

LEAN ASSESSMENT FOR MANUFACTURING OF RUBBER INDUSTRY IN THE NORTHEAST OF THAILAND: A CASE INDUSTRY OF SMALL AND MEDIUM ENTERPRISES (SMES)

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Abstract— Lean assessment is created as a guide for the organization in their lean journey. Therefore, lean assessment is provided a baseline upon improved most importantly and referred on what to do. This research are aimed at assessing for manufacturing to order leanness of an rubber industry in the Northeast of Thailand: A case industry of Small and Medium Enterprises (SMES). There are 14 criteria of lean technique and tools. The value of lean assessment criteria was scoring system derived from the Malcolm baldrige national quality award, the two-dimensioned scoring system composing of the process including approach (A), deployment (D), learning (L), and integration (I) reveal operations of each of lean techniques and tools, and the performance classified 0 - 4 level. They needed to be improved in depth for each by followed ADLI and then would reflect level of operations requiring sustainable outcomes. Assessor had been coming to sit and explaining 14 criteria to coordinator or production manager before he examined operations from a lean perspective and assessed the situation as prior. He taken a day to assess and discussed the lean assessment result with them. The finding of lean assessment was rubber industry have lowest of leanness comparing to other SMES. Highest scoring of lean technique and tools implemented, that was line balancing. The SMES will put a customized plan, training, designed to help make the improvements necessary to SMES continuous improvement.

Index Terms— Lean Assessment, Lean Manufacturing, Lean Tools, SMES.

I. INTRODUCTION

The direct creation of value for the end customer is lean manufacturing philosophy that considers the expenditure of resources in any aspect to be wasteful. The waste is a target for elimination [1].

Lean assessment is created as a guide for the organization in their lean journey. Therefore, lean assessment is provided a baseline upon improved most importantly and referred on what to do. Step by step is a plan putting a lean roadmap specifying to organization, training designed to help make the improvements necessary, then implement and monitoring. Based on organization needs, implementing of lean practices can help them in save money, increase sales, reduce cycle time, reduce inventory and work-in-process, increase capacity, increase productivity, improve quality [3].

Allocating of the appropriate resources identified by score of lean assessment will help your organization to do effectively [2]. They are classified to each of step. Some organization carry the scoring to be communicated to improvement team. Many organizations of manufacturing are timely to do but unconfident of where/what to start and actually desires to be done? Factors can influent transform to clothing industry Thailand's SMEs that is leadership, investment, teamwork, and R&D. And also the leadership must hold set vision and goals [11].

China is the No. 1 tire producer and has continually expanded. In 2013, 413.2 million car tires and 79.6 million truck tires, accounting for 25% and 44% of world tire production respectively are manufactured by China. China's utilization order of natural rubber

(NR) accounting for 70% of the world total is consequently highest for tire production. Thailand is China's biggest NR source of imports. They manufacture roughly approximated to 4,200,000 ton of NR, followed by 3,170,000 tons of Indonesia and 840,000 tons of Malaysia in 2014[14]. As in [5] expected that the demand for NR in the world will be raised by the2014 since china and India continuously demand in the automotive industry and also the economic recovery of the world regressive will be

raise the demand for NR increased slightly from a year ago. The data above recommends that rubber industry's potential and growth have positive impact on the economy of ASEAN, especially in Thailand. Therefore, it is necessary that Thai SMEs are creating their manufacturing with lowest cost continuously improving. From information above, we find Rubber Industry mostly in value of assessment. This information led to our decision to assess it. So, this research are aimed at assessing for manufacturing to order leanness of an rubber industry in the Northeast of Thailand.

II. RESEARCH METHODOLOGY

Quantities of lean assessment have been developed to help organizational giving the progress becoming a lean manufacturing. As in [4] are address that the multiple dimensions of a lean manufacturing are synthesized an overall structure integrating from previously development. Outside the structure, manufacturing equipment and processes, shop floor management, new product development, supplier

management, customer relations, and workforce management are six impact areas clear and then used as the basis for the development of survey questions. Respondents are asked to evaluate how often a specific lean practice used within their organization. Resembling, as in [6] establish a spreadsheet-based is assessment tool used nine key areas of manufacturing. Inventory, team approach, processes, maintenance, layout/handling, suppliers, setups, quality, and scheduling/control are focused from participants answer questions for each area. As in [7] apply the system consists of three leanness level which is first level consists of Management responsibility leanness, Manufacturing management leanness, Workforce leanness, Technology leanness, Manufacturing strategy leanness. Then second level consists of 20 lean criteria and the third level consists of several lean attributes. The importance of assessment as manufacturing leanness gains critical. Conceptual model are developed assessment in this leanness context. The assessment results are that the organization is leanness. Regarding to still improve the leanness of the organization, improvement areas have been identified on weak area. They could be improved enabled the organization to attain world-class status. However, most lean assessment tools provide qualitative analysis and do not provide any clear direction of where the improvement efforts should be directed.

Reference [8] show that a complementary methodology will be arranged to assist contemporary lean assessment of a quantitative measure by benchmarking other exemplar lean industries along with specific pointers for improvements based on cost considerations. The Lean Enterprise Self-Assessment Tool (LESAT) is one of the popular lean assessment tool used in the aerospace industry. It is "a tool for self-assessing the present state of leanness of an enterprise and its readiness to change. They consist of three sections that is life cycle processes, enabling infrastructure, and enterprise leadership processes. Each of these questions is assigned points based on the current state of leanness of the company. The information-gathering phase are critical point for the development of the lean assessment system determined that the most effective method to extract information from the lean thinking business society was a survey. As in [9] show that the survey consists of 100 questions is defined from the research to gather information help in the model's development. They are separated into eight model that paralleled Lean Manufacturing management strategies. Eight model are company overview, quality metrics and improvements, process and product standardization, supplier management, production control and inventory, employee empowerment/involvement, including training, reward and recognition, and lean manufacturing implementation. Demand fluctuates, custom orders increase, or simply an unbalanced workload are compromised with advantages of

becoming leanness.

A. *Lean assessment criteria*

This assessment criteria, weighting of the all, allows equally important in determining overall lean techniques and tools [4], [6]. They are selected for this study below from as in [13] and resemble those as in [2]'s research work, a survey on techniques and tools for SMEs applied lean manufacturing of USA.

The Lean assessment criteria are the leanness measurement system comprehensive from various perspectives. It is glossary of as in as in [12].

2.1.1. Kanban system means communication system by card within SMEs, it is the method the JIT pillar uses to minimize inventory and follow pull-demand (Takt time) system rules to reduce wastes. Minimize inventory is leveling production that is avoiding the unnecessary changes in production rates.

2.1.2. Visual management is the placing of tools, materials, and information in plain view using simple tools so the status of the process or product can be understood at a glance within SMEs. In addition workers should be known abnormal or normal, then take correct action immediately.

2.1.3. Supplier responsibility is entities that provide resources, usually, raw materials to a SMEs process. We have external suppliers and our own employees are internal suppliers. They focus on quality, delivery, and cost.

2.1.4. 5s is the name of a workplace organization method that uses a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke. The list describes how to SMEs a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. It mean ready for manufacturing.

2.1.5. Operation base layout is SMEs manufacturing equipment layout where people and machines are in close proximity to reduce transportation and WIP inventories. Cells are designed to achieve one-piece flow and safety, no cross Traffic, no backtracking.

2.1.6. Line balancing is SMEs synchronizing operations, generally making sure that each step has the same process cycle times.

2.1.7. Quick changeover or single Minute Exchange of Dies is methodology, largely developed by Shingo, and absolutely necessary in most plants to avoid large batch production. SMEs have a time for quick changeover as objective.

2.1.8. Multi skill is workers that are required to SMEs staff the production facilities, for two major reasons. First, to achieve process improvements it is often necessary to reduce or change the elements of the work. This in turn often requires a redistribution of the work. In addition, work cells are often designed so they can be operated by one, two, three, four, or five people, for example, depending on changes in demand.

2.1.9. Standard operation procedure is a document written for the SMEs manager and the engineer, not the line worker. It contains three elements: the work sequence, the standard inventory and the cycle time. It is part of the system of visual management, transparency system.

2.1.10. Poka-yoke is any mechanism in a SMEs lean manufacturing process that helps an equipment operator avoid mistakes. Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur.

2.1.11. Total preventive maintenance is the SMEs primary measure of production effectiveness. It can be used for value stream or individual workstation performance evaluation.

2.1.12. Policy deployment is more than goal setting, it is SMEs management’s way of communicating vision, guiding, following up on, and changing the important aspects of Targeted focus at all levels.

2.1.13. Awareness of 7 waste is most cultures that are developed unconsciously. The level of awareness is more about the SMEs training and behavior, following up on about the actions.

2.1.14. Kaizen is concept of making continual product and process improvements, usually small and typically done by the entire workforce that is value stream mapping, problem solving, and suggestion.

B. Scoring system

Score system will assist you into allocating the appropriate resources in your organization. This lean assessment is applied scoring system of the Malcolm Baldrige National Quality Award (MBNQA) of the USA. (2011-2012) is based on for its efficiency [10]. Other countries have applied the prize awarding criteria for their operational qualities such as the European Quality Award (EQA) or the Australian Quality Award (AQA), and a quality award in Thailand.

Scoring responses to lean assessment criteria involved two dimensions, i.e., process and performance. Process is a assessment systematic which is approach, deployment, learning, and integration. There are adapted appropriate scoring from percentage to numerical value. The numerical value at levels was adjusted from 6 in the Malcolm Baldrige National Quality award became 5 levels as Table 1 Scoring System. Those lean assessments enable detailed, systematic, quantitative scoring to diagnose the current state. The rigorous nature of this exercise ensures that the journey going forward will lead the SMEs toward a future state.

Table 1 Scoring System.

| Process | Performance |
|--------------|--|
| Approach (A) | 0. No systematic approach to item requirements is evident. |
| | 1. The beginning of a systematic approach to the requirements of the item is evident. |
| | 2. An effective, systematic approach, responsive to the some requirements of the item, is evident. |
| | 3. An effective, systematic approach, |

responsive to the moderate requirements of the item, is evident.
 4. An effective, systematic approach, responsive to the most requirements of the item, is evident.

| Process | Performance |
|-----------------|---|
| Deployment (D) | 0. Little or no deployment of any systematic approach is evident. |
| | 1. The approach is in the early stages of deployment in most areas or work units, inhibiting progress in achieving the requirement of the item. |
| | 2. The approach is deployed, although some areas or work units are in early stages of deployment. |
| | 3. The approach is well deployed, although deployment may vary in some areas or work units. |
| Learning (L) | 4. The approach is well deployed, with no significant gaps. |
| | 0. An improvement orientation is not evident; improvement is achieved through reacting to problems. |
| | 1. Early stages of a transition from reacting to problems to a general improvement orientation are evident. |
| | 2. The beginning of a systematic approach to evaluation and improvement of key process is evident. |
| Integration (I) | 3. A fact-based, systematic evaluation and improvement process and some organizational. |
| | 4. Fact-based, systematic evaluation and improvement and organizational learning, including innovation, are key management tools; there is clear evidence of refinement as a result of organizational-level analysis and sharing. |
| | 0. No organizational alignment is evident; individual areas or work units operate independently. |
| | 1. The improved approach is aligned with other areas or work units largely through joint problem solving. |
| | 2. The improved approach is in the early stages of alignment with some area or work units needs identified in response to the organizational profile and other process items. |
| | 3. The improved approach is aligned with moderate area or work units needs identified in response to the organizational profile and other process items. |
| | 4. The improved approach is integrated with most area or work units needs identified in response to the organizational profile and other process items. |

C. Selecting a case study of rubber industry.

SMEs rubber industry case study has six plants in different area. They have line- flow production meaning that timing on each task requirement must be of equal length and there should be no movement off. In this study Researcher have been focused on main product with Standard Thai Rubber (STR) comprising of 4 main groups-- STR10, STR20, STRxL and STR CV- depending on the specific control variables.

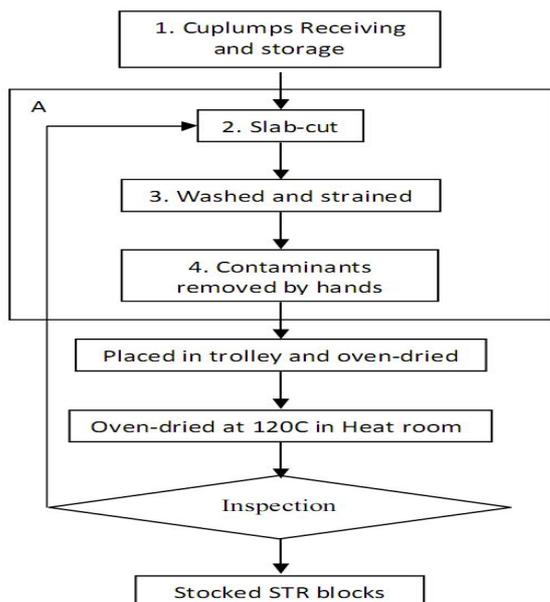


Fig. 1 STR 20 block rubber flow process

STR block rubber flow process, see figure 1, beginning received cuplumps are spread out in the reception area for contamination picking and percentage of dry rubber content (DRC) determination.

Big slabs of cup-lumps must be reduced to smaller sizes for effective removal of the contaminants and determination of the contamination levels. The contaminants removed, cup lumps are stored according to grade and rest to obtain leveled characteristics. Upon designated time, cup lumps enter the STR line. Slab-cut, washed and strained to further remove embedded contaminants. Next process is cup lumps collected in a tank with water overflowing to remove floating particles/contaminants such as raffia, woodchips, branches sinking material such as dirt, sand, gravel sinks to the bottom of the tank and remove periodically. They not removed during the automated processes are removed by hands. This process will be repeated 6 times from 2 to 4 as A to reduce the cuplumps size. After series of size reduction, rubber crumbs are crepe in series of decreasing thickness to obtain aggregated rubber crumbs. The crumbs are placed in trolley and oven-dried at 120C for 7-8 minutes depending on the nature of the input cup lumps. Biscuits are baled and packed in PE pouches. Bale are inspected and sampled for white spot/contamination Physical Characteristics. Baled STR blocks are packaged according to the customer specifications.

D. Visiting the SME plants

Preliminary visit to the plant is made a planning by assessor to make clear with SME’s window person or management team including purposes of this visit, a Visual Flow process. Assessor is needed to notify some of objective so they understand and not feel blockade while they are working. The second of

purpose of this visit is to select a product family of the plant to assess since time limit; it is not possible to assess the whole plant. Then, The Plant tour have done and also find a opportunity to explain point of real manufacturing and ask employees on the shop floor. Next is assessor to the factory interviewed a pair of the employees finding their operation about working in process. On the shop floor, necessary data and observations are made and recorded on the assessment form. The manager is asked with various points linking to the criteria very helpful. They are finished in a day.

E. Data analysis

The researcher presented the results in descriptive statistics showing averages of the results. It come from rating process assessing; approach, deploy learning and integration. Each of them is 0-4 level. For example Kanban system in SMEs Plant A have approach of 2 scoring, deployment of 1 scoring, learning of 0 scoring, and integration of 0 scoring. Then it becomes average of 0.75 scoring. There are 6 factories. The averages of Kanban system is 0.75, 0.75, 0.75, 1.5, 0.75 and 0.75 for SMEs plant 1, 2, 3, 4, 5, and 6 respectively. It will be averaged again that is 0.88.

III. RESEARCH RESULTS AND DISCUSSION

Figure 2 was a radar chart showing the lean assessment result of rubber industry in resent state. The resent state came from score for each 14 Lean assessment criteria. They was an extremely helpful to make continuous improvement showing the status of the manufacturing process. Gap on radar chart was from their specific lean targets.

In a radar chart, each criteria were drawn evenly weight, highest of the 2.0 point was line balancing and lowest of the 0.5 point was kaizen. A meddle value was 0.75 point of operation base layout. The 14 lean assessment aspects depicted by the waste reduction on the current operation management. In the radar charts on kanban system, visual management, supplier responsibility, 5S, standard operation procedures, and total preventive maintenance presented below 0.75, higher values represent quick changeover, multi skill, poya yoke, policy deployment, and awareness of 7 waste.

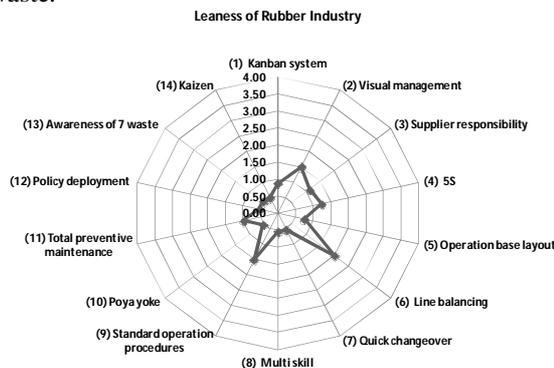


Fig. 2 The lean assessment result of rubber industry

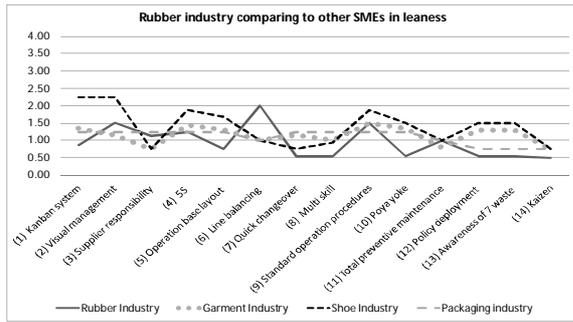


Fig. 3 Rubber industry comparing to other SMEs in leanness

Figure 3 show rubber industry comparing to other SMEs in leanness in average scoring of each SMEs. The average of leanness of rubber industry was lowest scoring with 0.94 or 24%. The first one was shoe industry with 1.40 or 35%, second one was garment industry with 1.15 or 29%, and the third one was packaging industry with 1.11 or 28%. The rubber industry comparing to other had maximum point in line balancing, but minimum point in kanban system, operation base layout, quick changeover, multi skill, poya yoke, total preventive maintenance, kaizen.

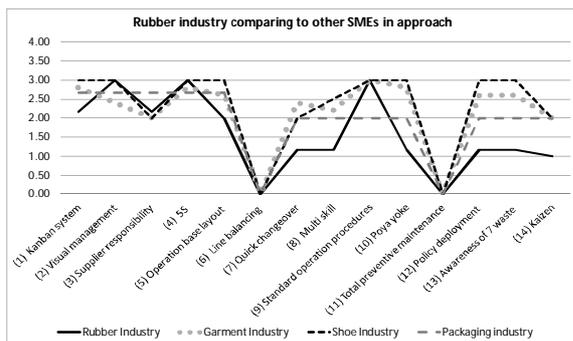


Fig. 4 Rubber industry comparing to other SMEs in approach

The further analyze was result of lean assessment in deep to better understand of approach, deployment, learning, and integration of lean implement in rubber industry. Comparing to other as show figure 4 in approach of leanness, they had maximum point in visual management, 5S same shoe industry, and standard operation procedures same both 3 industry, but minimum point in kanban system, supplier responsibility, operation base layout, quick changeover, multi skill, poya yoke, total preventive maintenance, policy deployment, awareness of 7 waste and kaizen.

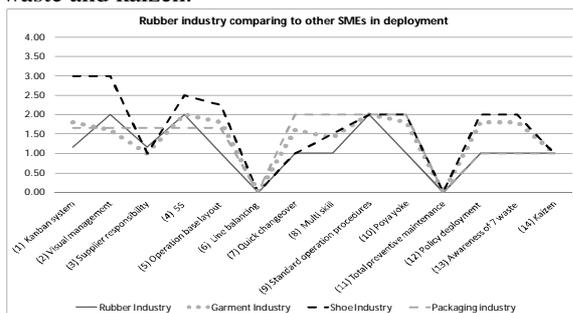


Fig. 5 Rubber industry comparing to other SMEs in deployment

Maximum point of rubber industry comparing to other as show in figure 5 in deployment of leanness was standard operation procedures same both 3 industry, but minimum point was kanban system, operation base layout, quick changeover same shoe industry, multi skill, poya yoke, total preventive maintenance, policy deployment, awareness of 7 waste and kaizen. Both of policy deployment, awareness of 7 wastes had lowest scoring same packaging industry.

Standard operation procedures as show figure 6 got maximum point of rubber industry comparing to other as show in figure 6 same both 3 industry, but kanban system, operation base layout, quick changeover same shoe industry, multi skill, poya yoke, total preventive maintenance, policy deployment, awareness of 7 waste and kaizen. Both of policy deployment, awareness of 7 waste had lowest scoring same packaging industry.

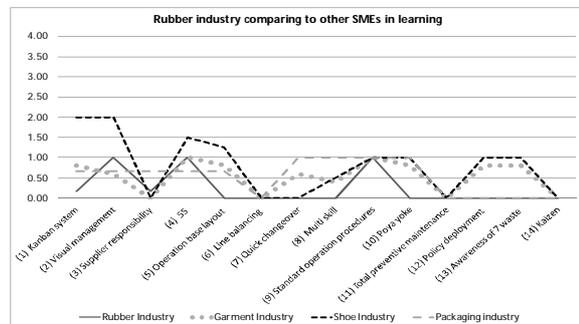


Fig. 6 Rubber industry comparing to other SMEs in learning

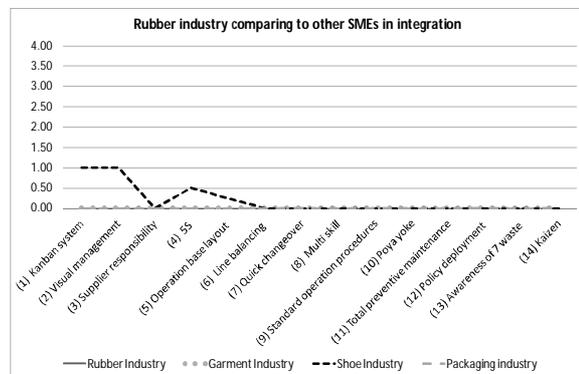


Fig. 7 Rubber industry comparing to other SMEs in integration

All lean technique and tools in integration comparing to other SMEs was zero as show Figure 7. They were meaning no organizational alignment as well as individual areas or work units operate independently and process of bringing together the component subsystems into one system.

CONCLUSION

Lean assessment is critically important because most appropriate starting point and identify potential gaps in lean technique and tools. The lean technique and tools is 14 items which measuring a leanness level of operation in case study of rubber industry. After assessment, we discussed with manager to make the

improvement point because they know to start and actually needs to do. They must carry the scoring to be communicated to improvement team. However, the rubber industry has got lowest of leanness when comparing to other. visual management, supplier responsibility, 5S, operation base layout, quick changeover, multi skill, standard operation procedures, poya yoke, total preventive maintenance, policy deployment, awareness of 7 waste, and kaizen. They are need to allocating of the appropriate resources.

Line balancing is strengths of lean technique and tools implemented as well. They are leveling the products across all processes in a product family to remove bottlenecks.

The value of lean assessment criteria was scoring system derived from the Malcolm baldrige national quality award, the two-dimensioned scoring system composing of the process including approach (A), deployment (D), learning (L), and integration (I) reveal operations of each of lean techniques and tools, and the performance classified 0 - 4 level.

Small number of rubber industry is possible that might be unable to accurately assess the level of implementation of all SMEs.

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