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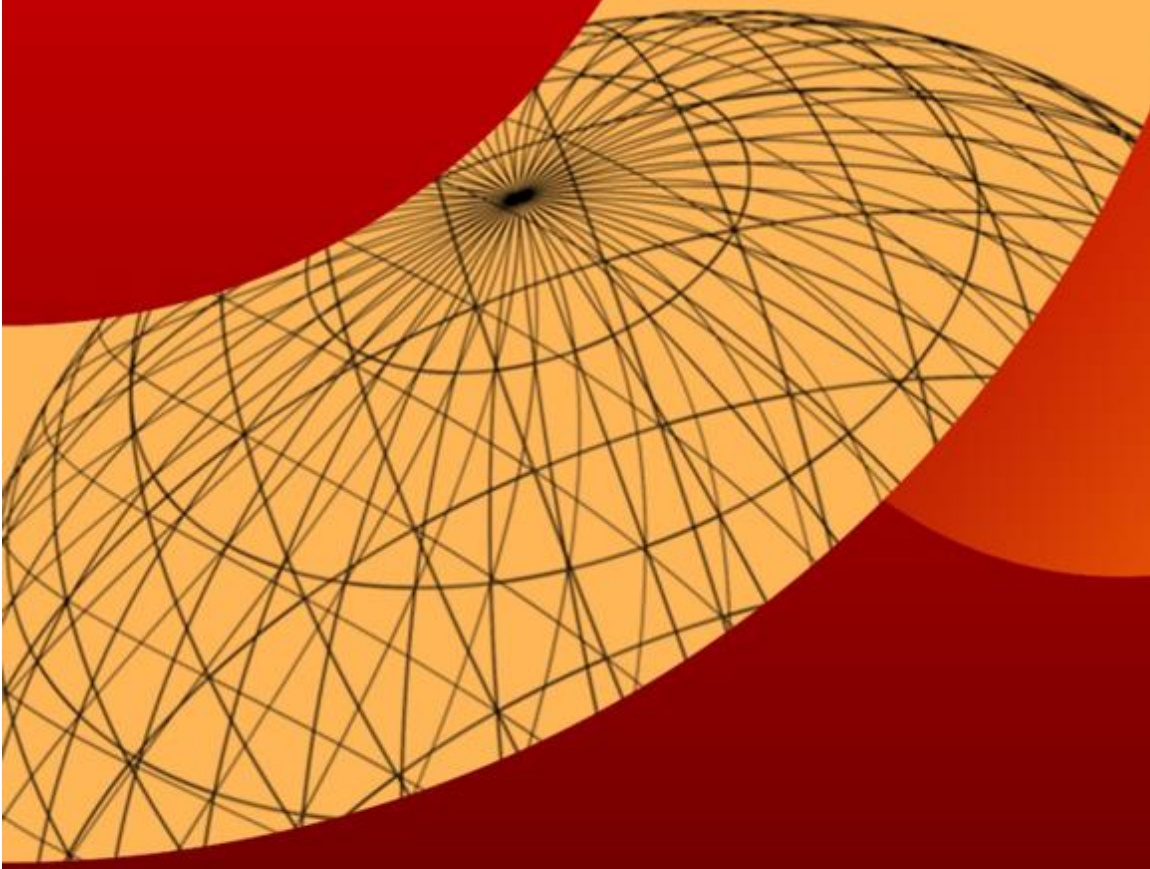

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Mapping of The Transportation Sector in Maluku Province Using Biplot Analysis

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Abstract: The transportation sector is one sector that contributes to economic development. Economic activity will develop if it has good infrastructure and accessible transportation facilities. This study aims to map regencies/cities in Maluku province based on the characteristics of the transportation sector. The method used is Biplot analysis. Based on the results of the study, it was found that the results of mapping 11 regencies/cities in Maluku Province, if grouped according to the location of the quadrant, divided into 2 clusters, namely Cluster 1 consisting of the City Ambon, West Seram Regency, Central Maluku Regency, Buru Regency, Tual City, Southeast Maluku Regency, and Tanimbar Islands Regency. The seven regencies/cities have similar characteristics of the transportation sector in the percentage of villages where public transportation is available with fixed routes, the most comprehensive type of land surface is asphalt/concrete, and the road can be passed by four wheels throughout the year. While Cluster 2 consists of Eastern Seram Regency, South Buru Regency, Southwest Maluku Regency, and Aru Islands Regency. The four regencies have similar characteristics of the transportation sector in the percentage of villages based on the availability of land and sea transportation infrastructure, the availability of sea transportation infrastructure only, public transportation is not available or available without a fixed route, the most comprehensive type of land surface is in the form of soil or hardened with gravel, the road cannot be passed by four wheels or four wheels can pass but only in the dry season. Meanwhile, based on the Euclidean distance, it can be made more specific into 4 clusters, namely Cluster 1 is Ambon City, Cluster 2 includes West Seram Regency, Central Maluku Regency, Buru Regency, Tual City, Southeast Maluku Regency, and Tanimbar Islands Regency. Meanwhile, Cluster 3 consists of the Eastern Seram Regency, South Buru Regency, and Southwest Maluku Regency, and Cluster 4 is the Aru Islands Regency.

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Keywords: Biplot Analysis, Maluku Province, Mapping, Transportation.

1. Introduction

The transportation sector is one sector that has a vital role in overall economic development. Transportation development has a crucial role in supporting and driving development dynamics because it is a catalyst for supporting economic growth and regional development. Transportation is one of the strategic components of inequitable economic growth, the flow of movement of people and goods, the flow of

information, and the flow of finance that needs to be managed quickly and accurately to meet the demands of punctuality [1]. Economic activity will develop if it has good infrastructure and accessible transportation facilities. The existing means of transportation on land, sea, and air hold a vital role in the socio-economic aspect through the distribution function between one region and another. The distribution of goods and people will be easier and faster if the existing transportation facilities function correctly so that transportation can be a means to integrate various regions in Maluku province. Maluku Province is an archipelago with a total of 1.340 islands, large and small. The area of Maluku province is 712.479,69 $km^{2,}$ consisting of 92,4% ocean and 7,6% land [2].

Based on BPS data, from 1.235 villages in Maluku province, there are 288 villages (23,32%) that do not have public transportation, and there are 229 villages (18,54%) that cannot be passed by four-wheeled vehicles throughout the year. The transportation problem in Maluku is, of course, a severe problem, considering that the poverty rate in Maluku contributes to the highest percentage of the poor population in Indonesia. According to the results of the BPS release in 2021 [3], Maluku province ranks fourth as the poorest area in Indonesia with a poverty rate of 16,30% or far above the national figure of 9,91%. In addition, it was noted that the economic growth conditions of the Maluku province were decreasing [4]. Therefore, it is necessary to conduct research related to mapping the transportation sector in Maluku province based on the characteristics of the transportation sector in each village, including the availability of transportation infrastructure, the availability of public transportation, the widest type of land surface, and the existence of roads that can be passed by four-wheeled vehicles. This is done in order to accelerate the improvement of community welfare and equitable development between regions in the Maluku region as an archipelagic region.

The method used in this research is biplot analysis. This biplot has the advantage of being built from principal component analysis, which is a technique used for transforming data sets [5]. This method has been widely applied to research related to mapping, including mapping of provinces in Indonesia based on the profile of the micro and small industry sector [6]; mapping of poverty characteristics in Southwest Maluku Regency [7], mapping of regencies/cities in North Sulawesi province based on the education sector [8]; mapping of ecosystem services flow from three protected areas in the far eastern Himalayan Landscape [9]; mapping of socio-economic relationships, knowledge of soil fertility and strategies for sustainable maize intensification in Embu District, Kenya [10]; correlation between landscape patterns and water quality in various pollutant source areas in the Watershed of Fuxian Lake, China [11]; and mapping the needs of mathematics graduates in Maluku Province [12].

2. Research Methods

2.1. Biplot Analysis

Biplot analysis was first introduced by Gabriel [13]. This analysis is based on Singular Value Decomposition (SVD). SVD aims to describe an *X* matrix of size $n \times p$ where n is the number of objects of observation and p is the number of variables, into 3 matrices. The equation used is a matrix of size $n \times p$ which contains n objects and p variables, can be written as:

$$X = ULA' \tag{1}$$

where:

X = Data matrix of size $n \times p$

U = Matrix of size $n \times r$ whose columns are called column singular vectors.

L = Diagonal matrix of size $r \times r$ with the main diagonal element being the singular value of the X matrix, which is the square root of the eigenvalues of the $X'X$ matrix

A = Matrix of size $p \times r$ whose columns are eigenvectors of the matrix $X'X$

U and A are orthonormal matrices, where $U'U = A'A = IX'X = I$ and $X'X = I$, U is the column of A' contain the eigen vectors of the matrix $X'X$ and the diagonal matrix of L containing the square root of the

eigen values $X'X$ or XX', so that $\sqrt{\lambda_1} \geq \sqrt{\lambda_2} \geq \cdots \sqrt{\lambda_n}$ the diagonal elements of the matx L are called the singular values of the matrix X. The columns of the matrix A are eigen vector of $X'X$ or XX' corresponding to λ.

L^{α} for $0 \leq \alpha \leq 1$ is a diagonal matrix of size $r \times r$ with the diagonal elements $\lambda_1^{\alpha/2}, \lambda_2^{\alpha/2}, \ldots, \lambda_r^{\alpha/2}$. The definition of L^{α} also applies to $L^{1-\alpha}$, so that the elements of the diagonal are obtained $\lambda_1^{1-\alpha/2}, \lambda_2^{1-\alpha/2}, \ldots, \lambda_r^{1-\alpha/2}$. Let UL^{α} and $H' = L^{1-\alpha}A'$ with $0 \leq \alpha \leq 1$. Equation (1) can be written as $X = UL^{\alpha}L^{1-\alpha}A' = GH'$. The G matrix scores the principal components which are the coordinates of n objects and the H matrix contains the eigen vectors which are the coordinates of the p variable. The biplot image of the X data matrix is obtained by taking the first two columns of the G matrix and the first two columns of the H matrix.

There are two values of used to define $G = UL^{\alpha}$ and $H' = L^{1-\alpha}A'$ yaitu $\alpha = 0$ dan $\alpha = 1$. If $\alpha = 0$, then the following equation is obtained: $G = U$ and $H' = LA'$. If $\alpha = 1$, then the following equation is obtained: $G = U \; and \; H' = LA'$. By using $\alpha = 1$, the biplot display will give a better picture of the distance between pairs of rows so it is good to use to see the proximity of objects.

2.2. Data Source And Research Variables

The data used for this study was obtained from the results of the village potential data collection in every village in Maluku Province in 2021. The software used for data processing and analysis is Matlab. The research variables which are characteristics of the transportation sector in a village include:

1. Type of Transportation Infrastructure
   - x_1 : Percentage of the number of villages based on the availability of land and sea transportation infrastructure.
   - x_2 : Percentage of the number of villages based on the availability of only sea transportation infrastructure.
2. Public Transportation Availability
   - x_3 : Percentage of the number of villages where public transportation is available with fixed routes.
   - x_4 : Percentage of the number of villages where public transportation is available without a fixed route.
   - x_5 : Percentage of the number of villages where public transportation is not available.
3. Widest Type of Road Surface
   - x_6 : Percentage of the number of villages that have the widest type of road surface is asphalt /concrete.
   - x_7 : Percentage of the number of villages that have the widest type of road surface is in the form of paved (with gravel or stone).
   - x_8 : Percentage of the number of villages that have the widest type of land surface is in the form of land.
4. The existence of a road that can be passed by four-wheeled vehicles
   - x_9 : Percentage of the number of villages whose roads can be passed by four wheels throughout the year.
   - x_{10} : Percentage of the number of villages whose roads can be passed by four wheels throughout the year, except for certain times.
   - x_{11} : Percentage of the number of villages whose roads can be passed by four wheels only in the dry season.
   - x_{12} : Percentage of the number of villages whose roads cannot be passed by four wheels.

3. Results and Discussion

3.1. Description of Research Data

Table 1 presents information on the characteristics of the transportation sector in each regency/city in Maluku province.

Table 1 .Tabel of Research Data

Regency/City	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
Tanimbar	80,9	19,10	47,19	13,48	39,33	59,55	13,48	7,87	70,79	4,49	2,25	3,37
Malra	95,34	4,66	45,60	40,41	13,99	76,68	8,29	9,84	78,24	4,66	0,52	11,92
Malteng	98,47	1,53	53,06	38,78	8,16	91,84	1,02	5,61	92,35	1,53	0,51	4,08
Buru	98,78	1,22	56,10	26,83	17,07	64,63	14,63	19,51	79,27	18,29	0	1,22
Aru	42,02	57,98	3,36	44,54	52,10	12,61	3,36	25,21	10,08	1,68	0	30,25
SBB	96,74	3,26	65,22	27,17	7,61	75,00	9,78	10,87	80,43	6,52	2,17	7,61
SBT	93,44	6,57	13,13	64,65	22,22	64,65	9,60	15,66	60,10	8,59	3,03	21,72
MBD	91,53	8,47	5,93	77,12	16,95	49,15	9,32	33,05	61,02	6,78	0	23,73
Bursel	95,07	4,94	23,46	66,67	9,88	37,04	9,88	48,15	43,21	28,40	4,94	18,52
Ambon	100	0	100	0	0	100	0	0	100	0	0	0
Tual	90	10	43,33	13,33	43,33	73,33	3,33	13,33	76,67	6,67	0	6,67

Descriptive statistics were conducted to find out the general description of the characteristics of the transportation sector for each of the indicators used. By referring to Table 1 and Table 2, based on the type of transportation infrastructure, some information is obtained as follows. The percentage of the number of villages based on the availability of land and land and sea transportation infrastructure, the maximum is 100% in Ambon City and the minimum is 42,02% in Aru Regency. The average percentage of the number of villages based on the availability of land and sea transportation infrastructure in Maluku Province is 89,30%. Thus, the maximum percentage of the number of villages based on the availability of sea transportation infrastructure is 57,98%, namely in Aru Regency. Meanwhile, the average percentage of the number of villages based on the availability of only sea transportation infrastructure in Maluku Province is 10,70%.

Based on the availability of public transportation, some information is obtained as follows. The percentage of the number of villages where public transportation is available with fixed routes is maximum 100% in Ambon City and the minimum is 3,36% in Aru Regency. Meanwhile, the average percentage of the number of villages where public transportation is available with fixed routes for each regency/city in Maluku Province is 41,49%. Furthermore, the maximum percentage of the number of villages where public transportation is available without fixed routes is 77,12%, namely in MBD Regency. Meanwhile, the maximum percentage of the number of villages where public transportation is not available is 52,10%, namely in Aru Regency.

Table. 2 Descriptive Characteristics of the Transportation Sector in Maluku Province

Characteristics	Minimum	Maximum	Average	Standard Deviation
x_1	42,02	100	89,30	16,56
x_2	0	57,98	10,70	16,56
x_3	3,36	100	41,49	28,70
x_4	0	77,12	37,54	24,51
x_5	0	52,10	20,97	16,71
x_6	12,61	100	64,04	24,59
x_7	0	14,63	7,52	4,88
x_8	0	48,15	17,19	13,81
x_9	10,08	100	68,38	24,83
x_{10}	0	28,40	7,96	8,35
x_{11}	0	4,94	1,22	1,66
x_{12}	0	30,25	11,74	10,26

Based on the widest type of road surface, some information is obtained as follows. The percentage of the number of villages that have the largest type of road surface in the form of asphalt/concrete maximum is 100%, namely in Ambon City and the minimum is 12,61%, namely in Aru Regency. Meanwhile, the average percentage of the number of villages that have the widest type of asphalt/concrete road surface for each district/city in Maluku Province is 64,04%. Furthermore, for the percentage of the number of villages that have the largest type of road surface in the form of hardened (with gravel or stone) maximum is 14,63%, namely in Buru Regency, while for the percentage of the number of villages that have the largest land surface type in the form of maximum land is equal to 48,15%, namely in South Buru Regency.

Based on the existence of roads that can be passed by four-wheeled vehicles, some information is obtained as follows. The percentage of the number of villages whose roads can be passed by four wheels throughout the year is 100% maximum in Ambon City and the minimum is 10,08% in Aru Regency. Meanwhile, in percentage terms, the number of villages whose roads can be passed by four wheels throughout the year for each regency/city in Maluku Province is 68,38%. Furthermore, for the percentage of the number of villages whose roads can be passed by four wheels throughout the year, except for certain times the maximum is 28,40%, namely in South Buru Regency, for the percentage of villages whose roads can be passed by four wheels only in the dry season the maximum is 4, 94% is in South Buru Regency, while the maximum percentage of villages whose roads cannot be passed by four wheels is 30,25%, namely in Aru Regency.

3.2. Biplot Eligibility Criteria

Biplot eligibility criteria in presenting data information is determined based on the value of ρ^2. If the value ρ^2 is close to 1 (≥ 70%), then the biplot provides a better presentation of the actual data information [14]. The presentation of this information depends on the eigenvalues (λ). In this study, the value of λ_1 was 24,0740 and λ_2 was 1,9628 so that the value of ρ^2 was obtained:

$$\rho^2 = \frac{(\lambda_1 + \lambda_2)}{\sum_{k=1}^{12} \lambda_k} = \frac{26{,}0368}{26{,}9556} = 0{,}9659$$

Because the value of ρ^2 obtained is close to 1, the resulting biplot is very good. The information provided by the biplot is 96,59% of the total information contained in the data.

3.3. Biplot Analyisis Result

Based on the stages of the biplot analysis, the biplot display is obtained as shown in the following fig. 1. In this study, a biplot graph with $\alpha = 1$. The reason for choosing a biplot with $\alpha = 1$ was generated, namely the product of the object coordinate matrix (G) and the variable coordinate matrix (H) equal to the elements in the initial data matrix. The biplot used in this study is a Row Metric Preserving Biplot. Therefore, there are three important things obtained from the results of biplot display which are the proximity between observed objects, variable diversity, and correlation between variables.

Proximity Between Observed Objects

This information is used as a guide to identify regencies/cities that have similar characteristics with other regencies/cities. Regencies/cities located in the same quadrant are said to have similar characteristics of the transportation sector which are quite close when compared to regencies/cities in different quadrants. In addition, the similarity of characteristics of the transportation sector can be determined through the Euclidean distance. The grouping of regencies/cities based on quadrants when viewed from Figure 1 is divided into two clusters, including:

Cluster 1 consists of 7 regencies/cities including: Ambon City, West Seram Regency, Central Maluku Regency, Buru Regency, Tual City, Southeast Maluku Regency, and Tanimbar Islands Regency. The seven regencies/cities have similar characteristics of the transportation sector in the percentage of the number of villages where public transportation is available with fixed routes (x_3), the percentage of the number of villages that have the widest type of road surface in the form of asphalt/concrete (x_6), and the percentage of the number of villages whose roads can be passed by four wheels throughout the year (x_9).

Cluster 2 consists of 4 regencies, namely: East Seram Regency, South Buru Regency, Southwest Maluku Regency, and Aru Islands Regency. The four regencies have similar characteristics of the transportation sector in the percentage of the number of villages based on the availability of land and sea transportation infrastructure(x_1), the percentage of the number of villages based on the availability of sea transportation infrastructure only(x_2), the percentage of the number of villages where public transportation is available without fixed routes(x_4), the percentage of the number of villages where public transportation is not

available(x_5), the percentage of the number of villages that have the widest type of land road surface is in the form of paved (with gravel or stone)(x_7), the percentage of the number of villages that have the widest type of road surface is soil(x_8), the percentage of the number of villages whose roads can be passed by four wheels throughout the year, except for certain times(x_{10}), the percentage of the number of villages whose roads can be passed by four wheels only in the dry season(x_{11}), and the percentage of the number of villages whose roads cannot be passed by wheels four(x_{12}).

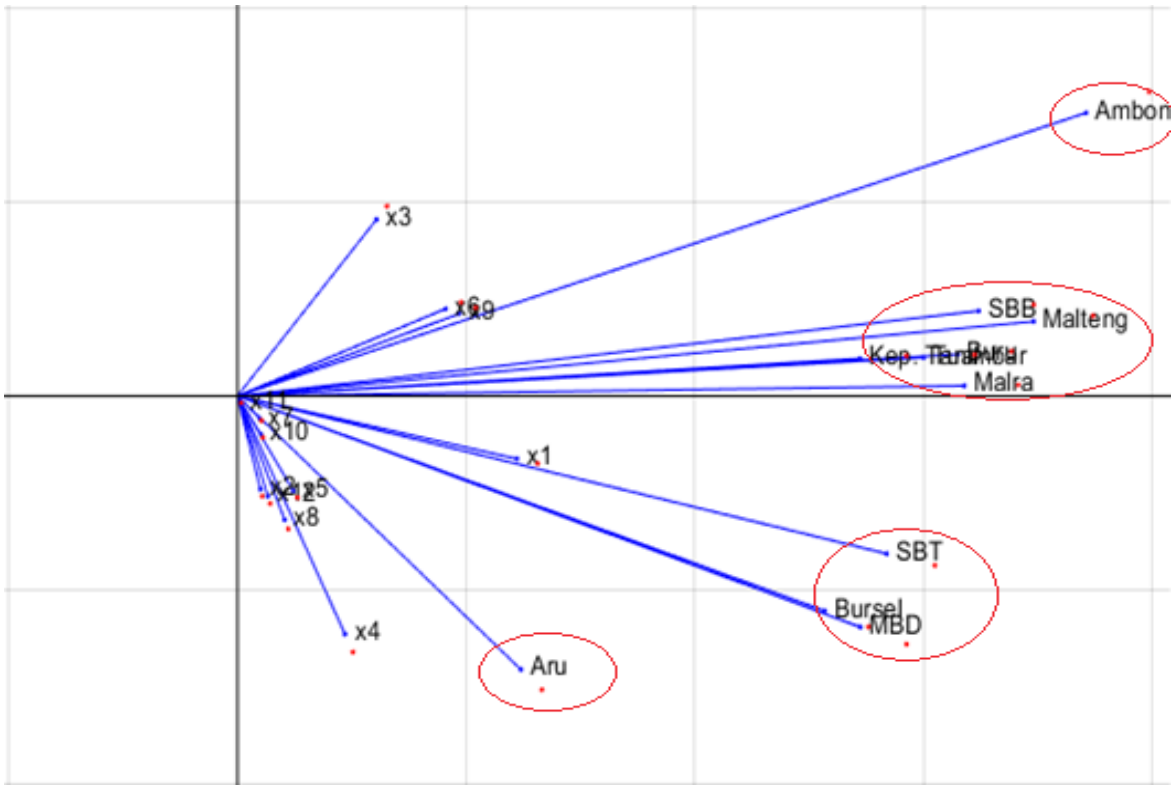

Fig. 1. Biplot Chart

If the grouping of regencies/cities is made more specific by taking into account the Euclidean distance, then 11 regency/cities in Maluku Province can be grouped according to the characteristics of the transportation sector into four clusters, including:

- **Cluster 1** : Ambon City
- **Cluster 2** : West Seram Regency, Central Maluku Regency, Buru Regency, Tual City, Southeast Maluku Regency, and Tanimbar Islands Regency.
- **Cluster 3** : East Seram Regency, South Buru Regency, and Southwest Maluku Regency.
- **Cluster 4** : Aru Islands Regency.

Variable Diversity

This information is used to see the diversity of characteristics of the transportation sector in each regency/city. In a biplot, components with a large diversity are represented as long vectors. From the calculation of the length of the vector based on the biplot coordinates, the longest variable vector is x_4, namely the percentage of the number of villages where public transportation is available without a fixed route. This means that this variable is the greatest diversity and can be said to be the most dominant characteristic of the transportation sector in Maluku Province. While the shortest variable vector is x_{11} which is the percentage of the number of villages that can be traversed by four wheels only in the rain that has a small diversity.

Correlation Between Variables

The correlation or interrelationship between the characteristics of the transportation sector can be interpreted from the presentation of the biplot graph. In the biplot graph, the characteristics of the transportation sector are depicted as directed lines. Two characteristics that have a positive correlation will

be described as two lines with the same direction so that they form an acute angle so that the cosine value of the angle formed is positive. Meanwhile, if two characteristics are described as two opposite lines, it is said to have a negative correlation. The angle formed is an obtuse angle so the cosine of the angle is negative. However, if two characteristics are depicted in the form of a line with a right angle (the cosine of the angle is 0) then it is said that the characteristics of the transportation sector are not correlated with each other.
The size of the cosine value of the angle formed between the two variables characteristic of the transportation sector will determine the high and low correlation between the two variables characteristic of the transportation sector. A cosine value of an angle that is close to -1 or +1 indicates a strong relationship between the two variables, while a cosine value of an angle that is close to 0 indicates a weak relationship.

Table 3. Cosine Value of Angle Between Variables

Variable	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
x_1	1											
x_2	0,28	1										
x_3	0,33	-0,82	1									
x_4	0,58	0,94	-0,58	1								
x_5	0,66	0,90	-0,49	1,00	1							
x_6	0,75	-0,42	0,91	-0,09	0,01	1						
x_7	0,82	0,78	-0,28	0,95	0,97	0,24	1					
x_8	0,54	0,96	-0,62	0,99	0,99	-0,14	0,93	1				
x_9	0,78	-0,38	0,84	-0,04	0,05	0,99	0,28	-0,10	1			
x_{10}	0,67	0,90	-0,48	0,99	0,99	0,02	0,98	0,99	0,07	1		
x_{11}	0,66	0,91	-0,50	0,99	0,99	0,00	0,97	0,99	0,04	1,00	1	
x_{12}	0,49	0,97	-0,67	0,99	0,98	-0,20	0,90	0,99	-0,16	0,97	0,98	1

Based on Figure 1 and Table 3, some information related to the correlation between variables of transportation characteristics is obtained as follows.

- The percentage of the number of villages that have the widest type of road surface in the form of asphalt/concrete (x_6) is positively correlated with the percentage of the number of villages whose roads can be passed by four wheels throughout the year (x_9) and the percentage of the number of villages where public transportation is available by route fixed (x_3). This is determined from the cosine value of the angle formed which is 0,99 and 0,91 respectively. The greater the percentage of the number of villages in a regency/city that has the widest type of land road surface in the form of asphalt/concrete, the greater the percentage of the number of villages in the regency/city whose roads can be traversed by four wheels throughout the year as well as the percentage of availability of public transportation with fixed routes, and vice versa.
- The percentage of the number of villages that have the widest type of road surface is paved (with gravel or stone) (x_7) is positively correlated with the percentage of the number of villages where public transportation is available without a fixed route (x_4), the percentage of then sumber of villages where public transportation is not available (x_5), the percentage of the number of villages whose roads can be passed by four wheels throughout the year, except for certain times (x_{10}), and the percentage of the number of villages whose roads can be passed by four wheels only in the dry season (x_{11}).This is determined from the cosine value of the angle formed, each of which is 0,95; 0,97; 0,98; and 0,97. The greater the percentage of the number of villages in a regency/municipality that has the widest type of road surface in the form of paved (with gravel or stone), the greater the percentage of the number of villages in the regency/city where public transportation is not available or is available without a fixed route, the road can be traversed by four wheels throughout the year, except at certain times or only during the dry season, and vice versa.
- The percentage of the number of villages that have the widest type of land surface in the form of land (x_8) is positively correlated with the percentage of the sumber of villages that only have sea transportation infrastructure (x_2), the percentage of the sumber of villages where public transportation is available without a fixed route (x_4), the percentage of the number of villages where public transportation is not available (x_5), the percentage of the number of villages whose roads can be passed by four wheels throughout the year, except for certain times (x_{10}), the percentage of the number of villages whose roads can be passed by four wheels only in the dry season (x_{11}), and the percentage of the number of villages whose roads cannot be passed by four wheels (x_{12}). This is

determined from the cosine of the angle formed between the variable x_8 and all these variables of 0,99 except for the variable x_2 which is 0,96. The greater the percentage of the number of villages in a regency/city that has the widest type of land surface in the form of land, the greater the percentage of the number of villages in the regency/city that only has sea transportation infrastructure, public transportation is not available or is available without a fixed route, the road four wheels cannot be passed, or four wheels can only be passed during the dry season or certain times, and vice versa.

- The percentage of the number of villages where public transportation is available with fixed routes (x_3) is negatively correlated with the percentage of villages based on the availability of sea transportation infrastructure only (x_2), the percentage of the number of villages that have the widest type of land surface in the form of land (x_8) as well as the percentage of the number of villages whose roads cannot be passed by four wheels (x_{12}) where the cosine values of the angles formed are -0,82; -0,62 and -0,67. The greater the percentage of the number of villages in a regency/city where public transportation is available with fixed routes, the smaller the percentage of the number of villages in the regency/city that only has sea transportation infrastructure, the widest type of land surface is land and cannot be passed by four wheels, and on the contrary.

4. Conclusion

a) The results of the mapping of 11 regencies/cities in Maluku Province if grouped according to the location of the quadrant divided into 2 clusters as follows:
   Cluster 1 : Ambon City, West Seram Regency, Central Maluku Regency, Buru Regency, Tual City, Southeast Maluku Regency, and Tanimbar Islands Regency. The seven regencies/cities have similar characteristics of the transportation sector in the percentage of villages where public transportation is available with fixed routes, the widest type of land surface is asphalt/concrete, and the road can be passed by four wheels throughout the year.
   Cluster 2 : Eastern Seram Regency, South Buru Regency, Southwest Maluku Regency, and Aru Islands Regency. The four regencies have similar characteristics of the transportation sector in the percentage of villages based on the availability of land and sea transportation infrastructure, the availability of sea transportation infrastructure only, public transportation is not available or available without a fixed route, the widest type of land surface is in the form of soil or hardened with gravel, the road cannot be passed by four wheels or four wheels can pass but only in the dry season.

b) The results of the mapping of 11 regencies/cities in Maluku Province if grouped based on Euclidean distance can be made more specific into 4 clusters as follows:
   Cluster 1 : Ambon City.
   Cluster 2 : West Seram Regency, Central Maluku Regency, Buru Regency, Tual City, Southeast Maluku Regency, and Tanimbar Islands Regency.
   Cluster 3 : Eastern Seram Regency, South Buru Regency, and Southwest Maluku Regency.
   Cluster 4 : Aru Islands Regency.

c) The characteristic of the transportation sector that has the greatest diversity in Maluku Province is the percentage of villages where public transportation is available without a fixed route. While the characteristics of the transportation sector that has the smallest diversity is the percentage of the number of villages whose roads can be passed by four wheels only in the dry season.

d) The correlation between the variable characteristics of the transportation sector in Maluku Province is as follows.
   - The percentage of the number of villages that have the widest type of land road surface in the form of asphalt/concrete is positively correlated with the percentage of the number of villages whose roads can be passed by four wheels throughout the year as well as the percentage of the number of villages where public transportation is available with fixed routes.
   - The percentage of the number of villages that have the widest type of road surface in the form of paved (with gravel or stone) is positively correlated with the percentage of the number of villages where public transportation is neither available nor available without a fixed route, as well as the percentage of the number of villages whose roads can be passed by four wheels throughout the year, except at certain times or during the dry season.
   - The percentage of the number of villages that have the widest type of land road surface in the form of land is positively correlated with the percentage of villages that only have sea transportation

infrastructure, the percentage of villages where public transportation is neither available nor available without fixed routes, and the percentage of villages whose roads cannot four-wheeled or four-wheel-passable all year round, except at certain times or during the dry season.

- The percentage of the number of villages where public transportation is available with fixed routes is negatively correlated with the percentage of the number of villages based on the availability of sea transportation infrastructure only, has the widest type of land surface in the form of land, or whose roads cannot be passed by four wheels.

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