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Analysis of the Effect of Infrastructure System at Kendari New Port Terminal on Container Customer Satisfaction Using Principal Component Analysis (PCA) Method

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ABSTRACT

Container Terminal Kendari New Port, located in Kendari, Southeast Sulawesi Province, is known to be one of the gateways for international logistics flow with adequate facilities and systems implemented where one of its activities is loading and unloading of containers supported by a reasonably large pier measuring 300 square meters. Even though it is equipped and supported by adequate infrastructure, it is not uncommon for customers to feel that the system and infrastructure provided are unsatisfactory. For this reason, in this study, satisfaction indicators are in the form of price (X1) and facilities (X2), and all of these variables have several indicators to determine customer satisfaction with the infrastructure offered using the PCA method. The PCA method is advantageous when the existing data has a large number of variables and has a correlation between the variables. In general, the principal component can be helpful for feature selection and interpretation of variables. The results of this study indicate that there is one variable that has an eigenvalue more significant than one, which indicates that this variable has a cumulative proportion of 58.278%, which means that 1 factor can absorb information in the data of 58.278% where the variable is Price (X1).

Keywords: *Customer Satisfaction, Infrastructure Systems, Kendari New Port, Principal Component Analysis*.

1. INTRODUCTION

PT. Pelabuhan Indonesia II (Persero) or better known as PT. Pelindo is a state-owned enterprise (BUMN) in the field of port services and the largest port operator in Indonesia. Pelindo carries the vision of becoming an integrated and world-class maritime ecosystem leader and the mission of realising a national maritime ecosystem network through increasing network connectivity and service integration to support Indonesia's economic growth [1]. PT. Pelindo has several subsidiary branches, one of which is Pelindo IV, which manages ports in 11 provinces, namely East Kalimantan, North Kalimantan, South Sulawesi, Central Sulawesi, Southeast Sulawesi, Gorontalo, North Sulawesi, Maluku, North Maluku, Papua and Papua. West [1]. One of the ports under the auspices of PT. Pelindo IV is the Port of Kendari New Port (KNP) container terminal, which is located in Kendari, Southeast Sulawesi Province which is known to be one of the gateways for international logistics flows with adequate facilities and systems implemented where one of its activities is loading and unloading of containers supported by the docks. It is spacious, measuring 300 square meters and equipped with a 5-hectare Container Yard that can accommodate around 250 thousand TEUs/year. The government has designated this container loading and unloading terminal as one of 10 ports in Indonesia that implements the National Logistic Ecosystem (NLE). Implementing NLE at ports will create an integrated and world-class maritime ecosystem. Containers can be transported by land and sea transportation modes, but to increase efficiency and be used for long journeys, sea transportation, such as barges and container ships, is better than land transportation [2]. Kendari New Port terminal has a land area of 8.7 hectares consisting of 5.1 hectares of container stacking yards and 3.6 hectares of supporting facilities. The supporting facilities include a 300 x 35-meter wharf, offices, workshops, and other buildings. This port also has two container cranes (CC) with a capacity of 24 containers per hour for each CC to unload or load containers or containers from ships to the wharf or the mainland [3]. The existence of container loading and unloading facilities at the Kendari New Port terminal aims to facilitate and streamline services for the public so that they are following the wishes and needs of customers.

However, due to the large number of loading and unloading activities and loading and unloading systems that do not yet use an automated system, many customers complain that the waiting time and service time are not following the costs incurred, resulting in customer dissatisfaction with the existing loading and unloading system. Therefore, to measure and reduce the level of customer dissatisfaction, this research will carry out an analysis and evaluation regarding the factors that affect the level of customer satisfaction based on the price (X_1) and facilities (X_2) variables, all of which have several further indicators will reveal container customer satisfaction with the infrastructure offered using the Principal Component Analysis (PCA) method. PCA is a linear combination of the initial variables, which geometrically this linear combination is a new coordinate system obtained from the rotation of the original system. The PCA method is advantageous when the existing data has a large number of variables and has a correlation between the variables. The principal component analysis calculation is based on the eigenvalues and eigenvectors, which express the data distribution from a dataset. The principal component (PC) can be helpful for feature selection and interpretation of variables [4]. Knowing the variable components that contribute highly to customer satisfaction can then be used as evaluation material to improve and increase customer satisfaction.

2. METHODOLOGY

2.1 Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is a reasonably good technique for extracting structure from a data set with many dimensions. The Principal Component Analysis (PCA) method is more appropriate for summarising data with fewer variables [5]. The calculation of principal component analysis is based on the calculation of eigenvalues and eigenvectors, which express the data distribution from a dataset. Variables that initially numbered n variables will be selected to become k new variables called principal components where k has a number less than n. With a value of k, the principal component will produce the same value using n variables. The Principal Component Analysis procedure aims to simplify and eliminate factors that are less dominant and less relevant without reducing the intent and purpose of the original data from random variables as follows [6].

The calculation of the variance-covariance matrix from the research data can be seen below.

$$Var(x) = \sigma^2 = \frac{1}{n}\sum_{i=1}^{n}\left(Z_{ij} - \mu_j\right)^2 \text{ and} \quad (1)$$

$$Cov(x,y) = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij} - \mu_{xj}\right)\left(y_{ij} - \mu_{yj}\right)$$

The Covariance Matrix (x,y) is a matrix in which the covariance value in each cell is obtained from the sample values (Jolliffe, 2010).

1. Calculating the eigenvalues and eigenvectors of the covariance matrices that have been obtained
2. Determine the proportion value of the principal component using the equation,

$$PC(\%) = \frac{Eigen\ Value}{Variance\ Covariance} \times 100\% \quad (2)$$

3. The factor is calculated factor loading based on eigenvectors (Jolliffe, 2010).
4. Gets a m eigenvector of size px1 from the associated m eigenvalue
5. Determine m PC equation
6. Comparing the importance of variables on each PC with other variables
7. Provides an interpretation of the formed PC combination equation.

2.2 Data Quality Test

Data quality testing is carried out before analysis using the Principal Component Analysis (PCA) method to determine whether the data is feasible for research. The data quality test consists of a validity test and a reliability test.

1. Data Validity Test

The data validity test shows the degree of accuracy or suitability between the actual data and the data collected by the researcher [7]. The validity test aims to measure whether the data obtained is valid data by using the equation,

$$r_{xy} = \frac{n\left(\Sigma xy\right)\left(\Sigma x\right)\left(\Sigma y\right)}{\sqrt{\left\{n\Sigma x^2 - \left(\Sigma x\right)^2\right\}\left\{n\Sigma y^2 - \left(\Sigma y\right)^2\right\}}} \quad (3)$$

With,

r_{xy}: the results of the correlation between the two variables that are connected

x : Selected statement item score

y : total score of statement items

$\sum x$: total score on the x distribution

$\sum y$: total score on the y distribution

$\sum x^2$: squared results in the x distribution of scores

$\sum y^2$: squared results in the y-score distribution

n : number of respondents

The criteria from the results of the validity test calculation are: if the value of $r_{count} > r_{table,}$ then the statement is declared valid; otherwise, if $r_{count} < r_{table}$, then the statement is declared invalid.

2. Reliability Test

The reliability test was carried out to determine to what extent the measurement results using the same object produced the same data or could be reliable for analysis [7]. Cronbach's Alpha calculations using the following equation determine whether the research object is reliable.

$$r^n = \left[\frac{k}{k-1}\right]\left[1 - \frac{\Sigma\sigma\frac{2}{b}}{\sigma\frac{2}{i}}\right] \quad (4)$$

With,

r^n = coefficient value

k = total statement items

$\Sigma\sigma\frac{2}{b}$ = the total variance of statement item scores

$\sigma\frac{2}{i}$ = the total variance

A variable is said to be good and reliable if its Cronbach's Alpha value is> 0.6 (Priyatno, 2013).

2.3 Assumption Testing

1. Data Adequacy Assumptions

The assumption of data adequacy can be analysed using the Kaiser Meyer Olkin (KMO) method, which aims to determine whether all the data to be used in the study are sufficient to factor in the hypothesis used [8].

H_0 : the amount of data is sufficient to be analysed

H_1 : the amount of data is not enough to be analysed

The mathematical calculation of KMO is as follows,

$$KMO = \frac{\sum_{j=1}^{p}\sum_{k=1}^{p} m_{jk}^2}{\sum_{j=1}^{p}\sum_{k=1}^{p} m_{jk}^2 + \sum_{j=1}^{p}\sum_{k=1}^{p} n_{jk}^2} \quad (5)$$

With,

j = 1,2,3,…,p and k= 1,2,3,…,p.

m_{jk} = Correlation coefficient between variable j and variable k

$_{jk}$ = Partial coefficient between variable j and variable k

If the calculation results of KMO <0.5 are obtained, a decision is made that the amount of data is insufficient to be analysed.

2. Multicollinearity Assumptions

Multicollinearity can be tested using the Barlett test, where the correlation value will be seen in this test [4]. The multicollinearity test aims to test whether there is a high correlation between the independent variables used in the analysis and the hypothesis used in the Barlett test [9].

$H_0 : \rho \neq 1$ (no correlation)

$H_1 : \rho = 1$ (There is a correlation)

If it is concluded that Reject H_0 means no correlation between the research variables.

2.4 Data Source

The data source used in this study is survey data on 50 communities related to container customer satisfaction in Kendari New Port Terminal, which is measured using variables in the form of price (X_1) and facilities (X_2), where each of these variables has an assessment indicator where the variable is the price (X_1) the evaluation indicator is the price paid in accordance with the facilities provided (Q_1), the price of infrastructure facilities and services provided is cheaper (Q_2), there is a discount during transactions (Q_3) and there is a return service (Q_4). The facility variable (X_2) is measured by the indicator of the facilities provided according to what you expect (Q_5), the facilities provided following the price you pay (Q6) and also the short service time (Q_7).

3. RESULTS AND DISCUSSION

3.1 Data Characteristics

At this stage, data characteristics will be presented as a distribution map showing the origin of most people who use container services at Kendari New Port terminal, as shown in Figure 1.

Figure 1: Map of the distribution of KNP container service users

The regional colour in Figure 1 shows the number of customers who have used container services at Kendari New Port (KNP) terminal, where the darker the colour, the higher the number, so it can be seen that the majority of the customers use container services at Kendari New Port

terminal. It comes from Southeast Sulawesi Province. Southeast Sulawesi Province is known as the location of the Kendari New Port (KNP) terminal. Hence, the Kendari New Port terminal services support the Southeast Sulawesi region.

3.2 Data Quality Test

The data quality test is carried out before starting to analyse using the Principal Component Analysis (PCA) method to find out more whether the data is suitable for use in research where the data quality test used is,

1. Validity test

Validity explains how well the collected data covers the actual area of investigation [10]. The validity test was carried out to test the validity of the data from the survey results because if the data is not valid, it will interfere with the analysis results using PCA. The following are the results of testing the validity of the data on the price variable (X_1) and facilities (X_2) with each of the existing indicators. Table 1 provides information that the value of r indicators and variables has a higher value when compared to the value of the r table so that it can be stated that each question item and variable is valid and can be used for further analysis.

Table 1: Validity Test

Variable	Indicator	r Indicator	r Variable	r table	Conclusion
Price (X_1)	Q1	0.449	0.663	0.235	Valid
	Q2	0.642		0.235	Valid
	Q3	0.352		0.235	Valid
	Q4	0.561		0.235	Valid
Facilities (X_2)	Q5	0.238	0.377	0.235	Valid
	Q6	0.422		0.235	Valid
	Q7	0.316		0.235	Valid

2. Reliability Test

Reliability concerns the extent to which a phenomenon's measurement provides stable and consistent results [11]. Reliability testing was carried out using Cronbach's Alpha, where if the Cronbach's Alpha value is more than 0.6, then the questions in the questionnaire are valid. The results of reliability testing are shown in Table 2.

Table 2: Reliability Test Result

Cronbach's Alpha Indicator	Cronbach's Alpha Variable	N
0.723	0.746	9

The information obtained from Table 2 is the Cronbach's Alpha value of 0.723 in the reliable test for each indicator. The value for each variable is 0.746, so it can be said that the indicators and variables in the questionnaire are reliable. So, based on Table 1 and Table 2, it can be concluded that the data used for each indicator and variable are valid and reliable for analysis.

3.3 Assumption Testing

Two assumptions must be met before analysing using Principal Component Analysis.

1. Data Adequacy Assumptions

The assumption of data adequacy can be analysed using the Kaiser Meyer Olkin (KMO) method, which aims to determine whether all the data to be used in the study are sufficient to factor in the hypothesis used [8].

H_0 : the amount of data is sufficient to be analysed

H_1 : the amount of data is not enough to be analysed

This study found that the KMO value for customer satisfaction data for petitmeas at Kendari New Port terminal Port was 0.5. This result means that the amount of data used in the study is sufficient to be analysed because the analysis cannot be continued if the KMO value <0.5

2. Multicollinearity Assumptions

The multicollinearity assumption in this study uses the Bartlett test with the hypothesis,

$H_0 : \rho \neq 1$ (no correlation)

$H_1 : \rho = 1$ (There is a correlation)

The results obtained using the Barlett test obtained a p-value of 0.385, which means that this value is > a significance level of 0.05. This result means it fails to reject H_0, so it can be concluded that there is no correlation between the independent variables. The results of the correlation matrix between the variables presented in Table 3 can be seen.

Table 3: Correlation Matrix

	X_1	X_2
X_1	1	0,126
X_2	0,126	1

The results of the correlation matrix between variables show that there is no multicollinearity between the observed variables. This result is consistent with the

correlation value between variables worth less than 0.8, so there is no indication of multicollinearity.

3.4 Principal Component Analysis (PCA)

Principal component analysis (PCA) is a multivariate technique that analyses a data table in which observations are described by several inter-correlated quantitative dependent variables [12]. The first stage in the Principal Component Analysis method is determining which variables are considered appropriate for inclusion in the next analysis. This test is carried out by entering all existing variables and then testing these variables. If a variable tends to group and form a factor, that variable will have a reasonably high correlation with other variables. Conversely, variables with weak correlations with other variables tend not to be grouped into certain factors. In this study, the commonalities values were obtained, which indicated the significant variance that could be explained by the factors presented in Table 4.

Table 4: Communalities

Variable	Extraction
X_1	0.563
X_2	0.563

The information obtained based on Table 4 is that the Extraction value for the Price (X_1) and Facilities (X_2) variables is 0.563 = 56.3%. This means that 56.3% of these variables can be explained by the factors formed. This value is large enough that these two variables are sufficient to explain the satisfaction of container customers at Kendari New Port terminal. Further information can be seen in Table 5 regarding the factoring results obtained from the eigenvalues.

Table 5: Eigenvalues

	Initial Eigenvalues		
Component	Total	% of variance	Cumulative %
X_1	**1.126**	56.278	56.278
X_2	0.874	43.722	100.000

In Table 5, variables with an eigenvalue greater than 1 give a cumulative proportion of diversity of 56.278%, which means that 1 factor can absorb information in the data of 56.278%. Thus, the price variable (X_1) has a role in determining container customer satisfaction at the Kendari New Port terminal.

4. CONCLUSIONS

Based on the characteristics of the data obtained in the survey, it is known that most of the population using container services at Kendari New Port (KNP) terminal comes from Southeast Sulawesi Province, followed by South Sulawesi Province. The survey used valid and reliable data and met data adequacy and multicollinearity assumptions. Based on the results of Principal Component Analysis (PCA), there is one variable that has an eigenvalue more significant than one, which indicates that this variable has a cumulative proportion of diversity of 58.278%, which means that 1 factor can absorb information in the data of 58.278% where the variable is Price (X_1). Thus, Kendari New Port terminal can use this variable as an evaluation material to increase customer satisfaction. For instance, assessing the tariff associated with the loading and unloading cost elements at the container terminal is crucial to facilitate revisions to the tariff structure for the Southeast Sulawesi Province.

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