Hazard Level of Slum Areas in Palembang City

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Abstract. The study aimed to identify the hazard level distribution in the slum areas in Palembang City. The research was a quantitative type with 382 families that live in the slums as the samples. The data were collected using proportional area random sampling and analyzed using the K-means Cluster test through SPSS 23. Spatial analysis through Arcgis was conducted to complete the understanding of the hazard distribution in the slum areas. The results showed that the hazard clusters formed by 64 areas could be categorized into three: low, medium, high. High level of hazards, reaching the one-third portion of the areas, dominated the slums in Palembang City. The cluster with a high hazard level was mostly in the city center, which was geographically located on the riverbanks, causing the areas to be vulnerable to flood, diseases, and crimes. The city center was known to offer high numbers of the job vacancy. People in the slums working in the city center were day laborers.

1. Introduction

Slums are areas with poor environmental quality, less qualified building materials, and low quality of life. On average, people living in the slums are under the poverty line. It has been a common phenomenon in cities of developed countries with poor quality of life and a high poverty rate [1]. People in the areas are from a low level of economy and education. The condition is continued from generation to generation. Slums quickly appear in the cities because of the high level of urbanization. The advances in technology and economic activities in the cities have triggered a population explosion. Unfortunately, technological advances were not followed by workforce absorption. Therefore, people who cannot compete and cannot find suitable occupations contribute to the increase of the new unemployment rate. Unemployment becomes one of the causes of slum emergence [2], [3].

Slum areas have provided affordable dwellings and living costs for people under the poverty line. However, they cannot prevent themselves from facing any kind of threat or hazard in the areas, such as natural disasters [4]. These people become vulnerable [5]. High vulnerability, especially in the economy, and the low capacity of the people have increased the disaster risk. For example, slum areas located on
the riverbanks can face numerous problems in several aspects, such as environment, social, and economy [6]. The issues are the hazards for the slum areas. They take the form of building damage, diseases, crimes, domestic conflict, drug abuse, promiscuity, unemployment, brawl/dispute, and drowning. Other kinds of hazards that may occur in the slum areas are fire [7] and flood [8]. Based on the types, the distribution of risks in the slum areas can be determined through mapping [9].

The study was significant; it can prevent the increase of poverty level and the spread of slums. Besides, it can also reduce the hazard upon those who live in the slum areas in Palembang cities. Therefore, the present study aimed to observe the hazard level in the slum areas in Palembang City.

2. Method
The research employed a quantitative method. The variables include floods, building fire, damage, epidemic, crimes, drug abuse, domestic conflict, promiscuity, and unemployment. The samples were 382 families living in the slum areas in Palembang City. The data were gathered through proportional area random sampling, of which the results were analyzed to categorize the hazard levels. The categorization was carried out using the K-means Cluster test of SPSS.23. The clusters of the hazard level were low, medium, or high, with different characteristics. The data were analyzed spatially using the Arcgis program to observe the hazard distribution in the slum areas of Palembang City.

3. Results and Discussion

3.1. The Hazard Distribution in the Slum Areas in Palembang City
The data of threats or dangers were gathered directly from the field because they were not available in the relevant agencies. The hazard level was determined by using the K-Means Cluster, of which the data were normally distributed based on the Kolmogorov-Smirnov formula. The normality test results were presented below.

| No. | Hazard Variable                        | Kolmogorov-Smirnova |
|-----|----------------------------------------|---------------------|
|     |                                        | Statistic | df | Sig. |
| 1.  | Average number of flood cases per year | 0.107     | 64 | 0.068 |
| 2.  | The average number of building fire cases per year | 0.110 | 64 | 0.053 |
| 3.  | Average number of building damage cases per year | 0.106 | 64 | 0.072 |
| 4.  | Average number of epidemic cases per year | 0.108 | 64 | 0.063 |
| 5.  | Average number of crimes per year      | 0.077     | 64 | 0.200* |
| 6.  | Average number of domestic conflict cases per year | 0.107 | 64 | 0.065 |
| 7.  | The average number of drug abuse cases per year | 0.106 | 64 | 0.072 |
| 8.  | Average number of promiscuity cases per year | 0.109 | 64 | 0.057 |
| 9.  | Average number of unemployment case per year | 0.107 | 64 | 0.068 |
| 10. | Average number of brawl/dispute cases per year | 0.193 | 64 | 0.000 |
| 11. | Average number of drowning cases per year | 0.534 | 64 | 0.000 |
Sources: Data analysis using *IBM SPSS 23*

Nine variables that were normally distributed were used, while the other two (dispute, drowning, and attacked by animals) were not. Based on the normality test, the research employed eleven variables with a significant value above 0.05 and the confidence rate of 5%. In other words, the nine variables were used for every 64 areas of the slums. Even so, data standardization was conducted to align the diverse data of each variable. To obtain accurate data, K-Means Cluster was employed to determine the area category based on the hazard level. From the calculation using *IBM SPSS 23*, the results were as follows.

### Table 2. Iteration History

| Iteration | Change in Cluster Centers | 1      | 2      | 3      |
|-----------|----------------------------|--------|--------|--------|
| 1         |                            | 2.860  | 2.628  | 2.626  |
| 2         |                            | .245   | .351   | .203   |
| 3         |                            | .136   | .131   | .169   |
| 4         |                            | .000   | .000   | .000   |

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 4. The minimum distance between the initial centers is 6.175.

Source: Data analysis using *IBM SPSS 23*

Based on the table, it needed five data iteration to obtain accurate data. Further, the final cluster centers' values were presented in the following table.

### Table 3. Final Cluster Centers

|                  | Cluster | 1      | 2      | 3      |
|------------------|---------|--------|--------|--------|
| Zscore: Average number of flood cases per year |         | .48915 | .02237 | -.40832 |
| Zscore: Average number of fire case per year    |         | .66505 | -.32214| -.28721 |
| Zscore: Average number of damage cases per year |         | .86134 | -.44301| -.35238 |
| Zscore: Average number of epidemic cases per year|       | .88471 | -.88041| -.03866 |
| Zscore: Average numbers of crime cases per year |       | .72798 | .21979 | -.74943 |
| Zscore: Average number of domestic conflict cases per year | | .69245 | -.20394| -.39897 |
| Zscore: Average number of drug abuse cases per year | | -.39426| 1.14739| -.55661 |
| Zscore: Average number of promiscuity cases per year | | -.40450| 1.12789| -.53360 |
| Zscore: Average number of unemployment case per year | | .79566 | -.35380| -.36764 |

Source: Data analysis using *IBM SPSS 23*
The table showed the calculation results of Final Cluster Centers of the hazard variables with similar characteristics. The clusters were as below.

| Characteristics of Hazard Clusters |
|----------------------------------|
| **Low Clusters (Cluster 3)**     | **Medium (Cluster 2)**       | **High (Cluster 1)**       |
| Low average number of flood cases per year | Medium average number of flood cases per year | High average number of flood cases per year |
| Medium average number of fire cases per year | Low average number of fire cases per year | High average number of fire cases per year |
| Medium average number of damage cases per year | Low average number of damage cases per year | High average number of damage cases per year |
| Medium average number of epidemic cases per year | Low average number of epidemic cases per year | High average number of epidemic cases per year |
| Low average number of crime cases per year | Medium average number of crime cases per year | High average number of crime cases per year |
| Low average number of domestic conflict cases per year | Medium average number of domestic conflict cases per year | High average number of domestic conflict cases per year |
| Low average number of drug abuse cases per year | **High average number of drug abuse cases per year** | Medium average number of drug abuse cases per year |
| Low average number of promiscuity cases per year | **High average number of promiscuity cases per year** | Medium average number of promiscuity cases per year |
| Low average number of unemployment cases per year | Medium average number of unemployment cases per year | Low average number of unemployment cases per year |

Source: Research analysis results

**Cluster 1**: The variable hazard score was higher than cluster 2 and 3, or six out of nine variables. Those were flood, fire, damage, epidemic, crime, and domestic conflict. From the characteristics, it was assumed that people living in the slums were vulnerable to high hazard, evident in the highest score of the six variables. Two variables, which were drug abuse and promiscuity, were in the medium category. Meanwhile, only one division was in the low cluster (unemployment). The results were in line with [10], revealing that the slums along the riverbanks were highly vulnerable to danger because of poor health and occupation resulted in poor disaster risk management.

**Cluster 2**, The group consisted of two variables with a high score (drug abuse and promiscuity). Similar to [11], social hazards mostly occurred to those living on the riverbanks. The low significance value was occupied by three variables, which were fire, damage, and epidemic. The values were lowered compared to clusters 1 and 2 on the variables of the flood, crime, domestic dispute, and unemployment.

**Cluster 3**, The cluster did not contain the high value. Three variables were in the medium category (fire, damage, and epidemic). The flood had brought about diseases to humans and animals [12]. The characteristics indicated that people in the slums were vulnerable to flood, crime, domestic disputes, drug abuse, promiscuity, and unemployment. It can be concluded that the cluster has a low vulnerability.

| Cluster | Error | F | Sig. |
|---------|-------|---|------|

Table 5. Data analysis results from ANOVA.
The table revealed that nine variables of the present study had a significance rate above 0.05. It can be concluded that there were differences between the three clusters. The number of cases identified using K- Means Cluster and tested using ANOVA was presented as follows.

**Table 6. Number of Cases in each Cluster.**

| Cluster | 1   | 20.000 |
|---------|-----|--------|
|         | 2   | 19.000 |
|         | 3   | 25.000 |
| Valid   |     | 64.000 |
| Missing | .000|        |

Source: Data analysis using IBM SPSS 23

The table showed that the highest number reached by cluster 3, which included 25 areas. It means that the areas had a low hazard level. Meanwhile, the lowest was in cluster 2, with 19 areas in the medium hazard category. Twenty areas in the high category showed that they were vulnerable to hazards. The results were presented in the following table.

**Table 7. Slum Areas with Low Hazard Level.**

| No. | Name of the slums       | Hazard Level | Notes |
|-----|--------------------------|--------------|-------|
| 1.  | 1 Ilir A                 | 1            | Low   |
| 2.  | 2 Ulu & Tuan Kentang     | 1            | Low   |
| 3.  | 5 Ulu B                  | 1            | Low   |
| 4.  | 9-10 Ulu                 | 1            | Low   |
| 5.  | 10 Ilir                  | 1            | Low   |
| 6.  | Kampung Arab A           | 1            | Low   |
| 7.  | 13 Ilir                  | 1            | Low   |
| 8.  | 16 Ulu A                 | 1            | Low   |
| 9.  | 16 Ulu B                 | 1            | Low   |
Twenty-five areas of the slums in Palembang City were in a low category. The rests were medium and high. In other words, there was only 39% showing a high vulnerability to hazard. Nevertheless, the people still need the government and Non-Government organizations to help them improve the physical and social conditions in the areas [13]. The medium category of the areas with hazard vulnerability was presented below.

Table 8. Slum Areas with Medium Hazard Level.

| No. | Name                        | Hazard Level | Note    |
|-----|-----------------------------|--------------|---------|
| 1.  | 1 Ilir B                    | 2            | Medium  |
| 2.  | 1 Ulu A                     | 2            | Medium  |
| 3.  | 2 Ilir A                    | 2            | Medium  |
| 4.  | 3 Ilir                      | 2            | Medium  |
| 5.  | 15 Ulu & Tuan Kentang       | 2            | Medium  |
| 6.  | 32 Ilir B                   | 2            | Medium  |
| 7.  | 32 Ilir A                   | 2            | Medium  |
| 8.  | Gandus B                    | 2            | Medium  |
| 9.  | Gandus C                    | 2            | Medium  |
| 10. | Gandus D                    | 2            | Medium  |
| 11. | Gandus E                    | 2            | Medium  |
| 12. | Karang Jaya B               | 2            | Medium  |
| 13. | Kebun Bunga D               | 2            | Medium  |
| 14. | Kebun Bunga E               | 2            | Medium  |
| 15. | Kemas Rindo Tepian Sungai   | 2            | Medium  |
| 16. | Kemas Rindo Dataran Rendah  | 2            | Medium  |
| 17. | Pulokerto A                 | 2            | Medium  |
| 18. | 35 Ilir                     | 2            | Medium  |
| 19. | Sei Buah                    | 2            | Medium  |

Source: Data analysis using IBM SPSS 23

Nineteen areas, or 29.7%, were in the medium category. The results were different from [14], mentioning that people living on the riverbanks were highly vulnerable to hazards. However, the high hazard level was also spread in the slum areas in Palembang City, shown in the following table:
| No. | Name                        | Hazard Level | Note |
|-----|-----------------------------|--------------|------|
| 1.  | 2 Ilir B                    | 3            | High |
| 2.  | 2 Ilir B 1                  | 3            | High |
| 3.  | Kampung Kapitan             | 3            | High |
| 4.  | 8 Ulu                       | 3            | High |
| 5.  | 15 Ulu B                    | 3            | High |
| 6.  | 36 Ilir A                   | 3            | High |
| 7.  | Karang Anyar A              | 3            | High |
| 8.  | Karang Jaya A               | 3            | High |
| 9.  | Karang Jaya C               | 3            | High |
| 10. | Karya Jaya B                | 3            | High |
| 11. | Kebun Bunga C               | 3            | High |
| 12. | Kemang Agung                | 3            | High |
| 13. | Kuto Batu & Lawang Kidul    | 3            | High |
| 14. | Keramasan A                 | 3            | High |
| 15. | Ogan Baru A                 | 3            | High |
| 16. | Kawasan Plaju Ulu           | 3            | High |
| 17. | Talang Putri                | 3            | High |
| 18. | 23 Ilir & 18 Ilir           | 3            | High |
| 19. | 30 Ilir                     | 3            | High |
| 20. | Karya Jaya C                | 3            | High |

Source: Data analysis result using IBM SPSS 23

Twenty areas, or 31.3%, were highly vulnerable to hazard. The areas were dangerous to live in as the result of the illegal settlement, exposing the people to disasters. The condition was worsened by the poverty level [15]. Spatially, the hazard level map based on the slum area in Palembang City can be described through the map below:
The map showed that the slum areas with high hazard levels were in the middle of Palembang City. The areas were on the riverbanks, of which the waste management was poor. It worsened the slum areas. However, the strategic location with the economic center made the people stay for the sake of easy access to the market flow. Even so, the areas were prone to crimes. In total, almost all areas with a high level of hazard were on the main or branch riverbank depended on the tidal of the Musi River. The waste thrown to the rivers returned to the residence because of the tidal. Further, people were prone to floods and diseases. Slum areas were identical to the riverbank, where waste was thrown to the areas [16], which influenced the water quality [17], causing the areas vulnerable to flood [18], [19], [20], [21] and landslides [22]. Therefore, it is necessary to manage the waste in the area by establishing a proper waste management system and developing the people's awareness to process their household garbage [23].

4. Conclusion
The results and discussion revealed the clusters formed by the four areas of the slums. The areas were categorized into three groups: cluster 1 (low) consisted of 20 areas, cluster 2 (medium) 19 areas, and cluster 3 (high) 25 areas. Cluster 3 dominated the slum areas in Palembang City. Nearly one-third of the areas were highly vulnerable to hazard. The average danger or threat was the city center, which was located on the riverbanks. The geographical condition caused the areas susceptible to flood, disease, and crimes. The city center offered job opportunities for people. However, most of the people in the slum areas were day laborers.

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