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Effect of Preventive Maintenance, Traffic Management, Technology, Communication Support, Operator Care on OSH Performance at PT. XYZ

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Abstract

Purpose: This study aims to determine the direction and strength of the influence of traffic management on the performance of K3 transportation at PT. XYZ Mining Service Company.
Research Methodology: This study was descriptive and quantitative. The population in this study was 2145 workers and staff members working in the construction service company PT. XYZ. The sampling technique in this study is the saturated sampling technique, and the samples taken are 145 workers and staff who work in the construction service company PT. XYZ.
Results: The study found that preventive maintenance, traffic management, technology and communication support, and operator care all significantly affect the performance of K3 transportation at PT XYZ Mining Service Company.
Conclusions: The results of this study indicate that the Improvement of Unit Truck Maintenance at the Mining Service Company PT. XYZ Against Mining Accident Reduction has performed well.
Limitations: The study is limited to a single mining service company, which may affect the generalizability of the findings. The cross-sectional design also limits the ability to assess long-term impacts or account for all relevant factors such as environmental conditions.
Contributions: This research provides valuable insights into how operational factors like preventive maintenance and traffic management can improve safety outcomes in the mining transportation sector. The findings offer empirical evidence that can aid mining and construction companies in enhancing their safety management systems.

Keywords: *Maintenance, Operator Maintenance, Preventive Maintenance, Technology and Communication Support, Traffic Management*

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1. Introduction

Mining is one of the industrial sectors that can provide substantial foreign exchange. Indonesia is a country with large coal reserves, where reserves in Indonesia currently reaching 38.84 billion tons. The age of coal reserves in Indonesia is still 65 years, with an average production of 600 million tons (Hariyanto et al., 2020; Song & Wang, 2019; Varghese & Xavier, 2018). (ESDM Press NUMBER: 246.Pers/04/SJI/2021, Ministry of Energy and Mineral Resources). An increasing number of large plantation companies are engaged in oil palm plantations, and the competition between these large plantations is becoming tougher. The moratorium on oil palm plantation permits as stipulated in Presidential Instruction Number 8 of 2018 (Cabinet Secretariat of the Republic of Indonesia, 2018) dated September 19, 2018, concerning the Suspension and Evaluation of Oil Palm Plantation Permits and Increasing Productivity of Oil Palm Plantations, which is valid for 3 (three) years, preventing oil palm plantation companies from obtaining permits to add new land, making it difficult for oil palm plantation companies to expand. This encourages oil palm plantation companies to increase the productivity of oil palm plantations on plantation lands that are currently under their control.

According to Kirk-Othmer (2000), effective and efficient mining business management includes lower capital expenditure, a smaller workforce, a focus on safety culture, access to competitive financing, lower mining costs, and flexibility in mining equipment and planning. The total integration of mining teams, risk sharing, and aligning business direction can lead to sharing capital to spend on business development opportunities, such as acquisitions and exploration, fewer industry problems, and continuous improvement strategies.

BERDASAR ALAT YANG TERLIBAT		
Alat Yang terlibat	Jumlah	Persentase
DT Tronton Coal	32	28%
Exca	24	21%
OHT	23	20%
LV, Bus, Man Haul	8	7%
Water Truck	5	4%
ADT	5	4%
Dozer	4	4%
Grader	3	3%
Fuel Truck	3	3%
hammer)	2	2%
Genset	2	2%
Service / Lube Truck	2	2%
DT Tronton OB	1	1%
Total	114	100%

Figure 1. Heavy Equipment Involved in PT.XYZ

Source: Report Data PT.XYZ, 2021.

The use of heavy equipment at work plays an important role in the speed and acceleration of construction projects. The effectiveness of using heavy equipment, such as excavators, dump trucks, wheel loaders, and motor graders, can be assessed based on the productivity of these tools. Thus, planning for the selection of heavy equipment must be conducted carefully and precisely to ensure optimal effectiveness. One of the characteristics of the mining industry is High Risk. The use of high-tech equipment that operates 24 h involves many facilities and infrastructure. Safety in the mining sector is one of the points of concern to be managed (Zhironkin & Szurgacz, 2021).

The core process in coal mining includes several activities, as shown in the following figure:

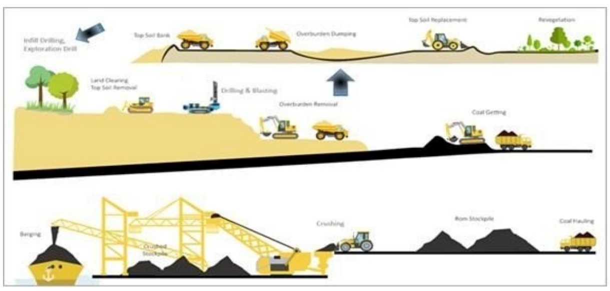

Figure 2. Coal mining process sequence (open pit)

1. Land clearing is the process of clearing forests to prepare for new mining areas. The process of land clearing is in the form of felling trees around the area, clearing up to the roots, and burning forests.
2. Peeling the top soil (Top Soil)
3. Top Soil Removal, Is the original stripping activity that will be moved to a predetermined area (Soil Bank).
4. Drilling is the first activity in rock blasting operations. This activity aims to create a blast hole that will later be filled with explosives to be detonated later. Blasting is a blasting activity that breaks up a mass that is at rest and has difficulty breaking down or breaking.
5. Excavation and Overburden Removal: It activity starts from the blasting process in the mining area and then transports the overburden material called overburden using an excavator excavated tool and then transported it using heavy equipment, namely heavy-duty trucks to the disposal area.
6. Coal Getting, Is the taking of coal in the PIT area which is ready to be loaded.
7. Coal transportation is the transportation of coal from the PIT area to the storage area.
8. Crushing is the process of adjusting the size of coal according to customer demand.
9. Barge is the process of loading coal into a transport ship.

All the coal mining processes mentioned above use heavy equipment in their operations. The types of heavy equipment units used include excavators, bulldozers, and off-highway trucks (OHTs). Poor management of mining equipment can result in the set targets not being achieved. The continuous use of heavy equipment can shorten the life of the unit, resulting in production delays and increased repair costs. To maintain the performance of heavy equipment units, a system for the inspection, maintenance, and testing of heavy equipment units is required according to the standards set by the manufacturer. In line with the previous research proposed by Alen et al. (2017), the results of designing an information system can facilitate the implementation of maintenance management and related data management. The availability of data recapitulation of damage and machine maintenance helps the head of the factory make decisions regarding maintenance activities, such as the types of components needed and the cost of repairing machines.

In supporting the activities of the Coal mining process, apart from heavy equipment units used as production equipment, and the supporting units also play a crucial role in supporting the smooth operation of the mining process. The supporting units used included the following:

1. Fuel Truck
2. Water Truck, and
3. Light Vihicle

Num	Indicator	Jul		Aug		Sep		Oct		Nov		Des	
		Actual	Theshold	Actual	Theshold	Actual	Theshold	Actual	Theshold	Actual	Theshold	Actual	Theshold
1	Death	0	0	0	0	0	0	0	0	0	0	0	0
2	KAPTK	0	0	0	0	0	0	0	0	0	0	0	0
3	Public Complain	0	0	0	0	0	0	0	0	0	0	0	0
4	TIFR	0,22	0,22	0,41	0,22	0,20	0,06	0,09	0,22	1,12	1,12	0,00	0,00
5	PDFR (dalam bahasa Inggris)	2,30	3,00	2,85	3,00	2,84	5,53	1,84	3,00	0,00	n/a	0,00	0,00
6	Pak	0	0	0	0	0	0	0	0	0	0	0	0

Figure 3. YTD Performance Index 2021

Source: Report Data PT.XYZ, 2021.

Based on the background of the above problems, PT.XYZ in the observations examined by researchers, there are still problem factors such as the increasing frequency of mining accidents involving support units, the absence of an adequate system for maintenance and repair of trucks in accordance with the manufacturer's needs on a regular basis, and the implementation of the system comprehensive mining safety management related to mining facilities, infrastructure, and equipment installation (SPIP).The problem formulation in this research is as follows:

1. Does preventive maintenance significantly affect the performance of K3 transportation in the Mining Service Company PT.XYZ.
2. Does traffic management have a significant effect on the performance of K3 transportation in the Mining Service Company, PT. XYZ.
3. Does the support of technology and communication significantly affect the performance of K3 transportation in the Mining Service Company PT. XYZ.
4. Does operator concern have a significant effect on the performance of OHS transportation in the Mining Service Company, PT. XYZ.

Based on the formulation of the problem, the research objectives are as follows:

1. To determine the direction and strength of the effect of preventive maintenance on the performance of K3 transportation at the Mining Service Company PT.XYZ.
2. To determine the direction and strength of the influence of traffic management on the performance of K3 transportation in the Mining Service Company PT. XYZ.
3. To determine the direction and strength of the influence of technology and communication on the performance of K3 transportation in the Mining Service Company PT. XYZ.
4. To find out the direction and strength of the influence of operator concern on the performance of OHS transportation by the Mining Service Company.

2. Literature Review & Hypothesis Development

2.1 Maintenance

Maintenance is also defined as an activity to maintain factory facilities or equipment and make necessary repairs, adjustments, or replacements to ensure satisfactory production operating conditions according to what is planned. It can be concluded that maintenance activities are carried out to maintain or repair equipment to carry out production activities effectively and efficiently with quality product results (Gackowiec, 2019; Pinto et al., 2020; Xiang & Chin, 2021). The maintenance system can be considered a shadow of the production system, where if the production system operates at a very high capacity, its maintenance will be more intensive (Ahmadi & Hidayah, 2017; Lumi & Yosef, 2022). The maintenance system includes the repair of damaged mechanical and electrical equipment (Ngadiyono, 2010; Parmenas, 2022). Maintenance is a combination of various actions taken to save item II-2 or repair it to an acceptable condition (Sari & Ridho, 2016).

Maintenance is an operation or activity that must be performed periodically to replace damaged equipment with existing resources (Dzulkifli et al., 2021; Nuraeni et al., 2022; Patel, 2021). Maintenance is also aimed at returning a system to its proper condition so that it can function properly, extend machine life, and minimize failures as much as possible. Maintenance management can be used to formulate policies regarding maintenance activities by incorporating technical aspects and management controls into the maintenance program. In general, the higher the repair activity in a system, the more important the need for maintenance management and control (Kusnadi & Taryana, 2016). According to Setiawan (2016) defines self-care as an activity performed in an industry to maintain or enhance the carrying capacity of the machine during the production process. Production machines that are used continuously experience a decline because they require maintenance. Optimal maintenance must be performed continuously and periodically to ensure that the machine functions optimally.

Maintenance is crucial to ensure that the machine is always in good condition and ready for use. Maintenance is a function that monitors and maintains factory facilities, equipment, and work facilities by designing, managing, handling, and inspecting work to ensure unit functions during working hours and to minimize downtime caused by damage or failure (Manzini, 2010). According to Hernawan et al. (2022) and Ngadiyono (2010), every type of maintenance activity should serve a purpose. In general, the purpose of maintenance is to maintain the condition and/or repair the machine so that it can function in accordance with business objectives. The conditions received are in accordance with the machine that is able to produce products according to standards, namely meeting the tolerances of shape, size, and function. However, in general, the main objective of maintenance is to ensure the optimal availability of the right equipment to fulfill the planned production activities and the production process can obtain maximum return on (Abidin et al., 2022; Teixeira et al., 2020; Tsarouhas, 2019). It extends the productive life of machines in the workplace and ensures the availability of all necessary equipment in the initial condition. It also ensures the safety of everyone inside and using the facilities.

According to Jono (2015) the main purpose of the maintenance system is to prevent a machine from being seriously damaged, so it does not take a long time and is also too expensive to conduct maintenance. Therefore, the machine can operate as much as possible, production activities run smoothly, and a quality product output is obtained. The main principle of the maintenance system consists of two things, namely: Suppressing (shortening) the breakdown (breakdown) period to a minimum by considering economic aspects (Djonli et al., 2020; Soesatijono & Darsin, 2021). Avoid unplanned and sudden damage. According to Subana and Sudrajat (2011), the form of treatment policy is as follows:

a. Preventive Maintenance

Preventive maintenance is performed before engine failure. This policy is sufficient to prevent unplanned machine shutdowns. The advantages of preventive maintenance policies are mainly to ensure the reliability of a system, ensure user safety, extend the life of a machine, and reduce downtime in the production process. The losses that occur include the amount of wasted operating time and the possibility of human error in the assembly process or others.

The goal of preventive maintenance is to maximize availability and minimize costs through increased reliability. Have been carried out, by carrying out preventive maintenance, the level of reliability can be increased according to the target desired by the company, which is up to 90% for the drain valve and oil filter components. In addition, the reliability of the drain valve component increased by 21.77%, and that of the oil filter increased by 33.34%. By performing preventive maintenance, it can provide lower costs than without using preventive maintenance, which can achieve cost savings of 40.13% for the drain valve component and 24.45% for the oil filter component. According to Smith and Hinchcliffe (2003), Preventive Maintenance is categorized into four types. The four categories are as follows (Smith & Hinchcliffe, 2003):

a) Time-directed (TD) maintenance is directed at preventing failure or damage.

b) Condition-directed (CD) is a treatment directed at detecting failures or symptoms of equipment damage.

c) Failure-finding is a maintenance-directed task for identifying hidden failures.

d) Run-to-Failure (RT) is a maintenance strategy based on the consideration of running a component until it fails because other options are impossible or economically unprofitable.

b. Damage Maintenance

Damage maintenance can be interpreted as a maintenance policy in which the machine/equipment is operated until it is damaged, and then repaired or replaced. This policy is a harsh and unprofitable strategy because it can lead to high costs, lost opportunities to take advantage of the company due to machine stalling, work safety is not guaranteed, machine conditions are unknown, and there is no time, manpower, and good cost planning. Advantages of the damage treatment policy:

a) Cheap and requires no maintenance.

b) Suitable for inexpensive, simple, modular machines and equipment.

c) Disadvantagegei.

d) Rude and dangerous behaviors.

e) Causes heavy losses when set on expensive and complex machines and requires a high level of security.

g) Unable to prepare human resources.

h) Scheduled Maintenance.

This maintenance aims to prevent damage and is carried out periodically within a certain time span. The maintenance time is determined based on experience, past data, or recommendations from the machine manufacturer.

1) Predictive Maintenance Predictive maintenance is also a part of preventive maintenance. Predictive maintenance can be interpreted as a maintenance strategy in which the implementation is based on the condition of the machine itself. Predictive maintenance is also called condition-based maintenance or engine condition monitoring, which means determining the condition of the machine by checking the machine regularly, so that the reliability and safety of the machine are

guaranteed.

The implementation of predictive treatment can increase the availability of pellet machines one, three, and four, where the increase ranges from 1% to 3% when compared to the previous treatment system. The reliability value for some pellet machines has increased by 20.55% for pellet 1 and 19.71% for pellet. The total cost of predictive maintenance for each critical component also decreased compared with the cost of previous maintenance. Cost savings for each critical component range from 12% to 90% of the cost of previous preventive maintenance activities.

2) Corrective Maintenance

According to Nachnul and Imron (2013), corrective maintenance is maintenance and maintenance activities carried out after the occurrence of damage to the equipment so that the equipment cannot function properly. Corrective maintenance activities include all activities required to restore a system from a faulty state to an operational state. New fixes occur when they crash, although some can be pushed back. Corrective Maintenance Activities include Preparation Time in the form of preparation of labor to carry out this work, travel, tools and test equipment, etc., and Active Maintenance Time in the form of routine maintenance work and maintenance activities. Active Maintenance time) in the form of routine maintenance activities. The purpose of the activities that have been carried out is repairs, namely waiting for damage to occur first, then repairing them so that existing production facilities and equipment can be reused in the production process so that operations in the production process can run smoothly and return to normal. According to Andrian (2010), in addition to checking for defects weekly, it is necessary to adopt a policy of reviewing all preventive maintenance programs every half year. This program review includes several aspects:

a. Review of all records, including inspection cards and equipment history cards.
b. Repair cost review.
c. Review of 'production loss' due to maintenance work.
d. Review for assurance of repair work orders and rearrangement of priority work.
e. Review of what alternatives are preceded or scheduled in advance, 'replacement' or 'dismantling'.

Preventive maintenance is an important component of maintenance activities. Preventive maintenance is a maintenance activity that is carried out before the failure or damage of a system or component, which was previously planned with systematic supervision, detection, and correction so that the system or component can maintain its functional capabilities (Kusnadi & Taryana, 2016). Preventive maintenance is a maintenance action that aims to prevent the occurrence of damage, the tendency to cause damage is known or can be predicted in advance (Praharsi et al., 2015).

The actual implementation of preventive maintenance varies significantly. Some programs are limited to lubrication and require only minor adjustments. The preventive maintenance program is more comprehensive and includes a schedule for repairing, lubricating, adjusting, and rebuilding all machinery as planned. The top priority for all preventive maintenance programs is the scheduling of guidelines (Ngadiyono, 2010). Thorough inspection and repair of a facility or part of a facility so that it reaches an acceptable standard (Andrian, 2010). In completing the work, at the end of each period, one day is added for the inspection of all units simultaneously. This is done to ensure that the order of work in each unit supports each other. Each task (job element), once started, can continue without separation, resulting in an optimal time for work completion (overhaul), including inspections. The work program can be applied to each unit separately. The work program for each unit involves all the workers concerned (Andrian, 2010).

Utilization of good preventive maintenance procedures, where there is good coordination between the production and maintenance departments, the following will be obtained (Praharsi et al., 2015): loss of production time can be minimized, expensive repair costs can be reduced or avoided, disruption to the planned schedule can be eliminated or reduced, and production and maintenance time can be eliminated or reduced. Factors for Implementing Preventive Maintenance.

The goals of preventive maintenance include early detection of failures and minimization of product failures caused by system failures. There are four basic factors in deciding the implementation of preventive maintenance Kusnadi and Taryana (2016):

1. prevent failure
2. detect failure
3. uncover hidden failure
4. do nothing because it is more effective than change

By identifying these four factors in carrying out preventive maintenance, four categories can be determined. The four categories are as follows Kusnadi and Taryana (2016):

1. Time-directed (TD) maintenance is directed to prevent failure or damage.
2. Condition-directed (CD) treatment is directed at detecting failure or symptoms of damage.
3. Failure fending (FF) is maintenance directed at finding hidden failures.
4. Run-to-failure (RTF) maintenance is based on the consideration of running a component until it fails because other options are impossible or economically unprofitable.

The implementation of preventive maintenance varies significantly. Some programs are limited to lubrication and require only minor adjustments. The preventive maintenance program is more comprehensive and includes a schedule for repairing, lubricating, adjusting, and rebuilding all machines as planned. The top priority for all preventive maintenance programs is to establish scheduling guidelines. All preventive maintenance program management assumes that the productivity of a machine will decrease over time. Prevention programs can be divided into three types (Ngadiyono, 2010):

1. Time Driver: Scheduled maintenance programs, where components are replaced based on time or distance traveled. This system is widely used by companies that use machines with components that are not expensive.
2. Prediktif: Measurements to detect the onset of system degradation (decrease in function), so it It is necessary to determine the cause of the disturbance, which will be eliminated or controlled before all of them have an impact on a significant decrease in component function.
3. Proactive: Engine repair is based on the results of engine feasibility studies. This system is widely applied to industries that use machines with expensive components.

According to Terplan, traffic management is an effort to coordinate and distribute resources to plan, analyze, evaluate, design, manage, and develop networks to obtain good service quality and optimal capacity. Network traffic management involves maintaining all network resources in good working order. According to a more modern understanding, in addition to these three traffic problems, they also include:

1. Maintenance process
2. Planning process
3. Administration process

4. Network development process

Traffic management allocates traffic to a defined LSP. These include a split function, which divides traffic into specific classes, and a dispatch function, which maps traffic into LSPs. The distribution of the load across the LSP array must be considered in this process. Generally, this is done by setting a weighting for the LSPs and traffic. This can be performed implicitly or explicitly.

Information and Communication Technology is commonly referred to as Information and Communication Technology (ICT). Information and communication technology can be defined as all technologies related to the retrieval, collection, processing, storage, dissemination, and presentation of information (Asmani, 2011).

Another opinion was expressed by according to Jono (2015) stated that information and communication technology is an interactive communication system guided by computers to store and filter text scripts, animations, and information sequences. Ananta Sannai according to Rusman et al. (2011) defines technology and communication as media or tools in obtaining knowledge from one person to another.

According to Aka (2017), Technology and Communication are inseparable counterparts that contain a broad understanding of all activities related to processing, manipulating, managing, and transferring information among media. Wawan Wardiana in Aka (2017) states that information and communication technology can also be interpreted as a tool used to process data, including processing, obtaining, compiling, storing, manipulating data in various ways to produce quality information, namely relevant, accurate and timely information.

Based on some of these understandings, technology and communication support can be interpreted as all technologies or tools that assist in the retrieval, collection, processing, storage, dissemination, and presentation of information to others. Information and communication technology has several main components that support it, including:

1. Computers (computer systems)
2. Communication
3. Skills on how to use them (Asmani, 2011)

The meaning of the word operator in the Big Indonesian Dictionary (KBBI) is "operator" someone who is in charge of maintaining, servicing, and operating equipment, machines, telephones, radios, etc.

Operators are symbols or characters used in programs to perform expressions or manipulations, such as adding up, assigning values to variables, and comparing values (operator-types-and-how-to-use-operators-in-javascrip/). An operator is someone who has the job of taking care of everything from activation to the repair of equipment. Operator becomes an important profession in an industry or company. The operator is the person who will carry out and take care of all the needs of the system operations (Peruzzini et al., 2020).

The definition/definition of OSH (Occupational Safety and Health) is generally divided into 3 (three) versions of which are the notion and definition of OHS according to Philosophy, understanding and definition of OSH according to Science and understanding and definition of OHS according to the OHSAS 18001:2007 standard (Adzim, 2013).

The definition of Occupational Health and Safety (OHS) Management according to the ISO 45001:2018 standard is a management system or part of a management system that is used to fulfill the OHS Policy or part of an organization and company management system that is used to develop and implement an OHS Policy and manage risks. OHS organizations and companies.

According to Mangkunegara (2002), occupational safety and health is a thought and effort to ensure the integrity and perfection of both physical and spiritual workers in particular, and humans in general, the results of work and culture towards a just and prosperous society. Vehicle and Equipment Management is one of the elements related to vehicles and equipment; vehicle equipment and vehicle maintenance to carry out FUEL distribution and related activities, which is also one of the Ministerial Regulations No. 5 of 1996 performance pillars in the Land Transportation Safety Management System (SMKTD). The Vehicle and Equipment Management Pillar includes the following elements:

Vehicle Management
Systems to ensure that all vehicles match the products stored, handled, and transported:

1. There is a policy to review if there is a vehicle modification
2. Vehicle complies with statutory regulations and minimum standards
3. The vehicle is maintained to keep it in good condition and ready to use
4. according to the manufacturer's recommendations
5. Determination of technical qualifications
6. Determination of the qualifications of personnel who carry out maintenance, maintenance, and repairs as well as modifications in accordance with the required qualifications

Safety Equipment

1. Implementation of safety equipment policies
2. Provision of personal protective equipment and protective clothing to all drivers
3. The minimum list of personal protective equipment meets these requirements
4. There is a schedule of periodic equipment inspections, to ensure the equipment is fit for use and does not expire
5. These tools are readily available and easily accessible to researchers

The term "truck" includes conventional rear-dump trucks, tractor-trailer trucks, and integral bottom-dump trucks. In general, the shovel-truck mining method is the most flexible mining method used in geologically complex deposits with varying depths and overburden thicknesses and smaller deposits (Burke, 2011).

The flexibility of the system and the ability to haul over long distances make the truck shovel mining method the preferred method of mining in almost any mining situation (Zeng et al., 2017).

A shovel truck mining system generally consists of a shovel and an associated fleet of trucks. The various grades and waste are loaded onto trucks with shovels and transported from the loading site to a crusher or landfill. Operating truck productivity depends on the actual truck load and cycle time. The truck cycle includes loading and searching, loaded hauling, dumping, empty hauling, waiting, and other operational delays (Zeng et al., 2017).

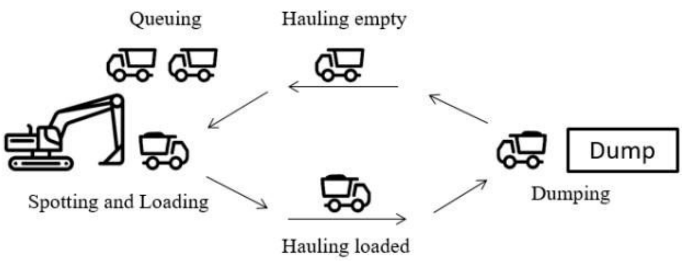

Figure 4. Cycle Rotation Truck

The truck cycle operational constraints are as follows:

1. Spotting dan loading: Spotting is the process by which the truck maneuvers into a loading position. Loading is the process of loading mining products onto trucks. The collection of materials into buckets and then unloading of materials onto trucks is called a pass cycle. Several passes are usually required to load a truck. The viewing time of the truck is affected by the loading method. There are usually four loading methods:
   (a) In the double-sided loading technique, trucks are sighted and loaded alternately on both sides of the shovel. The spade had a maximum swing of 90°. Sufficient workspace on the back and on both sides of the shovel should be ensured.
   (b) One-sided loading technique The truck is spotted and loaded onto one side of the shovel with a maximum swing of 90°. The second truck cannot be seen and loaded until the first truck is pulled out of the shovel; therefore, compared to double-sided loading, productivity is reduced.
   (c) Load driving technique, The shovel track is parallel to the face and the truck (tractor-trailer truck) travels to the access road and stops near a shovel. Once loaded, the truck passes through the shovel. The shovel had a maximum swing of 180°.
   (d) Modified Ride loading technique, The shovel path is parallel to the work surface and when the truck drives under the shovel swing path, the shovel is dumped before the truck stops, and the truck reverses and stops near the work surface. The spade has a maximum swing of 120°.
2. Travel includes transporting the loaded material to the dump site and back empty to the loading location. Travel time is subject to the following limitations:
   (a) Transport routes, including haul route length, slope, rolling resistance, and road conditions
   (b) Operational constraints such as speed limits and clustering
   (c) Operator performance
3. Dump: This is the process by which the truck unloads the load at the designated dumping site. There are three disposal methods:
   (a) Rear exhaust
   (b) Lower debit
   (c) Side and rear exhaust

   Off-road trucks can be classified into three main types:
   (a) Conventional rear dump trucks

(b) Tractor-trailer, bottom, side, and rear dump trucks

(c) Integral bottom dump trucks

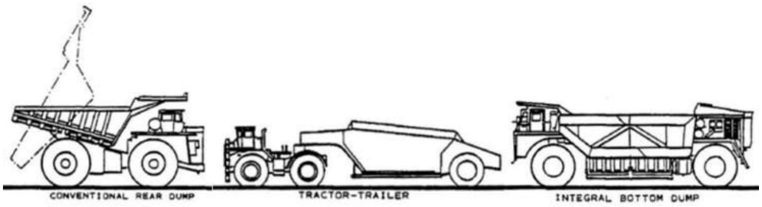

Figure 5. Truck Model

4. Waiting: When a truck reaches a loading or unloading location, it must wait in a queue if the loading or dumping site is occupied by another truck. This generally occurs when the resources (e.g., shovels and crushers) in the hauling system do not match the allocated trucks. Some of the factors that can cause waiting times are as follows:

    (a) Over-trucking (Over-trucking), When the capacity of trucks in the system exceeds the loading and/or dumping capacity, truck queues are formed, and truck waiting times increase. This can occur system-wide or at specific loading and/or dumping sites. The number of trucks, for example, may exceed the capacity of all shovels in the system, or the number of trucks allocated to one shovel may exceed the capacity of this shovel. In the latter case, the waiting time can be reduced by allocating the truck to an unused shovel.

    (b) Group (Bunching), The distance between haul trucks is reduced because of the mixing of trucks with varying capacities (Zeng et al., 2017). This is because overtaking is not allowed on most landmines. During transportation, the phenomenon of faster trucks following slower trucks causes the trucks to pile up on the track.

    (c) Equipment mismatch, This occurs when a shovel truck system has equipment of various sizes with varying performance characteristics; for example, small and large trucks in the same fleet result in different truck cycle times.

    (d) Operator performance and shovel performance vary greatly depending on the operator (Patnayak et al., 2008), with operator experience leading to variations in truck cycle times. It is estimated that by optimizing shovel performance, mines can save as much as 125 min per shovel per 20h a day (Fiscor, 2007).

    (e) Weather conditions, Weather conditions such as rain or snow may result in poor equipment performance, and delays in operation.

5. Delays, There are two types of operational delays that reduce the productive yield of equipment (Zeng et al., 2017):

    (a) Fixed delays are planned and usually not considered truck cycle time delays and include reasons such as shift changes, equipment inspections, operator breakdowns, refueling, and blasting. Shift changes are an important factor affecting the efficiency and productivity of shovel–truck systems. Operator performance varies among shifts.

    (b) Delays are caused when trucks are hauled into the parking lot for shift operator changes (Krause, 2006). The decision to assign trucks to either the shovel or the parking lot towards the end of a shift can impact shift production (Bastos, 2013). However, hot seat switching

(Burke, 2011), where a truck driver is immediately replaced with another worker at the end of a shift, has become common practice in the mining industry to prevent production stoppages.

(c) Variable delays are unpredictable and must be considered in truck cycle times, including maintenance, load class disturbances, stops, and equipment breakdowns.

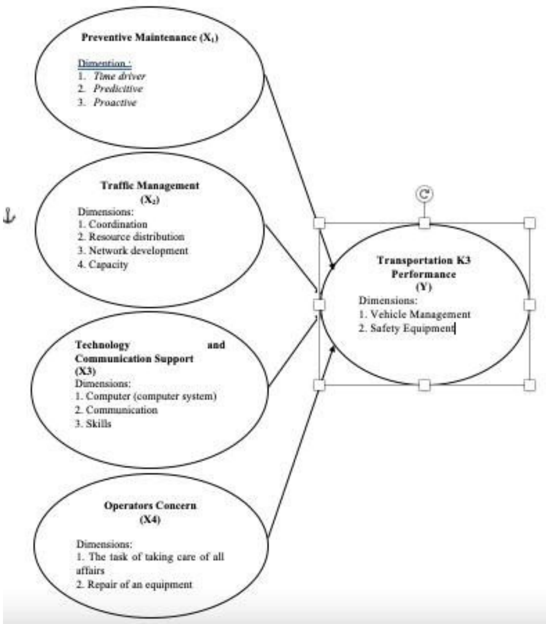

Figure 6. Framework Research

2.2 Hipotesis Penelitian

Berdasarkan landasan teori dan penelitian terdahulu yang telah diuraikan, maka hipotesis dalam penelitian ini dirumuskan sebagai berikut:

H_1: Preventive maintenance has a significant positive effect on the performance of transportation OHS in PT.XYZ Mining Service Company.

H_2: Traffic management has a significant positive effect on the performance of transportation OHS in PT.XYZ Mining Service Company.

H_3: Technology and communication support has a significant positive effect on the performance of transportation OHS in PT.XYZ Mining Service Company.

3. Methodology

The research method used was quantitative. Of the two types of quantitative methods (experimental method and survey method), this research uses a survey method. The data analysis technique used in this study is a qualitative data analysis technique with the aim of providing a systematic, accrual, and accurate description of the phenomenon under study.

3.1 Research Design

This study employs a descriptive quantitative research design. The research was conducted using a survey method, with the aim of examining the relationships between preventive maintenance, traffic management, technology and communication, and operator care on OHS performance in the mining service industry. Data were collected through structured questionnaires distributed to employees working in PT XYZ Mining Service Company, which provided the basis for hypothesis testing and statistical analysis.

3.2 Data Collection

Data for this study were collected through a structured questionnaire survey administered to 145 employees at PT XYZ Mining Service Company. The respondents included workers and staff who are directly involved in transportation and maintenance operations. The sample was selected using a saturated sampling technique, where all available workers were included in the study. This ensured that the sample adequately represented the workforce involved in the key processes under investigation.

3.3 Data Analysis

Data were analyzed using t-tests to examine the effects of the independent variables (preventive maintenance, traffic management, technology and communication, operator care) on the dependent variable (OHS performance in transportation). The results were validated with a significance level of 0.05, and the hypotheses were tested based on whether the t-statistic exceeded the critical value of the t-table. The analysis revealed that all independent variables had a significant effect on OHS performance.

4. Results and Discussion

4.1 Results

The respondents by gender are presented in the following table:

Table 1. Employee Composition by Gender

Man	**Woman**	**Total**
125 years	20 years	145 years
Total		145

Based on these results, there were 125 male and 20 female employees. This can be explained by the fact that, in general, the employees of PT.XYZ Mining Services Company are dominated by men. Gender can affect employees' perceptions. Effect of Preventive Maintenance on Occupational Health and Safety Performance in Transportation The results of the study indicate that Preventive Maintenance has a partial effect on the performance of K3 Transportation, as evidenced by the t-test value of the Preventive Maintenance variable of 4.618 with a significance level of 0.000. While the ttable value for $N = 145$ is 1.976. Therefore, $tcount > ttable$ $(4,618 > 1,976)$ with a significance of $0.000 < 0.050$, then H_0 is rejected and H_a is accepted, it can be stated that Preventive Maintenance $(X1)$ has a positive and significant effect on Transportation K3 Performance (Y).

In this study, Preventive Maintenance has a significant effect on the performance of K3 Transportation, this study is in accordance with previous researchers Dewi and Purnawati (2021) the research results indicate a maintenance role that can strengthen the influence of TQM on company performance. This research is supported by the theory proposed by Doloi et al. (2011) that the success of a project is strongly influenced by the expertise and performance of the contractor. Other than human resources, the factors that have a significant influence are materials and equipment. The selection and utilization of equipment must be in accordance with the needs in terms of type, quantity, capacity, and time available. Likewise, the use of the equipment must follow operating and maintenance procedures that are in accordance with the function of each piece of equipment. Construction management components, including contractors, consultants, PPK, materials, and equipment, significantly influence the achievement of flexible pavement preventive maintenance quality. Therefore, comprehensive management of construction components is required.

4.2 Discussion

4.2.1 The Effect of Traffic Management on OHS Performance in Transportation

The results of the study indicate that Traffic Management has a partial effect on the performance of K3 Transportation, as evidenced by the t-test value of the Traffic Management variable of 2.496 with a significance level of 0.014. The ttable value for $N = 145$ is 1.976. Therefore, $tcount > ttable$ $(2,496 > 1,976)$ with a significance of $0.014 < 0.050$, then H_0 is rejected and H_a is accepted, it can be stated that Traffic Management $(X2)$ has a positive and significant effect on Transportation OHS Performance (Y).

In this study, Traffic Management had a significant effect on Transportation K3 Performance, which is in accordance with the findings of (Bau et al., 2020). This study resulted in a new traffic management plan for the Losari area, which improved traffic conditions. The observed road sections had a service level of A, which means that the New Traffic Management implemented succeeded in reducing the potential for congestion in the area.

This research is supported by the theory proposed by Widowati (2017) that the results of monitoring and review must be properly recorded, documented, and reported to both internal and external stakeholders and used as input for further planning. In line with this, systematic monitoring and evaluation can improve the quality of data related to traffic accidents so that they can be used as a reference to improve safety programs in the future (Varhelyi, 2016). Monitoring and evaluation of traffic safety implementation are conducted through internal audits and periodic reviews of the traffic safety system to ensure continuous improvements.

4.2.2 Effect of Technology and Communication Support on Transportation K3 Performance

It is known that the results of the study indicate that Technology and Communication Support has a partial effect on OHS Transportation Performance, as evidenced by the t-test value of the Technology and Communication Support variable of 4.665 with a significance level of 0.000. The ttable value for $N = 145$ is 1.976. So $tcount > ttable$ $(4,665 > 1,976)$ with a significance of $0.000 < 0.050$ then H_0 is rejected and H_a is accepted, it can be stated that technology and communication support $(X3)$ positively and significantly affects Transportation K3 Performance (Y).

In this study, Technology and Communication Support had a significant effect on Transportation K3 Performance, which is in accordance with the results of (Jati, 2014). Each region faces problems with distinctive characteristics; therefore, the way the program is implemented Road transportation safety varies according to the complexity of the problem. Meanwhile, technology and communication support positively influence employee performance.

This research is supported by the theory put forward by Mangkunegara (2002) Occupational safety Health is a thought and effort to ensure the integrity and perfection of physical and spiritual work in particular, and humans in general, work results, and culture towards a just and prosperous society. According to Hariandja (2007), K3 is an important aspect of efforts to improve employee welfare and productivity. Technology is one of the best innovations developed by humans, greatly facilitating human life in carrying out its activities. Communication is a reciprocal activity carried out by individuals or groups with the help of the media or directly face-to-face.

4.2.3 *The Effect of Operator Care on Transportation OHS Performance*

The results of the study indicate that Operator Care has a partial influence on the performance of K3 Transportation, as evidenced by the t-test value of the Operator Care variable of 3.015 with a significance level of 0.003. While the ttable value for $N = 145$ is 1.976. Therefore, $tcount > ttable$ $(3{,}015 > 1{,}976)$ with a significance of $0.03 < 0.050$, then H_0 is rejected and H_a is accepted, it can be stated that Operator Care $(X4)$ has a positive and significant effect on OHS Transportation Performance (Y).

In this study the operator's concern has a significant effect on the performance of K3 Transportation, this study is in accordance with previous researchers Benny Agus Setiono, (2018) The results of the analysis show that there is a caring attitude from the management of PT Pelindo III East Java Province towards employee safety and the availability of adequate safety equipment. This study was supported by the theory proposed by BPSDM (2012). One of the individual tasks that impact the interests of the group is the implementation of K3-L so that each group member has been equipped with an attitude of concern for the implementation of K3-L in the workplace.

5. Conclusions

The author draws conclusions from the results of research or writing this research. The conclusions of this study are as follows:

1) There is an effect of preventive maintenance on the performance of K3 transportation, with the The $tcount$ value of the Preventive Maintenance variable was 4.618, with a significance level of 0.000. Therefore, $tcount > ttable$ $(4{,}618 > 1{,}976)$ with a significance of $0.000 < 0.050$.
2) There is an effect of traffic management on the performance of K3 transportation, with the $tcount$ value of the Traffic Management variable of 4.665, with a significance level of 0.000. So $tcount > ttable$ $(4{,}665 > 1{,}976)$ with a significance of $0.000 < 0.050$.
3) There is an influence of Technology and Communication Support on the performance of K3 transportation, with a $tcount$ value of 4.665 and a significance level of 0.000. While the $ttable$ value for $N = 145$ is 1.976. So $tcount > ttable$ $(4{,}665 > 1{,}976)$ with a significance of $0.000 < 0.050$.
4) Operator concern affects OSH transportation performance, with an operator concern variable $tcount$ of 3.015 and a significance level of 0.003. While the $ttable$ value for $N = 145$ is 1.976. Therefore, $tcount > ttable$ $(3{,}015 > 1{,}976)$ with a significance of $0.03 < 0.050$.

The results of this study indicate that the Improvement of Unit Truck Maintenance at the Mining Service Company PT. XYZ Against Mining Accident Reduction has performed well. This implies that Improved Maintenance of the Truck Unit plays a very important role in achieving the goal of Reducing Mining Accidents. Through the right strategy, it is expected that the performance of K3 transportation can be improved in accordance with the goal of Reducing Mining Accidents.

5.1 Research Limitations

This study has several limitations. First, it is limited to a single mining service company (PT.XYZ), which may restrict the generalizability of the findings to other companies within the industry. Second, the sample size (145 respondents) may not fully capture the diversity of perspectives across the entire workforce. Third, the study focuses on selected variables, including preventive maintenance, traffic management, technology and communication, and operator care, which might not account for other influencing factors such as environmental conditions and regulatory changes. Lastly, the study's cross-sectional nature limits the ability to draw conclusions regarding long-term impacts of these factors on OHS performance.

5.2 Suggestions and Directions for Future Research

Future research could expand the sample size to include multiple mining companies to improve the generalizability of the findings. Additionally, it would be beneficial to examine the long-term effects of preventive maintenance, traffic management, and technology on OHS performance through longitudinal studies. Future studies could also explore other factors influencing safety performance, such as organizational culture, employee training, and environmental factors. Furthermore, employing advanced statistical techniques like Structural Equation Modeling (SEM) could provide deeper insights into the relationships between these variables.

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Author Contributions

RH contributed to conceptualization and methodology, contributed to data collection, writing of the original draft, and validation. AH contributed to data analysis and supervision, writing—review and editing, and both authors provided final approval of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest in the conduct and publication of this research. The study was conducted independently, and the authors have no financial or personal interests that could influence the results of the study.

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