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DECISION RULES IN FIRE DISASTER IN DKI JAKARTA WITH IF-THEN METHOD FROM ROUGH SET THORY

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ABSTRACT

Rough set theory which was developed by Pawlak (1982) is a mathematical method that tries to find solutions by analyzing the vagueness and uncertain data. One of the advantages of rough set theory is that it can analyze data by using less information than the other methods. Due to this reason, this paper is aimed to describe and to obtain decision-rules from fire disaster in Jakarta with If-Then Rule method from rough set theory. The population in this research is summary data of fire disaster that occurred in 2014-2015 in Jakarta. The data will be analyzed using If-Then Rule method, it will be obtained some descriptions and some decision rules from the fire disaster data. The result from this result shows that most of victims were minor injured and caused by short circuit factor.

Key Words: Decision Rules, Fire disaster, If-Then Rules, Rough set.

1. Introduction

DKI Jakarta is the capital of the Republic of Indonesia which have a complex disaster problems. With an area of 661.52 km2, 40 % or 24,000 hectares of lowland with an average altitude below the sea level. Jakarta is also the confluence of the Southern part of the slope and high rainfall. There are 13 rivers flowing through and empties into the Bay of Jakarta. Naturally, this condition positioned that Jakarta area has a high vulnerability to flooding [1].

Beside the threat of floods, Jakarta also has other hazards, such as extreme weather, extreme waves, earthquakes, landslides and the threat of non-natural disasters and social conflicts, technological failures, epidemics and plagues, fires and residential buildings [2].

According to IFRC, Residential areas populated regions that are susceptible to disaster risk. One of them is fire disaster. The vulnerability to fire disaster and residential buildings in Jakarta are generally high in almost all regions. Because based on the results of vulnerability analysis across areas in Jakarta, although the threat level is medium, but with a large population, density above 1000 inhabitants/km², with a population of 7,530,545 inhabitants are exposed, and the economic losses could reach Rp. 1,148,461,299,884,000, makes the vulnerability of fire disaster and residential buildings to be high in almost all areas of Jakarta [3-5].

Fire disaster in Jakarta is a problem that occurs regularly every year, especially during the dry season. During the period of last three years for the year 2013-2015 there have been around 2,038 cases of fires in the area of Jakarta with the number of losses reached 3,214 billion. As well have damaged 14,303 pieces of medium consisting of homes, buildings, shop, and other vehicles. Fire disaster has also resulted in as many as 299 people became victims as well as 24,901 people were evacuated/displaced. The negative impacts of fire disaster are the destruction of infrastructure (buildings, houses, vehicles, etc.), eliminating the supplies and equipment property, economic damage, interfere with daily activities, disrupting even take out the future [6-8].

Based on the negative impacts of fire disaster that mentioned before, the problems which will be discussed are the characteristics of fire disaster's victims and decision rules from the summary data of fire disaster that occurred in 2014-2015in Jakarta. Both of these problems are intended to find out the characteristics of fire disaster's victims and the decision rules from the summary data of fire disaster that occurred on 2015 in Jakarta. The expected benefits of writing this paper are as an evaluation to government to fire disaster that occurred in Jakarta and as a consideration in making decisions in an effort to reduce the number of fire disaster.

2. Related Works

Applied research that related to rough set theory has been investigated by several researchers. First, analyzing rainfall forecast using rough set attribute reduction and data mining methods. The conclusion of the research are rough set attribute reduction technique based genetic algorithm approach has achieved optimal reduction for realtime meteorological (rainfall prediction) dataset with eight atmospheric parameters and Bayesian logistics regression have shown improved prediction accuracy than other classifier after attribute reduction [9]. Second, predicting debris low disaster using ADABOOST and rough set theory. The conclusion is this study presents an ADARST model integrating the capabilities of ADABOOST and RST in order to analyze debris flow in the Chen-Yu-Lan River in Taiwan. By comparing the experimental results from previous studies, the simulation results indicate that the proposed ADARST model is a promising alternative for analyzing debris flow [10]. Last, analyzing hazard assessment of the debris flow using rough sets and dempster-shafer theory. The result of the research suggest that the method is effective and reliable [11].

3. Basic Theory

Rough Set

Data mining is an information extraction process from data set through the use of algorithms and statistical techniques that involve science, machine learning and database management systems

[12]. Rough set theory is a new mathematical tool for imperfect data analysis. Rough set philosophy is founded on the assumption that with every object of the universe of discourse some information (data, knowledge) is associated [13]. Some of basic concepts from rough set theory are Information system (decision), indiscernibility relation, approximation set and reduction data [14].Some advantages of rough set method compared with the others method are[13]:

a. It provides efficient algorithms for finding hidden patterns in data;

b. It finds reduced sets of data;

c. It evaluates significance of data;

d. It generates minimal sets of decision rules from data;

e. It is easy to understand;

f. It offers straightforward interpretation of results;

g. It can be used in both qualitative and quantitative data analysis;

h. It identifies relationships that would not be found using statistical methods.

Rough set based data analysis starts from a data table called a decision table, columns of which are labeled by attributes, rows – by objects of interest and entries of the table are attribute values. Attributes of the decision table are divided into two disjoint groups called condition and decision attributes, respectively. Each row of a decision table induces a decision rule, which specifies decision (action, results, outcome, etc) if some conditions are satisfied. If a decision rule uniquely determines decision in terms of conditions – the decision rule is certain. Otherwise the decision rule is uncertain[15].

A decision rule in Rough Setis an implication "if Φ then Ψ" or "Φ → Ψ". Which Φ is condition and Ψ is decision from rule. Condition is the attributes and its values that placed to the left of the arrow. Meanwhile, the decision is the attributes and its values that placed to the right of the arrow. Φ and Ψ is a logic function that built from the attribute and the value, also have the function to explain the properties from the facts. Decision rule is an association rule because it is an expression of the relationship between condition and decision. Rough Set method used two probabilities in every decision rule (Φ → Ψ), named certainty factor dan coverage factor. Certainty factor indicates the probability of a particular object has a class label when it has certain conditions, while the coverage factor indicates the conditional probability of the reason given for a decision. Certainty and coverage factor is formulated as follows [15] :

Certainty Factor

$$\prod(\Psi|\Phi) = \frac{\text{Ta}\ \Phi\ \ \text{a}\ \ \Psi}{\text{Ta}\ \ \Phi} \qquad (1)$$

Coverage Factor

$$\prod(\Psi|\Phi) = \frac{Ta \quad \Phi \quad \Psi}{Ta \quad \Psi} \quad (2)$$

When a decision rule Φ □ Ψ, can determine the *decision* in a relation to condition surely, if the *certainty* factor is 1, then the rule is called certain. Meanwhile, when a decision rule Φ □ Ψ determine the *decision* in a relation to *condition* ambiguously, when the certainty factor of its value between 0 to 1, the rule is uncertain or rough [15].

Information System

Information system is a table, consisting of rows and columns that represent the attributes or variables of data. Information on data mining's system known by the name of the dataset. Information systems can be represented as a function of A = (U, A) , where U is not empty set of objects represented and A is not empty set of attributes or variables [13].

Indiscernibility

The main concept that used in variable selection using rough set is indiscernibility. For example, S = (U, A) as an information system, where U is the set of objects that are not empty and A is a set of attributes that are not empty, if ɑ:U□Vɑ, to each ɑ ϵ A, then Vɑ is the set of ɑ's attribute values. If P ⊆ A can be associated with the equivalence relation IND(P); then IND(P) = { (x,y) ϵ U^2 | ∀ɑ ϵ P, ɑ(x) = ɑ(y)} partition the set of U generated by IND(P) denoted by U/IND(P) [13].

Set Approximation

For a decision system, it is very important to find the entire subset using the equivalence class that has a value from the same class. However, this subset is not always defined precisely. Although the data table can't be defined precisely, this can be overcome by making an estimate using the lower and upper approximations, and it defined as:

$$\underline{B}\ X = \{x \in U : B(x) \subseteq X\} \text{ dan } \bar{B}\ X = \{x \in U: B(x) \cap X \neq X\} \quad (3)$$

Where B X is a lower approximation of the set X while B^{-} X is the upper

approximation of the set X[16].

Generally, the approximation can be defined as follows [16]:

1. Lower approximation is the set of all events than can be classified certainly as an element of the set X (only X) that indicates the attribute set B;

2. Upper approximation is the set of all possible events that can be classified as an element of the set X (which may be X) that indicates the attribute B.

3. Boundary region is the set of all events that can’t be classified into the set X and the set of non - X that indicates the attribute of set B.

4. Research Method

The population in this research is summary data of fire disaster that occurred on 2015 in Jakarta. There are 798fire disasters that occurred on 214-2015 in Jakarta. Variable research is a research’s objects or the factors that have role in the event or phenomenon that want to be studied. The variables that used in this research are one variable decision and two variables condition. Here are the variables that want to be studied:

a. Time the time of fire disaster occurred. This variable is divided into four categories, namely Morning, Noon, Night and Dawn.

b. Causes of fires the cause of fire disaster occurred. There are 16 factors that caused fires, Candle, Short Sircuit, Gas Stove, Gas Tube, Trash burning, Firewood, Cigarette Stub, Gasoline Vapors, Fireplace, Burning Stoves, Burning Bus, Non-electric Mosquito repellent (burn), Burned House (intentionally), Methylated, Kerosene spill, and incense [8].

c. Severity Level of the Victim the severity level of fire disaster victims. This variable is divided into four categories, namely Minor Injuries, Serious Injuries, Pass away, evacuated (displaced).

This research using Decision rules with if-then method from rough set theory to know the characteristic of fire disaster’s victims in Jakarta.

5. Result

Before looking at the relationship between each variable and determine the data pattern of victims of fire disaster in Jakarta, first describe about the variables that used in this research. The response variable (decision) that used is the severity of fires’ victims which consist of four categories, namely minor injuries, serious injuries, pass away and evacuated or displaced, showed in Table 1.

Characteristics of Fire Disaster in Jakarta

The response variable that used is the severity of fire disaster’s victims that consist of four categories, namely minor injuries, serious injuries, pass away and evacuated (displaced). Table 4.1 shows that in 2014-2015 a total of 798 people were the victims of fire disaster. And from 798 victim’s fires data are known that a total 96,24% or 768 victims were minor injured.

Table 1: Total and Percentage Severity Level of the Victim

Severity Level of The Victim	Frequency	Percentage (%)
Minor injuries	768	96,24

Serious Injuries	3	0,37
Pass away	7	0,87
Evacuated (displaced)	20	2,50
Total	798	100

The severity level of the fire disaster's victims also can be seen from the time of the fires. Table 4.2 shows that from 798 victim's fires data are known that a total of 25,68% or 205 victims are include in Morning category. Among them, 197 victims were minor injured, 2 victims were serious injured, 2 victims passed away and 4 victims need to be evacuated or displaced. While in Noon category, a total of 30,45% or 243 people became the victims. Among them, 236 victims were minor injured, a victim passed away and 9 victims need to be evacuated or displaced. In Night category, a total of 25,06% or 200 people became the victims. Among them, 193 victims were minor injured, a victim passed away and 6 victims need to be evacuated or displaced. And in Dawn category, a total of 18,42% or 147 people became the victims. Among them, 142 victims were minor injured, a victim were serious injured, 3 victims passed away and a victim need to be evacuated or displaced that showed in Table 2

Table 2: Frequency and Percentage of Severity Level of the Victim Based on the Time of the Fires

Security Level of The Victim	Frequency			
	Time			
	Morning	Noon	Night	Dawn
Minor Injuries	197	236	193	142
Serious Injuries	2	0	0	1
Pass Away	2	1	1	3
Evacuated (displaced)	4	9	6	1
Total	205	243	200	147
Percentage (%)	25,68	30,45	25,06	18,42

Set Approximation

From the level of severity's victim's point "evacuated or displaced", then that included in lower approximation, upper approximation and boundary region are :

- There is no object that included in lower approximation {}
- Set of objects with number {60, 86, 108, 136, 218, 231, 253, 326, 471, 478, 479, 517, 525, 545, 575, 627, 695, 735, 754, 784} included in upper

approximation of a set of objects with number {60, 136, 253, 326, 479,525, 545, 695,784}

- Set of objects with number {60, 86, 108, 136, 218, 231, 253, 326, 471, 478, 479, 517, 525, 545, 575, 627, 695, 735, 754, 784} is a boundary region from a set of objects with number {60, 136, 253, 326, 479,525, 545, 695,784}

Decision Rules

Here are the results of the calculation of certainty and coverage that showed in Table 3

Table 3: Certainty and Coverage Factor Based on the Time and the Factor of the Fires

Time	Causes of fires	Severity of the victims	N	Certainty	Coverage
Morning	Candle	Minor Injuries	2	1	0.002604167
	Short Sircuit	Minor Injuries	178	0.9673913	0.231770833
		Serious Injuries	1	0.00543478	0.333333333
		Pass Away	1	0.00543478	0.142857143
		Evacuated	4	0.02173913	0.2
	Gas Stove	Minor Injuries	3	1	0.00390625
	Gas Tube	Minor Injuries	6	1	0.0078125
	Trash Burning	Minor Injuries	1	1	0.001302083
	Cigarette Stub	Minor Injuries	1	1	0.001302083
	Gasoline Vapors	Minor Injuries	1	1	0.001302083
	Fireplace	Serious Injuries	1	1	0.333333333
	Burning Stoves	Minor Injuries	4	1	0.005208333
	Burning Bus	Minor Injuries	1	1	0.001302083

	Burned house (intentionally)	Pass Away	1	1	0.142857143
Noon	Candle	Minor Injuries	1	1	0.001302083
	Short Sircuit	Minor Injuries	221	0.9650655	0.287760417
		Pass Away	1	0.00436681	0.142857143
		Evacuated	7	0.03056769	0.35
	Gas Stove	Minor Injuries	1	0.5	0.001302083

		Evacuated	1	0.5	0.05
	Gas Tube	Minor Injuries	3	0.75	0.00390625
		Evacuated	1	0.25	0.05
	Trash Burning	Minor Injuries	2	1	0.002604167
	Firewood	Minor Injuries	1	1	0.001302083
	Fireplace	Minor Injuries	1	1	0.001302083
	Burning Stoves	Minor Injuries	4	1	0.005208333
	Methylated	Minor Injuries	1	1	0.001302083
	Kerosene spill	Minor Injuries	1	1	0.001302083
	Candle	Minor Injuries	1	1	0.001302083
	Short Sircuit	Minor Injuries	185	0.97368421	0.240885417
		Pass Away	1	0.00526316	0.142857143

Night		Evacuated	4	0.02105 263	0.2
	Gas Stove	Minor Injuries	1	1	0.0013020 83
	Gas Tube	Minor Injuries	3	0.75	0.0039062 5
		Evacuated	1	0.25	0.0 5
	Trash Burning	Minor Injuries	1	0.5	0.0013020 83
		Evacuated	1	0.5	0.0 5
	Cigarette Stub	Minor Injuries	2	1	0.0026041 67
Dawn	Trash Burning	Minor Injuries	1	1	0.0013020 83
	Fireplace	Minor Injuries	1	1	0.0013020 83
	Burning Stoves	Minor Injuries	2	1	0.0026041 67
	Non-electric mosquito repellent	Minor Injuries	1	1	0.0013020 83
	Incense	Pass Away	1	1	0.1428571 43

From Table 3, data can be interpreted based on the biggest terminology of N from four consequences of traffic accidents:

a. If the time of fires is Noon and the factor of fires is Short sircuit, then occurs victim with consequences minor injuries the most are 221 victims of other conditions.

b. If time of accidents is Noon and the facto r of fires is Short sircuit, then occurs victim with consequences evacuated or displaced the most are 7 victims of other conditions.

Decision rules on Table 3 and certainty factors above, leads to several conclusions as follows:

- If the fires' time is Morning, and the factor is candle, then the possibility of fires with victims were minor injured amounted to 1 or 100% under the same conditions.

- If the fires' time is Morning, and the factor is short sircuit, then the possibility of fires with victims were minor injured amounted to 0,967 or 96,7% under the same conditions. While the possibility with victims were serious injured amounted to 0,005 or 0,5%, the possibility with victims were passed away amounted to 0,005 or 0,5% under the same conditions and the possibility with victims were evacuated or displaced amounted to 0,021 or 2,1% under the same conditions.

- If the fires' time is Noon, and the factor is candle, then the possibility of fires with victims were minor injured amounted to 1 or 100% under the same conditions.

- If the fires' time is Noon, and the factor is short circuit, then the possibility of fires with victims were minor injured amounted to 0,965 or 96,5% under the same conditions. While the possibility with victims were passed away amounted to 0,004 or 0,4%, and the possibility with victims were evacuated or displaced amounted to 0,030 or 3% under the same conditions.

Decision rules on Table 3 and coverage factors above, leads to several conclusions as follows:

- Fire disaster with the consequences victims were serious injured occurs by 66,67% on Morning, with 33,33% caused by short sircuit and 33,33% caused by fireplace.

- Fire disaster with the consequences victims were minor injured occurs by28,77% caused by short sircuit on Noon.

- Fire disaster with the consequences victims were evacuated or displaced occurs by 45% on Noon, 35% caused by short sircuit, 5% caused by gas stove and 5% caused by gas tube.

6. Summary

Based on the results of the analysis can be concluded that the characteristic of fire disaster in Jakarta on 2015 known that about 768 out of 798 victims were minor injured.Based on time, most of fire disaster occurs in noon, with a percentage of 30,45% or about 243 victims were involved. The most possibility fire disaster with the consequences victims were minor injured is when the time is noon with the number of possibility by 28,77%.The most possibility fire disaster with the consequences victims were serious injured is when the time is morning with the number of possibility by 66,67%.The most possibility fire disaster with the consequences victims were evacuated or displaced is when the time is noon with the number of possibility by 45%.

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