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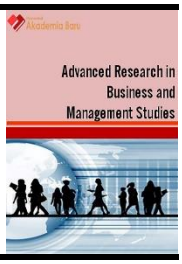

Strategic Deployment of Lean Six Sigma in Managing Inventory Escalation Issue

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ABSTRACT

Due to the massive evolution induced by information and communication technology in all aspects of life, organizations are experiencing rapid changes in organizational management, technical as well as operational aspects. Organizations need to improve their business processes in order to achieve customer demands and satisfaction and maintain competitive position in the market. A diversity of methodologies is available for process improvements. Lean Six Sigma is one of the most comprehensive methodologies known since more than fifteen years ago. Said to be originated by Toyota Japan and made famous by General Electric of USA. This paper presents an inclusive review on the deployment of Lean Six Sigma as a strategic tool or methodology in enhancing the level of efficiency in the specific business process in the organization under study. The aim was to evaluate the impact of Lean Six Sigma tools on the certain scope management process. In this study, the case was strategic inventory management. Based on the outcomes of the implementation, it can be stated that Lean Six Sigma tools have positive impact on the management process by eradicating wastes, improve internal process efficiency and optimizing the internal costs.

Keywords:
Lean, Six Sigma, Lean Six Sigma, Business Process Improvement, Structured Business Process Methodology, Value Optimization, Inventory Management

1. Introduction

The organization under studied decided to embark on Lean Six Sigma since 2016 as strategy to improve the company's internal processes to make it more competitive to face the ever challenging business environment. In the first phase of its implementation, one of the projects was Warehouse Inventory Value Optimization at one of the power plants. Details of the projects and their outcomes are described later in this paper. In one of the power plant owned and operated by the company, it was observed that the inventory value is building up from year to year at average about 9% per year. The management foresee that a strategic plan is required to ensure that the build up of inventory is kept well under control. The study began in 2016. The applicable data was collected based on records from 2015. In this paper, the author reviewed and reported the observations and findings as at August 2018.

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2. Methodology

Lean Six Sigma is a methodology that is characterized by five (5) steps namely Define, Measure, Analyze, Improve and Control [1][2][4][6]. This is further explained as follows.

2.1 Define Phase

The purpose of the define step to establish clear goals and objectives of the project [1]. During the phase, a project charter was developed, which included problem and goal statements, the scope for the project and the customer deliverables[2][4]. While it is very important to focus on defining what the problem is and what will be delivered at the end of it from a customer's point of view, it is of equal importance to identify what items will be considered to be in scope for the project to avoid project overrun [7]. The primary objective of this project is to establish strategy to reduce inventory values at the particular operating site to minimum by the end of the Power Purchase Agreement (PPA). The Project Charter is as shown in Figure 1.

PROJECT CHARTER

Project Champion: HEAD OF DIVISION
Co-Sponsor: PLANT MANAGER

Project Leader (BB/GB) : Black Belt Leader

CURRENT SITUATION/BACKGROUND	**VOICE OF CUSTOMER/STAKEHOLDER ANALYSIS**	**PROJECT TITLE**
Inventory value is build up from year to year at average about 9% per year that causes high inventory value. Strategic plan required to ensure the build up of inventory in control.	**Voice Of Customer/Stakeholder (VOC)** Inventory Value Optimization **Stakeholder Needs** • Reduce inventory Value • Optimize spare parts usage & purchase **Stakeholder Specific Needs** Reduce Inventory value	**Inventory Value Optimization** To Establish strategy to reduce inventory value to minimum value by the end of PPA (Subsidiary A by 2027 & Subsidiary B by 2022)
PROJECT GOAL	**ESTIMATED COST SAVING**	**KEY ACTION (CURRENT)**
✓ To reduce Inventory Value by 20% ✓ To establish strategy by end of July'17	RM60mil (subject to outcome of Analysis & improve stage)	- Develop fish bone diagram - Develop data collection plan - Process mapping - Develop FMEA
BARRIERS TO SUCCESS	**PROCESS SCOPE**	**KEY TEAM MEMBER**
✓ Segregation of spares and consumables in the inventory list ✓ Identification of parts categories critical & Non critical ✓ To get commitment from the resources required within the team	**Start Process:** Spare parts Planning/reservation – Plant & HQ **End Process:** Material Out to End User **PROJECT SCOPING** **In Scope:** Subsidiary A & B Spare parts inventory **Out of Scope:** Consumable, Non-stock, Plant C & Plant D	1. Mohd Norazam Shah 2. Mohd Rafee(BPI) 3. Ezraila (Commercial) 4. Zaidi Zainol (HEM) 5. Mohd Sharizal (HOS) 6. Asrulnizam (Warehouse LPP) 7. Raziyah (Account) 8. Haslina (Planner LPP) 9. Sarihan (EA) 10. Engineering Team (LPP)

Fig. 1. The Project Charter

2.2 Measure Phase

In measure phase, the identification and development of a number of metrics for the inventory management and control were conducted, to identify possible areas for improvement and evaluate their impact in the overall process [1][2]. The first set of data was the value of inventory in Ringgit Malaysia (RM) from 2015 until 2017. This is as shown by Figure 2. In 2016, the total value of the inventory was approximately RM351 million.

Based on the collected data, there was need to further study the contributing factors to the problem and further stream down to identify the most significant factors, also known as the Vital Few Factors (Xs) affecting the outcome (Y) of the project, i.e. factors those contributed significantly towards high inventory value and cost escalations [11][19].

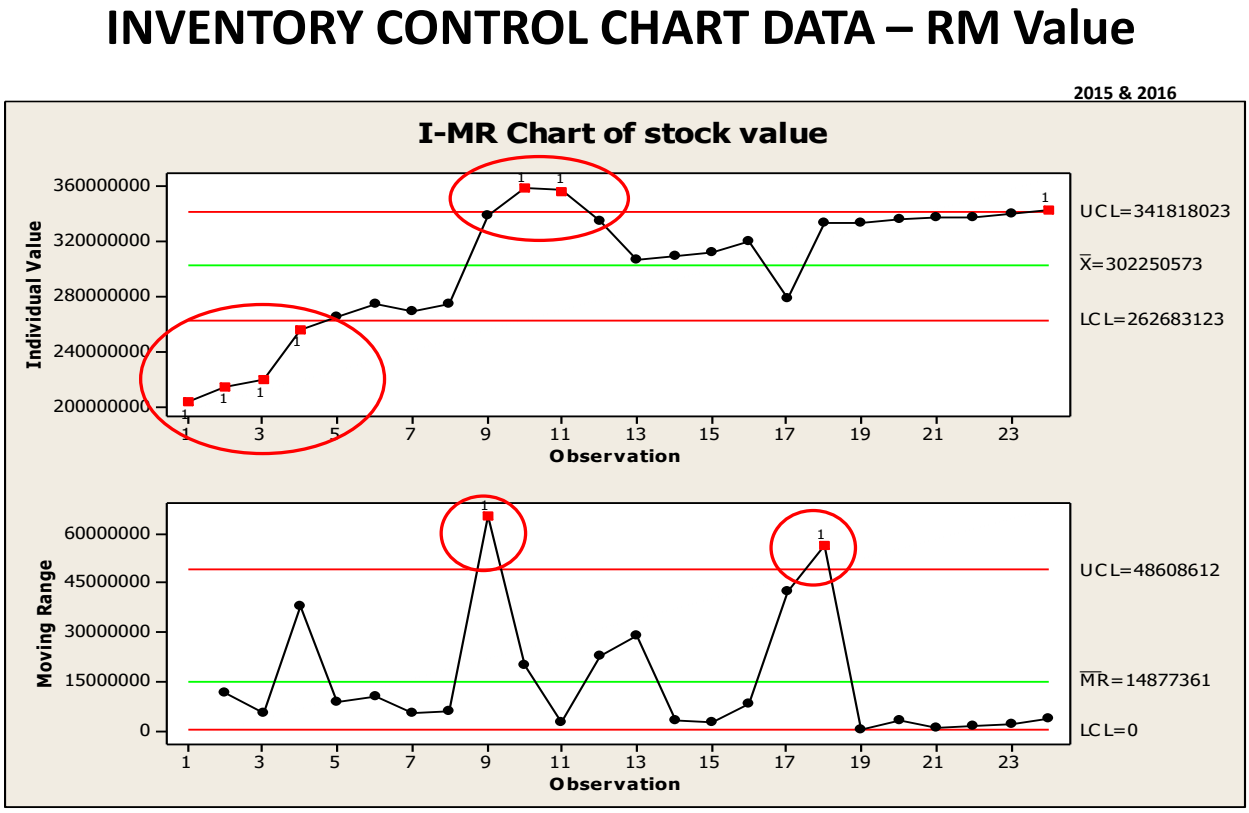

Fig. 2. Data of Inventory Value (RM)

2.3 Analyze Phase

In analysis step, the factors those significantly contribute towards the problem were determined [1][2]. The process was to identify all the factors thought to be the root cause of the problem. For this exercise, brainstorming was conducted between the project team members and supported by the members from site. Fishbone Diagram was drawn and established. The following step was to further challenge which factors were the most likely being more significant than others [17][19]. From the ranking exercise, the team agreed that there were 9 factors out of 25 factors listed initially as described in the initial list of possible contributing factors.

2.4 Improve Phase

Following the Analyze Phase, the team deduced the following recommendations to improve the inventory management in accordance to the project goal as set out in the project charter. In the Improve Phase, the proposed solutions or recommendations generated during Analyze Phase were further refined and the recommended actions were then prioritized [16][17][19].

Factor 1 – Outage Schedule Management

The recommendations were to optimize the major overhaul cycles, by optimizing the interval between the Major Inspections of any units to coincide with timing of refurbishment the spareparts. Next, was to optimize the running hours by negotiating the dispatch factor pattern with the electricity off-taker and to perform intermediate inspection in order to gain 10% extra Equivalent Operating Hours (EOH) prior to the Major Inspection. This involved more critical outage planning and the final recommendation was to maximize the EOH of the operating Gas Turbine units before end of the Power Purchase Agreement (PPA).

Factor 2 - Contractual obligations related to spareparts

At this stage, the team recommended to seek management consent for waiver of certain clauses regarding inventory, including to resolve the issues on categorization of Initial Spares, Emergency Spares & Noble Parts (gas turbine main spareparts).

Factor 3 – Gas Turbine Spareparts Management

The objective was to optimize usage of Gas Turbine spares. The recommendation was to sell those disposable items and adopt just-in-time strategy to ensure that the materials are delivered just-in-time before or during the scheduled inspection period.

Factor 4 – Long delivery lead-time of the spareparts

For spareparts those have long lead time before delivery, it was recommended to synergize with other power plants for spare part sharing. Other recommendations are to collaborate with Original Equipment Manufacturer (OEM) for parts storage at their warehouse (preferably close to plants site) and to further strengthen the planning towards outage program.

Factor 5 – Redundant or duplication of spareparts

For redundant spareparts, or if parts were commonly used for both power plants, only one common material group number (Material Code) should be assigned. Only one common material number for all identical spareparts shall be maintained. The extra materials, particularly those not required immediately shall be sold or auctioned.

The proposed solutions were then ranked and their priority in which there were to be implemented were prioritized [11]. During prioritization stage, three criteria were chosen. For each of the criteria, they were given weightage (%). The decision for the criteria and their weightage were based on the standard guide set by the Lean Six Sigma Secretariat based on advice by the Lean Six Sigma Consultant and endorsed by the Lean Six Sigma Supreme Council set earlier. The criteria were the Process Impact, or the degree of difficulty to implement the solutions (45%), Time Impact, i.e. the time required to implement the solutions (25%) and Cost to Benefit Impact (30%).

2.5 Control Phase

Control Phase is the stage whereby the recommended solutions were then put forward for implementation [3][5]. There were seven (7) detailed solutions, deduced from five (5) Contributing Factors were shortlisted for implementation. These solutions were approved to be implemented by the Approving Council as they are within the control of the organization [19]. Other proposed solutions those not directly within control of the organization were dropped from the list.

The recommended solutions were prioritized in the following order as shown in Table 1.

Table 1
List of Approved Solutions

NO.	RECOMMENDED SOLUTIONS	SHOW STOPPER	ROOT CAUSE FACTOR (Xs)
1	Seek management approval to waive / amend certain clauses present in the inter subsidiary agreement (Operation & Maintenance Agreement) related to the obligations to maintain the inventory level.	No getting the approval from management review the agreement.	X2 – Contractual obligations related to spareparts
2	To review and assign only one material number (code) for identical spareparts.	Not agreed by the subsidiary's owner.	X9 - Redundant Spares (duplication)
3	Resolve issues on categorization of Initial Spareparts, Emergency Spareparts & Noble Spareparts.	Not agreed by the respective management of the subsidiaries to review the agreement.	X2 – Contractual obligations related to spareparts
4	Perform intermediate inspection to gain 10% extra Equivalent Operating Hours (EOH) prior Major Inspection (C – Inspection).	Fail to obtain approval from the management.	X1 – Overall outage spareparts management
5	To dispose or auction the extra / redundant spareparts.	Fail to obtain approval from the respective management of the subsidiaries.	X3 - Gas Turbine spareparts management
6	To dispose or auction the extra / redundant spareparts from the initial handover of spareparts.	Fail to obtain approval from the respective management. Fail to obtain consent from the related parties to review the contractual requirements or obligations.	X9 - Redundant Spareparts (duplication)
7	Maintain 1 common number for all duplicated spares.	Fail to obtain local plant management consent.	

3. Observations

By 2018, the following actions items have been completed:

1. Review of redundant (duplicated) spareparts to identify and assign only a single Material Number (Material Code) for identical spareparts.
2. Identify surplus or extra material resulted from Item No. 1.
3. Coordinate between Operation, Maintenance, Procurement as well as the Head Quarters teams in terms of strategic purchasing of spareparts following Items 1 and 2.
4. Approval from the Board of Directors (management) has been obtained to amend certain clauses in the inter-subsidiary agreement (Operation & Maintenance Agreement). The

clause whereby the operator needs to replenish all spareparts once consumed has been waived.

5. Segregation of spareparts and consumables in the overall inventory list
6. Identification of spareparts categories for critical and non-critical spareparts

There were also a number of action items those require approval by the Top Management (Board of Directors) as follows:

- To dispose or auction the extra / redundant spareparts as identified in Item 2 above. This is also linked to the risk appetite of the organization, whereby the action could increase the risk of spareparts stock-out during unscheduled shutdown or emergencies.
- The status of Power Purchase Agreement, either to propose to the customer (off-taker) be extended or otherwise.

Apart from the list of action items to be implemented, the team also recommended specifically who or which party to implement the action items [19]. The feedback received were time constraints by the power plant people due to their existing day-to-day task. At this juncture, support and direction from the top management was obtained to emphasize the importance to carry out all the approved Lean Six Sigma recommended action items within the stipulated timeline. With clear direction by the top management and commitment by the relevant parties, most of the action items were successfully implemented and the result was very positive.

4. Results and Discussion

From the study conducted and based on experience gained, it can be deduced that Six Sigma is indeed a business strategy that can provide a breakthrough improvement. However, there were also factors or elements those were not under full jurisdiction of the organization. For the purpose of practicality, solutions those cannot be implemented by the organization were removed [19]. This may not be ideal from Lean Six Sigma perspective, by removing the uncontrollable solutions from the list, these lead to Lean Six Sigma generated solutions to be practical for implementation.

Another challenge faced was the difficulty to obtain data in terms of quantity as well as quality. For the organization that is the first time embarking on Lean Six Sigma Program, it is very important to recognize the need to archive data in structured way for easier retrieving and analysis later [8]. Lean Six Sigma demands time commitment from the team leaders, team members as well as the project sponsors and the top management itself [7][11]. All team leaders, team members as well as the sponsors have their existing day-to-day operational tasks. Involvement in Lean Six Sigma was additional task. At this juncture, support and direction from the top management is seriously needed to emphasize the importance to carry out all the approved action items within the stipulated timeline.

The overall result of the implementation of Lean Six Sigma methodology to manage and control spareparts inventory in the particular organization is as shown in Figure 3. From the exercise, it can be deduced that the deployment of Lean Six Sigma as a structured methodology has successfully aided the organization to manage the inventory level to meet the project objective as described in the approved Project Charter.

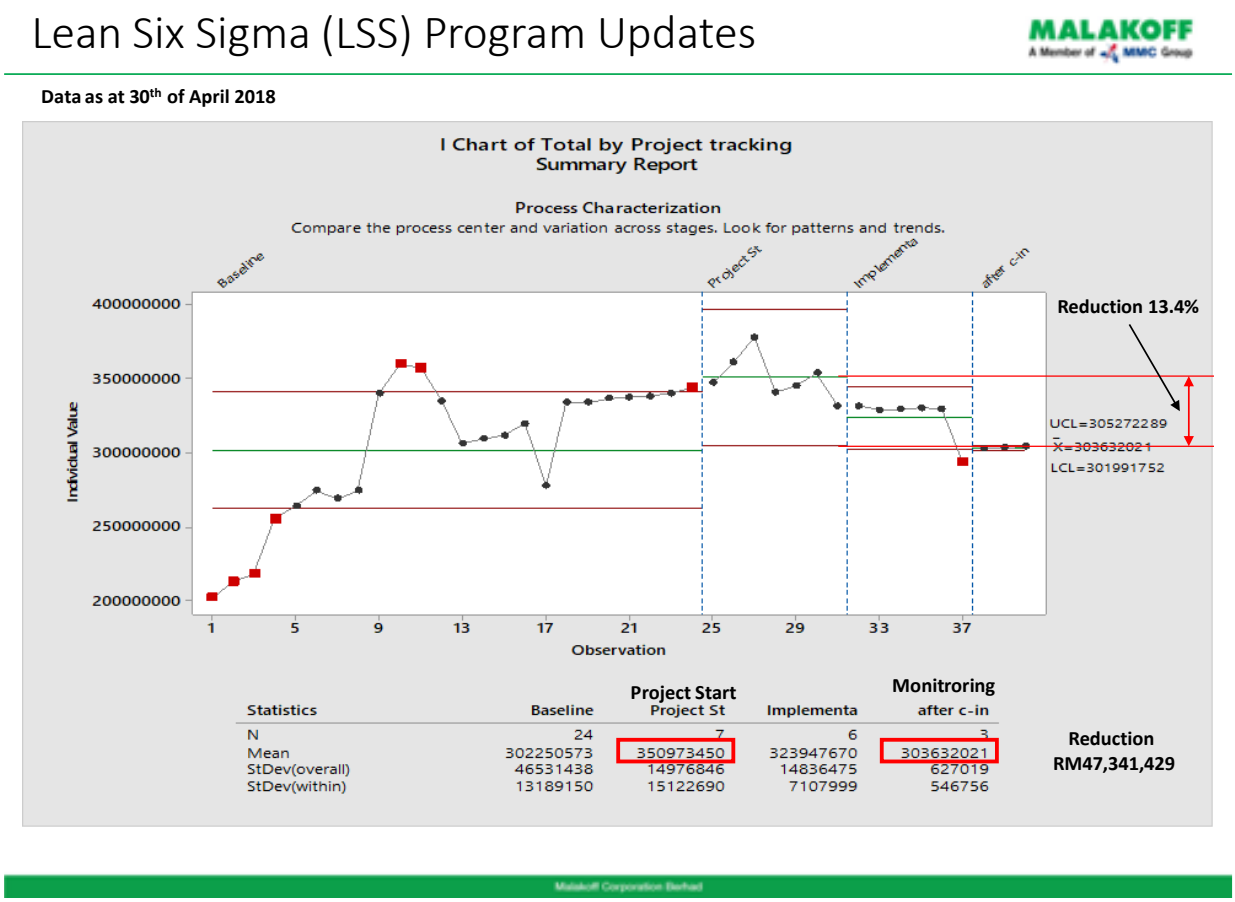

Fig. 3. Data of Inventory Value (RM) as at April 2018

Based on the data collected in April 2018, the total inventory level was at RM303,632,021. The result showed a reduction of inventory level from RM350,973,450. The difference was RM47,341,429 or 13.5% from the initial total value of the inventory. With reference to the target stated in the Project Charter, it was to reduce the inventory by 20% from the initial figure. From one aspect, the actual result may not be meeting the project's initial objective or target. However, the reduction of 13.4% is considered as significant considering from the Lean Six Sigma exercise, the direction from now onwards is much more definite compared to before. It can be concluded that the project was successful in setting up a clear direction for a given problem which had no clear direction earlier. With the implementation of Lean Six Sigma, the personnel involved were more accustomed with the methodology to solve problems based on data collected, followed by a structured way to analyze the data.

From the exercise, a list of action items was generated. A number of these action items were beyond the level of authority of an individual employee or even department or division. Some of the action items required approval or endorsement by the top most management level for a given organization, such as the Board of Directors themselves. In this project, there were also a number of the proposed action items those involved external parties, such as the electricity off-taker. Action items those were beyond the control of the organization were then removed from the list. Nonetheless, even with the uncontrolled factors or action items removed, the result has shown that Lean Six Sigma is still an effective tool that managed to deliver very positive outcomes.

6. Conclusion

Lean Six Sigma is a methodology that characterized by five (5) steps namely Define, Measure, Analyze, Improve and Control. Define phase was to establish clear goals and objectives of the project. A project charter was developed, which included the problem and goal statements, the scope for the project as well as the customer deliverables. In Measure phase, it was the identification and development of a number of metrics for the inventory management and control, to identify possible areas for improvement and evaluate their impact in the overall process. During Analyze and Improve phases, the proposed solutions were then ranked and their priority in which there were to be implemented were prioritized. Control phase is the stage the recommended solutions were then put forward for implementation. There were seven (7) detailed solutions, deduced from five (5) were shortlisted for implementation. These solutions were approved to be implemented by the Approving Council as they are within the control of the organization. Other proposed solutions not directly within control of the organization were removed from the list.

From the implementation of Lean Six Sigma methodology, it can be deduced that Lean Six Sigma is a structured methodology that has successfully aided the organization to manage the inventory level to meet the project objective as described in the approved Project Charter. The result showed a reduction of inventory level amounted RM47,341,429 or 13.4% from the initial total value of the inventory. The reduction of 13.4% from the target of 20% was considered significant considering that the direction from now onwards is much more definite compared to before.

It can be concluded that the project was successful in setting up a clear direction for a given problem. With the implementation of Lean Six Sigma, the personnel involved were more accustomed with the methodology to solve problems based on data, followed by a structured way to do analysis. Action items were systematically generated. A number of the action items were beyond the level of an individual employee, department or even division. A number of the action items required approval or endorsement by the top most management level for a given organization, such as the Board of Directors. These top level approvals were obtained in order for the action items to be completed. Proposed solutions beyond the reach of the organization were removed. Even with the uncontrolled action items removed, the result has shown that Lean Six Sigma is an effective tool that has delivered very positive outcome for a given specific and quantifiable problem. It was also concluded that inability to achieved the target objective of 20% was contributed by the list generated solutions cannot be implemented as they were beyond the boundary of the organization.

References

[1] Susana Portillo. “Using Lean Six Sigma in Business Surveys; Practical Example.” (2016)
[2] Bevan, Helen. *Lean Six Sigma: some basic concepts*. NHS Institute for Innovation and Improvement, 2006.
[3] Kumar, Sanjay, Sunil Luthra, D. Garg, and A. Haleem. "Lean six sigma implementation: An analytic hierarchy process approach." In *NITIE-POMS Conference 2014 on Manufacturing Excellence: Imperatives for Emerging Economies at National Institute of Industrial Engineering*, pp. 18-21. 2014.
[4] Mousa, Ahmed. "Lean, Six sigma and Lean six sigma overview." *International Journal of Scientific & Engineering Research* 4, no. 5 (2013): 1137-1153.
[5] Agus, Arawati, and Rosman Iteng. "Lean production and business performance: the moderating effect of the length of lean adoption." *Journal of Economics, Business and Management* 1, no. 4 (2013): 324-328.
[6] Muthukumaran, G., V. S. K. Venkatachalapathy, and K. Pajaniradja. "Impact on integration of Lean Manufacturing and Six Sigma in various applications-a review." *Journal of Mechanical and Civil Engineering* 6, no. 1 (2013): 98-101.
[7] Omar, Aminudin, and Zainol Mustafa. "Implementation of six sigma in service industry." *Journal of Quality Measurement and Analysis* 10, no. 2 (2014): 77-86.
[8] Doug Penner. “Lean Six Sigma for Medical Practices: Opportunities for Performance Improvement.” (2013)
[9] Lindquist, Kathy. "Synthesis of lean information and practice in government." *Pridobljeno* 5, no. 7 (2013): 2015.

[10] Radnor, Zoe J. *Review of business process improvement methodologies in public services*. London: Aim Research, 2010.
[11] Biao Hu & Yun Tian. “Six Sigma applied in inventory management.” (2011)
[12] Benmamoun, Zoubida, Hanaa Hachimi, and Aouatif Amine. "Inventory management optimization using lean sixsigma." (2012)
[13] Kholopane, P. "The Effect of the Implementation of Six Sigma in Reducing Obsolete Stock and Controlling Stock Inventory at a Flavor Manufacturing Company: A Case Study." In *International MultiConference of Engineers and Computer Scientists*. 2016.
[14] “Inventory at a Flavor Manufacturing Company: A Case Study." In International MultiConference of Engineers and Computer Scientists. (2016)
[15] Marasli, Hikmet, Rabia Sultan Halis, and Muhammed Furkan Halis. "Lean Medical Inventory Management in Hospitals." *Journal of Academic Value Studies* 3, no. 8 (2017): 16-2.
[16] Al-Qatawneh, Lina, Abdallah Abdallah, and Salam Zalloum. "Reducing stock-out incidents at a hospital using Six Sigma." *World Academy of Science, Engineering and Technology* 7, no. 5 (2013): 404-411.
[17] Manurung, Sotarduga. "Improvement material inventory tracking for maintenance and project through lean sigma methodology." (2014): 519-530.
[18] Choong, Kei Shing, Santhirasegaran Nadarajan, and Sitraselvi Chandren. "Scraps management with lean six sigma." *International Journal of Supply Chain Management (IJSCM)* 3, no. 3 (2014): 121-127.
[19] MdSaad N A. “Deployment of Lean Six Sigma in Strategic Inventory Management”. *Journal of Advanced Research in Business and Management Studies* 13, no. 1 (2018): 39 – 54.