

Structural model evaluation is carried out after assessing the measurement model. This evaluation aims to determine whether there is no multicollinearity between the exogenous latent variables (SP 1 - SP 9) and the endogenous variable (GII). It relies on the Variance Inflation Factor (VIF), where a value of less than 5 indicates no multicollinearity, and the R^2 value is used to gauge the strength of the structural model. As shown in Table 6, all latent variable VIF values are below 5, confirming that there is no multicollinearity among the variables. According to the data processed using SmartPLS, the model's fit evaluation shows an R^2 value of 0.720, suggesting that the structural model has moderate predictive ability [20].

3.1.3 Level of significance

Results of the t-statistic value and p-value are used to determine the level of significance of each latent variable in the exogenous model (UN-IGIF strategic path) to the endogenous model (benefits to GII development). Latent variables (nine strategic paths) are considered significant if they have a t-statistic value > 1.96 and a p-value < 0.05. Meanwhile, the direction and strength of the effect can be seen from the path coefficient value. The path coefficient value is between +1 and -1, a positive value indicates that exogenous latent variables have a positive impact on endogenous variables and vice versa; a negative value indicates that exogenous latent variables have a negative impact on endogenous variables. A path coefficient close to zero indicates that exogenous latent variables have no impact on endogenous variables. According to the T statistic and p-value presented in Table 7, only three strategic pathways significantly impact GII development when implemented: governance and institutions (SP1) (T=0.776, p=0.006), data (SP4) (T=2.284, p=0.022), and capacity and education (SP8) (T=2.177, p=0.03). All three pathways demonstrate a positive influence, ranked by their path coefficient values: governance and institutions (SP1) at 0.467, data (SP4) at 0.343, and capacity and education (SP8) at 0.322. In contrast, the remaining six strategic pathways (SP2, SP3, SP5, SP6, SP7, and SP9) do not show statistically significant effects, as indicated by p-values exceeding 0.05.

These results suggest that not all UN-IGIF strategic pathways equally affect GII development at the local government level in Indonesia. The significant impact of SP1, SP4, and SP8 highlights that key elements such as governance, data management, and human resource capacity are the most influential drivers in the current context. The lack of significance in the other pathways may indicate a misalignment between the UN-IGIF framework and the conditions of Indonesian local governments. These findings imply that policy focus and resource allocation should prioritize the pathways that have demonstrated impact. Additionally, further research is necessary to understand and adapt the remaining strategies for more effective local implementation.

Table 6: VIF value

Latent Variables	VIF
SP 1 => GII	4.121
SP 2 => GII	4.206
SP 3 => GII	4.172
SP 4 => GII	3.978
SP 5 => GII	4.256
SP 6 => GII	2.777
SP 7 => GII	2.531
SP 8 => GII	3.188
SP 9 => GII	3.579

Table 7: T statistic and p-value

Latent Variables	|T statistic|	P value	Path coefficient	Significant level
SP 1 => GII	2.776	0.006*	0.467	Significant
SP 2 => GII	0.927	0.354	-0.144	Not Significant
SP 3 => GII	1.068	0.286	-0.195	Not Significant
SP 4 => GII	2.284	0.022*	0.343	Significant
SP 5 => GII	0.303	0.762	-0.053	Not Significant
SP 6 => GII	0.061	0.951	-0.007	Not Significant
SP 7 => GII	0.417	0.676	0.038	Not Significant
SP 8 => GII	2.177	0.030*	0.322	Significant
SP 9 => GII	1.247	0.213	0.169	Not Significant

3.2 Interview Results

All twelve local governments have developed five GII elements as mentioned above, namely policies, institutional arrangements, technology, standards, and human resources to support the implementation of RGIN and One Data Indonesia. In terms of policy elements, three local governments, Central Java Province, DKI Jakarta Province and Bantul Regency, have integrated RGIN implementation activities into implementing One Data Indonesia at the regional level. For example, respondents from DKI Jakarta province stated, "One Data Indonesia is the legal basis for the implementation of geospatial information, including the development of geospatial information infrastructure in Jakarta Province as regulated in Governor Regulation No. 37/2022 on One Data Indonesia at the Provincial Level. Conversely, the other nine local governments have regulated the implementation of RGIN and One Data Indonesia separately. Nevertheless, the two regulations support each other, allowing both initiatives to be implemented simultaneously. Bandung City is one example that separates the two policies, as highlighted by a representative from Bandung City: "GII development in Bandung City is part of One Data, the implementation of GII and One Data Indonesia at the City Level is regulated in the Mayor Regulation No. 36/2023 on Local Geospatial Data and Information Governance and Mayor Regulation No. 11/2023 on One Data City". These regulations reflect the institutional arrangement of RGIN, which is aligned with the institutional framework of One Data Indonesia at the regional level.

All twelve local governments have established geoportals that connect to the national geoportal and utilize open-source and commercial software to organize geospatial information. While they have all made efforts to implement standards for organizing this information, for some, these efforts are still in the early stages. For instance, East Java Province is currently in the initiation phase, meaning that each Local Government Authority (LGA) is becoming acquainted with the standards used at every step of the process. One representative noted, "Gradually, we will enhance the implementation of Geospatial Information Infrastructure (GII) in accordance with the applicable standards. For now, the LGA is preparing geospatial information by compiling a data list and creating terms of reference so our staff can become more familiar with the referenced standards."

Additionally, all twelve local governments have sought to meet their human resource needs by hiring outsourced personnel and implementing training programs to improve the skills of their existing staff. Two local governments, Bandung City and Kubu Raya Regency, stated that some local government agencies have yet to fully realize their roles and functions in implementing RGIN. Good institutional arrangements are essential in producing good-quality spatial data. Good quality data is produced when all local government agency fulfil their roles well, starting from the planning and collecting steps at the data producer, verification and quality assurance by the data custodian. The last step was to disseminate to and utilize the data by various stakeholders. East Java Province states that the use of standards at every stage of geospatial information implementation is still not optimal. The lack of available human resources in every local government agency is the most common obstacle faced by local governments. Most of the available human resources are based on contract work, which has the potential to affect the continuity of work activities due to the lack of long-term job assurance. In addition, the current human resources capacity still needs to be improved through training and skill enhancement to support GII development effectively and sustainably. Based on the interviews, the local government faces three major obstacles in developing GII: institutional arrangements, standards, and human resources.

The fifth interview question was related to the local government's expectation of implementing UN-IGIF in GII development. All twelve local governments have high expectations that the implementation of UN-IGIF can help optimize GII development. Some respondents also see several strategic pathways from UN-IGIF that can indirectly provide benefits, such as communication and engagement, and encourage all stakeholders' collaboration and engagement. Partnerships can help expand cooperation between local governments and other parties in developing GII, as it is challenging to develop GII alone, such as providing human resources and infrastructure. One of the elements in the governance and institutions' strategic pathways, namely leadership, is also expected to increase leadership awareness of the role of IG in supporting government activities.

3.3 Developing a Strategic Plan Using a Logic Model

The development logic modelling begins with determining the desired end goal. The proposed impact is the implementation of geospatial information optimized and effective, in line with the objectives of GII development in Government Regulation 45/2021. The next step is to determine the outcomes.

Based on the problems faced by the local government from the interview results, the proposed outcomes are the development of GII through the improvement of institutional arrangements, the development of GII through the implementation of standards, and the development of GII through the fulfilment of human resources. All necessary activities to achieve the desired results have been identified. Seven activities have been proposed, each generating outputs that will collectively lead to the intended outcomes. The proposed activities are as follows:

1. Conduct regular inter-agency coordination forums.
2. Organize dissemination programs to highlight the importance and benefits of implementing geospatial standards.
3. Develop technical guidelines for the implementation of geospatial information.
4. Conduct a human resource needs analysis.
5. Conduct a workload analysis.
6. Recruit civil servants with a background in geospatial disciplines.
7. Provide training and capacity-building for human resources.

The last step was to identify the resources available and needed to carry out each activity. The resource components required are taken from the results of the questionnaire, namely governance and institutions (SP 1), Data (SP 4), and capacity and education (SP 8). In addition, respondents' answers to question number five of the interviews were also used as resource components, namely partnerships (SP 7) and communication and engagement (SP 9). Standards (SP 6) are also included as resources as they relate to the strategic pathways data (SP 4). Figure 4 presents the logic model for implementing UN-IGIF in developing GII, especially the problem-solving in the twelve local governments.

According to the interviews, five problems faced by the twelve local governments were identified, namely: Lack of understanding of the roles and functions of each LGA in the implementation of RGIN, lack of standard implementation in each step of organizing geospatial information, most of the available human resources are based on contract personnel, job requirements and workload analysis has not been conducted and lack of capacity of existing personnel. A logic model for the application of UN-IGIF in GII development was developed based on the problems faced by each local government. In order to simplify the logic model development, twelve local governments were divided into five classes based on the problems they faced (Table 8).

Class one consists of four local governments: Lampung Province, South Sumatra Province, Palembang City and Bantul Regency. The problem faced by class one is the lack of availability and capacity of human resources to organize geospatial information. To solve the problem of human resource availability, it is necessary to conduct human resources procurement through the recruitment of civil servants. Recruitment of civil servants also ensures the availability of sustainable human resources. In addition, beforehand, it is necessary to conduct job requirement analysis and workload analysis on each LGA to determine the number of human resources needed. Job requirement analysis and workload analysis are also required for the recruitment of civil servants.

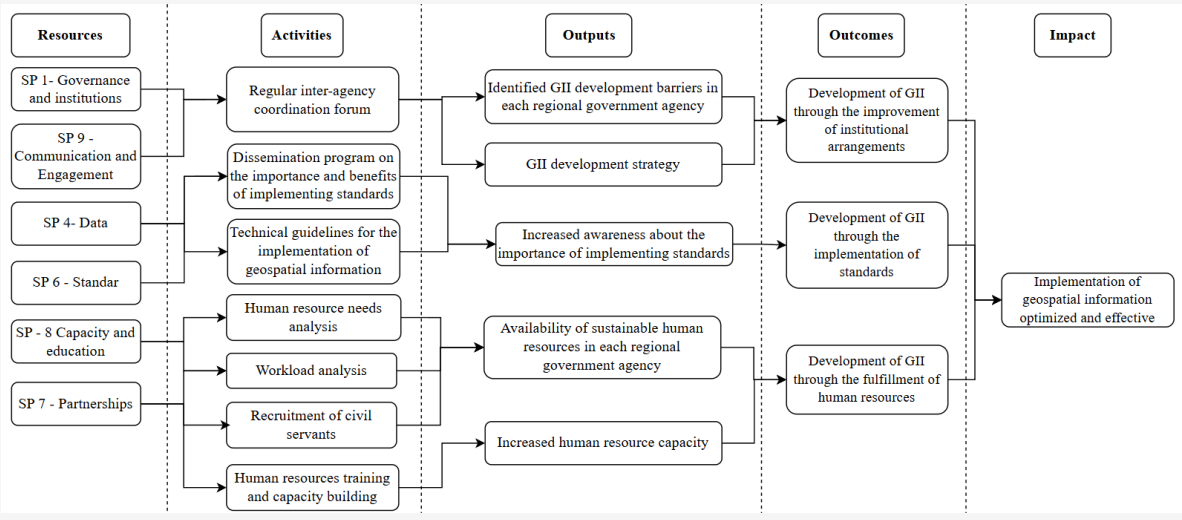

Figure 4: Logic model implementation of UN-IGIF in developing GII

Table 8: Classification of problems faced by local governments

Class	Problems faced	Local governments
Class one	Most of the available human resources are based on contract personnel, job requirements and workload analysis has not been conducted and lack of capacity of existing personnel	Lampung Province, South Sumatra Province, Palembang City and Bantul Regency
Class two	Most of the available human resources are based on contract personnel, and lack of capacity of existing personnel	Central Java Province, DKI Jakarta Province, Manado City, Tangerang City and Purbalingga Regency
Class three	Lack of standard implementation in each step of organizing geospatial information and lack of capacity of existing personnel	East Java Province
Class four	Lack of understanding of the roles and functions of each LGA in the implementation of RGIN, most of the available human resources are based on contract personnel, job requirements and workload analysis has not been conducted, and lack of capacity of existing personnel	Kubu Raya Regency
Class five	Lack of understanding of the roles and functions of each LGA in the implementation of RGIN and lack of capacity of existing personnel	Bandung City

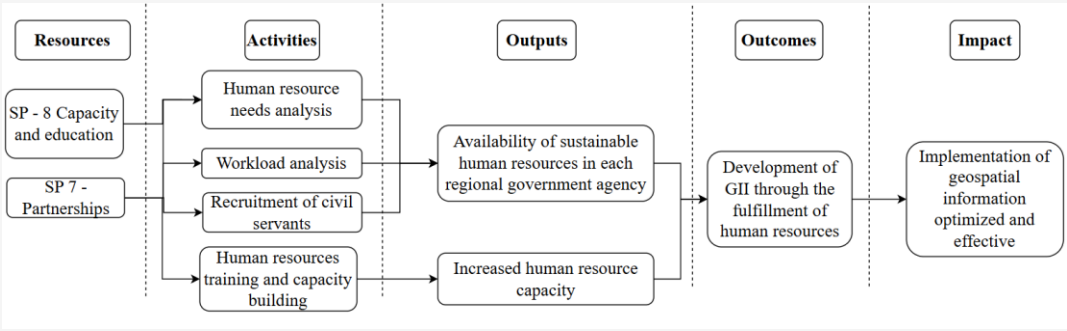

Figure 5: Logic model implementation of UN-IGIF for local government in class one

Human resources training in geospatial information is conducted to increase the capacity of human resources to organize geospatial information. Training programs can be arranged in collaboration with other government agencies, such as universities or BIG. The logic model for implementing UN-IGIF in the development of GII for class one can be seen in Figure 5. Class two consists of five local governments: Central Java Province, DKI Jakarta Province, Manado City, Tangerang City and Purbalingga Regency.

The problems faced by the second class are generally the same as those faced by the first class, namely, the lack of availability and capacity of human resources to organize geospatial information. The difference between these two classes is that the second class has already conducted a job requirement and workload analysis for each local government agency to determine the required number of human resources. Therefore, class two can immediately recruit civil servants to ensure the availability of sustainable human resources in each local government agency.

To increase human resource capacity in organizing geospatial information, training is provided in collaboration with other agencies, such as universities or BIG. The logic model for the implementation of UN-IGIF in the development of GII for class two can be seen in Figure 6.

Class three consists of one local government, namely East Java Province. The problems faced by East JavaProvince are the lack of standards at every step of the implementation of geospatial information and the lack of human resource capacity in each local government agency. To increase the awareness of the importance of applying standards, it is necessary to conduct dissemination programs related to the mandatory benefits of applying standards at each step of the implementation of geospatial information. Additionally, it is necessary to develop technical guidelines for the implementation of geospatial information, such as SOPs, that can assist each local government agency in producing geospatial information under their responsibility.

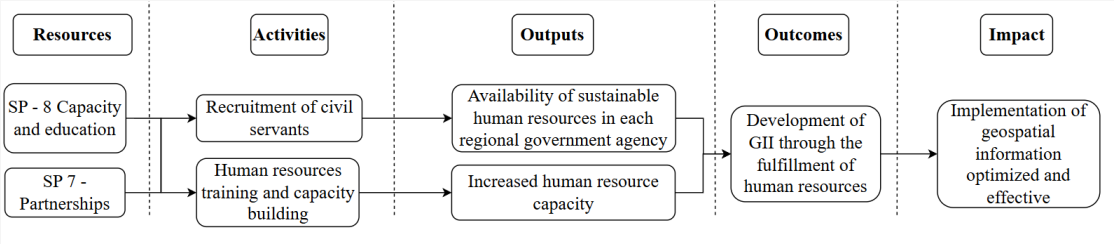

Figure 6: Logic model implementation of UN-IGIF for local government in class two

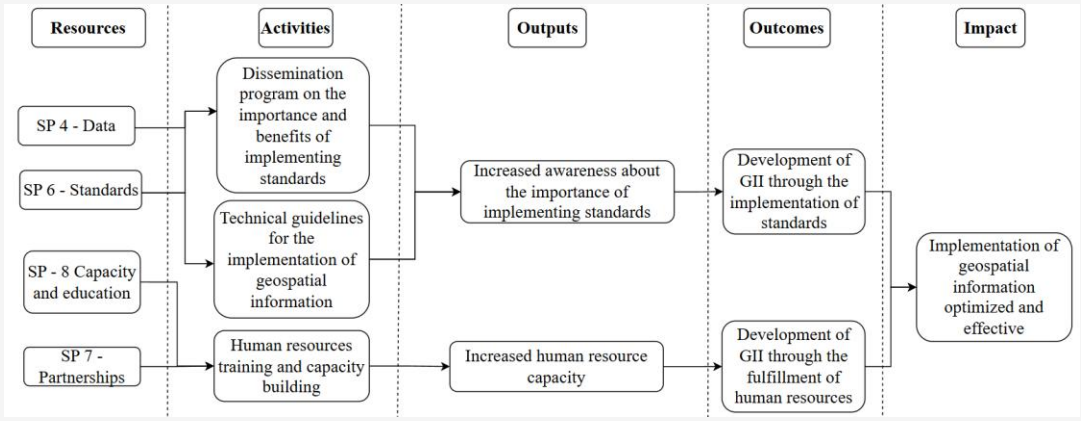

Figure 7: Logic model implementation of UN-IGIF for local government in class three

The problem of the lack of capacity of existing personnel can be improved by conducting training in the field of geospatial information, and local governments can cooperate with other government agencies, such as universities or BIG. The logic model for the implementation of UN-IGIF in the development of GII for class three can be seen in Figure 7.

Class four consists of one local government, namely the Kubu Raya Regency. The problems faced by this class are the lack of understanding of the roles and functions of each LGA in the implementation of RGIN and the lack of availability and capacity of human resources. Conducting a work coordination forum between LGA on a regular basis can improve the understanding of LGA regarding their respective roles and functions in the implementation of RGIN. The problem of human resource availability can be solved by recruiting civil servants while ensuring the sustainability of human resources. Prior to that, a job requirement and workload analysis should be conducted in each LGA to identify the number of human resources required. Training programs in collaboration with other government agencies, such as universities, can be conducted to increase the capacity of the current human resources. The logic model for the implementation of UN-IGIF in the development of GII for class four can be seen in Figure 8.

Class five consists of one local government, namely Bandung City. The problems faced by Bandung City are the lack of understanding of the roles and functions of each local government agency in the implementation of RGIN and the lack of human resource capacity. By conducting regular coordination forums, LGA can develop a clearer understanding of their roles and responsibilities in implementing RGIN. Human resource training in geospatial information can be done to improve the personnel capacity of geospatial information staff. This training can be conducted in collaboration with other government agencies, such as universities, or with BIG. The logic model for the implementation of UN-IGIF in the development of GII for class five can be seen in Figure 9.

The developed logic model can provide an overview of local government problem-solving in developing GII in their respective areas. Furthermore, the logic model can be used as a tool in the development of action plans by specifying each step and activity. The SMART, which stands for Specific, Measurable, Assignable, Realistic and Time-related, is a method designed to provide clear and measurable direction for an organization to achieve specified goals and can be used to specify each activity [22].

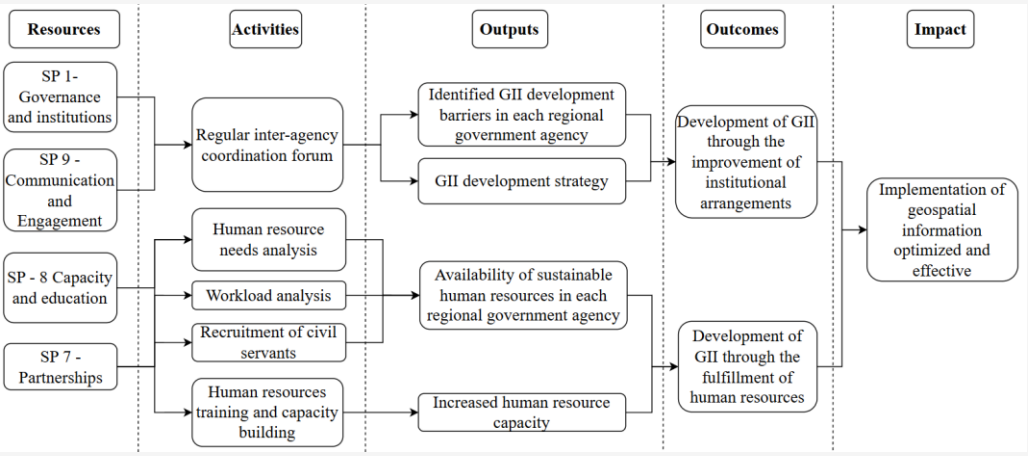

Figure 8: Logic model implementation of UN-IGIF for local government in class four

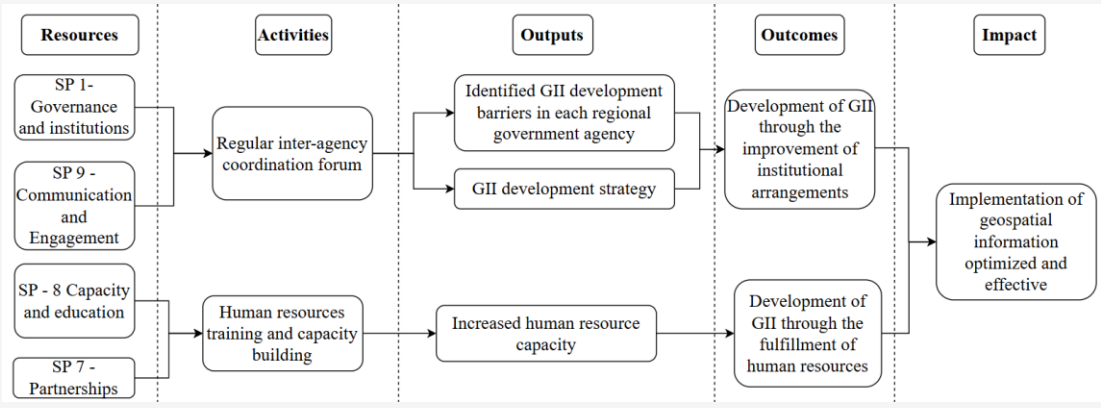

Figure 9: Logic model implementation of UN-IGIF for local government in class five

Each activity and step of the action plan clearly states what is to be achieved (Specific), has measurable success criteria (Measurable), assigns the people in charge of the activity (Assignable), is realistic and in accordance with the capacity and resources available (Realistic) and has a clear timeline for its achievement (Time-related). The developed logic model is a comprehensive framework for local governments to effectively tackle challenges associated with developing GII in their regions. By outlining a clear pathway for action, this model can be instrumental in formulating targeted action plans, detailing each necessary step and activity. Central to this process is the SMART criteria Specific, Measurable, Assignable, Realistic, and Time-related. This method not only aids in setting clearly defined objectives but also ensures that each action plan component is developed accordingly. While the proposed logic model offers a robust roadmap for enhancing GII development through the utilization of UN-IGIF, it is important to recognize that its implementation may vary significantly among local governments. Factors such as institutional maturity and resource availability can lead to differing capabilities and needs.

For local governments with limited resources, a phased or modular approach is more suitable. This approach could begin with establishing the five fundamental elements of the Indonesian GII framework, which serve as the cornerstone for more sophisticated geospatial initiatives. In addition, fostering collaborations with national agencies, academic institutions, and peer networks from regions with advanced capabilities can provide essential expertise and technological support. By leveraging these partnerships, local governments can address knowledge gaps and enhance operational effectiveness. Once the foundational elements of the GII are in place, subsequent phases of development can harness the wealth of guidance offered by the UN-IGIF. This strategic progression not only builds a solid groundwork but also opens avenues for continuous improvement and innovation in the realm of geospatial data management, ultimately leading to more informed decision-making and enhanced governance at the local level.

Integrating the logic model alongside the SMART method provides a structured approach enabling local governments to navigate the complexities of GII development. By embracing a tailored strategy that considers local contexts and fostering collaborative efforts, governments can effectively advance their geospatial initiatives, contributing to sustainable development goals and improved service delivery to their communities.

4. Conclusion

This study demonstrates that the UN-IGIF, while initially designed for national-level implementation, can be effectively adapted to support the development of GII at the local government level in Indonesia. Based on the results of the questionnaire, three strategic pathways of the UN-IGIF showed significant and impactful effects when implemented in GII development: governance and institutions (SP 1), data (SP 4), and capacity and education (SP 8). Additionally, findings from interviews indicate that several other strategic pathways from the UN-IGIF, including standards (SP 6), partnerships (SP 7), and communication and engagement (SP 9), can indirectly lead to positive outcomes in GII development. To address the challenges of GII development through the UN-IGIF framework, a logic model was created based on the insights from questionnaires and interviews. This model aims to guide the effective mobilization of resources toward achieving planned outcomes.

It is important to note that the design of the logic model was primarily influenced by feedback from local governments that have performed notably better than their peers. This suggests that the outcomes may reflect an optimistic viewpoint, which limits the generalizability of the model to less advanced local governments and necessitates cautious application. By showcasing the successful approaches of higher-performing local governments in GII, the logic model can also be adapted for use by lower-tier governments, keeping in mind the contextual differences and challenges they may encounter.

Future research should explore practical strategies to assist less advanced local governments in their GII development, including initiatives specific to GII development and collaborative efforts between stakeholders in utilizing the UN-IGIF to accelerate progress. The primary objective of UN-IGIF development is to provide a framework for optimizing and accelerating geospatial information utilization and management at the country level. At the local government level, the UN-IGIF has been shown to have an important role in accelerating the development of GII at the local government level.

However, the significance of the UN-IGIF's components may differ based on the specific settings of local governments and their current status in utilizing geospatial information. Furthermore, local governments in various countries may adopt different strategies for implementing the UN-IGIF, reflecting their distinct contexts and challenges in managing geospatial information. This variability underscores the need for tailored approaches that address the unique challenges and opportunities within each governance environment. Comparative studies across countries can offer valuable insights into how global frameworks like the UN-IGIF can be flexibly implemented to accommodate the varying levels of Spatial Data Infrastructure (SDI) readiness within different countries, particularly at the local government level.

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References

[1] Nebert, D., (2012). *Developing Spatial Data Infrastructure: The SDI Cookbook.* [Online]. Available: http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_from_Wiki_2012_update.pdf.

[2] Rajabifard, A., Feeney, M. E. F. and Williamson, I. P., (2002). Future Directions for SDI Development. *International Journal of Applied Earth Observation and Geoinformation,* Vol. 4(1), 11–22. https://doi.org/10.1016/S0303-2434(02)00002-8.

[3] Rajabifard, A. and Williamson, I. P., (2001). Spatial Data Infrastructures: Concept, SDI Hierarchy and Future Directions. *GEOMATICS'80 Conference*, 1-10.

[4] Rolf, A., Lemmens, R. and Morales, J., (2009). A Skeleton Design Theory for Spatial Data Infrastructure. *Earth Science Informatics*, Vol. 2(4). https://doi:10.1007/s12145-009-0034-7.

[5] Masser, I., (1999). All Shapes and Sizes: The First Generation of National Spatial Data Infrastructures. In*ternational Journal of Geographical Information Science*, Vol. 13(1), 67–84. https://doi.org/10.1080/136588199241463.

[6] Lilywati, H. and Gularso, S. K., (2000). SIGNas sebagai Landasan Informasi Spasial untuk Menunjang Manajemen Pembangunan [SIGNas as the Foundation of Spatial Information to Support Development Management]. *Komputasi dalam Sains dan Teknologi Nuklir*, Vol. 11, 15–37.

[7] Sutanta, H. and Aditya, T., (2023). An Initial Model to Assess SDI Readiness of the Indonesian Local Governments. *South East Asia Workshop on Geodetic Data Sciences, Geoinformatics and Land Administration*. 7–17.

[8] Budi, S. and Sutanta, H., (2023). Worldwide Status of Geoportal and Geospatial Data Completeness at National Geoportals. *IOP Conference Series: Earth and Environmental Science*, Vol. 1276. https://doi:10.1088/1755-1315/1276/1/012071.

[9] Coetzee, S., Gould, M. and McCormack, B., (2021). Towards a Sustainable Geospatial Ecosystem beyond SDIs. 1–33. https://doi.org/10.13140/RG.2.2.22555.39203.

[10] Grus, L., Crompvoets, J. and Bregt, A. K., (2010). Spatial Data Infrastructures as Complex Adaptive Systems. *International Journal of Geographical Information Science*, Vol. 24(3), 439–463. https://doi.org/10.1080/13658810802687319.

[11] UN-GGIM. *UN-GGIM Integrated Geospatial Information Framework (IGIF)*. Global Geospatial Information Management, The United Nations Statistics Division (UN-GGIM). [Online]. Available: https://ggim.un.org/UN-IGIF/. [Accessed Jul. 10, 2024].

[12] BIG. (2022). Geospatial Information Management of Indonesia Country Report. *Tech. Rep*. [Online]. Available: https://ggim.un.org/country-reports/documents/GGIM_Report_Indonesia_2022.pdf. [Accessed Jul. 10, 2024].

[13] Ali, A., Imran, M., Jabeen, M., Ali, Z. and Mahmood, S. A., (2023). Factors Influencing Integrated Information Management: Spatial Data Infrastructure in Pakistan. *Information Development*, Vol. 39(2), 213-234. https://doi.org/10.1177/02666669211048483.

[14] Lindgren, E., (2022). *Assessing Liberia's Spatial Data Infrastructure from a Data and Standards Perspective*. Student Thesis. Department of Computer and Geospatial Sciences. University of Gävle.

[15] Hair, J. F., Risher, J. J., Sarstedt, M. and Ringle, C. M., (2019). When to use and how to Report the Results of PLS-SEM. *European Business Review*, Vol. 31(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203.

[16] Hayuningsih, A. F., (2014*). Evaluasi Kesiapan Infrastruktur Data Spasial di Pemerintah Kabupaten/Kota Menggunakan Kuesioner Evaluasi Diri Dan Technology Acceptance Model [Evaluation of Spatial Data Infrastructure Readiness in Regency/City Governments Using Self Evaluation Questionnaire and Technology Acceptance Model]*. Master Thesis. Department of Geodetic Engineering. Universitas Gadjah Mada.

[17] W.K. Kellogg Foundation, (2004). Logic Model Development Guide. W.K. Kellogg Foundation, 2004. [Ebook] Available: W.K. Kellogg Foundation.

[18] Putra, T. Y. D. and Shibasaki, R., (2018). Logic Modeling for NSDI Implementation Plan - A Case Study in Indonesia. 4*th International Conference on Geographical Information Systems Theory*, *Applications and Management*, SciTePress, 247-254. https://doi.org/10.5220/0006755502470254.

[19] Henseler, J., Hubona, G. and Ray, P. A., (2017). *Partial Least Squares Path Modeling: Updated Guidelines. Partial Least Squares Path Modeling*. Springer. https://doi.org/10.1007/978-3-319-64069-3_2

[20] Hair, J. F., Hult, T. M., Ringle, C. M. and Sarstedt, M., (2022). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM),* Third Edition. Sage Publications, Inc.

[21] Hair, J. F., Ringle, C. M. and Sarstedt, M., (2011). PLS-SEM: Indeed, a Silver Bullet. *Journal of Marketing Theory and Practice,* Vol. 19(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202.

[22] Doran, G., (1981). S.M.A.R.T-Way-Management-Review. *Management Review*, Vol. 70(11), 35–36. [Online]. Available: https://community.mis.temple.edu/mis0855002fall2015/files/2015/10/S.M.A.R.T-Way-Management-Review.pdf.