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Lean Assessment for Manufacturing of Small and Medium Enterprises: A Case Study of 2 Industrial groups in Northeast of Thailand

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ABSTRACT

This research was aimed at lean assessment for manufacturing of small and medium enterprises of 2 Industrial groups in Northeast of Thailand. They developed lean assessment with identify lean technique and tools that was first stage, the problem was formulated, i.e., "What are the existing lean tools and techniques used in today's industries that are capable of eliminating the 7 wastes?" The second stage involved data collection from the 3 sources, research literature review, consultancy companies, and textbooks. The third stage was assessing accuracy and reliability of data. The details of data retrieval should be disclosable and accountable; repetitive data retrieval should lead to the same results. The fourth stage was data synthesis, and the fifth interpretation of results to see whether the overall revision answered the posed research query. The value of criterion was in the scoring system derived from The Malcolm Baldrige National Quality award, the two-dimensioned scoring system composing of the process – including approach, deployment, learning, and integration which reveal operations of each of lean techniques and tools, and the performance – indicating the level needed to be improved in depth and hence would reflect operations requiring sustainable outcomes. The findings in context after considering the 3 data sources, consultancy companies, articles, and textbooks, led to the right kinds of data which were mostly reliable. The lean techniques and tools can be concluded to be lean assessment that consists of 14 items. The lean assessment criterion has been carried out in SMEs using a lean technique and tools for assessing leanness. The Shoe industry has higher leanness level than Garment industries. The average of Lean manufacturing in Shoe industry is 1.38 or 34%, and Garment industry is 1.22 or 30%.

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 (Wikipedia). Lean assessment was created as a guide for the organization in their lean journey. The lean assessment will provide a baseline upon which organization can improve and most importantly also provide a reference on what to do. it has many categories that are further divided into sub-categories that are scored. (Tapping and Kremer, 2007a). 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 (Zhou, 2012a). Small and medium enterprises (SMEs) have restricted the development and implementation of operation management. It is reflected to many SMEs that are not able to transform themselves to the world-class organization. The transformation towards is filled with

arduous challenges, most particularly with respect to understanding the real essence of lean technique and tools. However, not only the majority of manufacture is now undertaken by SMEs who are not neither the resources nor the expertise to follow these approaches and find difficulty in knowing how to start a lean implementation and also limitations of SMEs are financial and capital, knowledge and human resources, management concept and philosophy (Little and McKinna, 2005; Kaya and Alpkan, 2012).

Thailand has 3 major routes in the greater mekong subregion (GMS) economic corridors, namely, the north-south economic corridor, the east-west economic corridor, and the southern economic corridor which each of them has its own sub-route connecting. east-west economic corridor (EWEC) or route no 9 is one of the three routes passing the Northeast. The northeast of Thailand has the greatest area of approximately 168,854 square kilometers or 33.17 percent, equivalent to one-third of the total area of the country. In 2010, the number of SMEs in the country reached 2.91 million, accounting for 99% of the entire country. In the Northeast alone, SMEs accounted for as high as 25.9% in which 17.9% was the manufacturing industry. SMEs played an important role in raising the values for the country's economy. SMEs contributed 37.1% to the country's production where SMEs' exports accounted for 1.75 billion baht or 28.4% of the national exports. Nevertheless, when they are compared our situation with SMEs in developed countries such as Japan, South Korea, France, and Germany, which SMEs in those countries contribute over 50% of production. This reflects that more can be added to Thai SMEs in order to upgrade the country's economic potential through development of the businesses (Business Research in Export-Import Bank of Thailand, 2012). Hence, the northeast of Thailand has high potentiality to be developed as the industrial center of the region. Whilst lean manufacturing is a topic of high current interest to manufacturing companies, most of the methodologies for lean implementation in existence in the literature and in the field have evolved from work carried out in large companies. Thus, this research was aimed at lean assessment for manufacturing of SMEs in the 2 Industrial groups in Northeast of Thailand so that SMEs will put a customized plan, deploy plan to the improvements necessary, leaning the production, and integration to their operation.

2. Research Approach

There are 4 step to catch out a lean assessment approach to develop criteria. The criteria is lean techniques and tools which is effective in eliminating wastes. The lean technique and tools combinate with scoring system to make a customized plan to help make the improvements necessary to organization's continued improvement.

2.1. Procedures in Developing a Lean Assessment Criterion

Step 1 Problem formulation – This was the forming of a question, "What are the techniques and tools in lean manufacturing applied by the present-day industries that can indicate the 7 wastes? This step was necessary for making revision, and the answers obtained are the techniques and tools in lean manufacturing used by most industries.

Step 2 Data collection – This step was the primary study in order to check the outcome of research literature review, consultancy companies, textbooks to measure if they held similar or contradicting information and knowledge.

Step 3 Assessing the studies – The data collected might be different in terms of qualities and reliability. This step checked the accuracy and reliability of data. Details in retrieval should be disclosable and auditable, with the principle being that if retrieval was repeated with the same steps, the results should be the same.

Step 4 Data synthesis – This step compiled quality and evident data already screened together and correlations with the 7 losses concluded.

Step 5 Interpretation of results – This step placed the findings in context after considering the overall revision to see if the posed questions were answered.

2.2. Scoring System

Some SMEs are ready to improve its leanness, but unsure of where to start and what actually needs to be done. Score system will assist you into allocating the appropriate resources in your organization. This lean assessment are applied scoring system of the Malcolm Baldrige National Quality Award (MBNQA) of the USA. (2011-2012) was based on for its efficiency. Other countries have applied the prize awarding criterion for their operational qualities such as the European Quality Award (EQA) or the Australian Quality Award (AQA), and a quality award in Thailand.

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.

Scoring responses to lean assessment criterior involved two dimensions, i.e., process and performance. Process is a assessment systematice 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 assessment enables detailed, step-by-step, 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.

2.3. Select a Case Study of 2 Industrial Group

The case study is Thai SMEs' garment and shoe industry, also called apparel. Factors can influenc chage to apparel industry Thailand's SMEs which is leadership, investment, teamwork, and R&D. The leadership must possess strategic vision abilities and set goals the organization can reach. It should refect the team's stage of development and when leader's delegate responsibility appropriately, team members become more confident and autonomous in their work (Nimlaor et al., 2015). SMEs case study have the plants located in the path of GMS economic corridors. It is conformity of production line which is flow production line. It mean that as work on a task at a particular stage is complete, it must be passed directly to the next stage for processing without waiting for the remaining tasks in the "batch". When it arrives at the next stage, work must start immediately on the next process. In order for the flow to be smooth, the times that each task requires on each stage must be of equal length and there should be no movement off the flow production line.

3. Data Analysis

The assessor presented the results in descriptive statistics showing averages of the results. Then the averages were turned into percentages for ease of description and for holistic illustration of lean production of SMEs.

3.1. Lean Assessment Procedure

The Lean assessment procedure used in this study is grouped into three stages: summary of lean assessment criterion, a visit out to assess in the factory, and Lean assessment result and analysis the data.

3.2. Summary of Lean Assessment Criterion

This assessment criterior allows weighting of the all. These criteriors are equally important in determining overall lean techniques and tools. The findings in context after considering the 3 data sources, consultancy companies, articles, and textbooks, led to the right kinds of data which were mostly reliable. The lean techniques and tools can be summary as table 2 The lean techniques and tools below resemble those in Zhou's research work, a survey on techniques and tools for SMEs applied lean manufacturing of USA. (Zhou, 2012b).

Table-2. lean techniques and tools summary

Lean technique and tools	Data source
1. Kanban system	Domingo et al., 2007a; Álvarez et al., 2009a; Lee-Mortimer, 2006a; Abdulmalek and Rajgopal, 2007a; Chet Marchwinski[1].a; Chet Marchwinski[2].a; Technical Change Associates, Inc.a; Strategos, Inc.a; Buker Corporate Headquarters Buker, Inc.a; Lean Blitz Consulting Services.a; ELSE Inc.a; EMS Consulting Group, Inc.a; Leanmap ltd.a; Lean Enterprise Institute, Inc.a; Kremer and Tapping, 2007b; Womack et al.,1990a; Wilson, 2010a; Dennis, 2007a; Feld, 2000a.

Table-2. continuous

Lean technique and tools	Data source
2. Visual Management	Abdulmalek and Rajgopal, 2007b; Chet Marchwinski[1]b; Chet Marchwinski[2]b; Renault-Nissan Consulting.a; Symbol Business Improvement.a; Buker Corporate Headquarters Buker, Inc.b; Lean Blitz Consulting Services.b; ELSE Inc.b; EMS Consulting Group, Inc.b; Leanmap ltd.b; Lean Enterprise Institute, Inc.b; Kremer and Tapping, 2007c; Womack et al.,1990b; Wilson, 2010b; Dennis, 2007b; Feld, 2000b.
3. Supplier Responsibility	James et al., 2014; Sahoo et al., 2008a; Technical Change Associates, Inc.b; Strategos, Inc.b; Buker Corporate Headquarters Buker, Inc.c; EMS Consulting Group, Inc.c; Leanmap ltd.c; Lean Enterprise Institute, Inc.c; Kremer and Tapping, 2007d; Womack, 1990c; Wilson, 2010c; Dennis, 2007c; Feld, 2000c.
4. 5S	Abdulmalek and Rajgopal, 2007c; Chet Marchwinski[1]c; Chet Marchwinski[2]c; Renault-Nissan Consulting.b; Symbol Business Improvement.b; Buker Corporate Headquarters Buker, Inc.d; Lean Blitz Consulting Services.c; ELSE Inc.c; Leanmap ltd.d; Lean Enterprise Institute, Inc.d; Kremer and Tapping, 2007e; Womack et al.,1990d; Wilson, 2010d; Dennis, 2007d; Feld, 2000d.
5. Operation Base Layout	Domingo et al., 2007b; Lee-Mortimer, 2006b; Technical Change Associates, Inc.c; Strategos, Inc.c; Renault-Nissan Consulting.c; Leanmap ltd.e; Lean Enterprise Institute, Inc.e; Kremer and Tapping, 2007f; Womack and Ross, 1990e; Wilson, 2010e; Dennis, 2007e; Feld, 2000e.

[1] Chet Marchwinski., "BUILD YOUR "HOUSE" OF PRODUCTION ON A STABLE FOUNDATION," Lean Enterprise Institute, http://www.lean.org/Search/Documents/223.pdf (accessed 28 Jun 2014)

[2] Chet Marchwinski., "Dentist Drills Down to the Root Causes of Office Waste ," Lean Enterprise Institute, http://www.lean.org/Search/Documents/447.pdf (accessed 28 Jun 2014)

Table-2. continuous

Lean technique and tools	Data source
6. Line Balancing	Brunet et al., 2003; Jainury et al., 2012; Domingo et al., 2007c; Álvarez et al., 2009b; Lee-Mortimer, 2006c; Chet Marchwinski[2]d, Technical Change Associates, Inc.d; Strategos, Inc.d; Symbol Business Improvement.c; Buker Corporate Headquarters Buker, Inc.e; Lean Blitz Consulting Services.d; ELSE Inc.d; EMS Consulting Group, Inc.d; Leanmap ltd.f; Lean Enterprise Institute, Inc.f; Kremer and Tapping, 2007g; Womack et al., 1990f; Wilson, 2010f; Dennis, 2007f; Feld, 2000h.
7. Quick Changeover	Sahoo et al., 2008b; Abdulmalek, 2007d; Chet Marchwinski[2]e; Technical Change Associates, Inc.e; Strategos, Inc.e; Renault-Nissan Consulting.d; Buker Corporate Headquarters Buker, Inc.f; Lean Blitz Consulting Services.e; ELSE Inc.e; Leanmap ltd.g; Lean Enterprise Institute, Inc.g; Kremer and Tapping, 2007h; Womack, et al., 1990g; Wilson, 2010g; Dennis, 2007h; Feld, 2000i.
8. Multi skill	Renault-Nissan Consulting.e; Symbol Business Improvement.d; ELSE Inc.f; Leanmap ltd.h; Lean Enterprise Institute, Inc.h; Womack et al., 1990h; Wilson, 2010h; Dennis, 2007i; Feld, 2000j.
9. Standard Operation Procedures	Saurin et al., 2012; Chet Marchwinski1[1]d; Chet Marchwinski2[2]f; Renault-Nissan Consulting.f; Lean Blitz Consulting Services.f; ELSE Inc.g; Leanmap ltd.i; Lean Enterprise Institute, Inc.i; Womack et al., 1990i; Wilson, 2010i; Dennis, 2007j; Feld, 2000k.
10. Poya Yoke	Brunet, 2003;
11. Total Preventive Maintenance	Abdulmalek and Rajgopal, 2007e; Chet Marchwinski[1]e;

Table-2. continue

Lean technique and tools	Data source
12. Policy Deployment	Technical Change Associates, Inc.f; Renault-Nissan Consulting.h;
13. Awareness of 7 Wastes	Technical Change Associates, Inc.g;
14. Kaizen	Brunet, 2003;

3.3. Assess in the Factory

The was a visit to the plant. The purposes of this visit was to introduced to production or factory manager or window person of SMEs who gave assessor a tour of the plant. I also got a chance to explain lean assessment criterior on the shop floor. Due to time constraints, it was not possible to assess the whole plant. Assessor select a value streaming line that produce most goods or main production line to assess. Assessor take 1 day to assess and discuss the lean assessment.

3.4. Lean Assessment Result and Analysis the Data

The result of lean assessment will put a table 3. Based on each of criterior which is ADLI provided a score average of performance between zero and four is given. The first column is manufactoring industry type for assessment that is shoe and garment industry. The second column is a SMEs case study which is namely A, B, C, and D, the score average ($\bar{x}$) for lean assessment result is thirth to sixth column. It is calculated by points total of ADLI then divided by the maximum rating point of 4 in process. The last column is AVG of each SMEs. The average of Leanness of shoe industry is 1.38 or 34%, and garment industry is 1.22 or 30%.

Table 3 shows that shoe industry have the maximum average scores ($\bar{\bar{x}}$) which is kanban system and visual management of 2.25 or 56% and the minimum average score is supplier responsibility, quick changeover, and kaizen of 0.75 or 19% Garment industry have the maximum average score which is kanban system, standard operation procedures, and policy deployment of 1.5 or 38% and the minimum average score which is supplier responsibility, total preventive maintenance, and kaizen of 0.75 or 19%

The lean technique and tools is same both shoe and garment industry that is kanban system in maximum average score and supplier responsibility and kaizen in minimum average score.

Table 4 shows that the performance level of 8 SMEs case study in both shoe and garment industry. There are leveled into 5-level. More than 50% of 8 SMEs have performance of implement in lean technique and tools which is kanban system and visual management in level 2 – 2.99 and 5S, operation base layout, line balancing, standard operation procedures, poya yoke, total preventive maintenance,

policy deployment, and awareness of 7 waste in level 1 – 1.99 and supplier responsibility, quick changeover, multi skill, and kaizen in 0 – 0.99.

Table-3. lean assessment result of shoe and garment industry

Industry	Companies	(1) Kanban system	(2) Visual management	(3) Supplier responsibility	(4) 5S	(5) Operation base layout	(6) Line balancing	(7) Quick changeover	(8) Multi skill	(9) Standard operation procedures	(10) Poya yoke	(11) Total Preventive maintenance	(12) Policy deployment	(13) Awareness of 7 waste	(14) Kaizen	Average in section
Shoe	A	2.25	2.25	0.75	2.25	2.25	1	0.75	1.50	2.25	1.50	1	1.50	1.50	0.75	1.54
	B	2.25	2.25	0.75	1.50	1.50	1	0.75	0.75	2.25	1.50	1	1.50	1.50	0.75	1.38
	C	2.25	2.25	0.75	2.25	1.50	1	0.75	0.75	1.50	1.50	1	1.50	1.50	0.75	1.38
	D	2.25	2.25	0.75	1.50	1.50	1	0.75	0.75	1.50	1.50	1	1.50	1.50	0.75	1.32
Garment	A	1.5	1.25	0.75	1.25	1.25	1	1.5	1.25	1.5	1.5	1	1.5	1.25	0.75	1.23
	B	1.5	1.5	0.75	1.5	0.75	1	1.25	1.5	1.5	1.5	1	1.5	1.5	0.75	1.18
	C	1.5	1.5	0.75	1.5	1.5	1	0.75	0.75	1.5	0.75	1	1.5	1.5	0.75	1.16
	D	1.5	0.75	0.75	1.5	1.5	1	1.5	0.75	1.5	0.75	1	1.5	1.5	0.75	1.16

Lean assessment result are a great way to show results of approach, deployment, learning, and integration, as figure 1 and 2. The data is in categories of A, D, L, and I. Lean assessment for manufacturing can represent the implementation of the techniques and tools. It shows the score level categorized to 16 levels. But, SMEs both shoe and garment industry can perform at most in level 9 and 6 perspectively, which has left wide gap. However, this can be interpreted that they have more room to be improved in the future.

Approach (A) shows that the score of 4 SMEs case study of shoe industry have more than 50% of 4 SMEs of implement in lean technique and tools which is kanban system, visual management, 5S, operation base layout, multi skill, standard operation procedures, poya yoke, policy deployment, and awareness of 7 waste in score 3 and supplier responsibility, quick changeover, and kaizen in score 2 and line balancing and total preventive maintenance in score 1.

Garment industry have kanban system, visual management, 5S, operation base layout, quick changeover, standard operation procedures, poya yoke, policy deployment, and awareness of 7 waste in score 3 and supplier responsibility, multi skill and kaizen in score 2 and line balancing and total preventive maintenance in score 1.

Deployment (D) show that shoe industry have more than 50% of 4 SMEs of implement in lean technique and tools which is kanban system, visual management, and 5S in score 3 and operation base layout, multi skill, standard operation procedure, poka yoke, policy deployment, and awareness of 7 waste in score 2 and supplier responsibility, line balancing, quick changeover, total preventive maintenance, and kaizen in score 1

Garment industry have kanban system, visual management, 5S, operation base layout, quick changeover, multi skill, standard operation procedures, poya yoke, policy deployment, and awareness of 7 waste in score 2 and supplier responsibility, line balancing, total preventive maintenance, and kaizen in score 1

Learning (L) show that shoe industry have more than 50% of 4 SMEs of implement in lean technique and tools which is kanban system, visual management, and 5S in score 2 and operation base layout, line balancing, multi skill, standard operation procedures, poya yoke, total preventive maintenance, policy deployment, and awareness of 7 waste in score 1 and supplier responsibility, quick changeover, and kaizen in score 0

Table-4. performance level of lean assessment result for each criterior.

Performance level	(1) Kanban system	(2)Visual management	(3) Supplier responsibility	(4) 5S	(5) Operation base layout	(6) Line balancing	(7) Quick changeover	(8) Multi skill	(9) Standard operation procedures	(10) Poya yoke	(11) Total Preventive maintenance	(12) Policy deployment	(13) Awareness of 7 waste	(14) Kaizen
3 - 4														
2 - 2.99	4	4		2	1				2					
1 - 1.99	4	3		6	6	8	3	3	6	6	8	8	8	
0 - 0.99		1	8		1		5	5		2				8

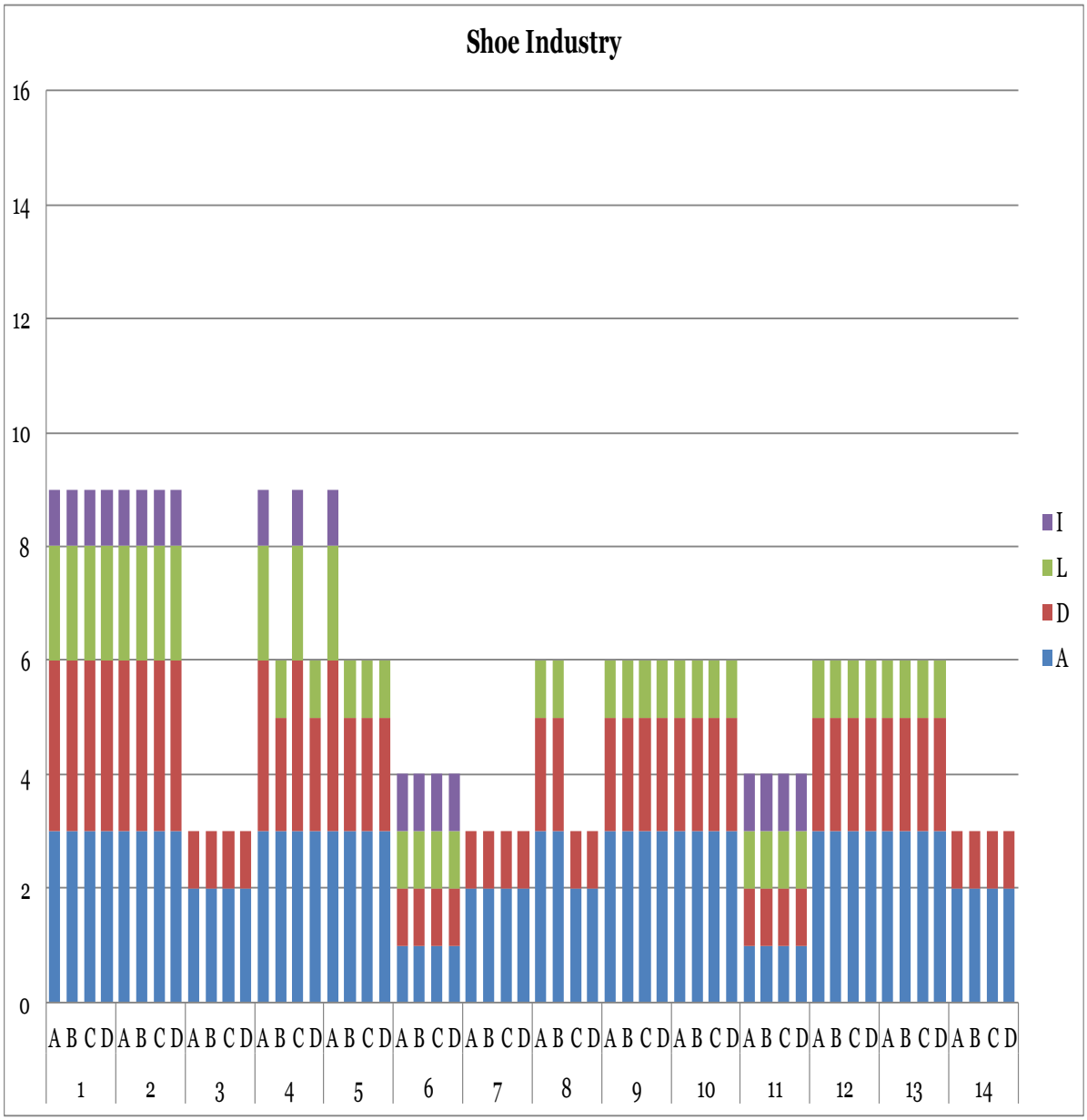

Figure-1. Lean assessment result of shoe industry

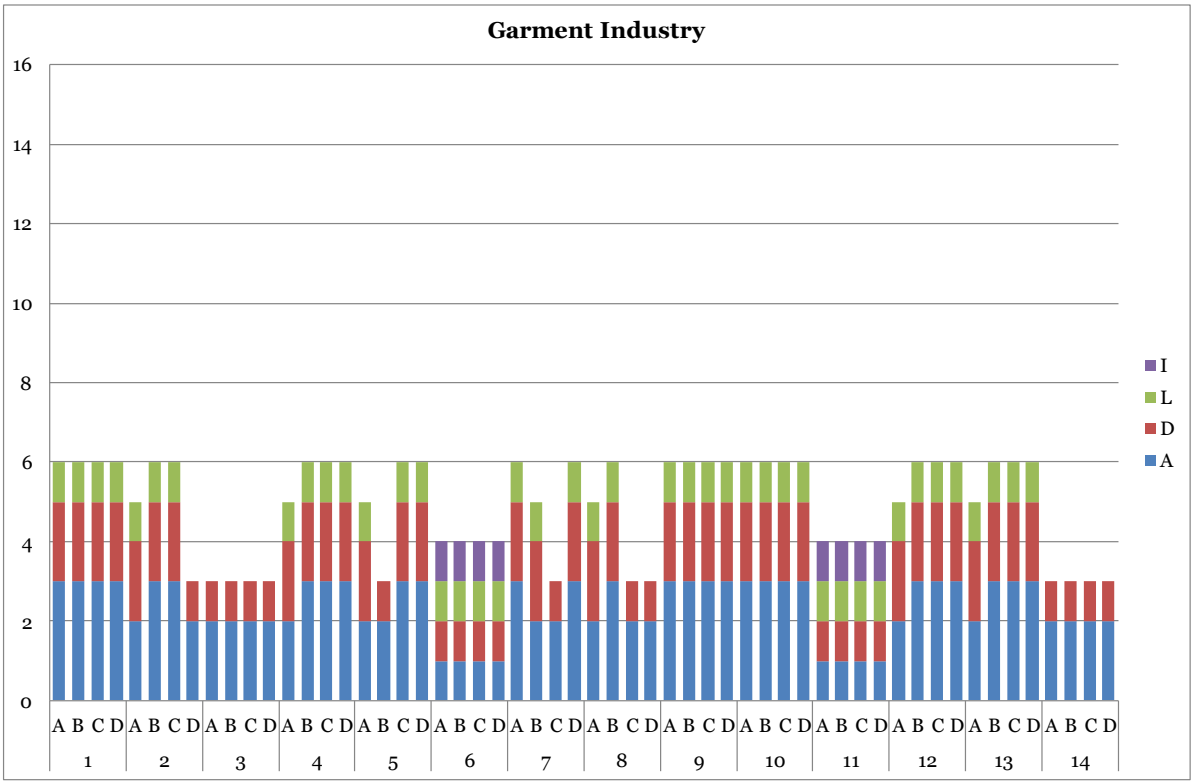

Figure-2. Lean assessment result of garment industry

Garment industry have kanban system, visual management, 5S, operation base layout, line balancing, quick changeover, multi skill, standard operation procedures, poya yoke, total preventive maintenance, policy deployment, and awareness of 7 waste in score 1 and supplie responsibility and kaizen in score 0.

Intergation (I) show that shoe industry have more than 50% of 4 SMEs of implement in lean technique and tools which is kanban system, visual management, 5S, line balancing, and total preventive maintenance in score 1 and supplie responsibility operation base layout, quick changeover, multi skill, standard operation procedures, poya yoke, policy deployment, awareness of 7 waste and kaizen in score 0.

Garment industry have line balancing and total preventive maintenance in score 1 and kanban system, visual management, supplier responsibility, 5S, operation base layout, quick changeover, multi skill, standard operation procedures, poya yoke, policy deployment, awareness of 7 waste and kaizen in score 0.

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 which measuring a leanness level of operation in SMEs case study. The shoe industry has higher leanness level than garment industries. Performanance of assessment for lean implement is score that measure of weak or strength in process. The lean assessment identified a weak of lean technique and tools is action planning for each. Process of assessment for lean implement is approach, deployment, learning, and integration which is next starting point.

The value of the lean assessment for the manufacturing system was the application of scoring from The Malcolm Baldrige National Quality award, which is the two-dimensioned scoring, for process and performance. The scoring is elaborate, and the steps for improvement could be described in depth, reflecting operations that require sustainable outcomes. Furture research should be expand to other in industrial manufacturing that is impacted from ASEAN Economic Community (AEC).

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