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Cluster Around Latent Variable for Vulnerability Towards Natural Hazards, Non-Natural Hazards, Social Hazards in West Papua

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ABSTRACT The diagnosis of a hazard can be classified into three key domains, particularly regarding the natural hazards, non-natural hazards and social hazards. The disasters which have actually happened in West Papua require considerable attention and consideration of the Indonesian Government, despite since they have handled as much as they can to provide solutions and make people feel secure and pleasant. The purpose of this study is to calculate the location-based social vulnerability in West Papua involves the components of Information, Technology, and Communication, Food Access, Natural Disaster, Social Protection Statement, Access to Financial Services, Description of the source of household income, Number of event floods, number of earthquake disasters, COVID-19 death cases, and Number of incidents of protest which are obtained from the National Socio-Economic Survey (SUSENAS) official statistics with the main focus of research on the millennial generation. After employ clustering of variables around latent variables with connectivity value of 3.9400794, Dunn 0.9373, and Silhouette 0.6333. Each factor provide a sign indicating a positive or negative effect on social vulnerability and finally a location cluster will be formed based on the index obtained.

INDEX TERMS Latent cluster, millennial, natural hazard, non-natural hazard, social hazard, vulnerability.

I. INTRODUCTION

Indonesia is undoubtedly one of the countries with a high potential for disaster [1]. From a geological point of view, Indonesia is placed between the junction of three large tectonic plates, which include the Indo-Australian plate, the Eurasian plate and the Pacific plate. The plate tectonics that followed led to a series of volcanoes along the Sumatra Island, Java-Bali-Nusa Tenggara, northern Sulawesi, Maluku and Papua. This sequence of volcanoes is part of the chain of volcanic activity in Asia-pacific region widely recognized as the Ring of Fire [2]. Earthquakes, tsunamis and volcanic eruptions are a variety of hazards that are affecting Indonesia due to these geological conditions. Economic losses cannot be prevented if there is a huge disaster. For example, there was an earthquake in Lombok and Sumbawa. The economic losses suffered amounted to IDR 17.3 trillion. Meanwhile, losses due to the earthquake and tsunami in Central Sulawesi reached more than IDR. 13.82 trillion. The government allocates a disaster budget from the State Revenue and Expenditure Fund (APBN) towards deal with disasters management. The budget is used for a variety of operations during the pre-disaster (disaster risk reduction) process, emergency response and post-disaster (rehabilitation and reconstruction)

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phases. Post-disaster operations require the most financial support. Geographically, West Papua contains 13 regencies/municipalities with a total area of 102946.15, with the highest number was Teluk Bintuni (20.24%) as well as the smallest was Sorong City (0.64%). Earthquakes, landslides, floods and social conflicts are the most common hazards in West Papua. Flash floods in the Sorong city caused damage to 754 residences that happened on 16 July 2020 and confirmed 5 deaths. Then in July 2020 BMKG Indonesia reported as many as 53 earthquakes in West Papua most of which were dominated by earthquakes with Magnitude<3 and shallow earthquakes (< 60KM). Mostly, 45% from the total earthquakes with a magnitude of 3m to < 5m, while 53% of the total earthquakes are driven by earthquakes with an intensity of less than 3m. Throughout July 2020, a group earthquake occurred in the city of Manokwari on 29 July 2020.

Indeed, the social conflict that has happened previously in Papua is a problem that has not yet been settled [3]. These were mentioned that the social conflicts that existed against the people of Papua were due to a variety of factors. For fairly obvious reasons, the cases of racial hatred in Surabaya, East Java, on 21 August 2019. Human rights violations in Papua will be the next source of the confrontation [4]. These cases were on the rise since the period of the new order, and repressive behavior has also persisted until this day. One of the cases that occurred during the reform period was the Wasior Wamena case [5]. The issue of human rights violations is an issue that always arises regarding the Papua problem. All parties need to understand this issue through dialogue. The security apparatus also needs to avoid violent means that have the potential to lead to further human rights violations [6]. Then it was figured that development in West Papua was uneven [7] and until now it has become a hot issue that needs addressing. According to a report by the Central Statistics Agency in 2019, the percentage of poor people in West Papua was 22.17% and in 2018 it was 23.01%, so there was a decrease of up to 0.84%. In total, the Percentage of Poor People in West Papua Province by Regency/Municipality is mostly found in the Arfak Mountains 34.83% and the lowest percentage of the Human Development Index is in Tambrauw at 52.90%.

Conceptually and theoretically the analysis of social vulnerability may be used as a screening criterion to recognize the problems or influences that cause vulnerabilities [8]. The weakness to risks is impacted by numerous variables, including age, salary, the quality of informal communities, and neighborhood attributes. Then it can be done to measure the risk of the impacts that occur and as a basis for determining important steps in overcoming the impact of disasters and disaster risk. Social Vulnerability Index (SoVI) was applied to delineation of natural risk zones [9], context of river flood [10], coastal communities [11], frailty and mortality in elderly people [12]. Therefore, [13] Perform biclustering to measure SoVI by extracted from the Indonesian National Socio-Economic Survey (SUSENAS) by BPS-Statistics in 2014 and [14] construction of social vulnerability index in Indonesia using partial least squares structural equation modeling. Thus, it is necessary to carry out an analysis to assess the relationship between natural hazard, non-natural hazard and social hazard which have never been linked.

In accordance with the definition of disasters referred to in Law No. 24 of the Republic of Indonesia of 2007, it's also categorized into three parts, consisting of natural hazards, non-natural hazards and social hazards. Natural hazards may be defined as natural events which including tsunamis, flooding, volcanic eruptions, earthquakes, hurricanes and landslides. Non-natural hazards include accidents generated by technological failures, refusal to modernize, epidemics, pandemics, or disease outbreaks. Finally, social disasters include conflict between communities and terrorism. Most cases of natural disasters occurred in West Papua in the period 2018 to 2019 according to official statistics data were earthquakes with 127 cases with the most cases in Sorong (46 cases), then flood cases with 17 cases and cities. Most of the flood cases were Mankowari (6 cases). Meanwhile, The COVID-19 pandemic outbreak, which was appalling and frightened the country [15], [16] also worrying in West Papua until either the data collected through 10 September 2020 was 35 deaths and 649 cases recovered.

Millennial generation has an important role to participate in mitigating the threats resulting from natural hazards, non-natural hazards and social hazards. Millennials are known for high creativity, optimism, and adaptive flexible skill, so that they can play a big role in the midst of a hazards. Millennial generation are quite knowledgeable through the use of information and technology [17]. This generation is willing to spend hours on digital technology, including cellphones or laptops, every day. The millennial generation has tremendous potential and resources to innovate. In terms of education, the millennial generation also has superior quality. This generation also has an interest in continuing their education to a higher level [18]. They realize that education is a top priority. With these conditions, Indonesia should be optimistic about the various potentials possessed by the millennial generation. An open, free, critical, and courageous mindset is a valuable asset. Also, mastery in the field of technology, foster opportunities and innovation [19].

The occurrence of hazards in Indonesia cannot be prevented, but society can minimize losses due to hazards, both material loss and loss of life. This is where Information Technology plays an important role [20] in overcoming and even providing early warnings before disasters occur and the participation of the millennial generation is required. Some experiences in the use of Information Technology in facilitating disaster management in Indonesia itself when the Tsunami hit Aceh [21] and North Sumatra where at that time the entire communication network was cut off, but volunteers and victims did not have any sense to optimize the internet as a communication channel to inform and inform the existing conditions at that moment to the outside world as well as to their relatives. Through blogs and websites, email, chat and

others, they use the internet. The impact is that assistance from within and outside the country is quickly distributed and volunteers continue to arrive to help evacuate the bodies of the victims who died as a result of the disaster. Indonesian citizens aged 16 to 64 years surf the internet (on all devices) in a day for an average of 7 hours 59 minutes. Meanwhile, Indonesian internet users reach 175.3 million or 64% of the total population of Indonesia. The majority of these users use cell phones, which is 171 million or 98% of Indonesian internet users. Social media ranks second with an average Indonesian population spending 3 hours 26 minutes. YouTube and WhatsApp are the most popular social media with a percentage of 88% and 84%, respectively. While other media for 3 hours 4 minutes to watch television, 1 hour 30 minutes to stream music, and 1 hour 23 minutes to use a game console. This paper will analyze the social vulnerability in West Papua by paying attention to participant respondents at SUSENAS 2017 starting at the age of 10-35 years with consideration of understanding of technology and access to information.

The purpose of this paper is to obtain the value of the relationship between SoVI and Natural Hazards, Non-Natural Hazards, Social Hazards in West Papua and make a spatial mapping based on SoVI values and latent values. Long story short, literature review including vulnerability index, clustering around latent variable are describe in section 2. Therefore, Results and Discussion in section 3 and finally conclusion in section 4.

II. LITERATURE REVIEW

A. VULNERABILITY INDEX TOWARDS NATURAL HAZARD, NON-NATURAL HAZARD, AND SOCIAL HAZARD

Basically, the existence of a disaster is not expected by anyone and it is very difficult to make an accurate forecast. So far, researchers can only do early warning detection. In dealing with the impact of a hazard, cooperation is required by the penta-helix which consists of government, industry or private sector, academia, local community, media, and society. The concept of Penta helix synergy is intended to avoid overlapping policies and programs between parties with an interest in implementing post-disaster recovery. This collaborative collaboration model is considered to be able to create community independence more quickly so that they do not always depend on assistance, especially the government, especially in post-disaster economic recovery.

The calculation of the vulnerability index is very important to do, especially to assess which areas have a very worrying vulnerability can be improved as soon as possible. Since the financial and environmental considerations are a repair cost for any concept of sustainability development, social conditions are no less problematic. A society which is poorly shaped, does not even have access to healthcare services and sanitation, or retains education opportunities, becomes bound only by aim to establish rural livelihoods that would mitigate resilience.

There are many other index-based methodologies to evaluating exposure to socio-natural hazards including different varieties throughout theoretical underpinnings, predictor specification and estimation methods. Furthermore, Anderson *et al.* [22] compares index outputs with Social Vulnerability Index (SoVI) and the vulnerability component of the Global Delta Risk Index (GDRI). The Disaster Risk Index [23], the Index for Risk Management (RMI) [24] and the Social Vulnerability Index (SoVI) [25]. Besides, SoVI calculation can also be used as a study to increase public awareness in disaster management. This study can involve and include infrastructure information that tends to be static to determine the level of development, the physical losses that may be felt by the community when a disaster occurs. Second, it covers a more dynamic socio-economic aspect and can better explain the vulnerability of a type of disaster.

A proper assessment also needs to be sustainable habits by monitoring all phenomena covering infrastructure, socio-economy and physics in disaster-prone areas and this information is also important for development planning. SoVI is also mismatched to theory and tends changes in variables that contribute to vulnerabilities, including unemployment, also minimize vulnerability [26]. Previous study, Nasution *et al.* [27] addressing the new biophysical indicators, which are renters and housing quality to measure the social vulnerability index in Indonesia. However, SoVI is a complex method that requires specialized knowledge and statistical expertise to implement [28]. SoVI can also be used to study disasters that are non-natural hazards such as COVID-19 [29], [30]. Even psychological indicators also need to be considered [31].

The National Socio-Economic Survey (SUSENAS) is one source important socio-economic data on households in Indonesia. In general, the purpose of collecting data through SUSENAS is the availability of people's welfare that can reflect the socio-economic conditions of the community. Specifically, the targets for SUSENAS are; availability of basic data on community welfare, at the district/city level, compiled detailed data on housing and health at the provincial level. The compilation of detailed data on household consumption expenditure both in rupiah value and in quantity, among others as a basis for estimating the pattern of consumption, the population, the adequacy of nutritional consumption, the distribution of expenditure, poverty at the national level.

In line with this, this paper uses the data from participants who fill out SUSENAS Official Statistics Indonesia with an age range of 10 years to 35 years with a total of 6586 people with the most participants in from Maybrat and the least from Teluk Bintung. The average millennial generation in West Papua uses a cell phone was 55%, owns a cellphone 61%, uses a computer 89%, accesses the internet 85%. However, Maybrat is the region with the lowest ownership of cellphones, laptops and internet access. In contrast, Tambrauw has the largest percentage of ownership of cellphones, laptops and internet access.

TABLE 1. Blok question.

Information, Technology, and Communication (X_1) Scale : Yes…..1 No…..5 Sources: SUSENAS 2017	[R701] Are you using a cell phone?
	[R702] Do you have a cell phone?
	[R703] Do you use a computer (pc / desktop, laptop / notebook / tablet?
	[R704] Have you ever accessed the internet (including Facebook, Twitter, BBM, and WhatsApp)?
Food Access. (X_2) Scale : Yes…..1 No…..5 Unknown…..8 Not Answer…..9 Sources: SUSENAS 2017	[R1501] During the past year, have you / other household members worried about not having enough food to eat due to lack of money or other resources?
	[R1502] During the past year, have there been times when you / other household members were unable to eat healthy and nutritious food due to a lack of money or other resources?
	[R1503] During the past year, did you / other household members eat only a few types of food because they did not have money or other resources?
	[R1504] During the past year, have you / other household members missed meals on a certain day because they did not have enough money or other resources to get food?
	[R1505] During the past year, did you / other household members eat less than they should because of a lack of money or other resources?
	[R1506] During the past year, has the household run out of food due to lack of money or other resources?
	[R1507] During the past year, did you / other household members feel hungry but did not eat because of lack of money or other resources to get food?
	[R1508] During the past year, did you / other household members not eat all day because of lack of money or other resources?
Housing status (X_3) Owned …..1 Contract / Lease…...2 Rental Free…..3 Office …..4 Others …..5 Sources: SUSENAS 2017	[R1602] What is the ownership status of the occupied building?
Natural disaster (X_4) Scale : Yes…..1 No…..5 Sources: SUSENAS 2017	[R1801A] Has (name) experienced natural disasters (such as earthquake, flood, tsunami, and tornado)?
	[R1802A] Is the neighborhood (name) included in the environment prone to natural disasters?
	[R1802B] Does (name) know how to save yourself from that natural disaster?
	[R1803] Is (name) aware of any signs or warnings to deal with a natural disaster emergency in the neighborhood (name)? (such as meeting areas, evacuation route instructions, sirens for warning of a tsunami disaster)
	[R1804] In the past year, has anyone in your household (name) attended any training / simulations on natural disaster rescue?
Social protection statement (X_5) Scale: Yes (can show card) …… .1 Yes (unable to show card)… 2 No…..5 Sources: SUSENAS 2017	[R2005] Does this household receive a social protection card (KPS) / a prosperous family card (KKS)?

TABLE 1. *(Continued)* Blok question.

Access to financial services (X_6) Scale : Number of persons Sources: SUSENAS 2017	[R2101] What is the number of adult households (15 years and over) having savings in formal financial institutions (banking, coop, etc.)?
Description of the source of household income (X_7) Scales Household members work …..1 Delivery of money / goods ..2 Investment (deposit, royalties, shares, bank interests) ….3 Pension …… 4 Sources: SUSENAS 2017	[R2301A] When receiving money / goods remittances. Where is the main source?
Number of event floods (X_8) Sources: BPS Indonesia	Starting from January 2018 to December 2019
Number of Earthquake disasters (X_9) Sources: BPS Indonesia	Starting from January 2018 to December 2019
COVID-19 death person (X_{10}) Sources: West Papua Provincial Health Office	Starting from 27 March 2020 to 10 September 2020
Number of incidents of protest (X_{11})	Collected from the media from January 2015 to December 2019

Resilience is characterized as the ability of a hazard-exposed system, community or society to quickly and effectively sustain, absorb, accommodate and recover from the effects of hazards, including the preservation and restoration of essential basic function and structure [32]. In addition, resilience is also defined as the ability to cope with others and respond to various stress and strain so that it recovers to its former condition [33]. Besides, resilience is a combination of the three main characters.

Absorption of shocks, steps which can be undertaken to deal through changes from a social perspective could be in the context of reducing poverty schemes and social protection throughout the form of resources and access to food [34]. Bounce back, the capacity of the system to return to its pre-disaster state (rebound). Efforts that can be made include building and rehabilitating refugee centers, supporting public institutions offering basic services and increasing access to water, basic sanitation and encouraging a healthy lifestyle.

Learning and adaptation, represent the actions which can be undertaken to strengthen the system's potential to understand and adapt could be achieved by implementing structured health care plans, growing children's rights, including the right to education, reinforcing the women's role in government, and developing political committees and parties. Resilience is a theoretical framework and social process that tries to explain how society cope with adversity [35]. The Adaptation measures in the early stages will increase resistance by reducing and absorbing the shock absorption changes that have taken place. The next stage of the

FIGURE 1. The Relationship Between the Concepts of Resilience, Vulnerability and Adaptation [42], [43].

adaptation process is aimed at improving self-adjustment of earnings and adaptation [36].

Resilience is the performance of hazard and risk reduction programs there is still a significant link between both the principle of adaptation of vulnerability and disaster risk management resilience [37], [38]. The relationship between the three definitions can be seen in Figure 1. In order to respond, in the last stage of the recovery process, the primary objective is to rebuild as well as stabilize the system so that it recovers immediately, as it would before the disaster recovers or improves for better transformation. Successful adaptation strategies will greatly reduce the likelihood of disasters [39]. There are three major stages of disaster risk mitigation adaptation, including the pre-disaster, disaster and post-disaster stages [40], [41]

B. CLUSTERING OF VARIABLES AROUND LATENT VARIABLE

Cluster analysis is a technique used to classify objects or cases into relatively homogeneous groups based on their characteristics [44]. Cluster analysis classifies objects so that each object that is most closely similar to another object is in the same cluster [45]. The clusters formed have high internal homogeneity and high external heterogeneity [46]. The purpose of clustering cluster analysis is to group similar objects together [47]. Objects with a smaller distance between them are more similar than objects with a greater distance [48]. Within a cluster, there are many methods that can be used.

The hierarchical method [49]–[51] is characterized by the creation of a hierarchical structure or tree-like structure [52]. The hierarchical method consists of divisive [53] and agglomerative [54]. The divisive method starts by placing all the objects as a cluster. Then gradually the objects are separated into different clusters. Meanwhile, the agglomerative method begins by placing each object in a separate different cluster. Clusters are formed by grouping objects into a larger cluster (the more objects that are members). This process ends until all objects are members of a single cluster [55]. Agglomerative method is divided into Variance Method [56], Centroid Method [57] and Linkage Method [58]. The Variance Method aims to obtain clusters that have the smallest possible internal variance.

The commonly used variance method is the Ward method, by calculating the average of the variables for each cluster, then calculating the Euclidean distance between each object and the average value, then all the distances are calculated. At each stage, the two clusters that have a small increase in the number of squares are combined into one cluster. The Centroid method uses a centroid distance (cluster center distance). Centroid itself is the average of all members in the cluster. Each time the objects are combined, new centroids are calculated. Every time a member is added, the centroid changes [59]. Linkage method is divided into 3 methods. First, Single Linkage, which is a method based on the minimum distance or nearest neighbor rule. The first two objects to group are those that have the closest distance between them. The disadvantage of this method is that if a cluster is combined only because it is closest to one of the members, then if there is one object that is far away, this method can cause unclear cluster interpretation. Second, Complete Linkage, which is a method that uses the maximum distance approach or the farthest neighbor. The weakness of this method is that if there are members that are close to the two clusters, this method can cause unclear cluster interpretation. Third, Average Linkage, which is using the distance between two clusters, is considered the average distance between all members in one cluster and all other cluster members. The downside of this method is that more information is required. Eq 1 describes the euclidean distance.

$$d_{AB} = \left(\sum_{j=1}^{p} \left| X_{Aj} - X_{Bj} \right|^2 \right)^{\frac{1}{2}} \tag{1}$$

To get components $\boldsymbol{c}$ above the standard $max_{\|c\|=1}$ on each matrix $\boldsymbol{X}$ which is included in each cluster formed by the Eel 2 [60], [61].

$$\begin{aligned} (P_A + P_B)\,\sigma\,(\bar{\mathbf{x}}_{A\cup B}) &= (P_A + P_B)\,\frac{1}{\sqrt{n}}\,\|(\bar{\mathbf{x}}_{A\cup B})\| \\ &= \frac{1}{\sqrt{n}}\,\|(P_A\bar{\mathbf{x}}_A + P_B\bar{\mathbf{x}}_B)\| \\ &\leq P_A\frac{1}{\sqrt{n}}\,\|(\bar{\mathbf{x}}_A)\| + P_B\frac{1}{\sqrt{n}}\,\|(\bar{\mathbf{x}}_B)\| \\ &= P_A\sigma\,(\bar{\mathbf{x}}_A) + P_B\sigma\,(\bar{\mathbf{x}}_B) \end{aligned} \tag{2}$$

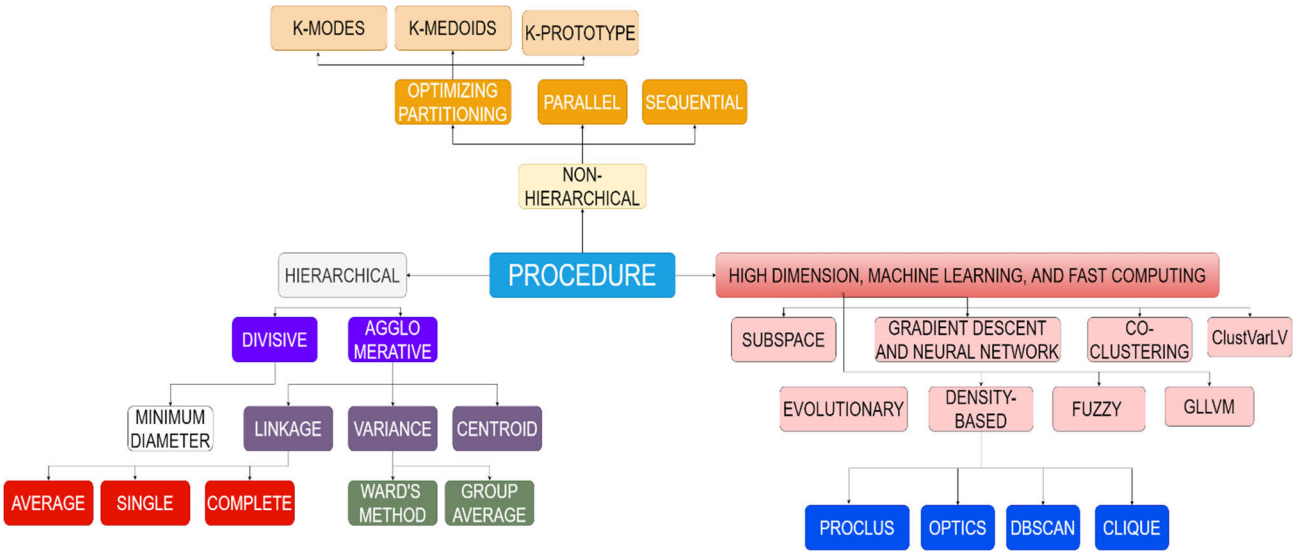

FIGURE 2. Clustering Procedure.

The latent variable is defined as a linear combination of only the variables belonging to the corresponding cluster. To cluster latent, for example in the instrument the data consists of $s_1, s_2, s_3, \ldots, s_p$ and consider t as an external variable so $u_1, u_2, u_3, \ldots, u_t; \mathbf{c}_t$ $(t = 1, \ldots, T)$ is the latent variable associated with cluster. First, find the covariance value of each variable with the criteria $\tilde{L}$ which can be expressed as Eq 3.

$$\tilde{L} = n \sum_{s=1}^{S} \sum_{u=1}^{U} d_{kj} Cov^2 \left(\mathbf{s_u}, \mathbf{c_s}\right)$$
$$\mathbf{c_s} = \mathbf{U}\, \mathbf{a_s} \text{ And } \mathbf{a_s'} \mathbf{a_s} = 1 \quad (3)$$

From the cluster or group that has been formed and the underlying data structure shown in the cluster, we get the information about the relationship between observations [62]. The structure of cluster analysis often shows relationships or similarities and differences not previously detected by other methods or analyzes such as discriminant analysis used to identify empirical relationships, or group research using other qualitative methods. The selected variables are then used to characterize objects in the grouping process. Figure 2 represent the clustering procedure including hierarchical, non-hierarchical, high dimension, machine learning and fast computing.

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Then it can determine some good starting center points from the data that has been reduced using the algorithm.

Psedocode 1

1. Assuming each point n represent itself by being a cluster $\mathbf{c}$, where $i = 1, 2, \ldots, n$
2. Calculate the shortest distance between $m\,(\mathbf{c_A})$ and $m\,(\mathbf{c_B})$, where $a \neq b$ and $m\left(\mathbf{c_j}\right)$ is a member of the cluster $\mathbf{c_j}$
3. Join $\mathbf{c_A}$ and $\mathbf{c_B}$ into a new cluster $\mathbf{c_{new}}$ where $m\,(\mathbf{c_{new}})$ is a member of $\mathbf{c_A}$ and $\mathbf{c_B}$
4. Repeat Step 2 with $m\,(\mathbf{c_A})$ represented by all of its members

To determine the starting center point, a hierarchical clustering algorithm is designed that works according to the centroid linkage algorithm paradigm. The following is a pseudocode of the hierarchy based starting center point determination algorithm:

Psedocode 2

1. Assuming each point $\boldsymbol{n_{reduction}}$ represent itself by being a cluster $\mathbf{c}$, where $i = 1, 2, 3, \ldots, \boldsymbol{n_{reduction}}$
2. Calculate the shortest distance between $m\,(\mathbf{c_A})$ and $m\,(\mathbf{c_B})$, where $a \neq b$ and $m\left(\mathbf{c_j}\right)$ is a member of the cluster $\mathbf{c_j}$
3. Join $\mathbf{c_A}$ **dan** $\mathbf{c_B}$ into a new cluster $\mathbf{c_{new}}$ where $m\,(\mathbf{c_{new}})$ is a member of $\mathbf{c_A}$ and $\mathbf{c_B}$
4. Repeat Step 2 with $m\,(\mathbf{c_A})$ represented by all of its members

With an algorithm like the one above, the main process and the most frequently done is measuring the distance between one cluster and another. In the initial stage, the distance to be measured involves a combination of the number of points in the input data. And in the next stage,

the distance measurement process will gradually decrease because at each stage there is a cluster merging process $O\left(n_{reduction}\right)^2 + O\left(n^{1+2C_{clust}}\right)$ Where C_{clust} is the number of central starting points that must be generated.

III. RESULTS AND DISCUSSION

A. STUDY AREA

West Papua Province is located at 0°, 0″ to 4°, 0″ South Latitude and 124°, 00″ to 132°,0″ East Longitude, just below the Equator with an altitude of 0 −100 meters from sea level. The total area of West Papua Province reaches 97.024.372 KM, divided into 10 districts and 1 city, consisting of 154 sub-districts and 1.361 villages. Based on the slope class, the province of West Papua can be divided into: slope 0-15% (45.44%), slope of 15-40% (4.24%), and slope >40% (50.31%). The territory of West Papua Province has slope class > 40% with the shape of the area in the form of quite large hills (1.069.807,15 Ha). There are many densely populated beaches in the province of West Papua, causing hazards and risk of a tsunami disaster.

B. INDEX MEASUREMENT

The assessment of three diffident scientific subjects including natural, social or non-social phenomena can be conduct even have diffident feedback on the society Because our goal is to get a value that can relate each phenomenon using SOVI analysis. The National Socio-Economic Survey (SUSENAS) is the main basis for meeting the government's needs in implementing national development so that it is in line with Sustainable Development Goals (SDGs). SUSENAS collected by the official statistics (BPS) to provide a portrait of development progress. The portrait must be accurate and can be trusted by the public at large. Therefore, SUSENAS provides development data in the socio-economic sector at the national, provincial and district/city levels. In line with this, this paper only uses the results of the survey with the millennial generation participant category in the age range 10-35 years which is described in Table 2.

C. DATA ANALYSIS

During 2019, there are 11 districts that have opened access to internet data services, including, FakFak, South Sorong, Raja Ampat, Bintuni Bay, Wondama Bay, Kaimana, Tambrauw, Maybrat, South Manokwari, Arfak Mountains and Sorong Regency. People in the frontier and outermost (3T) areas in West Papua Province can enjoy high-speed internet services. Through the East Palapa Ring Package program, internet networks can be enjoyed in areas that have not yet enjoyed cellular data networks at all. Internet services will soon reach the most difficult areas. Director of Telecommunication and Information Services, Telecommunication and Information Technology Accessibility Agency with access speeds in regencies reaching 10 Megabits, urban areas of 20 Megabits.

TABLE 2. Spearman correlation hazards in west papua.

Sample 1	Sample 2	95% CI for ρ	P-Value
COVID19_Death	SOVI	(0.208,0.945)	0.007
Flood	SOVI	(0.557,0.640)	0.00850
Earthquake	SOVI	(0.302,0.957)	0.003
Protest	SOVI	(0.359,0.780)	0.0333
Flood	COVID19_Death	(0.195,0.854)	0.0126
Earthquake	COVID19_Death	(0.238,0.837)	0.0165
Protest	COVID19_Death	(0.401,0.756)	0.00416
Earthquake	Flood	(0.445,0.728)	0.00516
Protest	Flood	(0.500,0.600)	0.0001
Protest	Earthquake	(0.439,0.732)	0.0502

In the block of access to food questions, 85% of the millennial generation in West Papua is not worried about having enough access to food due to financial problems and other resources with the highest average response to be in Teluk Bintung and the lowest in Kaimana. Then as many as 89% of this millennial generation never thought that there was a moment while they could not eat healthy and nutritious food due to financial problems and other resources, with much of the responses becoming the highest in Wondana Bay and the less in Kaimana. With the same percentage this generation does not really feel they are eating the least some kind food because they don't even have any money or other resources. Meanwhile 96% of the millennial generation in West Papua rarely run out of food due to financial problems or other resources, yet 97% don't really feel hungry due to financial problems and other resources.

West Papua is easily available with natural resources, and that most of the people there consume sago as a food staple, meaning that it the easy of having this food source allows the millennial generation a tendency to not have trouble getting food, and most of them still dependent on natural resources to end up living. Based on SUSENAS 2017 data, the percentage of millennial generation house ownership in West Papua is 28% with the highest percentage of self-ownership status in Kaimana. Then November 2017 there was a Mimika blockade from 12 to 15 July 2018.A series of gunfights were reported between the wing of the Free West Papua Movement and Indonesian security forces during 2019 Papua protests.

Throughout the natural hazard question block, mostly 94% of the millennial responded that theirs place was not included in category of disaster-prone areas, and also that the millennial which understood to save themselves against disasters was Kaimana (80%), Sorong City (77%) and Maybrat (68%), respectively. Nevertheless, it was upsetting, depending on the millennial which mostly filled the 2017 SUSENAS almost 100% they didn't really understand how to save themselves whenever a natural disaster occurred. At the same time, as many (93%) of the millennial generation in West Papua do not actually recognize warning signs of natural hazards also including meeting places, evacuation routes, tsunami warning and alert sirens. Consequently, the level of self-rescue understanding was only 22% in Manokwari and 19% in Maybrat. The line of reasoning is correct with a block of questions on post-disaster involvement. Almost 98% of the

millennial generation in West Papua has never participated in this activity, only with highest participation rate of just 5% in Maybrat. It is quite frightening that perhaps the participation rate of the millennial generation in Teluk Bintung, Raja Ampat and Fakfak reaches 0%. Special attention by the government, Non-Government Organization (NGO's) or any parties involved is needed to resolve these problems.

Socio-economic development, as part of the implementation of national development plans, indeed led to considerable of growth, including the enhancement of people's welfare. Such healthcare must be provided in a prosperous, fair and equitable manner in order to capture out to all citizens. The government shall implement a National Social Security System for certain Indonesians through Law No. 40 of 2004 on the National Social Security System. It claims that everyone has the right to be secure in order to meet basic needs of a good living and also to raise their dignity in the accomplishment of a prosperous society. The Indonesian Government is providing social assistance help and support through the Social Protection Card (KPS) or the Prosperous Family Card (KKS) through the National Poverty Reduction Acceleration Team.

This Social Protection Card is useful for benefiting from the Rice Subsidy Program for low-income people, known as the RASKIN Program. In addition, KPS can also be used to benefit from the poor student assistance program and the community temporary direct assistance program. The government issues this Social Protection Card to 15.5 million poor and vulnerable households which constitute 25% of households with the lowest socio-economic status in Indonesia. For example, during the COVID-19 pandemic, the 'staple food program' is a food social assistance program that began in 2020 and is a development of the Non-Cash Food Assistance (BPNT) program, this program is given to beneficiaries to access foodstuffs through a Prosperous Family Card (KKS) as a payment instrument that features a savings and/or electronic money that can be used as a medium for distributing social assistance. The benefits of this KKS also save the quota of social assistance for beneficiaries from the Government. Electronic money, debit cards that can be used to carry out banking transactions such as buying credit, paying bills, and disbursing social assistance funds. Then this can also be used to save and make cash withdrawals.

Based on SUSENAS 2017, 98% of millennial generation in West Papua do not have a prosperous family card or social protection card. They also feel that no household member has or receives social security. Then only 2% of the 15% millennial who have this card can show it. Furthermore, more than 96% felt that their household had never received the prosperous family program. However, as many as 25% of millennials from Teluk Wondana feel that they have been recipients of the prosperous family program. Meanwhile, if we pay attention to the block question of access to financial services. On average, each family has 1 person who has savings at a formal financial institution banking or cooperative. Overall, only 22% of the millennial generation in West Papua have savings at formal financial institutions. Then, 81% of the millennial generation who work send their income to their parents and family. Most cases in Raja Ampat are sources of household financing from other families. Table 2 and Figure 3 provides information of pairwise spearman correlations hazards in West Papua. In line with this, all of variables is significant with alpha = 5%. The highest correlation of SoVI is with COVID-19 cases and earthquake.

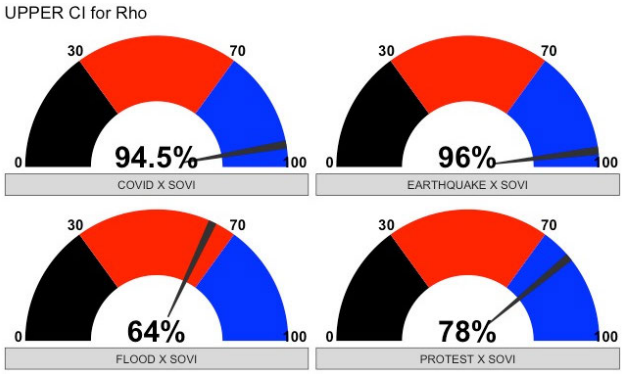


FIGURE 3. Upper Confidence Interval ρ SoVI.

In addition, Figure 4 explains in great detail that this our models validated very well by the Connectivity value of 3.9400794, Dunn 0.9373, and Silhouette 0.6333. A certain internal information mostly on clustering mechanism is being used to evaluate the goodness including its clustering framework without reference to external knowledge. All of that could be used to predict the amounts of clusters and the appropriate clustering algorithm without any data sources.

For each observation $\boldsymbol{i}$,the silhouette width $\boldsymbol{s_i}$ is calculated the average dissimilarity $\boldsymbol{a_i}$ between $\boldsymbol{i}$ and all other points of the cluster to which $\boldsymbol{i}$ belongs. Furthermore, for all other clusters $\boldsymbol{C}$, to which $\boldsymbol{i}$ does not belong, calculate the average dissimilarity $\boldsymbol{d(i, C)}$ of $\boldsymbol{i}$ to all observations of each $\boldsymbol{c}$. The smallest of these $\boldsymbol{d(i, C)}$ is defined as $\boldsymbol{b_i = min_c d(i, C)}$. Also, the value of $\boldsymbol{b_i}$ can be seen as the dissimilarity between ii and its ''neighbor'' cluster, including the nearest one to which it does not belong. Finally, the silhouette width of the observation is defined by $\boldsymbol{S_i} = \frac{b_i - a_i}{\max a_i - b_i}$.

At the same time, by each cluster, measure the distance for each object in the cluster and the objects from the other clusters. Then use minimum of the whole pairwise distance as just a cluster formation distance (min.separation) with each cluster to measure the distance between both the points in the same cluster. Use the maximal intra-cluster distance including the maximum diameter as the intra-cluster compactness Calculate the Dunn index $(\boldsymbol{Di}) = \frac{\min \textit{ separation}}{\max \textit{ diameter}}$.

External cluster validation, that also comprises by reviewing the outcomes of a cluster analysis to an otherwise key to improving, including an external class threshold. This tests the degree with which cluster labeling suit the labels of the exogenous grouping. Although we recognize the true cluster number in terms of planning, this methodology is mainly used to select the most appropriate clustering technique for

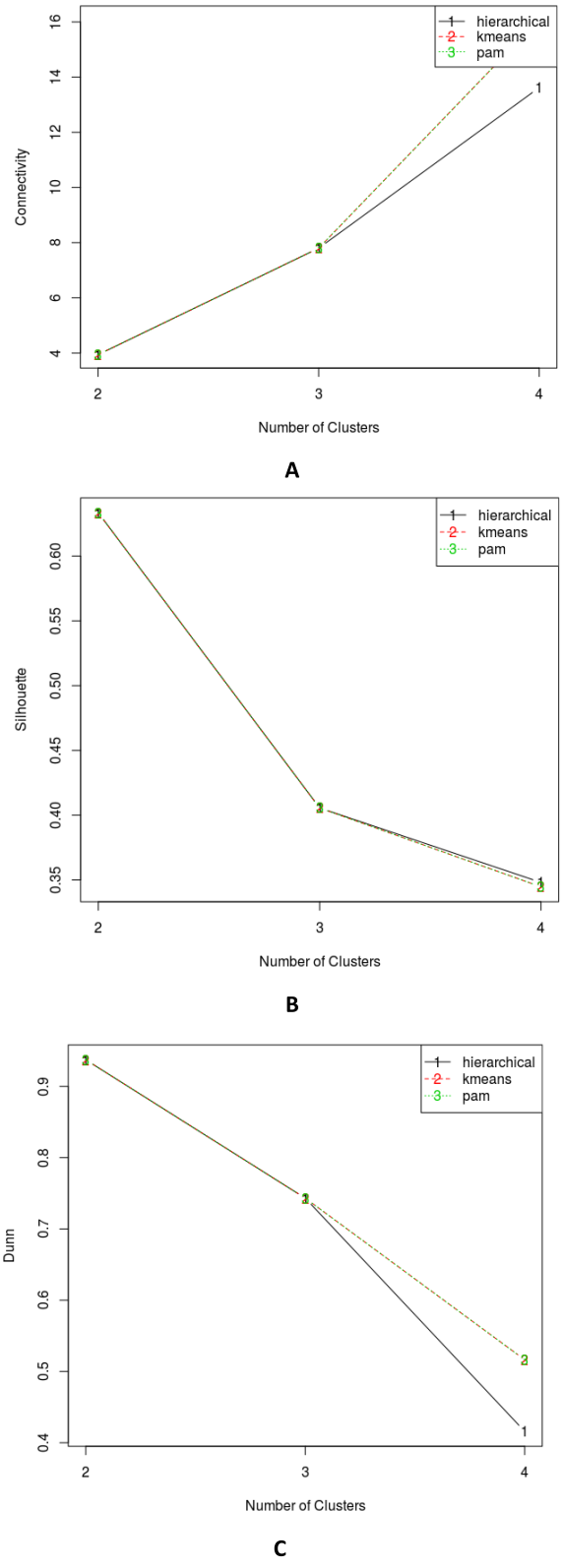


FIGURE 4. Internal Validity Connectivity(A), Silhouette(B), Dunn(C).

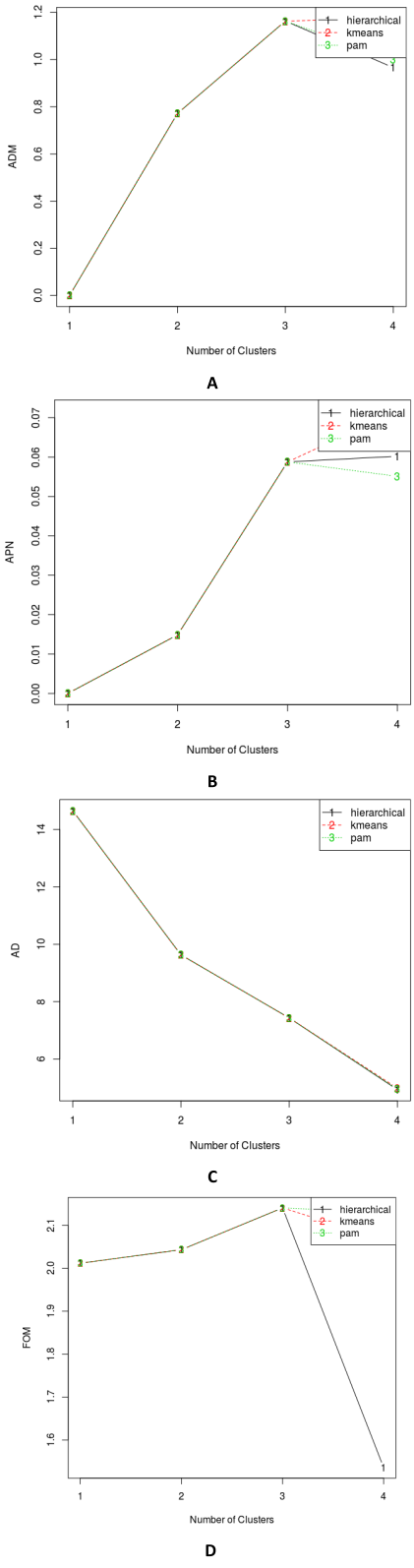


FIGURE 5. Average proportion of non-overlap (A), Average distance (B), Average distance between means (C), Figure of merit (D).

a particular instrument. Hierarchical technique is also better in cluster than K-Means and PAM. In line with this, greatest value is at an average distance was 3.924 and a figure of merit was 1.535 which explain in Figure 5.

Then, to exacerbate the Stability [63] of the cluster and verify the significance of the cluster model, we can use the stability test. This measurement tests the reproducibility of

the clustering solution on a set of data and can be interpreted as a classified risk in relation to the different classifiers generated by the clustering method.

Additionally, the stability test contrasts the results from clustering based on full data to clustering based on removing the column, again at the same time. Those same measures function quite well when there is a strong correlation between the results. It can be explained that $S(A_k) \leq 1 - \frac{1}{k}$ as there is a mark permutation for relatively high-stability index above the bound π so that the index after permuting drops below this bound more formally, since $d_{lk}\left(\phi\left(X'\right), Y'\right) \leq \mathbb{E}_{\prod \in lk}\left[d\left(\prod \circ \phi\left(X'\right), Y'\right)\right] = 1 - \frac{1}{k}$.

Algorithm of uncontrolled labeling R_k which assesses an item to a cluster c with probability $\frac{1}{k}$ an asymptotically reaches the centrality of this index for $n \to \infty$. Rather than normalizing the level of observational false negatives of the cluster algorithm $S(A_k) \leq$ asymptotic misclassification of arbitrary labels $S(R_k)$. This same stability index values are assigned to the very same scale and therefore the convergence is achieved $\bar{S}(R_k) := \frac{S(A_k)}{S(R_k)}$.

The included measures are the average distance (AD), the figure of merit (FOM), the average proportion of non-overlap (APN), and the average distance between means (ADM). Figure 6 A represents the clusters formed were Cluster 1 (Fakfak, Manokwari, Maybrat, Raja Ampat, South Sorong, Teluk Bintuni, Teluk Wondama), Cluster 2 (Kaimana, Tambrauw), and Cluster 3 (Sorong City), Cluster 4 (Sorong). In addition, Cluster 1 is the area with the highest risk value by involving all variables in this study.

IV. DISCUSSION AND POLICY IMPLICATIONS

Afterwards, it was stated that structurally the data sources from this paper were compiled with the 2017 SUSENAS participant (10 years-35 years) which generation is included in the millennial community. Based on the 2015 Inter-Census Population Survey (SUPAS) findings, the population of Indonesia was 269.6 million in 2020.Where the overall male population is 135.34 million, rather than the female population is just 134.27 million. Three provinces in Java Island comprise approximately 46% of Indonesia's population. The three provinces are West Java (49.57 million people), East Java (39.96 million people) and Central Java (34.74 million). In the meantime, the three provinces with smallest population were North Kalimantan (710 thousand people), West Papua (990 thousand people) and Gorontalo (1.19 million people). The three provinces are regions resulting from regional expansion.

In the previous portion, we generated a per-location cluster including all variables. Figure 6b further explains that on the model based for latent clustering, consent was given that there have been significantly different throughout the 2017 SUSENAS dimension, highlighting housing status millennial generation in West Papua. These might imply there is still a contrast the ownership status of the Millennial Generation Household in West Papua. Figure 7 represents

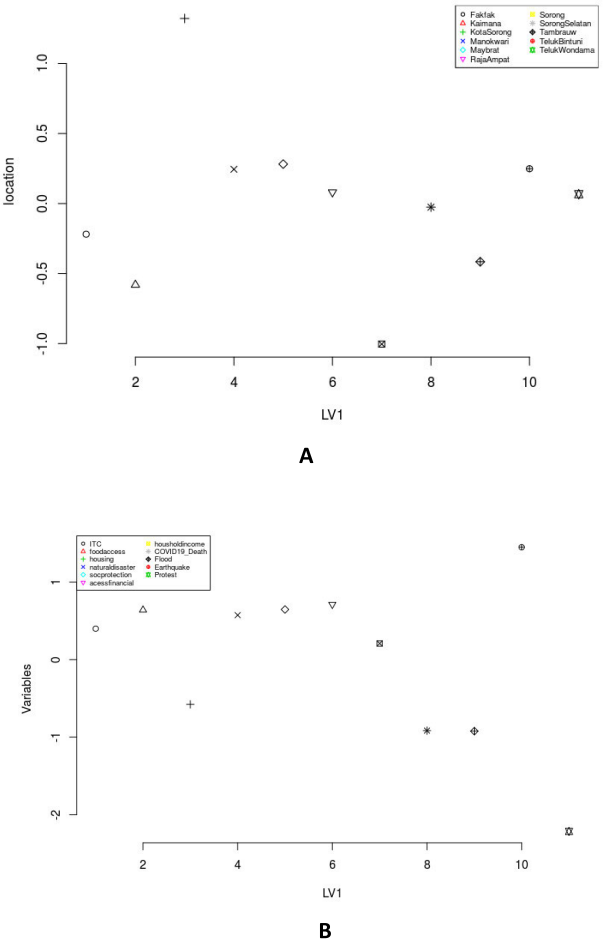
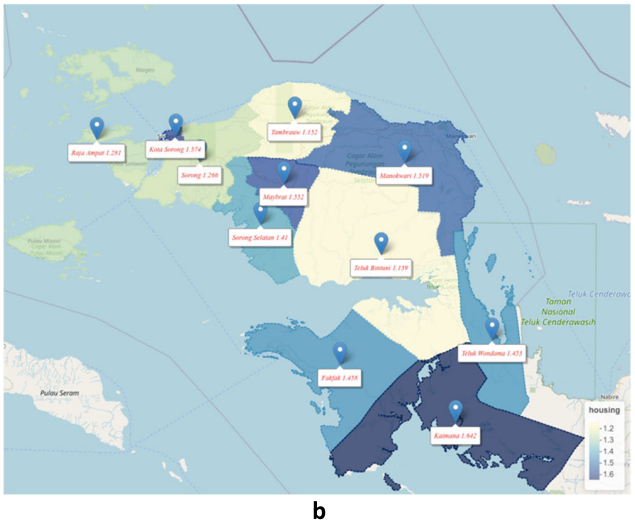


FIGURE 6. Ordination Latent Clustering location (A), Variables (B).

straightforwardly, household income in West Papua has a significant gap. Connecting to the natural hazard in West Papua, there is indeed a significant difference in the occurrence of earthquakes at each region. Throughout sharp contrast in Figure 8 the pattern of the number of COVID-19 deaths is almost the same as that of the flood events in West Papua. Afterward, there is indeed a disparity in the occurrence of social hazards, including protests in West Papua.

Furthermore, if the percentage of the population of productive age is related to the percentage of the millennial generation in 2017, which is 33.75% of the total population. This means that the contribution of the millennial generation in shaping the structure of the population of productive age is quite high, because around 50.36% of the population of productive age is basically the millennial generation (assumption: the dependency ratio of 2015 and 2017 is the same). This generation will be in control of the wheels of development, especially in the economic sector, which is expected to be able to lead the Indonesian nation towards a more advanced and dynamic development. In essence, the millennial generation is a great asset to create national independence in all aspects.

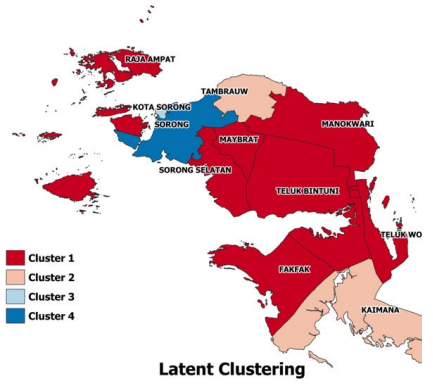
a



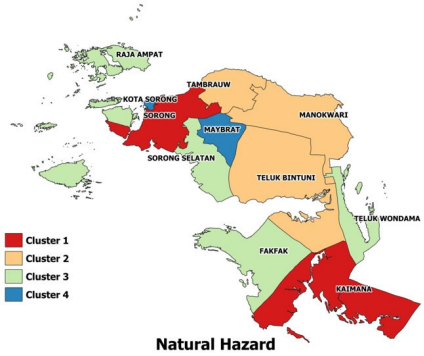
b

c

FIGURE 7. Food Access(A), Housing (B), Access financial(C).



A



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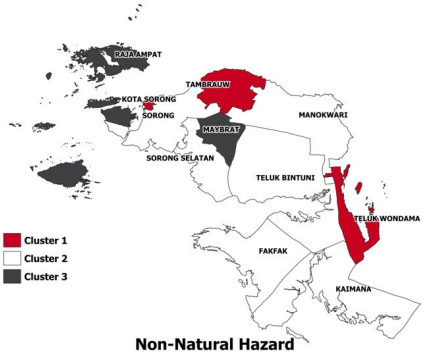
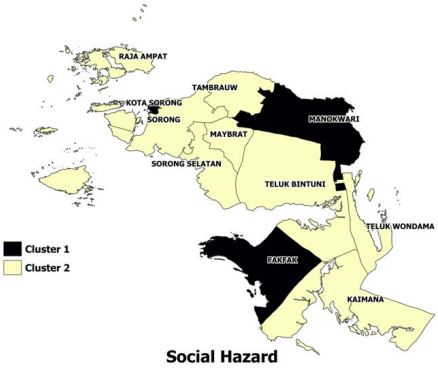


C



D

FIGURE 8. Hazard Latent Clustering (A),Natural Hazard (B), Non-Natural Hazard(C), Social Hazard (D) in west Papua.

To maximize the potential of the millennial generation in West Papua is to provide new local leadership so that they can increase the competence of workers through training and development including the leadership, decision making, strategic thinking, and analyst thinking. Various characteristics possessed by the millennial generation mentioned above are the capital to compete in Indonesia's demographic bonus. The generation of West Papuan millennials will be able to face the challenges of the demographic bonus while at the same time realizing the independence of the nation provided that they have to be aware of their potential. If this generation

is able to realize its various potentials, an optimistic attitude will emerge. This attitude is very important in facing the demographic bonus volatility that will occur in the near future.

In addition, this effort would be redundant if the government and various supporting components did not intervene. The role of the government through various policies and regulations to improve the quality of human resources and youth is needed. Thus, the millennial generation will be increasingly developed and competent to face this challenge. This will be more effective if each party is able to work together to realize what we are working on together. The Indonesian nation should be optimistic about the various potentials possessed by the millennial generation. Therefore, this generation is a great asset to create national independence in all aspects.

Unlike the urban millennial generation, social media is not an existential activity for the millennial generation in rural areas, it is just a filler of spare time. This is understandable because the rural millennial generation is not too obsessed with their cellphones. Due to economic reasons, even gadget brands are not a priority. In responding to issues on social media, they also seem more passive than, not as enthusiastic as the urban millennial generation. Several millennial generations are preoccupied with helping families earn income. Based on province, it can be seen that the largest percentage of millennials using computers is in DI Yogyakarta, DKI Jakarta Province and East Kalimantan Province, respectively 46.13% 45.84% and 38.28%. This percentage is bigger when compared to the percentage of Indonesian millennial generation who use computers which is only 29.57% meanwhile, the provinces with the lowest percentage of millennial generation using computers were Papua and Lampung provinces with 16.62% and 20.97%, respectively.

V. CONCLUSION

Returning to the topic of natural disasters in West Papua, the province of West Papua has a land area of around 10 million hectares and is known as one of the provinces with the largest natural forest wealth in Indonesia. However, based on data from 1990-2018, there has been a significant change in primary dry forest cover from around 69.76% to 48.61%, or loss of primary forest covering an area of 2.1 million hectares. During the period 1990-2018 there has been a change or reduction in primary dryland forest cover of around 20%, namely around 6.904.437 hectares to 4.784.997 hectares and an increase in secondary dryland forest from 838.229 hectares to 2.814.431 hectares. This number is certain to continue to decrease and this could also be caused by the flash flood disaster that occurred in 2015-2020. Then, floods and landslides that occurred in several areas were also caused by mining activities. The millennial generation can be used as an agent of change to minimize the risk of disasters that occur in Papua. While based on the results of SUSENAS 2017, many locations of the millennial generation have reported that they have never attended training, this really needs special attention and prompt action by the government in addressing it. Then it should be necessary to upgrade residential construction in West Papua through earthquake-resistant construction in compliance with the provision standards in Indonesia SNI 03-1726-2002, earthquake resistant design Preparation Procedures for Buildings. In particular, for example, the condition of the land to be constructed is solid and dense. There is also a need for the reconstruction of buildings that are not earthquake resistant and are in aged or unsafe construction. This is significant, mainly in the presence of public buildings used by many citizens, including educational facilities, health facilities and government buildings. Long story short, SoVI provide the solution to link between natural hazard, non-natural hazard, and social hazard by getting the ρ value. However, the accuracy of cluster around latent variable model can be measure by s connectivity value of 3.9400794, Dunn 0.9373, and Silhouette 0.6333. Future work can apply remote sensing [64]–[67].

APPENDIX A

Supposed to follow the iterative process through generating sets of variables, a series of clusters of predictor variables and associated latent variables is obtained either by the strategic approach. As far as the cluster around latent variable strategy is taken into consideration, the first latent variable, latent variable (LV) 1, is represented as a recursive-variable that is as directly linked as necessary with the y response. The second latent variable (LV) 2 is chosen to achieve the same goal when the first group predictors are removed. In all instances, the latent variable, $\boldsymbol{LV}_{zk}$ associated Z_k is a linear combination of Gk-associated predictors. In line with this, $\boldsymbol{LV}_{zk} = \boldsymbol{X}_k \boldsymbol{m}_k$. Where $\boldsymbol{X}_k \boldsymbol{m}_k$ is the matrix generated by the s_k variables belonging to the group Z_k and $\boldsymbol{m}_k = \left(m_{1k}, m_{2k}, \ldots, m_{s_k k}\right)^u$. Therefore, u of the loading vector associated with the first main component of $\boldsymbol{X}_k$.

$$\hat{\boldsymbol{y}} = \sum_{k=1}^{M} LV_{zk} \hat{\boldsymbol{\beta}} LV_{zk}$$

Throughout this method, we take into account the same line of reasoning as something like principle component analysis. Besides, it involves finding a Z_k, $(k = 1, 2, \ldots, K)$ by each set of variables. Latent variable C Latent variable K for which variables that contribute much to the latent variable have zero loading values. The theory is that it would be approximately the unconventional variables or the noise variables put in the Z_k group cluster that will have zero loading with $\boldsymbol{m}_k$ variables, we denote by the vector of loadings associated with the first component $\boldsymbol{c}_k$ of $\boldsymbol{X}_k$. In the case of large sets of variables, the notion of variational solutions is also viewed as an immediate benefit. It is considered to become a methodology that makes it possible to enhance the understanding of the model. The key idea is to find a solution by taking into consideration perhaps component of the details.

APPENDIX B

(See Table 3)

TABLE 3. SYMBOLS & ABBREVIATIONS.

C_{clust}	The number of central starting points that must be generated.
$\tilde{L}$	covariance value
R_k	Algorithm of uncontrolled labeling
Z_k	linear combination of Gk-associated predictors
$s_1, s_2, s_3, \ldots, s_p$	instrument the data
s_i	silhouette width
$u_1, u_2, u_3, \ldots, u_t.$	external variable
ADM	average distance between means
APBN	State Revenue and Expenditure Fund
APN	average proportion of non-overlap
BMKG	Meteorology, Climatology, and Geophysical Agency is an Indonesian non-departmental government agency for meteorology, climatology, and geophysics.
BPNT	Non-Cash Food Assistance program
BPS	Statistics Indonesia, locally known as BPS, is a non-departmental government institute of Indonesia that is responsible for conducting statistical surveys. Its main customer is the government, but statistical data is also available to the public
c	Components
FOM	figure of merit
IDR	Indonesia Rupiah
KKS	Prosperous Family Card
KPS	Social Protection Card
PAM	Partitioning Around Medoids
SoVI	Social Vulnerability Index
SUPAS	Inter-Census Population Survey
SUSENAS	National Socio-Economic Survey
Di	Dunn index
$d(i, C)$	average dissimilarity

CODE DATA AVAILABILITY

The analysis code datasets used in this paper available from the corresponding author upon reasonable request. Also, reader can reach STATCAL website https://www.statcal.com/ to perform graphical and statistical analysis.

COMPETING INTERESTS

The authors declare no competing interests.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Formal analysis: Rezzy Eko Caraka.

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