Model of agro-eco-village by using interpretative structural modeling for improving sustainable development

MDD Maharani

University of Jakarta's Sahid, Department of environmental engineering, JL. Prof. Dr. Supomo SH No. 84, Tebet, South Jakarta 12870

E-mail: mayasudarsono@gmail.com

Abstract. Governance of agricultural waste and potential environmental problems such as pollution, damage ecosystems, degradation and depletion of natural resources in rural areas require serious attention from the Government. The benefits of the study Model of Agro-Eco-Village as an ingredient in the preparation of innovation, research and development, as well as input document a long term development plan in Indonesia period 2020-2025. The purpose of the study is to formulate of Model of agro-eco-village by using Interpretative Structural Modeling for improving sustainable development. Method study of using Interpretative Structural analysis Modeling (ISM). This method uses expert judgment in data retrieval. Final results showed the consistency of the reachability of expert opinions (93-100) %. The ISM method result as the key institutional at the village is Farmer-owned enterprise or business entity belonging to the Village. The key purpose is the farm activity monitoring is driven to produce low carbon. The required changes are activities to recycle agricultural biomass resources and strengthening of the system of rural agribusiness. The affected sectors of society are the Farm Worker and Farm Tourism. As the key indicator is the increased exchange rate of the farmer, and the key constraints are the regulation of rural water resources governance.

1. Introduction

Governance of agricultural waste and potential environmental problems such as pollution, damage ecosystems, degradation and depletion of natural resources in rural areas require serious attention from the Government. The other fact is strengthened by the data that the number of cars worldwide projected 2 billion in the year 2030, so would increase rural and urban air pollution. Projected could become the top environmental cause of premature mortality by the year 2050 [1]. The benefits of the study Model of Agro-Eco-Village as an ingredient in the preparation of innovation, research, and development, as well as an input document a long term development plan in Indonesia period 2020-2025.

Eco-Village as a concept was first introduced in the 90s, but Eco-Villages never ceased to exist throughout history. These represented the idea of a sustainable and just society that meets the interests of ordinary people everywhere. The Eco-Village movement as a global phenomenon evolved from an initiative taken by Gaia Trust in 1995. Ross and Hildur Jackson (from Denmark) founded Gaia Trust, which funded and enabled the creation of the Global Ecovillage Network (GEN). Their motivation was fundamentally based on a need for a new paradigm [2]. The Eco-Village is a synergism with eco-city
that has the following definitions. The definition of eco-cities is newly created urban area, it was constructed with the intention to create a model city of, inter alia, ecologically benign technology, public transport, fresh air, and minimal carbon emissions [3-4].

In Indonesia, the new paradigm of Eco-Village development started from West Java province in 2018, including Bogor and Bekasi regency. Potential Investment Projects of ecovillage development from Bogor City is Water Tourism from Ciliwung River, that will be presented on Monday, 8th July 2019 in Brisbane.

The Ciliwung River is the Ordo-1 river that is still a surface water source needed for agriculture. The harmonization of agricultural affairs, economic-based, social and ecological tourism is expected to support the development of Agro-Eco-Village model concept. Agricultural and tourism activities that are more oriented to the economic dimension, are expected to act to allocate costs for the preservation of natural and environmental resources.

2. Subject Matter
The concept and technical implementation of Agro-Eco-Village refers to exchanges/interchangeably between agribusinesses sectors where the disposal of one agribusiness becomes the source of raw materials from other agribusinesses [5-6].

2.1. Interpretive Structural Modeling
Interpretive Structural Modeling (ISM) is a modeling technique developed for strategy policy planning [7-12]. As a descriptive modeling technique, ISM is also a structuring tool for a direct relationship. The ISM is a sophisticated planning methodology used to identify and conclude a wide variety of relationships between factors in a particular problem or issue. The basis of decision making in ISM technique is group. The resulting structural Model is intended to photograph complex problems of a system through carefully designed patterns using graphics and sentences. The ISM technique is able to transform a mental model that is unclear to be a visible system model. An interpretive structural model (ISM) is presented with elements classified using Matriced the impact of the thrust of Applique'e a UN Classement (MICMAC).

According to Saxena (1992) It is stated that the ISM technique provides a base analysis program where the information produced is very useful in policy formulation as well as strategic planning. The concept of Saxena (1992), the program is grouped into nine elements, namely: (1) The affected community sector, (2) the needs of the program, (3) Program objectives, (4) possible changes, (5) Major constraints, (6) Benchmarks to assess each objective, (7) Activities required for action planning, (8) Measures of activity to evaluate the results achieved by each activity, and (9) institutions involved in the implementation of the program. Referring to the concept, the formulation of policies and effective programs that support "Agro-Eco-Village" in this study prioritizes three elements, namely (i) The objectives of the program, (ii) Constraints, and (iii) of the institution involved in the program.

The three things that the ISM method generates include: (i) the key element, (ii) The structure of the element hierarchy, and (iii) the grouping of elements in four classification sectors. The four sectors of the classification are sector I or independent, sector II or linkage, sector III or dependent, and sector IV or autonomous. The independent sector classification is an element that has high thrust power and low dependence. The linkage sector classification is a sector that has an unstable inter-change relationship and any change in action from the amendment will have an impact on the other sub-elements. The feedback of its influence can enlarge the impact so that these sub-elements should be carefully examined. Classification of dependent sectors is non-free sub-elements. The Autonomus sector classification is a sub-element that has little relation but can affect the achievement of the objectives.

3. Results And Discussion
Based on literature, expert opinion and practitioners, as well as observation of the perception of the Agro-Eco-Village, identified sub-elements of the three elements (table 1).
Table 1. Contextual relationships between structural Model elements

| No. | Element                          | Contextual Relations   |
|-----|----------------------------------|------------------------|
| 1.  | The purpose                      | G_i Role support G_j   |
| 2.  | Main Obstacles                   | K_i Causes K_j         |
| 3.  | The institution involved         | L_j his role supports L_i |

3.1. Sub-elements of Program Objective

The destination element consists of ten sub-elements, namely: (i) Creating ecologically benign agriculture technology (G_1), Creating special transport Farmers (ii) (G_2), (iii) To create and promote sustainable human settlements that allow people to live more comfortably (G_3), (iv) Creating fresh air (G_4), (v) Creating minimal carbon emissions (G_5), (vi) Utilization of organic and inorganic waste into recycled products (G_6), (vii) Developing local food (G_7), (viii) Save energy (G_8), (ix) Supporting human health development based on organic farming (G_9), and (x) the monitoring of the driven agricultural activity source producing in low carbon (G_{10}).

An expert assessment of the contextual relationship between sub-elements of the goal resulted in a respondent's perceptual perception called the Structural Self Interaction Matrix (SSIM). Furthermore, a revision of SSIM with the rules of transitivity to the resulting final matric reachability matrix, as well as can be determined the level of dependency and the power driver of the destination element. The results of the consistency of expert opinion of > 80 percent, meaning that the perception of expert opinion can be judged well so it is acceptable.

The contextual relationship between the destination sub-elements in figure 1 shows that the monitoring of the driven agricultural activity source producing in low carbon (G_{10}) has the highest thrust or a key sub-element named. These Sub-elements have little reliance on the program, so the program failure does not directly impact. Sub-elements Creating Ecologically benign agriculture technology (G_1), Creating Special Transport Farmers (G_2), Creating Fresh Air (G_3), Creating minimal carbon emissions (G_5), Utilization of organic and inorganic waste into recycled products (examples of Compost and handicrafts) (G_6) [13], and Save Energy (G_8) [14], Have an unstable inter-change relationship or are included in the linkage sector which should be carefully examined.

Based on the sub-element objective classifications that seen in figure 1, it is identified that the the monitoring of the driven agricultural activity source producing in low carbon (G_{10}) is key sub-element, it is the objective sub-element that has a high driver power to the program's success (figure 1). These Sub-elements have little reliance on the program, so the program failure does not directly impact.

![Figure 1](image-url)  
**Figure 1.** The relationship of power drivers and dependence on the destination element you want to accomplish

Description:
G_1 : Creating ecologically benign agriculture technology
G2 : Creating special transport Farmers
G3 : To create and promote sustainable human settlements that allow people to live more comfortably.
G4 : Creating fresh air
G5 : Creating minimal carbon emissions
G6 : Utilization of organic and inorganic waste into recycled products
G7 : Developing local food
G8 : Safe energy
G9 : Supporting human health development based on organic farming
G10 : Monitoring of the driven agricultural activity source producing in low carbon

The classification analysis also shows the sub-elements included in the dependent sector: Supporting human health development based on organic farming (G9) [15], Developing local food (G7) [16], To create and promote sustainable human settlements that allow people to live more comfortably (G3) have low thrust but a huge dependence on the success of the Agro-Eco Village.

3.2. Sub-Element constraints

The constraints element consists of ten sub-elements, namely: (i) mastery of future technologies (e.g. solar food) (K1); (ii) the water resources governance act in fairness (K2), (iii) agricultural affairs policy (K3), (4) new renewable energy affairs policy (K4), (5) not yet synergized between new renewable energy policies and agricultural affairs policies (K5), (vi) Low levels of trust (K6); (vii) Heterogeneity of agriculture culture (K7), (viii) not synergy the success of the implementation of energy and agriculture policy (K8), (ix) Farmer culture of community discipline is still not optimal (K9), and (x) Conflicting public mental in the village (K10) shown in figure 2.

The assessment of the expert opinion on the contextual relationship between the sub-elements of constraints forms a perceptual perception of respondents called the Structural Self Interaction Matrix (SSIM) matrix. Furthermore, a revision of SSIM with the rules of transitivity to the resulting final matrix reachability matrix, as well as can be determined the level of dependency and the power driver of the destination element. The results of the consistency of expert opinion of > 80 percent, meaning that perceptions of expert opinion can be assessed well.

In accordance with the contextual relationships on these elements, the results of the ISM show that the water resources governance act in fairness (K2). It looks like the the water resources governance act in fairness K2 sub-elements have a high driving force and a low dependency, so those sub-elements are a key sub-element of the constraint element. The Sub-element of the constraints mastery of future technologies (e.g. solar food) (K1), agricultural affairs policy (K3), including the independent sector, namely having high thrust and low dependence (figure 2).

The New renewable energy affairs policy (K4), not yet synergized between new renewable energy policies and agricultural affairs policies (K5), and not synergy the success of the implementation of energy and agriculture policy (K8) are included in the linkage sector. The three obstacles (K4, K5 and K8) need to get special attention because they are unstable constraints. Every action on the obstacle will impact and influence the feedback can increase its impact on other constraints (figure 2).

Farmers culture of community discipline is still not optimal (K9) [17], Conflicting public mental in the village (K10) [18], heterogeneity of agriculture culture (K7), and Low levels of trust (K6), including in the dependent sector, and is a result of the actions undertaken by the constraints of linkage and independent sectors (figure 2).
Figure 2. Relationship of Driver Power - Dependence in Constraint Elements

Description:
K1: Mastery of future technologies (e.g. solar food)
K2: The water resources governance act in fairness.
K3: Agricultural affairs policy
K4: New renewable energy affairs policy
K5: Not yet synergized between new renewable energy policies and agricultural affairs policies
K6: Low levels of trust
K7: Heterogeneity of agriculture culture
K8: Not synergy the success of the implementation of energy and agriculture policy
K9: Farmer culture of community discipline is still not optimal
K10: Conflicting public mental in the village

Farmers culture of community discipline is still not optimal (K9) [17], Conflicting public mental in the village (K10) [18], heterogeneity of agriculture culture (K7), and Low levels of trust (K6), including in the dependent sector, and is a result of the actions undertaken by the constraints of linkage and independent sectors (figure 2).

3.3. Sub-Elements of Institutions Involved

Elements of the involved institutions consist of ten sub-elements, namely: (i) The local governmen (L1), (ii) The company owned by the farmer/business entity owned by the village/Company owned by village (L2), (iii) APEKSI (Asosiasi Pemerintah Kota Seluruh Indonesia/Indonesian city Government Association) (L3), (iv) Village Government (L4), (v) GEN (L5), (vi) District Government (L6), (vii) Rural communities (L7), (viii) Central government (L8), (ix) Network Ecovillage Work (L9), and (x) Colleges (L10). The 10 sub-elements identified relationship or association through an expert opinion survey with the ISM method.

The analysis results show that the institution that has a role in supporting the program is The company owned by the farmer/business entity owned by the village/Company owned by village (L2) [19]. This sub-element has a high driving force and a low dependency compared to other sub-elements, so the sub-elements are key sub-elements (Fig 3). Based on the level of dependency and force driver, sub-element of the The company owned by the farmer/business entity owned by the village/Company owned by village (L2) [19], The local governmen (L1) [20], Village Government (L4), and Rural communities (L7) is in the independent sector [18]. The 4 (four) sub-elements are (L1, L2, L4, and L7) as free repulsion that have great driving force and affect the success of the program.
Figure 3. Power-Dependence Driver relationships on institutional elements

**Description:**

- **L₁**: The local government
- **L₂**: The company owned by the farmer/business entity owned by the village/Company owned by villages
- **L₃**: APEKSI (Indonesian city Government Association)
- **L₄**: Village Government
- **L₅**: GEN
- **L₆**: District Government
- **L₇**: Rural communities
- **L₈**: Central government
- **L₉**: Network Ecovillage Work
- **L₁₀**: Colleges

The classification analysis of the institutional sub-elements also demonstrates the absence of free and affected the existence of the program as a result of the action of the Peubah of other sub-elements. Sub-Elements Network Ecovillage (L₉), Colleges (L₁₀), District Government (L₆), and GEN (L₅) (Fig. 3). Central government (L₈) and APEKSI (Indonesian city Government Association) (L₃) is classified in the autonomous sector, namely institutions that still have little relation but can affect the achievement of objectives (figure 3).

With the same analysis procedure generated the following key elements:

4. **Conclusions**

The Structural Model of Agro-Eco Village generated through ISM analysis covering the key purpose element is the monitoring of the driven agricultural activity source producing in low carbon. As a key institutional element involved in the implementation of Agro-Eco Village is the company owned by the farmer/business entity owned by the village/Company owned by villages. As a key constraint element is the Water Resources Governance Act in fairness.

With the same analysis procedure generated the following key elements. The required changes are activities to recycle agricultural biomass resources and strengthening of the system of rural agribusiness. The affected sectors of society are the Farm Worker and Farm Tourism. As the key indicator is the increased exchange rate of the farmer.
5. References

[1] Report of The Economic Impact of Geospatial Services: How Consumers, Businesses And Society Benefit From Location-Based Information 2016 Sydney@alphabeta.com

[2] Mick v. Eck Santos 2017 Potential of ecovillage as alternative models of sustainable development https://www.researchgate.net/publication/317415222

[3] Williams Q 2018 Eco-City Comparison: West versus East Sustainability the Journal of Record. 11(5): https://doi.org/10.1089/sus.2018.0018

[4] Olabode GKT, Yunus A, Kayode, Hilary ZY, Elizabeth O 2014 Millenium Development Goals (MDGs) in Nigeria: Issues and Problems Journal of Human Social Science: Sociology and Culture. 5(14): ISSN: 2249-460x & Print ISSN: 0975-587x

[5] Santoso H, Susanty A, Putriasisih J 2014 Rekayasa Ekologi Industri Dalam Mensukung Pembangunan Agro Eco-Industrial Park Skala Pedesaan Jurnal Teknik Industri. 9(2)

[6] Carlos Martinez-de-Ibarreta and Mick v. Eck Santos Carmen Valor 2017 Is it Worth Getting Labeled? The Case of MSC-Certified Seafood Journal of International Food & Agribusiness Marketing Pages 1-19 DOI: 10.1080/08974438.2017.1303657

[7] Maharani MDD, Sumardjo, Eriyatno, Priabdi ES 2015 Structural Model for Sustainable Management of Ruminant Cattle Slaughterhouse (RC-S): The Establishment and Renovation of RC-S Jurnal Global Veterinaria. 14(5):707-719 ISSN: 1992-6197

[8] Saptoriantoro P, Mustaruddin, Haluan J 2017 Planning Strategy of Management Information System Data Processing Fishing Surveillance Implementation in Ministry of Marine Affairs and Fisheries Republic of Indonesia Marine Fisheries. 8(2):149-162 ISSN 2087-4235

[9] A. Sage 1977 Interpretive Structural Modeling: Methodology for Large-Scale Systems. Pp. 91-164 (New York: McGraw-Hill)

[10] Singh S 2015 SM-Based Analysis for Modelling Factors in Railway Maintenance Task International Journal in IT and Engineering. 3(3):279-287

[11] Dewangan DK, Agrawal R, Sharma V 2015 Enablers for Competitiveness of Indian Manufacturing Sector: An ISM-fuzzy MICMAC Analysis Proceedings of XVIII Annual International Conference of the Society of Operations Management. (SOM-14) (189) 416-432

[12] Saxena 1992 Hierarchy and Classification of Program Plan Elements Using Interpretive Structural Modelling System Practice. 5(6):651-670

[13] Wallery NN, Kusmama C, Ramdan H 2016 Sustainability Study of Ecovillage Development in the Upper Basin of Citarum River Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan. 6(2): 131-141

[14] Clara MK, Siti A, Tazhila I, Faithiya A, Dainy NC, Rosmiati R 2012 Intervention with implementation of the millennium eco-village concept and the behavior changes of household food consumption in Petir Village, Dramaga, Bogor Jurnal Gizi dan Pangan. 7(2): 65-72

[15] Meiske Widyarti 2011 Kajian dan Rekonstruksi Konsep Eco-village dan Eco-house pada Permukiman Baduy Dalam berdasarkan Community Sustainability Assessment (Bogor: Sekolah Pascasarjana IPB)

[16] Newman L and Nixon D 2014 Farming in an Agriburban Ecovillage Development: An Approach to Limiting Agricultural/Residential Conflict SAGE Open: 1-10. DOI: 10.1177/21582440/4562389
[17] Mahlabani YG, Shahsavari F and Alamouti ZM 2016 Eco-Village, AModel of Sustainable Architecture *Journal of Fundamental and Applied Sciences*. ISSN 1112-9867. Doi: http://dx.doi.org/10.4314/jfas.v8i3s.312

[18] Kimberly LO, Teresa RJ 2019 Seeking sustainability: employing Ostrom’s SESF to explore spatial fit in Maine’s sea urchin fishery *International Journal of the Commons*. 13(01): 276-302

[19] Ramadana CB, Ribawanto H and Suwondo 2018 Keberadaan Badan Usaha Milik Desa (BMUDES) Sebagai Penguatan Ekonomi Desa (Studi di Desa Landungsari, Kecamatan Dau, Kabupaten Malang) *Jurnal Administrasi Publik (JAP)*. 1(6): 1068-1076

[20] Yuliastuti N, Wahyono H, Syafrudin S and Sariffuddin S 2017 Dimension of Community and Local Institutions Support: Towards an Eco-Village Kelurahan in Indonesia *Journal of Sustainability*. 9(2): 245

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