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Implementation of FSN Analysis and Periodic Review System for Inventory Management Improvement in Spare Parts Warehouse

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Abstract

Effective inventory management is essential for maintaining spare parts availability and ensuring high service levels in the automotive industry. PT IAMI, particularly the PSM Dept. and PC Dept. Bekasi, identified inventory management issues at its Medan Depot as a pilot project for inventory improvement. The depot initially achieved a fill rate of only 60%, below the company's target of 70%, due to the absence of standardized spare parts classification, review period policies, replenishment planning, and an integrated monitoring system. To address these issues, a community service program was conducted by Telkom University through technical assistance in developing an inventory management framework. The program integrated Fast-Slow-Non Moving (FSN) Analysis, the Periodic Review System (R,s), and a dashboard-based inventory monitoring system using Microsoft Excel. The implementation stages included field observation, focus group discussion, operational data analysis, spare parts classification, inventory parameter calculation, dashboard development, and validation with the partner. The results showed that the proposed inventory policy improved the fill rate from 60% to 99%, exceeding the company target. In addition, the dashboard improved inventory visibility by displaying stock status, fill rate, safety stock, reorder warnings, and other operational indicators.

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INTRODUCTION

Effective inventory management is a critical component of supply chain operations because it ensures product availability while minimizing inventory-related costs. In the automotive spare parts industry, inventory performance directly influences customer satisfaction, operational efficiency, and service quality. Poor inventory planning may lead to stock shortages, excessive inventory, increased holding costs, and reduced service levels, ultimately affecting the company's competitiveness (Chopra & Meindl, 2022). Therefore, companies are increasingly adopting systematic inventory control approaches to balance inventory availability with operational efficiency.

IAMI is an automotive company responsible for ensuring the availability of genuine spare parts through its national distribution network. One of its regional distribution facilities, the Medan Depot, plays an important role in supplying spare parts to authorized dealers across northern Sumatra. Based on field observations and discussions with the Parts Supply Management (PSM) Division, several inventory management issues were identified at the depot. The warehouse achieved a fill rate of only 60%, which was below the company's target of 70%, indicating that customer demand could not be consistently fulfilled from available inventory. Furthermore, inventory management activities were still performed using conventional approaches without standardized spare parts classification, review period policies, or integrated inventory monitoring. These conditions resulted in stock imbalances, inefficient replenishment decisions, limited inventory visibility, and delays in responding to fluctuations in spare parts demand.

Inventory management problems have become common challenges across manufacturing and distribution industries. Maintaining high service levels while avoiding excessive inventory requires systematic inventory classification and appropriate replenishment policies (Silver et al., 2017). One widely adopted inventory classification method is the Fast-Slow-Non Moving (FSN) Analysis, which categorizes inventory items according to their movement frequency to support differentiated inventory control strategies (Roda et al., 2014). Through FSN classification, organizations can identify fast-moving items requiring frequent replenishment, while simultaneously recognizing slow-moving and non-moving items that contribute to excessive inventory and higher holding costs.

In addition to inventory classification, establishing an appropriate replenishment policy is essential for improving inventory performance. The Periodic Review System (R,s) is widely implemented because it enables inventory inspection at predetermined intervals while considering demand variability, lead time, and safety stock requirements (Nahmias & Olsen, 2015). Compared with conventional replenishment practices, periodic review policies provide more systematic inventory control, improve product availability, and reduce the risk of stock shortages.

Recent developments in inventory management also emphasize the importance of digitalization and real-time monitoring. Dashboard-based inventory monitoring systems enable managers to visualize inventory status, reorder alerts, safety stock levels, and service performance through interactive displays, thereby supporting faster and more accurate operational decision-making (Ivanov, 2023). Integrating inventory analysis with digital monitoring tools therefore represents an effective strategy for improving warehouse visibility and strengthening inventory control.

To address these challenges, Telkom University conducted a community service program in collaboration with IAMI through technical assistance aimed at improving inventory management practices at the Medan Depot. The program integrated Fast-Slow-Non Moving (FSN) Analysis, the Periodic Review System (R,s), and the development of a dashboard-based inventory monitoring system. The implementation involved field observations, operational data analysis, inventory classification, replenishment parameter calculation, dashboard development, and validation with the partner.

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The implementation of the proposed framework successfully improved inventory management performance. The fill rate increased significantly from 60% to 99%, exceeding the company's performance target while providing better inventory visibility, standardized replenishment planning, and improved decision-making capabilities. In addition to improving operational performance, the program enhanced the partner's capability to apply data-driven inventory management practices and demonstrated the value of collaboration between higher education institutions and industry in addressing practical operational challenges.

This community service activity demonstrates that integrating FSN Analysis, the Periodic Review System, and a dashboard-based inventory monitoring system provides an effective approach for improving spare parts inventory management in the automotive industry. The developed framework not only addresses the operational needs of the Medan Depot but also offers a scalable model that can be replicated across other IAMI distribution depots facing similar inventory management challenges.

RESEARCH METHODS

Community Service Approach

This community service program adopted a participatory assistance approach, in which the academic team collaborated closely with the partner to identify operational problems, develop appropriate inventory management solutions, implement the proposed methods, and evaluate the outcomes. The program was conducted at the Medan Depot of IAMI, involving personnel from the Parts Supply Management (PSM) Division and warehouse operators. This collaborative approach ensured that the proposed solutions addressed the partner's actual operational needs while facilitating knowledge transfer and sustainable implementation. The implementation consisted of six sequential stages: problem identification, data collection, inventory analysis, inventory policy development, dashboard development, and evaluation, as illustrated in Figure 1.

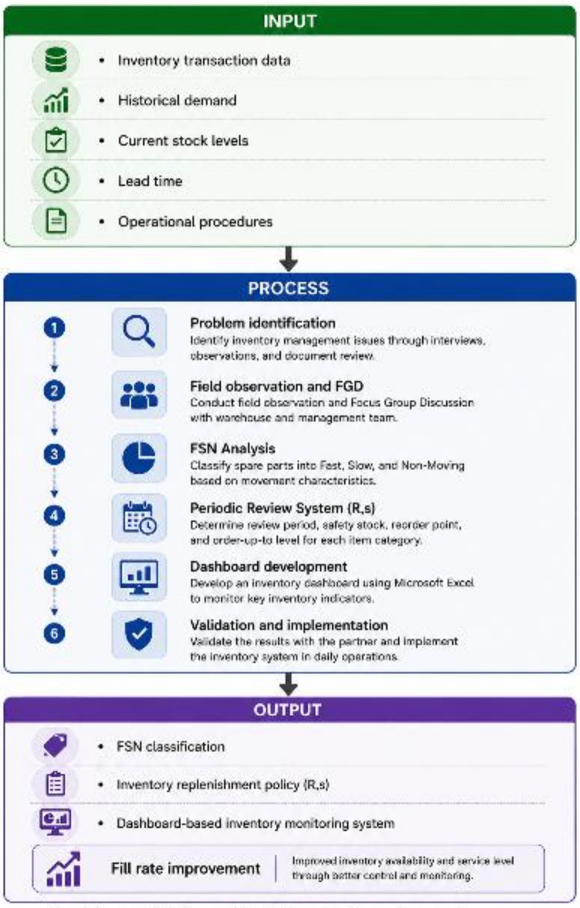

Figure 1. Framework of the Community Service Program for Inventory Management Improvement

Figure 1. Framework Community Services

Problem Identification and Data Collection

The first stage involved identifying inventory management issues through field observations, interviews, and Focus Group Discussions (FGDs) with warehouse personnel and managers. The discussions revealed that the Medan Depot experienced a fill rate of only 60%, which was below the company's target of 70%. Inventory control was performed without standardized spare parts classification or replenishment policies, resulting in stock shortages, excess inventory for certain items, and limited visibility of inventory performance.

Primary data were collected through direct observation and interviews, while secondary data were obtained from inventory transaction records and warehouse reports. The collected data consisted of spare parts master data, historical demand, current inventory level, lead time, fill rate performance, and warehouse operational procedures. These data were used to develop the inventory management framework tailored to the operational characteristics of the Medan Depot.

These data served as the basis for developing an inventory management framework tailored to the partner's operational conditions.

FSN Analysis

The Fast-Slow-Non Moving (FSN) Analysis was applied to classify spare parts according to their movement frequency. This inventory classification method enables organizations to distinguish between fast-moving, slow-moving, and non-moving items, allowing inventory control policies to be adjusted based on item characteristics (Roda et al., 2014). Inventory movement was evaluated using historical transaction data obtained from the partner. Each spare part was classified into one of the following categories:

Fast Moving (F): Items with high demand frequency requiring frequent replenishment.

Slow Moving (S): Items with moderate movement requiring periodic monitoring.

Non-Moving (N): Items with very low or no movement requiring inventory evaluation.

The classification results were subsequently used as the basis for determining appropriate replenishment policies.

Periodic Review System (R,s)

Following the FSN classification, the Periodic Review System (R,s) was implemented to establish a systematic replenishment policy. Under this approach, inventory is reviewed at predetermined intervals (R), and replenishment is initiated whenever the inventory position falls below the reorder level (s) (Silver et al., 2017; Nahmias & Olsen, 2015). The calculation of inventory parameters considered Historical demand, Demand variability, Lead time, Desired service level, and Safety stock.

The resulting review period and reorder parameters provided standardized inventory control guidelines that supported consistent replenishment decisions and improved spare parts availability.

The calculation of the periodic review parameters employed the standard loss function and Z-score approach to determine the appropriate safety stock corresponding to the target service level. Figure 2 presents the calculation of the Z-score and loss function, whereas Figure 3 illustrates the relationship between review period and service level.

No	Part Number	FSN Analisys	z-Score For L(z) R=6	St. Dev Every Lead Time R=6	Loss Function [L(z)] R=6	z-Score For L(z) R=12	St. Dev Every Lead Time R=12	Loss Function [L(z)] R=12	z-Score For L(z) R=18	St. Dev Every Lead Time R=18	Loss Function [L(z)] R=18	z-Score For L(z) R=24	St. Dev Every Lead Time R=24	Loss Function [L(z)] R=24
1	I6-13240 023-0	F	0,70	1246,71	0,1033	0,05	1461,89	0,0973	-0,56	1649,24	0,1280	-1,16	1817,37	0,1578
2	I6-97309 927-0	F	0,76	893,05	0,1032	0,28	1047,19	0,0858	-0,17	1181,39	0,1083	-0,60	1301,83	0,1299
3	I6-97172 549-0	F	0,51	676,05	0,1035	-0,02	792,74	0,1009	-0,51	894,34	0,1257	-0,99	985,51	0,1497
4	I6-97247 514-0	F	1,40	525,92	0,1026	0,78	616,69	0,0609	0,20	695,72	0,0902	-0,37	766,65	0,1187
5	I6-98159 693-0	F	-1,08	1091,34	0,1051	-1,48	1279,71	0,1742	-1,86	1443,70	0,1929	-2,22	1590,88	0,2108
6	I6-94430 983-1	F	-0,29	785,35	0,1043	-0,74	920,91	0,1372	-1,18	1038,92	0,1588	-1,59	1144,84	0,1794
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1198	I8-98125 402-3	N	-0,84	0,87	0,1048	-1,23	1,02	0,1616	-1,59	1,15	0,1797	-1,94	1,26	0,1968
1199	I8-97375 134-A	N	0,77	2,02	0,1032	0,49	2,37	0,0753	0,24	2,67	0,0880	0,01	2,95	0,0997
1200	6	N	2,26	1,37	0,1017	1,94	1,60	0,0030	1,65	1,81	0,0173	1,38	1,99	0,0308

Figure 2. Z-score and Loss Function

For Demand 100%	R=6	R=12	R=18	R=24
Mean ST.DEV During LT	24,33	28,53	32,19	35,47
Mean L(z)	0,10	0,04	0,06	0,08
Mean Expected Demand	1,55	1,17	0,81	0,47
Fill Rate	94%	96%	98%	99%

Figure 3. Service Level

Dashboard Development

To facilitate inventory monitoring, a dashboard-based inventory management system was developed using Microsoft Excel. The dashboard was designed to provide real-time visualization of inventory performance and support operational decision-making. The dashboard displays several key performance indicators, including Fill rate performance, Inventory availability, FSN classification, Safety stock, Reorder status, Review schedule, and Inventory movement trends.

The dashboard enables warehouse personnel to monitor inventory conditions more efficiently and supports timely replenishment decisions based on operational data.

Program Evaluation

The effectiveness of the community service program was evaluated by comparing inventory performance before and after implementation. Evaluation activities included validation sessions with warehouse personnel and management to assess the applicability of the proposed inventory policies and dashboard.

Program success was measured using several operational indicators, including:
Improvement in fill rate performance;
Availability of standardized inventory control procedures;
Implementation of FSN-based inventory classification;
Adoption of the Periodic Review System;
Utilization of the dashboard for inventory monitoring.

The implementation demonstrated a significant improvement in inventory performance, with the fill rate increasing from **60% to 99%**, indicating that the proposed framework effectively supported inventory control and enhanced operational decision-making at the Medan Depot.

RESULTS AND DISCUSSION

Initial Inventory Management Condition

The community service program began with an assessment of the inventory management practices at the Medan Depot of IAMI. Field observations, interviews, and Focus Group Discussions (FGDs) with warehouse personnel revealed that inventory management was still performed using conventional practices without standardized inventory classification or replenishment policies. Inventory monitoring also relied heavily on manual data processing, making it difficult to identify critical stock conditions and support timely replenishment decisions.

Performance evaluation showed that the warehouse achieved a fill rate of only 60%, which was below the company's target of 70%. This condition indicated that spare parts availability was insufficient to satisfy customer demand consistently, resulting in stock shortages for several high-demand items while other items remained overstocked. Similar findings have been reported by Destro et al. (2023), who highlighted that inventory record inaccuracies and inappropriate replenishment policies significantly reduce warehouse service performance. These findings confirmed the need for a structured inventory management framework capable of improving inventory visibility, supporting replenishment decisions, and increasing warehouse service performance.

Implementation of FSN Analysis

The first technical assistance activity focused on implementing Fast-Slow-Non Moving (FSN) Analysis to classify spare parts according to their movement frequency. Historical inventory transaction data were analyzed to categorize each part number into Fast Moving, Slow Moving, or Non-Moving groups. This classification enables warehouse personnel to prioritize inventory control based on actual demand characteristics rather than treating all spare parts equally.

The implementation of FSN Analysis provided several practical benefits for the partner. Fast-moving items were prioritized for inventory availability to minimize stock-out risk, whereas slow-moving and non-moving items became the focus of inventory evaluation to reduce unnecessary holding costs. Consequently, warehouse personnel gained a clearer understanding of inventory priorities and could allocate storage space and replenishment efforts more effectively. These findings are consistent with Roda et al. (2014), who reported that movement-based inventory classification improves inventory visibility and supports differentiated inventory policies according to item characteristics.

Development of the Periodic Review Inventory Policy

Following the FSN classification, a Periodic Review System (R,s) was developed to establish standardized replenishment policies for each inventory category. The proposed policy considered historical demand, lead time, demand variability, safety stock, and review intervals to determine appropriate reorder parameters.

Sensitivity analysis was performed by evaluating several review periods (R = 6, 12, 18, and 24). The results demonstrated a progressive improvement in inventory service performance as the review policy was optimized. The calculated fill rate increased from 94% at a six-day review period to 99% at the selected review configuration, indicating that the proposed replenishment policy substantially improved spare parts availability.

Table 1. Fill Rate Performance under Different Review Periods

Review Period	Fill Rate
R = 6	94%
R = 12	96%
R = 18	98%
R = 24	99%

The implementation of the Periodic Review System provided warehouse personnel with standardized replenishment procedures, replacing subjective ordering decisions with a systematic inventory control policy. According to Silver et al. (2017), periodic review systems improve service levels by balancing demand uncertainty and inventory availability through scheduled replenishment activities.

Dashboard-Based Inventory Monitoring System

The final output of the community service program was the development of a Dashboard-Based Inventory Monitoring System using Microsoft Excel. The dashboard integrates inventory data, FSN classification, and Periodic Review parameters into a single monitoring platform that supports warehouse operations.

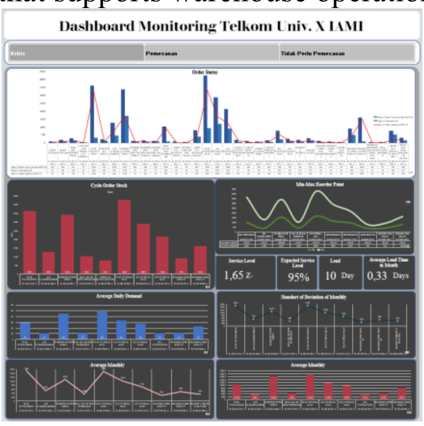

Figure 4. The dashboard includes several operational features, such as:

Inventory availability monitoring;
FSN classification for each spare part;
Fill rate visualization;
Safety stock information;
Reorder notification;
Recommended replenishment quantity.

Compared with the previous manual monitoring process, the dashboard enables warehouse personnel to identify inventory conditions more quickly and accurately. The automatic visualization of inventory indicators reduces the time required for monitoring activities while supporting faster operational decision-making. Similar findings were reported by Filani et al. (2020), who demonstrated that dashboard-based monitoring systems significantly improve logistics visibility and managerial responsiveness.

Partner Benefits and Program Evaluation

The implementation of the proposed inventory management framework generated both technical and organizational benefits for the partner. Technically, the integration of FSN Analysis, the Periodic Review System, and dashboard monitoring established standardized inventory control procedures tailored to the operational characteristics of the Medan Depot. Organizationally, warehouse personnel gained practical knowledge regarding data-driven inventory management and the use of analytical tools to support replenishment decisions.

Program evaluation conducted jointly with the partner confirmed that the developed framework met the operational requirements of the warehouse. The partner acknowledged that the recommendations were relevant to current operational challenges and expressed interest in implementing the proposed framework as a pilot project at the Medan Depot before expanding it to other distribution depots. The dashboard was also considered valuable for improving inventory visibility and supporting faster managerial decision-making.

Discussion

The community service program demonstrates that integrating FSN Analysis, the Periodic Review System (R,s), and a dashboard-based inventory monitoring system provides an effective approach to improving inventory management practices in the automotive spare parts industry. Unlike conventional inventory control methods that rely heavily on managerial experience, the proposed framework establishes standardized decision-making procedures based on historical demand and inventory performance.

The implementation successfully improved warehouse performance by increasing the fill rate from the initial 60% to 99%, indicating a substantial improvement in spare parts availability and service performance. This result supports the findings of Babiloni and Guijarro (2020), who emphasized that appropriate inventory policies significantly influence fill rate performance and customer service levels.

The implementation demonstrated that integrating FSN Analysis, the Periodic Review System, and the inventory dashboard successfully addressed the operational problems identified during the initial assessment. The standardized inventory policy reduced subjective replenishment decisions and enabled warehouse personnel to perform inventory monitoring more efficiently. Furthermore, dashboard visualization improved inventory transparency by providing fill rate monitoring, reorder notifications, safety stock information, and inventory status in a single interface. These improvements indicate that the developed framework is feasible for wider implementation across other IAMI depots with similar operational characteristics.

Beyond the technical improvements, the program strengthened the partner's capability to adopt structured and data-driven inventory management practices. The successful implementation at the Medan Depot demonstrates the feasibility of applying the framework as a pilot project, with strong potential for replication across other IAMI distribution depots. Therefore, this community service program not only addressed the partner's immediate operational challenges but also established a sustainable inventory management model that supports continuous improvement and digital transformation within the company's spare parts distribution network.

CONCLUSIONS AND SUGGESTIONS

Conclusion

This community service program successfully improved inventory management at the Medan Depot of PT IAMI through the integration of FSN Analysis, the Periodic Review System (R,s), and a dashboard-based inventory monitoring system. The implementation increased the warehouse fill rate from 60% to 99%, exceeding the company's target of 70%. In addition, standardized inventory classification, replenishment policies, and dashboard monitoring improved inventory visibility and supported faster data-driven decision making. The developed framework has demonstrated its feasibility as a pilot implementation and has strong potential for replication in other PT IAMI distribution depots.

Suggestion

The proposed inventory management framework has demonstrated its effectiveness in supporting inventory control at the Medan Depot. To maximize its long-term benefits, IAMI is encouraged to implement the developed framework as part of its standard operating procedures and periodically review inventory parameters to ensure that replenishment policies remain aligned with changes in demand patterns, lead times, and business requirements.

Future community service activities and applied research may extend this work by integrating the inventory management dashboard with the company's Enterprise Resource Planning (ERP) system to enable automatic data synchronization and real-time inventory monitoring. In addition, advanced analytical approaches, such as demand forecasting, machine learning, and Business Intelligence (BI), may be incorporated to improve inventory planning accuracy and support strategic decision-making across the entire spare parts distribution network.

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