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Original Article

Proposed Inventory Management System to Reduce Slow Moving and Deadstock Level at PT. Pertamina JOB Tomori

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Abstract: *This research focuses on JOB Tomori, a prominent gas producer in Indonesia, grappling with inventory management issues, particularly high levels of slow-moving and deadstock materials. The study aims to identify factors contributing to this problem and propose effective strategies for optimization. The root cause analysis reveals two main issues: the "run-to-failure" practice among end-users and the incomplete categorization of Material Criticality Ratings (MCR). Process-based, people-based, and technology-based solutions are proposed to address these challenges. Process-based solutions include the formulation of a process for MCR categorization and an evaluation of the current MCR categorization. People-based solutions involve training and awareness programs for end-users, emphasizing proper inventory management practices. Technology-based solutions encompass the implementation of an early warning system and the installation of banners or signs displaying real-time information about slow-moving and deadstock items. In conclusion, the research recommends a comprehensive approach involving the immediate implementation of short-term solutions, such as training and awareness, developing rewards and punishments, and evaluating MCR categorization. Long-term solutions, like integrating an early warning system, should be pursued within the next 1-2 years. These recommendations aim to enhance JOB Tomori's inventory management practices, aligning with industry regulations and ensuring efficient operations while minimizing the risk of slow-moving and deadstock materials.*

Keywords: *Material Management, Inventory, Slow Moving, Deadstock, Oil and Gas.*

I. INTRODUCTION

Indonesia's oil and gas industry has a long history of over 100 years, and the sector is characterized by a relatively well–understood regulatory framework. In many areas, including the production sharing contract (PSC) model and the commercialization of LNG, Indonesia has been an international pioneer. Indonesia's oil and gas industry continues to be a vital sector; not only does it contribute to national revenues, including 12% of the state budget in 2014, but it has also boosted national economic growth (PwC, 2023).

In general, there are five stages in oil and gas industry activities, namely exploration, production, processing, transportation, and marketing. These five stages activities are divided into two main activities, namely downstream activities, which include processing, transportation, and marketing, and upstream activities, which start from the study of the content of oil and gas in the earth to the activities of the process of lifting and collecting crude oil and natural gas. Upstream oil and gas activities play an important role because they begin a long chain of oil and gas business (Nugroho, 2019). Upstream oil and gas activities cover two main activities, namely exploration and production. Exploration, which includes geological studies, seismic surveys, and drilling exploration, is the initial stage of the upstream state; it aims to find new oil and gas reserves.

Meanwhile, the production activity is the activity of lifting the oil and gas from the bowels onto the surface of the earth. To support this activity, reliable and structured material management is required. A material management system's main objective is to minimize inventory capital while guaranteeing that the production process never slows down or stops. Material management conducts analysis, monitoring, and coordination of the warehouse, including activities in recording procurement, receipt, storage, and distribution of material stock and non–stock (Hidayat, 2018).

Materials in oil and gas industries are unique; one project material with another most likely has different specifications and depends on the condition on site, such as temperature, type of material, volume, pressure, etc. It includes a wide range of materials, from maintenance (valves, fittings, flanges), consumable items (safety materials, gloves, bolts, and nuts), spare parts (hand tools, gauges, thermometers), etc. These materials are used to support the oil and gas activities on-site and are very critical to day-to-day operations. For companies operating in this field, effective inventory management is essential to ensure the availability of necessary materials while minimizing excess stock that can lead to deadstock.

JOB Tomori, as one of the biggest gas producers and KKKS in Indonesia at this point in time, still faces difficulty in managing its inventory; the deadstock level still exceeds the regulation issued by SKK Migas. Slow moving, and deadstock

levels on both Capital Inventory Material (Project) and Maintenance Repair and Operation (MRO) currently reach 83,49% dan if there is no further action, it will result in the operational process in the warehouse being disrupted and may be subject to administrative sanctions for violating SKK Migas regulations. Therefore, reducing their deadstock level is a critical aspect of JOB Tomori.

Table 1: JOB Tomori's Inventory Data

Description	Total Inventory (Quantity)	Total Inventory (Value)	Percentage
FS – Fast Moving	21,659 pcs	$869,383.64	6,70%
SW – Moderate Moving	10,115 pcs	$1,273,479.89	9,81%
SP - Slow Moving	4,905 pcs	$3,387,531.48	26,10%
DS - Deadstock	42,752 pcs	$7,449,882.30	57,39%
Total Slow Moving and Deadstock	**47,657 pcs**	**$10,837,413.78**	**83,49%**

The Supply Chain Management Department, especially Material Management, ensures material availability during the JOB Tomori operational schedule. However, the uncertainty of operational and site conditions gives many disadvantages for the material management division. Items ordered by employees (end users) on–site are often left unused. Many of these items are not replaced according to the predetermined schedule because they are considered in good condition and still usable. Meanwhile, the material management division must continue to supply logistics and materials according to the plan and forecasting, which can lead to the occurrence of slow moving and even dead stock.

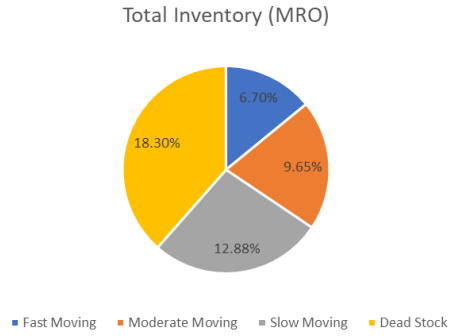


Figure 1: JOB Tomori's Inventory Data

Observing the inventory condition at the JOB Tomori, the total deadstock experienced by the material management division, especially in the MRO, is 18,30%, with a slow-moving of 12,88%, resulting in a total slow-moving and deadstock of materials at 31,18%. This is not in accordance with the regulations set by SKK Migas, which restrict the ratio of slow-moving and deadstock in the MRO inventory to be below 8%.

II. LITERATURE REVIEW

In this research, the literature review aims to obtain and compare the theoretical foundation regarding material management and deadstock, their relationship with the oil and gas industry, the elements considered for reducing deadstock, and related concepts and studies.

A. Material Management

Materials management manages the flow of materials into, though, and out of the system; it is essential to ensure an adequate supply of materials to meet a system's anticipated pattern of demand. Materials management pertains to decision-making with respect to materials to ensure the right quantity of materials of the right quality at the right time at the right place at the right price, and it is concerned with design, specification, procurement, transportation, inspection, storage, retrieval, use, disposal, and accounting of materials. In short, the scope of materials management includes purchased materials such as raw materials, bought–out components, spares, indirect materials, work-in-process, and finished goods. Materials account for a very substantive proportion of the total cost of goods and services, and in many cases, they account for more than half the cost of doing business. Therefore, the effective and efficient management of materials has become a very powerful potential area for cost reduction and value enhancement (Vrat, 2014).

B. Inventory Management

Inventory or stock (in common terms) is considered to be the central theme in managing materials. Generally, inventory means a physical stock of goods kept in store to meet the anticipated demand. However, from a materials management perspective, inventory is a usable but idle resource with some economic value (Vrat, 2014). It is necessary to have physical

stock in the system to take care of the anticipated demand because the nonavailability of materials when needed will lead to delays in projects or services delivered. However, keeping inventory is not an easy thing to do because excess inventory will lead to slow-moving or even deadstock. This situation makes inventory management a challenging problem area in materials management. Any company's inventory can be categorized into three major types: raw materials, work in process, and finished goods. Each of these types requires appropriate inventory management techniques (Tsourveloudis et al., 2000); (Rozhkov & Ivanov, 2018). Inventory management is an important aspect for any company to have an optimum inventory level, as excessive inventory can cost a company from about 20% to 40% of the total inventory throughout the year and should be monitored and maintained at a minimal level (Ganeshan, 1999). Inventory Management itself is the branch of business management concerned with planning and controlling inventories. The role of inventory management is to maintain a desired stock level of specific products or items. The systems that plan and control inventories must be based on the product, the customer, and the process (either manufactured or purchased) that makes the product available (Toomey, 2003).

According to PTK 007 (2022), inventory must be carried out according to the type and nature of the warehousing function, with the aim of protecting inventory from damage, not decreasing in quality, and remaining ready for use. Every inventory must be accompanied by a piece of information regarding codification, description, units, notes, or other related information. KKKS is obliged to implement good warehousing principles such as placing inventory materials in a place that suits the characteristics of the material and applying the FIFO (First In, First Out) principle in the use of inventory materials to avoid quality degradation due to long storage.

SKK Migas requires KKKS to optimize existing inventory to meet the operational needs of upstream oil and gas business activities. Inventory use can be done internally at KKKS or between KKKS and has different mechanisms:

a) Shared use is a form of asset use carried out on assets not optimally used by KKKS, such as idle capacity or excess stock. Shared use aims for operational efficiency through joint utilization of assets, carried out based on technical and economic studies of the KKKS and related functions of SKK Migas. The term of joint use is twenty years from the date of the joint use agreement and can be extended by looking at the term of the KKS of the related parties.

b) Lending and use: this mechanism is carried out using a return of goods mechanism. If the following KKKS users fail to return the goods within the specified time period, they are obliged to make a replacement in the form of money. The lending and use period between KKKS is a maximum of three years and must not exceed the KKS period of the related parties.

c) Transfer of Asset between KKKS in the form of inventory materials is carried out between the initial user KKKS and the next user KKKS after obtaining SKK Miga's approval.

d) Usage of Inventory Ex-KKKS, Ex-contractor inventory can be used by KKKS over Management and other KKKS. This method can be carried out after obtaining approval from the Ministry of Energy and Mineral Resources. It can only be carried out on inventory originating from work areas where the KKKS has ended.

Inventory removal is a mechanism that can be carried out by SKK Migas and KKKS for inventory that is not useful in upstream oil and gas business activities. This aims to free SKK Migas and KKKS from physical, administrative, legal, and cost responsibilities arising from management. The mechanism of removal can be done through:

a) Submission to the Government and removal of inventory through the mechanism for handing over inventory to the government is carried out through a KKKS statement or review because the material is damaged, obsolete, reduced in quality, expired, depreciation and inventory material is included in the deadstock category.

b) Transfer of Ownership: ownership of inventory held in KKKS can be transferred to other parties abroad or within the country. This transfer can be carried out after obtaining approval from SKK Migas.

c) Buyback: inventory held by the contractor can be repurchased by the supplier/manufacturer/vendor at fair value based on the assessment results.

d) Demolition can be carried out on inventory materials, production, and operational waste. Demolition can be carried out with consideration when inventory cannot be used, exploited, or transferred. This demolition can be carried out by burning, destroying, landfilling, drowning, or in other ways in accordance with statutory provisions. The demolition of inventory in the KKKS was carried out after obtaining approval from the Ministry of Energy and Mineral Resources.

In carrying out control and supervision of inventory materials, KKKS is required to pay attention to slow-moving and deadstock parameters; it is a comparison between the deadstock value plus the slow-moving value to the total value of inventory materials.

C. Material Criticality Rating

There are terms and categorizations of materials and equipment used by JOB Tomori in the material management

section, such as Material Criticality Rating (MCR). MCR is a measure of criticality level and is used to determine the inventory priority of a material, which is determined through material criticality assessment. MCR is calculated from various things so that the company can determine what materials must be stocked as a priority. In calculating MCR, there are several factors to consider, such as:

a) Obsolescence is a type of material that has a useful life because it has passed the limit of use and is outdated from a technological point of view, such as electrical components and instruments (E&I), or is no longer produced as a mechanical item. This material does not need to be stocked and is therefore categorized as MCR4.

b) Repairability is a type of material that can be repaired by welding and recoating, such as a pump and valve when damage occurs. With its reparability features, this material allows for remediation and restoration to optimal conditions after experiencing damage, thereby adding value in terms of durability and maintenance efficiency, so this material is categorized as MCR4.

c) Usage is defined as the frequency of material use. The frequency of material use is divided into four categories: fast-moving, moderate-moving, slow-moving, and deadstock. The higher the frequency of use, the higher the usage score level. The usage score assessment procedure is based on the usage category of moving equipment, which is conducted on JOB Tomori stock evaluation and SKK Migas regulation. The categories in the usage category are:

Table 2: Usage Category Score

Usage Category	Usage	Score
Fast Moving	Once a year	100
Moderate Moving	Once within two years	50
Slow Moving	Once within five years	25
Deadstock	More than five years	0

d) Critical equipment is a material indicator; if the CTE value of the material is high, then the related equipment cannot be used if the material is damaged. Determination of the score for CTE is influenced by two things: material criticality to equipment function (CTF) and ECA equipment category. The CTE score is as follows:

Table 3: Critical to Function Score

Description		Critical to Function (CTF)		
		High	Moderate	Low
Equipment Criticality Analysis (ECA)	C1	100	90	80
	C2	80	70	60
	C3	60	50	40
	C4	40	30	20
	C5	20	10	0

ECA categorization was obtained based on the ECA score evaluation that had been previously carried out by JOB Tomori. Meanwhile, the determination of Critical to Function (CTF) is obtained based on technical analysis carried out by related parties and is divided into three categories:

i) High: Material damage causing equipment operation to be stopped.
ii) Moderate: Material damage causing an unoptimal equipment operation.
iii) Low: Material damage does not affect equipment operations.

When the CTE score was≥ 60, spare part material was categorized as MCR1.

e) Lead Time is the duration for processing a Purchase Request (PR) into a Purchase Order (PO) until material delivery and material receipt. The maximum lead time value is 100, which will be achieved in 180 days or 6 months. The lead time score and classification are as follows:

Table 4: Lead Time Score

Category	Score	Characteristic
S (Scarce)	100	Rare to find within the regional boundaries. Such goods are limited in stock and are usually imported; hence, they take longer to arrive.
D (Difficult)	50	Inventory that is available domestically but is still limited and harder to arrange. The lead time for acquiring these goods is over two weeks but less than six months.
E (Easy)	25	Inventory that is readily available and high in supply. These items are available domestically and quickly arranged due to several suppliers in the market.

f) Formula of Material Criticality Rating

$$MCR = USG \times WF1 + LT \times WF2 + CTE \times WF3$$

Where:
MCR : Material Critical Rating
CTE : Critical to Equipment
USG : Usage Score
LT : Lead Time Score
WF : Weight Factor (WF1 = 50%; WF2 = 30%; WF3 = 20%)

The final product of critical spare part assessment is the Material Criticality Rating (MCR), which is presented in Table 2.4 as follows:

Table 5: MCR Score and Characteristic

Category	Score	Characteristic
MCR1	75>100	Must be stocked and available; if not available when needed, it could potentially disrupt oil and gas production activities.
MCR2	50>75	Must always be available to ensure continuity of operations
MCR3	25>50	It should not be in stock. This will have a low impact on production activities.
MCR4	0<25	Non–stock material group. This will have no effect on production.

C. Deadstock

Deadstock is considered unsold or unused stock that is stored in the warehouse for a long period of time (R. Snyder, 2002). These deadstock items lead to the obsolescence of goods, and there is also a huge inventory carrying cost associated with it. Holding the deadstock item for a longer duration will definitely lead to a significant amount of cost to an organization in terms of loss of investment opportunities, the non-value-added cost in storing and managing the items, and increment in the management costs (Fan & Zhou, 2018); (He & Wang, 2019). It is necessary for any organization to have an optimum inventory level in order to deal with uncertainty in the demand pattern and unreliability from the supplier and vendor side (Van Jaarsveld & Dekker, 2011). The categorization of inventory into slow-moving and deadstock varies from company to company; it depends on the management policies, types, and characteristics of the company. Companies that work in the oil and gas sector must comply with the policies issued by SKK Migas. Inventory that remains in the warehouse within five years is considered slow-moving, and an inventory stocked above five years is considered deadstock (skkmigas, 2022).

III. RESULTS AND DISCUSSION

A. Respondents and Interview

The purpose of selecting stakeholders and members of the material management division is to explore the data and determine the root cause of the inventory problem, as well as the expectations from each member of the material management division. Each respondent might have a different perspective and objectives in terms of the slow-moving and deadstock problem that occurred in the company inventory. The respondent groups and their profiling are described in the following tables.

Table 6: The Respondent

No	Position	Initial	Experience & Role
1	Head of Material Management Division	AY	Joined JOB Tomori in 2014, experience 3 years as System & Planning Section Head, 3 years as Procurement Section Head, and 4 years as Material Management Section Head. The MM Section Head's responsibilities are to ensure all material management matters run properly and based on regulation, coordinate with other sections related to material movement, and supervise all material management members.
2	Supervisor of Material Management Operation	BP	Joined JOB Tomori in 2018, experience 3 years in the procurement section and 1 year in the material management section. The MM Operation Supervisor's responsibilities are to supervise good issues good receive, and control material traffic from Jakarta to the site.
3	Supervisor of Material Management Planning	RA	Joined JOB Tomori in 2012, experience 4 years in the drilling section and 7 years in the material management section. The MM Planning Supervisor's responsibilities are to supervise the MRP and analyze the inventory to ensure the availability of goods.
4	Material Resources Planning	IR	Joined JOB Tomori in 2018, experience 4 years as the material man on site and 1 year in the material management section as MRP.
5	Good Issue	HS	Joined JOB Tomori in 2009, experience 1 year as a material man, 4 years in corporate social responsibility, and 8 years in material management section as the good issue.

The interview process arranged is based on the interview protocol to align with a research question. The author records information during the interview session and takes a note and audiotapes. The audiotaping result is then translated into transcription to get the keyword of every statement that the respondent mentioned during the interview session. The interview protocol used in collecting primary data based on interview results, which are translated into transcribed; the author prepared the interview question list as follows:

Table 7: Interview Question

No	Interview Question (General)	Purpose	Relation
1	To what extent is your role in this operation?	To get an understanding of their responsibilities in the material management section	To get insight and different perspectives based on their role
2	What do you think of the importance of Material Management in JOB Tomori?	To understand the objective of Material Management in JOB Tomori	Basic question about inventory related to RQ
3	What are the top three aspects to consider in controlling the inventory?	To know what aspects are being concerned by respondent based on their function and perspectives.	As a basis of evaluation related to RQ
4	What is the method or system used in material management to control the inventory?	To understand the advantages and disadvantages of the current system or method	Basiq question about inventory related to RQ
5	What are the most frequent constraints/challenges in the material management section, according to your experience, and what are the key factors that contribute to these constraints?	Identifying and confirming the most constraints/challenges that contribute to slow-moving and deadstock problem	To identify a strategic plan and system to minimize the impacts by focusing on the key factors that contribute to material management problems

Based on the interview results, the findings are divided into knowledge areas, existing conditions, relation to the research question, and the supporting statement. Knowledge areas consist of the interviewer positions. Existing conditions consist of the problems, constraints, and challenges that occurred in JOB Tomori's Material Management section. Relation to the problem consists of the relation to root causes of the slow-moving and deadstock problem and the possible improvement to reduce slow-moving and deadstock. The supporting statement consists of major points and a summary of key points from the interview.

Table 8: Interview Results

No	Knowledge Areas	Existing Conditions	Relation to Problem	Supporting Statement
1.	Head of Material Management Section	End users apply run-to-failure habits, rarely replacing materials that have been included in the replacement schedule according to the service book.	Factors that contribute to the accumulation of slow-moving and deadstock problems	The head of material management is aware that many new materials are not used by end users, even though existing materials have passed their useful life.
		There are plans for turn-around and drilling project activities in 2024 - 2025 so that the inventory value increases to fulfil safety stock.	Factors that contribute to the accumulation of slow-moving and deadstock problems	The head of material management is aware that there are plans for a new drilling project in 2024, which will lead to an increase in inventory due to the fulfillment of safety stock.
		Material Criticality Rating (MCR) has not yet been fully classified and categorized by Material Management Section.	Improvement to the current inventory system in the material management section.	He admits that the JOB Tomori's inventory system is still improving, and previously, the responsibility for MCR categorization had not been fully handed over to material management.
2.	Material Management Operation (Supervisor and Staff)	There are plans for turn-around and drilling project activities in 2024. The inventory value increases to fulfil safety stock	Factors that contribute to the accumulation of slow-moving and deadstock problems	The supervisor is aware that there are upcoming drilling projects that will increase the inventory value.
		End users apply run-to-failure habits, rarely replacing materials that have been included in the schedule according to replacement the service book.	Factors that contribute to the accumulation of slow-moving and deadstock problems	The supervisor admits that the inventory usage on site is quite low, and they face difficulties in managing the inventory because the MCR has not been fully classified.
		Material Criticality Rating (MCR) has not yet been fully classified and categorized by Material Management Section.	Improvement to the current inventory system in the material management section	The supervisor and staff are aware that the MCR is important and the classification must be completed quickly.

		Evaluation of the current Material Criticality Rating (MCR)	Improvement to the inventory system in the material management section	The supervisor and staff feel that the MCR must be evaluated because there is some material that must be nonstock still available in inventory
3.	Material Management Planning (Supervisor and Staff)	End users apply run-to-failure habits, rarely replacing materials that have been included in the replacement schedule according to the service book	Factors that contribute to the accumulation of slow-moving and deadstock problems	The supervisor admits that the inventory usage on site is quite low, and they face difficulties in planning the inventory because the MCR has not been fully classified
		Material Criticality Rating (MCR) has not yet been fully classified and categorized by Material Management Section.	Improvement to the inventory system in the material management section	The supervisor and staff are aware that the MCR is important to accurately plan the inventory, and the classification must be completed quickly
		Evaluation of the current Material Criticality Rating (MCR).	Improvement to the inventory system in the material management section.	The supervisor and staff feel that the MCR must be evaluated because there is some material that must be nonstock still available in inventory.

B. Analysis

Root cause analysis is a method to identify the potential cause of a problem and determine which cause can be the root cause. So that the most effective solutions can be identified and implemented, and those root causes can be addressed to ensure the problem does not occur (Barsalou, 2015). The root cause analysis in this research focuses on the constraints, problems, and challenges that occur at JOB Tomori, which can cause slow-moving and deadstock in inventory. In this research, the author uses the Current Reality Tree (CRT) to determine the root cause of the slow-moving and deadstock problem that occurred in the material management section of JOB Tomori.

To find the root cause of CRT, the first author defines the scope of the business issue, which is about the slow-moving and deadstock problem that occurred in the inventory that was caused by some undesirable effects (UDEs). After the UDEs have been identified, they will be put and described into a "cause and effect" relationship diagram tree (Dettmer, 2007).

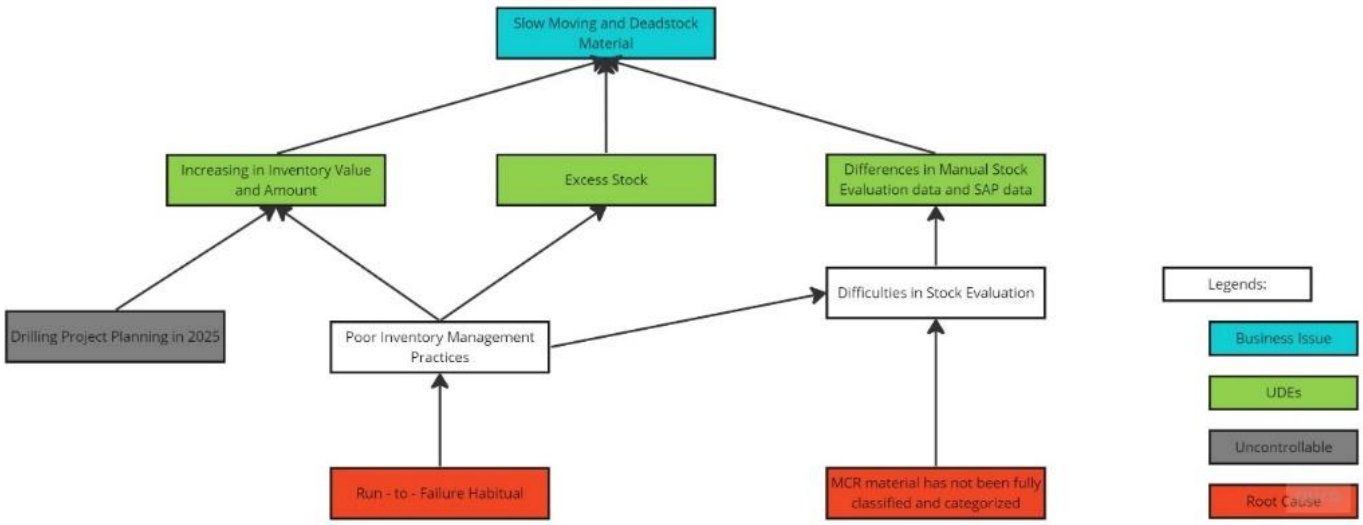


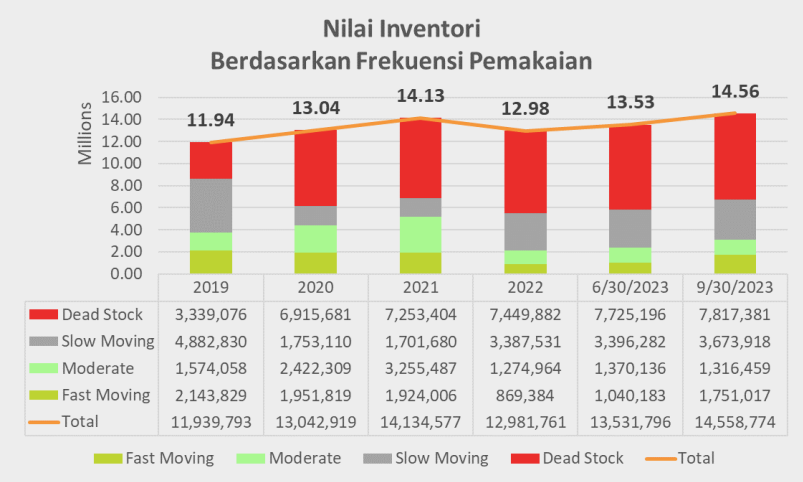
Figure 2: Current Reality Tree (CRT)

a) Undesirable Effects (UDEs)

i) Increasing Inventory Value and Amount, turn-around, and drilling project activities in 2024 and 2025 require significant materials and equipment, leading to an increase in inventory value and amount. Additionally, poor inventory management practices result in overstocking and inefficient utilization of resources, further contributing to the rise in inventory levels. The figure below clearly illustrates the upward trend in inventory value and amount over time:

ii) Excess Stock: JOB Tomori experienced excess stock in its inventory. One of the reasons was poor inventory management practices, which was caused by the habit of end users who implemented a run-to-failure system. This excess stock could lead to slow-moving and deadstock material in JOB Tomori's inventory.

iii) Differences in Manual Stock Evaluation data and SAP data: this problem occurred because material management members at the site experienced difficulties in stock evaluation due to materials in the warehouse that had not been fully categorized. This issue leads to discrepancies between the actual stock levels and the data recorded in the SAP system. As a result, it becomes challenging for the supervisors to accurately track and manage inventory, causing delays and inefficiencies in the warehouse operations.



	2019	2020	2021	2022	6/30/2023	9/30/2023
Dead Stock	3,339,076	6,915,681	7,253,404	7,449,882	7,725,196	7,817,381
Slow Moving	4,882,830	1,753,110	1,701,680	3,387,531	3,396,282	3,673,918
Moderate	1,574,058	2,422,309	3,255,487	1,274,964	1,370,136	1,316,459
Fast Moving	2,143,829	1,951,819	1,924,006	869,384	1,040,183	1,751,017
Total	11,939,793	13,042,919	14,134,577	12,981,761	13,531,796	14,558,774

Figure 3: Inventory Value

b) Root Cause

i) Run – to – failure habitual: the end user does not replace material even though the material has passed the replacement schedule based on the service book, and this could lead to increasing risk in material operation, decreasing reliability of material, and operational disruptions due to sudden breakdown. This habit represents the poor inventory management practices by JOB Tomori material management section that could further lead to slow-moving and deadstock material problems.

ii) MCR has not been fully classified and categorized; approximately 58% of the material in the inventory has not yet been classified and categorized. Categorization is a very important procedure in material management activities because this can help material management in managing the materials in inventory, which materials need to be in stock (Critical or Insurance) or materials that do not need to be in stock (MCR 3 & MCR 4). The unclassified and uncategorized MCR could lead to the difficulty of the stock evaluation and make the difference between manual stock evaluation and the SAP data.

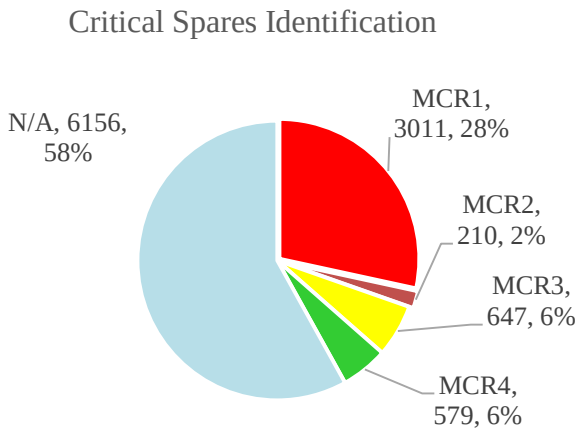


Figure 4: MCR Identification

After the root cause has been analyzed and concluded, the author will define and propose a method to be applied in the materials management section to solve and mitigate the problem further. The method will be proposed by considering the condition of the people, processes, and technology in the company, regulations in the oil and gas industry, and the company's ability to implement the method that will be proposed.

C. Business Solutions

a) People, Process, Technology (PPT)

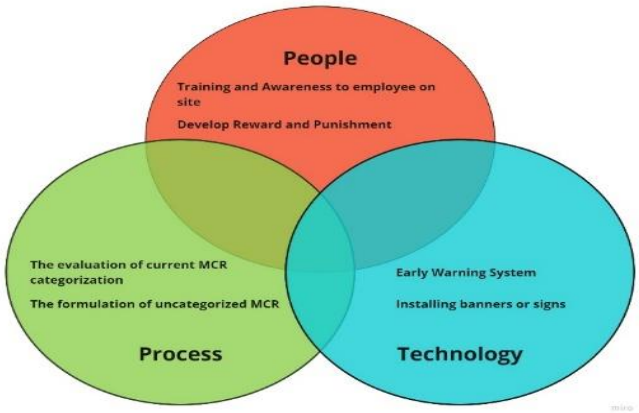


Figure 5: PPT Framework

i) The formulation of an uncategorized Material Criticality Rating. This solution is related to process improvement as it aims to optimize and standardize the formulation to categorize the Material Criticality Rating (MCR). It involves defining and implementing a structured process for calculating the MCR based on its value. By implementing a structured process, organizations can ensure consistent and accurate categorization of the material criticality rating.

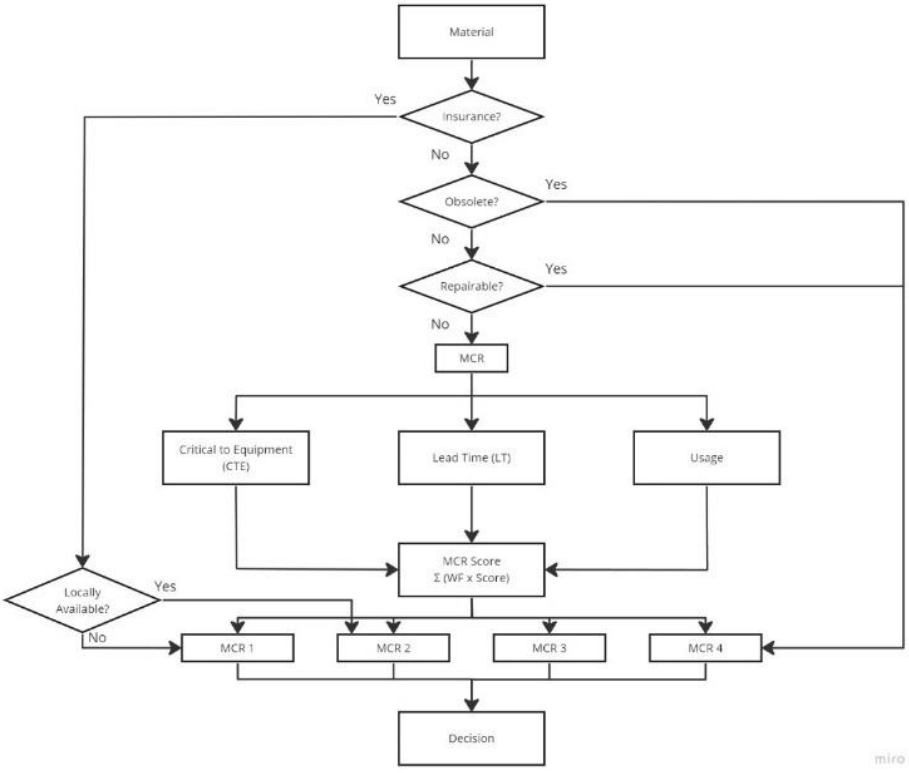


Figure 6: Solution for MCR Classification Framework

ii) The evaluation of the current MCR categorization solution aims to solve the problem of slow-moving and deadstock by selecting and evaluating what materials should be in stock so that no material accumulates in the warehouse, which could lead to obsolescence or even slow-moving and deadstock. This problem occurs in the inventory at JOB Tomori because there is a lot of material stock, which means it could increase the risk that the materials are not used and will be categorized as slow-moving and deadstock materials, and even become damaged and have to be thrown into the junkyard.

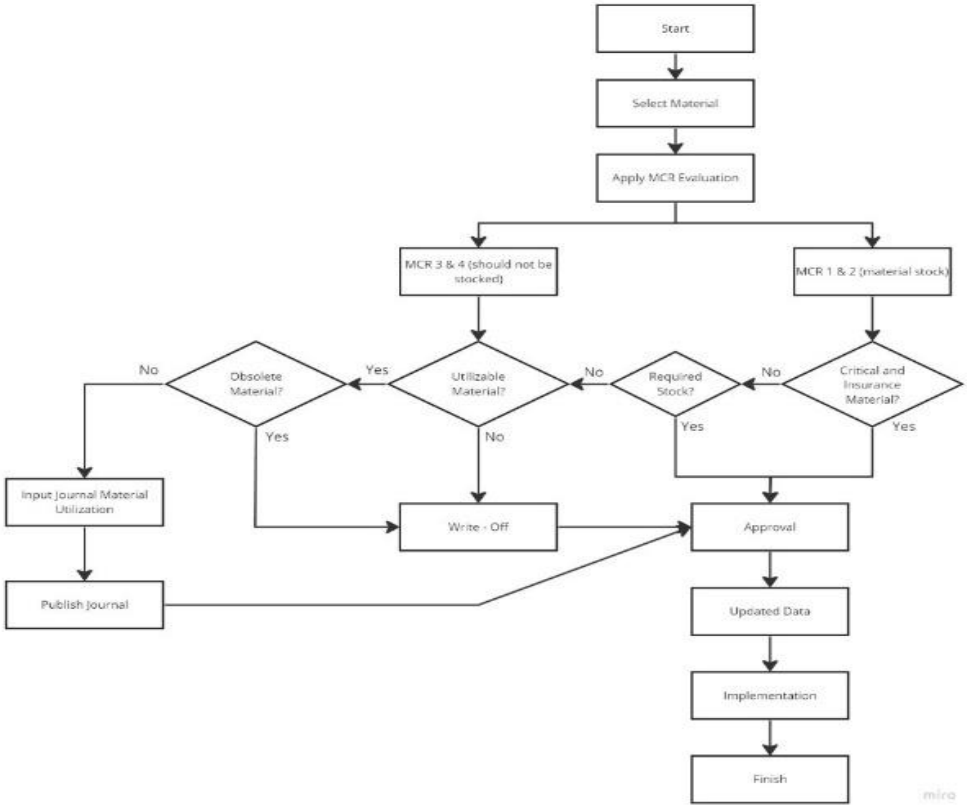


Figure 7: Solution for MCR Evaluation

Material that falls into the stock category (MCR 1 & MCR 2) will be evaluated again to determine whether the material is critical insurance or not. After evaluation, the material will be approved and updated to the JOB Tomori's inventory system. Material that falls into the nonstock category (MCR 3 & MCR 4) is not utilizable and already obsolescence will be separated in location for FUPP (Release and Removal Proposal Form). According to PTK 007 (2022), Release and Removal can be carried out by KKKS for inventory that is not useful in upstream oil and gas business activities, and the mechanism can be done through submission to the government, transfer of ownership, buyback, and demolition. This solution has challenges and constraints due to administration and bureaucracy related to approval from the Ministry of Energy and Mineral Resources. Material that falls into the nonstock category (MCR 3 & MCR 4), still utilizable and not obsolete, will be optimized by publishing and updating the journal to use materials for other KKKS via specified contracts. According to PTK 007 (2022), the usage of inventory can be done between KKKS through lending between KKKS, transfer of inventory, and the usage of inventory Ex – KKKS. This solution has challenges and constraints due to the uniqueness of each material and the function of the material to project in other KKKS.

iii) Training and awareness, the employees on the site still have the habit of Run - to – Failure; it will create poor inventory management practices that result in materials becoming unused and becoming slow moving or dead stock. Therefore, JOB Tomori needs to develop training modules to educate employees on how to identify the slow-moving and deadstock inventory. This includes understanding the criteria for deadstock, following the standard operational procedure (SOP), and distinguishing between critical and non-critical items. To mitigate the run-to-failure habitual, JOB Tomori also needs to educate the employees regarding the risk to safety, production schedules, and the impact on material management due to this habit.

iv) Develop Reward and Punishment: JOB Tomori has no reward and punishment system as a positive motivation for the employee on site. The reward system needs to be given to the employee to boost and add energy to the employee to work better and give the best result. Fairly, if the employee makes a mistake, the employee needs to learn from the mistake, and the company will give a punishment as part of the learning process. It is fair to evaluate the yearly performance evaluation to decide the remuneration of the employee.

v) Early Warning System: This solution is technology–driven; it involves the implementation of early warning system technology and is to be integrated with the company's existing technology, such as SAP, and shown on the

dashboard. An early warning system could notify certain stakeholders and material management staff when the material is approaching expiration, reaching a certain age on inventory, or exhibiting prolonged inactivity. The implementation of an early warning system should categorize the material based on its movement, age, and usage patterns. The purpose of this technology is to identify risks and give warning when materials become slow-moving and deadstock.

vi) Installing banners or signs containing current information on slow-moving and deadstock. Implementing banners or signs with current information on slow-moving and deadstock items involves communication to raise awareness among certain stakeholders and also all of the JOB Tomori section regarding inventory status. The utilization of banners and signs should be strategically placed in warehouses or storage areas and in the JOB Tomori main office. The information also includes the value and quantity of each categorization of materials: fast-moving, moderate-moving, slow-moving, and deadstock, with a different color for each categorization. The banner or signs could also include QR codes or links to training materials, guidelines, and best practices on the cause and effect of slow-moving and deadstock in inventory.

D. Benefits, Costs, Opportunity, and Risks (BCOR)

The BCOR framework provides a structured approach to assessing the potential impact and implications of a decision or solution. It helps decision-makers weigh the positives and negatives, identify trade-offs, and make informed choices that align with organizational objectives while managing associated costs, opportunities, and risks effectively.

Table 9: BCOR Framework

No.	Root Cause	Impact	Solution Recommendation	Benefit	Cost	Opportunity	Risk
1.	Run - to – Failure Habitual	Increasing Inventory Value and Amount and Excessive Stock	Training and Awareness	Improving Inventory Management practices and reducing excessive stock.	Cost for the HRD Department in conducting the training.	Opportunities to maintain optimal inventory levels.	Resistance among staff to adopt new inventory practices and initial operational disruption during training.
2.	Run - to – Failure Habitual	Increasing Inventory Value and Amount and Excessive Stock	Develop Reward and Punishment	Positive behavioral change and improved material management staff.	Cost for the HRD Department in implementing and monitoring the system.	Opportunities to reduce inventory level and positive cultural shift.	The system might create consequences, such as employees focusing solely on avoiding penalties.
3.	Run - to – Failure Habitual	Increasing Inventory Value and Amount and Excessive Stock.	Installing banners or signs containing current information on slow-moving and deadstock.	Enhance awareness among all JOB Tomori employees.	Cost for designing, producing, and installing banners or signs.	Opportunities to develop awareness and raise responsibilities to all JOB Tomori sections.	Risks in maintaining the accuracy and earliest inventory information.
4.	MCR has not been fully classified and categorized	Difficulties in stock evaluation lead to differences in manual data and SAP data.	Formulation of uncategorized MCR.	Enhance the accuracy of stock evaluation and better view of critical materials.	Labor Cost for Material Management Section Personnel.	Complete and structured classification allows for better identification and mitigation of risks.	The process might require significant resources, time, and effort.
5.	MCR has not been fully classified and categorized	Difficulties in Stock Evaluation and a difference in manual data and SAP data.	The evaluation of current MCR categorization.	This leads to improvements in material classification and resulting more accurate inventory assessments and resource	Labor Cost for Material Management Section personnel.	Opportunity to improve the accuracy of the material management and reliability of material classifications.	The evaluation process could potentially divert attention and resources from other critical tasks and projects.

				allocation.			
6.	Run–to–failure habitual and MCR has not been fully classified and categorized.	Difficulties in Stock Evaluation and makes a difference in manual data and SAP data.	Early Warning System	Leveraging the technology could enable early identification and mitigation of slow-moving and deadstock.	Cost for research and development, training, and integration.	Timely alerts enable better decision-making and could prevent any potential slow-moving and deadstock material.	Difficulties in implementing the technology and the complexity of implementation.

E. Implementation

After completing several stages of research, ultimately leading to the development of several solutions aimed at addressing the issues at the JOB Tomori's Material Management Section, the final stage of this research involves creating an implementation strategy. This strategy serves to assist in mapping the developed solutions for comprehensive and structured implementation. The implementation is a PDCA (Plan, Do, Check, Action) cycle.

No	Activity	PIC	2024											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	The formulation of uncategorized Material Criticality Rating	Material Management Section	PLAN	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	CK
					C			H			E			
					ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT
2	The evaluation of current MCR categorization	Material Management Section	PLAN	PLAN	DO	DO	DO	DO	DO	DO	DO	DO	DO	K
						C		H		E		C		
						ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT
3	Training and Awareness	HR	PLAN	PLAN	DO	DO	DO	DO	DO	DO	DO	DO	DO	K
						C		H		E		C		
						ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT
4	Develop Reward and Punishment	HR	PLAN	PLAN	DO	DO	DO	DO	DO	DO	DO	DO	DO	K
						C		H		E		C		
						ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT
5	Early Warning System	IT	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN	PLAN
									DO	DO	DO	DO	DO	CK
										CH		E		
										ACT	ACT	ACT	ACT	ACT
6	Installing banner or signs containing current information of slow moving and deadstock	IT & Material Management Section	PLAN	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO
					C			H			E			CK
					ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT	ACT

Figure 8: Implementation Timeline

IV. CONCLUSION

The run-to-failure practices of the end user on site are the main source of the slow-moving and deadstock issue in JOB Tomori's Material Management department. This habit makes materials in the warehouse unused because the old materials are still considered good and suitable. This practice indicates poor inventory management practices by employees at JOB Tomori, and if this continues to happen, unused materials in the warehouse will become obsolete and lead to slow-moving or even deadstock. The other root cause is the JOB Tomori inventory's unclassified and uncategorized Material Criticality Rating (MCR), which creates uncertainty about whether the material is a must-stock category or a nonstock category. This could lead to difficulty in stock evaluation and also a slow-moving and deadstock problem.

To address these issues, it is crucial for JOB Tomori to implement proper inventory management systems and processes. This includes regularly evaluating and updating the MCR for all materials in the warehouse, ensuring that each item is correctly classified as either a must-stock or nonstock category. Additionally, employees should be trained on the effects of the run-to-failure habits that represent poor inventory management practices. JOB Tomori also shall implement rewards and punishments for the employees to encourage them to manage the inventory better and give the best result. In terms of technology, JOB Tomori shall apply the early warning system technology that could be integrated with the existing system and install signs containing current information about slow-moving and deadstock to raise awareness and the the importance of inventory to of JOB To employeesmori.

By taking these steps, JOB Tomori can mitigate and solve complex problems and improve its inventory management practices to avoid further potential problems with slow-moving and deadstock.

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