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Analysis of Factors Affecting Determination of the Type of LRT Station's Maintenance

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Abstract:- Good and sustainable maintenance of Light Rail Transit (LRT) stations will have an impact on ensuring the operational sustainability of the station. Therefore, it is important to develop a station maintenance model based on a multi-criteria analysis related to the type of maintenance. The analytical method used in this study is the Structural Equation Modeling (SEM) method with the Partial Least Square (PLS) approach. The variable criteria used are structural stability, economic/financial, physical environment, and management. The results of the analysis show that the structural stability, economic/financial, physical environment, and management variables have a significant and strong influence on determining the type of station maintenance.

Keywords:- *factors; maintenance; SEM; station.*

I. INTRODUCTION

The Light Rail Transit (LRT) station is a train operational infrastructure project that is used as a stopping place to pick up / drop passengers (Prayudi, 2020). The high activity that will occur at this station makes maintenance as an important thing that must be done regularly to maintain the continuity of the station's operations (Bria et al., 2019). This routinity of maintenance includes daily maintenance activities and periodic maintenance which is carried out regularly within one year. Therefore, it is increasingly clear that the need for maintenance is an absolute thing that must be fullfiled so that the condition of the station remains in a proper and safe condition during the operational period of the LRT (Sitorus, 2021).

The problem is, the weaknesses in developing countries such as Indonesia can be seen through the low quality of the maintenance management system for public facilities owned. In this case, the station is an example of such a public facility (Buchari, 2010). The same thing was also revealed by a study made by Zefri and Maharani (2019), where public facilities such as stations, as a strategic functions in Indonesia still have weaknesses due to low maintenance carried out. The impact can cause technical problems when the operation of the station starts. Based on this, it is important to carry out various kinds of maintenance efforts and assessments of each public facility owned to support better and optimal operational system performance. This performance is certainly influenced by several factors, including aspects of station service, institutional aspects, human resources, modernization of operations, and maintenance (Bria et al., 2019). Of course, it will not be easy to carry out this operation and maintenance, but if this is not done from the start, it will lead to higher rehabilitation costs. So that planning for determining the type of maintenance for this station needs to be done to be more focused, systematic and comprehensive (Heryant et al., 2014).

In planning a maintenance program, of course, you will see the influence by several factors. According to Wieland (2016), one of the most important factors is in the aspect of structural stability. This is due to the large number of failure cases that can be prevented if the structure is properly maintained. Especially for buildings such as LRT stations, it requires careful planning so that they can apply strong structural designs to earthquake forces. Therefore, periodic maintenance is necessary. Determination of this type of maintenance also looks at the condition and functionality of the station building so that a priority order of maintenance can be made. In addition, this maintenance will of course be related to the economic aspect. This relates to the availability of investment funds needed to carry out maintenance (Hassan,2016).

In addition from all factors that has been informed, it is also necessary to pay attention to the environment around the LRT project location. For example, access to project sites, weather conditions, geological problems at the site, force majeure events, and waste generated during operations (Fakunle et al., 2020). This is also revealed in the regulation of the minister of public works no 24/PRT/M/2008, where maintenance also includes housekeeping activities such as pest control in order to eliminate pests around the environment (Fernandi, 2011).

From the technical aspect of management or operational management, conflicts often arise due to the implementation of inappropriate policies. Especially when there are limitations on operational and maintenance costs so that network function quickly declines (Noumeiry et al., 2017). With the description above, it can be identified the factors that influence the determination of the type of LRT station maintenance, including structural aspects, financial aspects, environmental aspects, and technical aspects of management. In previous studies, these four aspects have an influence in the selection of programs or types of maintenance of several civil buildings so that these aspects will be used in the object of this research, namely the LRT station.

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II. METHOD

This research uses quantitative research, where data will be obtained by conducting a survey. The results of the answers from the distributed surveys will be analyzed using Structural Equation Modeling through the SmartPLS tool. The population of this research is all staff of the Jabodebek Lintas Service II LRT project with a total of 65 people. Meanwhile, to determine the number of samples using saturated samples, so that the number of samples in this study were 65 staff of the Jabodebek Lintas Service II LRT project.

The first step after the data has been collected completely is making design the inner model and outer model. The inner model will show the position of the relationship between variables in the model. While the outer model will show the nature of the indicators that make up the variables, whether they are reflective or formative. Of course, it is necessary to identify the observed latent variables along with their indicators. In the outer model it is necessary to measure convergent validity (factor loading, AVE, and communality), discriminant validity (cross loading), and reliability (Cronbach's Alpha and composite reliability values), while the inner model requires measurements of R-Square (R2), Q-Square, and the path coefficient value. The construct is declared valid if the loading factor value is more than 0.7, the AVE value and communality are more than 0.5, and the crossloading value is more than 0.7. The measuring instrument is declared reliable if the Cronbach's Alpha value is more than 0.6 and the composite reliability value is more than 0.7. In the inner model, it is necessary to follow the following criteria: the value of R^2 (R Square) is closer to 1, the closer the relationship between variables is. The model will have predictive relevance if Q Square > 0, the path coefficient value is indicated by the T-statistic value which can be declared significant if it is above 1.96 for the two-tailed hypothesis (Abdillah and Jogiyanto, 2015).

In this study, the variables used are structural, financial, physical and environmental stability, as well as management aspects. While the variables that will be seen in relation to the four variables above are station maintenance. Each variable certainly has indicators that are obtained based on theoretical studies from previous research as well as adjustments to project conditions in this study. The variables and indicators that will be used in this study are described in Table 1

Variable	***Indicator***
Structure Stability (X1)	Physical / Station Body (X1.1) Load Distribution (X1.2) Auxiliary Building/ Auxiliary Building (X1.3)
Financial (X2)	Availability of Investment Funds (X2.1) Value of Economic Benefits (X2.2) Financial Control Effectiveness (X2.3)
Physical and Environment (X3)	Location Access (X3.1) Rainfall (X3.2) Geological Conditions Around the Site (X3.3) Incident*Force Majeure (X3.4)* Operational Waste (X3.5)
Management Management (X4)	Field Investigation Activities (X4.1) Communication Network between Sections (X4.2) Job Control (X4.3) Problem Solving Ability (X4.4) Commitment to Good Cooperation (X4.5)
Station Maintenance Type (Y)	Routine Maintenance (Y1) Periodic Maintenance (Y2) Station Repair (Y3)

Table 1:- Variables and indicators

Based on Table 1, it can be seen the indicators of each variable in this study. Furthermore, the variables and indicators are compiled and described as a conceptual framework to show the model of the relationship between variables and indicators in this study through the figure below:

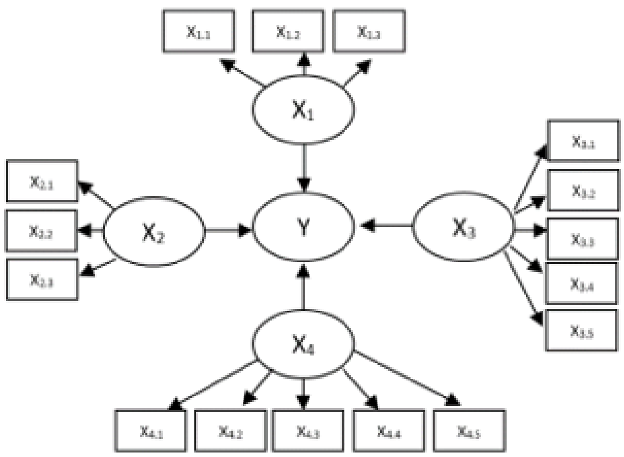

Fig 1:- Conceptual Framework of Relationship Model between Variables and Characteristics of Indicators

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Figure 1 shows the influence relationship as a form of approach to describe the actual conditions which will be followed by testing the level of influence or relationship. This conceptual framework shows the pattern of relationships between latent variables that influence each other, so that hypotheses can be made, including:
H1: The structural stability variable has a positive and significant effect on determining type of station maintenance.
H2: Financial variables have a positive and significant effect on determining type of station maintenance.
H3: Physical and environmental variables have a positive and significant effect on determining type of station maintenance
H4: The management variable has a positive and significant effect on determining type of station maintenance

III. DATA ANALYSIS AND RESEARCH OUTCOMES

After going through the process of collecting data through a survey, then proceed with data processing using SMARTPLS software. The results of the data processing will show the factors that influence the determination of the type of maintenance for the Jabodebek LRT station using structural equation modeling analysis and is illustrated in the figure below:

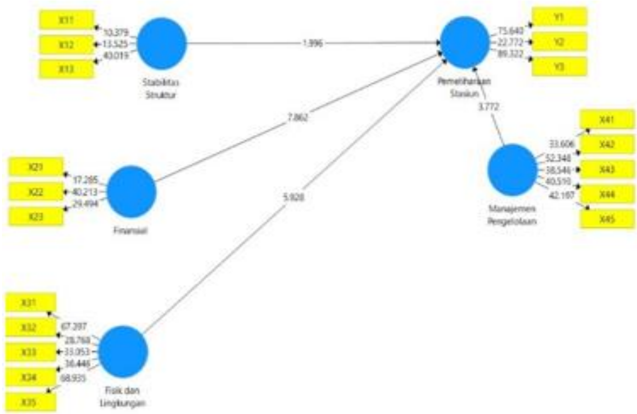

Fig 2:- Structural Equation Modeling PLS Analysis

Based on the analysis model that has been carried out above, the following results are obtained:

	Structure Stability (X1)	Financial (X2)	Physical & Environment (X3)	Management Management (X4)	Determining Station Maintenance Type (Y)
X1.1	0.913				
X1.2	0.925				
X1.3	0.949				
X2.1		0.880			
X2.2		0.930			
X2.3		0.930			
X3.1			0.971		
X3.2			0.937		
X3.3			0.935		
X3.4			0.934		
X3.5			0.971		
X4.1				0.939	
X4.2				0.958	
X4.3				0.945	
X4.4				0.950	
X4.5				0.949	
Y1					0.971
Y2					0.916
Y3					0.975

Table 2:- Loading Factor

Can be seen in Table 2, that the results of the loading factor test of each indicator on the structural stability variables (X1), financial (X2), physical and environmental (X3), management management (X4), and the type of station maintenance (Y) show a value of more than 0.7 . So it can be seen that all indicators of each variable are declared valid. The next step will show the results of the Average Varianced Extracted / AVE value in this study.

	Average Variance Extracted (AVE)	*Information*
Structure Stability (X1)	**0.863**	**Valid**
Financial (X2)	**0.835**	**Valid**
Physical and Environment (X3)	**0.902**	**Valid**
Management Management(X4)	**0.899**	**Valid**
Station Maintenance Type (X5)	**0.911**	**Valid**

Table 3:- AVE

In Table 3, the Average Variance Extracted (AVE) value of each variable shows a result of more than 0.5. It can be concluded that all variables are declared valid.

	Communality	***Information***
Structure Stability (X1)	**0.863**	**Valid**
Financial (X2)	**0.835**	**Valid**
Physical and Environment (X3)	**0.902**	**Valid**
Management Management (X4)	**0.899**	**Valid**
Station Maintenance Type (X5)	**0.911**	**Valid**

Table 4:- Communality

In Table 4, the communality value obtained by each variable is more than 0.5. It can be seen that all variables are declared valid.

	Labor (X1)	**Materials (X2)**	**Equipment (X3)**	**Finance (X4)**	**Determining Station Maintenance Type (Y)**
X1.1	0.913	0.777	0.786	0.775	0.753
X1.2	0.925	0.795	0.804	0.791	0.765
X1.3	0.949	0.817	0.844	0.825	0.805
X2.1	0.738	0.880	0.909	0.931	0.849
X2.2	0.795	0.930	0.870	0.850	0.920
X2.3	0.816	0.930	0.827	0.841	0.858
X3.1	0.867	0.916	0.971	0.942	0.927
X3.2	0.819	0.899	0.937	0.938	0.903
X3.3	0.810	0.904	0.935	0.900	0.933
X3.4	0.775	0.879	0.934	0.958	0.848
X3.5	0.873	0.912	0.971	0.945	0.914
X4.1	0.834	0.909	0.925	0.939	0.904
X4.2	0.775	0.879	0.934	0.958	0.848
X4.3	0.873	0.912	0.971	0.945	0.914
X4.4	0.812	0.938	0.924	0.950	0.900
X4.5	0.766	0.889	0.915	0.949	0.845
Y1	0.820	0.926	0.912	0.888	0.971
Y2	0.853	0.882	0.898	0.869	0.916
Y3	0.813	0.938	0.921	0.910	0.975

Table 5:- Cross Loading

It can be seen in Table 5. that the cross loading value of each indicator of the structural, financial, physical and environmental stability variables, management management, and type of station maintenance shows a value of more than 0.7. This indicates that all indicators are declared valid.

	Cronbach's Alpha	***Composite Reliability***	***Information***
Structure Stability (X1)	**0.921**	**0.950**	**Reliable**
Financial (X2)	**0.901**	**0.938**	**Reliable**
Physical and Environment (X3)	**0.973**	**0.979**	**Reliable**
Management Management(X4)	**0.972**	**0.978**	**Reliable**
Station Maintenance Type (Y)	**0.951**	**0.968**	**Reliable**

Table 6:- Cronbach's alpha and composite reliability

Table 6 shows the results of Cronbach's Alpha test, where the value of each variable shows a number more than 0.6. While the Composite reliability value of each variable also shows a number more than 0.7. This indicates that all variables meet the test requirements so that they can be declared reliable.

	R Square	***Q Square***
Station Maintenance Type (Y)	**0.955**	**0.952**

Table 7:- R-Square and Q-Square

Table 7 shows the results of the R2 value of project delays, which is 0.955 or 95.5%. This shows that the relationship between the variables of the type of station maintenance is considered good. The R2 value indicates that the structural model made provides a good prediction. While the value of Q Square is 0.952 or 95.2% (Q Square > 0). This shows that the model in this study has predictive relevance, where the model used in this study can explain the information contained in the research data by 95.2%.

	T-Statistic	*Information*
Structure Stability (X_1)→Station Maintenance Type (Y)	**1,996**	**Positive and significant**
Financial (X_2)→Station Maintenance Type (Y)	**7.617**	**Positive and significant**
Physical and Environment (X_3)→Station Maintenance Type (Y)	**5.680**	**Positive and significant**
Management Management (X_4)→Station Maintenance Type (Y)	**3,706**	**Positive and significant**

Table 8:- Path coefficient value

Table 8 shows that the T-Statistics value between structural, financial, physical and environmental stability, as well as management of the type of station maintenance is above 1.96. This shows that structural, financial, physical and environmental stability, as well as management are important factors influencing the determination of the type of station maintenance (Y). The following is a sequence of factors that determine the type of maintenance from the most positive and significant, namely financial (X_2) followed by physical and environmental factors (X_3), management management (X_4), and finally the structural stability factor (X_1).

IV. DISCUSSION AND CONCLUSION

Based on the results of the analysis above, it shows that the stability of the structure (X_1) has a direct influence on determining the type of station maintenance. The structural stability variable is formed from several indicators such as physical or station body, load distribution, and auxiliary buildings or complementary buildings where the three indicators make a very significant contribution to the series of determining the type of station maintenance. This means that any changes to the station's structural components such as the physical station from the roof to the base, load distribution and auxiliary buildings or complementary buildings need to be followed by changes to the station structure maintenance actions that have been adapted to current conditions.

Fig 3:- Station's Stability Structure

The condition of the structure also needs to look at the age of the building because it can have an impact on the decline in the quality of the structure. This is what makes the structure necessary to carry out periodic maintenance actions as part of the station's preventive maintenance. This study supports the results of research conducted by Bria et al.(2019) which revealed that structural stability has an influence on determining the type of maintenance of civil buildings. As for the maintenance action process, it requires a structural audit process to determine the status or condition of the structure of the building which is useful to avoid unwanted accidents (Bhadania et al., 2020).

Fig 4:- Environment & Location Access

Furthermore, physical and environmental aspects also have a strong and significant influence on determining the type of station maintenance. It means changing that occur in indicators in physical and environmental aspects can cause changes to the determination of the type of station maintenance. Therefore, the project owner must also pay attention to the importance of applying maintenance measures to the physical and environmental aspects around the station to avoid the impact of fatal damage to the station. This is also revealed from research conducted by Kaelan (2020) and Bria et al. (2019) that physical conditions and the surrounding environment such as location access, rainfall, surrounding geological conditions, force majeure conditions, and operational waste playing important role in determining the type of maintenance that will be applied at the station. As we can see in figure 4, access to the location of the LRT station that is difficult to reach because it is hovering above the ground and it will certainly require more specific equipment in carrying out maintenance. Likewise, the condition of the station that is in an open area, of course, has a risk of rainfall in the vicinity of the project site. This also will be related to the method that will be implemented to carry out the maintenance. Likewise with geological conditions, anticipation of force majeure events that may occur such as earthquakes will require the right type of maintenance so that the station conditions remain good during operations. Besides that, in a journal written by Risanji and Rafli (2018) revealed that waste arising from operational activities also requires special treatment which aims to maintain the condition of the station so that it is well maintained. With the maintenance of both the physical station and the surrounding environment, it is expected to be able to provide a sense of comfort for station users.

In the aspect of financial variables, it shows that it has a strong and most dominant influence on determining the type of station maintenance. This is strongly related to the indicators contained in it, such as the availability of investment funds to carry out maintenance, the value of the economic benefits of the maintenance process carried out, and also the effectiveness of financial controls in compiling a series of station maintenance. The results in this study support the journal created by Wardhana (2017), where the planning and implementation of a maintenance activity, of course, will require the availability of funds or the allocation of the required budget. After the budget is available, it is important for the station manager to control or supervise the use of the maintenance budget effectively and efficiently. The same thing was also revealed by Prayudi et al. (2016), where building maintenance cannot be carried out properly if there are problems with budget availability. In addition, on the financial aspect, it is also important to control the effectiveness of the use of available funds. The building owner must be able to determine the priority scale for the maintenance of the station building, both interior and exterior.

Finally, the management factor also shows that it has a strong and significant influence on determining the type of station maintenance. This is related to field investigation activities, communication networks between departments, work control, problem solving abilities, and commitment to good cooperation. Optimizing maintenance at the station operational stage will of course require good management. This is related to the management's way of making a guide or SOP (Standard Operational Procedure) which is used as a guide to carry out the entire series of station maintenance activities. A maintenance activity that is carried out without SOP guidelines has the potential to produce unplanned activities and does not have a measure of the success of station maintenance (Wardhana, 2017). In addition, the journal created by Stanitsas et al. (2021) revealed that discipline in project management to carry out maintenance was able to integrate the sustainability of the project building. This is of course related to the management steps taken to create and determine the right maintenance system that will be able to maintain the sustainability of the project building.

REFERENCES

[1]. Prayudi & Simanjuntak, M.R.A. (2020). Analisis risiko faktor prasarana kereta api yang berdampak terhadap nilai kinerja operasional. Surakarta : Universitas Muhammadiyah Surakarta

[2]. Bria, M., Sutirto, & Muda, A.H. (2019). Analisis faktor-faktor yang mempengaruhi penentuan jenis pemeliharaan embung irigasi. *Media Komunikasi Teknik Sipil*, 25(2), 160–170.

[3]. Abdillah, W., & Jogiyanto, H. (2015). *Partial Least Square (PLS) alternative Structural Equation Modeling (SEM) in business research*. Yogyakarta: Andi.

[4]. Sitorus, O.R.R.(2021). Analisa Pemeliharaan Kereta Api Medan-Tebing Tinggi. Skripsi. Program Sarjana Universitas Medan Area. Medan.

[5]. Buchari, E. (2010.). Kinerja Stasiun Kereta Api Lubuk Linggau. *Jurnal Transportasi*, 10(2), 111-118.

[6]. Zefri & Maharani, M.J. (2019). Analisis Kualitas Pelayanan KRL Commuter Line di Stasiun Bekasi. *Jurnal Ilmiah Plano Krisna*, 14(2), 27-38.

[7]. Heryant, LY, Sobriya & Suprapto, M. (2014). Development of Dam Physical Condition Assessment for Determinants of Dam Maintenance Management (Case Study: Lodan Reservoir). *Journal of Civil Engineering Masters in Civil Engineering Universitas Sebelas Maret*, II(1), 89–99.

[8]. Wieland, M. (2016). Safety Aspects of Sustainable Storage Dams and Earthquake Safety of Existing Dams. *Engineering.* 2(2016), 325–331.

[9]. Hassan, H., Mangare, J. B., & Pratasis, P. A. K. (2016). Faktor-faktor penyebab keterlambatan pada proyek konstruksi dan alternatif penyelesaiannya (Studi kasus : di Manado Town Square II). *Jurnal Sipil Statik*, 4(11), 657–644.

[10]. Fakunle, F., & Fashina, A. A. (2020). A global overview major delays in construction projects: A global overview 1. *PM World Journal, IX(May)*, 2330–4480.

[11]. Fernandi, I. (2011). Kajian pengaruh faktor-faktor pemeliharaan bangunan Gedung perkuliah terhadap kenyamanan kegiatan perkuliah. Skripsi. Program Sarjana Universitas Sebelas Maret. Surakarta.

[12]. Noumeiry, & Mursadin, A. (2017). Study of the factors that influence the performance of construction projects (Case Study of Building Projects in Samarinda City). *Journal of Sustainable Technology*, 2(1), 29–40.

[13]. Abdillah, W., & Jogiyanto, H. (2015). *Partial Least Square (PLS) alternatif Structural Equation Modeling (SEM) dalam penelitian bisnis*. Yogyakarta: Penerbit Andi.

[14]. Bhadania, VK, Patel, IN, Patel, VB (2020). Structural stabil-ity analysis of structure by destructive and NDT: case study of ladies hostel, Valabh Vidyanagar, Anand Cuj. *SSRG International Journal of Civil Engineering*, 7(7).

[15]. Kaelan, S., Bintoro, B. P. K., & Nugroho, R. E. (2020). Analysis of the factors causing delay in completion of light rail transit (LRT) project on Cawang-East Bekasi. *International Journal of Research and Review*, 7(10), 356–368.

[16]. Risanji, M.A., & Raflis. (2018). Analisis faktor pemeliharaan bangunan gedung terhadap kenyamanan pekerja kantor. *Potensi: Jurnal Sipil Politeknik*, 20(2): 95-102.

[17]. Wardhana, D. (2017). Faktor-faktor yang mempengaruhi pengambilan keputusan pada pemeliharaan gedung hunian vertical. *Jurnal Infrastruktur*,3(2), 1-9.

[18]. Prayudi, H., Elvira, & Nurhayati. (2016). *Penentuan prioritas penanganan pemeliharaan bangunan gedung pemerintah di kota Pontianak*. Pontianak : Fakultas Teknik Universitas Tanjungpura

[19]. Stanitsas, M. & Kirytopoulos, K.. (2021). Integrating sustainability indicators into project management : the case of construction industry. *Journal of Cleaner Production*.