IMPROVEMENT OF INVENTORY MANAGEMENT IN A STAMPING MANUFACTURER USING LEAN TECHNIQUES

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DEDICATION

This dissertation will dedicate to Valiant Precision company management.

.

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ABSTRACT

One of the major challenges faced by small and medium enterprise (SME) industry is in managing inventories. Inaccuracies in inventory create various problems such as loss of productivity, unwanted items manufactured, difficulty customer needs, the accumulation of costly physical inventories and others. Majority of SMEs are doing inventory management based on the experience and intuition of the entrepreneurs. However, most of them have limited knowledge of production technique in resolving non-value-added activities in the production operation. This research aims to establish a framework on lean implementation in SMEs in enhancing inventory management. A stamping manufacturer company in automotive industry was selected as a case study. This is a mixed method case study. Observations of the production process time and inventory level were done to establish the value stream mapping (VSM). This study adopted lean tools for enhancing inventory management, and the implementation of lean tools begins when non-value added area detected. The project Risk Failure Mode Effect and Analysis (RFMEA) had been adopted for the selection of lean technique risk assessment for inventory improvement and current production floor environment. In addition, a five-point Likert scale survey was conducted with 85 staff in the operation team to identify the barriers affecting lean implementation and causes of non-value added. The findings showed the implementation of lean techniques such as supermarket storage racking concept for work-in-progress inventory, Kanban pull system for finished goods inventory, and "Kaizen" activities for process setting had improved the inventory to sales ratio and reduction in non-value-added activities. This study has established a framework for lean implementation for SMEs in managing effective inventory management. This framework is useful for SME entrepreneurs and managers to assess the inventory production against customers' demands. Future studies should consider products in other industries.

ABSTRAK

Salah satu cabaran utama yang dihadapi oleh perusahaan kecil dan serderhana (SME) adalah menguruskan inventori. Ketidaktepatan dalam inventori menghasilkan pelbagai masalah seperti kerugian atas produktiviti, mengeluarkan barangan yang tidak diperlukan, kesukaran dalam memenuhi keperluan pelanggan, timbunan ke atas inventori fizikal yang berharga dan lain-lain. Majoriti SME melakukan pengurusan inventori berdasarkan pengalaman dan intuisi usahawan. Walau bagaimanapun, kebanyakan mereka mempunyai pengetahuan tentang teknik pengeluaran yang terhad dalam menyelesaikan aktiviti-aktiviti yang tidak menghasilkan nilai tambah dalam operasi pengeluaran. Kajian ini bertujuan untuk mewujudkan satu rangka kerja bagi pelaksanaan kejat di SME dalam meningkatkan pengurusan inventori. Sebuah syarikat pengeluar pengecapan dalam industri automotif dipilih sebagai kajian kes. Ini adalah kajian kes kaedah campuran. Pemerhatian ke atas masa proses pengeluaran dan aras inventori dilakukan untuk menentukan "peta aliran nilai" (VSM). Kajian ini mengamalkan alat kejat untuk meningkatkan pengurusan inventori dan pelaksanaan alat kejat digunakan apabila kawasan tidak menghasilkan nilai dikesan. Kesan dan Analisis Mod Kegagalan Risiko (RFMEA) telah digunakan untuk pemilihan penilaian risiko di pemilihan teknik kejat untuk kemajuan inventori dan suasana lantai pengeluaran semasa. Selain itu, tinjauan skala "Likert" lima-mata telah dilakukan bersama 85 kakitangan dalam pasukan operasi untuk mengenal pasti halangan yang mempengaruhi perlaksanaan kejat dan alasan kepada tidak menghasilkan nilai. Dapatan ini menunjukkan pelaksanaan teknik kejat seperti konsep rak pasaraya untuk inventori kerja dalam kemajuan, sistem tarikan "Kanban" untuk inventori barangan siap, dan aktiviti "Kaizen" untuk proses pelarasan telah meningkatkan nisbah inventori kepada jualan dan pengurangan dalam aktiviti-aktiviti yang tidak menghasilkan nilai. Kajian ini telah menghasilkan sebuah rangka kerja untuk perlaksanaan kejat bagi SME dalam pengurusan inventori yang berkesan. Rangka kerja ini bermanfaat kepada usahawan dan pengurus SME untuk menilai pengeluaran inventori terhadap permintaan pelanggan. Kajian seterusnya harus mempertimbangkan produk dalam industri lain.

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LIST OF ABBREVIATIONS

ABC	-Always better control
AIS	-Assembly instruction sheet
CSB	-Control circuit board
CSF	-Critical success factor
CT	-Cycle time
C2	-Second simulation
EMQ	-Economic manufacturing quantity
EPQ	-Economic production quantity
EOQ	-Economic ordering quantity
FIFO	-First in first out
I-MR	-Individual value and moving range
JIT	-Just in time
LCL	-Lower control limit
LI	-Lean implementation
LM	-Lean manufacturing
MES	-Manufacturing execution system
MRP	-Material requirement planning
OEE	-Overall equipment efficiency
PPVM	-Product process setting value mapping
PRA	-Project risk assessment
RM	-Ringgit Malaysia
RPN	-Risk failure number
RFMEA	-Risk failure mode analysis
SME	-Small and medium enterprise
SMED	-Single minute exchange die
SOP	-Standard operating procedure
TPM	-Total productive maintenance
TPS	-Toyota production system
TQC	-Total quality cycle
UCL	-Upper control limit

VMI	-Vendor managed inventory
VP Co	-Valiant Precision
VSM	-Value stream mapping
WIP	-Work in progress

LIST OF SYMBOLS

X_{bar}	-Average value
C_{pk}	-Process capability
O_{rate}	-Operation per second
$Ratio_1$	-WIP inventory to sales ratio
$Ratio_2$	-Finished goods inventory to sales ratio
α	-Proportional

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CHAPTER 1

INTRODUCTION

1.1 Background

Globalization has prompted many businesses to explore opportunities to increase their efficiency, competitiveness and ability to sustain their operations in an ever-changing marketplace. However, companies are also experiencing numerous problems resulting from globalization, such as managing inventory within the supply chain system (Hadas *et al.*, 2014; Madhusudhana, 2009). In the context of the manufacturing industry, there are several reasons why manufacturing firms hold large inventories in order to avoid the costs of adjusting production capacity, and in accommodating unanticipated demands (Obermaier, 2012; Madhusudhana, 2009; Alan, 2008). The Toyota Production System (TPS) for example, following the second world war, adopted the lean philosophy (Ohno, 1988). The term “lean” means fewer resources in creating more value-added activities to related parties (i.e. consumers, distributors, etc.). A lean organization understands the needs of various parties and focuses its key processes on continuously increasing its value (i.e. value-add). Moreover, organizations may reduce their workforce effort, rearrange or restructure their manufacturing operations and facilities, and on-site inventory by adapting a lean philosophy.

Moreover, by reclassifying their inventory as unavoidable waste, this helps to mitigate and eliminate issues such as over-stocking or removing unproductive elements in the manufacturing process (Hofer *et al.*, 2012; Womack et al., 1990). The importance of inventory management has been recognized as a key area in operational management disciplines (Hofer *et al*., 2012). The intervention of traditional inventory management models aimed to establish economic production quantities in order to control or regulate work-in-progress (WIP), raw materials and finished goods (Felica *et al*., 2014; Chiu *et al*., 2011). However, the effectiveness of inventory management models was reflected in the analysis of inventory turnover against sales or revenue (Obermaier, 2012; Madhusudhana, 2009; Alan, 2008). Several decades ago, industrial practitioners in manufacturing enterprises established inventory management techniques to evaluate performance using materials requirement planning (MRP), fixed order quantities, fixed period ordering, economical production quantities, economical ordering quantities and just-in-time (JIT) implementation (Chiu *et al*., 2011; Sana, 2010; Carol, 1989). However, the reduction of inventory levels led to certain risks in terms of fulfilling the fluctuating demand, and uncertainty attributed to manufacturing such as poor quality, reworking, facilities and equipment downtime and malfunctioning, etc. (Xuechang, 2018; Obermaier, 2012;).

More modern manufacturing conditions, instead of the standalone implementation of an inventory management model as mentioned, the integration of lean techniques into operational management disciplines helped to enhance the effectiveness of inventory reduction and mitigating the inherent risk in the supply chain (Felice *et al*., 2014; Hadas *et al*., 2014; Hofer *et al*., 2012). Lean Manufacturing (LM) aims to serve or meet customer demands quickly and without sacrificing quality by using the most efficient and economical methods available (Deshkar *et al*., 2018; Richard, 2018). Companies implement LM to maintain their competitiveness over their competitors by improving the manufacturing system's productivity and quality of the product (Garre *et al*., 2017; Jafri, 2015). Several lean tools adopted by companies producing mechanical equipment indicate the improvements as a result of recommended hardware (Oliveira, 2017). There has been much literature written about lean implementation in larger organizations with a specific focus on the automotive industry. Identifying the main challenges faced in lean implementation in SME's, and to bridge the gap is undertaken in this study by reviewing the relevant literature in this field (Alkhoraif, 2018). The successful implementation of lean is not restricted by merely by focusing on large corporates, as several empirical cases have demonstrated the success of lean implementation small and medium-sized enterprises

(SMEs) (Matt, 2013). Regarding inventory management, the implementation of systematically managing inventory in SMEs along with successful lean production implementation at the micro-level in streamlining or decomposing operations is seen by reducing inventory levels to reduce wastage (Hu *et al*., 2015; Matt, 2013; Rajeev, 2008). Although, in many cases study, lean practitioners have demonstrated that there are significant factors that impact the adoption of lean in the context of SMEs which are discussed in the literature review section of this study (Rymaszewsku, 2014).

1.2 Inventory Issues in SMEs

Inventories represent a significant portion of the business regarding total assets (Capkun *et al*., 2009; Koumanakos, 2008). Incorrectly recording inventories create significant issues in business, including lost productivity, unwanted items manufactured, difficulty in fulfilling customer needs, and the accumulation of costly physical inventories. The issues surrounding poor inventory management faced by SMEs include underproduction, overproduction, stock-out situations, delays delivering raw materials and inaccurate record-keeping (Deep *et al*., 2008; Svensson, 2002). According to Norazina (2018), 31 per cent of Malaysian companies experienced poor inventory record keeping. As such, inventory management is crucial, given mismanagement of inventory threatens a firm's viability and sustainability. Another study mentioned that the majority of SMEs in the context of manufacturing experienced greater challenges in quantitative inventory analysis for decision making (Marie *et al*., 2016; Rajeev, 2008).

In the traditional manufacturing paradigm, work-in-progress (WIP) inventory proved to be most problematic in improving inventory turnover resulting from restructuring the production line or relevant processes. The stacking of WIP was often placed pervasively in the production line without a proper assigned location. Furthermore, the level of WIP inventory was not consistent over a certain period, and instead, it depended on the process of line balancing and the application of economic ordering quantities (EOQ) from the customer (Lluis, 2015).

Similarly, the finished goods warehouse failed to fulfil the inconsistent or erratic demand with goods being delivered from the plant *ad-hoc* in a rush to ship the goods or product. In the productivity assessment context, delivery accuracy is more relevant as a measure of internal precision. The plant is unable to perform flexible production planning to meet uncertain demand, given customers expect a high degree of individuality and shortened delivery times (Grewal *et al*., 2014; Karel,2013).

The production line downtime, plant breakdown and obsolete machinery and equipment also affect productivity. Manufacturing downtime is due to several reasons such as material shortage, line unbalance between the processes, quality issues and un-planned production schedules (Bevilacqual, 2015; Samuel, 2013). Also, the lack of information flowing to the production line fails to establish a link between the processes and departments. Indeed, the effectiveness of production planning is governed by information generated by the system. However, manufacturing plants often overlook the flow of information on the shop floor or via miscommunication. Production data, such as operational times and manufacturing sequences, are important inputs for determining when and how the resources in the factory will be utilized (Jafri, 2015; Vinodh *et al*., 2013).

1.3 Research Objectives

Based on the discussion presented in the earlier sections, this study aims to establish a framework on lean implementation in SMEs to enhance inventory management.

To achieve this aim, the following objectives are presented:

i. To develop and survey the barriers of lean implementation, waste observation and risk assessment in the implementation of a lean pilot project.

ii. To construct value stream mapping to identify non-value-added elements and inventory levels brought about through the change resulting from lean implementation.

iii. To establish longitudinal cases and deploy lean techniques for waste reduction improvement.

iv. To integrate lean techniques into inventory management in order to enhance inventory turnover against sales and to validate the effectiveness.

1.4 Research Questions

The development of several research questions support the research objectives presented above:

i. What is the type of waste that exists in the current value stream mapping and its causes in the deployment and implementation of lean techniques?

ii. How to establish a longitudinal case study and to synthesize the appropriate deployment of lean techniques?

iii. How does the integration of lean techniques enhance the evaluation of inventory turnover that implicates the effectiveness of inventory management?

1.5 The Research Scope and Significant

Numerous industries have adopted different reasons and views in implementing lean to enhance their business operations. In the present research, the scope has been narrowed down into several areas:

i. The implementation of lean through establishing a case study framework in the manufacturing industry that specializes in metal stamping manufacturing and supplying metal press parts to the electronics industry.

ii. In this research, a pilot project is selected for the appointed press part along with the application of value stream mapping in identifying the waste and barriers that occur in the present operation. Thus, the case study depicts waste reduction and operational improvement.

iii. The deployment of lean techniques is fundamental for inventory management and the evaluation of inventory turnover to indicate the effectiveness of inventory management.

The purpose of this search is to construct a lean technique case study implementation framework to enhance the effectiveness of inventory management in the SME context. Lean implementation is initiated through the adoption of value stream mapping (VSM). According to Matt (2013) and Hu *et al*. (2015), VSM is the most favourable lean technique used to implement the practice of lean in the context of SMEs. In addition, this research will contribute to the pool of knowledge in this field by enabling industry managers, lean practitioners, and academic researchers to comprehend the issues and opportunities in adopting lead in the context of SMEs based on the following perspectives.

i. Waste detection in production operations (i.e. on the shop floor) through the implementation of lean in the context of SMEs in the manufacturing industry.

ii. Best practices associated with the lean implementation framework to improve the effectiveness of inventory management.

iii. The implementation of lean techniques in monitoring inventory turnover on a real-time basis.

The perspectives adopted in this research will not simply be limited to the review of literature in this field but will also reflect the findings from the pilot project as mentioned. It is anticipated that the research will enable industrial practitioners to understand the issues and opportunities in implementing lean techniques when transitioning from a non-lean company to a lean company.

1.6 Thesis Outline

The structure of the thesis is organized into seven chapters. Chapter 1, as already discussed, provided the background and an overview of the study, including objectives, research questions and contributions. Chapter 2 presents the literature review on lean philosophy in enhancing the operations and barriers in lean implementation in the context of SMEs. Specifically, the literature review is related to lean techniques in improving inventory management within the manufacturing environment. In Chapter 3, the establishment of the research methodology to develop the lean implementation framework via a case study approach and depicting the research flow is presented. Chapter 4 presents and discusses the pilot project and constructing the case study on the implementation of lean techniques. Chapter 5 discusses the findings and results on the lean techniques that correlate to inventory management effectiveness. This is followed by Chapter 6, which validates the adoption of lean techniques to enhance inventory management against sales and the developed VSM established for continuous improvement. Lastly, Chapter 7 presents an overview of the research undertaken in this study along with conclusions, contributions to the industry, and recommendation for further improvement.

1.7 Chapter Summary

This chapter presented an overview and background of the research along with the problem statement, research objectives, research questions and structure of this study. The following chapter presents the review of relevant literature in this field, along with highlighting the gaps and issues.

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APPENDIX A

Barriers affecting lean implementation

Name: ……………………………………. Department :………………….

Title :………………………. Date :……………..

Working year :……………

1 Lack of proper employee involvement

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐Absolutely

2 Lack of top management commitment

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

3 Lean as a complex tool

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

4 Lean as an expensive tool

☐ Absolutely Low ☐Slightly Low ☐ Neutral ☐Slightly High ☐Absolutely

5 Change in culture required by lean

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐ Slightly High ☐Absolutely

6 lack of information visibility

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

7 lack of leadership for lean implementation

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

8 Lack of expertise required for lean implementation

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

9 lack of understanding of lean concept

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

10 Lack of resources and long lead time

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

11 Lack of training and knowledge

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

12 Lack of understanding for implementing lean in SME's.

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

13 No visibility of lean benefits

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

14 Lack of planning

☐ Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☐Absolutely

APPENDIX B

Causes of non-value-added activities

Name: ……………………………………. Department :………………….

Title :………………………. Date :……………..

Working year :……………

1 Difficult to find dies or tools during process changing period from store

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

2 Lack of tidiness and cleanliness in the current work environment make it difficult to work.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

3 Difficult to search tools or dies due to bunch of tools piled together

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

4 Lack of safer workplace.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

5 Lack of standard procedure to be follow by operator.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

6 Lack of specific place for tools and dies storage.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

7 Lack of specific place for tools and dies in advance preparation.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

8 Insufficient of tooling management knowledge at shop floor.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

9 Lack of production floor process schedule.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

10 Lack of guidance from management in process changeover improvement.

☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

APPENDIX C

Risk event evaluation

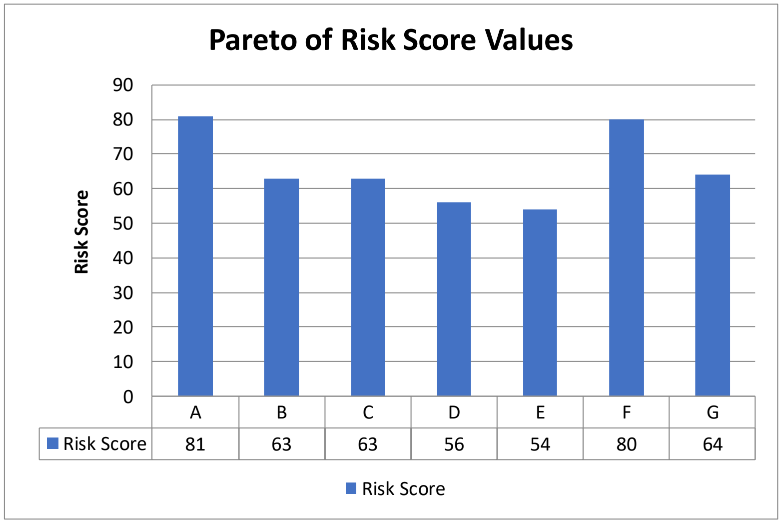
Risk ID	Risk Event (If.... Then....)	Symptom	Likelihood	Impact	Risk Score	Detection	RPN
A	If the re-layout on the current production process fail to supply other product.	Production output dropping and stop supply to customer	9	9	81	5	405
B	If the lean techniques fail to transfer from top management to down production team	Lean teachniques fail to improve for the selected product.	7	9	63	3	189
C	If the new plant layout shifting cost excess the allocated operation budget for the selected product.	Increasing in operation cost and affecting profit and loss for the selected product.	7	9	63	5	315
D	If the new production line for the selected product fail to achieve the production process levelling.	Line WIP inventory out of control and affecting the product quality.	7	8	56	6	336
E	If the training fail to develop the initial lean thinking on the production floor team	Lean techniques fail to execute in the company	6	9	54	6	324
F	If the re-layout project time excess the project allocation timing	Production stop for the selected part and affecting supplying to customer.	8	10	80	5	400
G	If the production planning fail to plan based on the new re-layout.	Production stop and cannot supply to customer	8	8	64	4	256

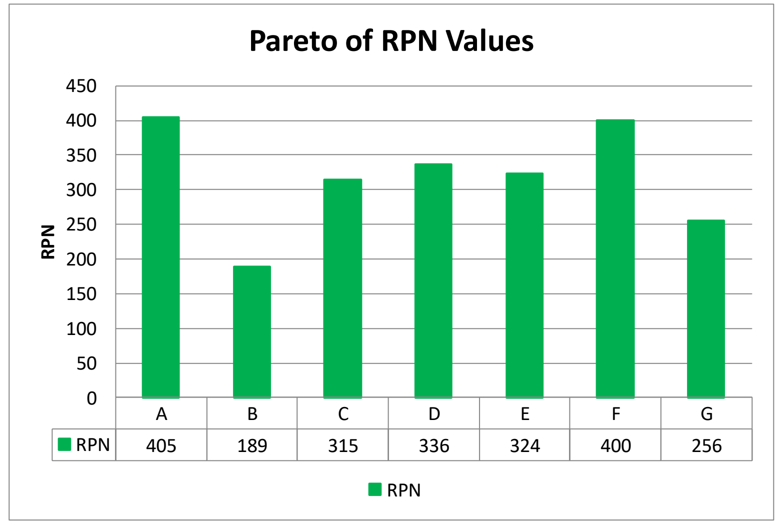
Note:

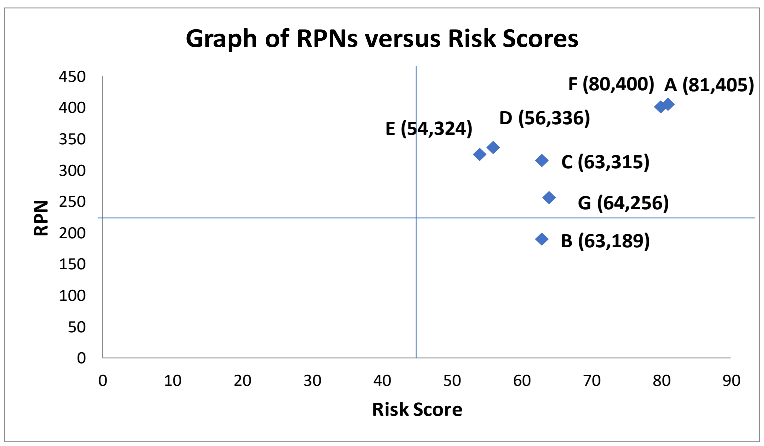
1. Likehood Value Guidelines:
9 or 10 ---> Very likely to occur
7 or 8 ---> Will probably occur
5 or 6 ---> Equal chance of occuring or not
3 or 4 ---> Probably will not occur
1 or 2 ---> Very unlikely

2. Impact Value Guidelines:
9 or 10 **Schedule** - Major milestone impact and > 20% impact to critical path.
Operation Cost - Total cost increase > 20%
Production / Technical - The effect on the scope renders end item unusable.
7 or 8 **Schedule** - Major milestone impact and 10% - 20% impact to critical path.
Operation Cost - Total cost increase 10% - 20%
Production / Technical - The effect on the scope changes the output of the project and it may not be usable to client
5 or 6 **Schedule** - Major milestone impact and 5% - 10% impact to critical path.
Operation Cost - Total cost increase 5% - 10%
Production / Technical - The effect on the scope changes the output of the project and it will require client approval
3 or 4 **Schedule** - Impact of < 5% to critical path
Operation Cost - Total cost increase of < 5%
Production / Technical - The effect on the scope is minor but requires an approval scope change internally and may be with client
1 or 2 **Schedule** - Impact insignificant
Operation Cost - Project cost increase insignificant
Production / Technical - Changes are not noticeable.

3. Detection
9 or 10 - Detection method not avalaible. 7 or 8- Detection method unreliable. 5 o 6- Detection method medium effectiveness. 3 or 4- Detection method moderate high effectiveness. 1 or 2-Detection method high effectiveness.

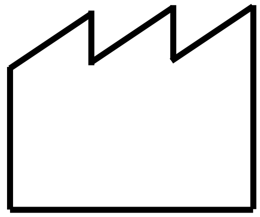
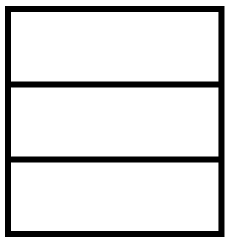
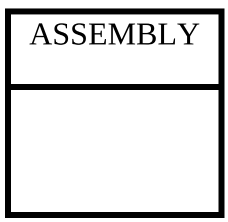
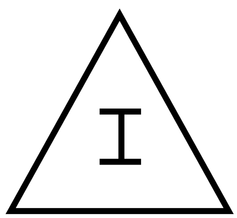
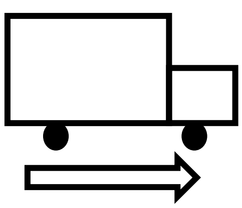

Pareto of Risk Score Values
Risk Score
90
80
70
60
50
40
30
20
10
0
A B C D E F G
Risk Score 81 63 63 56 54 80 64
Risk Score

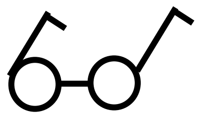
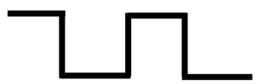
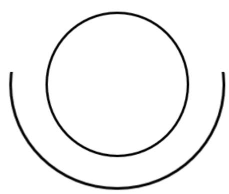
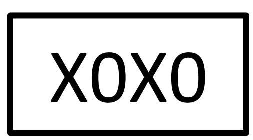
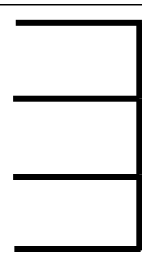

Pareto of RPN Values
RPN
450
400
350
300
250
200
150
100
50
0
A B C D E F G
RPN 405 189 315 336 324 400 256
RPN

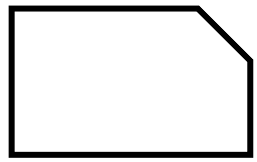
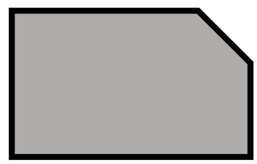
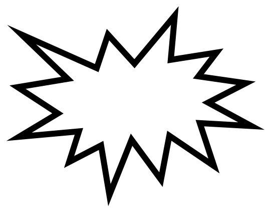
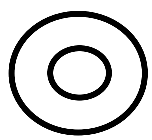

Graph of RPNs versus Risk Scores
RPN
450
400
350
300
250
200
150
100
50
0
0 10 20 30 40 50 60 70 80 90
Risk Score
F (80,400)
A (81,405)
D (56,336)
E (54,324)
C (63,315)
G (64,256)
B (63,189)

APPENDIX D

Value Stream mapping symbols

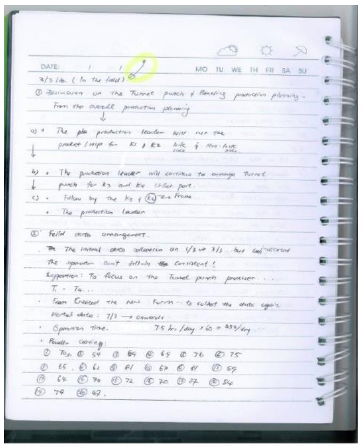
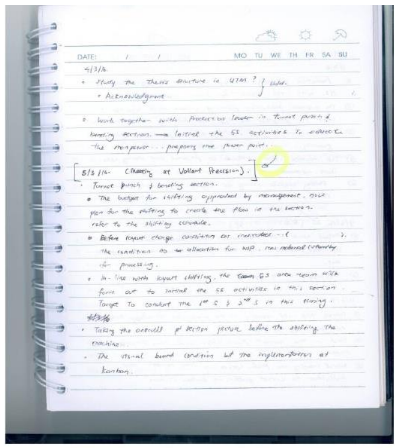
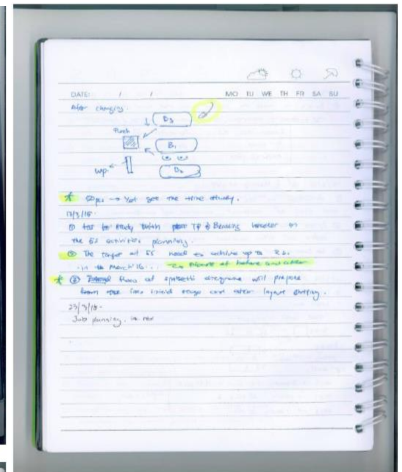
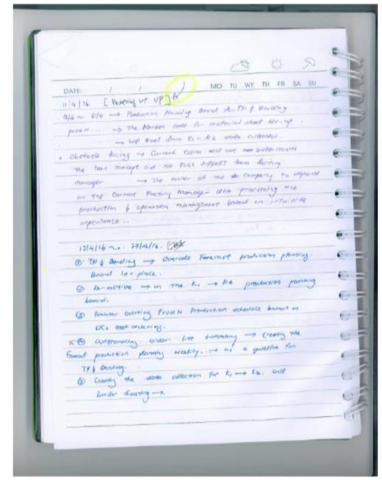
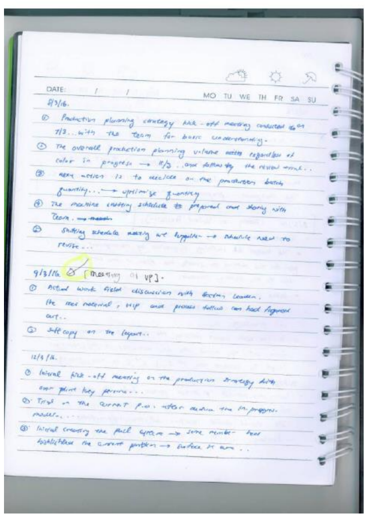
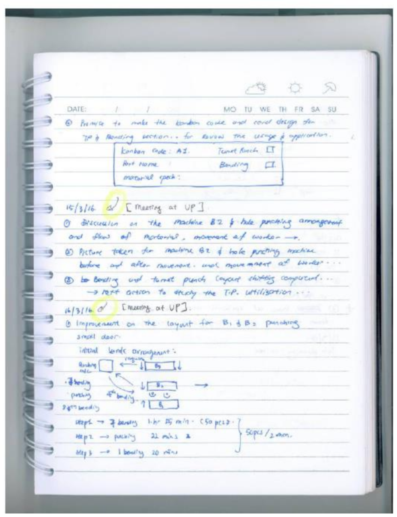
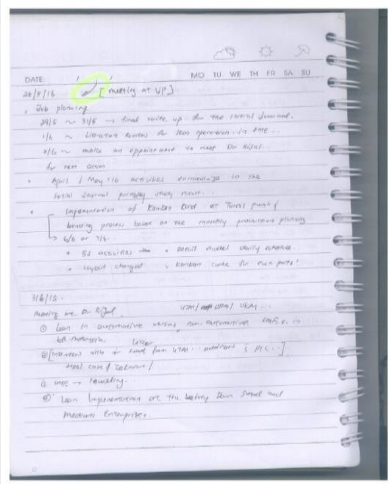
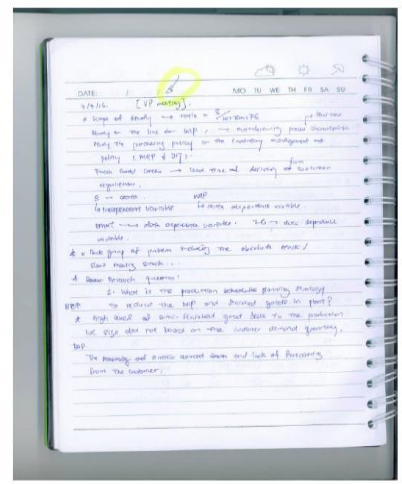
Name	Symbol	Description
Outside source		Includes suppliers and customers
Data box		Displays important data such as machine availability; number of product variations; product changeover time and etc.
Process box		It indicates a process in which the material is flowing. The bottom of the icon shows resource, information or a relevant lean enterprise technique.
Inventory		This triangular icon is used to capture the location, time and amount of inventory
Truck shipment		Indicates movement of goods by truck and also show the frequency of shipments on your map.
Information flow		Shows information transferred by hand.

Electronic Information flow		Shows information that is transferred electronically.
“Go see” scheduling		Schedule adjustment based on inventory levels
Push movement of material		It indicates the transfer of material from one process to the next is occurring via push.
Timeline		Indicates the production lead time, which is the time it takes one part to make its way through the shop floor.
Operator		The number of employees required to perform an operation
Load leveling		Used for Kanban systems to indicate load leveling
Supermarket		Displays count of products contains in the storage area.

Production Kanban		Card used to indicate production of a certain items
Withdrawal Kanban		Card used to obtain certain an item from storage
Kaizen burst		It highlights problem areas which indicates a further improvement in the process
Sequenced pull		Eliminates need for supermarket storage of inventory between processes by providing instruction to a subassembly process.
First-In-First-Out		Represents First-In-First-Out system. The maximum inventory capacity can be written below the lane.
Material pull		This pull symbol represents physical removal of stored inventory from supermarkets.

APPENDIX E

Project meeting minutes

APPENDIX F

Example of surveying on lean barriers

Barriers affecting lean implementation

Name: Lim Yue Tong. Department: Purchasing.
Title: Executive Date: 13/4/19.
Working year: 5.

1 Lack of proper employee involvement
☐ Absolutely Low ☒ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

2 Lack of top management commitment
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

3 Lean as a complex tool
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

4 Lean as an expensive tool
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

5 Change in culture required by lean
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☒ Absolutely High

6 lack of information visibility
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

7 lack of leadership for lean implementation
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☒ Absolutely High

8 Lack of expertise required for lean implementation
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

9 lack of understanding of lean concept
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

10 Lack of resources and long lead time
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

11 Lack of training and knowledge
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

12 Lack of understanding for implementing lean in SME's.
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

13 No visibility of lean benefits
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

14 Lack of planning
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☐ Slightly High ☒ Absolutely High

Barriers affecting lean implementation

Name: Wong Suee Sez. Department: Warehouse.
Title: Executive. Date: 15/4/19.
Working year: 5.

1 Lack of proper employee involvement
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

2 Lack of top management commitment
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

3 Lean as a complex tool
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

4 Lean as an expensive tool
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

5 Change in culture required by lean
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

6 lack of information visibility
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

7 lack of leadership for lean implementation
☐ Absolutely Low ☒ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

8 Lack of expertise required for lean implementation
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

9 lack of understanding of lean concept
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

10 Lack of resources and long lead time
☐ Absolutely Low ☒ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

11 Lack of training and knowledge
☐ Absolutely Low ☐ Slightly Low ☒ Neutral ☐ Slightly High ☐ Absolutely High

12 Lack of understanding for implementing lean in SME's.
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

13 No visibility of lean benefits
☐ Absolutely Low ☒ Slightly Low ☐ Neutral ☐ Slightly High ☐ Absolutely High

14 Lack of planning
☐ Absolutely Low ☐ Slightly Low ☐ Neutral ☒ Slightly High ☐ Absolutely High

APPENDIX G

Example of surveying on causes of non-value-added activities

(12)

Causes of non-value-added activities

Name: Ivan | Department : Planning

Title : Executive. | Date : 16/5/2019.

Working year : 6.

1 Difficult to find dies or tools during process changing period from store
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

2 Lack of tidiness and cleanliness in the current work environment make it difficult to work.
☐Absolutely Low ☒Slightly Low ☐Neutral ☐Slightly High ☐Absolutely High

3 Difficult to search tools or dies due to bunch of tools piled together
☐Absolutely Low ☒Slightly Low ☐Neutral ☐Slightly High ☐Absolutely High

4 Lack of safer workplace.
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

5 Lack of standard procedure to be follow by operator.
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

6 Lack of specific place for tools and dies storage.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

7 Lack of specific place for tools and dies in advance preparation.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

8 Insufficient of tooling management knowledge at shop floor.
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

9 Lack of production floor process schedule.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

10 Lack of guidance from management in process changeover improvement.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

(8)

Causes of non-value-added activities

Name: Aman. | Department : Production Engineering.

Title : Technician - Prep part. | Date : 15/05/19

Working year : 3

1 Difficult to find dies or tools during process changing period from store
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

2 Lack of tidiness and cleanliness in the current work environment make it difficult to work.
☐Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☒Absolutely High

3 Difficult to search tools or dies due to bunch of tools piled together
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

4 Lack of safer workplace.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

5 Lack of standard procedure to be follow by operator.
☐Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☒Absolutely High

6 Lack of specific place for tools and dies storage.
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

7 Lack of specific place for tools and dies in advance preparation.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

8 Insufficient of tooling management knowledge at shop floor.
☐Absolutely Low ☐Slightly Low ☐Neutral ☐Slightly High ☒Absolutely High

9 Lack of production floor process schedule.
☐Absolutely Low ☐Slightly Low ☐Neutral ☒Slightly High ☐Absolutely High

10 Lack of guidance from management in process changeover improvement.
☐Absolutely Low ☐Slightly Low ☒Neutral ☐Slightly High ☐Absolutely High

APPENDIX H

Calculation of charge rate

A. Machine charge rate
Term and conditions;
1. Machine repayment period is 4 years
2. Loan interest is 3.5% per annum
3. Operation time in 4 years will be, 4 years x 12 months x 22 days x 8 hours x 60 minutes then will be 506,880 minutes.

Machine	Total Machine cost	Charge rate calculation
Shearing	RM22, 500 + (RM22, 500 x 0.035 x 4) = RM25,650	RM25, 650 / 506, 880 = RM0.05 / minute
Stamping	No machine cost (totally paid up)	
Turret Punch	RM90, 000 + (RM90, 000 x 0.035 x 4) = RM102,600	RM102, 600 / 506,880 = RM0.20 / minute
Tapping	RM3, 420 + (RM3, 420 x 0.035 x 4) = RM3,898.80	RM3, 898.80 / 506, 880 = RM0.01 / minute
Hemming	RM90, 000 + (RM90, 000 x 0.035 x 4) = RM102,600	RM102, 600 / 506,880 = RM0.20 / minute
Stamp Bend	RM28, 000 + (RM28, 000 x 0.035 x 4) = RM31,920	RM31, 920 / 506, 880 = RM0.06 / minute
Bending	RM46, 200 + (RM46, 200 x 0.035 x 4) = RM52,668	RM52, 668 / 506,880 = RM0.10 / minute
Spot welding	RM51,000 + (RM51,000 x 0.035 x 4) = RM52,668	RM52, 668 / 506, 880 = RM0.01 / minute

B. Rental charge cost
Term and conditions
1. Monthly rental is RM15,000 for 1,487m^2 (16,000 ft^2)
2. Renatl rate is RM10.09/m^2
3. Operation time is 10,560 minutes (8 hours x 22 days x 60 minutes)

Machine	Working area	Charge rate calculation
Shearing	10.56m^2	(10.56m^2 x RM10.09 / m^2) / 10,560 minutes = RM0.01/minute
Stamping	17.28m^2	(17.28m^2 x RM10.09 / m^2) / 10, 560 minutes = RM0.017/minute
Turret Punch	42.32m^2	(42.32m^2 x RM10.09 / m^2) / 10, 560 minutes = RM0.04/minute
Tapping	24m^2	(24m^2 x RM10.09 / m^2) / 10, 560 minutes = RM0.02/minute
Hemming	14m^2	(14m^2 x RM10.09 / m^2) / 10, 560 minutes =RM0.01/minute
Stamp Bend	9.12m^2	(9.12m^2 x RM10.09 / m^2) / 10, 560 minutes = RM0.009/minute
Bending	7.2m^2	(7.2m^2 x RM10.09 / m^2) / 10, 560 minutes = RM0.007/minute
Spot welding	3.6m^2	(3.6m^2 x RM10.09 / m^2) / 10,560 minutes = RM0.004/minute

C. Operator and technician charge rate

Category	Salary(monthly)	Charge rate calculation
Technician	RM2,470	RM2,470 / 10,560 minutes = RM0.24 / minute
Operator	RM1,317	RM1,317 / 10,560 minutes = RM0.13 / minute

D. Power Charge rate
1. Monthly electricity bill, RM15,000 @ RM0.51/Kw per hour (RM0.009/Kw per minute)

Machine	Power usage	Charge rate
Shearing	3Kw	3 x 0,009 = RM0.027/minute
Stamping	3Kw	3 x 0,009 = RM0.027/minute
Turret Punch	5Kw	5 x 0,009 = RM0.045/minute
Tapping	3Kw	3 x 0,009 = RM0.027/minute
Hemming	3Kw	3 x 0,009 = RM0.027/minute
Stamp Bend	3Kw	3 x 0,009 = RM0.027/minute
Bending	3Kw	3 x 0,009 = RM0.027/minute
Spot welding	6Kw	6 x 0,009 = RM0.054/minute

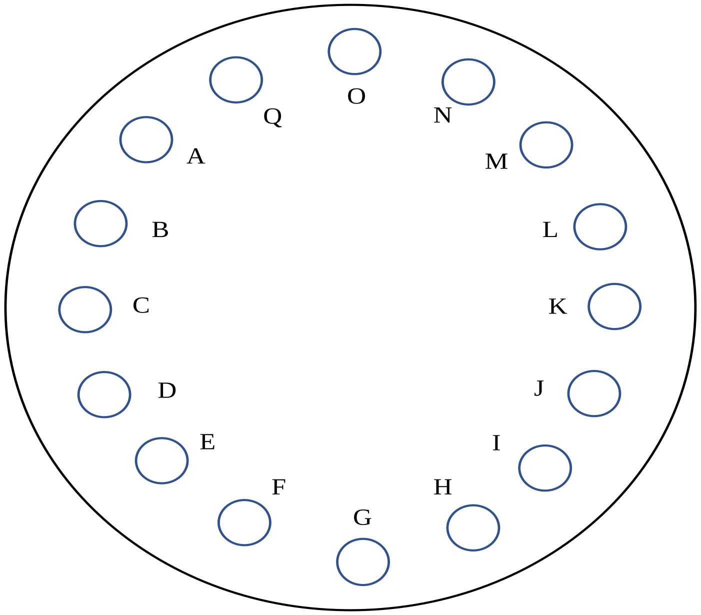
APPENDIX I

Turret punch tool preparation sheet

Product:

Date:
Time:

No	Tool code	Position	Remarks
1		A	
2		B	
3		C	
4		D	
5		E	
6		F	
7		G	
8		H	
9		I	
10		J	
11		K	
12		L	
13		M	
14		N	
15		O	
16		Q	



Prepared by:

Confirmed by:

APPENDIX J

Process Setting Confirmation and Production Commision

Process: Slitting / Tapping / Hemming

Reference No:

No	Date	Part Code	Spec ±0.5 (mm)	Process Setting Part Inspection							In-Porduction Part Audit					
				1	2	3	4	5	Checked	Confirmed	1	2	3	4	5	Checked

Instruction: Process setting checking conduct by Technician & in production part inspection shall be conducted by QA/QC personals.

Confirmed by :
(Production Manager)

Approved by:
(QA Manager)