Industrial Application Tools and Techniques in Lean Manufacturing and Total Quality Management

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ABSTRACT

The purpose of this paper is to discuss the tools and techniques used by industrialist in the implementation of two different types of company approach: Lean Manufacturing (LM) and Total Quality Management (TQM). A survey was conducted for data collection. A total of 26 respondent companies had responded and the data was analysed by using SPSS programming. The results were shown that some of the industrial application tools and techniques are significant with the types of industry. No significance value is well below the alpha level 0.05 for Chi Square Test between the tools and techniques with company status (SMI / MNC) and the duration of LM / TQM implementation. This paper will provide a guide for other industrialists to identify the best tools and techniques when applying one or both approaches stated above. In addition, its expected to guide the academicians to prepare the material for future engineer (student) with better knowledge and understanding of the tools and techniques which commonly used by industrialist in Lean Manufacturing and Total Quality Management.

Keywords

Lean Manufacturing, Total Quality Management, tool and techniques.

1.0 INTRODUCTION

The previous studies on Lean Manufacturing and Total Quality Management have shown that there are a lot of beneficial gained by industrialists in order to improve and maintain the overall business operation (Womack *et al*., 1990; Womack and Jones, 1996; Dahlgaard, 1998; Hellsten and Klefsjo¨, 2000). In addition, the implementation of the both company approaches above had received good attention from industrialist since introduced. Although, there are shown that many companies had been withdrew from implementing its. The companies are failed to understand the approaches itself and failed to define the suitable tools and techniques with the company operations. Regarding to the problem statement, this paper will provide a guide for other industrialists to identify the best tools and techniques when applying the approaches. The results are expected to guide the academicians to prepare the material for future engineer (student) with better knowledge and understanding of the tools and techniques which commonly used by industrialist in Lean Manufacturing and Total Quality Management.

2.0 LEAN MANUFACTURING

Lean means "manufacturing without waste" (Wader, 2005). Waste is anything other than minimum amount of equipment, materials, parts, and working time that are absolutely essential to production. The lean approach is focused on systematically reducing waste (*Muda*) in the value stream (Conner, 2001; Carreira, 2005; Wader, 2005). The waste concept includes all possible defective work / activities, not only defective products.

This waste falls into seven basic categories: over production, defects, motion, transportation, inventory, over processing and waiting. These waste increase cost while adding no value from the customer's perspective. The seven hidden wastes are the enemy of people trying to improve processes in all industries (Wader, 2005).

According to McCurry and McIvor (2001), Lean Manufacturing is the performance of lean activities throughout the business process, from taking an order to collecting payment. If the organisation conducts design activities, then the definition of lean manufacturing extends to the conception through design, launch, production, shipment, and service.

Consequences of this are striving for perfection and a customer-driven pull of the process. A systematic approach to identifying and eliminating waste through continuous improvement, flow the product at the pull of the customer in pursuit of perfection (NIST, 2000).

Lean systems are characterised by five key principles (Womack *et al*., 1990; Womack and Jones, 1996):

1. *Value:* "Precisely specify value by specific product" – redefine the whole product through the eyes of the customer.
2. *Value stream:* "Identify the value stream for each product" – this is the entire set of actions required to bring a product from its raw materials to the customer.
3. *Flow:* "Make value flow without interruptions" – eliminate departmentalisation and batch processing so that the process can flow, leading to a short lead-time, high quality and low cost.
4. *Pull:* "Let the customer pull value from the producer" – if lead-times are reduced, then a producer can design, schedule and make exactly what the customer wants, when he wants it, rather than relying on a sales forecast. In practice, pull is usually achieved using the system known as "just-in-time" (JIT). (JIT is a system whereby an upstream process does not produce parts until requested to do so by a downstream process.)
5. *Perfection:* "Pursue perfection" – do not attempt to be slightly better than your competitors, but rather strive for perfection through the use of continuous improvement.

Close co-operation with suppliers and empowerment of the workforce are also key characteristics of the lean organisation.

There are many tools and techniques of lean manufacturing. Many of the tools and techniques can be used together as part of an overall initiative because they compliment each other. Each tool will help remove wastes and reduce the cost of operations.

Table 1 shows the lean tool and techniques that are appropriate to be considered for lean manufacturing system implementation.

Table 1: Lean Tool and Techniques.

No	Lean tool and techniques	Descriptions
1	Kaizen	The process of continuous improvement in small increments that make the process more efficient, effective, under control, and adaptable.
2	Kanban	To signal need and movement instructions will greatly support the plan.
3	5S	To reduce the clutter and inefficiency of any typical production and office environment.
4	Total Productive Maintenance (TPM)	Aimed at improving the reliability, consistency and capacity of machines through maintenance management
5	Value Stream Mapping (VSM)	A visual illustration of all activities required to bring a product through the main flow, from raw material to the stage of reaching the customer.
6	Cellular Manufacturing (CM)	Provide all of the equipment, tools, work instructions and materials to accomplish a single task or group of related tasks.
7	Poka-Yoke	The method of applying mistake proofing techniques to eliminate the possibility of errors occurring.
8	Single Piece Flow	Where products proceed, one complete product at a time through various operations in design, order taking and production, without interruptions, backflows or scrap.
9	Line Balancing	To identify the number of workers and the duties each should accomplish to meet the changing demands of the customers and to balance a production line for different levels of production and keep everyone informed.
10	Single Minute Exchange Die (SMED)	To reduce the lead-time and improve flows it is necessary to eliminate delays in change-over times on machines.
11	Kaikaku	To make radical improvements of an activity to eliminate waste.
12	Supplier Base Reduction (SBR)	To reduce the number of suppliers an organisation engages with.

3.0 TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is an approach to improve the competitiveness, effectiveness and flexibility of an organisation for the benefit of all stakeholders (Besterfield *et al*, 2003). It is an enhancement to the traditional way of doing business. It is a proven technique to guarantee survival in world-class competition. Only by changing the actions of management will the culture and actions of an entire organization be transformed. It is a way of planning, organising and understanding each activity, and of removing all the wasted effort and energy that is routinely spent in organisations. It ensures the leaders adopt a strategic overview of quality and focus on prevention not detection of problems.

TQM is for the most part common sense. Analyzing the three words, we have

a. *Total* – made up of the whole
b. *Quality* – degree of excellence a product or service provides
c. *Management* – act, art, or manner of handling, controlling, directing, etc.

TQM is defined as both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organisation. It is the application of quantitative methods and human resources to improve all the processes within an organisation and exceed customer needs now and in the future. TQM integrated fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach (Besterfield *et al*, 2003).

Dahlgaard (1998) view TQM as a corporate culture characterised by increased customer satisfaction through continuous improvement, in which all employees in the firm actively participate. Shiba *et al* (1993), on the other hand, argue that: TQM is an evolving system of practices, tools, and training methods for managing companies to provide customer satisfaction in a rapidly changing world. Hellsten and Klefsjo¨ (2000) support the view that TQM is an evolving system. Hellsten and Klefsjo¨ (2000) define TQM: as a continuously evolving management system consisting of values, methodologies and tools, the aim of which is to increase external and internal customer satisfaction with a reduced amount of resources.

TQM tools and techniques are divided into the categories of quantitative and non quantitative. Table 2 shows the TQM tool and techniques that are suitable to be considered for TQM implementation.

Table 2: TQM Tool And Techniques.

No	TQM tool and techniques	Descriptions
1	Statistical Process Control (SPC)	Statistical approach on measuring and maintaining quality.
2	Quality Management System (QMS) (ISO 9001)	To enhance customer satisfaction through effective application of system.
3	Environmental Management System (EMS) (ISO 14001)	A part of quality management system of an organization pertaining to environment management.
4	Total Productive Maintenance (TPM)	An equipment management program that involves all employees in the organisation in the maintenance and repair of the organization assets, whether a facility or plant
5	Failure Mode Effect Analysis (FMEA)	An analytical technique (a paper test) test that combines the technology and experience of people in identifying foreseeable failure modes of a product or process and planning for it elimination
6	Quality Function Deployment (QFD)	Converting consumers' demands into "quality characteristics" and developing a design quality for the finished product by systematic-cally deploying the relationships between the demands and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part and process
7	Benchmarking	A systematic method by which organizations can measure themselves against the best industry practice.
8	Design Of Experiment (DOE)	A systematic manipulation of a set of variables in which the effect of these manipulations is determined, conclusions are made, and the results are implemented.
9	Taguchi's Method	Statistical methods developed by Genichi Taguchito improve the quality of manufactured goods and, more recently, to biotechnology, marketing and advertising.

4.0 DATA COLLECTION

This study has focused on the companies involved in manufacturing activities and operating in Melaka which implementing Lean Manufacturing and TQM. This study was undertaken by semi-structured interviews and questionnaire survey. The respondents of this survey include the middle managers, operation executives and senior managers. Samples were chosen from a list of companies in MITC (Melaka International Trade Centre) directory.

5.0 RESULTS AND DISCUSSIONS

Figure 1 (a) shows the fraction of the respondents in terms of company status. As can be seen in the Pie Chart below, the main respondents of this study are Multinational Companies (MNC) which contributed 81% the sources of data. The rest of the respondents are Small Medium Industry (SMI) which contributed 19% the sources of data. Although, figure 1 (b) shows that only 95.23% of MNC and 80% of SMI implemented Lean Manufacturing (LM). In addition, 90.48% of MNC and all of the SMI implemented Total Quality Management (TQM). Table 3 shows the information details. As the conclusion, from out of a total 26, 93.3% or 24 companies are implemented LM and TQM were used to analysis.

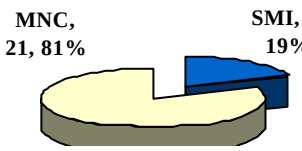

Figure 1(a): Respondent vs. MNC/SMI

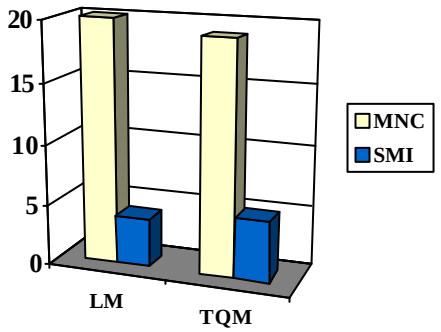

Figure 1(b): LM / TQM Implementation

Table 3: Company Status vs. LM/TQM Implementation

Company status	(LM)		TQM		Total
	Yes	No	Yes	No	
SMI	4, 80%	1, 20%	5, 100%	-	5, 100%
MNC	20, 95.23%	1, 4.77%	19, 90.48%	2, 9.52%	21, 100%
Total	24, 93.3%	2, 6.7%	24, 93.3%	2, 6.7%	26, 100%

N: 26

Table 4 shows the respondents' types of industry. From the table, it can be seen that the majority of the companies are involved in Electric & Electronic Industry (55.7%), followed by Metal & Fabrications Industry (23.1%), Plastic & Plastic Product Industry (11.5), Food & Beverages Industry (3.8%) and Information Technology (3.8%).

Most of companies especially MNC are implemented LM/TQM above 3 years. Table 5 shows the duration of LM/TQM implementation of SMI and MNC. It shows that most of the companies are experienced in TQM compared to LM.

Table 4: Type Of Industry

No	Type of industry	*f*	%
1	Electric & Electronic	15	55.7
2	Metal & Fabrications	6	23.1
3	Plastic & Plastic Product	3	11.5
4	Food and beverages	1	3.8
5	Information Technology	1	3.8

N: 26

Table 5: The Duration Of LM / TQM Implementation

	Duration	Lean Manufacturing		TQM	
		SMI	MNC	SMI	MNC
1	Below 6 Months	25%	-	-	-
2	1 - 2 Years	-	35%	40%	-
3	2 - 3 Years	50%	20%	-	26%
4	Above 3 Years	25%	45%	60%	74%
	Total	100%	100%	100%	100%

N: 24

As can be seen in Table 6, there are considered four (4) main LM tools and techniques used by industrialist. Based on the mean of the usage rating score, it is clear to show that Kaizen (4.88), 5S (4.70), TPM (4.63) and Kanban (4.33) are the favourite LM tools and techniques among respondents. Although, Table 6 shows that the listed LM tools and techniques is highly used for some of industrialist. Most of the companies not implement Kaikaku and Cellular Manufacturing in their LM implementation.

From Table 8, the result of non-parametric test shown that the TPM implementation in LM is significant with the types of industry. Even though, the others LM tools and techniques used by industrialist are not significant with company status, types of industry and the duration of the LM implementation.

Table 7 shows the industrialist TQM tools and techniques. Based on the result, it can be seen that SPC (4.83), TPM (4.58), FMEA (4.61) and Taguchi's Method (4.09) are the main four (4) TQM tools and techniques in industry which mean score of usage are almost 5.00 to show highly used. SPC is considered compulsory tool for TQM, this is because 87.5% of industrialist are highly used in TQM implementation. The rest of TQM tools are generally moderately used by industrialist. Although, the Table 7 shows that all the listed TQM tools and techniques in survey are highly used for some of the industrialist.

In addition, the result of non-parametric test shown that three (3) out of four (4) TQM main tools and techniques are significant with types of industry. There are SPC, TPM and FMEA. From Table 8, the result also shown that the others TQM tools and techniques are not significant with company status, types of industry and the duration of the TQM implementation.

Table 6: Industrial Lean Tool And Techniques

Lean Tools	Frequencies (Rating Score)						Mean	Sd
	0	1	2	3	4	5		
Kaizen	-	-	-	-	3	21	4.88	0.338
5S	1	-	-	2	3	18	4.70	0.635
TPM	-	-	-	1	7	16	4.63	0.576
Kanban	-	1	1	1	7	14	4.33	1.049
Poka-Yoke	1	-	-	11	7	5	3.74	0.810
Line Balancing	-	1	2	10	7	3	3.79	0.721
Single Pieces Flow	-	4	4	8	7	1	2.88	1.154
VSM	3	2	5	7	5	2	3.00	1.140
SMED	12	3	-	5	3	1	2.92	1.311
Step Change/ Kaikaku	16	1	1	4	1	1	3.00	1.195
SBR	8	6	1	1	8	-	2.69	1.448
CM	13	3	3	2	2	1	2.55	1.368

N:24

Scale:

(Rating Score) 0 1 2 3 4 5

(Not Use) (Rarely Used) (Highly Used)

Table 7: Industrial TQM Tool And Techniques

TQM Tools	Frequencies (Rating Score)						Mean	Sd
	0	1	2	3	4	5		
SPC	-	-	-	1	2	21	4.88	0.338
FMEA	1	-	1	1	4	17	4.70	0.635
TPM	-	-	1	-	7	16	4.63	0.576
Taguchi's Method	2	-	1	2	13	6	4.33	1.049
QFD	1	2	1	4	9	7	3.74	0.810
QMS	2	-	6	6	6	4	3.79	0.721
Benchmarking	2	1	6	8	4	3	2.88	1.154
DOE	4	4	6	2	5	3	3.00	1.140
EMS	5	2	7	5	3	2	2.92	1.311

N:24

Table 8: Result of Non-Parametric Test

no	Lean tool & techniques	C1	C2	C3
1	Kaizen	0.408	0.654	0.957
2	5S	0.347	0.093	0.421
3	TPM	0.870	**0.001**	0.517
4	Kanban	0.849	0.711	0.163
5	Poka-Yoke	0.397	0.788	0.103
6	Line Balancing	0.178	0.658	0.234
7	Single Pieces Flow	0.199	0.387	0.311
8	VSM	0.380	0.668	0.500
9	SMED	0.351	0.213	0.672
10	Step Change/ Kaikaku	-	0.238	0.647
11	Supplier Base Reduction	0.620	0.449	0.585
12	Cellular Manufacturing	0.569	0.454	0.819

no	TQM tool & techniques	C1	C2	C3
1	SPC	0.637	**0.001**	0.811
2	FMEA	0.254	**0.003**	0.074
3	TPM	0.224	**0.002**	0.169
4	Taguchi's Method	0.249	0.594	0.066
5	QFD	0.832	0.600	0.332
6	QMS	0.118	0.180	0.134
7	Benchmarking	0.566	0.835	0.352
8	DOE	0.740	0.200	0.733
9	EMS	0.225	0.533	0.364

Note:
Significant level: 0.05
(Asymp. Sig (2-sided)
C1: Pearson Chi Square Test on Company Status
C2: Pearson Chi Square Test on Types of Industry
C3: Pearson Chi Square Test on Duration Of Implementation

6.0 CONCLUSIONS

As the conclusion, there are many tools and techniques used by industrialist in implementing lean manufacturing and TQM. Although, there are several tools and techniques which suggested from previous case study are not applicable for other organisations. SPC is the most highly used in TQM while Kaizen for Lean manufacturing. TPM is thirdly highly used by industrialist in both approaches. The result shows that SPC, TPM and FMEA are significant with the types of industry. The selection of tools and techniques in Lean Manufacturing or TQM must be appropriate with the organisational operation background. Every organisations must have proper understanding and knowledge before implement its. In addition, the commitment and employee involvement in strategic development plan is crucial to ensure the overall implementation of Lean Manufacturing or TQM been succeed.

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