

# Elimination of Waste through Value Add/Non value Add Process Analysis to Improve Cost Productivity in Manufacturing - A Case Study

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**Abstract** – Value Stream Mapping (VSM) is a very comprehensive tool that allows an organization to identify sources of waste and implements process improvements. This paper describes the adoption of VSM in a semiconductor manufacturing company to improve personnel efficiency and optimize headcount in the production lines. Based on the future state of the value stream mapping a new production process flow was implemented. Non value added activities were reduced or removed by assigning butterfly operators to perform these tasks. The new system successfully resulted in the reduction of six headcounts in the taping process. This is equivalent to a saving of approximately eighty seven thousand Malaysian ringgits per annum. This systematic approach can be similarly employed by the lean practitioners to conduct lean activities in other manufacturing sectors.

**Keywords** – Value stream mapping (VSM), Productivity and Value added/Non Value Added Analysis, Semiconductor industry

## I. INTRODUCTION

The increase of operations and maintenance cost from year to year is of a great concern in most manufacturing firms today. In an effort to optimize and reduce operation and maintenance cost, the Total Preventive Maintenance programme has played a key role to increase equipment availability and hence reducing the needs for further investments [1]. In today's competitive environment, a manufacturing firm's success is very much dependent on its capability in incorporating cost reduction measures and productivity improvements in its daily operations [2]. Productivity can be expressed as a physical measurement of the rate at which outputs of goods or services are produced per unit of input. If a manufacturing firm is able to produce output beyond than desired with a given input, then higher productivity efficiency is achieved.

Lean manufacturing was developed based on the knowledge and know-how obtained from the Toyota Production System (TPS); where Toyota had successfully increased their world-wide market share by improving product lead-time, quality and employee productivity [3]. The fundamental principle behind lean manufacturing is to reduce non-value added process and reduced process lead-time. Non- value added activities refers to those activities which consume resources but produces nothing at the end of process [4]. The main objective of lean manufacturing

practices are to improve overall productivity, personal cost, equipment performance and product quality [5].

## II. LITERATURE REVIEW

According to Ohno [6], the Toyota Production System is a systematic approach to identify and eliminate production losses. TPS helps to reduce cost and product lead-time by challenging and analysing every single process step flow. It applies the "why-why analysis" by asking why an activity is performed and continues asking why after each answer and response [6]. By understanding each why, this will undoubtedly lead to the root-cause being identified so that the appropriate corrective action may be taken to address the situation [6].

Researchers such as McDonald et al. [7], Abdulmalek and Rajgopal [8] and Greasley [9] have explored and carried out study on the integration of value stream mapping (VSM) by using simulation. Simulation is one of the most appropriate tools that can be incorporated with the other practical methods such as business model and operation research [9].

Chitturi et al. [10] discussed and defined the method on how to calculate process time and how to continue process improvement activities in order to close the gap between the existing process flow and the future process flow steps. Chitturi et al. also pointed out that all detailed data and information must be collected from the beginning until the end of the process step during mapping the VSM process.

Chandradeep [11] pointed out that the lean approach and VSM methodology can be implemented and applied for a small company. He also ascertained that VSM is a comprehensive and powerful production tool to highlight the inefficiency and improvement areas of the identified future state of the process. Bhim Singh et al. [12] claimed that the implementation of lean manufacturing with the assistance of VSM methodology in the manufacturing industry resulted in a 83.14 percent decrease in the lead time, 12.62 percent decrease in the processing time and 89.47 percent decrease in the work-in-process inventory. In addition, they managed a 30 percent decrease in manpower requirement with productivity increasing to 42.86 percent per operator.

Another researcher, Ibon [13] claimed that the VSM is a comprehensive industry engineering tool to develop and design process flows through the identification of non-value added processes, removing these processes and to join or combine with other value-added process in order to cut down the cost of production and reduce product overall lead time. It is the production

tool used for re-designing and re-engineering the production system.

Based on a case study done by Belokar et al. [14], by adopting the VSM methodology, the production lead time improved from 18 days to 11 days and the processing lead time improved from 124.7 seconds to 107.2 seconds. In addition, in-process inventory was reduced from three days to one day. This translated to a 44% improvement in the value adding activities. As a result, the process flow became much simpler and less expensive to achieve operational excellence.

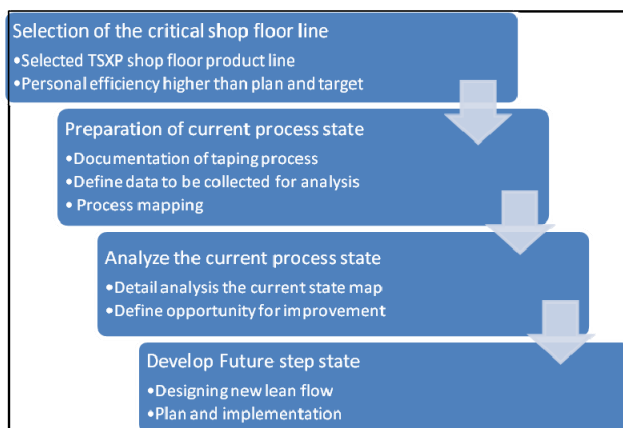
### III. METHOD AND METHODOLOGY

The adoption of the value added and non value added analysis is demonstrated through a case study in a well known semiconductor. This case company is located in Malaysia and started to introduce lean manufacturing since 2012. The case company is actively involved in a market that is expected to grow at an average of 10 percent annually over the next few years. To achieve this, the company focuses on Quality and Productivity (Q&P) as its key thrust in attaining competitive advantage for the company.

To improve productivity, it is essential to identify the production waste and eliminate the waste by applying VSM principles and methodology in the production lines. For the case study, the Thin Small Leadless Package (TSXP) taping production line was chosen because the personnel efficiency level was above the Target Cost Roadmap (TCR). The various steps undertaken in the VSM implementation are illustrated in Figure 1.

The problem is clearly defined by using tools such as 12 dimensions approach and SIPOC. Issues on containment and actual performance were also carefully examined to ensure viability of the project. The problem description however does not contain the cause of the deficiency and likely actions or solution. At the first stage, the project team was able to identify non-conformity issues.

Figure 1: VSM Implementation Flow in the Case Company



For the purpose of validation measurement and evaluation against the baseline performance, tools such as trend charts, basic Pareto chart, process flow chart and process flow VA-NVA analysis were used. The team was able to identify potential root causes that can be used as levers for improvement for the problem under investigation.

In the next phase of the study, the team determined the type of non-conformity and the true root cause of these non-conformity. The team verified the hypotheses defined at earlier stage either by direct observation of by suitable statistical test. The hypotheses examines the relationships between NVA activities and low personnel efficiency; operator manual activities and low personnel efficiency; and high frequency of visual inspection processing time and low personnel efficiency.

In the improvement phase of the study the project team developed solutions to improve the process capability, implement and test the solutions. In this phase, after the process and its capability have been characterized, those process elements that need to be improved are identified and the improvement target has been defined, the next action is execution.

Finally, the proposed solution was implemented; process performances were monitored and acted upon on any deviation encountered. The project team also stabilized the process and measured the long term process capability.

### IV. RESULTS AND DISCUSSION

The non-conformity for this case study is the Test Handler and Automation (THA) taping personnel efficiency which is above the planned target. The final problem statement developed was: TSxP THA taping personal efficiency is five cents above planned target which was three cents and headcount optimization is not optimized where the current man-machine-ratio is 1:2. The objective, background and scope of the case study were defined and shown in Figure 2.

Figure 2: Objective and scope of the case study

Project Background	TSxP THA Taping Personal Efficiency above Target Cost Roadmap
Scope	To improve personal efficiency and optimize headcount at TSxP THA Taping area
Objective	To improve personal efficiency by using VSM Approach To optimize MMO from 1:2 to 1:3
Resource	Timeline: 6 months. Target to complete by Feb 2013 Team Member : IE, Production, Maintenance, Test Process Engineering, Finance, Quality, HR
Benefit	Target annual saving: MYR87,000 (3 H/C)
Potential Constraint	Area Layout , Investment on Infrastructure
Project Metric	Multi-Machine-Operation

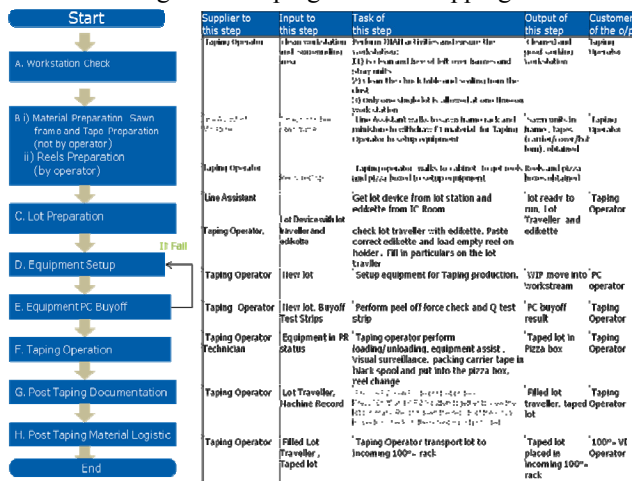
The problem statement was clearly developed by using the twelve dimension approaches. Figure 3 provides the details of the approach.

Figure 3: 12 Dimension Approach

No	Dimension	Is
1	Geographically where was the object when the nonconformity was noticed first?	TSXP taping process
2	Where is the nonconformity located on the object?	TSXP THA taping
3	At which time and date was the nonconformity first noticed	Since September 2012
4	What is the pattern of occurrences? (over time) What is the type of the nonconformity?	Pattern of occurrence: continuous trend. Type of nonconformity: No seasonal pattern
5	Where in the sequence of events (process steps) of the object was the nonconformity first noticed?	Taping process
6	Where in the sequence of events (process steps) of the object was the nonconformity first noticed?	All THA machine have the same nonconformity
7	How many faults are there on one object?	N.A.
8	What is the size of the nonconformity or how bad is the nonconformity?	Potential saving RM87,000 annually
9	Is the number of objects with the same nonconformity growing/ staying the same, stable / decreasing?	Stable
10	Is the nonconformity getting worse / stable / getting better?	stable

In the stage of the case study, process mapping was employed to identify the potential source of the low personnel efficiency at TSXP process. The actual process capability at the potential sources for this non-conformity was measure using the VA/NVA approach. The process mapping was based on the insights of more than one person and from different perspectives. Figure 4 shows the result for the taping process mapping.

Figure 4: Taping Process Mapping

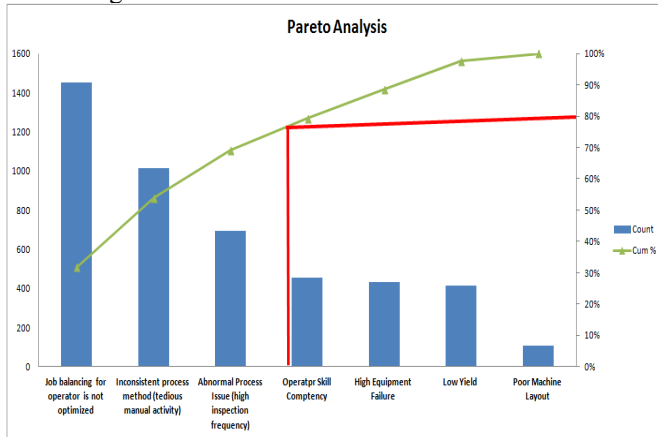


After the process mapping has been completed, the team used value added and non-value added analysis to identify and eliminate production waste at the taping process. Figure 5 details the VA/NVA analysis for the TSXP taping.

Figure 5: Value Added/Non Value Added Mapping

Original Work flow									
Product / Lot #			Process Name : Taping Lot						
Activity / Step #			Step #		Step #		Step #		
No	Op	Operation Description (Process Activity Capture in Nov 2010)	Prng	VA NVA QVA	7 Waste Class	Time (min)	Total Time (min)	Distance (Steps)	Responsible
A. Workstation Check									
1	1	Check workstation	1	OVA		10	10	0.0	QMS #
2	2	Check workstation	1	OVA		10	20	0.0	QMS #
3	3	Check workstation	1	OVA		10	30	0.0	QMS #
B. Material Preparation									
4	4	Travel to cabinet to get the reel and pizza boxes	1	NVA	T	10	40	8.0	QMS #
5	5	Insert carrier tape	1	OVA		10	50	0.0	QMS #
6	6	Insert carrier tape	1	OVA		10	60	0.0	QMS #
7	7	Insert Carrier Tape (Station)	1	NVA		10	70	0.0	QMS #
8	8	Post Taping	1	NVA	M	10	80	0.0	QMS #
C. Lot Preparation									
9	9	Travel to cabinet to get the reel and pizza boxes	1	NVA	M	10	90	0.0	QMS #
10	10	Insert carrier tape	1	OVA		10	100	0.0	QMS #
11	11	Insert carrier tape	1	OVA		10	110	0.0	QMS #
12	12	Insert Carrier Tape (Station)	1	OVA		10	120	0.0	QMS #
13	13	Post Taping	1	NVA		10	130	0.0	QMS #
D. Equipment Setup									
14	14	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	140	0.0	QMS #
15	15	Insert carrier tape	1	OVA		10	150	0.0	QMS #
16	16	Insert carrier tape	1	OVA		10	160	0.0	QMS #
17	17	Insert Carrier Tape (Station)	1	NVA	T	10	170	0.0	QMS #
18	18	Post Taping	1	OVA		10	180	0.0	QMS #
19	19	Travel to cabinet to get the reel and pizza boxes	1	NVA	T	10	190	0.0	QMS #
20	20	Insert carrier tape	1	OVA		10	200	0.0	QMS #
21	21	Insert carrier tape	1	OVA		10	210	0.0	QMS #
22	22	Insert Carrier Tape (Station)	1	OVA		10	220	0.0	QMS #
23	23	Post Taping	1	OVA		10	230	0.0	QMS #
24	24	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	240	0.0	QMS #
25	25	Insert carrier tape	1	OVA		10	250	0.0	QMS #
26	26	Insert carrier tape	1	OVA		10	260	0.0	QMS #
27	27	Insert Carrier Tape (Station)	1	OVA		10	270	0.0	QMS #
28	28	Post Taping	1	NVA		10	280	0.0	QMS #
29	29	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	290	0.0	QMS #
30	30	Insert carrier tape	1	OVA		10	300	0.0	QMS #
31	31	Insert carrier tape	1	OVA		10	310	0.0	QMS #
32	32	Insert Carrier Tape (Station)	1	OVA		10	320	0.0	QMS #
33	33	Post Taping	1	OVA		10	330	0.0	QMS #
34	34	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	340	0.0	QMS #
35	35	Insert carrier tape	1	OVA		10	350	0.0	QMS #
36	36	Insert carrier tape	1	OVA		10	360	0.0	QMS #
37	37	Insert Carrier Tape (Station)	1	OVA		10	370	0.0	QMS #
38	38	Post Taping	1	NVA		10	380	0.0	QMS #
39	39	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	390	0.0	QMS #
40	40	Insert carrier tape	1	OVA		10	400	0.0	QMS #
41	41	Insert carrier tape	1	OVA		10	410	0.0	QMS #
42	42	Insert Carrier Tape (Station)	1	OVA		10	420	0.0	QMS #
43	43	Post Taping	1	OVA		10	430	0.0	QMS #
44	44	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	440	0.0	QMS #
45	45	Insert carrier tape	1	OVA		10	450	0.0	QMS #
46	46	Insert carrier tape	1	OVA		10	460	0.0	QMS #
47	47	Insert Carrier Tape (Station)	1	OVA		10	470	0.0	QMS #
48	48	Post Taping	1	OVA		10	480	0.0	QMS #
49	49	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	490	0.0	QMS #
50	50	Insert carrier tape	1	OVA		10	500	0.0	QMS #
51	51	Insert carrier tape	1	OVA		10	510	0.0	QMS #
52	52	Insert Carrier Tape (Station)	1	OVA		10	520	0.0	QMS #
53	53	Post Taping	1	OVA		10	530	0.0	QMS #
54	54	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	540	0.0	QMS #
55	55	Insert carrier tape	1	OVA		10	550	0.0	QMS #
56	56	Insert carrier tape	1	OVA		10	560	0.0	QMS #
57	57	Insert Carrier Tape (Station)	1	OVA		10	570	0.0	QMS #
58	58	Post Taping	1	OVA		10	580	0.0	QMS #
59	59	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	590	0.0	QMS #
60	60	Insert carrier tape	1	OVA		10	600	0.0	QMS #
61	61	Insert carrier tape	1	OVA		10	610	0.0	QMS #
62	62	Insert Carrier Tape (Station)	1	OVA		10	620	0.0	QMS #
63	63	Post Taping	1	OVA		10	630	0.0	QMS #
64	64	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	640	0.0	QMS #
65	65	Insert carrier tape	1	OVA		10	650	0.0	QMS #
66	66	Insert carrier tape	1	OVA		10	660	0.0	QMS #
67	67	Insert Carrier Tape (Station)	1	OVA		10	670	0.0	QMS #
68	68	Post Taping	1	OVA		10	680	0.0	QMS #
69	69	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	690	0.0	QMS #
70	70	Insert carrier tape	1	OVA		10	700	0.0	QMS #
71	71	Insert carrier tape	1	OVA		10	710	0.0	QMS #
72	72	Insert Carrier Tape (Station)	1	OVA		10	720	0.0	QMS #
73	73	Post Taping	1	OVA		10	730	0.0	QMS #
74	74	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	740	0.0	QMS #
75	75	Insert carrier tape	1	OVA		10	750	0.0	QMS #
76	76	Insert carrier tape	1	OVA		10	760	0.0	QMS #
77	77	Insert Carrier Tape (Station)	1	OVA		10	770	0.0	QMS #
78	78	Post Taping	1	OVA		10	780	0.0	QMS #
79	79	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	790	0.0	QMS #
80	80	Insert carrier tape	1	OVA		10	800	0.0	QMS #
81	81	Insert carrier tape	1	OVA		10	810	0.0	QMS #
82	82	Insert Carrier Tape (Station)	1	OVA		10	820	0.0	QMS #
83	83	Post Taping	1	OVA		10	830	0.0	QMS #
84	84	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	840	0.0	QMS #
85	85	Insert carrier tape	1	OVA		10	850	0.0	QMS #
86	86	Insert carrier tape	1	OVA		10	860	0.0	QMS #
87	87	Insert Carrier Tape (Station)	1	OVA		10	870	0.0	QMS #
88	88	Post Taping	1	OVA		10	880	0.0	QMS #
89	89	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	890	0.0	QMS #
90	90	Insert carrier tape	1	OVA		10	900	0.0	QMS #
91	91	Insert carrier tape	1	OVA		10	910	0.0	QMS #
92	92	Insert Carrier Tape (Station)	1	OVA		10	920	0.0	QMS #
93	93	Post Taping	1	OVA		10	930	0.0	QMS #
94	94	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	940	0.0	QMS #
95	95	Insert carrier tape	1	OVA		10	950	0.0	QMS #
96	96	Insert carrier tape	1	OVA		10	960	0.0	QMS #
97	97	Insert Carrier Tape (Station)	1	OVA		10	970	0.0	QMS #
98	98	Post Taping	1	OVA		10	980	0.0	QMS #
99	99	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	990	0.0	QMS #
100	100	Insert carrier tape	1	OVA		10	1000	0.0	QMS #
101	101	Insert carrier tape	1	OVA		10	1010	0.0	QMS #
102	102	Insert Carrier Tape (Station)	1	OVA		10	1020	0.0	QMS #
103	103	Post Taping	1	OVA		10	1030	0.0	QMS #
104	104	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1040	0.0	QMS #
105	105	Insert carrier tape	1	OVA		10	1050	0.0	QMS #
106	106	Insert carrier tape	1	OVA		10	1060	0.0	QMS #
107	107	Insert Carrier Tape (Station)	1	OVA		10	1070	0.0	QMS #
108	108	Post Taping	1	OVA		10	1080	0.0	QMS #
109	109	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1090	0.0	QMS #
110	110	Insert carrier tape	1	OVA		10	1100	0.0	QMS #
111	111	Insert carrier tape	1	OVA		10	1110	0.0	QMS #
112	112	Insert Carrier Tape (Station)	1	OVA		10	1120	0.0	QMS #
113	113	Post Taping	1	OVA		10	1130	0.0	QMS #
114	114	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1140	0.0	QMS #
115	115	Insert carrier tape	1	OVA		10	1150	0.0	QMS #
116	116	Insert carrier tape	1	OVA		10	1160	0.0	QMS #
117	117	Insert Carrier Tape (Station)	1	OVA		10	1170	0.0	QMS #
118	118	Post Taping	1	OVA		10	1180	0.0	QMS #
119	119	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1190	0.0	QMS #
120	120	Insert carrier tape	1	OVA		10	1200	0.0	QMS #
121	121	Insert carrier tape	1	OVA		10	1210	0.0	QMS #
122	122	Insert Carrier Tape (Station)	1	OVA		10	1220	0.0	QMS #
123	123	Post Taping	1	OVA		10	1230	0.0	QMS #
124	124	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1240	0.0	QMS #
125	125	Insert carrier tape	1	OVA		10	1250	0.0	QMS #
126	126	Insert carrier tape	1	OVA		10	1260	0.0	QMS #
127	127	Insert Carrier Tape (Station)	1	OVA		10	1270	0.0	QMS #
128	128	Post Taping	1	OVA		10	1280	0.0	QMS #
129	129	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1290	0.0	QMS #
130	130	Insert carrier tape	1	OVA		10	1300	0.0	QMS #
131	131	Insert carrier tape	1	OVA		10	1310	0.0	QMS #
132	132	Insert Carrier Tape (Station)	1	OVA		10	1320	0.0	QMS #
133	133	Post Taping	1	OVA		10	1330	0.0	QMS #
134	134	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1340	0.0	QMS #
135	135	Insert carrier tape	1	OVA		10	1350	0.0	QMS #
136	136	Insert carrier tape	1	OVA		10	1360	0.0	QMS #
137	137	Insert Carrier Tape (Station)	1	OVA		10	1370	0.0	QMS #
138	138	Post Taping	1	OVA		10	1380	0.0	QMS #
139	139	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1390	0.0	QMS #
140	140	Insert carrier tape	1	OVA		10	1400	0.0	QMS #
141	141	Insert carrier tape	1	OVA		10	1410	0.0	QMS #
142	142	Insert Carrier Tape (Station)	1	OVA		10	1420	0.0	QMS #
143	143	Post Taping	1	OVA		10	1430	0.0	QMS #
144	144	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1440	0.0	QMS #
145	145	Insert carrier tape	1	OVA		10	1450	0.0	QMS #
146	146	Insert carrier tape	1	OVA		10	1460	0.0	QMS #
147	147	Insert Carrier Tape (Station)	1	OVA		10	1470	0.0	QMS #
148	148	Post Taping	1	OVA		10	1480	0.0	QMS #
149	149	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1490	0.0	QMS #
150	150	Insert carrier tape	1	OVA		10	1500	0.0	QMS #
151	151	Insert carrier tape	1	OVA		10	1510	0.0	QMS #
152	152	Insert Carrier Tape (Station)	1	OVA		10	1520	0.0	QMS #
153	153	Post Taping	1	OVA		10	1530	0.0	QMS #
154	154	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1540	0.0	QMS #
155	155	Insert carrier tape	1	OVA		10	1550	0.0	QMS #
156	156	Insert carrier tape	1	OVA		10	1560	0.0	QMS #
157	157	Insert Carrier Tape (Station)	1	OVA		10	1570	0.0	QMS #
158	158	Post Taping	1	OVA		10	1580	0.0	QMS #
159	159	Travel to cabinet to get the reel and pizza boxes	1	OVA		10	1590	0.0	QMS #
160	160	Insert carrier tape	1	OVA		10	1600	0.0	QMS

Figure 6: Pareto Chart for Non-conformities



The three non conformities were then analyzed by using fish bone diagram to identify potential root-causes that contributed to the high non-value added activities. Figure 7 demonstrate the potential root-cause for the identified non-conformities.

Figure 7: Potential Root-causes for Non-conformities

Non-conformities	Potential Root-causes
Job balancing for Op is not optimized (operators)	High percentage of NVA activities in taping operation causing low personnel efficiency
Inconsistent manual activities process method among operators	Operator to operator manual activities processing time is not consistent resulting low personnel efficiency
Abnormal Process Issue (Visual Inspection process)	High frequency of Visual Inspection Processing Time causing low personnel efficiency

The three hypotheses were evaluated based on the non-conformities identified at the previous stage. Figure 8 shows the three hypotheses developed and the summary of findings

Figure 8: Hypotheses developed

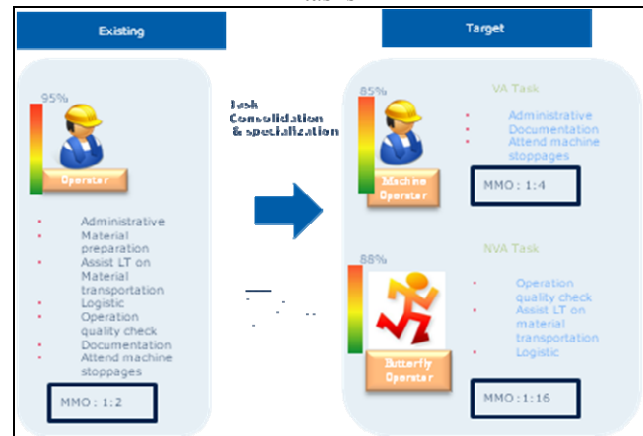
Hypothesis	Hypothesis Test	Result
High percentage of NVA activities in Taping Operation causing low personnel efficiency	<p>Ho: NVA activities cause no significant impact to low personnel efficiency</p> <p>H1: NVA activities cause significant impact to low personnel efficiency</p>	Accept H1
Operator to operator manual activities processing time is not consistent resulting low personnel efficiency	<p>Ho: No significant difference between operator manual activities processing time</p> <p>H1: Significant difference between operator manual activities processing time</p>	Accept H0
High frequency of Visual Inspection Processing Time causing low personnel efficiency	<p>Ho: High frequency of Visual Inspection Processing Time cause no significant impact to low personnel efficiency</p> <p>H1: High frequency of Visual Inspection Processing Time cause significant impact to low personnel efficiency</p>	Accept H0

In order to analyse each hypothesis developed, propositional test method used to determine the p value. If p value smaller than 0.05, this revealed that there is a significant difference and the hypothesis accepted. Based

on the proportion test carried out, p value obtained for high percentage of NVA activities in taping operation which cause low personnel efficiency was 0.025 and smaller than 0.05, this two proportion test indicate NVA contribution is significantly higher than the VA activity and therefore the NVA operator activities needed to be reduced.

A suggestion of regrouping and re-consolidating the value added and non-value added THA taping activities with the idea of removing the NVA task from the operator was proposed to improve multi-machine operations. Compared to the current state, the future state of process introduced “machine operator and “butterfly operator” concept by re-assigning the value added and non-value added task into two different groups of operators. Figure 9 illustrates the consolidation of value added and non value added tasks.

Figure 9: Consolidation of value add and non value add tasks



The new task allocation after the regrouping of value added and non value added process step after the improvement idea is demonstrated in Figure 10.

Based on the new future state of process steps, the workflow step for THA taping was divided into two separate parts. There are the “machine operator” activities and “butterfly operator” activities. The non value added activities of carried out by the machine operator was reduced by 31.5% compared with before improvement. By introducing butterfly operator, it shares some of the activities which original own by the machine operator. As a result, the machine operator was able to take-care additional equipment since the job load significant reduces compare to the initial state.



Figure 10: Improved process step by regroup VA and NVA activities

Machine Operator

Butterfly Operator

Original Workflow									
Product: TSP									
Process Name: TSP Taping									
Rev: 1									
Page: 1									
No	Operation Description	VA	Time (min)	VA	Time (min)	VA	Time (min)	VA	Time (min)
1	1. Preparation Work	1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
1	1.1. Prepare the machine	1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
2	2. Check the material	2	2.1	2.1	2.1	2.1	2.1	2.1	2.1
3	3. Check the machine	3	3.1	3.1	3.1	3.1	3.1	3.1	3.1
4	4. Check the material	4	4.1	4.1	4.1	4.1	4.1	4.1	4.1
5	5. Check the machine	5	5.1	5.1	5.1	5.1	5.1	5.1	5.1
6	6. Check the material	6	6.1	6.1	6.1	6.1	6.1	6.1	6.1
7	7. Check the machine	7	7.1	7.1	7.1	7.1	7.1	7.1	7.1
8	8. Check the material	8	8.1	8.1	8.1	8.1	8.1	8.1	8.1
9	9. Check the machine	9	9.1	9.1	9.1	9.1	9.1	9.1	9.1
10	10. Check the material	10	10.1	10.1	10.1	10.1	10.1	10.1	10.1
11	11. Check the machine	11	11.1	11.1	11.1	11.1	11.1	11.1	11.1
12	12. Check the material	12	12.1	12.1	12.1	12.1	12.1	12.1	12.1
13	13. Check the machine	13	13.1	13.1	13.1	13.1	13.1	13.1	13.1
14	14. Check the material	14	14.1	14.1	14.1	14.1	14.1	14.1	14.1
15	15. Check the machine	15	15.1	15.1	15.1	15.1	15.1	15.1	15.1
16	16. Check the material	16	16.1	16.1	16.1	16.1	16.1	16.1	16.1
17	17. Check the machine	17	17.1	17.1	17.1	17.1	17.1	17.1	17.1
18	18. Check the material	18	18.1	18.1	18.1	18.1	18.1	18.1	18.1
19	19. Check the machine	19	19.1	19.1	19.1	19.1	19.1	19.1	19.1
20	20. Check the material	20	20.1	20.1	20.1	20.1	20.1	20.1	20.1
21	21. Check the machine	21	21.1	21.1	21.1	21.1	21.1	21.1	21.1
22	22. Check the material	22	22.1	22.1	22.1	22.1	22.1	22.1	22.1
23	23. Check the machine	23	23.1	23.1	23.1	23.1	23.1	23.1	23.1
24	24. Check the material	24	24.1	24.1	24.1	24.1	24.1	24.1	24.1
25	25. Check the machine	25	25.1	25.1	25.1	25.1	25.1	25.1	25.1
26	26. Check the material	26	26.1	26.1	26.1	26.1	26.1	26.1	26.1
27	27. Check the machine	27	27.1	27.1	27.1	27.1	27.1	27.1	27.1
28	28. Check the material	28	28.1	28.1	28.1	28.1	28.1	28.1	28.1
29	29. Check the machine	29	29.1	29.1	29.1	29.1	29.1	29.1	29.1
30	30. Check the material	30	30.1	30.1	30.1	30.1	30.1	30.1	30.1
31	31. Check the machine	31	31.1	31.1	31.1	31.1	31.1	31.1	31.1
32	32. Check the material	32	32.1	32.1	32.1	32.1	32.1	32.1	32.1
33	33. Check the machine	33	33.1	33.1	33.1	33.1	33.1	33.1	33.1
34	34. Check the material	34	34.1	34.1	34.1	34.1	34.1	34.1	34.1
35	35. Check the machine	35	35.1	35.1	35.1	35.1	35.1	35.1	35.1
36	36. Check the material	36	36.1	36.1	36.1	36.1	36.1	36.1	36.1
37	37. Check the machine	37	37.1	37.1	37.1	37.1	37.1	37.1	37.1
38	38. Check the material	38	38.1	38.1	38.1	38.1	38.1	38.1	38.1
39	39. Check the machine	39	39.1	39.1	39.1	39.1	39.1	39.1	39.1
40	40. Check the material	40	40.1	40.1	40.1	40.1	40.1	40.1	40.1
41	41. Check the machine	41	41.1	41.1	41.1	41.1	41.1	41.1	41.1
42	42. Check the material	42	42.1	42.1	42.1	42.1	42.1	42.1	42.1
43	43. Check the machine	43	43.1	43.1	43.1	43.1	43.1	43.1	43.1
44	44. Check the material	44	44.1	44.1	44.1	44.1	44.1	44.1	44.1
45	45. Check the machine	45	45.1	45.1	45.1	45.1	45.1	45.1	45.1
46	46. Check the material	46	46.1	46.1	46.1	46.1	46.1	46.1	46.1
47	47. Check the machine	47	47.1	47.1	47.1	47.1	47.1	47.1	47.1
48	48. Check the material	48	48.1	48.1	48.1	48.1	48.1	48.1	48.1
49	49. Check the machine	49	49.1	49.1	49.1	49.1	49.1	49.1	49.1
50	50. Check the material	50	50.1	50.1	50.1	50.1	50.1	50.1	50.1
51	51. Check the machine	51	51.1	51.1	51.1	51.1	51.1	51.1	51.1
52	52. Check the material	52	52.1	52.1	52.1	52.1	52.1	52.1	52.1
53	53. Check the machine	53	53.1	53.1	53.1	53.1	53.1	53.1	53.1
54	54. Check the material	54	54.1	54.1	54.1	54.1	54.1	54.1	54.1
55	55. Check the machine	55	55.1	55.1	55.1	55.1	55.1	55.1	55.1
56	56. Check the material	56	56.1	56.1	56.1	56.1	56.1	56.1	56.1
57	57. Check the machine	57	57.1	57.1	57.1	57.1	57.1	57.1	57.1
58	58. Check the material	58	58.1	58.1	58.1	58.1	58.1	58.1	58.1
59	59. Check the machine	59	59.1	59.1	59.1	59.1	59.1	59.1	59.1
60	60. Check the material	60	60.1	60.1	60.1	60.1	60.1	60.1	60.1
61	61. Check the machine	61	61.1	61.1	61.1	61.1	61.1	61.1	61.1
62	62. Check the material	62	62.1	62.1	62.1	62.1	62.1	62.1	62.1
63	63. Check the machine	63	63.1	63.1	63.1	63.1	63.1	63.1	63.1
64	64. Check the material	64	64.1	64.1	64.1	64.1	64.1	64.1	64.1
65	65. Check the machine	65	65.1	65.1	65.1	65.1	65.1	65.1	65.1
66	66. Check the material	66	66.1	66.1	66.1	66.1	66.1	66.1	66.1
67	67. Check the machine	67	67.1	67.1	67.1	67.1	67.1	67.1	67.1
68	68. Check the material	68	68.1	68.1	68.1	68.1	68.1	68.1	68.1
69	69. Check the machine	69	69.1	69.1	69.1	69.1	69.1	69.1	69.1
70	70. Check the material	70	70.1	70.1	70.1	70.1	70.1	70.1	70.1
71	71. Check the machine	71	71.1	71.1	71.1	71.1	71.1	71.1	71.1
72	72. Check the material	72	72.1	72.1	72.1	72.1	72.1	72.1	72.1
73	73. Check the machine	73	73.1	73.1	73.1	73.1	73.1	73.1	73.1
74	74. Check the material	74	74.1	74.1	74.1	74.1	74.1	74.1	74.1
75	75. Check the machine	75	75.1	75.1	75.1	75.1	75.1	75.1	75.1
76	76. Check the material	76	76.1	76.1	76.1	76.1	76.1	76.1	76.1
77	77. Check the machine	77	77.1	77.1	77.1	77.1	77.1	77.1	77.1
78	78. Check the material	78	78.1	78.1	78.1	78.1	78.1	78.1	78.1
79	79. Check the machine	79	79.1	79.1	79.1	79.1	79.1	79.1	79.1
80	80. Check the material	80	80.1	80.1	80.1	80.1	80.1	80.1	80.1
81	81. Check the machine	81	81.1	81.1	81.1	81.1	81.1	81.1	81.1
82	82. Check the material	82	82.1	82.1	82.1	82.1	82.1	82.1	82.1
83	83. Check the machine	83	83.1	83.1	83.1	83.1	83.1	83.1	83.1
84	84. Check the material	84	84.1	84.1	84.1	84.1	84.1	84.1	84.1
85	85. Check the machine	85	85.1	85.1	85.1	85.1	85.1	85.1	85.1
86	86. Check the material	86	86.1	86.1	86.1	86.1	86.1	86.1	86.1
87	87. Check the machine	87	87.1	87.1	87.1	87.1	87.1	87.1	87.1
88	88. Check the material	88	88.1	88.1	88.1	88.1	88.1	88.1	88.1
89	89. Check the machine	89	89.1	89.1	89.1	89.1	89.1	89.1	89.1
90	90. Check the material	90	90.1	90.1	90.1	90.1	90.1	90.1	90.1
91	91. Check the machine	91	91.1	91.1	91.1	91.1	91.1	91.1	91.1
92	92. Check the material	92	92.1	92.1	92.1	92.1	92.1	92.1	92.1
93	93. Check the machine	93	93.1	93.1	93.1	93.1	93.1	93.1	93.1
94	94. Check the material	94	94.1	94.1	94.1	94.1	94.1	94.1	94.1
95	95. Check the machine	95	95.1	95.1	95.1	95.1	95.1	95.1	95.1
96	96. Check the material	96	96.1	96.1	96.1	96.1	96.1	96.1	96.1
97	97. Check the machine	97	97.1	97.1	97.1	97.1	97.1	97.1	97.1
98	98. Check the material	98	98.1	98.1	98.1	98.1	98.1	98.1	98.1
99	99. Check the machine	99	99.1	99.1	99.1	99.1	99.1	99.1	99.1
100	100. Check the material	100	100.1	100.1	100.1	100.1	100.1	100.1	100.1
101	101. Check the machine	101	101.1	101.1	101.1	101.1	101.1	101.1	101.1
102	102. Check the material	102	102.1	102.1	102.1	102.1	102.1	102.1	102.1
103	103. Check the machine	103	103.1	103.1	103.1	103.1	103.1	103.1	103.1
104	104. Check the material	104	104.1	104.1	104.1	104.1	104.1	104.1	104.1
105	105. Check the machine	105	105.1	105.1	105.1	105.1	105.1	105.1	105.1
106	106. Check the material	106	106.1	106.1	106.1	106.1	106.1	106.1	106.1
107	107. Check the machine	107	107.1	107.1	107.1	107.1	107.1	107.1	107.1
108	108. Check the material	108	108.1	108.1	108.1	108.1	108.1	108.1	108.1
109	109. Check the machine	109	109.1	109.1	109.1	109.1	109.1	109.1	109.1
110	110. Check the material	110	110.1	110.1	110.1	110.1	110.1	110.1	110.1
111	111. Check the machine	111	111.1	111.1	111.1	111.1	111.1	111.1	111.1
112	112. Check the material	112	112.1	112.1	112.1	112.1	112.1	112.1	112.1
113	113. Check the machine	113	113.1	113.1	113.1	113.1	113.1	113.1	113.1
114	114. Check the material	114	114.1	114.1	114.1	114.1	114.1	114.1	114.1
115	115. Check the machine	115	115.1	115.1	115.1	115.1	115.1	115.1	115.1
116	116. Check the material	116	116.1	116.1	116.1	116.1	116.1	116.1	116.1
117	117. Check the machine	117	117.1	117.1	117.1	117.1	117.1	117.1	117.1
118	118. Check the material	118	118.1	118.1	118.1	118.1	118.1	118.1	118.1
119	119. Check the machine	119	119.1	119.1	119.1	119.1	119.1	119.1	119.1
120	120. Check the material	120	120.1	120.1	120.1	120.1	120.1	120.1	120.1
121	121. Check the machine	121	121.1	121.1	121.1	121.1	121.1	121.1	121.1
122	122. Check the material	122	122.1	122.1	122.1	122.1	122.1	122.1	122.1
123	123. Check the machine	123							