PENCERAH PUBLISHING

Available online at: https://journal.pencerah.org/index.php/jspi

Journal of Social and Policy Issues

E-ISSN: 2807-3843 I P-ISSN: 2829-8632

Utilizing System Dynamics for Border Area Development in Napan Village, North Bikomi, East Nusa Tenggara

Yoos Suryono Hadi, Moh. Khusaisni, Moh. Fadli, Adi Kusumaningrum

Universitas Brawijaya, Malang, Indonesia

ARTICLE INFORMATION

Received: March 05, 2024
Revised: May 07, 2024
Available online: June 30, 2024

KEYWORDS

Border Area Development, Development Scenarios, System Dynamics

CORRESPONDENCE

Name: Yoos Suryono Hadi
E-mail: yoosseskoal@gmail.com

A B S T R A C T

Napan Village, North Bikomi District - North Central Timor Regency - East Nusa Tenggara is some of the areas that border Indonesia on land with neighboring countries. Napan Village shares a land border with Timor Leste. Various issues regarding security, prosperity and the environment in development often arise. This research was conducted to develop models dynamically in three development scenarios using these three approaches. The research sample was obtained using a questionnaire distributed to 78 respondents consisting of village soldiers and police, Napan village officials, the North Bikomi sub-district head, and border officers in Napan village. From the results of the questionnaire, descriptive analysis and multiple regression analysis were carried out to obtain a regression model of the influence of security, prosperity, and environmental approach variables on border area development. Next, the analysis results are used to develop a system dynamics model with three simulation scenarios. The reference used in this simulation is the average data value for each variable minus and adding one standard deviation and the equation resulting from multiple regression analysis. The simulation results show that the target for achieving development in border areas will reach 73% within 5 years if input from security, prosperity, and environmental factors is increased from the current condition of 8% for security, 6% for prosperity, and 9% for the environment. Furthermore, it is recommended to increase development on factors in security, prosperity, and environmental approaches according to these results so that in the next five years significant progress can be achieved, which reaches almost double the current conditions.

INTRODUCTION

Indonesia, with 17,504 islands, is the largest archipelagic country in the world. Indonesia's sea area reaches 3,257,483 square kilometers, much larger than its land area of only 1,904,569 square kilometers. Indonesia's Exclusive Economic Zone (EEZ) also stretches wide, reaching 2,749,000 square kilometers (Djunarsjah & Putra, 2021). This shows the very wide territorial reach. Indonesia's vast territory is managed into 38 provinces, some of which are areas that border other countries, both sea borders and land borders.

This geographical position means that Indonesia has extensive maritime boundaries, bordering 10 neighboring countries, such as India, Singapore, Malaysia, Thailand, Vietnam, the Philippines, Palau, Australia, Timor Leste and Papua New Guinea. In addition, Indonesia shares land borders with three countries, namely: Malaysia in Kalimantan, Papua New Guinea in Papua, and Timor Leste in East Nusa Tenggara. Characteristics of Indonesia's territorial boundaries, include: The land borders are situated in Kalimantan, Papua, and East Nusa Tenggara. The border is marked with boundary markers and state border crossing posts (Winarwati, 2021). Maritime boundaries, determined by imaginary straight lines connecting the outermost points of the outer islands, are delimited by the Exclusive Economic Zone (EEZ) and the Continental Shelf.

Indonesia's border areas have an important role in various aspects of national and state life. Therefore, it is very important to prioritize the development of border areas. In the political and security aspects involve bolstering strengthening the sovereignty and territorial integrity of the Republic of Indonesia, combating smuggling, illegal trade, and other criminal activities, enhancning security stability in border areas, and establishing a robust and resilient national defense (Bria & Lam, 2022). In the economic aspect, namely: increasing economic growth in border areas, creating jobs and business opportunities for local communities, strengthening connectivity between regions in Indonesia, and increasing trade and investment with neighboring countries (Sudiar & Irawan, 2018; Sunarya et al., 2016). In the social and cultural aspect, namely: improving the quality of life of people in border areas, strengthening the sense of national unity and integrity, increasing access to education, health, and other public services, and preserving the culture and customs of local communities (Gunawan & Ratmono, 2018). In the Defense and Security aspect, namely: strengthening national defense in border areas, preventing the entry of radicalism and terrorism, and increasing security cooperation with neighboring countries, other aspects are: improving Indonesia's image and profile in international eyes, and realizing integrated and sustainable border area management.

Various laws and regulations that can be used to implement border area development include: Law Number 43 of 2008 concerning State Territory mandates the government to develop border areas in order to realize the sovereignty and territorial integrity of the Republic of Indonesia. Next is Presidential Regulation Number 12 of 2010 concerning the National Border Management Agency (BNPB), which explains the BNPP as the institution responsible for planning, implementing, and supervising development in border areas. Furthermore, the 2020-2024 National Medium-Term Development Plan makes border area development one of the country's priorities. (Mangku, 2018).

Development in border areas is still lagging behind compared to other regions in Indonesia. This is caused by several factors, including: limited infrastructure in the form of road

https://doi.org/10.58835/jspi.v4i2.323

access, electricity and telecommunications in border areas. The limited human resources in border areas stem from the low levels of education and skills among the people living there. Budget limitations include the government's insufficient allocation of funds for development in border areas. Security includes: border areas are still vulnerable to various illegal activities, such as smuggling and drug trafficking.(Bobrovskaya et al., 2019; Gunawan & Ratmono, 2018).

Conversely, the system dynamics approach has gained widespread use in development modeling and analysis. This is due to the fact that the border area is a complex system with various elements that are interconnected and dynamic. The system dynamics approach offers several advantages for analyzing and modeling border area development, namely: it can be used to understand complexity, predict policy impacts with various scenarios prepared, and improve communication and collaboration. Several uses of system dynamics to analyze and model border area development in various countries include: studying the impact of infrastructure development in border areas, analyzing the dynamics of migration and trade in border areas, developing strategies to increase resilience and stability in border areas, and predicting the impact of climate change in border areas.(Tommy et al., 2016).

Based on this background, the problem in this research is how to analyze border area development through security, prosperity, and environmental approaches using system dynamics in various development scenarios. The aim of research on developing border areas with various scenarios using system dynamics is to obtain sufficient scenario input for sustainable development in border areas with optimal results. This is also the novelty of this research, namely that the border area development model uses security, prosperity and environmental approaches simultaneously with various scenarios that have not existed in previous researches.

METHOD

This research used dynamic simulation. The dynamic simulation method utilized data about border area development, which was obtained from a questionnaire distributed to Napan village officials, border guard officers, the nearest military post, and 78 North Bikomi sub-district officials. The data from the questionnaire is arranged in the form of averages and standard deviations for security factors, prosperity factors, and environmental factors. Meanwhile, the border area development model used a multiple linear regression model on the data.

The simulation was developed with three scenarios based on the average of the data and reduced and increased by the standard deviation. The first scenario was a simulation based on the average security, prosperity, and environmental approach data minus the standard deviation. The second scenario was a simulation based on the average of security, prosperity, and environmental approach data. The third scenario was a simulation based on the average security, prosperity, and environmental approach data plus the standard deviation.

In detail, the research steps can be described as follows.

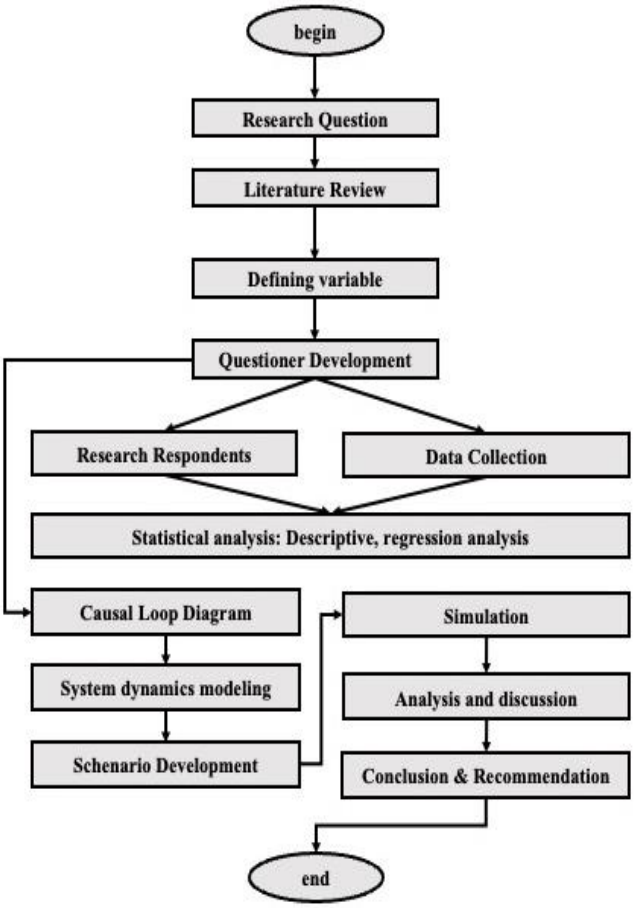

Figure 1. Research flow diagram
(Currie et al., 2018; Eidin et al., 2024)

RESULT AND DISCUSSION

Based on the research results, the research results can be compiled as a description of the research respondents. A description of the results of the weighted questionnaire is presented as follows.

Table 1. Description of research results

Variable	Average	Standard Deviation	Min	Max
Security factors	0.65	0.08	0.49	0.81
Prosperity factors	0.60	0.06	0.48	0.72
Environmental factors	0.55	0.09	0.37	0.73

Based on the description above, it appears that the average scores on security factors, prosperity factors and environmental factors are 65%, 60% and 55% respectively with standard deviations of 8%, 6%, and 9%. These results show that the three development factors in border areas are still not optimal and need to be accelerated. Next, the results of the regression analysis are presented as follows.

 https://doi.org/10.58835/jspi.v4i2.323

Table 2. Regression model

Variable	Beta (Standardized Coefficients)	t	Sig
Constant			
Security App	0.36	4.75	0.000
Prosperity App	0.44	5.93	0.000
Environmental App	0.20	3.92	0.000

Based on the results of the regression analysis, a regression equation is then prepared, namely:

$$\begin{aligned} \textit{Border Area Dev} = {} & 0.36\,\textit{Security App} \\ & + 0.46\,\textit{Prosperity App} \\ & + 0.20\,\textit{Environmental App} \end{aligned}$$

Information:
Border Area Dev = Border Area Development
Security App = Security Approach
Prosperity App = Prosperity Approach
Environmental App = Environmental Approach

The results of this regression analysis will be used to develop scenario-based analysis using system dynamics. The first step in system dynamics is to construct a Causal Loop Diagram as a diagram that describes the cause-and-effect relationship between variables in a system. In detail it is described as follows.

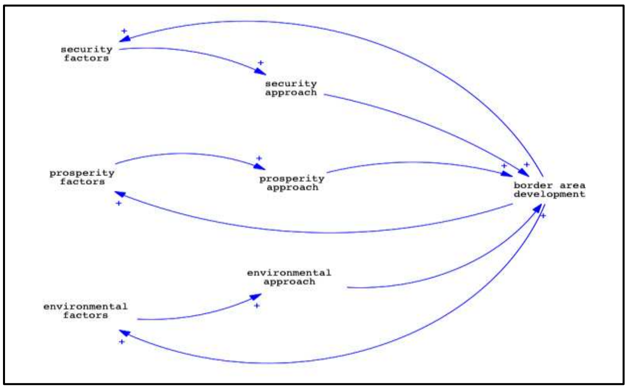

Figure 2. Causal loop diagram in the dynamic model of border area development in Napan village, North Bikomi District

The causal loop diagram shows that border area development is positively influenced by the security approach, prosperity approach and environmental approach. Meanwhile, each approach is influenced by security factors, prosperity factors and environmental factors. Furthermore, border area development influences every development factor. Based on the causal loop diagram above, a system dynamics model was prepared for modeling and calculating according to the following scenario.

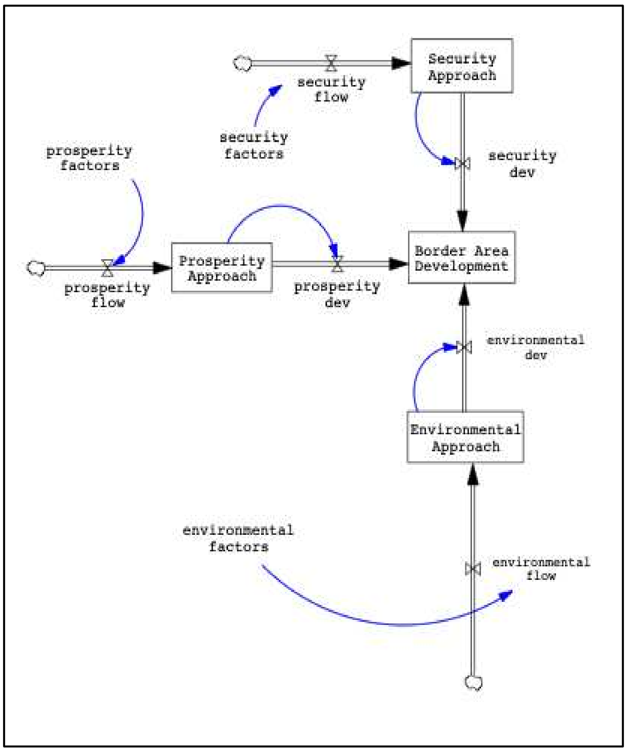

Figure 3. Dynamic model of border area development

Based on the model in Figure 2, the model function framework is prepared as follows. First, security factors, prosperity factors, and environmental factors are functions with a uniform distribution in the data range of the average value of the questionnaire results minus the standard deviation to plus the standard deviation. Second, the functions of security flow, prosperity follow, and environmental flow are the values of each corresponding factor. Third, the stock for the security approach, prosperity approach, and environmental approach is an integral result of the respective input flow which is reduced by the outflow for the corresponding security development, prosperity development, and environmental development. Fourth, outflow for security, prosperity, and environmental are the input flow of all proceeds from stocks from security, prosperity, and environmental which are reduced by the output flow which is channeled to the border development area. Fifth, border area development is formulated in an integral form of security, prosperity, and the environment, each of which is given a weight according to the parameters calculated from the regression equation resulting from questionnaire processing, namely: 0.36 for security, 0.44 for prosperity, and 0.20 for the environment.

Based on this model, three border area development scenarios will be carried out based on security, prosperity, and environmental approaches. The three scenarios were carried out respectively with input from security, prosperity, and environmental factors with low, medium, and high values. The distribution of security, prosperity, and environmental factor scores is being carried out based on the results of a questionnaire given to experts and practitioners who understand border issues in Napan village, North Bikomi sub-district – East Nusa Tenggara. Next, the low scenario is approached by subtracting the medium value by the standard deviation, and the scenario with the high value is done by adding the standard deviation. Input data for the three scenarios for the three approaches is presented as follows.

Table 3. Data for scenarios 1, 2, and 3 on the security approach

	Average	Standard deviation	Min	Max
Scenario 1	0.51	0.08	0.35	0.67
Scenario 2	0.65	0.08	0.49	0.81
Scenario 3	0.79	0.08	0.63	0.95

From table 1, for the three scenarios in the security approach, the average score for the security approach is 0.50 in the first scenario, 0.65 in scenario 2 and 0.80 in scenario 3. Based on these three scenarios, border development patterns are simulated under conditions of a prosperity approach and an environmental approach in scenario 1, scenario 2 and scenario 3.

Table 4. Data for scenarios 1, 2, and 3 on the prosperity approach

	Average	Standard deviation	Min	Max
Scenario 1	0.49	0.06	0.37	0.61
Scenario 2	0.60	0.06	0.48	0.72
Scenario 3	0.71	0.06	0.59	0.83

According to table 2, in the three scenarios for the prosperity approach, the average score is 0.50 in the first scenario, 0.65 in scenario 2, and 0.80 in scenario 3. These three scenarios simulate border development patterns under security and environmental approaches in scenarios 1, 2, and 3.

Table 5. Data for scenarios 1, 2, and 3 on the environmental approach

	Average	Standard deviation	Min	Max
Scenario 1	0.42	0.09	0.24	0.60
Scenario 2	0.55	0.09	0.37	0.73
Scenario 3	0.78	0.09	0.60	0.96

Based on the three scenarios in the environmental approach, in the environmental approach the average score for the environmental approach is 0.40 in the first scenario, 0.55 in scenario 2 and 0.70 in scenario 3. Based on these three scenarios, border development patterns are simulated under conditions of a security approach and a prosperity approach in scenario 1, scenario 2 and scenario 3. Next, based on the scenario data, the model function is prepared as follows.

Table 6. Variables/ factors, formulation, and unit in the scenarios

Variable/ factor	Formulation	Unit
Border Area Development	Int (0.01*(3.6*security dev+ 4.4*prosperity dev+ 2*environmental dev))	Unit
security dev	Security Approach – Border Area Development	Unit
Security Approach	Int (security factors – security dev)	Unit
security factors (scenario1)	Random Uniform (0.43, 0.59, 0.05)	Unit
security factors (scenario2)	Random Uniform (0.57, 0.73, 0.05)	Unit
security factors (scenario3)	Random Uniform (0.71, 0.88, 0.05)	Unit
prosperity dev	Prosperity Approach – Border Area Development	Unit
Prosperity Approach	Int (prosperity factors – prosperity dev)	Unit
prosperity factors (scenario1)	Random Uniform (0.43, 0.55, 0.05)	Unit
prosperity factors (scenario2)	Random Uniform (0.54, 0.66, 0.05)	Unit
prosperity factors (scenario3)	Random Uniform (0.65, 0.77, 0.05)	Unit
environmental dev	Environmental Approach – Border Area Development	Unit
Environmental Approach	Int (Environmental factors – environmental dev)	Unit
Environmental factors (scenario1)	Random Uniform (0.33, 0.51, 0.05)	Unit
Environmental factors (scenario2)	Random Uniform (0.46, 0.64, 0.05)	Unit
Environmental factors (scenario3)	Random Uniform (0.69, 0.87, 0.05)	Unit

Security Approach

In the security approach, simulation results are obtained randomly with a uniform distribution. Graphically presented as follows.

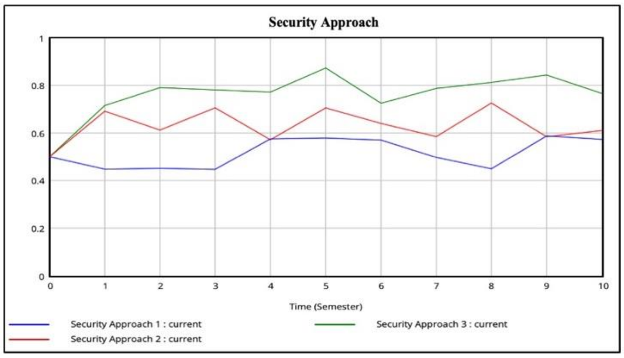

Figure 4. Simulation results of the security approach

Figure 4 shows a simulation of uniform random results with scores ranging from average – standard deviation to average + standard deviation in the three scenarios. The first scenario is the lowest level of security development (blue), then the second scenario is development at the middle level of security factors (red), and the third scenario is the highest (green). Based on the three scenarios, development is carried out based on safety factors as presented in Figure 4.

Prosperity Approach

In the prosperity approach, simulation results are obtained randomly with a uniform distribution. Graphically, it is presented as follows.

https://doi.org/10.58835/jspi.v4i2.323

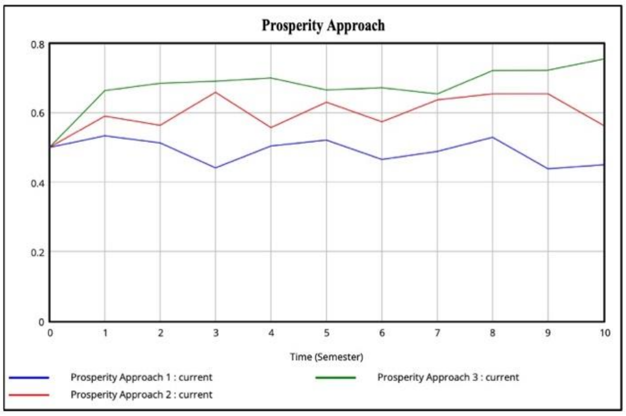

Figure 5. Simulation results of the prosperity approach

Figure 5 shows a simulation of random uniform results with scores ranging from average – standard deviation to average + standard deviation in the three scenarios. The first scenario is the lowest level of prosperity factor development (blue), then the second scenario is development at the middle level of prosperity factors (red), and the third scenario is the highest (green). Based on the three scenarios, development is carried out based on prosperity factors as presented in Figure 5.

Environmental Approach

In the environmental approach, simulation results are obtained randomly with a uniform distribution. Graphically, it is presented as follows.

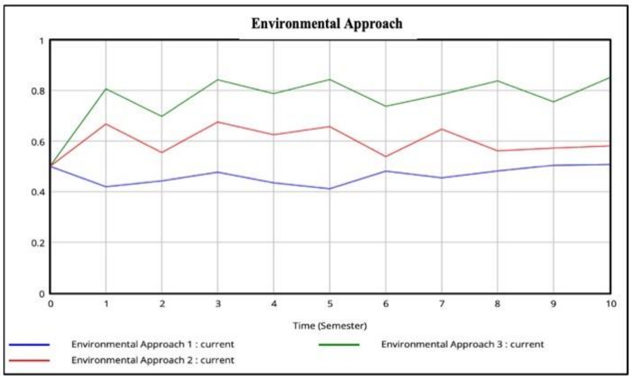

Figure 6. Simulation results of the environmental approach

Figure 6 shows a simulation of random uniform results with scores ranging from average – standard deviation to average + standard deviation in the three scenarios. The first scenario is the lowest level of environmental factor development (blue), then the second scenario is development at the middle level of environmental factors (red), and the third scenario is the highest (green). Based on the three scenarios, development is carried out based on environmental factors as presented in Figure 6.

Border Area Development

In developing border areas, simulation results are obtained within a specified time span, namely from t=0 to t=10 (t in semester). The result of simulation is presented graphically as follows.

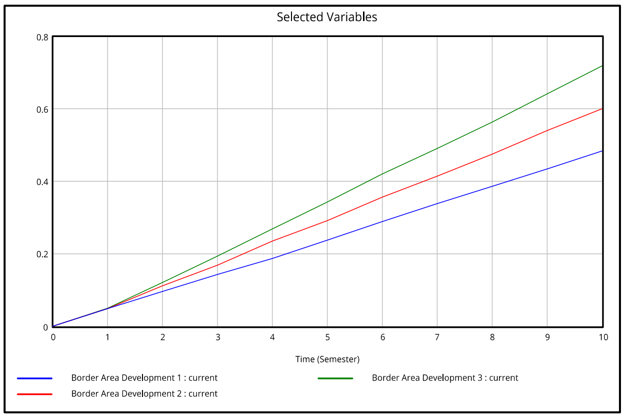

Figure 7. Border area development simulation results based on the three scenarios

Based on the Figure 7 as simulation results, it appears that with the highest scenario, results reach 73% of current conditions with a development period of 5 years. If calculated annually, the development achievements of border areas can increase from the previous condition of 14.5%. This condition has the prerequisite that input from security, prosperity, and environmental factors be increased from the current condition of 8% for security, 6% for prosperity, and 9% for the environment consistently for 5 years. If security, prosperity, and environmental factors are developed with the same development capital as today, then the development of border area development in Napan will only reach 58% higher than now within a period of 5 years. Even if security, prosperity, and environmental factors are reduced by 8%, 6%, and 9%, it will reduce the percentage increase in border area development achievements within five years to an increase of only 48% from now. For this reason, the desired major achievements can be achieved by using an optimized approach to security, prosperity, and environment.

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the system dynamics model for the development of the RI border area with Timor Leste in Napan Village, North Bikomi District - East Nusa Tenggara can be developed using multiple regression analysis. The equation resulting from multiple regression was used as a basic model, which was then developed into three system dynamics simulation scenarios, with reference to the average value of data for each variable being reduced, and one standard deviation added. The simulation results show that the target for achieving development in border areas will reach 73% within 5 years if input from security, prosperity, and environmental factors is increased from the current condition of 8% for security, 6% for prosperity, and 9% for the environment consistently. If the current situation persists, the development of border areas in Napan will only increase by 58% over a 5-year period. Even if security, prosperity, and environmental factors are reduced by 8%, 6%, and 9%, it will reduce the percentage increase in border area development achievements to only 48%.

Furthermore, it is recommended to increase development on factors in security, prosperity, and environmental approaches by a minimum of 8%, 6%, and 9% from current conditions. This is intended so that in the next five years significant progress will be achieved which will reach almost double the current condition.

REFERENCES

Bobrovskaya, T., Gherman, O., & Zaytseva, T. (2019). Sustainable development of border areas as a subject of scientific research. *Advances in Social Science, Education and Humanities Research*, *364*.

Bria, M. E., & Lam, K. F. T. (2022). Strengthening national identity partnerships through community participation in border areas. *Jurnal Civics: Media Kajian Kewarganegaraan*, *19*(2), 329–335. https://doi.org/10.21831/jc.v19i2.53541

Currie, D. J., Smith, C., & Jagals, P. (2018). The application of system dynamics modelling to environmental health decision-making and policy - A scoping review. *BMC Public Health*, *18*(1). https://doi.org/10.1186/s12889-018-5318-8

Djunarsjah, E., & Putra, A. P. (2021). The concept of an archipelagic Province in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *777*(1). https://doi.org/10.1088/1755-1315/777/1/012040

Eidin, E., Bielik, T., Touitou, I., Bowers, J., McIntyre, C., Damelin, D., & Krajcik, J. (2024). Thinking in Terms of Change over Time: Opportunities and Challenges of Using System Dynamics Models. *Journal of Science Education and Technology*, *33*(1), 1–28. https://doi.org/10.1007/s10956-023-10047-y

Gunawan, B., & Ratmono, B. M. (2018). Perspectives on the Development of Border Regions in Indonesia. *Research on Humanities and Social Sciences*, *8*(6). www.iiste.org

Mangku, D. (2018). Legal Implementation On Land Border Management Between Indonesia and Papua New Guinea Accroding to Stephen B. Jones Theory. *Veteran Law Review*, *1*(1).

Sudiar, S., & Irawan, B. (2018). Indonesia's Development Policy to Increase Prosperity of the People in the Border Area. *Advances in Social Science, Education and Humanities Research*, *231*. https://doi.org/10.1016/S0362-3319(03)00069

Sunarya, A., Tetap, D. S., Raharja Tangerang, S., Jendral Sudirman No, J., & Cikokol, M. (2016). The Strategic Issues of Economic Development of Border Area of Indonesia-Malaysia (Study Case of Entikong Sub-District of West Kalimantan). *Cyberpreneurship Innovative and Creative Exact and Social Science*, *2*(2).

Tommy, I., Dwi, D., & Fitri, S. (2016). Systems Dynamic Approach in Development of Infrastructure in Entikong, Border Regions Indonesia-Malaysia. *MATEC Web of Conferences*, *47*. https://doi.org/10.1051/C

Winarwati, I. (2021). Indonesian Authority to Determine Maps as the Legality of Country Territorial Boundaries. *Advances in Social Science, Education and Humanities Researc*, *603*.

https://doi.org/10.58835/jspi.v4i2.323