Cost reduction by borderless warehouse operation: a case study in national upstream oil & gas company zona 11

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Abstract
Purpose – This research to evaluate the opportunities of cost reduction in warehouse operation with no additional cost in National Upstream Oil & Gas Company Zona 11. Design/methodology/approach – Methodology using DMAIC approach for problem solving and quantitative data research. Data gathered form activities and finance in National Oil & Gas Company Zona 11. Findings – Combining Warehouse Operation can gain efficiency with the no trade-off in warehouse effectiveness. Theoretical or Practical Implication – Borderless Warehouse Operation can gain good efficiency with the approach of employee engagement and leadership, for combining those warehouse operation. Originality/value – Combining Warehouse Operation with application of Dynamic Capability approach resulting efficiency in reducing number of Supervisors, but guaranteed in robust operation in warehouse

Keywords:
Borderless Warehouse Operation; Dynamic Capability; Efficiency; Leadership.

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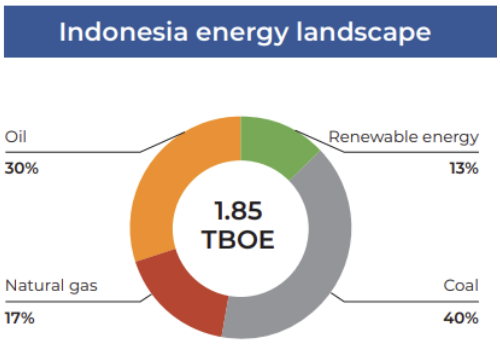
INTRODUCTION

In Upstream Oil & Gas Companies, with the main business activity of producing crude oil and natural/petroleum gas, hold significant role in providing energy in Indonesia. As shown in Figure 1, Oil (and gas) still holds major energy producer in Indonesia, with rank-2 after Coal providing the energy. As President of Indonesia ASTACITA point 2 (two), which stated " Memantapkan sistem pertahanan keamanan negara dan mendorong kemandirian bangsa melalui swasembada pangan, energi, air, ekonomi kreatif, ekonomi hijau, dan ekonomi biru" so for National Upstream Oil & Gas Company had been responsible for producing more energy, and in the same

time as the National Owned Company (called Badan Usaha Milik Negara – BUMN) been responsible for contributing profit for Indonesia Government.

Figure 1.
Indonesia energy consumption



Source: Indonesia Energy Transition Outlook 2025

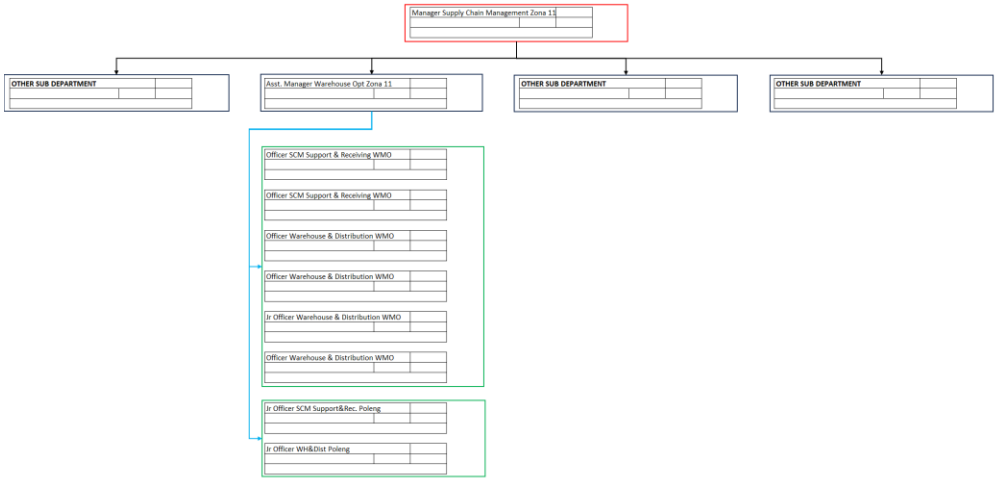
National Upstream Oil & Gas Company Zona 11, one of National Owned Company (BUMN), located in East Java Area, has been operating for producing oil & gas in designated area of onshore and offshore area. National Upstream Oil & Gas Company Zona 11 has 2 (two) kind of operation based of Onshore and Offshore in 5 (five) Field operation. Onshore area of its company located in Cepu Field (Blora – Bojonegoro), Sukowati Field (Bojonegoro) and TEJ Field (Tuban), while Offshore Area in WMO Field and Poleng Field (Northern Sea of Madura Island). The total of more than 10k barel oil per day and 140 metric million cubic feet of gas produced in a day by National Upstream Oil & Gas Company Zona 11.

Business process in Upstream Oil & Gas Companies with many process from exploration-exploitation-production, will be supported also by Supply Chain process, with 1 (one) of Supply Chain implementation will be Warehouse Operation. For supporting business process in Upstream Oil & Gas industry, warehousing also hold vital contribution for maintaining operation by holding material stocks for its operation. Material stock which consists of mainly critical materials, are stocked in warehouse because those materials are long-lead items and mainly imported products. For upstream oil & gas business, majority the materials needed for its operation almost similar kinds of materials, but for offshore based operation upstream oil & gas Field, will be using more higher specification materials. As for the offshore based operation, which using more hi-tech and specific materials, the urgency of materials availability will be the most important requirement of warehouse operation in supporting 2 (two) Offshore Field of WMO and Poleng. WMO and Poleng before joining operation National Upstream Oil & Gas Company Zona 11 were

2 (two) different companies which were operated separately, so they were had different warehouses but located in same area of Lamongan.

Warehouse Operation in National Upstream Oil & Gas Company Zona 11 is as part of Supply Chain Management Department which has top leader on Supply Chain Manager and Warehouse Assistant Manager as the "Head" of all warehouse operation in the company. The structure (simplified) of the organization in Figure 2 below. Supply Chain Manager has role for managing all activities in higher level perspective along with budget, policy and Key Performance Indicator (KPI). Warehouse Assistant Manager as direct operation head ensuring all duties of warehouse operation to be fulfilled, and also ensuring safety – security while supervising all warehouse officer's (also called warehouse supervisor) in conducting warehouse operation in company.

Figure 2.
Organization Structure of Warehouse Management

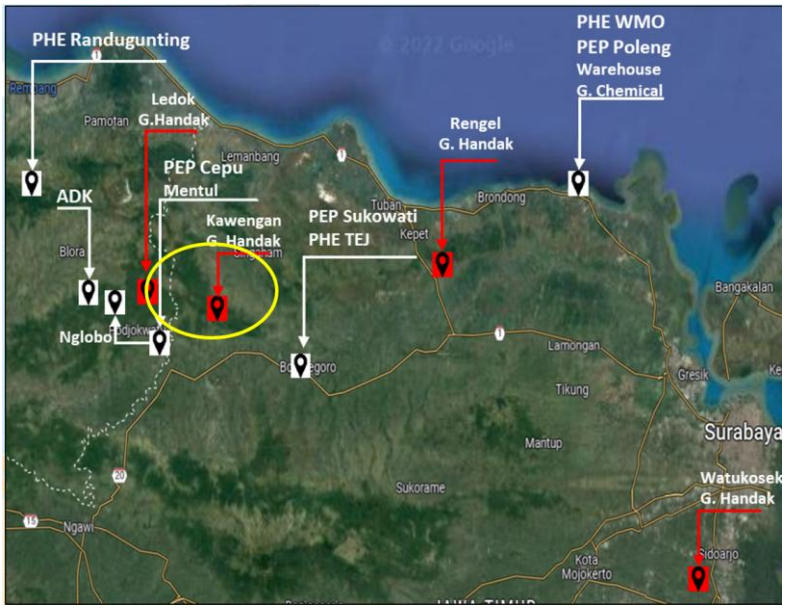


Source: Author(s) 2025

Warehouses in National Upstream Oil & Gas Company Zona 11 lies in 3 major area as shown as Figure 3. Onshore Fields have 2 locations of warehouse in Cepu and Tuban, while for Warehouse of WMO Field and Poleng located in area of Lamongan called Lamongan Shore Base (LSB). The uniqueness of the warehouses of Onshore Based Field compared to Offshore Based Field in National Upstream Oil & Gas Company Zona 11, while in warehouses of Onshore Based Field are owned warehouses or assets, in Offshore Based Field (in Lamongan Shore Base) are rent from the logistic company. At glance rented-warehouse will be more expensive than owned-warehouse, so the operation in rented-warehouse have to be more effective in order to avoid more cost paid for warehouse operation. While in Onshore Based Field warehouse (owned-warehouse) the challenge will be more for

maintenance cost of the warehouses, in Offshore (rented-warehouse) will be for rental cost of the warehouse.

Figure 3.
Warehouses of National Upstream Oil & Gas Company Zona 11



Source: Author(s) 2025

In rented-warehouse of WMO & Poleng Field, the price of rental will be the area which is rent by in National Upstream Oil & Gas Company Zona 11, and also the activities provided by operator of Lamongan Shore Base, such as Cargo Handling, Jetty Services, Personel and Other Services. The cost for warehouse operation for WMO and Poleng in a year reached 23 billion rupiah for WMO and 3.4 billion rupiah for Poleng. Total cost of warehouse in WMO and Poleng contributed of 4% of its WMO and Poleng revenue, so there is Room for Improvement for more effective and efficient warehouse operation to be implemented in WMO and Poleng (National Upstream Oil & Gas Company Zona 11) warehouse operation.

LITERATURE REVIEW

a. Case-study analysis of warehouse process optimization by Margareta Živičnjak, Kristijan Rogića Ivona Bajor

- Introduction:
  - Identify bottlenecks and propose optimization methods to improve efficiency and reduce costs in Croatia.
- Research Goals:

  - Identify critical factors affecting warehouse process quality and speed.
  - Demonstrate that simple methods and tools can achieve significant optimization without complex algorithms.
- Method: Quantitative
  - Analyze the current state of warehouse systems for detecting bottleneck in warehouse process by simulation of Flexsim and Autocad.
- Main Finding:
  - Significant deviations in order-picking times due to warehouse size and layout
  - Order-picking is the most problematic process
- Research Gap:
  - Research conducted in only three warehouses storing similar goods
  - Not all optimization proposals were implemented

b. Improvement of Warehouse Operations Management by Considering Competencies of Human Resources by Ramūnas Palšaitis, Kristina Čižiūnienė, Kristina Vaičiūtė.

- Introduction:
  - Importance of Human Resource Competencies in Warehousing for Competence includes knowledge, skills, abilities, and values necessary for professional activities
- Research Goals:
  - Examine the impact of human resource competencies on organizations providing warehouse logistics services.
  - Suggest improvements for developing competencies in warehouse managers and senior warehouse managers.
- Method: Quantitative
  - Expert questionnaires were used to assess the importance of competencies.
  - The concordance correlation coefficient confirmed agreement among experts.
- Main Finding:
  - Key Competencies for Senior Warehouse Managers to warehousing processes, deployment, and development of procedures, and Examine and control inventory levels
- Research Gap:
  - The research focused on logistics companies in Lithuania, which may not fully represent global warehousing practices
  - The study does not account for dynamic changes in logistics trends or emerging technologies that may influence future competencies.

c. Improvement of warehouse logistics based on the introduction of lean manufacturing principles by Olga Voronova.

- Introduction:

  - Focuses on optimizing warehouse logistics at Coca-Cola HBC Russia in Moscow using lean manufacturing principles.
- Research Goals:
  - Study and apply lean manufacturing concepts to eliminate losses, reduce costs, and improve quality in warehouse operations.
  - Create a plan to mechanize warehouse operations, optimize space utilization, and reduce maintenance costs.
- Method: Quantitative
  - Conducted to identify the strengths, weaknesses, opportunities, and threats of Coca-Cola HBC Russia's warehouse operations.
  - Performed to assess the financial impact of proposed improvements and optimizations.
- Main Finding:
  - Correlation Between Mechanization and Costs, mechanization of warehouse operations reduces maintenance costs for finished products.
  - The warehouse's cargo turnover has steadily increased, driven by higher production volumes and demand.
- Research Gap:
  - The research is centered on the "Coca-Cola HBC Russia" warehouse in Moscow, which limits the generalizability of findings to other industries or warehouse setup.
  - The research does not compare the "Coca-Cola HBC Russia" warehouse with other similar facilities, which could provide additional insights into best practices or alternative solutions

d. Optimalisation of Internal Logistics Transport Time Through Warehouse Management: Case Study by Natalia Burganova, Patrik Grznar, Milan Gregor, Štefan Mozol.

- Introduction:
  - Effective internal logistics ensures a well-synchronized flow of materials, which is critical for production efficiency, timely deliveries, customer satisfaction, and profitability.
  - Logistics is described as a business function responsible for delivering the right goods in the right quantity, time, place, price, and condition to the right customer, ultimately enhancing productivity
- Research Goals:
  - The research aims to optimize internal logistics and warehouse management to reduce transport time and improve efficiency.
  - Streamline material flow, reduce costs, improve inventory management, enhance productivity, and achieve faster delivery of finished products to the market, leading to increased customer satisfaction and profitability
- Method: Quantitative
  - Designing supply routes and schedules for material delivery based on calculated delivery cycles, with proposed variants for routes and stops (Mily Run).

  - Introducing Kanban cards to manage material flow efficiently, enabling workers to signal replenishment needs using handheld scanners.
- Main Finding:
  - Streamlined material flow and reduced downtime.
  - Enhanced supply system through Kanban cards and Milk Run schedules.
- Research Gap:
  - The study primarily focuses on Kanban and Milk Run systems, which may not be universally applicable to all industries or logistics setups.
  - The research is based on a case study of a specific warehouse and production system, which may limit its generalizability to other contexts or larger-scale operations.

RESEARCH METHOD

For this research, authors using DMAIC methods. DMAIC is abbreviation of Define – Measure – Analyse – Improve and Control. DMAIC is one of six sigma tools for solving problem in process. DMAIC very common method for identification to creating solution in a business process. According to Chapter 11, Six Sigma: A Complete Step-by-step guide.

The Council of Six Sigma Certification, DMAIC process in general consists of 5 steps:

- Define : Define or finding issue(s), also needs to state goals
- Measure : Step of measuring or making clear impact of problems
- Analyze : Finding the root cause of problem
- Improve : Finding alternatives and solution
- Control : making plan for improvements and monitoring it.

DMAIC Cycle Method can be seen on appendix 1 and for the DMAIC steps for the research in this case:

- DEFINE Phase
  - Identification for warehouse operation process in WMO & Poleng warehouse in Lamongan Shore Base (LSB). The main activities are receiving goods from supplier, storing and preservation materials, and distributing materials mainly to handling into ships at Lamongan Jetty.
  - Identification of cost in rental warehouse of LSB for WMO and Poleng and seeking for improvement between gaps of WMO and Poleng cost differences.
  - Identification on minimum specification and approved level of safety operation in Warehouse operation such as manpower and tool-equipment.

- MEASURE Phase

Calculating cost of the existing business process, from data gathered and calculated into designated form for future comparison when improvement implemented. For this phase the cost of warehouse operation in WMO and Poleng (year 2023) reflected as table below:

Table 1.
Warehouse Operation Cost in 2023 (in rupiah)

COST ACTIVITY	WMO FIELD	POLENG FIELD
EMPLOYEE :		
DIRECT EMPLOYEES (SPV + CREW)	3,105,240,000	547,989,600
LSB SERVICES :		
RENTAL WAREHOUSE AREA	10,981,800,000	1,062,000,000
CARGO HANDLING SERVICE	7,941,124,925	2,208,638,400
JETTY SERVICE	543,100,000	15,975,000
PERSONNEL	1,920,000,000	-
OTHER SERVICES	2,087,085,000	163,743,720
TOTAL	26,578,349,925	3,998,346,720

Source: Author(s) 2025

From data shown, it is considered big cost which challenge of decreasing revenue of Company because of decreasing of crude & gas production that pressed the urgency of all cost efficiency.

- ANALYZE Phase

  In this phase author also using of Dynamic Capability approach for this research. Using Dynamic Capability pillars of Sensing – Seizing – Reconfiguring for further problem or challenge solving in warehouse cost in National Upstream Oil & Gas Company Zona 11. In this phase by Dynamic Capability pillar of Sensing, it found that the Stock Keeping Unit (SKU) of the materials were decreased, decreasing activity in WMO Field and Poleng Field, and also the ineffective number in supervisor. Yet these finding (Sensing) the will analyzed for deeper research question, and also for problem solving.

- IMPROVE Phase

  In this phase with the approach of Dynamic Capability pillar of Seizing, leadership came forward for mediating the problem solving. As mention before that there were 3 challenges of Stock Keeping Unit (SKU) of the materials were decreased, decreasing activity in WMO Field and Poleng Field, and also the ineffective number in supervisor. As the result of decreasing of oil & gas production in National Upstream Oil & Gas Company Zona 11, the company decided to reduce all activity in WMO Field & Poleng Field, resulting of decreasing warehouse activities as well.

And also with minimizing layoff policy that taken by company, it will be challenging for improvement without reducing number of direct employee in company.

- CONTROL Phase

  At this phase, author found that Top Management implemented a direct assignment of manager to execute program of efficiency, especially for SCM Manager in responsibilities of those program. By the Dynamic Capability pillar of Reconfiguring, the organization structure is modified to be less supervisor number, re-layout warehouse and re-negotiating with the Warehouse Base Operator (LSB) for reducing the cost of warehouse operation.

  Above all strategies all, still needed approval for the CEO for implementing the program. Because the program would have consequences for technical, financial and also socials (non technical) aspect. And to comply in ethical issues, ensuring that the program is minimum to any conflict especially avoiding to regulation issues and conflict of interest. Overall for research framework can be seen on appendix 2.

FINDINGS AND DISCUSSION

Base on the improvement conducted in WMO Field and Poleng Field Warehouse, combining DMAIC Methods and Dynamic Capability, is resulting of:

1. Optimizing Cost by Decreasing of Rental Area

   By the time when remapping warehouse Stock Keeping Unit (SKU) in early 2024, and justified by Management Walkthrough by Managers, it was found that many of area were not occupied or not optimized for storing stock materials. Especially in open yard because of decreasing in material stocked in open yard, which dominated by ex project material / junk. These material can be reduced by regulation in Indonesia with strategy of Extermination and Eradication to National Regulation. By this strategy, these kind of materials in upstream oil & gas business could be “returned” to the government and further action would be sold by government.

   For the other materials can be merged in area, especially many materials in area of WMO Field open storage area, moved into Poleng Field open storage area. With consideration of safety and also excellency of the operation (simple and better handling), the movement of materials were executed.

   As the result, when these materials were gone or sold, and combining storage area between WMO Filed and Poleng Field, then unused area that were occupied before could be “returned” to the Lamongan Shore Base Operator and National Upstream Oil & Gas Company Zona 11 would be charged no more on those area that were returned to the warehouse operator.

The National Upstream Oil & Gas Company Zona 11 had gained a efficiency illustrated on table below:

Table 2.
Effect for Optimizing Rental Area

COST ACTIVITY	BEFORE (IN IDR)	AFTER (IN IDR)	EFFICIENCY
LSB SERVICES :			
RENTAL WAREHOUSE AREA			
WMO FIELD	10,981,800,000	7,763,040,000	29.31%
POLENG FIELD	1,062,000,000	1,062,000,000	0.00%
TOTAL	12,043,800,000	8,825,040,000	**26.73%**

Source: Author(s) 2025

Even the efficiency on table shown, only WMO Field that gained efficiency by reducing rental area, the total efficiency by reducing rental area in Lamongan Shore Base gained for the overall for National Upstream Oil & Gas Company Zona 11. By stacking more compact in area storage and decreasing Stock Keeping Unit (SKU) had gained more than 25% efficiency for the company.

2. Optimizing Cost by Decreasing of Warehouse Activity
   As the reduction in Production activity in National Upstream Oil & Gas Company Zona 11, then activity in warehouse operation could be less efficient if run in “routine based”. So by the Sensing of warehouse activities on WMO Field and Poleng Field, it came in picture that decreasing activity can be more efficient. The execution of this strategy came in Warehouse Officer along with Warehouse Assistant Manager to do some Supply Chain breakthrough method of Milky Run and Cross-Docking.
   The Milky Run executed by combining load of WMO Field and Poleng Field when it came of cargo-dooring to ship at Jetty. The number of load could be optimized by consideration of safety practices on optimal loads of transportation. When Cross Docking was executed when shipping material directly from outside warehouse (often delivered-materials from suppliers) directly transported to the ship in Jetty. The illustration of Cross Docking can be seen on appendix 3.

The efficiency gain for activity optimization was:

Table 3.
Effect for Optimizing Warehouse Activity

COST ACTIVITY	BEFORE	AFTER	EFFICIENCY
	(IN IDR)	(IN IDR)	
LSB SERVICES :			
CARGO - JETTY - PERSON - OTHER			
WMO FIELD	12,491,309,925	6,429,091,286	48.53%
POLENG FIELD	2,388,357,120	2,208,637,200	7.52%
TOTAL	14,879,667,045	8,637,728,486	**41.95%**

Source: Author(s) 2025

The implementation of this strategy was by synchronizing and combining schedule of materials movement (cargo dooring / steve dooring) in WMO Field and Poleng Field, so in the same time the materials shipment could be compacted in more efficienty transportation, and with the one time cost, more materials could be compacted. This is the implementation of Milky Run method. For example one truck for 30 metric ton could be utilized for maximizing the load transported from combining materials from WMO Filed and Poleng Field. And for the Cross Docking implementation majority for the materials that were been purchased and supplied by supplier, then scheduled delivery to time when it would be shipped on ship. So minimizing the cost of unloading purchased material in warehouse and storing before shipped to shipment to Offshore field. So in overall reducing activities in warehouse operation in this case would be on methods of Milky Run and Cross Docking in National Upstream Oil & Gas Company Zona 11.

3. Optimizing Cost by Decreasing of Supervisor's number.

   As for these solutions, simply of reducing number of employee because of decreasing of warehouse activities. But in reality, reducing employee or related to human / people would be extra approach and other consideration to execution. Because human / people would ignite more concerns or problems when those were being laid off or even fired. So for the approach of this execution lied on leadership and also Human Resource Management (HRM). The efficiency for employee cost can be seen on appendix 4.

   National Upstream Oil & Gas Company Zona 11 has other sister company that also in upstream oil & gas business, but in different location. By the proper approach of Human Resource Management (HRM) which by remapping employee of all National Upstream Oil & Gas Companies through its Holding Company, then the map of man power in all companies can be structured. The other areas or Field on other National Upstream Oil & Gas Company had vacant position of Warehouse Supervisor. While in WMO Field and Poleng Field had "surplus" Supervisors compared to workload in its activities, the vacant position in other area could be the answered for reducing cost in warehouse cost of WMO Field and Poleng Field.

By people movement especially for WMO Field warehouse supervisor, which had initial number of 6 (six) supervisors, reduced to only 2 (two) supervisors based on number warehouse activities. The 4 supervisors whom moved to other areas still working as the warehouse supervisor, so minimizing the warehouse cost of WMO Field and Poleng Field, and in the same time Holding Company could balance man power in Warehouse Operation.

CONCLUSIONS

Based on this research, optimizing Warehouse Operational Cost in National Upstream Oil & Gas Company Zona 11 have been successfully executed through grand method of Borderless Warehouse Operation. WMO Field and Poleng Field which are separate entities or company with the right handling or approach can be united to join operation for more effective and efficient in Warehouse Operation which resulting reduction in warehouse operation cost.

In total the efficiency in warehouse operation cost of WMO Field and Poleng Field National Upstream Oil & Gas Company Zona 11 as shown in table below: Warehouse Cost of WMO Field & Poleng Field (in a year) can be seen on appendix 5.

The point of this improvement are:

1. Higher Management Commitment
   Management commitment is essential for business process and issue especially in Upstream Oil & Gas business. While its very affected by the behavioral market and demand in business sustainability issues in global industry. Commitment of reducing cost must be aligned with operational excellent with purpose for more effective and efficient warehouse operational cost. Including when team leader or top management change, the goal or the mission for goal related to company performances should be retained and delegated to successors.
2. Business Awareness of Employee
   Every employee in organization National Upstream Oil & Gas Company Zona 11 especially in direct hired, had been trained to management. Based on the training to them, then its continued by socialization of the company condition to the updated situation in WMO Field and Poleng Field. So it grew the awareness of the Leader dan Supervisor for making initiatives for improvement in Warehouse Operation.
3. Leadership of Team Leader
   Team Leader in level of Assistant Manager in the case of National Upstream Oil & Gas Company Zona 11 should have leadership for guiding the warehouse team, especially when trying to find Room For Improvement

of structuring warehouse cost. The opportunity from structured warehouse cost can be analyzed for improvement in efficiency, synchronized by business need that run by the company. And also by initiative of supervisor (as resulted from employee awareness, vital role of Assistant Manager and Supervisor fir ensuring warehouse activity delivered in standard quality required and with optimal cost or can be said reduced cost.

4. Manager Empowerement & Engagement
   While conducting implementation of Efficiency strategy, often front liner in warehouse operation confused of the mission or company goals. Manager has to be in charge to encourage front liners – supervisor and Warehouse Assistant Manager in executing the program. By Management Walk Through (MWT) more often and live discussion with all warehouse employees for making employee engagement to the aspiration of the company for more competitive in upstream oil & gas company business. With the MWT also making warehouse employees feel more that top management care with the operation, not only asking for the result gathered.

LIMITATION & FURTHER RESEARCH

Limitation of the research the quantitative based research with data only from onshore-based warehouse management in East Java. And also only for Upstream Oil & Gas industry for the sample and object for this research.

AUTHOR CONTRIBUTION

Author:

1. Combination of Dynamic Capability in Human Resource Management improving the Supply Chain Operation that has operation related to Human activity.
2. Re-evaluation of warehouse activity to similar warehouse operation for aggregation of warehouse activity, so with the same borderless treatment can result more efficient warehouse cost.
3. Optimization by digital warehousing for more effective on warehouse activity especially in Upstream Oil & Gas Business.

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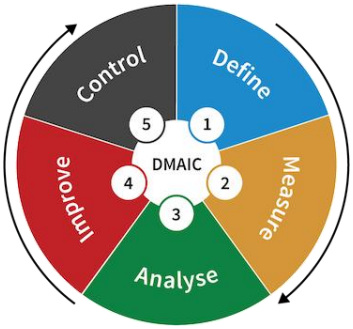
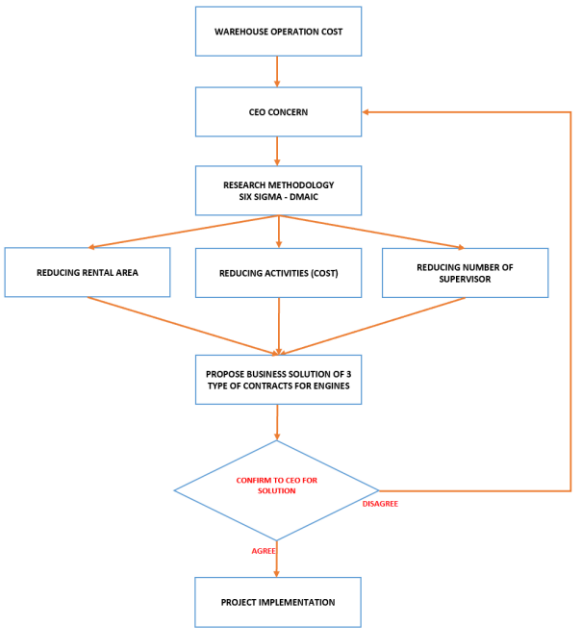
Appendix 1.

DMAIC Cycle Method



Source: Author(s) 2025

Appendix 2.
Research Framework



Source: Author(s) 2025

Appendix 3.
Cross Docking in National Upstream Oil & Gas Company Zona 11

Source: Author(s) 2025

Appendix 4.

Effect for Optimizing Direct Employee

COST ACTIVITY	BEFORE (IN IDR)	AFTER (IN IDR)	EFFICIENCY
EMPLOYEE :			
DIRECT EMPLOYEES			
WMO FIELD	3,105,240,000	1,664,520,000	46.40%
POLENG FIELD	547,989,600	547,989,600	0.00%
TOTAL	3,653,229,600	2,212,509,600	**39.44%**

Source: Author(s) 2025

Appendix 5.

Warehouse Cost of WMO Field & Poleng Field (in a year)

COST ACTIVITY	WMO FIELD		POLENG FIELD		EFFICIENCY
	BEFORE (IN IDR)	AFTER (IN IDR)	BEFORE (IN IDR)	AFTER (IN IDR)	
EMPLOYEE :					
DIRECT EMPLOYEES	3,105,240,000	1,664,520,000	547,989,600	547,989,600	39.44%
LSB SERVICES :					
RENTAL WAREHOUSE AREA	10,981,800,000	7,763,040,000	1,062,000,000	1,062,000,000	26.73%
CARGO - JETTY - PERSON - OTHER	12,491,309,925	6,429,091,286	2,388,357,120	2,208,637,200	41.95%
TOTAL	**26,578,349,925**	**15,856,651,286**	**3,998,346,720**	**3,818,626,800**	**35.65%**

Source: Author(s) 2025