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Applying Quality Function Deployment Techniques in Lead Production Project Selection and Assignment

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Abstract. In the past few decades' lean production has become widely adopted in many industries, however there is still great opportunity to combine lean production with other methods or tools to reduce waste and improve production performance. QFD (Quality Function Deployment, QFD) is a combination of quality control and quality assurance methods that transform the customer's requirements into the technical aspects of response to the customer. This study is based on the lean production concept to create a QFD model to reduce waste in the manufacturing process and reflect customer feedback. This article presents a literature review and then defines the QFD and lean manufacturing concepts and relationships. We use the Pareto chart to select the waste materials priority and build some technical solutions into the HOQ. Finally, this article provides lean concepts and QFD links and revises the standard manufacturing operating procedures (standard operation procedure, SOP). Management will be based on the newly revised SOP to improve waste management and further improve quality management.

Introduction

Lean manufacturing is a kind of methodology for achieving continuity in manufacturing. From the journal of Industrial Engineering the lean approach is used to develop waste management by eliminating non value added activities [1]. Lean philosophies were implemented for the first time at Toyota Corporation, Japan and successfully became a leader at that time. From 1968-1978 US productivity increased by 23.6 %, but the Japanese experienced an impressive level at 89.1 % [2] .Sometimes lean philosophies cannot be implemented in mass production. Firstly, huge product portfolios cannot be standardized. Secondly, the products' characteristics create production constraints. Thirdly, the job-shops or smaller firms simply cannot match the dominance or resources that the larger firms enjoy, allowing them to be inflexible along their supply chains. Some references emphasized there are some critical successes in lean implementation, such as human resources, organizational design, finance organizational culture and skills and expertise [3].

Some researches pointed about there are some project selection criteria to achieve Lean Six sigma. Integration with the company's strategies also becomes a main criteria. Object prioritization in some companies can be analyzed by using cost benefit analysis, cause and effect matrix, brainstorming and Pareto technique.

In essence, the QFD approach establishes a matrix, called House of Quality to emphasize the relationships between WHATs sub matrix and HOWs sub-matrix. Quality Function Deployment is a methodology that answers to the voice of the customer. It means operations face two problems, from inside (waste) and outside (customer need). QFD has been developed in many regions, many kinds of manufacturing such as banking, public service, or even mass production manufacturing. It also has influence beyond Japan and the US [4]. This research tries to analyze the integration between quality function deployment and Lean Manufacturing.

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METHODOLOGY

This study is specifically focused on medium corporation/organizations, to figure out where waste comes from. This research is linked between quality function deployment and lean manufacturing, because it can be summarized as a methodology for developing a value stream across all products to eliminate the seven types of waste. In this paper author manage between QFD and Lean. The matter is there is no definite boundary for QFD application so author builds a new model that is a link between lean manufacturing and QFD is shown in Fig.1. This research focuses on the voice of the customer to identify the types of waste correlated with which department the waste could come from. The picture below describes how QFD analyzes waste management:

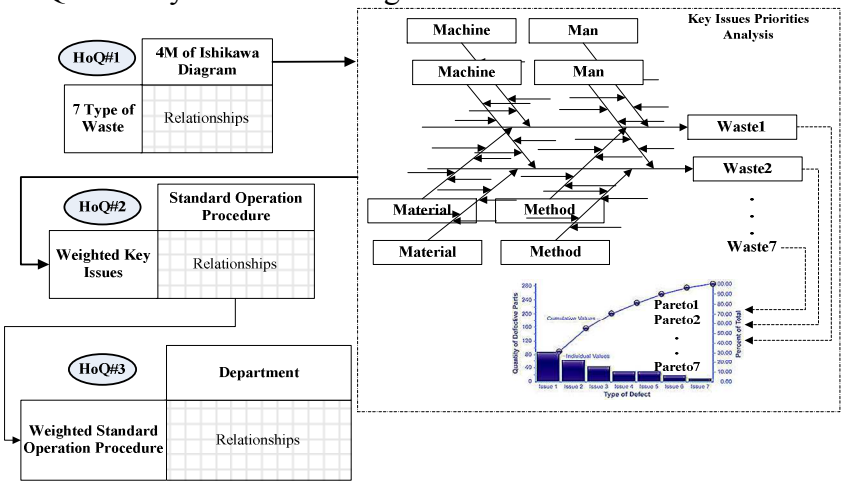

Fig.1. Linkage four QFD and Lean

Step by step of House of Quality linked with lean concept:

1. Determine the causes of every waste using the Ishikawa Diagram
2. Collect key issues on every waste, and then make priorities using the Pareto diagram
3. Relationship between WHATs and HOWs
4. Determine the relative importance of most causes from 4M of the Ishikawa Diagram

House of Quality #1 step by step:

1. Make relationships between most causes from 4M and key issues from three fishbone diagram
2. Linked top three of categories with other categories
3. Determine the relative importance of key issues

House of Quality #2 step by step:

1. Determine the most important key issues and put on WHAT's sub-matrix
2. Identify the relationships between key issues and standard operation procedure (SOP)
3. Determine relative importance of SOP

House of Quality #3 step by step:

1. Determine most importance of SOP
2. Making relationships between standard operation procedure (SOP) and departments related

Result

House of Quality #1

This calculation using five level of weighted value: 9 = strong, 7 = moderate strong, 5 = moderate weak and 3 = weak. Sub matrix of correlation in house of quality having three types of value which are shown in Table 1:

Table 1, Value of relationship symbol

No	Symbol	Value	Remark
1	●	9	Strong
2	○	3	Moderate
3	▽	1	Weak

Seven types of waste can be affected by four facets of the Ishikawa diagram to analyze their relationships and which one will have highest score of relationships in this first sub matrix is shown in Table 2. The aim of this HOQ is to give a score every category of Ishikawa diagram, whether man, machine, method or material have the same score or not.

Table 2, House of Quality #1

Waste	Weighted Value	Man	Machine	Method	Material
Defect	9	● 81	○ 27	○ 27	○ 27
Inventory	9	● 81	▽ 9	▽ 9	● 81
Overproductio	9	▽ 9	○ 27	○ 27	● 81
Overprocessing	7	○ 21	○ 21	○ 21	▽ 21
Transporting	5	○ 15	○ 15	○ 15	▽ 5
Waiting	5	○ 15	○ 15	▽ 5	○ 15
Motion	3	● 27	▽ 3	▽ 3	▽ 3
TOTAL		249	117	107	233

Weighted values are given in order to calculate with value of relationships, and how important every waste is. From the table above we can conclude that man is the highest score rather than another category of the Ishikawa diagram. It means that man has leverage in waste production with total score 249 then followed with material factor with total score 233. As we can see defect had strong relationship with man factor, so that indicate commonly defect waste is caused by man, it can be fatigue, poor attitude or omission. And also inventory was affected by man factor but there was no strong relationship in transporting and waiting criteria.

After we determine the many causes of three types of wastes, the key issues of three main wastes are classified. So with the election of key issues, will be analyzed the relationship between the key issues with the existing variable of Ishikawa diagram. The variables in the Ishikawa diagram are also selected whether all of the variables are used.

There are many key issues in each of the top three wastes, so we have to make some priorities. After collecting the key issues from every Ishikawa, a Pareto chart can be used to find out the priorities of key issues. Most companies have limited resources so that they have to make priorities to attain waste elimination capability. By using the Pareto chart, companies would know the highest impact key issues to undertake for SOP distribution.

House of Quality #2

Standard Operating Procedure is created to guide every worker on each job floor. Waste can be detected because white collar didn't fully give their attention to the SOP, or might they just ignore the SOP. Thus, to reduce inefficiency a SOP can be created for every department in spite of waste eliminating such as waiting time, inventory or even top three of waste in this research, which are defect, over production, and inventory. Table 3 correlates between relative important of 4M and SOP itself:

Table 3, House of Quality #2

SOP	Weighted Value	1	2	3	4	5	6	7	8	9	10	11	12
Key Issues – Standard Operating Procedure		Production part approval process	New product developing control procedure	Continuous improvement procedure	Supplier control procedure	Purchasing control procedure	Process control procedure	Machine preventive maintenance procedure	Training and education control procedure	Employee certification and promotion procedure	Calibration control procedure	Corrective and preventive action procedure	Management review and responsibility control
excessive variation	3	▽	●	▽	▽	▽	○		▽		●	●	
poor attitude	3	○		▽			○	●	●	○		●	○
Damaged	3	▽	●	●				○	○	○	○	●	
Mishandling of setup	5	▽	○					●	○			▽	
High defective rate of raw materials	7	○	▽	○	○	○	▽		○		▽		
Careless handling of operator	3	○					▽		●				
Wrong working instruction used	9	●	●	○		▽	●	○	●	○	○	▽	●
Poor market forecast of sales	5				▽	●				●			○
Poor quality of raw materials	9		○	●	○	○	○			○	▽	▽	●
Improper setting of material safety stock	7		○	▽	○	○	○						○
Poor delivery accuracy of suppliers	7				●	○	○						
Inexperienced	3	▽	○				○	○	●				○
operating too fast	3			▽			○						
over supply of materials	5		▽	○	●	●	▽			▽			○
extra waste handling	3		○	○			▽						●
High rework and scrap rate	7		●	●				●				○	
Poor production schedule arrangement	5				▽	▽	▽	○					▽
Total		134	291	259	190	197	209	195	210	122	79	125	263
Rank		9	1	3	8	6	5	7	4	11	12	10	2

House of Quality #3

Last step is to build a third HOQ in order to determine where the common department SOPs are appropriately distributed. There are six common departments such as quality assurance, warehousing, production, process engineering, research and development and the last is human resources and

management. Just like the previous step, every SOP is filled in with weighted values from 9, 7, 5 and 3 is shown in Table 4.

Table 4, House of Quality #3

	Column	Weighted Value	1	2	3	4	5	6
Row	Standard Operating Procedure - Manufacturing Department		Quality Assurance	Warehousing	Production	Process engineering	Research and Development	Human Resource and Management
1	New product developing control procedure	9	●	▽	○	▽		
2	Continuous improvement procedure	9	●	○	○	○	●	○
3	Management review and responsibility control	9	○	○	▽		○	●
4	Training and education control procedure	7	●	○	○			●
5	Machine preventive maintenance procedure	7			○	▽		
6	Purchasing control procedure	5	▽				▽	▽
7	Process control procedure	7	▽	○	▽	●		
8	Supplier control procedure	9	▽	●	▽		▽	▽
9	Production part approval process	3	○		○	○	○	
10	Employee certification and promotion procedure	5	○		○			●
11	Corrective and preventive action procedure	5	▽		○	○		▽
12	Calibration control procedure	3			○	●		
Total			302	186	169	157	131	235
Rank			1	3	4	5	6	2

CONCLUSION

Lean manufacturing and quality function deployment implementation can be a new model to effectively and efficiently eliminate waste. This research provides that waste does not always come from one department and often comes from multiple departments.

The procedures to handle that involve arranging a new standard operating procedure distribution into appropriate departments. The top three wastes are defects, over production and inventory can be addressed by continuous improvement procedures, process control procedures and training and education procedures. Revised standard operating procedures can eliminate key issues from man, materials, methods and machines because those key issues must be eliminated. The author hopes this integrated procedure can be useful for manufacturing and service companies.

SOP cannot be addressed successfully without involvement from the white collar side, according to the management responsible to run the production line, warehousing line, quality assurance line and etc. so that also a part of lean implementation. To achieve maximum eliminating non added value results the organization must ensure that every department always maintains their lean philosophy for continuous improvement.

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