CHAPTER 9
CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

From the analysis and the design of the system made in this project, the key problem encountered by PT XX was failure to achieve the planned production target caused by low fleet availability that led to low Effective Working Hours (EWH). The key issues affecting the company were related to low Physical Availability (PA), low target achievement in terms of Mean Time Between Failures (MTBF), excessive downtime, and losses due to maintenance and environmental issues. The MTBF achieved from previous performance stood at 38 to 61 hours, well below the targeted company performance level of 72 hours, while operational losses attributed to downtime and weather conditions accounted for 53% in 2023 and 47% in 2024.

After analysing the spare parts inventory, the research identified the optimal EOQ and ROP for each fleet based on the company's minimum acceptable service level of 95%. Following the recalculation of demand and inventory parameters based on the new maintenance scheduling system, the final cluster-based configurations were selected for each fleet. For the 777E fleet, ROP 3, 7, and 11 with EOQ 4, 14, and 26 across Cluster 1, 2, and 3 achieved an average service level of 98.15%. For the HD 785-7 fleet, ROP 4, 4, 6, 12, and 20 with EOQ 6, 6, 12, 26, and 46 across Cluster 1 through 5 achieved an average service level of 95.34%. For the 777 fleet, ROP 4 and 6 with EOQ 8 and 17 across Cluster 1 and 2 achieved an average service level of 95.83%. The implementation of these cluster-based inventory parameters, combined with the proposed inventory SOP and reorder mechanism, contributed to improving spare part availability and reducing operational downtime caused by stock shortages.

On the maintenance side, the research moved from the traditional inflexible 250 HM schedule to a reliability-focused approach driven by production needs, guided by the Ceiling 20 Policy. This schedule was tested through a stochastic discrete-event simulation replicated 240 times. Within the asset-specific scope, the CAT 777E fleet showed the most significant gain, with a 26.79% increase in EWH and a 19.51% increase in BCM, fully addressing the existing production gap. The bottleneck loading unit, PC1250SP-8R, saw a 9.67% increase in EWH and a 9.83% increase in BCM, while the HD 785-7 fleet improved by 0.87% in EWH and the CAT 777 fleet improved by 5.59% in EWH and 4.52% in BCM. Aggregated across the full fleet of 35 HD 785-7, 6 CAT 777, and 22 CAT 777E units, these gains produced a total production surplus of 137,753.71 BCM, with a 12-month simulation-to-plan ratio of 98.489%.

When the optimized maintenance scheduling and the updated cluster-based inventory service levels were integrated, the combined effect generated a total production improvement of 133,639.29 BCM/month, equivalent to 386.16 BCM/hour across the hauler fleet. This integration raised total hauler production capacity from 4,121.28 to 4,507.44 BCM/hour before any rental adjustment, though this still reach the 4,621 BCM/hour target. Once the fleet rental decision was optimized around this improved baseline, the required rental cost dropped from Rp 2,293.50 million to Rp 1,660.50 million per month, saving Rp 633 million per month, while still meeting production requirements with fewer rented hauler units.

The final simulation results confirm that the integrated system closes the production gap effectively. Loader achievement improved from an average of 81.19% to 100.13% after the rental decision. For the hauler fleet, integrating the maintenance and inventory improvements alone raised average achievement from 90.09% to 97.77% before any rental adjustment, and after the rental decision was applied, production achievement reached 100.58% before integration and 100.22% after integration, confirming that the monthly production target is consistently fulfilled with a leaner rental requirement.

9.2 Recommendations

Based on the findings and limitations identified in this study, several recommendations are proposed for PT XX as well as for future research development.

9.2.1 Recommendations for PT XX

Based on the results of this research, several recommendations are proposed for PT XX to support the implementation and sustainability of the designed fleet management system.

First, PT XX is recommended to gradually implement a data-driven maintenance management system by integrating maintenance history, breakdown records, spare part usage, and operational data into a centralized database. Better data integration will help the company improve maintenance planning accuracy, monitor fleet performance more effectively, and support faster decision-making.

Second, the company is advised to improve spare part inventory management by prioritizing critical spare parts and implementing a more structured reorder policy. Monitoring spare part lead time, stock levels, and usage patterns regularly can help reduce maintenance delays caused by spare part shortages and minimize unnecessary inventory costs.

Third, PT XX should strengthen preventive maintenance practices by regularly evaluating MTBF and MTTR performance for each fleet type. Maintenance schedules should be adjusted based on actual operating conditions and historical failure patterns so that equipment breakdowns can be reduced before causing major downtime.

Fourth, PT XX should adjust the production plan and rental decision with the consideration of the rainfall event. The EWH will decrease because of rain, and it is something that can not be prevented. So, in order to achieve the production target, the production capacity should be increased by renting fleet based on the necessity.

In addition, coordination between departments such as maintenance, production, engineering, warehouse, and PKPP should be improved through better communication and standardized operational procedures. Stronger coordination can reduce delays in maintenance execution, improve fleet readiness, and support smoother operational activities.

The company is also encouraged to optimize the use of operational dashboards and visualization systems. Dashboard improvements should focus on displaying important operational indicators such as downtime trends, fleet availability, maintenance status, rainfall impact, and production achievement in a more compact and user-friendly format to support real-time monitoring. Lastly, PT XX is recommended to continuously evaluate the effectiveness of the implemented system through periodic performance reviews and operational audits. Continuous evaluation will help the company identify new operational issues, improve system adaptability, and maintain long-term operational performance improvements.

9.2.2 Recommendations for Future Research

This research focuses on designing a fleet management system to improve physical availability and effective working hours in coal mining operations. However, several limitations still exist, especially regarding data availability, simulation scope, and operational variability. Therefore, future research is recommended to expand and improve the current study in several aspects.

First, future studies can develop a more advanced predictive maintenance system by integrating real-time monitoring technologies such as Internet of Things (IoT) sensors and machine learning models. In this research, preventive maintenance scheduling is mainly based on historical breakdown and maintenance data. Real-time condition monitoring may provide more accurate failure prediction and support faster maintenance decision-making.

Second, future research can include a more comprehensive simulation of fleet operations by considering dynamic operational variables such as fuel consumption, operator performance, traffic conditions in hauling roads, and equipment interaction between loading and hauling units. This study mainly focuses on maintenance, spare part inventory, and fleet allocation aspects, therefore broader operational variables may provide a more holistic system evaluation.

Third, future researchers are encouraged to evaluate the economic impact of the proposed fleet management system in greater detail. Cost-benefit analysis, investment feasibility, and long-term operational savings can be analysed to measure the financial effectiveness of implementing the proposed system in mining companies.

In addition, future studies may explore the integration of dashboard visualization and decision-support systems into a single digital platform. Since the current research identifies limitations in data visualization and monitoring effectiveness, further development of an interactive and real-time dashboard could improve coordination, monitoring speed, and managerial decision-making.

Lastly, future research can validate the proposed system implementation over a longer observation period and across different mining sites or fleet types. A broader implementation scope may help evaluate the consistency, scalability, and adaptability of the system under different operational and environmental conditions.

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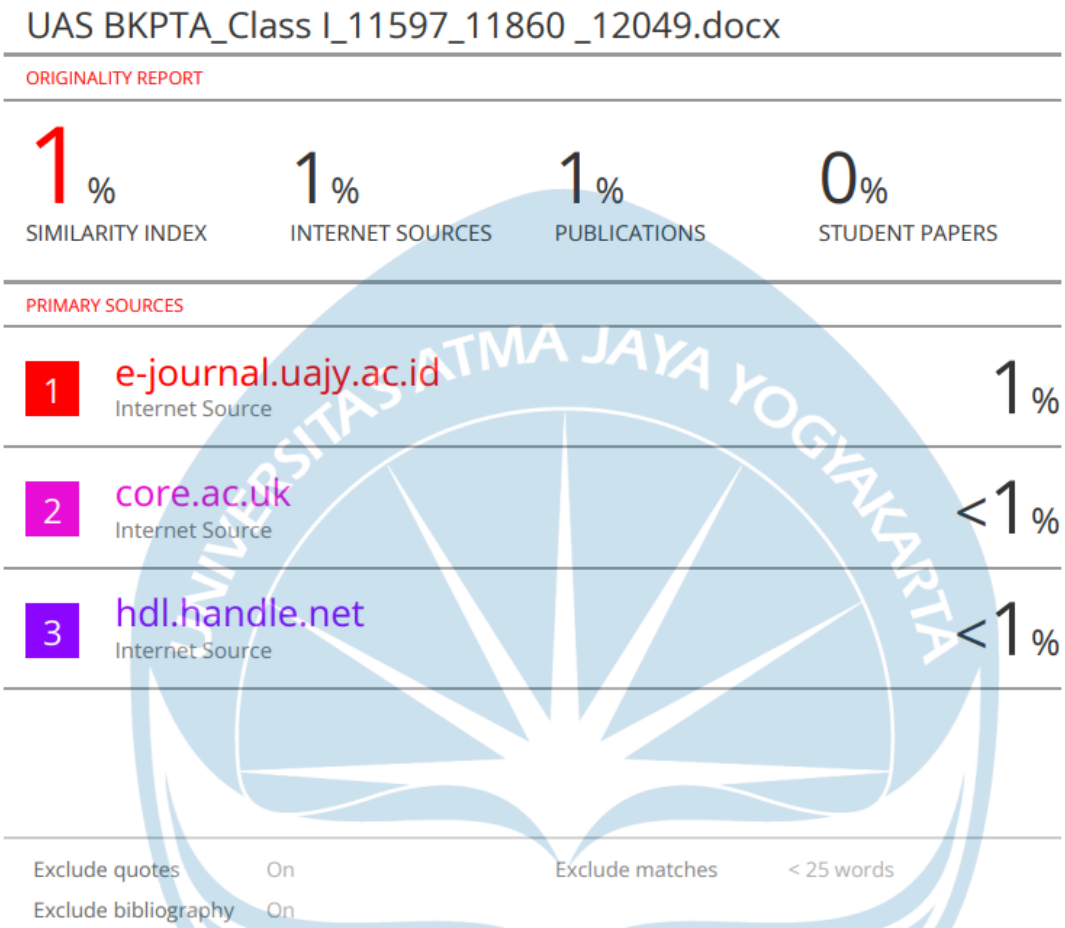
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LIST OF APPENDIXES

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Appendix 2 Letter of Approval from the company

Mining Solution

Tanjung Enim, 16 September 2025

Nomor : 265/SBS-HO/SDMS/IX/2025
Lampiran : 1 (satu) Berkas
Hal : Pemintaan Penempatan Siswa PKL

Kepada Yth,
Manajer Perencanaan Tambang
Di –
Tempat

Dengan hormat,
Merujuk pada nomor surat **417/V.4/2025** perihal Persetujuan Balasan Permohonan Praktek Kerja Lapangan (PKL) Universitas Atma Jaya Yogyakarta yang di laksanakan pada Dept. Perencanaan Tambang. Adapun informasi mahasiswa/i sebagai berikut :

No	Nama	Jurusan	Waktu Kegiatan	Penempatan
1.	Sindi Artania	Teknik Pertambangan	11 Agustus 2025 s.d 30 April 2026	Perencanaan Tambang
2.	Gabriella Amanda Ayu N			
3.	Christoforus Ariffianto R			

Peserta PKL dilengkapi dengan APD dan SIB yang sudah dikeluarkan oleh PTBA. Selama magang perserta PKL wajib mengikuti peraturan yang ada di Perusahaan. Kegiatan PKL dimulai dari pukul 07.00 s.d 16.00 WIB dan peserta PKL menggunakan Identitas Universitas Atma Jaya Yogyakarta. Untuk kelancaran dalam proses magang kami mohon untuk memberikan pembimbing ke peserta PKL.

MANAJER SDM STRATEJIK

Mining Solution

PAMUJI PANCA PUTRA

Tembusan :
1. Arsip
2. SM SDM Umum & MSI
3. Project Manajer Unit Banko

PT SATRIA BAHANA SARANA
Mining Solution
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Muara Enim - Sumatera Selatan 31716
Tlp +62734 453035 Fax +62734 453039

Appendix 3 Commitment statement from all team members

STATEMENT LETTER OF FINAL PROJECT IMPLEMENTATION
AS *A CAPSTONE DESIGN PROJECT* IN GROUPS

We undersigned the following:

No	Student Name	Student ID
1	Sindi Artania	221411597
2	Gabriella Amanda Ayu Narasitha	221411860
3	Christoforus Ariffianto Roesmarjati	221412049

It is hereby stated that we will carry out the **Final Project in the form of *a Capstone Design Project*** in **groups**, with the proposed title/topic:

Designing Fleet Management System to Increase Effective Working Hours By 25% At PT XX

Our statement of commitment is as follows:

1. Each member of the group carries out the Final Project collaboratively, professionally, and responsibly in accordance with the applicable academic rules at the Department of Industrial Engineering FTI UAJY.
2. Each member of the group is responsible for making a proportionate contribution and carrying out tasks according to the agreed division of roles.
3. Each member of the group carries out the entire process in accordance with the applicable provisions in the Department of Industrial Engineering FTI UAJY and upholds academic integrity.
4. If in the future there is a violation of academic provisions or inconsistency in the performance of duties, we are willing to accept sanctions in accordance with the regulations set by the Department of Industrial Engineering FTI UAJY.

Thus, this statement letter is made correctly to be used as it should be.

Yogyakarta, 19 Desember 2025

Signature



Sindi Artania
Student ID: 221411597



Gabriella Amanda Ayu Narasitha
Student ID: 221411860



Christoforus Ariffianto Roesmarjati
Student ID: 221412049

Appendix 4 SOP Spare Part Ordering and Stock Control

STANDARD OPERATING PROCEDURE

Spare Part Ordering and Stock Control

HD757 | Caterpillar 777 | Caterpillar 777E

Document Number	**SOP-INV-001**
Effective Date	21 April 2026
Title: Standard Operating Procedure -Spare Part Ordering and Stock Control	
Revision	Rev. 00
Status	**ACTIVE**
Normative Reference	ISO/TR 10013:2001
Prepared By	Inventory / Warehouse Supervisor
Approved By	Maintenance / Procurement Manager

CONTROLLED DOCUMENT -ISO/TR 10013:2001 Cl. 6.5 -This document is valid only when bearing an original signature or 'CONTROLLED' stamp. Copies without such marking are uncontrolled and shall not be used as operational references.

Table of Contents

1. Scope
2. Purpose
3. Normative References
4. Terms and Definitions
5. Responsibility and Authority
6. Risk Classification and Stock Policy
   6.1 Inventory Parameters in Effect
7. Multi-Item Ordering Policy
   7.1 Core Principle
   7.2 Order Quantity Logic (Qorder)
   7.3 Emergency Procedure (Stockout of CRITICAL Part)
8. Description of Activities
9. Stock Reference Data by Equipment Unit
   9.1 Unit HD757
   9.2 Unit Caterpillar 777E
   9.3 Unit Caterpillar 777
10. Performance Indicators (KPI) and Monitoring
11. Records
12. Internal Audit and Continual Improvement
13. Appendices
   Appendix A -Order Quantity Adjustment Example
14. Revision History
15. Document Approval

UNIVERSITAS ATMA JAYA YOGYAKARTA

1. Scope

ISO/TR 10013:2001 Reference -Section 4.5.2.3 -Scope
The scope of the documented procedure, including the areas to be covered and areas not to be covered, should be described.

This Standard Operating Procedure (SOP) defines the requirements, methods, responsibilities, and records for the ordering and stock control of spare parts used in the maintenance of heavy equipment units HD757, Caterpillar 777, and Caterpillar 777E.

This procedure covers:

- All spare parts registered in the inventory system for units HD757, Caterpillar 777, and Caterpillar 777E.
- Stock monitoring, demand planning, purchase request and purchase order processing, goods receipt, system update, and monthly review activities.
- All personnel involved: Warehouse Officer, Warehouse Supervisor, Inventory Planner, Procurement Department, Quality Control, and Maintenance Manager.

This procedure does not cover:

- Spare parts for equipment units not listed above.
- Capital expenditure procurement not related to inventory replenishment.
- Supplier qualification and evaluation

2. Purpose

ISO/TR 10013:2001 Reference -Section 4.5.2.2 -Purpose
The purpose of the documented procedure should be defined.

This procedure is established to:

- Ensure adequate availability of spare parts to continuously support operations of units HD757, Caterpillar 777, and Caterpillar 777E without interruption.
- Prevent stockout of critical spare parts that may cause unit downtime.
- Control inventory to avoid overstock, minimize holding costs, and maintain service level ≥ 95%.
- Ensure all ordering is executed using the multi-item simultaneous model (one PO for all items within one unit) with quantity adjustment for overstocked items.
- Ensure all processes are documented, traceable, and auditable in accordance with ISO/TR 10013:2001.

3. Normative References

ISO/TR 10013:2001 Reference -Section 4.4.7 -References
The quality manual should contain a list of documents referred to but not included in the manual.

Standard / Document	Relevant Clause / Description
ISO/TR 10013:2001	Section 4.5 = Documented Procedures (primary normative reference for this SOP structure)
ISO 9000:2015	Quality Management Systems -Fundamentals and Vocabulary
SOP-INV-001-REF-HD757	Spreadsheet: SS, ROP, EOQ, Max Stock data for 16 spare parts -HD757
SOP-INV-001-REF-777E	Spreadsheet: SS, ROP, EOQ, Max Stock data for 26 spare parts -Cat 777E
SOP-INV-001-REF-777	Spreadsheet: SS, ROP, EOQ, Max Stock data for 26 spare parts -Cat 777
REF-PRC-001	Company Procurement Policy: PO authorization, Approved Vendor List (AVL), purchase value limits

4. Terms and Definitions

ISO/TR 10013:2001 Reference -ISO/TR 10013:2001 Section 3 -Terms and Definitions
For the purposes of this Technical Report, the following terms and definitions apply. An organization's quality management system may use different terminology for the defined types of documentation.

Term / Abbreviation	Definition
Safety Stock (SS)	Buffer stock to accommodate variability in demand and lead time uncertainty. Calculated as: SS = Z × σ_d × √(LT), where Z = 1.645 for 95% service level.
Reorder Point (ROP)	Minimum stock level at which reordering must be initiated to prevent stockout during lead time. ROP = (d̄ × LT) + SS.
Economic Order Quantity (EOQ)	Optimal order quantity minimizing total inventory cost (ordering + holding), using multi-item simultaneous order model: $y^*_i = t^* \times D_i$, where $t^* = \sqrt{(2K / \Sigma h_i d_i)}$.
Max Stock	Maximum allowable stock level = ROP + EOQ. Stock exceeding this value indicates potential overstock requiring corrective action.
Multi-Item Simultaneous Order	Ordering model in which all items for one equipment unit are ordered in a single PO simultaneously using the same cycle, to minimize combined ordering cost (K).
Qorder (Order Quantity)	Units to be ordered in one cycle. Normally = EOQ. If overstock adjustment applies: Qorder = Max(0, ROP − S + SS) for items exceeding Max Stock.
Lead Time	Time between PO issuance and goods receipt at warehouse. Standard: 7 calendar days.
CRITICAL Risk Level	HIGH classification: parts whose absence directly causes unit downtime. Requires daily stock monitoring.
IMPORTANT Risk Level	MEDIUM classification: parts important for optimal performance; do not directly cause downtime but affect efficiency. Requires weekly monitoring.
NORMAL Risk Level	LOW classification: supporting parts, generally available in the local market. Monthly monitoring cycle.
CAPA	Corrective Action and Preventive Action -systematic response to non-conformities.
GRN	Goods Receipt Note -documented evidence of goods received and inspected at the warehouse.
AVL	Approved Vendor List -list of suppliers verified and approved by Procurement.
NCR	Non-Conformance Report -document recording any product or process deviation from specified requirements.

5. Responsibility and Authority

ISO/TR 10013:2001 Reference -Section 4.5.2.4 -Responsibility and Authority
The responsibility and authority of people and/or organizational functions, as well as their interrelations associated with the processes and activities described in the procedure, should be identified.

Role	Responsibilities	Authority Limit
Warehouse Officer	Daily stock monitoring, goods receiving and issuing, stock card updates, physical stock count, GRN inspection	Warehouse operations
Warehouse Supervisor / Inventory Planner	Order need analysis, PR verification and submission, Qorder determination (including overstock adjustment), PO status monitoring, monthly review, KPI reporting	PR approval ≤ IDR 5,000,000
Procurement Department	PO creation and issuance per approved PR, supplier selection from AVL, price and lead time negotiation, claim/return handling	PO issuance -all values

QC / Receiving Inspector	Physical and technical inspection of incoming goods, part number and specification verification, GRN issuance, accept/reject decision	Accept/reject incoming goods
Maintenance Manager	PR approval above threshold, parts priority setting, inventory policy review, emergency escalation, quarterly KPI review	PR approval -all values; inventory policy

6. Risk Classification and Stock Policy

ISO/TR 10013:2001 Reference -Section 4.5.2.5 -Description of Activities
The level of detail may vary depending on the complexity of activities, the methods used, and the levels of skills and training required.

Risk Level	Code	Criteria	Emergency Condition
HIGH	CRITICAL	Parts whose absence directly cause unit downtime.	Buy first
MEDIUM	IMPORTANT	Parts important for optimal performance; do not directly cause downtime.	Better buy
LOW	NORMAL	Supporting parts; generally available locally.	Order can be postponed

6.1 Inventory Parameters in Effect

Parameter	HD757	777E	777
Supplier Lead Time (days)	7	7	7
Service Level Target (%)	95%	95%	95%
Z-Score (95% service level)	1.645	1.645	1.645
Working Days per Month	30	30	30
Order Cost per PO -K (IDR)	300,000	300,000	300,000
Annual Holding Cost Rate -i (%)	5.75%	5.75%	5.75%
Review Period	Monthly (30 days)	Monthly (30 days)	Monthly (30 days)
EOQ Model	Multi-item simultaneous	Multi-item simultaneous	Multi-item simultaneous

7. Multi-Item Ordering Policy

ISO/TR 10013:2001 Reference -Section 4.5.2.5 (b,c) -Description of Activities
Describing the processes in terms of text and/or flow charts related to the required activities; establishing what is to be done, by whom or by which organizational function; why, when, where and how.

7.1 Core Principle

All spare parts within one equipment unit (HD757, 777, or 777E) are ordered in ONE Purchase Order simultaneously. The order cycle is triggered by whichever item first reaches its ROP.

⚠ **IMPORTANT NOTE -When ONE item reaches its ROP, ALL items within the same equipment unit MUST be ordered in the same PO. Items with stock already high (approaching or exceeding Max Stock) are NOT cancelled -their order quantity is reduced, not eliminated.**

7.2 Order Quantity Logic (Qorder)

#	Condition	Order Quantity (Qorder)	Basis
1	Actual stock (S) ≤ ROP and stock is NORMAL (no excess from previous order)	**Qorder = EOQ Order the full EOQ quantity as per multi-item calculation.**	EOQ multi-item simultaneous order model. Minimizes total ordering + holding cost.
2	S ≤ ROP AND other items in the same PO already exceed their Max Stock	**STILL ORDER -but reduce quantity for excess items: Qorder_i = EOQ_i (for triggering item) Qorder_j = Max(0, ROP_j – S_j + SS_j) for items where S > Max**	Multi-item purchase must proceed. The triggering item must not be delayed. Items already overstocked are reduced to zero if S > ROP + EOQ.
3	Actual stock = 0 (STOCKOUT) -CRITICAL part	**EMERGENCY ORDER Qorder = Max(EOQ, estimated urgent need until unit returns to normal)**	Activate Emergency Procedure (Cl. 7.3). Document in F-INV-004.
4	S > ROP for ALL items in one PO cycle	**NO PO in this cycle. Continue monitoring. Initiate order when the first item reaches ROP.**	Overstock control. Avoid unnecessary holding cost.

7.3 Emergency Procedure (Stockout of CRITICAL Part)

- Warehouse Officer reports stockout conditions to Supervisor and Manager directly (verbal + written) within 1 hour.
- Supervisor contacts AVL supplier to confirm stock availability and express lead time.
- Maintenance Manager provides verbal approval, confirmed in writing within 2 working hours.
- Procurement issues Emergency PO with code EP-[number]-[year]. Quantity = EOQ or urgent need, whichever is greater.
- After resolution: prepare Stockout Report (F-INV-004), conduct root cause analysis within 3 working days, and define CAPA.

8. Description of Activities

ISO/TR 10013:2001 Reference -Section 4.5.2.5 -Description of Activities
The following aspects should be considered as applicable: (a) defining the needs of the organization; (b) describing processes in terms of text and/or flow charts; (c) establishing what is to be done, by whom, why, when, where and how; (d) describing process controls; (e) defining necessary resources; (f) defining appropriate documentation; (g) defining input and output of the process; (h) defining measurements to be taken.

Process inputs: actual stock data, demand history, supplier availability, approved budget.

Process outputs: issued POs, updated stock records, GRNs, monthly review reports, CAPA documentation.

No.	Activity	Description & Work Instructions	Responsibility	Output / Record
1	**Stock Monitoring**	Warehouse Officer monitors physical stock and system stock at frequencies determined by risk level: CRITICAL = daily; IMPORTANT = weekly; NORMAL = monthly. Compare actual stock (S) against each part's ROP value. Any discrepancy between physical count and system must be reported to the Supervisor within the same working day.	Warehouse Officer	Daily Stock Report (F-INV-001)
2	**Demand Identification & Order Quantity Determination**	When one or more items reach S ≤ ROP: (a) Identify all items to be included in a single multi-item PO for the affected unit. (b) For the triggering item (S ≤ ROP): Qorder = EOQ. (c) For other items in the same PO: if S > Max Stock, apply Qorder = Max(0, ROP − S + SS). (d) Record final quantity per item in the Purchase Request.	Inventory Planner / Warehouse Supervisor	Purchase Request (F-INV-002)
3	**Purchase Request Verification & Approval**	Supervisor verifies PR for part number accuracy, quantity, and budget alignment. Authorization levels: PR value ≤ IDR 5,000,000 → Supervisor; PR value > IDR 5,000,000 → Maintenance Manager. CRITICAL parts: approval must be completed within 4 working hours.	Supervisor / Maintenance Manager	Approved PR (F-INV-002)
4	**Purchase Order (PO) Issuance**	Procurement receives approved PR, selects supplier from Approved Vendor List (AVL), and issues PO. Standard lead time: 7 calendar days. For urgent CRITICAL parts, coordinate expedited delivery with supplier.	Procurement Department	Purchase Order (F-PRC-001)
5	**Goods Receipt & Inspection (GRN)**	Warehouse Officer receives goods and inspects: (a) Part number and technical specification match; (b) Quantity as per PO; (c) Physical condition and packaging intact; (d) Expiry date where applicable. Non-conforming goods → initiate return/claim process with supplier. Document in NCR.	Warehouse Officer / QC	Goods Receipt Note (F-WH-001)
6	**System Update & Post-Receipt Stock Control**	Update stock in CMMS/ERP system. Check whether stock now exceeds Max Stock. If yes: record the cause and report to Supervisor for corrective action.	Warehouse Officer / Inventory Admin	Updated Stock Card (F-WH-002)
7	**Monthly Review**	At month-end: (a) Update actual demand data in forecasting spreadsheet; (b) Verify SS, ROP, EOQ parameters; (c) Identify slow-moving or dead stock; (d) Evaluate KPIs (Fill Rate ≥ 95%, CRITICAL stockout = 0); (e) Report to Manager.	Inventory Planner / Supervisor	Monthly Review Report (F-INV-003)
8	**Corrective Action & Improvement (CAPA)**	If deviations are found (repeated stockout, chronic overstock, late supplier): (a) Document in NCR/CAR; (b) Perform root cause analysis; (c) Define corrective and preventive actions; (d) Verify CAPA effectiveness at next review.	Supervisor / Manager	CAPA Form (F-INV-005)

9. Stock Reference Data by Equipment Unit

ISO/TR 10013:2001 Reference -Section 4.5.2 -Contents
Documented procedures should contain the necessary information, including reference data that supports operational decisions.

Column key: D/Month = Average monthly demand | SS = Safety Stock | ROP = Reorder Point | EOQ = Economic Order Quantity | Max Stock = ROP + EOQ

9.1 Unit HD757

Part Name	Risk Level	D/Month	SS	ROP	EOQ	Max Stock	Unit
Engine Oil & Filter	CRITICAL	15	2.5	6	16	37	pcs
Transmission Oil	CRITICAL	15	2.5	6	16	22	pcs
Main Fuel Filter	CRITICAL	15	2.5	6	16	22	pcs
Trans. Oil Filter	CRITICAL	15	2.5	6	16	22	pcs
Engine Oil (2nd)	CRITICAL	15	2.5	6	16	22	pcs
Brake Friction Disc	CRITICAL	7	1.8	4	8	12	pcs
Hydraulic Filter	CRITICAL	3	1.3	2	4	6	pcs
Final Drive Oil	CRITICAL	3	1.3	2	4	6	pcs
Hydraulic Hose (Critical)	CRITICAL	3	1.3	2	4	6	pcs
Air Filter Element	IMPORTANT	27	3.3	10	28	38	pcs
Belt Set	IMPORTANT	27	3.3	10	28	38	pcs
Battery	IMPORTANT	27	3.3	10	28	38	pcs
Breather	IMPORTANT	7	1.8	4	8	12	pcs
Lamp	NORMAL	27	3.3	10	28	38	pcs
Clamp	NORMAL	27	3.3	10	28	38	pcs
Gasket Minor	NORMAL	27	3.3	10	28	38	pcs

9.2 Unit Caterpillar 777E

Part Name	Risk Level	D/Month	SS	ROP	EOQ	Max Stock	Unit
Engine Oil Filter	CRITICAL	7	2.2	4	9	13	pcs
Engine Oil	CRITICAL	7	2.2	4	9	13	pcs
Fuel Primary Filter (Water Sep.)	CRITICAL	7	2.2	4	9	13	pcs
Fuel Secondary Filter	CRITICAL	7	2.2	4	9	13	pcs
Transmission Oil Filter	CRITICAL	2	1.1	2	3	5	pcs
Brake Filter Element	CRITICAL	2	1.1	2	3	5	pcs
Brake Cooling Filter	CRITICAL	2	1.1	2	3	5	pcs
Transmission Oil	CRITICAL	2	1.1	2	3	5	pcs
Hydraulic Filter	CRITICAL	2	1.1	2	3	5	pcs
Hydraulic Oil	CRITICAL	2	1.1	2	3	5	pcs
Final Drive Oil	CRITICAL	2	1.1	2	3	5	pcs
Differential Oil	CRITICAL	2	1.1	2	3	5	pcs
Hydraulic Hose (Critical)	CRITICAL	2	1.1	2	3	5	pcs
Primary Air Filter Element	IMPORTANT	13	2.9	6	16	22	pcs
Secondary Air Filter Element	IMPORTANT	13	2.9	6	16	22	pcs

Part Name	Risk Level	D/Month	SS	ROP	EOQ	Max Stock	Unit
Belt Drive (Alternator/AC)	IMPORTANT	13	2.9	6	16	22	pcs
Battery	IMPORTANT	13	2.9	6	16	22	pcs
Differential Breather	IMPORTANT	2	1.1	2	3	5	pcs
Fuel Tank Breather	IMPORTANT	2	1.1	2	3	5	pcs
Coolant	IMPORTANT	2	1.1	2	3	5	pcs
Brake Wear Indicator	NORMAL	2	1.1	2	3	5	pcs
Lamp	NORMAL	13	2.9	6	16	22	pcs
Clamp	NORMAL	13	2.9	6	16	22	pcs
Gasket Minor	NORMAL	13	2.9	6	16	22	pcs
Hose Protector	NORMAL	13	2.9	6	16	22	pcs
Cable Tie / Fixing	NORMAL	13	2.9	6	16	22	pcs

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9.3 Unit Caterpillar 777

Part Name	Risk Level	D/Month	SS	ROP	EOQ	Max Stock	Unit
Engine Oil Filter	CRITICAL	3	1.3	2	5	7	pcs
Engine Oil	CRITICAL	3	1.3	2	5	7	pcs
Fuel Primary Filter (Water Sep.)	CRITICAL	3	1.3	2	5	7	pcs
Fuel Secondary Filter	CRITICAL	3	1.3	2	5	7	pcs
Transmission Oil Filter	CRITICAL	3	1.3	2	5	7	pcs
Brake Filter Element	CRITICAL	3	1.3	2	5	7	pcs
Brake Cooling Filter	CRITICAL	3	1.3	2	5	7	pcs
Transmission Oil	CRITICAL	3	1.3	2	5	7	pcs
Hydraulic Filter	CRITICAL	1	0.8	2	2	4	pcs
Hydraulic Oil	CRITICAL	1	0.8	2	2	4	pcs
Final Drive Oil	CRITICAL	1	0.8	2	2	4	pcs
Differential Oil	CRITICAL	1	0.8	2	2	4	pcs
Hydraulic Hose (Critical)	CRITICAL	1	0.8	2	2	4	pcs
Differential Breather	IMPORTANT	3	1.3	2	5	7	pcs
Fuel Tank Breather	IMPORTANT	3	1.3	2	5	7	pcs
Coolant	IMPORTANT	3	1.3	2	5	7	pcs
Brake Wear Indicator	IMPORTANT	3	1.3	2	5	7	pcs
Primary Air Filter Element	IMPORTANT	7	1.8	4	11	15	pcs
Secondary Air Filter Element	IMPORTANT	7	1.8	4	11	15	pcs
Belt Drive (Alternator/AC)	IMPORTANT	7	1.8	4	11	15	pcs
Battery	IMPORTANT	7	1.8	4	11	15	pcs
Lamp	NORMAL	7	1.8	4	11	15	pcs
Clamp	NORMAL	7	1.8	4	11	15	pcs
Gasket Minor	NORMAL	7	1.8	4	11	15	pcs
Hose Protector	NORMAL	7	1.8	4	11	15	pcs
Cable Tie / Fixing	NORMAL	7	1.8	4	11	15	pcs

10. Performance Indicators (KPI) and Monitoring

ISO/TR 10013:2001 Reference -Section 4.5.2.5 (h) -Description of Activities
Defining the measurements to be taken.

KPI	Definition	Formula	Target	Period
Fill Rate	% of spare part requests fulfilled immediately from available stock	Fulfilled / Total Requests × 100%	**≥ 95%**	Monthly
Stockout Freq. (CRITICAL)	Stockout events (stock = 0) on CRITICAL parts	Number of events	**= 0**	Monthly
Stockout Freq. (IMPORTANT)	Stockout events on IMPORTANT parts	Number of events	**≤ 1**	Monthly
Overstock Incident	Parts with actual stock > Max Stock at GRN	Count of parts > Max Stock	**= 0**	Per GRN

Lead Time Compliance	% of POs received on time (≤ 7 days)	On-time PO / Total PO × 100%	**≥ 90%**	Monthly
CAPA Closure Rate	% of corrective actions closed on time	CAPA Closed / CAPA Open × 100%	**100%**	Quarterly

KPI monitoring results are reported in the Monthly Review Report (F-INV-003) and presented at the quarterly management review meeting.

11. Records

ISO/TR 10013:2001 Reference -Section 4.5.2.6 -Records
The records related to the activities in the documented procedure should be defined in this section. The forms to be used for these records should be identified as applicable. The method required to complete, file and keep the records should be stated.

Form Code	Document / Form Name	Responsible Party	Retention	ISO/TR 10013 Ref.
F-INV-001	Daily Stock Report	Warehouse Officer	3 months	Cl. 4.5.2.6
F-INV-002	Purchase Request (PR)	Warehouse Supervisor	5 years	Cl. 4.5.2.6
F-INV-003	Monthly Review Report	Inventory Planner	2 years	Cl. 4.11
F-INV-004	Stockout Report & CAPA	Supervisor + Manager	5 years	Cl. 4.11
F-INV-005	CAPA Form	Supervisor / Manager	5 years	Cl. 4.7
F-PRC-001	Purchase Order (PO)	Procurement Dept.	5 years	Cl. 4.5.2.6
F-PRC-002	Supplier Performance Evaluation	Procurement Dept.	3 years	Cl. 4.11
F-WH-001	Goods Receipt Note (GRN)	Warehouse Officer / QC	5 years	Cl. 4.11
F-WH-002	Stock Card	Warehouse Officer	3 years	Cl. 4.11

All records shall be maintained in a legible, readily identifiable, and retrievable manner. Electronic copies are acceptable provided they are backed up and access-controlled. Records are not subject to revision control - once created, they constitute objective evidence and must not be altered.

12. Internal Audit and Continual Improvement

ISO/TR 10013:2001 Reference -Section 4.5.3 -Review, Approval and Revision
Evidence of review and approval, status and date of revision of the documented procedure should be indicated.

- Internal audit of this procedure shall be conducted at minimum once (1) per year by a competent auditor independent from the audited function.
- Audit findings shall be documented in the Internal Audit Report (F-QMS-001) and followed up with CAPA within 30 calendar days.
- Audit results shall be presented at the Management Review meeting.
- Continual improvement shall be applied based on KPI analysis results, audit findings, and operational feedback.

13. Appendices

ISO/TR 10013:2001 Reference -Section 4.5.2.7 -Appendices
Appendices containing information supportive to the documented procedure may be included, such as tables, graphs, flow charts and forms.

Appendix A - Order Quantity Adjustment Example

Scenario: Unit HD757. Engine Oil & Filter reaches ROP = 6. Check all items in the same PO:

Part Name	Actual Stock (S)	ROP	EOQ	Max Stock	Qorder	Note
Engine Oil & Filter	6 (= ROP)	6	16	22	**16**	Full EOQ -order trigger
Transmission Oil	18	6	16	22	**16**	Full EOQ -within normal range
Air Filter Element	35	10	28	38	**28**	Full EOQ -within normal range
Battery	40 (> Max)	10	28	38	**0**	Overstock -skip this item
Lamp	36	10	28	38	**28**	Full EOQ -within normal range

Conclusion: PO is issued. Battery is not ordered (overstock). All other items ordered at full EOQ in one PO.

Appendix B - Inventory Control Forms

The following forms support administrative documents for the proposed Spare Part Ordering and Stock Control System at PT XX. These forms are developed based on SOP-INV-001 and are intended to support inventory monitoring, purchasing, KPI evaluation, and corrective action documentation.

Appendix B.1 – F-INV-001 Daily Stock Report

This form is provided as a sample administrative template supporting the implementation of the proposed inventory control system.

Date	Part Name	Risk Level	Current Stock	ROP	Max Stock	Status	Action Required	Checked By

Prepared By	Approved By

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Appendix B.2 – F-INV-002 Purchase Request Form

This form is provided as a sample administrative template supporting the implementation of the proposed inventory control system.

PR Number	Date	Part Name	Risk Level	Current Stock	ROP	EOQ / Qorder	Reason for Order	Requested By	Approved By

Prepared By	Approved By

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Appendix B.3 – F-INV-003 Monthly Review Report

This form is provided as a sample administrative template supporting the implementation of the proposed inventory control system.

Month	Fill Rate (%)	Critical Stockout Frequency	Important Stockout Frequency	Overstock Incident	Lead Time Compliance	CAPA Required	Reviewed By

Prepared By	Approved By

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Appendix B.4 – F-INV-004 Stockout Report & CAPA

This form is provided as a sample administrative template supporting the implementation of the proposed inventory control system.

Date	Part Name	Risk Level	Stockout Cause	Operational Impact	Corrective Action	Preventive Action	Responsible Person

Prepared By	Approved By

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Appendix B.5 – F-INV-005 Corrective Action and Preventive Action (CAPA) Form

This form is provided as a sample administrative template supporting the implementation of the proposed inventory control system.

Problem Description	Root Cause	Corrective Action	Preventive Action	PIC	Target Completion Date	Verification Result

Prepared By	Approved By

14. Revision History

ISO/TR 10013:2001 Reference -Section 4.5.3 -Review, Approval and Revision
Evidence of review and approval, status and date of revision of the documented procedure should be indicated. Section 4.5.4 - Where practicable, the nature of the change should be identified either in the document or the appropriate attachments.

Rev.	Date	Description of Change	Prepared By	Approved
00	21 Apr 2026	Initial Release -New document creation per ISO/TR 10013:2001	Inventory Dept.	Mgr. Maintenance

15. Document Approval

ISO/TR 10013:2001 Reference -Section 6.1 -Review and Approval
Prior to issue, the documents should be reviewed by authorized individuals to ensure clarity, accuracy, adequacy and proper structure. Release of documents should be approved by the management responsible for their implementation.

Prepared By	Reviewed By	Approved By
Inventory Supervisor Date: _____	**Procurement Supervisor** Date: _____	**Maintenance Manager** Date: _____

-END OF DOCUMENT SOP-INV-00-

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