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Indonesian Big Agrarian Data: A Contextual-Based Interpretive Structural Model

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The government neglects to pay attention to village development as a result of the inaccurate data collected by numerous entities. Whereas in reality, there are many people who currently hold land tenure that might be used to grow into a community that is sustainable. This study evaluates the implementation paradigm of Indonesian Big Agrarian Data (IBAD) for sustainable villages. The study was conducted in Senawang Village, West Nusa Tenggara, using primary data from questionnaire and secondary data from literature review. An Interpretive Structural Model analysis approach was used to examine the theoretical framework, drivers, barriers, and changes in IBAD implementation involving institutions or groups. The findings suggest that implementation can benefit the community, *BPN/ATR*, and *BIG* by focusing on policy interpretation from the Coordinating Ministry for the Economy. However, the implementation faces challenges, such as the lack of a holistic data survey, map method, and data guardian. Therefore, this study recommends developing comprehensive village measurement policies and changing employee mindsets.

ABSTRACT

Introduction

Currently, Indonesia lacks a comprehensive inventory of islands and landmasses that accurately reflects its national potential. Owing to technical limitations, data recording in some sectors is still performed manually, resulting in inconsistent and inaccurate data across agencies. While Industry 4.0 has had an impact on major cities, technology diffusion in rural areas remains at the 3.0 or 2.0 level [1]. This data constraint renders data collection for the Indonesian region ineffective and results in the dissemination of inaccurate data owing to technological disparities [2–3].

In addition to the vast quantity of poorly declared scattered data, the availability of geographic data representing places/areas, such as the coordinates of points, lines, and polygons, makes the situation even more complex. For instance, in the case of paddy fields, the data utilized thus far are based solely on estimations and village-level eyewitness accounts, which are subsequently submitted to the local government to become national statistics [4–5]. This is essential because the number of paddy fields is a big issue, involving budget allocations, fertilizers, agricultural equipment, etc.

Disparities in land tenure arrangements are common in emerging countries, where several large landowners frequently underutilize the majority of their property, whereas numerous farmers manage limited areas. Rural unemployment and landlessness are increasing in most countries [6]. In contrast, Indonesia's Gini Ratio of land ownership has ranged between 0.50 and 0.72 over the past four decades, with a Gini ratio of 0.68 in 2013. This indicates that one percent of the people control 68 percent of the land in Indonesia. There has been a widening disparity between Indonesia and other Asia-Pacific nations,

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with the exception of China, during this decade. Based on the study by [7] Indonesia's Gini coefficient of income grew by 1.4% per year between 1990 and 2011, from 29.2 to 38.9. A study of 73 nations conducted between 1960 and 2000 found that countries with relatively equitable land allocation policies experienced substantial economic growth. The relationship between equitable distribution and economic expansion is significant [8].

Because of their location on state land, contentious behavior implies that these settlements are illegal. This would not be problematic if the forested areas claimed by the Ministry of Forestry were restricted to places that were actually forested. Nonetheless, a shift in function that does not hinder the growth of rural areas requires a data-driven land transfer. Land redistribution is included in the government's concept of agrarian reform, which includes policies, laws, and government activities developed and implemented in a coordinated and systematic manner [9–10].

Indonesia faces the challenge of unmapped territorial potential due to the lack of accurate data distributed among various organizations, which has led to the neglect of rural land rights and the impediment of village sustainability [11]. Hence, this study aims to explore the theoretical framework, drivers, barriers, and changes in IBAD implementation for sustainable villages involving institutions or groups using the ISM analysis approach.

Method

Study Area

The research object and location were conducted on Sumbawa Island, precisely in the Senawang Village, Orongtelu Subdistrict, Sumbawa Regency, West Nusa Tenggara. Senawang Village is categorized as a developing village. Based on the residents' livelihoods, it is an agrarian village, with the main sources of income being corn, rice, and cattle farming. Generally, the residents of Senawang Village belong to a genealogical village, meaning the population is united by blood or familial relationships. The population of Senawang Village falls into the category of a small village, numbering below 1,600 people. Senawang Village is the largest village with an area of 10,000 hectares. The research was conducted over a period of six (6) months, from February to September 2021, as indicated precisely in Figure 1.

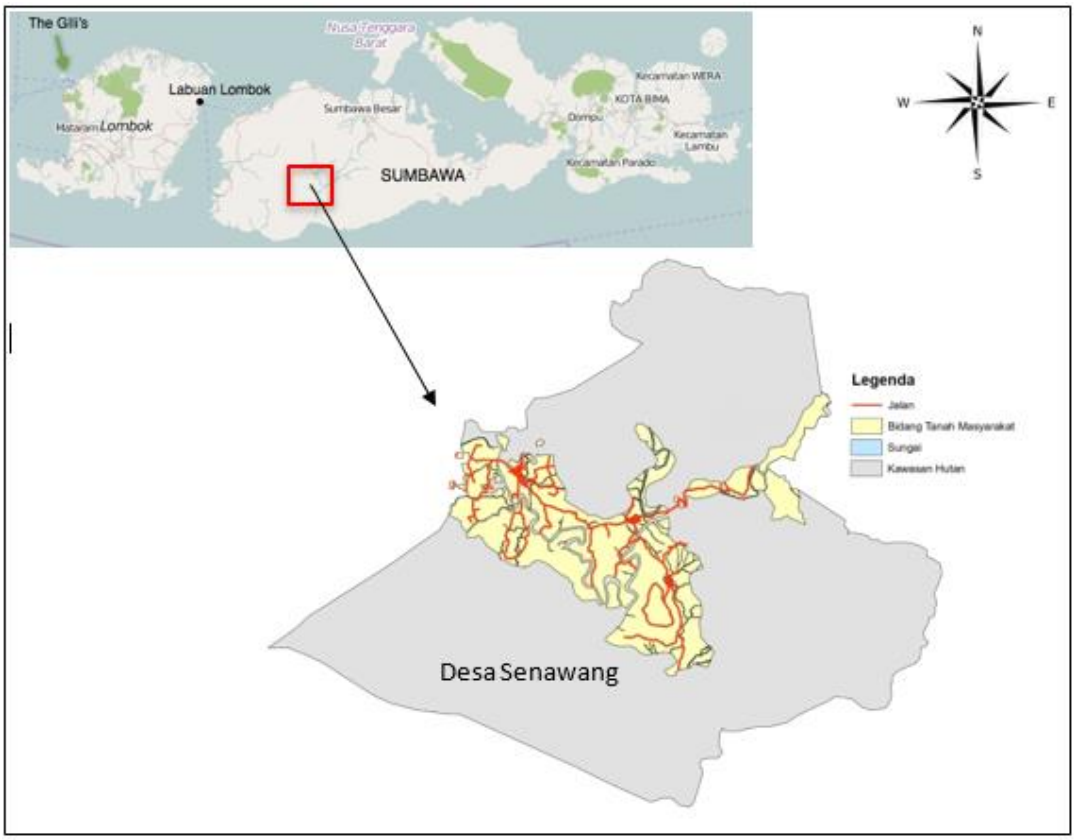

Figure 1. Senawang Village Map.

Data Collection

Primary and secondary data were used in this study. Primary data were collected through interviews and consultations with internal and external experts, and key individuals. The questionnaire was completed by 17 experts with a minimum of five years of experience in land management, including land registration, *Pendaftaran Tanah Sistematis Lengkap* (PTSL), and agrarian reform. These experts were selected for their professional expertise and track record, and were drawn from a range of organizations, including *Kementerian Agraria / Badan Pertanahan Nasional* (ATR/BPN), *Kantor Wilayah Badan Pertanahan Nasional* (Kanwil BPN), National Geospatial Information Agency, Department of Agriculture, Licensed Surveyors, Agrarian Activists, Academics, and Village Officials. As such, they possess a high level of experience and deep understanding of agrarian issues. Secondary data were derived from literature review, relevant reports, and data. The Interpretative Structural Modeling (ISM) technique was employed to develop a model for sustainable agrarian village reform.

Data Analysis

ISM is a strategic policy planning approach that involves a descriptive modeling technique, which is a tool for structuring direct relationships [12]. To implement this approach, experts familiar with the ISM concept, land concerns, and land management, particularly PTSL, were consulted during initial brainstorming sessions. Based on these discussions, several concepts or variables were identified for analysis using ISM in the context of PTSL development. These items were further divided into sub-elements and contextual relationships were established to facilitate additional pairwise comparisons.

The findings of this study were translated into a Reachability Matrix (RM) table by replacing the letters V, A, X, and O with numbers 1 and 0. The RM matrix was then adjusted to satisfy the transitivity rules and form a closed transitive matrix. This matrix was further processed to classify sub-elements based on their driver power (DP) and dependence (D) values. According to [13] sub-elements can be divided into four sectors based on their function: sector 1, autonomous variables with weak drivers and weak dependence. Sub-elements in this sector are usually unrelated to the system and may have weak relationships. Sector 2: Dependent variables with weak drivers and strong dependence; sub-elements in this sector are typically influenced by other sub-elements and are not independent. Sector 3: Linkage variables with strong drivers and strong dependence; sub-elements in this sector have unstable relationships and must be carefully examined because actions on these sub-elements can influence other variables and have amplified feedback effects. Sector 4 - Independent variables with strong drivers and weak dependence; sub-elements in this sector are often free and strong.

Result and Discussion

ISM analysis based on expert judgment. The element classification is determined using the ISM Cartesian diagram, the Driver Power (DP) value, and the Dependence (D) value. These elements are broadly divided into four categories [13]:

Sector I: Weak driver-weak dependent variables (AUTONOMOUS). In general, the sub-elements included in this sector are unrelated to the system and may have a weak relationship despite the fact that the relationship can be strong.

Sector II: Weak driver-strongly dependent variables (DEPENDENT). The sub-elements included in this sector are typically independent sub-elements.

Sector III: Strong driver-strongly dependent variables (LINKAGE). The sub-elements of this sector must be thoroughly examined because of the instability of its interrelationships. Every action on a sub-element affects other sub-elements, and positive feedback can amplify this effect.

Sector IV: Strong driver-weak dependent variables (INDEPENDENT). The sub-elements of this sector are the remaining system components and are known as independent variables. This sub-element is the most potent and principal element (Driver Power).

Data for the ISM and MICMAC analyses were collected through structured interviews, literature reviews, and discussions. MICMAC, an acronym for Matrice d'Impacts Croisés-Multiplication Appliquée à un Classement, is a method used in strategic management and planning. This method is utilized to evaluate a program and identify key variables that could be leveraged for future improvements. These consultations provided key information and helped identify important sub-elements. ISM analysis can determine the

hierarchical structure of sub-element relationships and the driving power of sub-elements. The key sub-elements have the strongest influence over the other sub-elements. MICMAC analysis classifies elements in each sector/cluster/factor group based on their DP and D values, which are calculated by summing the relevant rows and columns of the Reachability Matrix (RM).

Affected Institutions or Groups

The sixteen sub-components of the model's institutional elements or groups are as follows; 1) Community or Public, 2) Local Government, 3) Ministry of Social Affairs, 4) Ministry of Health, 5) *BPN/ATR*, 6) The Ministry of Environment and Forestry, 7) The Ministry of Public Works and Housing, 8) National Agency for Disaster Management, 9) *Badan Pusat Statistik* (*BPS*), 10) Ministry of National Development Planning, 11) Ministry of Village, Development of Disadvantaged Regions And Transmigration, 12) Coordinating Minister for the Economy, 13) *Komisi Penilihan Umum* (*KPU*), 14) Minister of Home Affairs, 15) Ministry of Energy and Mineral Resources, and 16) Geospatial Information Agency. The results of interviews with experts were classified based on the structural self-interaction matrix (SSIM), which is based on the VAXO system.

The data processing phases, which include the Structural Self Interaction Matrix (SSIM), Reachability Matrix (RM), and interpretation of the sub-elements, are presented in a sequential order. These phases are detailed in Tables 1, 2, and 3 respectively. Figure 2 provides a visual representation of the outcomes derived from the matrix analysis. The SSIM elements of affected institutions or groups are outlined in Table 1, while Table 2 models these elements using the RM. The interpretation of the sub-elements of the affected institutions or groups is further explained in Table 3. The result shows the Community, *BPN/ATR*, and Geospatial Information Agency sub-elements are in sector IV (independent), and these are the driving forces (the main driving force with the greatest degree of dependence on the sub-element). Regional Government, Ministry of Social Affairs, Ministry of Health, The Ministry of Environment and Forestry, The Ministry of Public Works and Housing, National Agency for Disaster Management, *BPS*, Ministry of National Development Planning, Ministry of Village, Development of Disadvantaged Regions and Transmigration, *KPU*, and Ministry of Energy and Mineral Resources as second driver power Figure 2 depicts the hierarchical structure of the institutions or organizations involved.

Table 1. Structural Self Interaction Matrix (SSIM) elements of affected institutions or groups.

Description of sub-elements (ij)		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Community or Public	1	X	V	V	V	V	V	V	V	V	V	V	X	V	V	V	
Local Government	2	A	V	X	V	V	V	V	V	V	V	V	A	V	V		
Ministry of Social Affairs	3	A	X	A	X	V	X	X	X	X	X	X	A	X			
Ministry of Health	4	A	X	A	X	V	X	X	X	X	X	X	A				
BPN/ATR	5	X	V	V	V	V	V	V	V	V	V	V					
The Ministry of Environment and Forestry	6	A	X	A	X	V	X	X	X	X	X						
The Ministry of Public Works and Housing	7	A	X	A	X	V	X	X	X	X							
National Agency for Disaster Management	8	A	X	A	X	V	X	X	X								
BPS	9	A	X	A	X	V	X	X									
Ministry of National Development Planning	10	A	X	A	X	V	X										
Ministry of Village, Development of Disadvantaged Regions and Transmigration	11	A	X	A	X	V											
Coordinating Minister for the Economy	12	A	A	A	A												
KPU	13	A	X	A													
Minister of Home Affairs	14	A	A														
Ministry of Energy and Mineral Resources	15	A															
Compilation from Respondents/DM: (All experts)																	

Table 2. Reachability Matrix (RM) models the elements of affected institutions or groups.

Description of sub-elements (ij)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Community or public	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Local government	2	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0
Ministry of Social Affairs	3	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
Ministry of Health	4	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
BPN/ATR	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
The Ministry of Environment and Forestry	6	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
The Ministry of Public Works and Housing	7	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
National Agency for Disaster Management	8	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
BPS	9	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
Ministry of National Development Planning	10	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
Ministry of Village, Development of Disadvantaged Regions and Transmigration	11	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
Coordinating Minister for the Economy	12	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
KPU	13	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0
Minister of Home Affairs	14	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0
Ministry of Energy and Mineral Resources	15	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0
BIG (Geospatial Information Agency)	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 3. Interpretation of sub-elements of affected institutions or groups.

Sub-Elements Are Divided Into	**3**	Levels			
Number of Opinion Revisions	**20**				
Consistency (%)	**100**	%			
Sub-Elements studied	**(i)**	**Lock To**	**Hierarchy to**	**Sector**	**DP**	**D**
Community or Public	**1**	1	3	4	16	3
Local Government	**2**	2	2	3	13	15
Ministry of Social Affairs	**3**	2	2	3	13	15
Ministry of Health	**4**	2	2	3	13	15
BPN/ATR	**5**	1	3	4	16	3
The Ministry of Environment and Forestry	**6**	2	2	3	13	15
The Ministry of Public Works and Housing	**7**	2	2	3	13	15
National Agency for Disaster Management	**8**	2	2	3	13	15
BPS	**9**	2	2	3	13	15
Ministry of National Development Planning	**10**	2	2	3	13	15
Ministry of Village, Development of Disadvantaged Regions and Transmigration	**11**	2	2	3	13	15
Coordinating Minister for the Economy	**12**	3	1	2	1	16
KPU	**13**	2	2	3	13	15
Minister of Home Affairs	**14**	2	2	3	13	15
Ministry of Energy and Mineral Resources	**15**	2	2	3	13	15
BIG (Geospatial Information Agency)	**16**	1	3	4	16	3

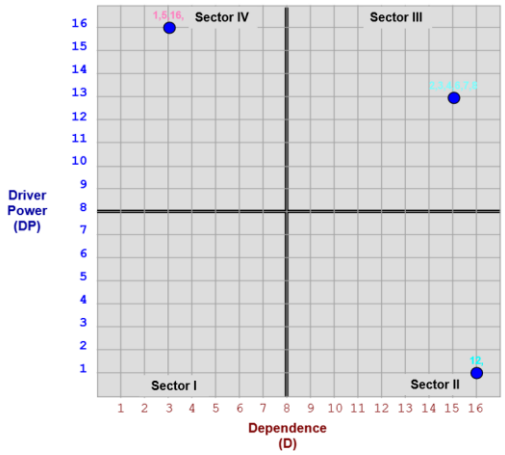

Figure 2. Matrix of the distribution of the results of the ISM study of the elements of affected institutions or groups.

The sub-elements of community, *BPN/ATR*, and the Geospatial Information Agency will be affected by the holistic village map as the existing data will be modified. *BIG* is a highly significant agency responsible for establishing data standards for geospatial data, and it plays a crucial role within the ministry, as well as other ministries and institutions. Similarly, the community, as a party, is intimately connected to all village-wide developments. Whereas the BMKG is impacted by its job as an institution examining geographical and meteorological conditions, it is impacted by its role as a data collector on productive and unproductive land [14]. Village development is a national program conducted universally throughout Indonesia with the goal of boosting the well-being of rural communities, thereby making the community one of the most essential factors [15]. Sustainable livelihoods enable communities to evaluate the sustainability of assets already owned or administered. The establishment of a sustainable village affects the community because it cannot be developed without the assistance of the local government and community [16–17].

The analysis of the matrix in the graphical distribution reveals that the community sub-elements *BPN/ATR* and *BIG* are in sector IV as driver power. These elements exhibit the highest degree of dependence among the sub-elements involved in constructing a qualitative assessment model for sustainable village design. On the other hand, the Local Government, Ministry of Social Affairs, Ministry of Village, Development of Disadvantaged Regions and Transmigration, The Ministry of Environment and Forestry, and the Ministry of Energy and Mineral Resources are identified as secondary drivers.

The MICMAC study generated sector-specific sub-elements. The elements of institutions or organizations participating in the design of a sustainable village are classified into sectors I (autonomous), II (dependent), III (linkage), and IV, according to the value of driver power (DP) and dependent variables (D) (driver power). The driving force behind sustainable community design is the driving power of the RM matrix. When a sub-element has a high driver power value and can drive additional elements.

The sub-elements of the concerned institutions or groups were divided into four sectors. Sector I (independent) had weak DP and D (Figure 3). This sector contains sub-elements that are unrelated to system relations. This sector does not have any sub-elements based on the institutions or groups involved. Sector II (dependent/influenced) had a low DP-D value for strength. The sub-elements in this sector of a sustainable village rely on those from other sectors. The Coordinating Minister for the Economy is responsible for the sub-elements of this sector. Sector III (linkage) had a strong D-DP value. This sector has sub-elements that can mutually alter its components, including local government sub-components, the Ministry of Social Affairs, the Ministry of Health, The Ministry of Environment and Forestry, The Ministry of Public Works and Housing, National Agency for Disaster Management, *BPS*, Ministry of National Development Planning, Ministry of Village, Development of Disadvantaged Regions and Transmigration, *KPU*, Minister of Home Affairs, and Ministry of Energy and Mineral Resources.

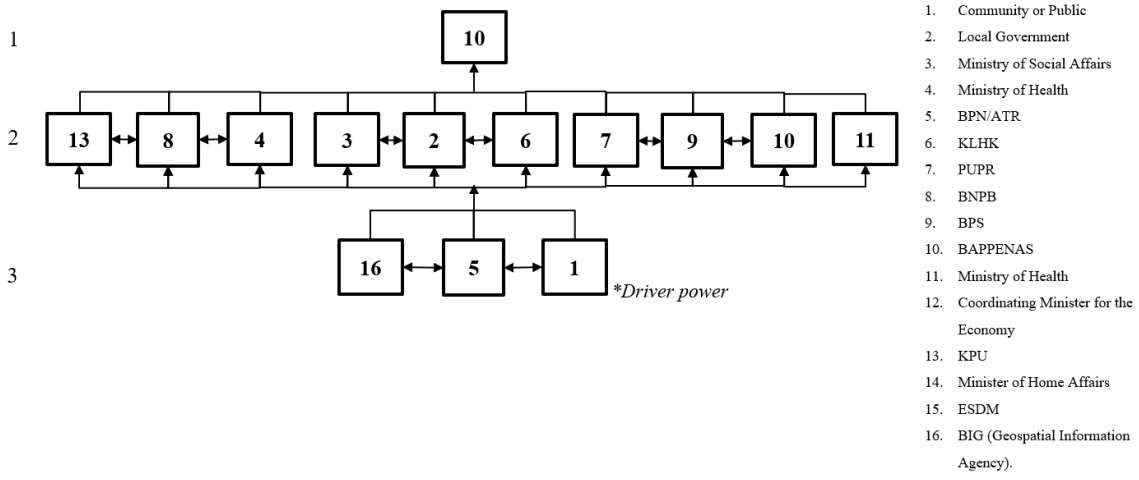

Figure 3. Model of the hierarchical structure of the affected institutions or groups.

Sector IV (independent) had a high DP-D value for weakness. These sub-elements are power drivers or determining factors for other sub-elements. This sector includes sub-elements of the Community, *BPN/ATR*, and *BIG*. In addition to physical changes, once the hamlet underwent development, there were also

changes from a more modern aspect of society [15]. This has an impact on *BIG* when the method of geospatial information use is increasingly employed by local governments [18]. To achieve sustainable village-based Indonesian Big Agrarian Data (IBAD) in Indonesia, *BIG* needs to provide implementation strategies and funds for small- and large-scale base maps for educational support maps, schools, and more precise maps for urban planning and other fundamental infrastructure projects [19].

Program Requirements

Elements of Program Requirements in the model consist of five sub-elements, namely: 1) Regulations that support holistic maps, 2) Commitment of all parties involved, 3) Support for all parties involved, 4) Interpretating the Policies of the Coordinating Ministry of Economic Affairs, 5) Develop an extensive training program for data steward. The data processing phases, which include the SSIM, RM and interpretation of the sub-elements, are presented in a sequential order. The SSIM elements of program requirements are outlined in Table 4, while Table 5 models these elements using the RM. The interpretation of the sub-elements program requirements is further explained in Table 6. Figure 4 provides a visual representation of the outcomes derived from the matrix analysis.

Table 4. Structural Self Interaction Matrix (SSIM) elements of program requirements.

Description of sub-elements (ij)		5	4	3	2	1
Regulations that support holistic maps	1	V	A	V	V	
Commitment of all parties involved	2	A	A	X		
Support for all parties involved	3	A	A			
Interpretating the policies of the coordinating Ministry of Economic Affairs	4	V				
Compilation from Respondents/DM: (All experts)						

Table 5. Reachability Matrix (RM) models the elements of program requirements.

Description of sub-elements (ij)		1	2	3	4	5
Regulations that support holistic maps	1	1	1	1	0	1
Commitment of all parties involved	2	0	1	1	0	0
Support for all parties involved	3	0	1	1	0	0
Interpretating the policies of the coordinating Ministry of Economic Affairs	4	1	1	1	1	1
Develop an extensive training program for data steward	5	0	1	1	0	1
Compilation from Respondents/DM: (All experts)						

Table 6. Interpretation of program requirements sub-elements.

Sub-elements are divided into	**4**	Levels				
Number of opinion revisions	**0**					
Consistency (%)	**100**	%				
Sub-Elements studied	**(i)**	**Lock To**	**Hierarchy**	**Sector**	**DP**	**D**
Regulations that support holistic maps	**1**	**2**	**3**	**4**	**4**	**2**
Commitment of all parties involved	**2**	**4**	**1**	**2**	**2**	**5**
Support for all parties involved	**3**	**4**	**1**	**2**	**2**	**5**
Interpretating the policies of the coordinating Ministry of Economic Affairs	**4**	**1**	**4**	**4**	**5**	**1**
Develop an extensive training program for data steward	**5**	**3**	**2**	**3**	**3**	**3**

According to the matrix analysis results in Figure 4, interpreting the policies of the Coordinating Ministry of Economic Affairs, sub-element (4) is in sector IV (independent), and all of these sub-elements operate as drivers (the main driving force is the highest with the degree of dependency). The second driving force is the regulations that support holistic maps (1). The policies of the Coordinating Ministry for the Economy are urgently needed to support the implementation of this collaboration through the coordination, synchronization, and control of policies and programs to meet the desired goals.

Based on Figure 4, no sub-elements are grouped into sector I (autonomous). Sector I (autonomous) has a weak DP-weak D. The sub-elements in this sector are not related to system relations. The sub-element commitment of all parties involved supports all parties involved and included in sector II. The sub-elements included in Sector III developed an extensive training program for data steward.

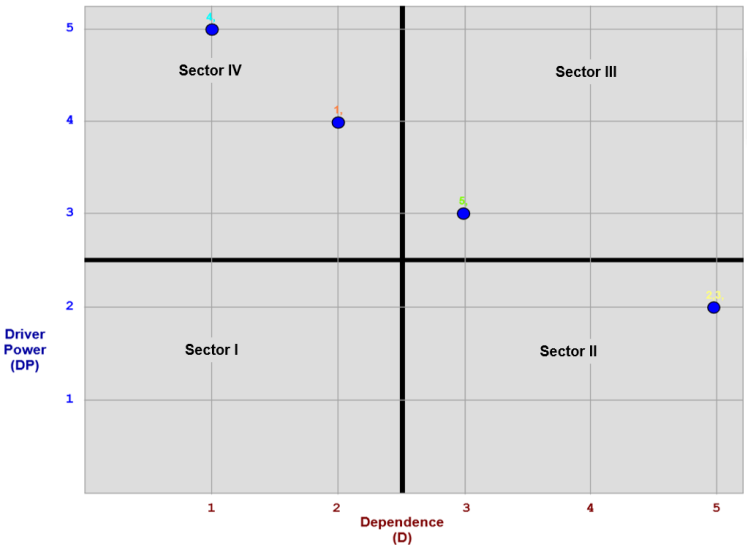

Figure 4. Matrix of the distribution of the results of the ISM study of elements of program needs.

Sector IV (independent) has a strong DP-D weak value. The sub-elements included in this sector are the power drivers or determinants of the other sub-elements. Interpreting the Policies of the Coordinating Ministry of Economics that supports a holistic map is included in sector IV. To achieve sustainable village-based IBAD, it is crucial for the Coordinating Ministry for Economic Affairs to issue a "one map one policy" directive. This ensures that disparate data sources are unified under a single reliable reference system. Implementing the One Map One policy would be a significant step towards centralizing national power and enhancing the state's authority over its borders, in line with the country's expansion goals [20]. As a result, the Coordinating Ministry for Economic Affairs has full control over spatial planning and the development of related policies [20]. The hierarchical structure model of the elements of the program requirements shown in Figure 5.

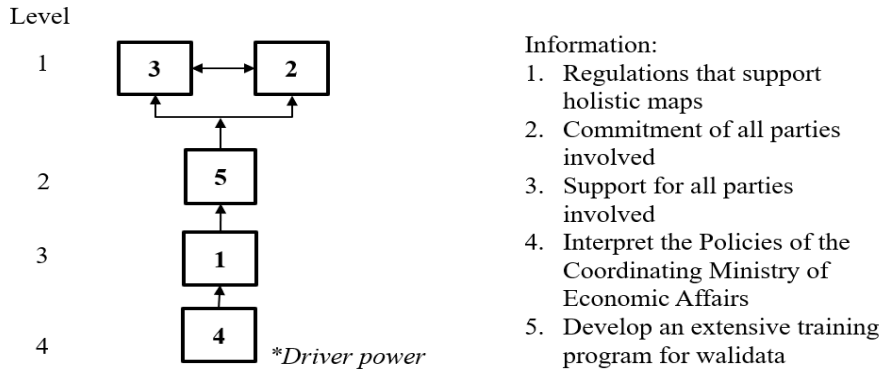

Figure 5. Hierarchical structure model of program requirement elements.

Main Constraints

The main constraints in the model consist of six sub-elements; 1) the competent data steward have not yet been formed, 2) there is currently no holistic map and data survey approach, 3) the survey application system is still in development, 4) not all licensed surveyors have the ability to carry out socio-agrarian surveys, 5) Physical Representative and Juridical Representative mindsets simply to acquire measurements, and 6) there is no holistic measurement policy. The following are the results of the data processing include the SSIM, RM and interpretation of the sub-elements, are presented in a sequential order. The SSIM elements of main constraint are outlined in Table 7, while Table 8 models these elements using the RM. The interpretation of the sub-elements main constraint is further explained in Table 9. Figure 6 provides a visual representation of the outcomes derived from the matrix analysis.

Table 7. Structural Self Interaction Matrix (SSIM) main constraint element.

Description of sub-elements (ij)		6	5	4	3	2	1
The competent data steward has not yet been formed	1	V	V	V	V	X	
There is currently no holistic map and data survey approach	2	V	V	V	V		
The survey application system is still in development	3	A	A	A			
Not all licensed surveyors have the ability to carry out socio-agrarian surveys	4	A	A				
Physical Representative and Juridical Representative mindsets simply to acquire measurements.	5	X					
Compilation of Respondents/DM (All experts)							

Table 8. Reachability Matrix (RM) models the main constraint elements.

Description of sub-elements (ij)		1	2	3	4	5	6
The competent data steward has not yet been formed	1	1	1	1	1	1	1
There is currently no holistic map and data survey approach	2	1	1	1	1	1	1
The survey application system is still in development	3	0	0	1	0	0	0
Not all licensed surveyors have the ability to carry out socio-agrarian surveys	4	0	0	1	1	0	0
Physical Representative and Juridical Representative mindsets simply to acquire measurements	5	0	0	1	1	1	1
There is no holistic measurement policy	6	0	0	1	1	1	1
Compilation from Respondents/DM: (All experts)							

Table 9. Interpretation of main constraint sub-elements.

Sub-elements are divided into	**4**	Level
Number of opinion revisions	**0**	
Consistency (%)	**100**	%

Sub-Elements studied	**(i)**	**Lock To**	**Hierarchy to**	**Sector**	**DP**	**D**
The competent data steward has not yet been formed	**1**	1	4	4	6	2
There is currently no holistic map and data survey approach	**2**	1	4	4	6	2
The survey application system is still in development.	**3**	4	1	2	1	6
Not all licensed surveyors have the ability to carry out socio-agrarian surveys	**4**	3	2	2	2	5
Physical Representative and Juridical Representative mindsets simply to acquire measurements	**5**	2	3	3	4	4
There is no holistic measurement policy	**6**	2	3	3	4	4

The matrix analysis results in Figure 6 indicate that the sub-elements of competent data steward have not yet been formed, and there is currently no comprehensive map and data survey approach included in sector IV (independent) that acts as driver power, with the main driving force being the highest obstacle. With the information acquired, data steward are thought to play a crucial role because they can define the criteria that can be used to assess the applicability of current data in the field [21]. Therefore, if data steward do not exist, the accuracy of the data will not be realized. Data steward must strike a balance between fine-scale data and possible field enhancements [22].

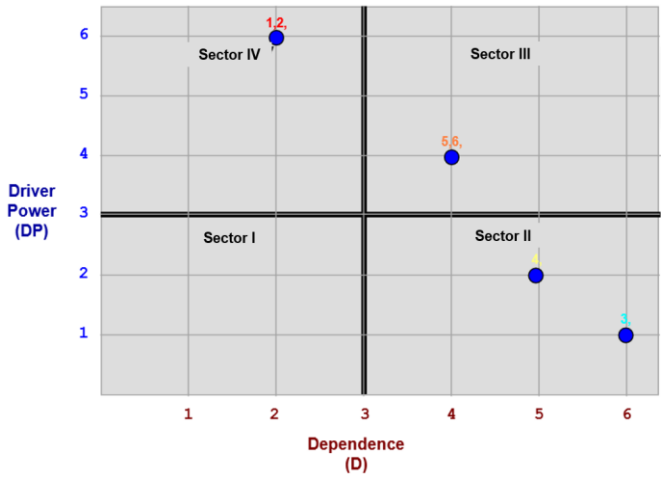

Figure 6. The distribution matrix of the results of the ISM study of the main constraint elements.

Physical Representative and Juridical Representative mindsets simply acquire measurements, and there is no holistic measurement policy, which is a second driver of power in sector III. The sub-elements included in Sector II are as follows: the survey application system is still in development, and not all licensed surveyors have the ability to conduct socio-agrarian surveys. Based on the main constraint element, there are no sub-elements included in Sector I. The hierarchical structure of the elements of the institution or group involved is shown in Figure 7.

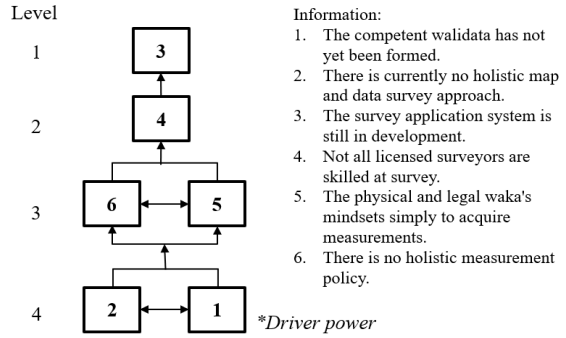

Figure 7. The hierarchical structure model of the main constraint elements.

Required Changes

Elements of required changes in the model consist of 5 sub-elements, namely: 1) The development of holistic village measurement policies/regulations, 2) Transforming employee perspectives, 3) Formed Data steward, 4) Standardization of holistic data and mapping survey procedures, 5) Survey system discussion. The results of the matrix analysis in Figure 8 show that the sub-elements for the development of holistic village measurement policies/regulations and transforming employee perspectives [23] are in sector IV (independent). All of these sub-elements act as driver power, with the highest main driving force and the degree of dependence on the next sub-elements. The current challenges for national development based on villages and suburban areas include the availability of adequate Geospatial Data and Information, both in terms of scope of availability and level of detail, which is still limited. Therefore, it must be encouraged through a holistic village measurement policy [18].

This is due to the fact that this concept describes an adaptable agricultural system that responds to various social, ecological, and economic factors. By implementing clear data policies, governments can safeguard or enhance a region's potential value [24–26] have also advocated for the continuation of policies aimed at efficiently consolidating agricultural land, as failure to do so may lead to villages becoming marginal activities. The following are the results of the data processing include the SSIM, RM and interpretation of the sub-elements, are presented in a sequential order. The SSIM elements of required changes are outlined in Table 10, while Table 11 models these elements using the RM. The interpretation of the sub-elements required changes is further explained in Table 12. Figure 8 provides a visual representation of the outcomes derived from the matrix analysis.

Table 10. structural Self Interaction Matrix (SSIM) elements of required changes.

Description of Sub-Elements (ij)		5	4	3	2	1
The development of holistic village measurement policies/regulations	1	V	V	V	X	
Transforming employee perspectives	2	V	V	V		
Formed data steward	3	V	A			
Standardization of holistic data and mapping survey procedures	4	V				
Compilation from respondents/DM: (All experts)						

Table 11. Reachability Matrix (RM) models the elements of required changes.

Description of sub-elements (ij)		1	2	3	4	5
The development of holistic village measurement policies/regulations	1	1	1	1	1	1
Transforming employee perspectives	2	1	1	1	1	1
Formed Data steward	3	0	0	1	0	1
Standardization of holistic data and mapping survey procedures	4	0	0	1	1	1
Survey system discussion	5	0	0	0	0	1
Compilation from respondents/DM: (All experts)						

Table 12. Interpretation of sub-elements of required changes.

Sub-elements are divided into	**4**	Levels				
Number of Opinion Revisions	**0**					
Consistency (%)	**100**	%				
Sub-Elements studied	**(i)**	**Lock To**	**Hierarchy**	**Sector**	**DP**	**D**
The development of holistic village measurement policies/regulations	**1**	**1**	**4**	**4**	**5**	**2**
Transforming employee perspectives	**2**	**1**	**4**	**4**	**5**	**2**
Formed Data steward	**3**	**3**	**2**	**2**	**2**	**4**
Standardization of holistic data and mapping survey procedures	**4**	**2**	**3**	**3**	**3**	**3**
Survey system discussion	**5**	**4**	**1**	**2**	**1**	**5**

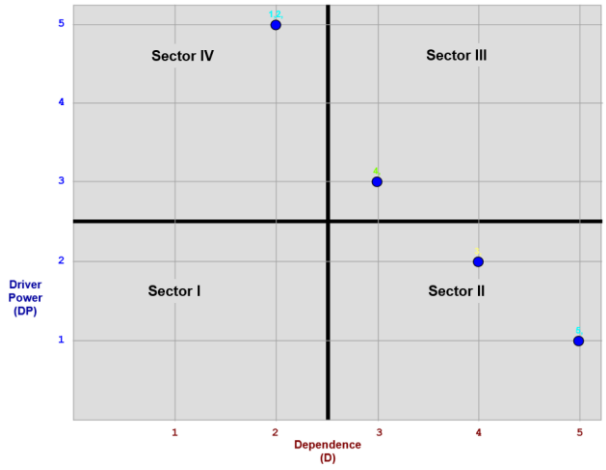

Figure 8. The distribution matrix of the results of the ISM study elements of required changes.

Meanwhile, the standardization of holistic data and mapping survey procedures is the second driver of power in sector III. The sub-elements included in sector II are formed data steward and survey system discussion. Based on required changes element, there are no sub-elements included in sector I. The hierarchical structure of the elements of the institution or group involved is shown in Figure 9.

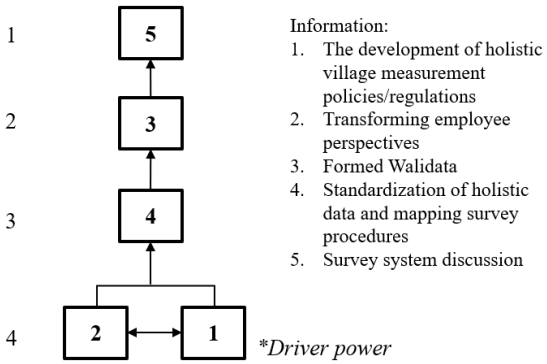

Figure 9. Model of the hierarchical structure of the elements of required changes.

Stakeholders Involved

The stakeholders involved in the model consisted of nine sub-elements: 1) Selected Village Officials, 2) Community or Public, 3) Licensed Surveyors, 4) physical representatives, and 5) juridical representatives. The following are the results of the data processing by presenting a matrix starting from the SSIM Matrix, RM, and interpretation of the results. The matrix analysis results in Figure 10 show that the stakeholders involved in the licensed survey are in sector IV (independent) as the driver power (the main driving force is the highest element of the changes that must be made). The significance of implementing the actions of a licensed surveyor in measurement and mapping is that they guarantee the accuracy and reliability of the

data collected [27–28]. One of the solutions to ensure that the data collected is accurate and reliable is to have a licensed cadastral surveyor present.

A cadastral surveyor has expertise and skills in carrying out land surveying and mapping processes in the framework of land registration and is responsible for survey data and land mapping [29]. This is also supported by research by Molen et al. [30] where licensed land surveyors have a role in land administration and thus can make a difference when the existing administration system is unable to meet the desired demands. The main keys of a licensed surveyor are land management and administration. The following are the results of the data processing include the SSIM, RM and interpretation of the sub-elements, are presented in a sequential order. The SSIM elements of stakeholders involved are outlined in Table 13, while Table 14 models these elements using the RM. The interpretation of the sub-elements stakeholders involved is further explained in Table 15. Figure 10 provides a visual representation of the outcomes derived from the matrix analysis.

Table 13. Structural Self Interaction Matrix (SSIM) stakeholders involved elements.

Description of sub-elements (ij)		5	4	3	2	1
Selected village devices	1	X	X	A	V	
Community or public	2	A	A	A		
Licensed surveyor	3	V	V			
Deputy physical	4	X				
Compilation from respondents/DM: (all experts)						

Table 14. Reachability Matrix (RM) models the stakeholders involved elements.

Description of sub-elements (ij)		1	2	3	4	5
Selected village officials	1	1	1	0	1	1
Community or Public	2	0	1	0	0	0
Licensed surveyors	3	1	1	1	1	1
Physical representative	4	1	1	0	1	1
Juridical representative	5	1	1	0	1	1
Compilation from respondents/DM: (All experts)						

Table 15. Interpretation of stakeholders involved in the sub-elements.

Sub-elements are divided into	**3**	Levels				
Number of opinion revisions	**0**					
Consistency (%)	**100.00**	%				
Sub-elements studied	**(i)**	**Lock To**	**Hierarchy to**	**Sector**	**DP**	**D**
Selected village officials	**1**	**2**	**2**	**3**	**4**	**4**
Community or public	**2**	**3**	**1**	**2**	**1**	**5**
Licensed surveyors	**3**	**1**	**3**	**4**	**5**	**1**
physical representative	**4**	**2**	**2**	**3**	**4**	**4**
juridical representative	**5**	**2**	**2**	**3**	**4**	**4**

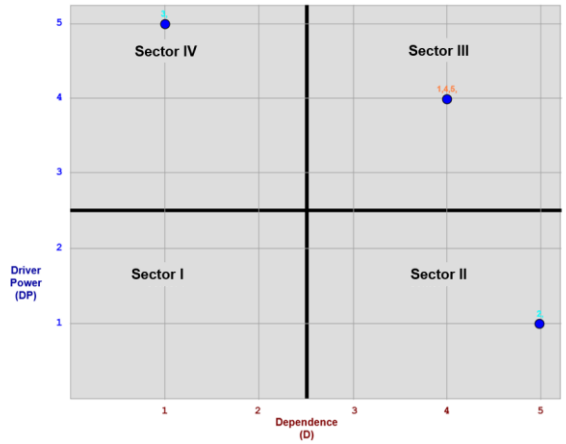

Figure 10. Matrix of the distribution of the results of the ISM study on the stakeholders' involved elements.

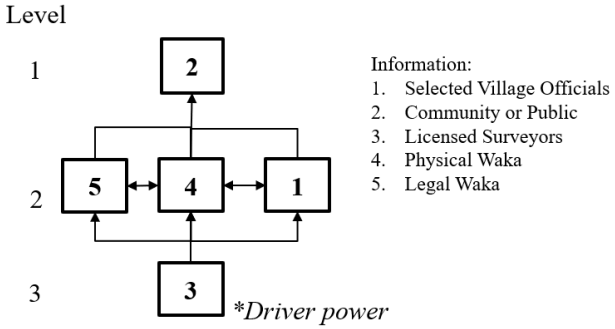

Figure 11. Model of the hierarchical structure of the stakeholder elements involved.

Selected village officials, physical representatives, and juridical representatives are the second-power drivers included in sector III. The sub-elements included in sector II is community or public, and there are no sub-elements included in sector I. Figure 11 shows the hierarchical structure of the elements of the institution or group involved. The key elements and sub-elements are listed in Table 16.

Table 16. The matrix of the results of the synthesis of the ISM method.

	ISM technique		
Element	Independent sub-elements	Linkage sub-element	Affected dependent sub - element and autonomos sub-element
Institutions or groups affected	1) Community or Public, 5) *BPN/ATR*, 16) *BIG* (Geospatial Information Agency)	2) Local Government, 3) Ministry of Social Affairs, 4) Ministry of Health, 6) The Ministry of Environment and Forestry, 7) The Ministry of Public Works and Housing, 8) National Agency for Disaster Management, 9) *BPS*, 10) Ministry of National Development Planning, 11) Ministry of Village, Development of Disadvantaged Regions and Transmigration 13) *KPU*, 14) Minister of Home Affairs, 15), Ministry of Energy and Mineral Resources	12) Coordinating Minister for the Economy
Program requirements	1) Regulations that support a holistic map, 4) Interpretating the Policies of the Coordinating Ministry of Economic Affairs	5) Develop an extensive training program for data steward	2) Commitment of all parties involved 3) Support of all parties involved
Main obstacle	1) The competent data steward has not yet been formed, 2) There is currently no holistic map and data survey approach	5) Physical Representative and Juridical Representative mindsets simply to acquire measurements, 6) There is no holistic measurement policy.	3) The survey application system is still in development. 4) Not all licensed surveyors are skilled at survey.
Changes That Must Be Made	1) The development of holistic village measurement policies/regulations, 2) Transforming employee perspectives	4) Standardization of holistic data and mapping survey procedures	3) Formed Data steward, 5) Survey system discussion
Institutions or groups involved	3) Licensed Surveyor,	1) Selected Village Officials, 4) Physical Representative, and 5) Judicial Deputy	2) Community or Public

Sustainable Village Model

The ISM analysis results indicate that data custodians, licensed surveyors, and selected village officials are the key factors that can influence other stakeholders in building sustainable village models. The success of agrarian reform depends on the involvement of key stakeholders, especially civil society/agrarian activists, the function of land plot maps related to ATR/BPN and the significance of small-scale big data. These stakeholders require interviews with landowners and land plot mapping (PTSL) to create comprehensive village maps and IBAD, and to support the identification of the subject and object of agrarian reform and existing forces into one integrated map, data, and policy.

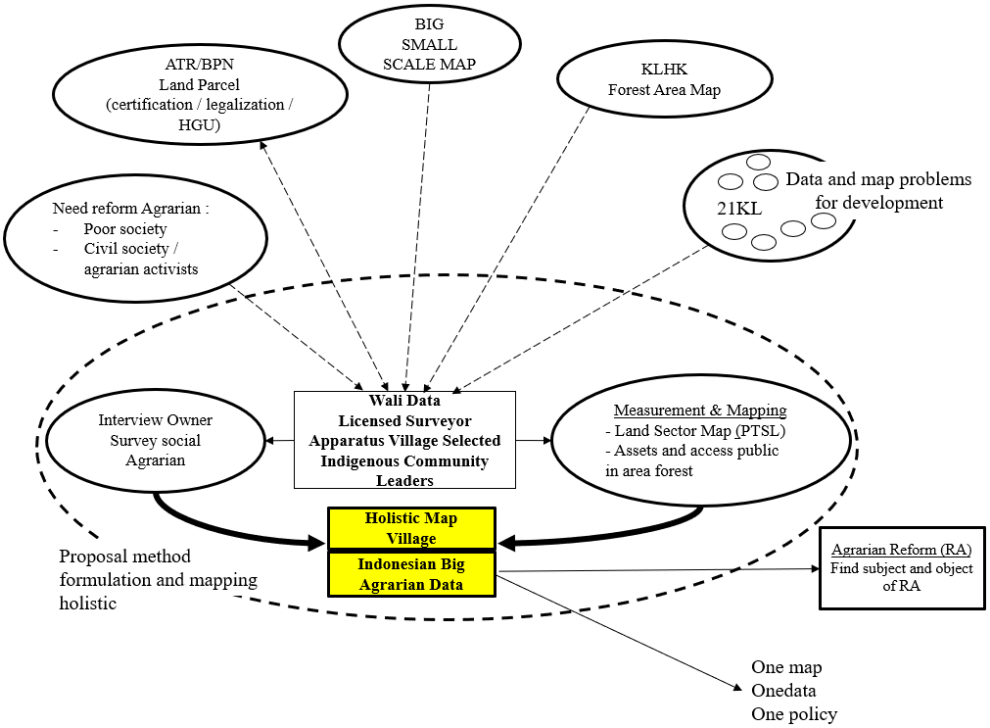

Figure 12. The sustainable village model.

Conclusion

The lack of accuracy in the data dispersed across numerous organizations in Indonesia has resulted in the unmapping of Indonesia's territorial potential. This has led to the government's disregard of the land tenure of rural residents, which can impair the sustainable development of villages. Despite the existence of *BIG* data technologies that can facilitate the government's process of discovering the required data, this is not the basic case. The results of the analysis of the sustainable village-based IBAD implementation model indicate that the Community or Public, *BPN/ATR*, and *BIG* are the institutions or groups affected by building a sustainable village model, while the stakeholders involved are Licensed Surveyors. Regulations that support a holistic map and interpret the policies of the Coordinating Ministry of Economic Affairs are the primary driver program requirements. However, the most significant barrier to its implementation is that competent data steward have not yet been formed, and there is currently no holistic map or data survey approach. The required changes consist of the development of holistic village measurement policies/regulations and the transformation of employee perspectives.

To address the challenges of inaccurate data and promote sustainable village development in Indonesia, a centralized data governance framework can be established. This would involve creating a dedicated agency to oversee data management and ensure accuracy across organizations and institutions. The agency would work with stakeholders such as the Community or Public, *BPN/ATR*, *BIG*, and Licensed Surveyors to develop standardized data protocols. Regular data audits and quality checks can be implemented to maintain data integrity. This framework can improve data accuracy, support evidence-based decision-making, and foster long-term sustainable village development.

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