

The integration of dynamic value stream mapping and cost time profile method for optimizing offshore drilling logistic base operations

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ABSTRACT

Keywords:

lean

DVSM

CT-Profile

shore base

lifting

The research aims to analyze the integration of Dynamic Value Stream Mapping (DVMM) and Cost Time Profile (CT-profile) method for optimizing offshore drilling logistic base operations. The novelty of the research is the implementation of DVMM and CT-profile that implemented in monitoring system INTACTS (Integrated Dynamic value stream mapping and Cost time profile for shore base operation) which is directly connected to shore base material movement recording system. Each successful lift performed in JIT mode will be recorded and its characteristics studied so that it can be applied to other material lifting operations. This research uses data on the lifting operation on July - December 2020. The new method is applied in a logistic system for drilling activity. The research shows that DVSM is suitable to be applied for logistics in off shore base problems since the job and situation are very dynamics.

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INTRODUCTION

Lean is an efficiency concept to use minimum effort, energy, equipment, time, facility space, materials, and capital – while giving customers exactly what they want. Lean thinking developed to extend lean concept implementation from manufacturing floor to business operation level (Gaspar & Leal, 2020; Jituri et al., 2021; Kurdve & Bellgran, 2021; Roth et al., 2020; Smith & Thangarajoo, 2015). Those methods widely spread from manufacturing industry to another type of industries including petroleum industry. Despite increasing research interest, the subject of lean concepts in the petroleum industry is still immature in terms of the types of literature identified, lack of depth of research methodology and lack of description of the lean tools used (Rachman & Ratnayake, 2019). Value stream mapping is a very important tool in lean manufacturing (Manjunath et al., 2014). The result of VSM analysis will give an insight about inefficient step (waste) in company business process. The waste shall be removed by several implementation plan to make the business process streamline and efficient. Lean emphasizes the learning by doing approach (Klein et al., 2022; Leatherbee & Katila, 2020; Parameswaran & Ranadewa, 2023; Simonyte et al., 2022). Many lean tools have been developed for lean implementation. Some of the lean methods known are: One piece flow, Poka Yoke, Visual Management, 5S, VSM, Kaizen, Kanban and Heijunka.

Each lean methods have their own characteristic. Selecting the right lean tool will be a critical step for the lean implementation in an organization. VSM provides a better view of total efficiency, not the independent efficiency of each department. VSM can eliminate 50% of waste from process/step, shorten cycle time by 30%, reduce variation up to 50% and improve product quality. One of the tools used in the early phases of lean implementation at Statoil is Value Stream Mapping (VSM) (Wasenberg, 2017). Its shows that the VSM concept has sufficient implementation flexibility in oil & gas industry. Standard VSM which is static in nature has been developed to adapt with modern situation which more dynamic and challenging. Several VSM development can be divided in four group (Lugert et al., 2018). VSM development with an organizational approach is needed so that VSM which is generally static / project-based becomes a continuous value stream mapping process. Therefore, a holistic VSM development design is carried out by integrating technical and managerial approaches into DVSM (Lugert et al., 2018). The nature of DVSM is in accordance with the character of developing organizational approaches to enhance VSM.

It was found that only 2% of organizations are actually successful at implementing lean. The reason for the VSM high failure rate is because the main focus is on the hard side lean (tools) and neglecting the soft side (culture) section (Gregory, 2012). It is clear that focusing in VSM analysis will not enough to get maximum implementation result. Organizational aspect shall be considered in the implementation plan. VSM has limitation due to its static nature, a development framework related VSM and organizational approach called Dynamic Value stream Mapping (DVSM) will maximize the implementation for dynamic environment (Lugert et al., 2018).

VSM development does not consider cost accumulation. Cost will determine the profit or loss for the company financial performance. Beside operational side, cost optimization also very important for the company (Gracanin et al., 2014). Cost time profile will give a good visual view of operational cost and time utilized in the production process. Value stream optimization is very important in the manufacturing process. VSM focuses on visualizing duration related with activities. In addition to shortening lead times, cost efficiency is also very important for the company, so controlling costs every time can be a driver for improvement (Gracanin et al., 2014).

There were many researchers who applied DVSM and cost time profile independently. However, not many discuss the combination of DVSM and CT profile. This paper developed combination of DVSM and CT profile method. The new method is applied in a logistic system for drilling operation. Drilling operation as an important part in oil and gas cycle operation. Excellent drilling operation require excellent logistic system to mobilize & demobilize the equipment in time. Shore base as central point of logistic operation system in offshore drilling activity shall provide excellence support to the drilling rig. Shore base characteristic are dynamic & punctual to synchronize with drilling operation progress. Field maturity and volatile crude oil price challenge shall be handled systematically & continuously to ensure shore base operation can be done optimally. More expensive shore base operation means more expensive drilling operation cost and more expensive oil & gas production cost. It will reduce the profit margin of the oil & gas company.

The research aims to analyze the integration of dynamic value stream mapping and cost time profile method for optimizing offshore drilling logistic base operations. The novelty of the research is the integration of DVMM & CT-profile that implemented in monitoring system INTACTS (Integrated Dynamic value stream mapping and Cost time profile for shore base operation) which is directly connected to shore base material movement recording system. The research contributes by introducing an innovative approach to optimizing offshore drilling logistic base operations through the integration of Dynamic Value Stream Mapping (DVMM) and Cost Time Profile (CT-profile) methods. This integration is novel and significant because it is implemented within a monitoring system called INTACTS (Integrated Dynamic Value Stream Mapping and Cost Time Profile for Shore Base Operation). The INTACTS system is directly connected to the shore base material movement recording system, enabling real-time monitoring and optimization of logistic base operations. This direct connection enhances the efficiency and effectiveness of managing material movements, thereby improving overall operational performance.

METHOD

The main objective of this research is implementation of the DVMM and CT-Profile concepts in shore base operations. This research is a combination of quantitative and qualitative methods. However, the portion of quantitative methods is greater (DVMM Technical infrastructure concept and CT-Profile) than qualitative methods (DVMM management approach concept), so the research flow follows more of the quantitative method concept from Silva (2017) and Lugert et al. (2018). Method of this research consist of 4 main steps. Step 1 is planning, data collection, access & preparation that focus on data preparation. Step 2 is Data Analysis to develop technical infrastructure DVMM. Step 3 is Management Approach DVMM to develop organization & communication strategy for the implementation. Then step 4 is conclusion from this research.

RESULTS AND DISCUSSION

The six lifting modes will always be occurred in shore base operations with different DVSM-CT for each mode. The dynamic shore base operational conditions mean that each lifting activity is only compatible with one of the six existing DVSM modes (TRS, S-JIT and JIT for outgoing and incoming material). In addition, the data shows that the lifting activity varies widely in each month, both in terms of the number of appointments and the composition of the lifting mode as shown in Figure 7 which shows a graph of the upward trend during July - October 2020. This situation confirmed that of shore base operations are dynamic where JIT as the best system cannot always be implemented since there many variations in material lifting systems. This requires the application of DVSM to accommodate these dynamic activities. The DVSM dashboard is expected to provide a more structured operational overview to be used as lessons learned for the next operation. Each successful lift performed in JIT mode will be recorded and its characteristics studied so that it can be applied to other material lifting operations.

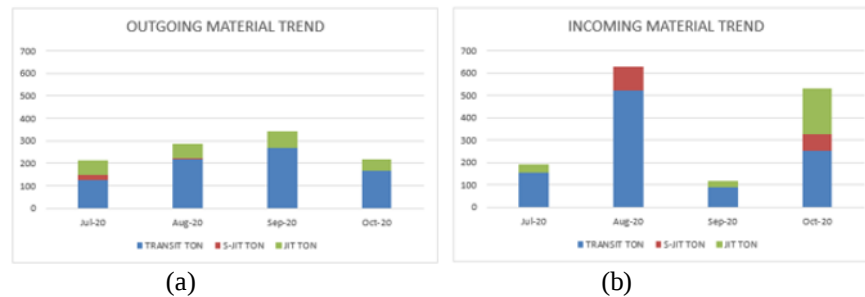


Figure 1. Lifting trend of outgoing material (a) and incoming material (b)

5 Whys analysis provides a structured and fact-based approach to problem identification and correction that focuses on not only reducing defects but eliminating it (Murugaiah et al., 2010). Using 5 Whys analysis, we find that root of the transit mode lifting operation problem is the planning of ship and truck operations that not synchronized. Truck operation planning involves drilling team and service company. Meanwhile, ship operations mostly involve rigs and shore base teams. This is a challenge for synchronization between ship and truck operations because it involves four different parties. Three internal parties (Drilling Team BPN, Rig and Shore base) and one external party (service company). Planning for the arrival of ships and trucks must be done perfectly to minimize the risk of delays in delivery, and materials can be lifted directly in Non-transit (JIT) mode.

Dashboard Shore-Base Operation

Synchronization is required between the dashboard of the shore base operation data analysis results and the DVSM concept dashboard. The main parameter in this dashboard is the lifting operation. Framework for shore base operations will use the concept of integration of DVSM & CT-Profile called INTACTS (Integrated Dynamic value stream mapping and Cost time profile for shore base operation). Meanwhile, DVSM performance will be used to show the performance of each DVSM in the appointment of the BPN service company. The fewer transit operation modes, the better DVSM the lifting operation performance. Continues improvement and communication are also accommodated in the DVSM performance dashboard. This will be very useful for evaluating the operation of lifting materials for the BPN service company on the shore base, given the very dynamic data on appointments.

DVSM performance dashboard is a summary of the operation of the appointment of the BPN service company at the shore base as shown in Figure 8. Dashboard will show the trend of lifting operations for a month. The summary of service company material lifting operations is shown in the upper left table while the composition of the lifting type and lifting weight can be seen in the lower left pie chart. However, the main part of this dashboard is the bar chart display on the right side which shows the trend of the lifting type for further evaluation. The green (JIT) and blue (S-JIT) bar chart shows that the lifting operation has been performed optimally and the orange (transit) pie chart shows that the lifting operation needs to be improved. The evaluation carried out at the end of the month is expected to provide an overview of the operating strategy next month.

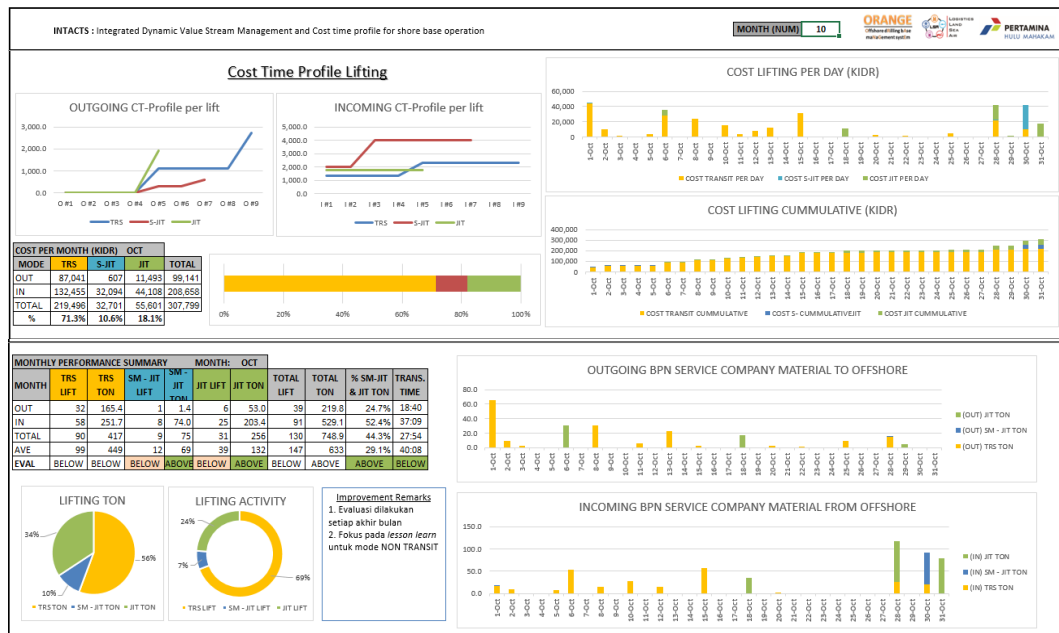


Figure 2. DVSM Dashboard

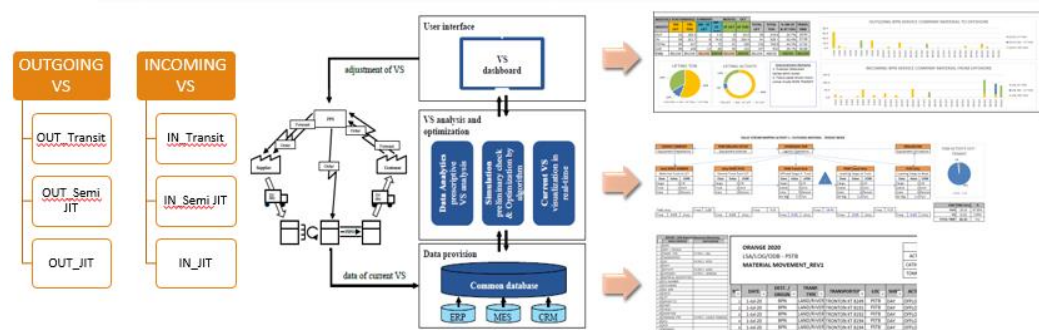


Figure 3. DVSM-CT Profile Implementation Framework

The user interface is expected to provide a comprehensive picture to the shore base team to evaluate the performance of the lifting operations for the BPN service company material. The previous month's evaluation is carried out at the beginning of each month. In the evaluation session, lessons learned from previous operations will be discussed to be used as improvement in future operations. This is in accordance with the concept of DVSM technical infrastructure which is continuous improvement because the feedback from the dashboard will be used as input value stream in the future and the next operational data will be input to the dashboard. DVSM & CT-Profile can be implemented in shore base operation as shown in Figure 9.

Management Approach

Modification of the method from a purely technical perspective using digital technology is still not enough, even if the solution comes from industry 4.0 and still need more attention to organizational and human factors (Lugert et al., 2018). This concept places the managerial approach as an integral part of the application of DVSM in the field. No matter how good the technical design is made, it still requires a human managerial role for application in the field. Communication is an important aspect of the lean process for the successful implementation of lean manufacturing.

In the philosophy of shore base operation, there are four parties directly involved in planning the material movement of BPN service company, who are a Logistics Representative, a Logistic Dispatcher, a Representative Material Drilling and a Service Company. Meanwhile other parties focus on fulfilling operational obligations, for example shore base operators ensuring the reliability of lifting equipment or ship contractors ensuring the reliability of their vessels. The implementation of the new management approach concept for shore base operations is as shown in Figure 10. The diagram does not show the organizational structure on the shore base, but rather shows the DVSM approach strategy that involves entities inside and outside the company. The blue colour represents the logistics entity at the shore base, the brown colour

represents the drilling entity at the shore base and the yellow colour represents the BPN service company entity (external party).

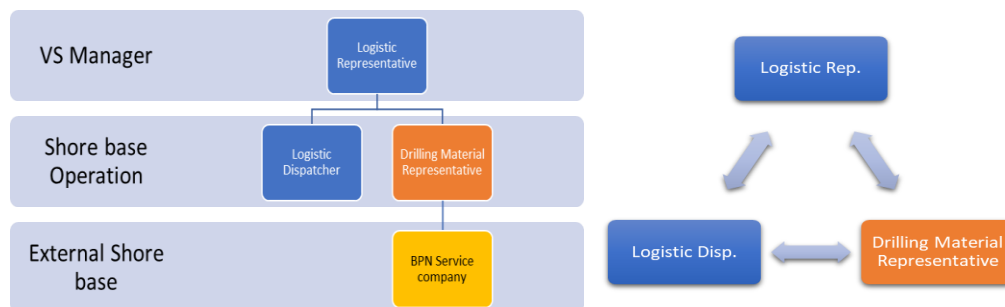


Figure 4. The New Management Approach Concept for Shore Base Operations

This research uses data on the lifting operation on July - December 2020. The first phase of data collection and analysis was carried out in July - October 2020. After that, a more intense campaign and discussion was carried out with the shore base team in November - December 2020. The main indicators used for assessing the operating performance of the appointment of the BPN Service company is the percentage of the transit rate (%) which shows how many transit mode operations are carried out for the BPN Service company material. The analysis results in Figure 11 show that at the first phase, the transit rate (July - October 2020) is 77.2% while at the second phase, the transit rate (November - December 2020) is 71.2%. This shows an increase in the optimization of the appointment of BPN Service companies by 6% in two months of implementation. Lower percentage of transit rate means lower of the number of appointments, activities and operating costs.

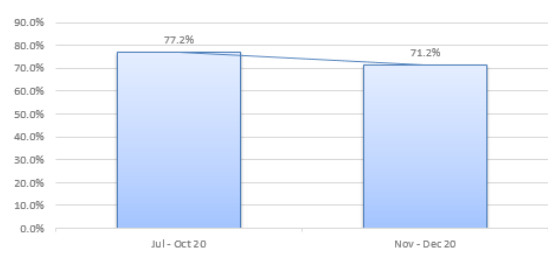


Figure 5. Transit rate comparison before and after DVSM-CT profile implementation

Monthly meetings to discuss the performance of shore base operations will deepen the understanding, ideas and solutions of the team so that the logistic performance can be improved continually. Good cooperation and communication will be the key to the success of implementing lean thinking on the shore base.

CONCLUSION

The application of the DVSM and CT-Profile concepts in the field of oil and gas logistics requires some adjustments from the concept of activity flow on the production floor (manufacturing) to the flow of logistical activities (material movement on the shore base). The integration of DVSM and CT-Profile is carried out with the concept of INTACTS (Integrated Dynamic value stream mapping and Cost time profile for shore base operation). The INTACTS system will provide the results of the evaluation of the BPN service company's material lifting operations. So that the shore base team can develop a better operating strategy to maximize the concept of JIT lifting which can reduce 66.7% of total lifting and 58.8% of lifting costs. An organizational approach that is designed in accordance with the organizational structure on the shore base so that continuous improvements can be made.

The implementation of INTACS reduce transit rate from 77.2% to 71.2% in two months (6% reduction). The smaller the transit rate, more optimal the operation. Monthly meetings to discuss the performance of shore base operations will deepen the understanding of the shore base team's lean thinking to operate more optimally in a gradual and sustainable manner. The evaluation and optimization of shore base operations can be carried out comprehensively, starting from lifting operations, ship docking, storage and all activities that raise costs by using the dashboard of DVSM and CT-profile.

The application of the DVSM & CT-Profile integration concept in the field is a never-ending process. Lean thinking must be instilled and well understood by every individual at the shore base. Optimization that is

gradual but consistent will have a positive impact on shore base operations, therefore the main thing that is needed by the shore base team is to continuously implement lean thinking with the INTACS concept.

This research shows that DVSM is suitable to be applied for logistics in off shore base problems since the job and situation are very dynamics. In this research, the DVSM and CT-profile application as novel approach to integrate technical, organizational and cost concern are applied directly in shore base field. However, there are some situations where the method cannot be applied directly and need more analysis using simulation. Therefore, the application of simulation to evaluate DVSM and CT-profile will be an interesting topic for the next research.

REFERENCES

- Gaspar, F., & Leal, F. (2020). A methodology for applying the shop floor management method for sustaining lean manufacturing tools and philosophies: a study of an automotive company in Brazil. *International Journal of Lean Six Sigma*, 11(6). <https://doi.org/10.1108/IJLSS-09-2019-0098>
- Gracanin, D., Buchmeister, B., & Lalic, B. (2014). Using cost-time profile for value stream optimization. *Procedia Engineering*, 69. <https://doi.org/10.1016/j.proeng.2014.03.113>
- Gregory, B. (2012). The softer side of lean: Analyzing corporate culture can point the way to necessary changes. *Human Resource Management International Digest*, 20(6). <https://doi.org/10.1108/hrmid.2012.04420faa.003>
- Jituri, S., Kaur, R., Mourtzis, D., Fleck, B., & Ahmad, R. (2021). A decision support system to define, evaluate and guide the lean assessment and implementation at the shop-floor level. *International Journal of Manufacturing Research*, 16(4). <https://doi.org/10.1504/ijmr.2021.119650>
- Klein, L. L., Alves, A. C., Abreu, M. F., & Feltrin, T. S. (2022). Lean management and sustainable practices in Higher Education Institutions of Brazil and Portugal: A cross country perspective. *Journal of Cleaner Production*, 342. <https://doi.org/10.1016/j.jclepro.2022.130868>
- Kurdve, M., & Bellgran, M. (2021). Green lean operationalisation of the circular economy concept on production shop floor level. *Journal of Cleaner Production*, 278. <https://doi.org/10.1016/j.jclepro.2020.123223>
- Leatherbee, M., & Katila, R. (2020). The lean startup method: Early-stage teams and hypothesis-based probing of business ideas. *Strategic Entrepreneurship Journal*, 14(4). <https://doi.org/10.1002/sej.1373>
- Lugert, A., Völker, K., & Winkler, H. (2018). Dynamization of Value Stream Management by technical and managerial approach. *Procedia CIRP*, 72. <https://doi.org/10.1016/j.procir.2018.03.284>
- Manjunath, M., Prasad, H. S., Kumar, K. K., & Deepa, P. (2014). Value stream mapping as a tool for lean implementation: A case study. *International Journal of Innovative Research & Development*, 2(4).
- Murugaiah, U., Benjamin, S. J., Marathamuthu, M. S., & Muthaiyah, S. (2010). Scrap loss reduction using the 5-whys analysis. *International Journal of Quality and Reliability Management*, 27(5). <https://doi.org/10.1108/02656711011043517>
- Parameswaran, A., & Ranadewa, K. A. T. O. (2023). Learning-to-learn sand cone model integrated lean learning framework for construction industry. *Smart and Sustainable Built Environment*. <https://doi.org/10.1108/SASBE-10-2022-0234>
- Rachman, A., & Ratnayake, R. M. C. (2019). Adoption and implementation potential of the lean concept in the petroleum industry: state-of-the-art. *International Journal of Lean Six Sigma*, 10(1). <https://doi.org/10.1108/IJLSS-10-2016-0065>
- Roth, N., Deuse, J., & Biedermann, H. (2020). A framework for System Excellence assessment of production systems, based on lean thinking, business excellence, and factory physics. *International Journal of Production Research*, 58(4). <https://doi.org/10.1080/00207543.2019.1612113>
- Simonyte, S., Adomaitiene, R., & Ruzele, D. (2022). Experience of lean application in higher education institutions. *International Journal of Lean Six Sigma*, 13(2). <https://doi.org/10.1108/IJLSS-11-2020-0208>
- Smith, A., & Thangarajoo, Y. (2015). Lean Thinking: An Overview. *Industrial Engineering and Management*, 04(02). <https://doi.org/10.4172/2169-0316.1000159>
- Wasenberg, M. (2017). *A review of lean and the lean and the lean implementation in Statoil* [Master Thesis]. University of Stavanger.