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Opportunities for improvement in five groups of SMEs by a new lean assessment tool

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Abstract

The object of this research was to evaluate the implementation of lean manufacturing for Small and Medium Enterprises of five industries in Northeast Thailand. The five industries were Machinery Industry, Food industry, Rubber Industry, Packaging industry and Garment Industry. The instruments used were applying the lean assessment tool. There were five steps. The first was a lean assessment providing a baseline of 14 items for lean perspective. The 14 items were Kanban system, Visual management, Supplier responsibility, 5s, Operation base layout, Line balancing, Quick changeover, Multi-skill, Standard operation procedure, Poka-yoke, Total preventive maintenance, Policy deployment, Awareness of 7 waste, and Kaizen. The second step was the Malcolm Baldrige National Quality Award for process evaluation by Approach Deployment Learning and Integration (ADLI). The ADLI included performance evaluation items classified 0 - 4 for in depth evaluation reflecting level of operations. The last steps were selecting a case study, visiting the SME plants, and data analysis. The findings of the lean assessment process were amazingly at a high level of leanness in the garment industry in all cases. The rubber industry was the lowest.

Keywords: Lean Assessment, Lean tools, MBNQA, ALF, SMEs

1. Introduction

The lean manufacturing philosophy directly creates value for the final customer, considering the costs of resources in any aspect to be wasteful. Lean assessment is one of the tools in lean manufacturing, giving a guide for the organization to eliminate waste in their lean journey, providing a good baseline and most importantly focusing on what to do. The result from the lean assessment is a score, which is the lean perspective indicator. Many organizations use the score to communicate with their team to improve their manufacturing status. It can help your organization work more effectively [1].

Implementing lean practices can assist organizations in saving money, increasing sales, reducing cycle time, reducing inventory and work-in-process, increasing capacity, increasing productivity, and improving quality [2]. An overall structure integrated from previous development synthesizes the multiple dimensions of lean manufacturing [3]. There are three leanness levels. The initial level is Management responsibility leanness, Manufacturing management leanness, Workforce leanness, Technology leanness and Manufacturing strategy leanness [4]. The next level is 20 lean criteria and the final level is several lean attributes. The importance of lean assessment in manufacturing leanness is critical. It can enable the organization to achieve an excellent status [5]. However, most lean assessment tools provide qualitative analysis and do not provide any plain direction of where they should be directed. This led to our decision to assess it. Therefore, this research is aimed at assessing the manufacturing leanness of SMEs of five industries in the Northeast of Thailand.

2. Research methodology

The lean assessment procedure was the same as in Laoha and Sukto. [6]. This paper was “Lean assessment for manufacturing of small and medium enterprises (SMEs): A case study of the electronics industry in the Northeast of Thailand”. There were four steps. The first was an evaluation form with lean assessment items and performance items. The second step was selecting SMEs to study, and SME plant visits. The last step was data analysis.

2.1 Lean assessment items

The lean assessment criteria form a comprehensive leanness measurement system with various perspectives. The glossary is given in the literature [7]. (2.1.1) Kanban system means communication method by card within SMEs. It uses the JIT pillar method to minimize inventory and follow pull-demand system rules to reduce waste. (2.1.2) Visual management is a technique to graphically describe the value stream so a system review of lead time and value added time can be made. It is a key tool in the battle for waste reduction. (2.1.3) Supplier responsibility is to focus on quality,

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Table 1 Index of item objective congruence

		Result of Expert Evaluation				
Item	**Description**	**Expert 1**	**Expert 2**	**Expert 3**	**IOC**	**Judgment**
1	The lean assessment criteria has achieved its objective.	1	1	1	1.00	Agreeable
2	The lean assessment criteria is a guide to SMEs improving their manufacturing to be lean.	1	0	0	0.33	Non
3	The lean assessment criteria follow lean concepts.	1	1	1	1.00	Agreeable
4	The lean assessment criteria are clear in meaning.	1	1	1	1.00	Agreeable
5	The lean assessment criteria is a guide to SMEs' continuous improvement of their manufacturing.	1	1	0	0.67	Agreeable

Table 2 Assessment criteria and Scoring

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 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 organization. (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.

delivery, and cost. (2.1.4) 5s is a tool for organizing the workplace with the goals of increasing work efficiency. (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 and no backtracking. (2.1.6) Line balancing is synchronizing operations, generally making sure that each step has the same process cycle time. (2.1.7) Quick changeover is converting a machine, or process to make a different model or different product. (2.1.8) Multi skill is SMEs staff in the production line must be flexible to reduce or increase the elements the work depends on. (2.1.9) Standard operation procedure contains three elements: the work sequence, the standard inventory and the cycle time. (2.1.10) Poka-yoke is any mechanism in an SME's lean manufacturing to avoid mistakes. Its purpose is to eliminate product defects by preventing, correcting, or drawing out human errors. (2.1.11) Total preventive maintenance is overall equipment effectiveness (OEE). The OEE measurement also commonly used is a key performance indicator (KPI). (2.1.12) Policy deployment is more than goal setting, but SME management's way of communicating vision, guiding, following up on, and changing the important aspects targeted. (2.1.13) Awareness of 7 wastes involves a culture developing unconsciously. The level of awareness is more about the SMEs training and behavior, and following up on actions. (2.1.14) Kaizen is a concept of making a continual product and process improvements, usually small and typically done by the entire workforce.

2.2 Item Objective Congruence (IOC)

The lean assessment form was evaluated for content according to the index of item objective congruence (IOC) method by experts from King Mongkut's Institute of Technology Ladkrabang and Burapha University, Thailand as detailed in Table 1. It can be seen that the second item in the Table is non-agreeable. Therefore, we edited the lean assessment criteria by adding the Adidas Lean Fulfillment (ALF) to be a performance evaluation.

2.3 Assessment criteria and scoring

The Malcolm Baldrige National Quality Award (MBNQA) of the USA (2011-2012) [8] was applied for process evaluation of each item in Approach, Deployment, Learning and Integration called ADLI as shown in Table 2.

Table 3 The result of lean assessment of five industries

	Leanness		Approach process		Deployment process		Learning process		Integration process	
Industry studied	**score**	**SD**	**score**	**SD**	**score**	**SD**	**score**	**SD**	**score**	**SD**
Packaging	1.11	0.30	2.28	0.44	1.61	0.50	0.61	0.50	0.00	0.00
Garment	1.13	0.34	2.48	0.50	1.63	0.49	0.63	0.49	0.00	0.00
Rubber	0.91	0.49	1.75	0.87	1.25	0.45	0.25	0.45	0.00	0.00
Food	1.06	0.34	2.42	0.50	1.42	0.50	0.42	0.50	0.00	0.00
Machinery	1.01	0.33	2.33	0.47	1.33	0.47	0.33	0.47	0.00	0.00

Performance evaluation criteria are classified 0 – 4, reflecting the level of operations. This comes from Adidas Lean Fulfillment (ALF) [9].

2.4 Selecting a case study

A sample was selected from five industries of all SMEs in the field within high impact sectors of the ASEAN Economic Community (AEC) in Thailand being the machinery industry, the food industry, the rubber industry, the packaging industry and the garment industry [10]. Sixteen factory studies were selected from five industries depending on the assessor. Three plants of the packaging industry, 4 plants of the garment industry, 4 plants of the rubber industry, 2 plants of the food industry, and 3 plants of the machinery industry located in the Northeast of Thailand where chosen as a sample.

2.5 Visiting the SME plants

The preliminary visit is held to make a plan and explain clearly the details of lean assessment to the SME's window person or management team to be the objective of awareness while they are working.

2.6 Data analysis

The assessor evaluated the manufacture plants in 14 criteria by observation and in – depth interview. The answers from the interview were recorded into assessment forms which generated a score between 0-4 for data analysis by descriptive statistics with a mean and a standard deviation (SD) on approach, deployment, learning, and the integration process.

3. Results

The result of lean assessment collected from the data of the implementation of 14 lean tools and techniques in SMEs having a gap from their specific targets are show in Table 3. The $\bar{\bar{X}}$ score identified the leanness of the five SME industries in column two. The $\bar{X}$ score of a lean tool and technique implemented are in columns three, five, seven, and nine. The standard deviation (SD) is also shown.

The garment industry had the highest score of all the processes. The package industry was close behind at second position on deployment, learning and the integration process but fourth on the approach process of lean tools and techniques. The food industry was third on deployment, learning and integration, but second on the approach process. The machine industry was fourth on deployment, learning and integration, but third on the approach process. The lowest was the rubber industry.

The garment industry also had strong points on standard operation procedure, operational base layout, kanban, policy deployment and awareness of seven wastes, but there were weak points on kaizen, multi skill, and poka yoke. The package industry had strong points only in quick changeover compared to the other four industries but there were many tools and techniques that were second. Kanban, visual manangement, supplier responsibility, operational base layout, multi skill, standard operation procedure, poka yoke, policy deployment, and awareness of seven wastes were mentioned. The weak points were 5s and kaizen. The food industry had strong points on visual management and the same for the rubber industry, 5s and multi skill. They also had weak points on standard operation procedure, quick changeover, and operational base layout, supplier responsibility and the same as the garment industry, kanban and kaizen. The machine industry had strong points on supplier responsibility and multi skill, similar to the food industry, and poka yoke. The weak points were visual management, operational base layout, quick changeover and kaizen. The operational base layout, and quick changeover were the same as for the food industry. The rubber industry had strong points on visual management and standard operation procedure the same as the garment industry. Multi skill and kaizen were the weak points.

The kaizen was weak in all, as in the literature [6,11]. It is similar in Thailand since kaizen activity is not implemented. Shetty et al. [12] note that kaizen had ten tools with low implementation, similar to the findings by Bin Zhou [1] in his survey of SMEs in USA applying lean tools and programs. A probable cause is that deployment and the learning process were both at a minimum. This means their applications were also minimum.

4. Discussion

We found that application of lean tools and techniques overall was not integrated. The integration process with the continuous improvement concept require integration with most areas or work units' needs identified in response to the organizational profile and other process items. There was no preventive action by analyzing the data and applying results in all areas. This was why SMEs got a low score for Kaizen activity.

5. Conclusions

Many manufacturers have the opportunity to take lean manufacturing as a guide, but are unsure of where to start and what they actually desires to be done. The object of this

research was to evaluate the implementation of lean manufacturing for Small and Medium Enterprises of five industries in the Northeast of Thailand to be lean. The result of lean assessment of five industries indicated a new method to implement a plan for lean manufacturing. The assessment had three section being lean tools and techniques, process and performance sections. The Malcolm Baldrige National Quality Award gives a value of process and performance derived from approach (A), deployment (D), learning (L), and integration (I) revealed through operations of each lean tool and technique. They have showed a somewhat significant gap from lean tools and techniques. The highest and lowest common data scores point to strengths and weak points respectively. The strength and weak points are considered by SMEs to plan the 4 M and budget to improve the manufacturing to make it lean.

Some people may need to make sure that lean assessment can give guidelines for a big factory. However, I am convinced that lean assessment, the Malcolm Baldrige National Quality Award scoring system, and Adidas Lean Fulfillment (ALF) are appropriate methods and that they will continue to benefit SMEs in new and wonderful ways.

Further research should be expanded nationwide in industrial manufacturing impacting ASEAN Economic Community (AEC).

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