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The Effect of Maintenance and Repair on the Inventory of Spare Parts in Trucking Fleet Through Maintenance Costs in Transportation Companies

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Abstract: Land Transportation Radiation Activities is a transportation company located at Marunda Center Block A, North Jakarta. The company's main activity involves renting trucks for logistics operations across Indonesia. This research employs a quantitative research approach. The findings indicate that there is an influence of the maintenance variable on inventory, as the results show that the better the maintenance carried out, the more it minimizes the occurrence of further damage, which, in turn, affects the company's spare parts inventory. The study also found an influence of the repair variable on inventory, with the positive result showing that repairs require adequate inventory. There is an influence of the maintenance variable on servicing, as the results show that good repairs minimize the occurrence of more severe damage, which can impact inventory levels. However, there is no influence of the servicing variable on inventory, as the results show that servicing costs do not occur if maintenance and repairs are not performed. Furthermore, there is no influence of the repair variable on servicing, as the repair costs are absent when a company performs good maintenance. Additionally, there is no influence of maintenance on inventory through servicing, as field data processing indicates that maintenance does not occur according to the preventive maintenance schedule, due to a high number of orders and limited time for preventive maintenance. There is also no influence of repairs on inventory through servicing, as the results indicate that repairs are quite frequent due to the lack of scheduled preventive servicing.

Keyword: Maintenance, Repair, Maintenance Costs, Spare Parts Inventory.

INTRODUCTION

Import export activities related to container transportation are carried out every day at the port, in addition to that, import export activities are increasing every year. Pancaran Darat

Transport is a transportation company located in Marunda Center Block A, North Jakarta, which has the main activity of renting trucks for logistics activities throughout Indonesia.

Based on observations, the total number of trucks operated by the transportation company used in the study was 98. The following is documentation of the truck fleet from the transportation company used in the study

Table 1. Group Emission Unit Data

No Police	Unit Description	Year Unit	Brand
KT9913LD	6x4 trailer	2018	HINO
KT8673LU	Long Chassis Tronton	2013	HINO
KT8672LU	Long Chassis Tronton	2019	HINO
KT8562ND	6x4 trailer	2020	NISSAN
KT8397LV	6x4 trailer	2020	HINO
B9415UDH	3 Way Ankle	2014	NISSAN
B9995UEL	6x4 trailer	2019	HINO
B9994UEL	6x4 trailer	2023	HINO
B9993UEL	6x4 trailer	2023	HINO
B9992UEL	6x4 trailer	2013	HINO
B9954UEK	6x4 trailer	2013	NISSAN
B9953UEK	6x4 trailer	2013	HINO
B9942TEH	6x4 trailer	2013	MARCEDES
B9941UIZ	6x4 trailer	2013	HINO
B9941TEH	6x4 trailer	2013	MARCEDES
B9937UWX	6x4 trailer	2013	HINO
B9921UWX	6x4 trailer	2013	HINO
B9919UWX	6x4 trailer	2013	VOLVO

Source: Gsheet Master Data Unit Pancaran Group

Figure 1. Fleet Units Owned by PT Pancaran Darat Transport North Jakarta

The company's fleet consists predominantly of Hino trucks, including containers, mixer trucks, and flatbed trucks. The transportation company maintains a workshop for parking, repairs, maintenance, and spare parts inventory. The following is documentation of the company's workshop

Table 2. Fleet Maintenance Schedule

Police No.	Last Service KM	Last Service Date	Next Service KM	Plan Service Date

B9560UEK	308,075	January 19, 2024	323,075	Wednesday, July 17, 2024
B9561UEK	468,855	26-Jan-24	483,855	Wednesday, July 24, 2024
B9554UVW	14,862	January 12, 2024	29,862	Wednesday, July 10, 2024
B9557UVW	15,937	January 15, 2024	30,937	Saturday, July 13, 2024
B9560UVW	14,669	January 15, 2024	29,669	Saturday, July 13, 2024
B9556UVW	14,035	January 11, 2024	29,035	Tuesday, July 9, 2024
B9552UEK	220,088	24-Jan-24	235,088	Monday, July 22, 2024
B9550UEK	336,955	06-Feb-24	351,955	Sunday, August 4, 2024

During operation, every truck must have a maintenance schedule. This maintenance is necessary because each component has a specific lifespan and therefore must be replaced. Furthermore, components must be repaired if they are found to be damaged. Broadly speaking, maintenance programs can be divided into two categories.

There are two major groups, namely preventive and corrective maintenance. Preventive maintenance is maintenance that prevents component failure before it fails. Corrective maintenance, on the other hand, is maintenance that restores a damaged component to its original condition.

There are two types of components, namely repairable and non-repairable, repairable is a component where when a damage occurs, the component can be repaired with several repair processes other than replacing the entire system. An incident when a truck experienced brake failure on the KM 88 toll road towards Bandung hit a road divider, the maintenance team carried out storage to repair the problem, brake failure usually occurs because there is air leaking in the chamber which causes the braking system to not be able to be done, so it must be repaired so that the unit is optimal again.

Table 3. Fleet Maintenance Spare Part Usage

Classification	Purchase Product	VAU	Year	Month	Grand Total
Preventive	ENGINE OIL	B9033UWY	2024	Jul	1,056,000
Preventive	ENGINE OIL	B9037UWY	2024	May	1,056,000
Preventive	ENGINE OIL	B9019UIT	2024	Feb	392,000
Preventive	ENGINE OIL	B9019UIT	2024	Jul	392,000
Preventive	ENGINE OIL	B9035UWY	2024	Jul	784,000
Preventive	ENGINE OIL	B9054UIT	2024	June	784,000
Preventive	ENGINE OIL	B9054UIT	2024	Mar	784,000
Preventive	DIFFERENTIAL OIL	B9035UWY	2024	Jul	1,189,650
Preventive	DIFFERENTIAL OIL	B9054UIT	2024	June	1,189,650
Preventive	DIFFERENTIAL OIL	B9054UIT	2024	June	396,550
Preventive	PRIMARY FUEL FILTER	B9054UIT	2024	June	239,640
Preventive	PRIMARY FUEL FILTER	B9054UIT	2024	Mar	239,640
Preventive	Grease	B9019UIT	2024	Jul	279,045
Preventive	Grease	B9037UWY	2024	May	343,750
Preventive	TRANSMISSION OIL	B9035UWY	2024	Jul	577,500
Preventive	TRANSMISSION OIL	B9054UIT	2024	June	500,500
Preventive	OIL FILTER	B9054UIT	2024	June	296,554

Source: Pancaran Group Unit Maintenance Gsheet

Non-repairableIf damaged, it must be replaced with a new component, meaning the component cannot be repaired. This is called the renewal process, where a damaged system or

component is returned to as good as new condition after being repaired. Minimal repair, a term used in preventive maintenance, means that a failed system will function again after repairs are carried out with the same conditions and effective life as at the time of the last failure.

Inventory can be defined as the stock of goods to be sold or used within a specific time period. Without inventory, a spare parts warehouse faces the risk of not being able to meet customer needs. Inventory can arise intentionally or unintentionally. Intentional inventory arises from planning to maintain inventory, while unintentional inventory also exists because goods are unsold due to low demand.

Inventory is a fundamental and phenomenal issue within a company. Inventory can be defined as the stock of goods to be sold or used within a specific time period. Without inventory, a company faces the risk of being unable to meet customer needs. Inventory is also a company asset that plays a crucial role in manufacturing operations, including raw materials, auxiliary materials, work-in-progress, finished goods, and spare parts.

Inventory shortages can result in sales interruptions, indicating that inventory is a crucial issue in a company's operations. Excessive inventory or overstocking can result in excessively high costs for storing and maintaining materials during warehouse storage, even though these items still have an "opportunity cost" (funds that could be invested in more profiTable activities). A company's goal is not to reduce or increase inventory, but to maximize profits.

Every vehicle engine has a lifespan, which can be determined by operating hours or a calendar. Maintaining a vehicle's reliability requires both regular and ongoing maintenance and upkeep.

This is because all engine elements, spare parts, and other components must be inspected and replaced. This ensures maintenance costs do not increase. This is not only the intangible assets, but also the human resources operating the truck must possess strong competencies. Poor maintenance management, lack of ownership by personnel operating the vehicle, and the lack of readily available spare parts in the spare parts warehouse will reduce the vehicle's lifespan, leading to serious damage.

The damage experienced can result in decreased vehicle productivity and other damage that can seriously impact the company's operations and operational costs. To ensure operational activities can continue and avoid significant maintenance costs, proper management is necessary to balance operational and maintenance costs.

One of the things that affects the availability and quantity of spare parts in the warehouse is the smoothness of maintenance and repairs. If the smoothness of maintenance and repairs runs well, the availability of spare parts in the warehouse can be reduced. However, if the smoothness of spare parts runs poorly, it can be ensured that the availability of spare parts in the warehouse of fast moving such as bulb leg 1, bulb leg 2, fuse, H4 lamp, battery acid water, rubber chamber, lamp cable, battery clamp, battery parallel cable, oil filter, diesel filter, watersparator filter, engine oil then slow moving such as single chamber, double chamber, upper clutch master, lower clutch master, clutch lining, dekrup, clutch bearing, brake lining, N70 battery, turn signal flasher, spiral air hose, spiral cable, original 1000 R20 tire, becomes a lot.

Lack of spare parts availability in the warehouse can make it difficult for trucking companies to meet their needs. This can lead to future costs, as damaged parts impact other parts and lead to high repair costs. In the worst case, the company can incur losses due to a lack of maintenance and repairs.

METHOD

This research uses quantitative research. Quantitative data is data presented in numerical form. The resulting numerical data serves as a reference or parameter, making it crucial for the research.(Sugiyono, 2014)The research was conducted through direct observation around the author's workplace, namely the Marunda Center Block A, North Jakarta, PT. Pancaran Darat

Transport (PDT). A preliminary study was conducted on previous research to identify theories and literature that could support the research.

In this research, it is important to have an object of study. A population is a generalization area consisting of subjects/objects with certain qualities and characteristics determined by the researcher to be studied and then conclusions drawn.(Sugiyono, 2017)The population in this study is the number of time series data for each research variable obtained from the company data of PT Pancaran Darat Transport (PDT) Marunda Center Blok A using the company's secondary data related to maintenance, repairs, spare parts inventory and maintenance costs for the trucking fleet for the last 1 year from September 2023 to August 2024. The sample is part of the number and characteristics possessed by the population. The sampling technique used is random sampling, a sampling technique in which each member of the population has an equal opportunity to be selected as part of the sample, aiming to obtain a sample from a population randomly. The sampling technique used in this study is a random sampling technique, a sampling technique using all members of the population as samples.(Sugiyono, 2017) The number of samples in this study was 98 units of company data from PT Pancaran Darat Transport Marunda Center Blok A.

The data analysis methods used in this study include descriptive statistical analysis, hypothesis testing, and path analysis. Descriptive statistical analysis is a statistical analysis used to analyze data by describing or depicting the collected data as it is without the intention of drawing general conclusions or generalizations.(Sugiyono, 2017) With descriptive statistics, the collected data is analyzed by calculating the average and percentage so that it can describe the average maintenance of the trucking fleet per day, the average repair of the trucking fleet per day, the average inventory of spare parts for the trucking fleet per day and the maintenance costs for the trucking fleet per day.

Meanwhile, to test the hypotheses in this study, partial regression analysis (Partial Least Squares/PLS) was used to test the seven hypotheses proposed in this study. Each hypothesis will be analyzed using SmartPLS 4.0 software to examine the relationship between variables. PLS 4 is a multivariate statistical technique that compares multiple dependent variables and multiple independent variables.

RESULTS AND DISCUSSION

Research Data.

The following are descriptive results for four variables: Maintenance, Repairs, Maintenance Costs, and Inventory, with weekly data for the period September 2023 to August 2024.

Table 4. Data Description

	Missing	Mean	Median	Min
X1	0.000	0.033	0.022	0.001
X2	0.000	0.028	0.017	0.004
Z	0.000	0.026	0.021	0.021
Y	0.000	0.026	0.025	0.025

Table 5. Advanced Data Description

Max	Standard Deviation	Excess Kurtosis	Skewness
X1	0.099	0.026	0.095	1,117
X2	0.098	0.024	1,593	1,601
Z	0.081	0.019	0.223	0.826
Y	0.084	0.016	2,304	1,142

Based on the data above, there are no missing values, meaning all data is valid and can be processed. The Table above also explains the Mean, Median, Min, Max, Standard Deviation, Excess Kurtosis, and Skewness values.

Research Result

The next step is to evaluate the relationship between the hypothesized variables in this study after evaluating the inner model. In this study, P-values and T-statistics are used to test the hypothesis. If the T-statistic value is >1.96 and the P-value is <0.05, the hypothesis is accepted (Andini & Surya, 2020). The hypothesis testing using SmartPLS results is shown below:

Figure 2. Graphical PLS-SEM Algorithm

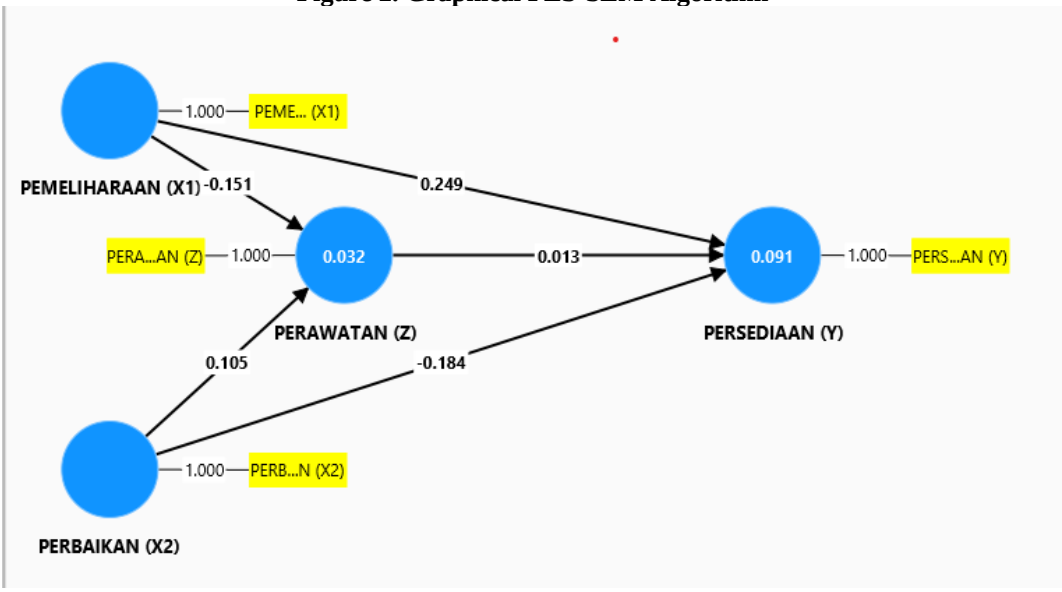

Figure 3. Graphical SEM-PLS Bootstrapping

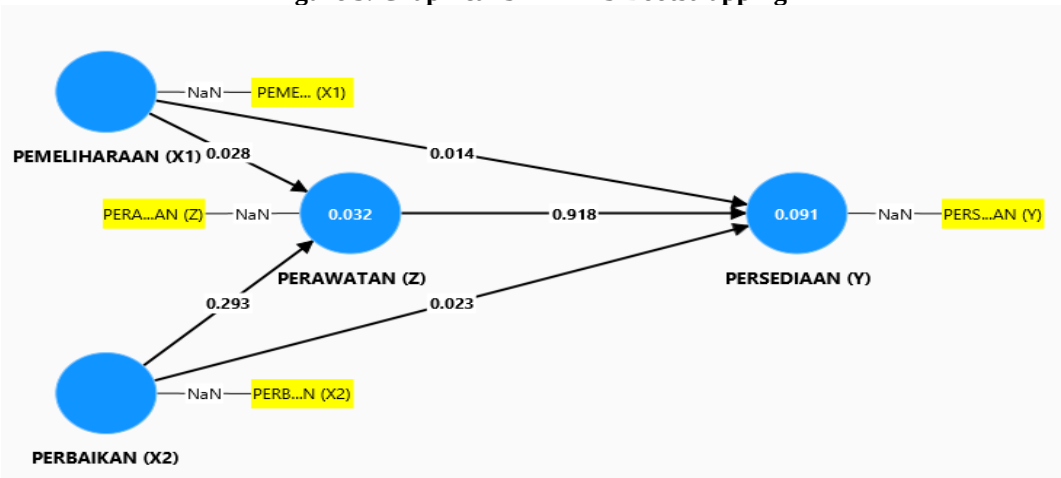

Table 6. Hypothesis Testing Results

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values

X1 -> Y	0.249	0.251	0.102	2,449	0.014
X1 -> Z	-0.151	-0.150	0.069	2,193	0.028
X2 -> Y	-0.184	-0.189	0.081	2,280	0.023
X2 -> Z	0.105	0.104	0.100	1,052	0.293
Z -> Y	0.013	0.011	0.123	0.103	0.918

Based on the Table above, it shows that the three hypotheses that have a direct influence are accepted because the T-Statistics value is > 1.96 P-Values < 0.05.

Table 7. Specific Indirect Effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
X1 -> Z -> Y	-0.002	-0.001	0.021	0.092	0.926
X2 -> Z -> Y	0.001	0.001	0.018	0.074	0.941

Based on the Table above, it shows that both hypotheses that have a direct influence are accepted because the T-Statistics value is > 1.96 P-Values < 0.05.

Hypothesis 1: Maintenance of Inventory.

Shows that the original sample value (O) is positive at (0.249) with a t-statistic value (2.449) > t-Table (1.96) and p-values (0.014) < (0.05). So it can be concluded that there is an influence between Maintenance on Inventory.

Hypothesis 2: Improvement to Inventory.

Shows that the original sample value (O) is minus (-0.184) with a t-statistic value (2.280) > t-Table (1.96) and p-values (0.023) < (0.05). So it can be concluded that there is an influence between Improvement on Inventory.

Hypothesis 3: Maintenance Costs on Inventory

Shows that the original sample value (O) is positive at (0.013) with a t-statistic value (0.103) < t-Table (1.96) and p-values (0.918) > (0.05). Therefore, it can be concluded that there is no influence between Maintenance Costs and Inventory.

Hypothesis 4: Maintenance on Maintenance Costs.

Shows that the original sample value (O) is minus (-0.151) with a t-statistic value (2.193) > t-Table (1.96) and p-values (0.028) < (0.05). So it can be concluded that there is an influence between Maintenance on Maintenance Costs.

Hypothesis 5: Improvement in Maintenance Costs.

Shows that the original sample value (O) is positive at (0.105) with a t-statistic value (1.052) < t-Table (1.96) and p-values (0.293) > (0.05). So it can be concluded that there is no influence between Repairs on Maintenance Costs.

Hypothesis 6: Maintenance of Inventory is mediated by Maintenance Costs.

Shows that the original sample value (O) is minus (-0.002) with a t-statistic value (0.092) < t-Table (1.96) and p-values (0.926) > (0.05). So it can be concluded that there is no influence between Maintenance on Inventory mediated by Maintenance Costs.

Hypothesis 7: Maintenance of Inventory is mediated by Maintenance Costs.

Shows that the original sample value (O) is positive at (0.001) with a t-statistic value (0.074) < t-Table (1.96) and p-values (0.941) > (0.05). Therefore, it can be concluded that there is no influence between Maintenance on Inventory mediated by Maintenance Costs.

Discussion

Maintenance affects inventory.

Based on the analysis results in the study, it was found that Maintenance has an effect on Inventory, this can be seen from the original sample value (O) which is positive at (0.249) with a t-statistic value (2.449) > t-Table (1.96) and p-values (0.014) < (0.05). So it can be concluded that there is an influence between Maintenance on Inventory. So it can be concluded that H0 is rejected and Ha is accepted.

This research is in line with the theory that states that According to Wang & Pham, (2006) maintenance aims to keep the existing system running properly and also to control costs for both prevention and repair if damage occurs. According to Mobley, (2011) the purpose of the maintenance program is to send roadworthy transportation facilities to the operational department according to the activity schedule. So there is a correlation that the better the maintenance carried out, the less likely it is to cause further damage, which will affect the company's spare parts inventory.

Improvements affect inventory.

Based on the analysis results in the study, it was found that Improvement had an effect on Inventory. The results showed that the original sample value (O) was minus (-0.184) with a t-statistic value (2.280) > t-Table (1.96) and p-values (0.023) < (0.05). Therefore, it can be concluded that there is an influence between Improvement on Inventory. Therefore, it can be concluded that H0 is rejected and Ha is accepted.

The results of this study are in line with According toManzini et al., (2010) Repair is the effort to restore the condition and function of an object or tool that has been damaged due to use to its original condition. Repair is a type of planned maintenance and is usually carried out comprehensively on the system, so that the system or most of the subsystems are expected to be in reliable condition.(Ansori & Mustajib, 2013) According toEbeling, (2019) Repair is an action taken when damage occurs. This theory suggests that good repairs will minimize the occurrence of more serious damage, which can impact spare parts inventory.

Maintenance Costs do not affect Inventory

Based on the results of the analysis in the study, it was found that Maintenance Costs have an effect on Inventory, showing that the original sample value (O) is positive at (0.013) with a t-statistic value (0.103) < t-Table (1.96) and p-values (0.918) > (0.05). So it can be concluded that there is no influence between Maintenance Costs on Inventory. So it can be concluded that H0 is accepted and Ha is rejected.

The results of this study are not in line with the theory according toAstuti, (2017)Costs are all expenses incurred by the firm to ensure the health of the machine before breakdown maintenance occurs, which will be used for the firm's activities. Costs are all expenses incurred by the firm to obtain production factors and raw materials that will be used to create the goods that the firm will produce.(Sukirno, 2017). The results of previous research data conducted bySiti Hafsari et al., (2020) There will be no repair costs if a company carries out maintenance properly so that the stock of repair components will not be used.

Maintenance affects maintenance costs.

Based on the results of the analysis in the study, it was found that Maintenance has an effect on Maintenance Costs, showing that the original sample value (O) is negative at (-0.151) with a t-statistic value (2.193) > t-Table (1.96) and p-values (0.028) < (0.05). So it can be concluded that there is an influence between Maintenance on Maintenance Costs. So it can be concluded that H0 is rejected and Ha is accepted.

This research is in line with the theory that states that according to Wang & Pham (2006), maintenance aims to ensure that the existing system can run properly and can also control costs for both prevention and repair if damage occurs. According to Mobley (2011), the purpose of

the maintenance program is to deliver roadworthy transportation facilities to the operational department according to the activity schedule. Therefore, there is a correlation that maintenance has an effect on maintenance costs.

Repairs do not affect Maintenance Costs.

Based on the results of the analysis in the study, it was found that Repairs had no effect on Maintenance Costs, showing that the original sample value (O) was positive at (0.105) with a t-statistic value (1.052) < t-Table (1.96) and p-values (0.293) > (0.05). So it can be concluded that there is no influence between Repairs on Maintenance Costs. So it can be concluded that H0 is accepted and Ha is rejected.

The results of this study are in line with field data. According toManzini et al., (2010) Repair is the effort to restore the condition and function of an object or tool that has been damaged due to use to its original condition. Repair is a type of planned maintenance and is usually carried out comprehensively on the system, so that the system or most of the subsystems are expected to be in reliable condition.(Ansori & Mustajib, 2013) According toEbeling, (2019) Repair is an action taken when damage occurs. The results of data processing in the field show that repairs will not occur if we carry out maintenance properly so that maintenance costs are not incurred, and the results of previous research byDewi Indah Sari, (2017)repairs do not affect maintenance costs if maintenance is not carried out properly.

Maintenance does not affect Inventory mediated by Maintenance Costs.

Based on the results of the analysis in the study, it was found that Maintenance had no effect on Inventory mediated by Maintenance Costs, showing that the original sample value (O) was negative at (-0.002) with a t-statistic value (0.092) < t-Table (1.96) and p-values (0.926) > (0.05). So it can be concluded that there is no influence between Maintenance on Inventory mediated by Maintenance Costs.

So it can be concluded that H0 is accepted and Ha is rejected.

This research is in line with the theory that states that According to Wang & Pham, (2006) maintenance aims to keep the existing system running as it should and also to control costs for both prevention and repair if damage occurs. According to Mobley, (2011) the purpose of the maintenance program is to send roadworthy means of transport to the operational department according to the activity schedule.

The results of data processing in the maintenance field do not run according to the preventive maintenance schedule because the unit receives many orders and the preventive maintenance time for periodic services is delayed so that the variable value does not meet the requirements.

Repairs do not affect Inventory mediated Maintenance Costs.

Based on the results of the analysis in the study, it was found that Maintenance had no effect on Inventory mediated by Maintenance Costs, showing that the original sample value (O) was positive at (0.001) with a t-statistic value (0.074) < t-Table (1.96) and p-values (0.941) > (0.05). So it can be concluded that there is no influence between Maintenance on Inventory mediated by Maintenance Costs. So it can be concluded that H0 is accepted and Ha is rejected.

The results of this study are in line with According toManzini et al., (2010) Repair is the effort to restore the condition and function of an object or tool that has been damaged due to use to its original condition. Repair is a type of planned maintenance and is usually carried out comprehensively on the system, so that the system or most of the subsystems are expected to be in reliable condition.(Ansori & Mustajib, 2013) According toEbeling, (2019) Repairs are actions taken when damage occurs. Data processing in the field shows that many repairs are due to inadequate preventive maintenance, resulting in the unit running out of oil, which damages the engine. This results in high repair costs and the need for overtime maintenance to

return the unit to operation.

CONCLUSION

There is a direct influence of Maintenance on the inventory of spare parts for the trucking fleet at PT Pancaran Darat Transport North Jakarta. There is a direct influence of the direct influence of Repair on the inventory of spare parts for the trucking fleet at PT Pancaran Darat Transport North Jakarta. There is no direct influence of Maintenance Costs on the inventory of spare parts for the trucking fleet at PT Pancaran Darat Transport North Jakarta.

There is a direct influence of Maintenance on the Maintenance Costs of the trucking fleet at PT Pancaran Darat Transport North Jakarta. There is no direct impact of repairs on the maintenance costs of the trucking fleet at PT Pancaran Darat Transport North Jakarta. There is no indirect effect of Maintenance on the inventory of spare parts for the trucking fleet through Maintenance Costs at PT Pancaran Darat Transport North Jakarta. There is no indirect effect of Repair of Trucking Fleet Spare Parts Inventory through Maintenance Costs at PT Pancaran Darat Transport North Jakarta

Suggestion

It is recommended to add independent variables so that all factors that influence maintenance, repair and care can be identified. It is recommended to create a QP (Quality Procedure) to improve compliance with maintenance. If the service schedule is already in accordance with the parameters but is still running, the unit will be locked and cannot generate income for the driver.

Spare parts inventory management has significant implications for managers in maintaining smooth operations and cost efficiency within an organization. Proper maintenance and optimal inventory management not only minimize downtime and maintenance costs but also help improve product or service quality, customer satisfaction, and maintain a company's competitive advantage.

Managers need to implement data- and technology-driven inventory management strategies to ensure efficient and effective processes. Well-managed maintenance has a significant impact on a company's operations and finances. Managers must be able to plan and manage maintenance activities effectively, optimize existing resources, and minimize risks. Implementing the right maintenance strategy will ensure smooth operations, extend asset lifespan, and reduce long-term costs.

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