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Lean assessment for manufacturing of small and medium enterprises (SMEs): A case study of electronics industry in the Northeast of Thailand

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Abstract

This research was aimed at assessing for manufacturing a small and medium enterprise of electronic industry case study in the Northeast of Thailand. Electronic industry produces integrated circuits products (IC). We use lean assessment tools with 14 lean technique and tools. The value of lean assessment are scoring system derived from the malcolm baldrige national quality award, the two-dimensioned scoring system composing of the process; approach, deployment, learning, and integration. There are reveal operations of each of lean techniques and tools, and the performance; the 0 - 4 level needed to be improved in depth and hence would reflect operations requiring sustainable outcomes. This lean assessment is a systematic approach, assessor come to sit, examine operations from a lean perspective and assessed the situation as prior. The purposes of this visit were to introduced to production or factory manager or window person of SMEs who gave assessor a tour of the plant. Assessor also got a chance to explain lean assessment criteria on the shop floor. Assessor selects a value streaming line that produce most goods or main production line to assess. Assessor takes 1 day to assess and discuss the lean assessment. As a result, the lean assessment survey should be adjusted to fit the systems adaptively. Three plants of electronic industries were leanness of 1.06 or 26%. Five plants of garment industry were leanness of 1.13 or 28%. Four plants of shoe industry were leanness of 1.39 or 34%. Shoe industry had high leanness all unless quick changeover and multi skill. The quick changeover and multi skill were high score on garment industry. Electronics industry has not the lead but second in visual management, 5s, operation base layout, quick changeover, multi skill, standard operation procedures, and policy deployment.

Keywords : Lean assessment, Lean manufacturing, Lean tools, SMEs

1. Introduction

Lean manufacturing, lean enterprise, or lean production, often simply, "lean", is a production philosophy that considers the expenditure of resources in any aspect other than the direct creation of value for the end customer to be wasteful, and thus a target for elimination [1]. Lean assessment was created as a guide for the organization in their lean journey. They will provide a baseline upon which organization can improve and most importantly also provide a reference on what to do. Score will assist you into allocating the appropriate resources in your organization [2]. Some organization are ready to improve its processes, but unsure of where to start and what actually needs to be done? Factors can influent change to apparel industry Thailand's SMEs that is leadership, investment, teamwork, and R&D. The leadership must possess strategic vision abilities and set goals the organization can reach [3]. Lean assessment will lead for small and medium enterprise (SME) in their vision and goals. They will give a baseline upon which SME can get better on what to do.

Electronic industry is many challenging conditions that limit the applicability of lean manufacturing. As in Doolen [4] electronics industry is unique in the type of process used, but as a whole these manufacturers share two important characteristics-utilizing high-technology processes and materials and being subject to rapid product development cycle times and short product life cycles. The electronics industry is one of Thailand's most prominent industries within the manufacturing sector. In 2011, Thailand's overall trade in the electronics industry alone was worth approximately US$56 billion, an increase of 10% from 2007. In 2011, Thailand's main electronics exports were hard disk drives (HDD) and integrated circuits (IC), which accounted for approximately 34% and 26% of total electronics exports, respectively. Because of the sustained growth in electronics production and exports, an increase in electronic imports was also observed, especially for semiconductors, discrete components and electronics subcomponents. The total value of electronics imported into Thailand in 2011 was approximately US$25 billion [5]. Therefore, this research was aimed at assessing for manufacturing an electronic

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industry case study of small and medium enterprises (SMEs) in the Northeast of Thailand.

2. Research methodology

A number of lean assessments have been developed to help organizational leaders giving their progress toward becoming a lean manufacturing. As in Doolen [4] conclude that an overall structure integrating the multiple dimensions of a lean enterprise was synthesized from these previously developed instruments. Within this structure, six impact areas were defined and then used as the basis for the development of survey questions regarding the adoption of specific lean manufacturing practices. The six areas incorporated into the survey were: manufacturing equipment and processes, shop floor management, new product development, supplier management, customer relations, and workforce management. For each item, respondents were asked to evaluate how often a specific practice was used within their organization. Like, as in Taj [6] made a spreadsheet-based assessment tool is used to evaluate nine key areas of manufacturing. Participants are asked to answer questions for each area, namely inventory; team approach; processes; maintenance; layout/handling; suppliers; setups; quality; and scheduling/control. As in Vinodh [7] made the system consists of three levels. The first level consists of five leanness enablers; Management responsibility leanness, Manufacturing management leanness, Workforce leanness, Technology leanness, Manufacturing strategy leanness. The second level consists of 20 lean criteria; and the third level consists of several lean attributes. The assessment of manufacturing leanness gains vital importance. In this context, this paper reports a case study in which the leanness of a manufacturing organization has been assessed using the developed conceptual model. The assessment results indicated that the organization is lean. In order to still improve the leanness of the organization, improvement areas have been identified. On improvement of the identified weak areas, the leanness of organization could be improved which enables 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. As in Srinivasaraghavan [8] propose a complementary methodology to assist contemporary lean assessment tools that will provide a quantitative measure of leanness by benchmarking other exemplar lean industries along with specific pointers for improvements based on cost considerations. One of the popular lean assessment tool used in the aerospace industry is the Lean Enterprise Self-Assessment Tool (LESAT). The LESAT is "a tool for self-assessing the present state of leanness of an enterprise and its readiness to change. It consists of three sections, namely, life cycle processes, enabling infrastructure, and enterprise leadership processes. During self-assessment, each of these questions is assigned points based on the current state of leanness of the company. The information-gathering phase was necessary for the development of the lean assessment system. It was determined that the most effective method to extract information from the lean thinking business society was a survey. As in Shetty [9] propose that the survey consists of a questionnaire of 100 questions were developed from the research to gather information to assist in the model's development. The 100 questions were separated into eight categories that paralleled Lean Manufacturing management strategies. The questionnaire categories 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. The advantages of becoming lean are compromised when demand fluctuates, custom orders increase, or simply a balanced workload cannot be achieved.

2.1. Lean assessment criteria.

This assessment criteria allows weighting of the all [4], [6]. These criteria are equally important in determining overall lean techniques and tools. The assessment criteria selected for this study below was Laoha [10] he make a literature review in article, textbook, and consultant company of application in lean technique and tools in many countries and many industries. His research found 14 technique and tools are most application. I also found that 14 technique and tools resemble those in Zhou's research work, a survey on techniques and tools for SMEs applied lean manufacturing of USA. Zhou (2).

Lean assessment criteria are the leanness measurement system that is comprehensive from various perspectives. It is glossary of as in Wilson [11].

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 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. If the workers are not multi skilled, the dynamics of Lean are lost. Multi skilled workers are at the heart of flexibility in Lean Manufacturing.

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.

2.2. Scoring system

Score system will assist you into allocating the appropriate resources in your organization. This lean assessment is applied of the Malcolm Baldrige National Quality Award (MBNQA) of the USA [12]. 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.

We use MBNQA for each criterion determined two dimensions, process and performance. Process is an assessment systematic that is approach (A), deployment (D), learning (L), and integration (I) calling ADLI. Performance is adapted appropriate scoring from percentage to numerical value because easy to remember. The numerical value at levels was adjusted from six in the MBNQA became five as Table 1 because a low level.

Evaluator assesses the process on ADLI and get more information by interviewed employees' operation. On the shop floor, he find a difference operation that mean difference point in each ADLI. The data observations are made and recorded on the assessment form. They are finished in a day.

2.3 Selecting a case study of electronic industry.

SMEs electronic industry case study has the plants located in the path of GMS economic corridors. There are 3 plants that locate in different area. They are production line, which is flow production line. It means that as work on a task at a particular stage is complete. When it arrives at the next stage, work must start immediately on the next process.

2.4 Data analysis

The assessor 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, it is approach of 3, deployment of 2, learning of 1, and integration of 0. Then it become average of 1.5 in factory SMEs A. There are 3 factories. The averages of Kanban system is 1.5, 1.25, and 1.5 for factory SMEs A, B, and C perspectively. It will be averaged again that is 1.42. Finally, They were turned into percentages for ease of description and comparing with lean assessment result of SMEs shoe and garment industry. They are also called apparel. It is conformity of production line.

3. Research results and discussion

A lean profile chart is also created from these results showing the status of the manufacturing process and the gap from their specific lean targets. We focus on three industries, electronic, garment and shoe industry. Three plants of electronic industries were leanness of 1.06 or 26%. Five plants of garment industry were leanness of 1.13 or 28%. Four plants of shoe industry were leanness of 1.39 or 34%.

As in Figure 1 showed current strengths and weaknesses of main topic of research. The maximum point on radar chart was 1.50 or 38% of visual management, 5s, and standard operation procedures. The minimum point was 0.67 or 17% of total preventive maintenance. Comparing the result of lean assessment of 3 manufacturing industry showed in Figure 2. No manufacturing industry was the leader in all technique and tools that like a result as in Doolen [4].

Shoe industry had high leanness all unless quick changeover and multi skill. The quick changeover and multi skill were high score on garment industry. Electronics industry has not the lead but second in visual management, 5s, operation base layout, quick changeover, multi skill, standard operation procedures, and policy deployment.

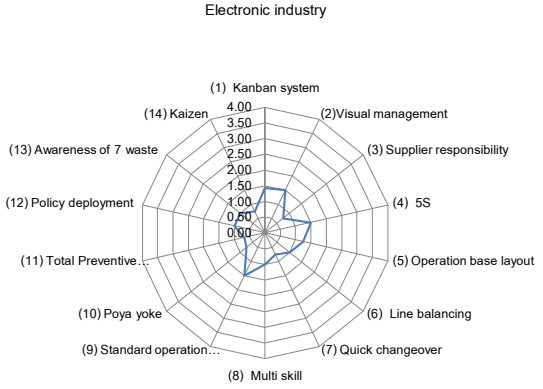

Figure 1 Result of Lean assessments in of Electronic industry

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.
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. 4. The approach is well deployed, with no significant gaps.
Learning (L)	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. 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.
Integration (I)	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.

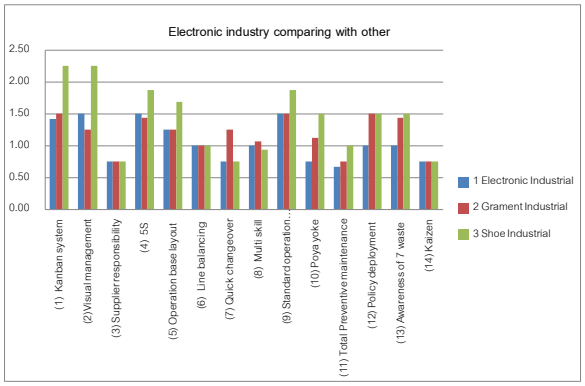

Figure 2 Electronic industry comparing with other

Lean assessment will endow with a baseline improved and most importantly provided a reference on how to apply lean manufacture. The MBNQA are determined a systematic that is approach (A), deployment (D), learning (L), and integration (I). Each ADLI are point a scoring to support them into allocating the suitable resources to manufacturing systemt.

The further analyze was result of lean assessment in deep to better understand of approach, deployment, learning, and integration of lean implement in focus area three plants of electronic industry.

As it was comparing with 3 manufacturing industry and addition in average score for each technique and tools.

As in figure 3, A was electronic, B was garment, and C was shoe industry. Approach (A) showed that the score of electronic industry had less than other, kanban system, awareness of 7 waste, policy deployment, and poya yoke. They had an intermediate score with other, which was multi skill and a same score, which is supplier responsibility, line balancing, total preventive maintenance, and kaizen.

They had also a score higher than other but same shoe industry, which was visual management, 5s, operation base layout, standard operation procedures, and quick changeover.

Deployment (D) showed that the score of electronic industry had less than other, multi skill, policy deployment, awareness of 7 waste, and poka yoke. They had a score less than other but same shoe industry, quick changeover and standard operation procedure. They had also a score less than other but same garment industry, which was kanban system and 5s. They had an intermediate score with other, which was

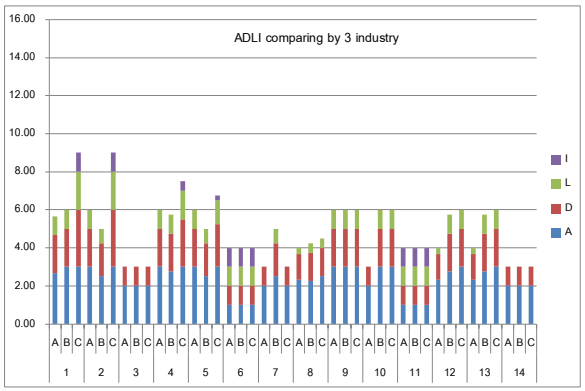

Figure 3 Lean assessment result of Electronic industry in ADLI process

visual management and operation base layout and a same score, supplier responsibility, line balancing, total preventive maintenance, and kaizen.

Learning (L) showed that no score of electronic industry was supplier responsibility, quick changeover, poka yoke, and kaizen. They had less than other, multi skill, policy deployment, and awareness of 7 waste. They had also less than other but same with garment industry, kanban system and 5s. They had an intermediate score with other, visual management and operation base layout and a same score, line balancing, standard operation procedure, and total preventive maintenance.

Integration (I) showed that a same score of electronic industry were line balancing and total preventive maintenance and no score of lean assessment result was the rest.

4. 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 measuring a leanness level of operation in case study of three plants of electronic industry. The three plants of Electronic industry already gave a scoring to allocate the suit resource to improve its processes, because they want to know how to start and actually needs to do.

They had lowest of leanness when comparing with garment and shoe industry but also having a strengths of lean technique and tools of 50% of 14 techniques and tools should maintain and improve on ADLI system in the future. The 4 technique and tools of weakness for leanness much be improved.

The value of the lean assessment for the manufacturing is the application of scoring from the MBNQA. Manager or management team can elaborate, and make a steps for improvement described in depth as ADLI, reflecting operations. A small number of electronic industry case study was impossible accurately assess the level of implementation of all.

Thai SME for manufacturing need to make the lean assessment to eliminate waste. The lean assessment was very easy to use and apply there. The result of lean assessment will then put a recommended lean roadmap specific to organization which is a customized plan, training, designed to help make the improvements necessary to organization's continued success. Based on organization needs, implementing 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 [13].

Future research should be expand to other in manufacturing industry that is impacted from ASEAN Economic Community (AEC).

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