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Community Awareness and Participation for Land and Forest Fire Prevention and Implementation of Lancang Kuning Nusantara System Application in Toba District, North Sumatra Province

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Abstract

This study employs a sociometric analysis of Community Concern and Participation in Implementing the Lancang Kuning Nusantara Application for Forest and Land Fire Prevention in Toba Regency, Indonesia. With a sample of 401 respondents, the study aims to comprehensively understand social interactions and community engagement in this context. Results indicate that the perception score (X(i.1)) and participation score (X(i.2)) are high or significant, reflecting positive community awareness and active involvement in fire prevention activities. However, the acceptability score (X(i.3)) is low or insignificant, suggesting potential dissatisfaction or skepticism regarding the effectiveness or implementation of current programs. Furthermore, standard deviation analysis reveals that variability in respondent ratings is generally within control, with only 2 out of 15 testing points showing high standard deviation, while 13 are within acceptable limits. Nevertheless, the proportion of respondents who rate low (PRMR) exceeds the desired threshold of 10% across all variables, indicating that many respondents have low evaluations. These findings suggest a need for improved communication, education, and potential adjustments to enhance the acceptability and effectiveness of the fire prevention initiatives and the Lancang Kuning Nusantara System application.

***Keywords**: Sociometric Analysis, Community Awareness, Participation, Forest Fire Prevention, Toba Regency.*

1. Introduction

Forest and land fires (karhutla) are a severe problem in Indonesia, exacerbated by natural factors such as the long dry season and flammable peatlands. Natural factors, such as the tropical climate and mountainous topography, also contribute to the rapid spread of fires [1] [2]. In addition to natural factors, many forest and land fires occur due to human actions, mainly related to land clearing for agriculture, plantations, or other profitable activities [3] [4]. Some reasons for intentional fires include land clearing, concession management, economic interests, and traditional practices. While sometimes profitable, these practices have negative environmental impacts, including land degradation, ecosystem damage, greenhouse gas emissions, and human health threats [5] [6]. Combating forest and land fires requires a holistic approach involving advanced technology, cross-sector collaboration, and active community participation. Technology such as satellite imagery and hotspot detection applications like "Lancang Kuning" play an essential role in monitoring and preventing forest and land fires [7] [8]. In addition, community participation in prevention efforts is crucial, including early detection, reporting, and environmental conservation [9] [10]. A practical approach to forest and land fire prevention involves using risk management systems, community education, and implementing policies that support environmental conservation. Through this approach, it is hoped that the risk of forest and land fires can be reduced and their negative impacts on the environment and community wellbeing can be minimized [11] [12].

2. Literature Review

Prevention of forest and land fires (Karhutla) is essential to protect the environment. Forest and land fires can damage ecosystems, biodiversity, and air and water quality. Prevention is needed to protect biodiversity, maintain ecosystem balance, and ensure a sustainable environment [13]. Fire can also destroy natural habitats, threaten plant and animal species, and disrupt natural resources. The smoke can pollute the air and endanger human health. Prevention of forest and land fires is essential to maintain clean air and public health. It also impacts climate change by releasing greenhouse gases into the atmosphere. Prevention can help mitigate climate change and support global climate stability. Forests and land act as large carbon sinks, so preventing forest and land fires is essential to maintain the carbon balance in nature. Economic factors, limited resources and technology, knowledge, social and cultural aspects, community involvement, climate change, and dry seasons may complicate handling forest and land fires [14] [15] [16].

Socialization and education to the community on forest and land fire prevention will involve working with local stakeholders to create an effective socialization campaign. Education will focus on sustainable practices in land management. Evaluation will be conducted to measure the effectiveness of the socialization and education program. Through holistic, in-depth understanding, it is hoped that community awareness can be increased, behavior can be changed, and the environment can be protected from the threat of forest and land fires. Prevention of forest and land fires (Karhutla) with a social humanities approach emphasizes the importance of understanding social, cultural, and humanitarian factors. Social Contextual Analysis is needed to understand the social structure, local values, community governance, and other factors influencing forest and land fire prevention [17].

Community participation is critical in planning and implementing prevention strategies through education that are appropriate to the local social and cultural context. Integration of traditional practices with modern solutions can increase the effectiveness of prevention programs. Collaboration with various stakeholders, such as government, non-government organizations, and educational institutions, is needed for a holistic and sustainable solution. Building community resilience to the risk of forest and land fires is a key focus, with joint monitoring and collaboration between communities. Social Contextual Analysis helps understand social structures, local values, community governance, economic dynamics, inter-community relations, cultural sustainability, and migration and mobility patterns.

Community participation enables improved understanding of risks, identification of local solutions, empowerment, collaboration, joint supervision, continuous education, and responsiveness to change. Forest and land fire prevention efforts can be more effective and sustainable in the long term with a social humanities approach and community participation [18].

Measurement systems are an essential part of management science that helps understand a system's condition and performance. Measurement data provides the basis for efficient decision-making, performance evaluation, identification of improvements, and achievement of organizational goals. With a sound measurement system, managers can focus on critical aspects, prioritize actions, and make adjustments and continuous improvements. A sociological approach is required in complex and dynamic measurement systems. Social structure analysis helps understand social interaction, community structure, and the social impact of various interconnected factors. Through this approach, researchers can design more accurate and relevant measures by considering the values and norms in the society under study. Understanding the dynamics of social interactions allows the disclosure of patterns that may be missed in traditional approaches. Thus, the measurement system with a sociological approach provides a deeper understanding of the interconnected variables in achieving organizational goals and increasing competitiveness [19] [20].

Knowledge of the risks of forest and land fires (Karhutla) is significant in fire prevention and impact mitigation. Here are some descriptions of the importance of knowledge of forest and Karhutla risks: (1) Awareness Raising: Knowledge of the risks of forest and land fires helps increase community awareness of potential hazards. With better understanding, communities become more vigilant and prepared for emergencies, minimizing possible losses and accelerating response. (2) Preventive Behavior: Knowledge of risks can shape preventive behavior. Communities that understand the negative consequences of forest and land fires tend to be more proactive in taking preventive measures, such as cleaning the area around their homes, not engaging in activities that can trigger fires, and adopting safety principles. (3) Effective Evacuation Measures: In the case of widespread fires, a good knowledge of the risks helps communities plan practical evacuation actions. This includes knowing safe evacuation routes, shelters, and safety measures during the evacuation process. (4) Rapid Response to Changing Conditions: Risk knowledge enables communities to respond quickly to changing fire conditions [21] [22].

Accurate and up-to-date information can help people make timely decisions, such as leaving a threatened area or assisting firefighters by providing accurate reports. (1) Community Safety and Health: Knowledge of the risks of forest and land fires is directly related to public safety and health. By knowing the health risks from fire smoke, communities can take preventive measures to protect themselves and their families, especially vulnerable groups such as children and older people. (2) Shaping Environmental Perceptions: Risk knowledge also shapes people's perception of their environment. By understanding the possible impacts of forest and land fires, communities can become more concerned about environmental sustainability and support preservation and fire prevention efforts. Overall, knowledge of the risks of forest and land fires creates communities that are better prepared for emergencies and contributes to developing attitudes and behaviors that support environmental sustainability and fire prevention [23].

Previous studies on the risks of forest and land fires have provided insights into various aspects, and some of the common types of studies include (1) Risk Factor Analysis: Some studies focus on analyzing the risk factors that contribute to the occurrence of forest and land fires. This involves identifying and evaluating weather conditions, land use patterns, human activities, and forest management policies that can trigger fires. Such studies help better understand the underlying causes of forest and land fires. (2) Health and Environmental Impacts: Several studies have focused on the public health and environmental impacts arising from the risk of forest and land fires.

This involves analyzing air quality during fire periods, long-term effects on human health, and ecological impacts on flora and fauna. Such studies help to recognize the consequences of the risk of forest and land fires that can harm human wellbeing and ecosystems. Evaluation of Response and Risk Mitigation: Some studies focus on evaluating the response and risk mitigation efforts implemented by governments, non-governmental organizations, and communities.

This includes analyzing the effectiveness of fire prevention policies, the response of firefighting agencies, and the role and participation of communities in risk mitigation. Such studies provide insights into the success or failure of prevention and mitigation measures that have been put in place. With a combination of studies like this, previous research has contributed to our understanding of the risks of forest and land fires. These different types of studies complement each other to form a more holistic picture, help design more effective prevention strategies, and improve the capacity of communities to manage risks associated with forest and land fires. Community

involvement in prevention programs is crucial in preserving the environment and preventing fires, including Karhutla (Forest and Land Fires). The following explains the importance of community involvement in prevention programs : (1) Significant Human Resources: Communities are a significant human resource in implementing prevention programs. With active involvement, communities can act as extra eyes and ears on the ground, helping to detect potential hotspots and taking direct preventive action. (2) Local and Cultural Understanding: Community involvement brings a deep understanding of local and cultural conditions. Local communities know land use patterns, dry seasons, and other aspects of the environment that can contribute to the risk of forest and land fires. This understanding is crucial in designing prevention programs that are contextual and relevant. (3) Participation in Training and Education: Engaging communities in prevention programs includes participation in training and education. This can include familiarization with light firefighting techniques, household fire prevention, and understanding the environmental impacts of fires. Participation in this education increases the community's capacity to respond to and prevent fires. (4) Collaboration and Mutual Aid: Community involvement encourages collaboration and a spirit of cooperation. When communities come together to engage in prevention efforts, a solidarity network is formed that can support each other. This creates a climate of cooperation that strengthens the collective capacity to deal with the risks of forest and land fires. (5) Strengthening Early Warning Systems: Engaged communities can be crucial in early warning systems. They can be involved in developing local monitoring systems, including reporting potential hotspots or behaviors that could lead to fires. This supports a faster and more efficient response to emergencies. (6) Maintenance of Awareness and Concern: Community engagement also plays a role in maintaining awareness and concern about the risks of forest and land fires.

Prevention programs that involve communities on an ongoing basis help maintain focus and attention on the fire threat, encourage preventive practices, and build a safety culture. Involving communities in prevention programs has a positive effect on environmental sustainability. It creates active involvement in collective efforts to prevent the risk of forest and land fires and maintain ecological safety. Some of these references are appropriate and related to fire and forest prevention programs and need to be adapted to community conditions, as follows: (1) Ministry of Environment and Forestry of the Republic of Indonesia. Guidance on Community Involvement in Forest and Land Fire Prevention. This reference may include official guidance or policy documents issued by the authorities on engaging communities in forest and land fire prevention. (2) Community Engagement in Wildfire Prevention Programs: Lessons from Case Studies. Journal of Environmental Management.

These references may be research articles that discuss experiences and lessons learned from case studies related to community involvement in fire prevention programs. United Nations Development Programme. Community-Based Approaches to Forest Fire Prevention: A Global Perspective. This reference may include a global view or framework from an organization such as UNDP on community-based approaches to forest fire prevention. Adapting the reference format to local community conditions recognized in the discipline or journal is necessary. Variable X3, "Environmental Concerns and Forest Preservation," refers to an essential dimension in the research context that reflects the extent to which people are concerned about environmental sustainability and forest preservation efforts.

The following explains this variable: (1) Definition of Environmental Concern: Environmental concern encompasses people's awareness, concern, and caring attitude towards environmental sustainability. It includes understanding environmental values, the consequences of human actions on ecosystems, and a desire to contribute to maintaining the balance of nature. (2) Forest Preservation as the Main Focus: In the context of this variable, forest conservation is the main focus of environmental concern. This includes recognizing the importance of forests as habitats for biodiversity, ecosystem supports, and carbon sinks. Concern for forests reflects the intention to engage in efforts to conserve and prevent forest damage, including the risk of forest and land fires. (3) Indicators of Environmental Concern: Indicators of environmental concern can involve community knowledge about environmental issues, positive attitudes towards nature conservation, and participation in forest conservation activities. Survey or questionnaire questions related to knowledge of forest ecosystems, attitudes towards illegal logging, or involvement in tree-planting activities could be relevant indicators. (4) Link to Fire Preparedness and Prevention: Environmental concerns and forest preservation are closely linked to fire preparedness and prevention. Communities that care about the environment are likely to be more responsive to the threat of forest fires and more likely to engage in prevention measures, such as participation in forest patrols or supporting prevention campaigns. (5) Role in the Measurement System: In a measurement system using this variable, high values on the variable "Environmental Concern and Forest Preservation" can be interpreted as an indication that the community has a high awareness and concern for environmental sustainability, particularly in the context of forest preservation. By including this variable in the study, researchers can gain a deeper insight into how community environmental concerns can influence preparedness and participation in forest fire prevention.

Preventive policies and measures refer to steps taken by governments, institutions, and communities to prevent forest and land fires (Karhutla). The following explains policies and preventive measures: (1) Prevention Policy: Forest and land fire prevention policies include regulations, norms, and guidelines set by the government or relevant institutions. These policies regulate land management, land clearing permits, and fire prevention and control efforts. Examples of policies include the establishment of no-burn zones, restrictions on land clearing by burning methods, and sanctions for violators. (2) Law Enforcement: Law enforcement is integral to forest and land fire prevention. This involves prosecuting individuals or parties who violate prevention policies, such as illegally burning land. Strict penalties can be an effective deterrent and provide a strong signal against practices that harm the environment. (3) Monitoring and Early Warning System: Establishing monitoring and warning systems is a critical preventive measure. Monitoring involves using satellite technology, weather sensors, and field observations to detect potential hotspots. Early warnings allow authorities to respond quickly and take preventive action before fires develop. (4) Community Education and Campaign: Community education and campaign efforts are proactive measures to increase community awareness and knowledge of the dangers of forest and land fires. These programs can include education on fire risks, prevention methods, and actions communities can take to engage in prevention efforts. (5) Community Participation: Community involvement in prevention activities, such as forest patrols, initial fire suppression, and reporting of potential hotspots, is an essential part of prevention measures. Empowering the community creates an effective synergy between authorities and citizens in keeping the environment safe. (6) Preventive Technology: Modern technology, such as drones and forest monitoring apps, can improve efficiency and accuracy in detecting and controlling fires. This technology can map risk, identify hotspots, and facilitate rapid response. (7) Research and Innovation: Supporting research and innovation is essential to fire prevention. Research can lead to a better understanding of the causes of fires, the effectiveness of preventive measures, and new technologies to improve prevention capacity. With this combination of policies and preventive measures, a holistic and responsive system is hoped to be created to prevent forest and land fires and reduce their negative impacts on the environment and society.

3. Research Method

The research method uses quantitative, statistical, and Wellbeing Methodology approaches. The research activities are illustrated in the image below. The formulation identifies specific research questions related to community participation concerns in preventing forest and land fires using the Lancang Kuning Nusantara System Application and the development of a conceptual framework by building a conceptual framework to understand the relationships between the involved variables, such as community concern, participation, and the effectiveness of the Lancang Kuning Nusantara System Application. The research location for the study on community awareness and involvement in the prevention of forest and land fires (Karhutla) in Toba Regency.

With the implementation of the Lancang Kuning Nusantara System Application, North Sumatra Province could be a highly relevant research topic. The population in this study is the entire community of Toba Regency. Data collection (Surveys and Interviews, live monitoring, focus group discussions) and data analysis using data analysis methods following the Wellbeing Methodology approach to understanding the impact of community concern and participation in preventing forest and land fires. The data analysis combines qualitative and quantitative data to obtain a more complete picture of community concern and participation and conducts a holistic analysis by examining exploratory.

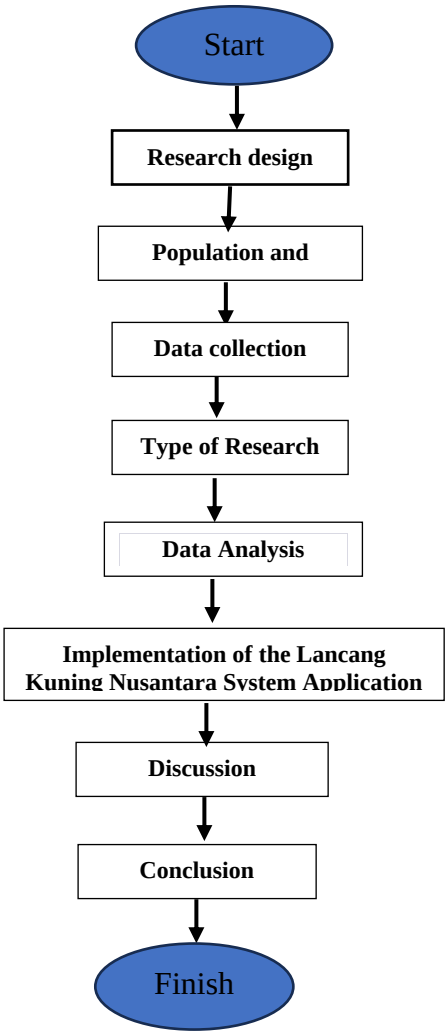

Fig 1. Research Procedure

It analyzes holistically by examining exploratory, qualitative, and quantitative findings to create a comprehensive overview. With this approach, it is possible to investigate the complex interactions between community concerns, participation, and implementation of the Lancang Kuning Nusantara System Application better in preventing forest and land fires in Toba Regency.

The implementation and application of the Lancang Kuning Nusantara system involve determining parameters to measure the effectiveness of the application, such as the number of fire reports successfully prevented or the response time to reports. This will be followed by reviewing the implementation of the application and evaluating the implementation of the Lancang Kuning Nusantara System Application by involving stakeholders, including the government, communities, and relevant organizations. The evaluation of the effectiveness of the Lancang Kuning Nusantara System Application could include analyzing data on application usage and the outcomes of forest and land fire prevention.

The instruments used include questionnaires, interviews, or observations as tools to collect data on community concerns and participation. Evaluating the effectiveness of the Lancang Kuning Nusantara Application can involve analyzing application usage data and the results of forest fire prevention and implementation, research gaps, and research questions in the study titled "Measurement System of Community Concern and Participation in Forest Fire Prevention" in Toba Regency, North Sumatra, Indonesia. This is a crucial step in assessing and understanding the role of the community in efforts to prevent forest fires in the region.

Discussion by interpreting research results and discussing findings in the context of the success of forest fire prevention and its impact on community welfare by implementing the Langcang kuning system as follows : (1) This application serves as a detection tool using remote sensing; previously, before this application existed, we often received information late, (2) The identification process is carried out by contacting personnel who are directly on the ground to verify the accuracy of the detection from the first stage of the application. "After detection, there are two stages we must undertake, namely identification.
Identification uses personnel in the field as we contacted earlier (through the application), and (3) Execution. Execution requires a unified command, necessitating resources, including the equipment we have prepared, whether aircraft or other tools. The conclusion of the research findings and recommendations based on the research findings to enhance community awareness, participation, and the effectiveness of the Lancang Kuning Nusantara System Application.

4. Result and Discussion

Before presenting survey or research data, testing the validity and reliability of the instruments used is essential. Validity tests determine whether the instrument measures what it is intended to, including content, construct, and criterion validity. Content validity ensures all aspects of the concept are covered, construct validity assesses whether the instrument measures the intended concept, and criterion validity assesses the instrument's ability to correlate with other measures.
Reliability testing is essential to ensure consistency of instrument results. Methods include test-retest, internal consistency, and parallel forms. Validity and reliability are necessary for accurate data in research. Valid and reliable survey instruments are the foundation of good research. The validity and reliability test steps are critical for developing survey instruments. Methods such as Pearson correlation are used in validity tests to determine item-instrument relationships. A high correlation value indicates a valid item.
For an accurate instrument, validity and reliability must be ensured. Researchers must be committed to ethical standards, and valid and reliable instruments strengthen the quality of research. Pearson validity tests help confirm relevant items and improve data accuracy. Through validity and reliability tests, researchers can ensure their instruments measure accurately and consistently.
This strengthens the quality of the research. In addition, the instrument development process must involve testing and refinement to ensure consistent and accurate data. Researchers must be responsible for ethical standards and ensure their survey instruments are valid and reliable. Validity and reliability are critical steps in the development of effective survey instruments. By ensuring that the instruments measure and produce consistent data, researchers can enhance the quality of their studies and provide a solid foundation for decision-making.
Validity testing with Pearson helps assess item-instruments' relevance, ensuring valid and accurate instruments. Thus, the validity and reliability of survey instruments are essential aspects of research that affect the accuracy of results. The reliability test using Cronbach's Alpha coefficient aims to measure the internal consistency of the survey instrument. Cronbach's Alpha is an index that indicates how well each item in an instrument contributes to the overall measurement of the intended construct. The Cronbach's Alpha value ranges from 0 to 1, where a higher value indicates better internal consistency.
Generally, a Cronbach's Alpha value above 0.7 indicates adequate reliability, a value above 0.8 indicates good reliability, and above 0.9 indicates excellent reliability. If the Cronbach's Alpha value is low, it suggests that the items in the instrument may not correlate well with each other, and revisions may be necessary. By ensuring that the instrument has a high Cronbach's Alpha coefficient, researchers can confirm that the results are consistent and reliable, essential before presenting data or conducting further analysis.
Data analysis for variable X1 shows that knowledge of Forest and Land Fire Risks (Karhutla) involves Community perception, participation, and acceptance. Perception measures how the community views the risk of forest and land fires, which the effectiveness of educational campaigns can influence. Participation measures the extent to which the community is involved in mitigation activities, reflecting the level of awareness and commitment. Acceptability assesses the community's acceptance of government policies on forest and land fires, which is crucial for successfully implementing those policies. Analyzing the relationship between these three aspects can provide deeper insights into how the interaction among variables can be used to formulate more effective mitigation strategies. Based on the analysis, researchers or policymakers can formulate appropriate recommendations to enhance public knowledge about the risks of forest and land fires, encourage active participation, and improve policy acceptability.
For instance, by conducting intensive educational campaigns if public perception is low, or finding ways to boost active community participation if it is lacking. If acceptability is low, then existing policies need to be reviewed to ensure transparency, fairness, and effectiveness in the eyes of the public. Thus, a comprehensive analysis of this variable X1 is critical for holistic and sustainable forest fire mitigation. Understanding the perceptions, participation, and acceptability of the community can help formulate more effective strategies for managing the risks of forest and land fires in society.
Based on data from 401 respondents regarding knowledge of the risks of forest and land fires, a mean of 7.38, a median of 5, and a mode of 9 were obtained, indicating an exponential distribution pattern. With 44% of respondents giving the highest score, this indicates a significant awareness of the risks of forest and land fires among a large portion of the community. The relatively high mean suggests a good level of knowledge overall, but the lower median indicates a significant disparity where some respondents still possess lower expertise. Mode 9 indicates that the largest group of respondents understands the risks of forest and land fires. Still, the exponential distribution suggests increased education to raise awareness among groups with lower scores. Assessment using an exponential curve pattern, where the mean is 7.38, the median is 5, and the mode is 9, along with 44% of respondents giving the highest scores, indicates that public knowledge about the risks of forest and land fires is still primarily influenced by emotional factors or high euphoria.
This exponential pattern suggests that most respondents may be evaluating the risks with an imbalance of optimism or concern, which could be caused by recent information or current events significantly affecting their perceptions. Such a curve is often less stable because it does not reflect a consistent and even distribution of knowledge across the entire population. Therefore, there needs to be an effort to enhance the stability of public knowledge through continuous education and the dissemination of more structured and in-depth information so that assessments of the risks of forest and land fires become more realistic and based on consistent understanding.

5. Conclusion

The analysis of the environmental sociometric study in Toba Regency, North Sumatra Province, was conducted with 401 respondents to measure community awareness and participation in forest fire prevention and implementing the Lancang Kuning Nusantara System

application. The sociometric approach is used with data collection instruments through questionnaires and interviews. The results of the analysis show a high level of concern and variation in community participation in fire prevention activities. Although the implementation of the application has been quite successful, there is still a need to enhance participation and usage through further education. The positive correlation between awareness, participation, and usage of the application indicates that the greater the community's concern, the higher the participation and usage of the application.

The study results show that the community in Toba Regency has a high perception of fire prevention, enhancing their understanding and awareness of the dangers of fire. Community participation in prevention activities is also high, but the level of acceptability towards the programs still needs to be improved by identifying and addressing existing obstacles.

The standard deviation and the proportion of respondents rating low indicate that the majority of the data is consistent and stable; however, further evaluation is needed to understand the reasons behind the low perceptions of the public.

The recommendations include enhancing education and outreach regarding fire prevention and empowering the community to increase participation in prevention activities. Thus, efforts to prevent forest and land fires in Toba Regency can continuously improve through collaboration between the government, the community, and relevant organizations.

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