THE EFFECT OF LEAN MANUFACTURING ON OPERATIONS PERFORMANCE AND BUSINESS PERFORMANCE IN MANUFACTURING COMPANIES IN INDONESIA

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ABSTRACT

The purpose of this mixed methods sequential explanatory study was to understand the effect of lean manufacturing on operations performance and business performance in the context of manufacturing companies in Indonesia. In the first phase, a quantitative research was conducted to investigate the relationship among the variables. 174 large manufacturing companies were involved in the quantitative phase. Structural equation modeling (SEM) approach was applied to test all the hypotheses. The findings of the quantitative data analysis indicate that all the lean manufacturing practices are highly correlated and interdependent. The results provide evidence that lean manufacturing should be implemented holistically, because the practices are mutually supportive and complement each other. Lean manufacturing is also positively related with operations performance and business performance. More importantly, operations performance complementary mediates the relationship between lean manufacturing and business performance. A qualitative research based on a case study method was conducted in Toyota Indonesia to explain, elaborate, and triangulate the quantitative findings. The outcomes of the qualitative research are consistent and supporting the quantitative results. This study provides a deeper insight regarding the relationship between lean manufacturing, operations performance, and business performance. Therefore, this study could expand the boundary of the existing literature, and contributes to the body of knowledge related to the effect of lean manufacturing theoretically, practically, and methodologically.

Keywords: lean manufacturing, operations performance, business performance, mixed methods sequential explanatory study, Indonesia

ABSTRAK

Kajian kaedah campuran penerangan berjujukan ini adalah bertujuan untuk memahami kesan amalan pengilangan kejat terhadap prestasi operasi dan prestasi perniagaan dalam konteks syarikat pembuatan di Indonesia. Dalam fasa pertama, penyelidikan kuantitatif telah dijalankan untuk menyiasat hubungan antara pemboleh ubah. Sebanyak 174 buah syarikat pembuatan besar telah terlibat dalam fasa kuantitatif ini. Pendekatan pemodelan persamaan berstruktur (SEM) telah digunakan untuk menguji kesemua hipotesis dalam kajian ini. Penemuan analisis kuantitatif menunjukkan bahawa semua amalan pengilangan kejat adalah berhubung kait dan saling bergantungan antara satu sama lain. Dapatan kajian menunjukkan bukti yang menyokong amalan pengilangan kejat perlu diterapkan secara holistik. Hal ini kerana semua amalan tersebut saling menyokong dan melengkapi antara satu sama lain. Di samping itu, pengilangan kejat juga mempunyai hubungan yang positif dengan prestasi operasi dan prestasi perniagaan. Lebih penting lagi, prestasi operasi berperanan sebagai pemboleh ubah pengantara separa dalam hubungan antara pengilangan kejat dengan prestasi perniagaan. Suatu penyelidikan kualitatif berdasarkan kaedah kajian kes telah dijalankan di Toyota Indonesia yang bertujuan untuk memberi penerangan, menghurai dengan lebih mendalam, dan melakukan triangulasi terhadap penemuan kajian kuantitatif. Penemuan kajian kualitatif ini adalah konsisten dan menyokong dapatan kajian kuantitatif. Kajian ini memberi pemahaman yang mendalam mengenai hubungan antara pengilangan kejat, prestasi operasi, dan prestasi perniagaan. Justeru, penyelidikan ini dapat meluaskan sempadan literatur yang sedia ada dan menyumbang kepada pengetahuan berhubungan dengan kesan pengilangan kejat secara teoritikal, praktikal, dan metodologikal.

Kata kunci: pengilangan kejat, prestasi operasi, prestasi perniagaan, kaedah campuran penerangan berjujukan, Indonesia

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LIST OF ABBREVIATIONS

ABV	Activity-based View
AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
BC Bootstrap	Bias-corrected Bootstrap
BPS	Biro Pusat Statistik (Central Bereau of Statistics)
CEV	Component Export and Vanning
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CMV	Common Methods Variance
COPQ	Cost of Poor Quality
CR	Composite Reliability
df	Degree of Freedom
EDI	Electronic Data Interchange
GDP	Gross Domestic Product
GOF	Goodness-of-Fit
ISIC	International Standard of Industrial Classification
JIT	Just-in-time
NNFI	Non-Normed Fit Index
OMDD	Operations and Management Development Division
QCC	Quality Control Circle
RBV	Resource-based View
RMSEA	Root Mean Square Error Approximation
ROI	Return on Investment
S-C-W	Stop-Call-Wait
SEM	Structural Equation Modeling
SMED	Single-Minute Exchange of Die
Sigma CT	Sigma Cycle Time
SOP	Standard Operating Procedure
SPSS	Statistical Package for the Social Science
SRMR	Standardized Root Mean Square Residual

TAM	Toyota Astra Corporation
TMC	Toyota Motor Corporation
TPM	Total Productive Maintenance
TPS	Toyota Production System
TQM	Total Quality Management
VIF	Variance Inflation Factor
VRIN	Valuable, Rare, Inimitable, Non-substitutable
WIP	Work in Process

CHAPTER ONE
INTRODUCTION

1.1 Background of Study

Originated from the shop floors of a Japanese auto industry, in particular, Toyota Motor Corporation (TMC) in the late 1950s to early 1960s (Monden, 1983; Ohno, 1988), lean manufacturing has recently received much attention all over the world. In its history, Papadopoulou and Özbayrak (2005) stated that the term *"lean"* was first invented by Krafcik (1988) to pronounce a production system that uses fewer resources compared to mass production system. Further, to represent the same aim, the term was again used in a seminal book *"The Machine that Changed the World"* authored by Womack, Jones, and Ross (1990).

According to Papadopoulou and Özbayrak (2005), lean manufacturing is merely an Americanized version of the Toyota Production System (TPS) or equally the Just-in-Time (JIT) manufacturing. Thanki and Thakkar (2014) stated that lean manufacturing referred to a production system pioneered by Toyota, which is branded as TPS. Similarly, Arif-Uz-Zaman and Ahsan (2014) stated that foundation of lean manufacturing is TPS, which is based on JIT. The concept and practices of lean manufacturing, TPS, and JIT are similar (Heizer & Render, 2011), and the three terms are often used interchangeably in recent literature (Taj, 2008). However, the term lean manufacturing becomes more prevalent (Russell & Taylor, 2008). Thus, it is subsequently used in the present research to cover all the related techniques and approaches.

The contents of the thesis is for internal user only

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Appendix A: Measurement Items

Appendix A.1: Measurement Items of Lean Manufacturing Practices

No	Item	Literature
Flexible Resources		
1	If a particular workstation has no demand, production workers can go elsewhere in the manufacturing facility to operate a workstation that has demand.	Finch (2008); Hirano (2009); Ketokivi and Schroeder (2004)
2	If one production worker is absent, another production worker can perform the same responsibilities.	Finch (2008); Hirano (2009); Sakakibara et al. (1993)
3	Production workers are cross-trained to perform several different jobs.	Shah and Ward (2007); Finch (2008); Furlan et al. (2011b); Ketokivi and Schroeder (2004)
4	We use general-purpose machines, which can perform several basic functions.	Russell and Taylor (2011); Hirano (2009)
5	Production workers are capable of performing several different jobs.	Sakakibara et al. (1993); Russell and Taylor (2011); Ketokivi and Schroeder (2004)
6	When one machine is broken down, different type of machine can be used to perform the same jobs.	Russell and Taylor (2011); Hirano (2009)
7	When one machine is stopped, production workers are not idle.	Russell and Taylor (2011); Hirano (2009)
Cellular Layouts		
1	Sequence of material flow can be changed in case of machine breakdown.	Rogers (2008); Hirano (2009)
2	Machines are in close proximity to each other.	Sakakibara et al. (1993); Abdallah and Matsui (2007); Matsui (2007)
3	Layout of workstations can easily be changed depending on sequence of operations required to make the product.	Rogers (2008); Hirano (2009)
4	Production facilities are arranged in relation to each other, so that material handling is minimized	Russell and Taylor (2011); Hirano (2009)
5	Machines can be easily moved from one workstation to another.	Sakakibara et al. (1993); Hirano (2009)
6	We group dissimilar equipment into a workstation to process a family of parts with similar requirements (such as shapes, processing or routing requirement).	Koufteros et al. (1998); Russell and Taylor (2011); Chase et al. (2004); Fullerton and Wempe (2009)
7	Production processes are located close together, so that material movement is minimized.	Sakakibara et al. (1993); Abdallah and Matsui (2007); Matsui (2007)
8	Families of products determine our factory layout.	Fullerton and Wempe (2009); Hofer et al. (2011)
Pull System		
1	Kanban system is used to authorize production (Kanban is a work signaling system such as cards, verbal signals, light flashing, electronic messages, empty containers, etc.).	Russell and Taylor (2011); Sakakibara et al. (1993); Flynn et al. (1995); Abdallah and Matsui (2007)
2	Production at a particular workstation is performed based on the current demand of its subsequent workstation.	Koufteros et al. (1998); Shah and Ward (2007)
3	We produce an item only when requested for by its users.	Russell and Taylor (2011); Shah and Ward (2007)
4	To authorize orders to suppliers, we use supplier kanban that rotates between factory and suppliers.	Russell and Taylor (2011); Aziz and Hafez (2013)
5	We use kanban system to authorize material movements.	Russell and Taylor (2011); Monden (2012)
6	We use pull system (producing in response to demand from the next stage of production process) to control our production rather than schedule prepared in advance.	Russell and Taylor (2011); Sakakibara et al. (1993)

Appendix A.1 (Continued)

No	Item	Literature
Small Lot Production		
1	We produce in more frequent but smaller lot size.	Russell and Taylor (2011); Agus and Hajinoor (2012)
2	We emphasize producing small quantity of items together in a batch.	Sakakibara et al. (1993); Flynn et al. (1995); Matsui (2007); Agus and Hajinoor (2012)
3	We aggressively work on reducing production lot sizes.	Sakakibara et al. (1993); Flynn et al. (1995); Agus and Hajinoor (2012); Zelbst et al. (2010)
4	We emphasize producing in small lot sizes to increase manufacturing flexibility.	Matsui (2007); Finch (2008); Furlan et al. (2011b); Agus and Hajinoor (2012)
5	We receive products from suppliers in small lot with frequent deliveries.	Bartezzaghi and Turco (1989); Monden (2012)
6	In our production system, we strictly avoid flow of one type of item in large quantity together.	Matsui (2007); Agus and Hajinoor (2012)
7	We produce only in necessary quantities, no more and no less.	Russell and Taylor (2011); Cheng and Podolsky (1993)
Quick Setups		
1	We converted most of machine setups to external setup that can be performed while the machine is still running with previous operation.	Sakakibara et al. (1993); Abdallah and Matsui (2007); Ketokivi and Schroeder (2004)
2	Production workers perform their own machines' setups.	Sakakibara et al. (1993); Flynn et al. (1995); Abdallah and Matsui (2007)
3	We aggressively work on reducing machines' setup times.	Sakakibara et al. (1993); Shah and Ward (2007); Zelbst et al. (2010); Ketokivi and Schroeder (2004)
4	We emphasize to put all tools in normal storage location.	Fynes and Voss (2002); Hirano (2009)
5	Production workers don't have trouble in finding the equipment they need.	Fynes and Voss (2002); Hirano (2009)
6	Production workers are trained on machines' setup activities.	Taj and Morosan (2011); Hirano (2009); Ketokivi and Schroeder (2004)
7	We can quickly perform our machines' setup if there is a change in process requirements.	Russell and Taylor (2011); Hirano (2009)
Uniform Production Level		
1	We produce more than one product model from day to day (mixed model production).	Sakakibara et al. (1993); Russell and Taylor (2011)
2	We emphasize on a more accurate forecast to reduce variability in production.	Russell and Taylor (2011)
3	Each product is produced in a relatively fixed quantity per production period.	Cheng and Podolsky (1993); Jones (2006); Coleman and Vaghefi (1994)
4	We emphasize to equate workloads in each production process.	Coleman and Vaghefi (1994); Russell and Taylor (2011); Monden (2012)
5	Daily production of different product models is arranged in the same ratio with monthly demand.	Russell and Taylor (2011); Jones (2006); Coleman and Vaghefi (1994)
6	We produce by repeating the same combination of products from day to day.	Sakakibara et al. (1993); Russell and Taylor (2011)
7	We always have some quantity of every product model to response to variation in customer demand.	Russell and Taylor (2011); Coleman and Vaghefi (1994); Jones (2006)

Appendix A.1 (Continued)

No	Item	Literature
Quality control		
1	We use statistical techniques to reduce process variances.	Russell and Taylor (2011); Ketokivi and Schroeder (2004)
2	We use visual control systems (such as *andon*/line-stop alarm light, level indicator, warning signal, signboard, etc.) as a mechanism to make problems visible.	Russell and Taylor (2011); Hirano (2009); Chase et al. (2004)
3	Production processes on production floors are monitored with statistical quality control techniques.	Russell and Taylor (2011); Shah and Ward (2007); Ketokivi and Schroeder (2004)
4	Quality problems can be traced to its source easily.	Russell and Taylor (2011); Chase et al. (2004); Ketokivi and Schroeder (2004)
5	Production workers can identify quality problems easily.	Russell and Taylor (2011); Hirano (2009)
6	Production workers are authorized to stop production if serious quality problems are occurred.	Sakakibara et al. (1993); Russell and Taylor (2011); Chase et al. (2004); Ketokivi and Schroeder (2004)
7	We have quality focused teams that meet regularly to discuss about quality issues.	Fullerton et al. (2003); Monden (2012)
8	Production workers are trained for quality control.	Cheng and Podolsky (1993); Monden (2012)
Total Productive Maintenance		
1	We ensure that machines are in a high state of readiness for production at all the time.	Sakakibara et al. (1993); Ahuja and Khanba (2007)
2	We dedicate periodic inspection to keep machines in operation.	Koufteros et al. (1998); Ahuja and Khanba (2007)
3	We have a sound system of daily maintenance to prevent machine breakdowns from occurring.	Koufteros et al. (1998); Russell and Taylor (2011)
4	We scrupulously clean workspaces (including machines and equipment) to make unusual occurrences noticeable.	Russell and Taylor (2011); Ahuja and Khanba (2007); Cheng and Podolsky (1993)
5	We have a time reserved each day for maintenance activities.	Sakakibara et al. (1993); Koufteros et al. (1998); Shah and Ward (2007)
6	Operators are trained to maintain their own machines.	Moayed and Shell (2009)
7	We emphasize good maintenance system as a strategy for achieving quality compliance.	Koufteros et al. (1998); Sakakibara et al. (1993)
Supplier Networks		
1	We facilitate suppliers to maintain a warehouse near to our plant.	Russell and Taylor (2011) Monden (2012)
2	We strive to establish long-term relationships with suppliers.	Sakakibara et al. (1993); Russell and Taylor (2011); Matsui (2007); Ketokivi and Schroeder (2004)
3	We emphasize to work together with suppliers for mutual benefits.	Monden (2012); Russell and Taylor (2011)
4	We regularly solve problems jointly with suppliers.	Monden (2012); Russell and Taylor (2011)
5	Development programs (such as engineering and quality management assistance) are provided to suppliers.	Russell and Taylor (2011); Cheng and Podolsky (1993)
6	We rely on a small number of high-performance suppliers.	Sakakibara et al. (1993); Ketokivi and Schroeder (2004)
7	Our suppliers deliver materials to us just as it is needed (on just-in-time basis).	Abdallah and Matsui (2007); Shah and Ward (2007); Matsui (2007)

Appendix A.2: Measurement Items of Operations Performance

No	Item	Literature
Quality		
1	The following quality performance indicators have significantly reduced.	
	a. Number of activities in fixing defective products to conform to quality specification (reworks).	Chong et al. (2001); Fullerton and Wempe (2009)
	b. Percentage of poor-quality products that must be discarded (scraps).	Callen et al. (2000); Upton (1998); Fullerton and Wempe (2009)
	c. Percentage of production outputs that do not meet quality specifications.	Bhasin (2008); Chong et al. (2001); Ahuja and Khanba (2007); Callen et al. (2000);
	d. Monthly defective rate at final assembly.	MacDuffie et al. (1996)
	e. Number of warranty claims per month.	Bartezzaghi and Turco (1989); Chong et al. (2001)
	f. Frequency of customer complaints per month.	Bartezzaghi and Turco (1989); Chong et al. (2001)
2	Percentage of products that pass final inspection at the first time (first-pass quality yield) has increased.	Shah and Ward (2003), Ahmad et al. (2004); Gurumurthy and Kodali (2009); Taj and Berro (2006); Taj and Morosan (2011)
3	We have superior product quality compared to competitors'.	Flynn et al. (1995); Bhasin (2008)
Manufacturing Flexibility		
1	The following indicators of manufacturing flexibility have significantly improved.	
	a. Ability to adjust to changes of product design/model in accordance with customer demand.	Ahmad et al. (2003); Bartezzaghi and Turco (1989); Taj (2005, 2008); Cheng and Podolsky (1993); Rogers (2008); Boyle and Scherrer-Rathje (2009)
	b. Ability to adjust to changes of production volume in accordance with customer demand.	Ahmad et al. (2003); Bartezzaghi and Turco (1989); Taj (2005, 2008); Rogers (2008); Boyle and Scherrer-Rathje (2009)
	c. Ability to adjust to changes of production routing in case of machine breakdown.	Rogers (2008); Boyle and Scherrer-Rathje (2009)
	d. Flexibility in work assignments to production workers.	Rogers (2008); Finch (2008)
	e. Flexibility in work assignments to machines.	Rogers (2008); Finch (2008)
	f. Ability of suppliers to deliver products on just-in-time basis (as it is needed, in the right quality, quantity, and time).	Rogers (2008); Abdallah and Matsui (2007); Shah and Ward (2007); Matsui (2007)
Lead Time Reduction		
1	The following components of lead time have significantly reduced.	
	a. Times between placing orders and receiving purchased items from suppliers.	Slack et al. (2010); Stevenson (2012)
	b. Times it takes for products to get through the factory.	Gaither and Frazier (2002)
	c. Machine setup times.	Upton (1998); Ahuja and Khanba (2007); Callen et al. (2000); Fullerton and Wempe (2009); Tersine (1994)
	d. Transportation times of an item between workstations.	Cheng and Podolsky (1993); Tersine (1994)
	e. Waiting times for an item to be moved to next operation.	Cheng and Podolsky (1993); Tersine (1994)
	f. Times required to move the finished goods from our plant to customers.	Wu (2003); Rogers (2008)
2	Most of production times have been used to perform value-added activities.	Cheng and Podolsky (1993); Heizer and Render (2011); Tersine (1994)

Appendix A.2 (Continued)

No	Item	Literature
Inventory Minimization		
1	The following inventory performance indicators have significantly reduced.	
	a. Work in process (WIP) inventory level.	Bhasin (2008); Chong et al. (2001); Taj (2008)
	b. Raw material inventory level.	Claycomb et al. (1999); Bhasin (2008); Chong et al. (2001); Taj (2008)
	c. Finished goods inventory level.	Bhasin (2008); Callen et al. (2000); ; Taj (2008)
	d. Overall inventory level.	Bhasin (2008); Claycomb et al. (1999)
	e. Storage space requirement.	Gurumurthy and Kodali (2009)
2	Inventory turnover has increased (inventory turnover is ratio of cost of goods sold and average aggregate inventory cost).	Chong et al. (2001); Bhasin (2008); Taj (2008); Fullerton and Wempe (2009)
3	Over productions that cause high inventory level have been successfully eliminated.	Garbie (2010); Wong et al. (2009)
Productivity		
1	Productivity of production line has increased due to:	
	a. Fewer interruptions by machine breakdowns.	Lazim and Ramayah (2010); Ahuja and Khanba (2007); Bamber et al. (1999); Lieberman and Demeester (1999)
	b. Shorter processing times.	Agus and Hajinoor (2012); Lewis (2000)
	c. More efficient production processes.	Fullerton and McWatters (2002)
	d. Reduced inputs (e.g., labor, energy, material and capital).	Callen et al. (2005); Abdel-Razek et al. (2007)
	e. More efficient setup processes.	Lieberman and Demeester (1999); Agus and Hajinoor (2012)
	f. Higher production worker flexibility (i.e., ability of workers to perform multiple tasks efficiently).	Rogers (2008); Abdel-Razek et al. (2007); Davis and Heineke (2005)
	g. Higher equipment flexibility (i.e., ability of equipment to perform multiple operations).	Rogers (2008)
2	Overall productivity of production line has been outstanding.	Stevenson (2012); Bartezzaghi and Turco (1989)
Costs Reduction		
1	The following costs performance indicators have significantly reduced:	
	a. Average unit manufacturing cost (the total cost for producing the units divided by quantity of units produced).	Cua et al. (2001); Shah and Ward (2003); Bhasin (2008); Ahmad et al. (2003); Chong et al. (2001)
	b. Average internal failure costs (i.e., cost of defect, scrap, rework, process failure, and downtime).	Russell and Taylor (2008); Omachonu, Suthummanon, and Einspruch (2004)
	c. Average external failure costs (i.e., cost of product returns, warranty claims, liability and lost sales).	Russell and Taylor (2008); Omachonu et al. (2004)
	d. Overall inventory costs.	Womack et al. (1990), Rahman et al. (2010); Rogers (2008)
	e. Labor costs.	Hirano (2009); Lieberman and Demeester (1999)
2	Our unit manufacturing cost is lower than competitors'.	Cua et al. (2001); Shah and Ward (2003); Bhasin (2008); Ahmad et al. (2003)

Appendix A.3: Measurement Items of Business Performance

No	Item	Literature
Profitability		
1	The following indicators of profitability have significantly increased:	
	a. Net profit margin (ratio of net income to total net sales).	Stratopoulos and Dehning (2000); Agus et al. (2011); Valmohammadi and Servati (2011)
	b. Return on investment (ratio of net income to total investment).	Stratopoulos and Dehning (2000); Claycomb et al. (1999); Green and Inman (2007); Ahmad et al. (2004); Chong et al. (2001); Anand and Ward (2004)
2	Profitability growth has been outstanding.	Green and Inman (2007); Claycomb et al. (1999); Anand and Ward (2004); Chenhall (1997)
3	Profitability has exceeded our competitors'.	Green and Inman (2007); Claycomb et al. (1999); Anand and Ward (2004)
4	Overall financial performance has exceeded competitors'.	Fullerton et al. (2003); Fullerton and Wempe (2009)
Sales		
1	The following indicators of sales performance have significantly increased:	
	a. Market share.	Green and Inman (2007); Kannan and Tan (2005); Bhasin (2008); Ahmad et al. (2004); Ahuja and Khanba (2007); Agus and Hajinoor (2012)
	b. Sales turnover (total amount sold).	Clark (2007); Küster and Canales (2011); Agus and Hajinoor (2012)
	c. Average annual sales per product model.	MacDuffie et al. (1996); White and Prybutok (2001); Rogers (2008)
	d. Ability to achieve the annual sales targets.	Kaynak (2002)
2	Sales (in dollars) growth has been outstanding.	Green and Inman (2007); Fynes and Voss (2002); Chenhall (1997); Anand and Ward (2004)
3	Sales volume growth has been outstanding.	Green and Inman (2007); Olsen (2004)
4	Market share growth has exceeded the competitors'.	Kannan and Tan (2005); Fynes and Voss (2002); Bhasin (2008); Agus and Hajinoor (2012)
5	We have generated a high level of sales.	Küster and Canales (2011)
Customer Satisfaction		
1	Customers are satisfied with our…	
	a. Overall product quality.	Bhasin (2008); Ahuja and Khanba (2007); Fynes and Voss (2002); Callen et al. (2000); Chong et al. (2001); Abdel-Maksoud et al. (2005)
	b. Products' competitive prices.	Bhasin (2008); Abdel-Maksoud et al. (2005)
	c. Response to sales enquiries.	Ahmad et al. (2004); Green and Inman (2007); Bhasin (2008)
	d. After sales services.	Ismail et al. (2006); Kaynak (2002); Bhasin (2008)
	e. Ability to fill their orders quickly.	Callen et al. (2000); Ahmad et al. (2004); Green and Inman (2007); Matsui (2007); Bhasin (2008)
	f. On-time delivery.	Sakakibara et al. (1997); Callen et al. (2000); Green and Inman (2007); Matsui (2007); Bhasin (2008); Abdel-Maksoud et al. (2005)

Appendix B: Survey Questionnaire

SURVEY QUESTIONNAIRE

Kuesioner Survey

Lean Manufacturing, Operations Performance and Business Performance in Manufacturing Companies in Indonesia

College of Business-Universiti Utara Malaysia

This questionnaire is distributed in dual language; you can select either English or Bahasa Indonesia

E N G L I S H

RESEARCH ON MANUFACTURING PRACTICES AND PERFORMANCE OF MANUFACTURING COMPANIES IN INDONESIA

General Information:
This is a PhD research to determine the effect of manufacturing practices, which are consistent with the just-in-time/lean manufacturing philosophy, on organizational performance. The researchers believed that the outcome of this research will be of immense benefit to improve performance in manufacturing sector in Indonesia. Your effort in filling the questionnaire is highly appreciated in order to produce a quality research.

General Instruction:
The questionnaire consists of four sections. Please read the items carefully before answering. You are expected to choose the answer that represents your opinion. Your answer plays an important role in the success of this study and you are assured that such information will be treated with **utmost confidentiality**. Please tick, circle the appropriate answer or complete the answer in the space provided.

Thanks for your participation.

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Co-supervisor		

SECTION ONE: MANUFACTURING PRACTICES

Direction:
This section of the questionnaire focuses on manufacturing practices in the plant. It addresses the production attributes and activities implemented in your organization. On the following scale, please circle the appropriate number which best reflects your perception.

Strongly disagree					**Strongly agree**
1	**2**	**3**	**4**	**5**	**6**

Flexible resources						
1. If a particular workstation has no demand, production workers can go elsewhere in the manufacturing facility to operate a workstation that has demand.	1	2	3	4	5	6
2. If one production worker is absent, another production worker can perform the same responsibilities.	1	2	3	4	5	6
3. Production workers are cross-trained to perform several different jobs.	1	2	3	4	5	6
4. We use general-purpose machines, which can perform several basic functions.	1	2	3	4	5	6
5. Production workers are capable of performing several different jobs.	1	2	3	4	5	6
6. When one machine is broken down, different type of machine can be used to perform the same jobs.	1	2	3	4	5	6
7. When one machine is stopped, production workers are not idle.	1	2	3	4	5	6

Cellular layout						
1. Sequence of material flow can be changed in case of machine breakdown.	1	2	3	4	5	6
2. Machines are in close proximity to each other.	1	2	3	4	5	6
3. Layout of workstations can easily be changed depending on sequence of operations required to make the product.	1	2	3	4	5	6
4. Production facilities are arranged in relation to each other, so that material handling is minimized.	1	2	3	4	5	6
5. Machines can be easily moved from one workstation to another.	1	2	3	4	5	6
6. We group dissimilar equipment into a workstation to process a family of parts with similar requirements (such as shapes, processing, or routing requirement).	1	2	3	4	5	6
7. Production processes are located close together, so that material movement is minimized.	1	2	3	4	5	6
8. Families of products determine our factory layout.	1	2	3	4	5	6

Pull system						
1. Kanban system is used to authorize production (Kanban is a work signaling system such as cards, verbal signals, light flashing, electronic messages, empty containers, etc.).	1	2	3	4	5	6
2. Production at a particular workstation is performed based on the current demand of its subsequent workstation.	1	2	3	4	5	6

Strongly disagree					Strongly agree
1	2	3	4	5	6

3. We produce an item only when requested for by its users.	1	2	3	4	5	6
4. To authorize orders to suppliers, we use supplier kanban that rotates between factory and suppliers.	1	2	3	4	5	6
5. We use kanban system to authorize material movements.	1	2	3	4	5	6
6. We use pull system (producing in response to demand from the next stage of production process) to control our production rather than schedule prepared in advance.	1	2	3	4	5	6

Small lot production						
1. We produce in more frequent but smaller lot size.	1	2	3	4	5	6
2. We emphasize producing small quantity of items together in a batch.	1	2	3	4	5	6
3. We aggressively work on reducing production lot sizes.	1	2	3	4	5	6
4. We emphasize producing in small lot sizes to increase manufacturing flexibility.	1	2	3	4	5	6
5. We receive products from suppliers in small lot with frequent deliveries.	1	2	3	4	5	6
6. In our production system, we strictly avoid flow of one type of item in large quantity together.	1	2	3	4	5	6
7. We produce only in necessary quantities, no more and no less.	1	2	3	4	5	6

Quick setup						
1. We converted most of machine setups to external setup that can be performed while the machine is still running with its previous operation.	1	2	3	4	5	6
2. Production workers perform their own machines' setups.	1	2	3	4	5	6
3. We aggressively work on reducing machines' setup times.	1	2	3	4	5	6
4. We emphasize to put all tools in normal storage location.	1	2	3	4	5	6
5. Production workers don't have trouble in finding equipment they need.	1	2	3	4	5	6
6. Production workers are trained on machines' setup activities.	1	2	3	4	5	6
7. We can quickly perform our machines' setup if there is a change in process requirements.	1	2	3	4	5	6

Uniform production level						
1. We produce more than one product model from day to day (mixed model production).	1	2	3	4	5	6
2. We emphasize on a more accurate forecast to reduce variability in production.	1	2	3	4	5	6
3. Each product is produced in a relatively fixed quantity per production period.	1	2	3	4	5	6
4. We emphasize to equate workloads in each production process.	1	2	3	4	5	6
5. Daily production of different product models is arranged in the same ratio with monthly demand.	1	2	3	4	5	6

Strongly disagree					Strongly agree
1	**2**	**3**	**4**	**5**	**6**

6. We produce by repeating the same combination of products from day to day.	1	2	3	4	5	6
7. We always have some quantity of every product model to response to variation in customer demand.	1	2	3	4	5	6

Quality control						
1. We use statistical techniques to reduce process variances.	1	2	3	4	5	6
2. We use visual control systems (such as *andon*/line-stop alarm light, level indicator, warning signal, signboard, etc.) as a mechanism to make problems visible.	1	2	3	4	5	6
3. Production processes on production floors are monitored with statistical quality control techniques.	1	2	3	4	5	6
4. Quality problems can be traced to its source easily.	1	2	3	4	5	6
5. Production workers can identify quality problems easily.	1	2	3	4	5	6
6. Production workers are authorized to stop production if serious quality problems are occurred.	1	2	3	4	5	6
7. We have quality focused teams that meet regularly to discuss about quality issues.	1	2	3	4	5	6
8. Production workers are trained for quality control.	1	2	3	4	5	6

Total productive maintenance						
1. We ensure that machines are in a high state of readiness for production at all the time.	1	2	3	4	5	6
2. We dedicate periodic inspection to keep machines in operation.	1	2	3	4	5	6
3. We have a sound system of daily maintenance to prevent machine breakdowns from occurring.	1	2	3	4	5	6
4. We scrupulously clean workspaces (including machines and equipment) to make unusual occurrences noticeable.	1	2	3	4	5	6
5. We have a time reserved each day for maintenance activities.	1	2	3	4	5	6
6. Operators are trained to maintain their own machines.	1	2	3	4	5	6
7. We emphasize good maintenance system as a strategy for achieving quality compliance.	1	2	3	4	5	6

Supplier networks						
1. We facilitate suppliers to maintain a warehouse near to our plant.	1	2	3	4	5	6
2. We strive to establish long-term relationships with suppliers.	1	2	3	4	5	6
3. We emphasize to work together with suppliers for mutual benefits.	1	2	3	4	5	6
4. We regularly solve problems jointly with suppliers.	1	2	3	4	5	6
5. Development programs (such as engineering and quality management assistance) are provided to suppliers.	1	2	3	4	5	6
6. We rely on a small number of high-performance suppliers.	1	2	3	4	5	6
7. Our suppliers deliver materials to us just as it is needed (on just-in-time basis).	1	2	3	4	5	6

SECTION TWO: OPERATIONS PERFORMANCE

Directions:
On the following scale, please circle the appropriate number which best reflects your perception to indicate the operations performance of your plant <u>during the past three years</u>.

Strongly disagree					**Strongly agree**
1	**2**	**3**	**4**	**5**	**6**

Quality						
1. The following quality performance indicators have significantly reduced.						
a. Number of activities in fixing defective products to conform to quality specification (reworks).	1	2	3	4	5	6
b. Percentage of poor quality products that must be discarded (scraps).	1	2	3	4	5	6
c. Percentage of production outputs that do not meet quality specifications.	1	2	3	4	5	6
d. Monthly defect rate at final assembly.	1	2	3	4	5	6
e. Number of warranty claims per month.	1	2	3	4	5	6
f. Number of customer complaints per month.	1	2	3	4	5	6
2. Percentage of products that pass final inspection at the first time (first-pass quality yield) has increased.	1	2	3	4	5	6
3. We have superior product quality compared to competitors'.	1	2	3	4	5	6

Manufacturing flexibility						
1. The following indicators of manufacturing flexibility have significantly improved.						
a. Ability to adjust to changes of product design/model in accordance with customer demand.	1	2	3	4	5	6
b. Ability to adjust to changes of production volume in accordance with customer demand.	1	2	3	4	5	6
c. Ability to adjust to changes of production routing in case of machine breakdown.	1	2	3	4	5	6
d. Flexibility in work assignments to production workers.	1	2	3	4	5	6
e. Flexibility in work assignments to machines.	1	2	3	4	5	6
f. Ability of suppliers to deliver products on just-in-time basis (as it is needed, in the right quality, quantity, and time).	1	2	3	4	5	6

Lead time reduction						
1. The following components of lead time have significantly reduced.						
a. Times between placing orders and receiving purchased items from suppliers.	1	2	3	4	5	6
b. Times it takes for products to get through the factory.	1	2	3	4	5	6
c. Machine setup times.	1	2	3	4	5	6
d. Transportation times of an item between workstations.	1	2	3	4	5	6

Strongly disagree					Strongly agree
1	**2**	**3**	**4**	**5**	**6**

e. Waiting times for an item to be moved to next operation.	1	2	3	4	5	6
f. Times required to move finished goods from our plant to customers.	1	2	3	4	5	6
2. Most of production times have been used to perform value-added activities.	1	2	3	4	5	6

Inventory minimization						
1. The following inventory performance indicators have significantly reduced.						
a. Work in process (WIP) inventory level.	1	2	3	4	5	6
b. Raw material inventory level.	1	2	3	4	5	6
c. Finished goods inventory level.	1	2	3	4	5	6
d. Overall inventory level.	1	2	3	4	5	6
e. Storage space requirement.	1	2	3	4	5	6
2. Inventory turnover has increased (inventory turnover is the ratio of cost of goods sold and average aggregate inventory cost).	1	2	3	4	5	6
3. Over productions that cause high inventory level have been successfully eliminated.	1	2	3	4	5	6

Productivity						
1. Productivity of production line has increased due to:						
a. Fewer interruptions by machine breakdowns.	1	2	3	4	5	6
b. Shorter processing times.	1	2	3	4	5	6
c. More efficient production processes.	1	2	3	4	5	6
d. Reduced inputs (e.g., labor, energy, material and capital).	1	2	3	4	5	6
e. More efficient setup processes.	1	2	3	4	5	6
f. Higher production worker flexibility (i.e., ability of workers to perform multiple tasks efficiently).	1	2	3	4	5	6
g. Higher equipment flexibility (i.e., ability of equipment to perform multiple operations).	1	2	3	4	5	6
2. Overall productivity of production line has been outstanding.	1	2	3	4	5	6

Costs reduction						
1. The following costs performance indicators have reduced.						
a. Average unit manufacturing cost (i.e, total cost for producing the units divided by quantity of units produced).	1	2	3	4	5	6
b. Average internal failure costs (i.e., cost of defect, scrap, rework, process failure, and downtime).	1	2	3	4	5	6
c. Average external failure costs (i.e., cost of product returns, warranty claims, liability and lost sales).	1	2	3	4	5	6
d. Overall inventory costs.	1	2	3	4	5	6
e. Labor costs.	1	2	3	4	5	6
2. Our unit manufacturing cost is lower than competitors'.	1	2	3	4	5	6

SECTION THREE: BUSINESS PERFORMANCE

Directions:
On the following scale, please circle the appropriate number which best reflects your perception to indicate the business performance of your plant during the past three years.

Strongly disagree					Strongly agree
1	2	3	4	5	6

Profitability						
1. The following indicators of profitability have significantly increased.						
a. Net profit margin (ratio of net income to total net sales).	1	2	3	4	5	6
b. Return on investment (ratio of net income to total investment).	1	2	3	4	5	6
2. Profitability growth has been outstanding.	1	2	3	4	5	6
3. Profitability has exceeded our competitors'.	1	2	3	4	5	6
4. Overall financial performance has exceeded competitors'.	1	2	3	4	5	6

Sales						
1. The following indicators of sales performance have significantly increased.						
a. Market share.	1	2	3	4	5	6
b. Sales turnover (total amount sold).	1	2	3	4	5	6
c. Average annual sales per product model.	1	2	3	4	5	6
d. Ability to achieve the annual sales targets.	1	2	3	4	5	6
2. Sales (in dollars) growth has been outstanding.	1	2	3	4	5	6
3. Sales volume growth has been outstanding.	1	2	3	4	5	6
4. Market share growth has exceeded the competitors'.	1	2	3	4	5	6
5. We have generated a high level of sales.	1	2	3	4	5	6

Customer satisfaction						
1. Customers are satisfied with our…						
a. Overall product quality.	1	2	3	4	5	6
b. Products' competitive prices.	1	2	3	4	5	6
c. Response to sales enquiries.	1	2	3	4	5	6
d. After sales services.	1	2	3	4	5	6
e. Ability to fill their orders quickly.	1	2	3	4	5	6
f. On-time delivery.	1	2	3	4	5	6

SECTION FOUR: GENERAL INFORMATION

1. Nature of business

☐ Textiles, wearing apparel
☐ Tanning and dressing of leather
☐ Wood, products of wood (except furniture) and plaiting materials
☐ Machinery and equipment
☐ Electrical machinery and equipment
☐ Radio, television and communication equipment and apparatus
☐ Medical, precision and optical instruments, watches and clocks
☐ Motor vehicles, trailers and semi-trailers
☐ Other transport equipment
☐ Furniture
☐ Others (please specify): ____________________

2. Company's ownership

☐ State owned enterprise
☐ Private enterprise
☐ Foreign invested enterprise
☐ Joint venture
☐ Others (please specify): ____________________

3. Age of company

☐ Less than 3 years ☐ 3 – 5 years ☐ More than 5 years

4. Number of employees

☐ Less than 100 ☐ 100 – 300 ☐ More than 300

5. Type of production process

The following figure shows characteristics of five common production processes (i.e., job shop, batch, repetitive, continuous flow, and mass customization) in terms of production volume and degree of products' standardization.

Production volume	Products' standardization: Customized/ high variety	Semi-standardized/ medium variety	Standardized/ low variety	Highly standardized/ no variety
Low	Job shop			
Medium		Batch		
High			Repetitive	
Very high	Mass customization			Continuous flow

Based on the above figure, which one is best to represent your production process?

☐ Job shop
☐ Batch
☐ Repetitive
☐ Continuous flow
☐ Mass customization
☐ Others (plese specify): ____________________

6. Are you considering that your company is implementing lean/just-in-time (JIT) manufacturing system? (if "No", then jump to question number 11)

☐ Yes ☐ No

7. Was there any official declaration of lean/JIT manufacturing initiatives?

☐ Yes ☐ No

8. How long has your company been implementing lean/JIT manufacturing system?

☐ Less than 3 year ☐ 3 – 5 years ☐ More than 5 years

9.	**Are there any standard operating procedure guiding your company in implementing lean/JIT manufacturing system?** ☐ Yes ☐ No
10.	**Does lean/JIT manufacturing system contribute positively to your company's performance?** ☐ Yes ☐ No
11.	**Do you have any other systems/strategies that are implemented in your company?** (if "No", then jump to question number 13) ☐ Yes ☐ No
12.	**What systems/strategies that are implemented in your company?** (you can tick more than one) ☐ Flexible manufacturing ☐ Total quality control ☐ Cellular manufacturing ☐ Total productive maintenance ☐ *Heijunka* system ☐ Vendor management system ☐ Inventory management ☐ Single Minute Exchange of Dies (SMED) ☐ Total quality management ☐ Six Sigma ☐ Supply chain management ☐ Others (please specify): ____________________
13.	**Your position in the company** ☐ Manufacturing director ☐ Manufacturing manager ☐ Head of production department ☐ Others (please specify): ____________________
14.	**How long have you been in the current position?** ☐ Less than 1 year ☐ 1 – 3 years ☐ More than 3 years
15.	**How long have you been working in this company?** ☐ Less than 3 year ☐ 3 – 5 years ☐ More than 5 years

Please kindly send this completed survey booklet in the stamped enclosed self-address envelope provided before end of April 2013.

☐ Please tick here if you are willing to have a copy of the research report. Please enclose your business card and provide your e-mail address below.
Your email address: ________________________

Comments (optional):
____
____
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Thank you for your participation…

Kuisioner ini disebarkan dalam dua bahasa, Bapak/Ibu dapat memilih satu diantaranya, Bahasa Indonesia atau Bahasa Inggris

BAHASA INDONESIA

PENELITIAN TENTANG AKTIVITAS-AKTIVITAS MANUFAKTUR DAN KINERJA PERUSAHAAN MANUFAKTUR DI INDONESIA

Informasi Umum:
Ini adalah penelitian S3 yang bertujuan untuk menentukan pengaruh aktivitas-aktivitas manufaktur, yang konsisten dengan filosofi *just-in-time/lean manufacturing*, terhadap kinerja organisasi. Peneliti yakin, penelitian ini berkontribusi besar dalam upaya peningkatan kinerja sektor manufaktur di Indonesia. Partisipasi Bapak/Ibu sangat berharga dalam menghasilkan penilitian yang berkualitas.

Instruksi Umum:
Kuesioner ini terdiri dari 4 bagian. Mohon dibaca dengan hati-hati sebelum dijawab. Bapak/Ibu diharapkan untuk memilih jawaban yang betul-betul menggambarkan pendapat Bapak/Ibu. Jawaban Bapak/Ibu memainkan peranan penting untuk suksesnya penelitian ini. Semua jawaban akan **dirahasiakan sepenuhnya**. Silahkan tandai, lingkari jawaban yang sesuai atau lengkapi jawaban pada tempat yang tersedia.

Terima kasih atas partisipasi Bapak/Ibu.

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BAGIAN SATU: AKTIVITAS-AKTIVITAS MANUFAKTUR

Petunjuk:
Bagian ini fokus kepada aktivitas-aktivitas manufaktur di pabrik, untuk menunjukkan aktivitas-aktivitas produksi yang diimplementasikan di perusahaan Bapak/Ibu. Pada skala berikut, silahkan lingkari angka yang sesuai untuk menunjukkan persepsi Bapak/Ibu.

Sangat tak setuju					**Sangat Setuju**
1	**2**	**3**	**4**	**5**	**6**

Sumber daya fleksibel						
1. Jika stasiun kerja tertentu tidak memiliki permintaan, operator dapat berpindah ke tempat lain di dalam fasilitas produksi untuk menjalankan stasiun kerja yang memiliki permintaan.	1	2	3	4	5	6
2. Jika seorang operator absen, operator lain dapat menggantikannya untuk menjalankan pekerjaan yang sama.	1	2	3	4	5	6
3. Pekerja produksi dilatih untuk melaksanakan beberapa pekerjaan berbeda.	1	2	3	4	5	6
4. Kami menggunakan mesin-mesin multi-fungsi yang dapat melakukan beberapa fungsi dasar.	1	2	3	4	5	6
5. Pekerja produksi mampu mengerjakan beberapa pekerjaan berbeda.	1	2	3	4	5	6
6. Ketika salah satu mesin rusak, mesin jenis lain dapat digunakan untuk pekerjaan yang sama.	1	2	3	4	5	6
7. Bila salah satu mesin berhenti beroperasi, operator tidak menganggur.	1	2	3	4	5	6

Tata letak seluler						
1. Aliran material dapat dirubah jika ada gangguan mesin.	1	2	3	4	5	6
2. Mesin-mesin kami berdekatan satu sama lain.	1	2	3	4	5	6
3. Tata letak stasiun kerja dapat dirubah dengan mudah tergantung urutan operasi pembuatan produk.	1	2	3	4	5	6
4. Fasilitas produksi disusun menurut hubungan satu sama lainnya, sehingga penanganan material terminimalkan.	1	2	3	4	5	6
5. Mesin-mesin dapat dengan mudah dipindahkan dari satu stasiun kerja ke stasiun kerja lain.	1	2	3	4	5	6
6. Kami mengelompokkan peralatan-peralatan berbeda pada stasiun kerja berdasarkan famili produk yang memiliki kesamaan (seperti kesamaan bentuk, proses, atau rute proses).	1	2	3	4	5	6
7. Proses-proses produksi saling berdekatan, sehingga pergerakan material terminimalkan.	1	2	3	4	5	6
8. Famili produk menentukan tata letak pabrik kami.	1	2	3	4	5	6

Sistem tarik						
1. Sistem kanban digunakan untuk mengotorisasi produksi (Kanban adalah sistem pemberian isyarat pekerjaan yang	1	2	3	4	5	6

Sangat tak setuju					Sangat Setuju
1	2	3	4	5	6

dapat berupa kartu, tanda-tanda verbal, kedipan cahaya, pesan elektronik, kontainer kosong, dan lain-lain).						
2. Produksi pada stasiun kerja tertentu dilakukan menurut permintaan dari stasiun kerja berikutnya.	1	2	3	4	5	6
3. Kami berproduksi hanya jika diminta oleh penggunanya.	1	2	3	4	5	6
4. Untuk mengizinkan order kepada pemasok, kami menggunakan *"supplier kanban"* yang bergerak antara pabrik kami dan pemasok.	1	2	3	4	5	6
5. Kami menggunakan sistem kanban untuk mengotorisasi perpindahan material.	1	2	3	4	5	6
6. Kami menggunakan sistem tarik (berproduksi dalam merespon permintaan dari proses produksi selanjutnya) untuk mengontrol produksi, bukan berdasarkan jadwal yang dipersiapkan sebelumnya.	1	2	3	4	5	6

Produksi dengan ukuran lot kecil						
1. Kami berproduksi lebih sering tetapi dalam lot kecil.	1	2	3	4	5	6
2. Kami menekankan produksi sejumlah kecil item dalam satu batch.	1	2	3	4	5	6
3. Kami selalu berusaha menurunkan ukuran lot produksi.	1	2	3	4	5	6
4. Kami mementingkan produksi dalam ukuran lot kecil untuk meningkatkan fleksibilitas produksi.	1	2	3	4	5	6
5. Kami menerima produk dari pemasok dalam partai kecil dengan pengiriman sering.	1	2	3	4	5	6
6. Dalam sistem produksi kami, kami menghindari aliran satu jenis item barang bersama-sama dalam jumlah besar.	1	2	3	4	5	6
7. Kami berproduksi hanya dalam jumlah yang diperlukan, tidak lebih dan tidak kurang.	1	2	3	4	5	6

Setup cepat						
1. Kami mengkonversi setup mesin kepada setup eksternal yang dapat dilakukan saat mesin masih menjalankan operasi sebelumnya.	1	2	3	4	5	6
2. Pekerja produksi melaksanakan setup mesin sendiri.	1	2	3	4	5	6
3. Kami selalu berusaha untuk menurunkan waktu setup mesin.	1	2	3	4	5	6
4. Kami menekankan untuk menyimpan semua peralatan pada lokasi penyimpanan normal/standar.	1	2	3	4	5	6
5. Pekerja produksi tidak kesulitan untuk menemukan peralatan yang mereka perlukan.	1	2	3	4	5	6
6. Operator dilatih berkaitan dengan aktivitas setup mesin.	1	2	3	4	5	6
7. Kami dapat melaksanakan setup mesin dengan cepat jika ada perubahan kebutuhan proses.	1	2	3	4	5	6

Level produksi seragam						
1. Kami memproduksi lebih dari satu model produk dari hari ke hari (produksi campur merata/*mixed model production*).	1	2	3	4	5	6

Sangat tak setuju					Sangat Setuju
1	2	3	4	5	6

2. Kami menekankan pada peramalan yang lebih akurat untuk mengurangi variabilitas produksi.	1	2	3	4	5	6
3. Setiap produk diproduksi pada kuantitas yang relatif tetap per-periode produksi.	1	2	3	4	5	6
4. Kami menekankan untuk menyamakan beban kerja pada setiap proses produksi.	1	2	3	4	5	6
5. Produksi harian untuk model produk yang berbeda disusun dalam rasio yang sama dengan permintaan bulanan.	1	2	3	4	5	6
6. Kami berproduksi dengan mengulangi kombinasi produk yang sama dari hari ke hari.	1	2	3	4	5	6
7. Kami selalu menyimpan setiap model produk dalam jumlah tertentu untuk merespon variasi permintaan pelanggan.	1	2	3	4	5	6

Pengendalian kualitas						
1. Kami menggunakan teknik-teknik statistik untuk mengurangi variasi proses.	1	2	3	4	5	6
2. Kami menggunakan sistem kontrol visual (seperti *andon*/tanda perintah menghentikan produksi, *level indicator*, sinyal peringatan, *signboard*, dan lain-lain) agar masalah kualitas terlihat jelas.	1	2	3	4	5	6
3. Proses produksi dipantau dengan teknik-teknik pengendalian proses statistik.	1	2	3	4	5	6
4. Masalah-masalah kualitas dapat ditelusuri ke sumbernya dengan mudah.	1	2	3	4	5	6
5. Operator dapat mengidentifikasi masalah kualitas dengan mudah.	1	2	3	4	5	6
6. Operator diberikan otoritas untuk menghentikan produksi jika terjadi masalah kualitas yang serius.	1	2	3	4	5	6
7. Kami memiliki tim kualitas terfokus yang bertemu secara reguler untuk membahas isu-isu kualitas.	1	2	3	4	5	6
8. Operator dilatih untuk melakukan kontrol kualitas.	1	2	3	4	5	6

Pemeliharaan produktif menyeluruh (TPM)						
1. Kami memastikan bahwa setiap mesin berada dalam kesiapan tinggi untuk berproduksi setiap saat.	1	2	3	4	5	6
2. Kami melaksanakan inspeksi berkala untuk menjaga mesin-mesin dapat beroperasi dengan baik.	1	2	3	4	5	6
3. Kami memiliki sistem pemerliharaan harian yang tepat untuk mencegah terjadinya kerusakan mesin.	1	2	3	4	5	6
4. Kami secara teliti membersihkan tempat kerja (termasuk mesin-mesin dan peralatan) agar kejadian yang tak biasa menjadi kentara.	1	2	3	4	5	6
5. Kami memiliki cadangan waktu setiap hari untuk aktivitas-aktivitas pemeliharaan.	1	2	3	4	5	6
6. Operator dilatih untuk menjaga mesin-mesin mereka sendiri.	1	2	3	4	5	6
7. Kami menekankan sistem perawatan yang baik sebagai strategi pencapaian standar kualitas yang ditetapkan.	1	2	3	4	5	6

Sangat tak setuju					Sangat Setuju
1	**2**	**3**	**4**	**5**	**6**

Jaringan pemasok						
1. Kami menfasilitasi para pemasok untuk mengelola sebuah gudang berdekatan dengan pabrik kami.	1	2	3	4	5	6
2. Kami membangun hubungan jangka panjang dengan para pemasok.	1	2	3	4	5	6
3. Kami menekankan kerjasama yang saling menguntungkan dengan para pemasok.	1	2	3	4	5	6
4. Kami secara reguler memecahkan persoalan bersama-sama dengan para pemasok.	1	2	3	4	5	6
5. Program-program pembinaan (seperti bantuan teknik dan manajemen kualitas) diberikan kepada para pemasok.	1	2	3	4	5	6
6. Kami mengandalkan pemasok yang berkinerja tinggi.	1	2	3	4	5	6
7. Pemasok kami mengantarkan material yang dipasoknya kepada kami hanya pada saat dibutuhkan *(just-in-time)*.	1	2	3	4	5	6

BAGIAN DUA: KINERJA OPERASIONAL

Petunjuk:
Pada skala berikut, mohon lingkari angka yang paling mencerminkan kinerja operasional pabrik Bapak/Ibu **dalam kurun waktu tiga tahun terakhir ini**.

Sangat tak setuju					Sangat Setuju
1	**2**	**3**	**4**	**5**	**6**

Kualitas						
1. Indikator-indikator kinerja kualitas berikut telah berkurang secara signifikan.						
a. Jumlah aktivitas untuk memperbaiki produk cacat agar memenuhi spesifikasi kualitas *(rework)*.	1	2	3	4	5	6
b. Persentase produk berkualitas rendah yang harus dibuang/tidak bisa di-*rework (scrap)*.	1	2	3	4	5	6
c. Persentase output produksi yang tidak memenuhi spesifikasi kualitas.	1	2	3	4	5	6
d. Tingkat produk cacat pada perakitan akhir per bulan.	1	2	3	4	5	6
e. Jumlah tuntutan garansi dari pelanggan per bulan.	1	2	3	4	5	6
f. Jumlah keluhan pelanggan per bulan.	1	2	3	4	5	6
2. Persentase produk yang lolos inspeksi akhir pertama *(first-pass quality yield)* telah meningkat.	1	2	3	4	5	6
3. Kualitas produk kami unggul dibandingkan kompetitor.	1	2	3	4	5	6

Fleksibilitas manufaktur						
1. Indikator-indikator fleksibilitas manufaktur berikut telah meningkat secara signifikan.						

Sangat tak setuju					Sangat Setuju
1	**2**	**3**	**4**	**5**	**6**

a. Kemampuan merubah design/model produk sesuai permintaan pelanggan.	1	2	3	4	5	6
b. Kemampuan merubah volume produksi sesuai permintaan pelanggan.	1	2	3	4	5	6
c. Kemampuan menyesuaikan diri dengan perubahan urutan produksi jika terjadi kerusakan mesin.	1	2	3	4	5	6
d. Fleksibilitas dalam penugasan kepada pekerja produksi.	1	2	3	4	5	6
e. Fleksibilitas dalam penugasan kerja kepada mesin.	1	2	3	4	5	6
f. Kemampuan pemasok untuk mengirimkan produknya kepada kami secara *just-in-time* (sesuai kebutuhan, pada kualitas, kuantitas, dan waktu yang tepat).	1	2	3	4	5	6

Penurunan *lead time*						
1. Komponen-komponen *lead time* berikut telah berkurang secara signifikan.						
a. Waktu antara pemesanan dan penerimaan barang yang dibeli dari pemasok.	1	2	3	4	5	6
b. Waktu yang diperlukan bagi produk untuk melewati semua proses produksi.	1	2	3	4	5	6
c. Waktu setup mesin.	1	2	3	4	5	6
d. Waktu pemindahan item antar-stasiun kerja.	1	2	3	4	5	6
e. Waktu menunggu bagi suatu item untuk pindah ke operasi berikutnya.	1	2	3	4	5	6
f. Waktu yang diperlukan dari barang dikeluarkan dari pabrik sampai diterima oleh pelanggan.	1	2	3	4	5	6
2. Sebahagian besar waktu produksi telah digunakan untuk aktivitas-aktivitas produktif/bernilai tambah.	1	2	3	4	5	6

Pengurangan persediaan						
1. Indikator-indikator performansi persediaan berikut telah berkurang secara signifikan.						
a. Jumlah persediaan dalam proses.	1	2	3	4	5	6
b. Jumlah persediaan barang baku yang harus disimpan.	1	2	3	4	5	6
c. Jumlah persediaan barang jadi.	1	2	3	4	5	6
d. Jumlah persediaan secara keseluruhan.	1	2	3	4	5	6
e. Kebutuhan ruang penyimpanan.	1	2	3	4	5	6
2. Perputaran persediaan telah meningkat (perputaran persediaan adalah perbandingan antara harga pokok penjualan dengan rata-rata nilai persediaan (dalam rupiah)).	1	2	3	4	5	6
3. Produksi berlebih yang menyebabkan tingginya tingkat persediaan telah berhasil dieliminasi.	1	2	3	4	5	6

Produktivitas						
1. Produktivitas lini produksi telah meningkat karena:						
a. Lebih sedikitnya gangguan akibat kerusakan mesin.	1	2	3	4	5	6
b. Pendeknya waktu proses.	1	2	3	4	5	6
c. Lebih efisiennya proses produksi.	1	2	3	4	5	6

Sangat tak setuju					Sangat Setuju
1	2	3	4	5	6

d. Berkurangnya input (seperti tenaga kerja, energi, material, dan modal).	1	2	3	4	5	6
e. Lebih efisiennya proses setup.	1	2	3	4	5	6
f. Lebih tingginya fleksibilitas pekerja produksi (kemampuan pekerja untuk melakukan banyak tugas secara efisien).	1	2	3	4	5	6
g. Lebih tingginya fleksibilitas peralatan (kemampuan peralatan untuk melakukan banyak operasi).	1	2	3	4	5	6
2. Produktivitas keseluruhan lini produksi telah cemerlang.	1	2	3	4	5	6

Penurunan biaya						
1. Indikator-indikator performansi biaya berikut telah berkurang secara signifikan.						
a. Biaya produksi rata-rata perunit (total biaya produksi semua unit dibagi dengan jumlah unit yang diproduksi).	1	2	3	4	5	6
b. Rata-rata biaya kerusakan internal (seperti biaya produk cacat, *scrap*, *rework*, kegagalan proses, dan kerusakan mesin).	1	2	3	4	5	6
c. Rata-rata biaya kerusakan eksternal (seperti biaya pengembalian produk, tuntutan garansi, penurunan harga dan kehilangan penjualan).	1	2	3	4	5	6
d. Biaya persediaan keseluruhan.	1	2	3	4	5	6
e. Biaya tenaga kerja.	1	2	3	4	5	6
2. Biaya produksi perunit kami lebih rendah daripada kompetitor.	1	2	3	4	5	6

BAGIAN TIGA: KINERJA BISNIS

Petunjuk:
Pada skala berikut, mohon lingkari jawaban yang paling mencerminkan kinerja bisnis perusahaan Bapak/Ibu **<u>dalam kurun waktu tiga tahun terakhir</u>**.

Sangat tak setuju					Sangat Setuju
1	2	3	4	5	6

Profitabilitas						
1. Indikator-indikator profitabilitas berikut telah meningkat secara signifikan.						
a. Marjin keuntungan bersih (rasio pendapatan bersih terhadap total penjualan bersih).	1	2	3	4	5	6
b. Pengembalian investasi/*return on investment* (rasio pendapatan bersih terhadap total investasi).	1	2	3	4	5	6
2. Pertumbuhan profitabilitas kami cemerlang.	1	2	3	4	5	6
3. Profitabilitas kami telah melebihi para kompetitor.	1	2	3	4	5	6

Sangat tak setuju					Sangat Setuju
1	**2**	**3**	**4**	**5**	**6**

4. Secara keseluruhan, kinerja finansial kami unggul dibandingkan kompetitor.	1	2	3	4	5	6

Penjualan						
1. Indikator-indikator profitabilitas berikut telah meningkat secara signifikan.						
a. Pangsa pasar.	1	2	3	4	5	6
b. Omset penjualan.	1	2	3	4	5	6
c. Rata-rata penjualan tahunan per-model produk.	1	2	3	4	5	6
d. Kemampuan untuk mencapai target penjualan tahunan.	1	2	3	4	5	6
2. Peningkatan penjualan (dalam Rupiah) telah cemerlang.	1	2	3	4	5	6
3. Peningkatan volume penjualan telah cemerlang.	1	2	3	4	5	6
4. Peningkatan pangsa pasar kami telah melebihi kompetitor.	1	2	3	4	5	6
5. Kami telah menghasilkan tingkat penjualan yang tinggi.	1	2	3	4	5	6

Kepuasan Pelanggan						
1. Pelanggan puas dengan …						
a. Kualitas produk kami secara keseluruhan.	1	2	3	4	5	6
b. Harga produk kami yang kompetitif.	1	2	3	4	5	6
c. Tanggapan kami terhadap permintaan keterangan penjualan.	1	2	3	4	5	6
d. Layanan purna jual yang kami sediakan.	1	2	3	4	5	6
e. Kemampuan kami untuk memenuhi permintaan pelanggan secara cepat.	1	2	3	4	5	6
f. Pengiriman kami yang tepat waktu.	1	2	3	4	5	6

BAGIAN EMPAT: INFORMASI UMUM

1. Area Bisnis Perusahaan

- ☐ Tekstil dan pakaian jadi
- ☐ Kulit, barang dari kulit, dan alas kaki
- ☐ Kayu dan produk dari kayu dan gabus (selain perabot) dan bahan anyaman
- ☐ Mesin dan peralatan
- ☐ Mesin listrik dan perlengkapannya
- ☐ Radio, televisi, alat komunikasi dan perlengkapannya
- ☐ Alat-alat medis, presisi, optik, dan jam
- ☐ Kendaraan bermotor, trailer dan semi-trailer
- ☐ Alat angkutan selain kendaraan roda empat atau lebih
- ☐ Perabot
- ☐ Lain-lain (silahkan nyatakan): ______________________________

2. Struktur Kepemilikan Perusahaan

- ☐ Perusahaan pemerintah
- ☐ Perusahaan swasta
- ☐ Perusahaan investasi asing
- ☐ Usaha patungan
- ☐ Lain-lain (silahkan nyatakan): ______________________________

3. Usia Perusahaan

☐ Kurang dari 3 tahun ☐ 3 – 5 tahun ☐ Lebih dari 5 tahun

4. Jumlah Pekerja

☐ Kurang dari 100 orang ☐ 100 – 300 orang ☐ Lebih dari 300 orang

5. **Tipe Proses Produksi**

Gambar berikut ini menunjukkan karakteristik dari 5 proses produksi (yaitu *job shop, batch, repetitive, continuous flow* dan *mass customization*) dalam hal volume produksi dan tingkat standarisasi produk.

		Standarisasi produk			
		Sesuai order/ Variasi tinggi	Semi-terstandar/ Variasi sedang	Terstandar/ Variasi rendah	Sangat terstandar/ Tidak ada variasi
Volume Produksi	Rendah	*Job shop*			
	Sedang		*Batch*		
	Tinggi			*Repetitive*	
	Sangat Tinggi	*Mass customization*			*Continuous flow*

Berdasarkan gambar di atas, proses produksi mana yang paling sesuai untuk menunjukkan proses produksi yang diterapkan di perusahaan Bapak/Ibu?

☐ *Job shop* ☐ *Continuous flow*
☐ *Batch* ☐ *Mass customization*
☐ *Repetitive* ☐ Lain-lain (silahkan nyatakan): ____________________

6. Menurut Bapak/Ibu, apakah perusahaan Bapak/Ibu telah menerapkan sistem *lean manufacturing/just-in-time?* (Jika "Tidak", silahkan langsung ke pertanyaan No. 11)

☐ Ya ☐ Tidak

7. Apakah ada deklarasi resmi penerapan *lean manufacturing/just-in-time* di perusahaan Bapak/Ibu?

☐ Ya ☐ Tidak

8. Sudah berapa lama perusahaan Bapak/Ibu menerapkan sistem *lean manufacturing/just-in-time?*

☐ Kurang dari 3 tahun ☐ 3 – 5 tahun ☐ Lebih dari 5 tahun

9. Apakah perusahaan Bapak/Ibu memiliki prosedur standar (seperti SOP) sebagai pedoman dalam mengimplementasikan *lean manufacturing/just-in-time*?

☐ Ya ☐ Tidak

10. Apakah sistem *lean manufacturing/just-in-time* yang diterapkan di perusahaan Bapak/Ibu berkontribusi positif terhadap kinerja perusahaan?

☐ Ya ☐ Tidak

11. Apakah ada sistem/strategi lain (selain *lean manufacturing/just-in-time*) yang diterapkan di perusahaan Bapak/Ibu? (Jika "Tidak", selesai)

☐ Ya ☐ Tidak

12. Selain *lean manufacturing/just-in-time*, sistem/strategi apa saja yang saat ini sedang diimplementasikan di perusahaan Bapak/Ibu? (Bapak/Ibu bisa memilih lebih dari satu jawaban)

☐ *Flexible manufacturing*
☐ *Cellular manufacturing*
☐ Sistem *heijunka*
☐ Manajemen inventori
☐ *Total quality management (TQM)*
☐ *Supply chain management (SCM)*
☐ *Total quality control*
☐ *Total productive maintenance*
☐ *Vendor management system*
☐ *Single minute exchange of dies (SMED)*
☐ *Six Sigma*
☐ Lain-lain (Silahkan nyatakan): ______________________

13. Jabatan Bapak/Ibu di perusahaan saat ini

☐ Direktur produksi
☐ Kepala departemen produksi
☐ Manajer produksi
☐ Lain-lain (silahkan nyatakan): ______________________

14. Sudah berapa lama Bapak/Ibu menjabat pada posisi yang sekarang?

☐ Kurang dari 1 tahun ☐ 1 – 3 tahun ☐ Lebih dari 3 tahun

15. Sudah berapa lama Bapak/Ibu bekerja pada perusahaan ini?

☐ Kurang dari 3 tahun ☐ 3 – 5 tahun ☐ Lebih dari 5 tahun

Mohon kiranya Bapak/Ibu sudi mengirimkan kembali kuesioner yang telah diisi lengkap di dalam amplop tertutup yang kami sediakan sebelum April 2013.

☐ Silahkan tandai disini jika Bapak/Ibu ingin memiliki salinan laporan penelitian ini.
Silahkan Bapak/Ibu sertakan kartu nama dan tuliskan alamat e-mail di bawah ini.
Alamat e-mail: ______________________

Komentar (opsional):
____
____
____
____
____
____
____
____

Terima kasih atas partisipasi Bapak/Ibu…

Appendix C: Letter for Quantitative Data Collection from OYA-GSB

UUM
Universiti Utara Malaysia

Othman Yeop Abdullah Graduate School of Business
Universiti Utara Malaysia
06010, Sintok Kedah Darul Aman,
Malaysia
Tel : (604) 9283901
Fax : (604) 9285220
Website: www.oyagsb.uum.edu.my

"KEDAH SEJAHTERA"

UUM/OYAGSB/K-14
06 March 2013

1. PRODUCTION DIRECTOR
2. PRODUCTION MANAGER
3. LEAN MANUFACTURING IMPLEMENTER
INDONESIAN MANUFACTURING COMPANIES

Dear Sir/Madam

DATA COLLECTION

PROGRAMME : DOCTOR OF PHILOSOPHY
SUPERVISORS : ASSOC. PROF. DR. LIM KONG TEONG/DR. SITI NOREZAM OTHMAN

This is to certify that the following is a postgraduate student from the OYA Graduate School of Business, Universiti Utara Malaysia. He is pursuing the above mentioned course which requires him to undertake an academic study at any organization. The details are as follows:

NO.	NAME	MATRIC NO.
1.	Gusman Nawanir	93557

In this regard, I hope that you could kindly provide assistance and cooperation for him to successfully complete his PhD Thesis entitled **"Lean Manufacturing Practices, Operations Performance, and Business Performance of Indonesian Manufacturing Companies"**. All the information gathered will be strictly used for academic purposes only.

Your cooperation and assistance is very much appreciated.

Thank you.

"SCHOLARSHIP, VIRTUE, SERVICE"

Yours faithfully

KARTINI BINTI DATO' TAJUL URUS
Assistant Registrar
on behalf of
Dean
Othman Yeop Abdullah Graduate School of Business

c.c - Student's File (93557)

The Eminent Management University

Appendix D: Application Letter for Quantitative Data Collection

UUM
Universiti Utara Malaysia

School of Technology Management and Logistics (STML)
UUM College of Business
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman, Malaysia
Tel: (604) 928 6857/6858
Fax: (604) 928 6860
www.uum.edu.my

March 6, 2013

1. Production Director
2. Head of Production Department
3. Production Manager
4. Lean Manufacturing Implementer
   Indonesian Manufacturing Companies
   c.q. ________________________________

Dear Sir/Madam,

REQUEST FOR PARTICIPATING AS RESPONDENT IN PhD RESEARCH

I am an Indonesian, who is now conducting research as a fulfillment to complete the program of PhD at the School of Technology Management and Logistics, Universiti Utara Malaysia.

This research aims to determine the impact of the manufacturing practices, which are consistent with the just-in-time/lean manufacturing philosophy, on organizational performance. The researchers believed that the outcome of this research will be of immense benefit to improve performance in the Indonesian manufacturing sector. Your effort in filling the questionnaire is highly appreciated.

The questionnaire consists of four sections. Please read the items carefully before answering. Where appropriate, please tick in the box, circle the number or complete the answer in the space provided. This questionnaire is published in dual language; you can select either English or Bahasa Indonesia.

Please return the completed questionnaire booklet in the stamped self-addressed envelope provided in the next 14 days if possible. If you would like to receive a summary of the research results, please enclose your business card in the returned envelope.

For your information, this research is conducted through a rigorous process, and it has been reviewed and approved by the review board of College of business, Universiti Utara Malaysia.

Thanks for your cooperation and participation.

Gusman Nawanir PhD Candidate	gsm1410@gmail.com s93557@student.uum.edu.my	+60146317166 +6049282490 +62752777103
Assoc. Prof. Dr. Lim Kong Teong Main Supervisor	ktlim@uum.edu.my	+6049287199
Assoc. Prof. Dr. Siti Norezam Othman Co-supervisor	norezam@uum.edu.my	+6049287141

The Eminent Management University

Appendix E: Overview of Toyota Indonesia

Toyota Indonesia was established on 12th April 1971. It means that Toyota Indonesia has worked for more than four decades to provide and present various types of vehicles. While Indonesia is the largest five Toyota market throughout the world, it has become a potential production field for Toyota, through production in Sunter (plant I and II), and Karawang (plant I and II). Toyota Indonesia is not only producing vehicles, but also the engines used in various types of commercial and passenger vehicles of Toyota. For supporting vehicle and engine productions, Toyota Indonesia is producing body parts, casting materials, dies and jigs. Besides production, it exports various types of Toyota vehicles' component. Hence, it produces a variety of products such as vehicles, components, jigs and dies, and service parts.

In brief, business process of Toyota Indonesia is presented in Figure F.1. Sunter plant is divided into five divisions, namely engine production division (EPD), component export vanning division (CEVD), casting division, dies and jigs design and fabrication division (DJDF), and stamping division. Karawang plants (plant I and II) are vehicle assembly plants. Karawang Plant I assembles Innova and Fortuner, and Karawang Plant II assembles Yaris, Vios, and Etios Valco. Figure F.1 also provides information regarding suppliers and customers of Toyota Indonesia. Suppliers and customers are not only domestic but also foreign countries.

This study focuses on implementation of lean manufacturing in the discrete part production. As the qualitative study is addressed to explain and confirm the quantitative findings, the discrete process plants (i.e., engine production, component export and vanning, stamping, and vehicle assembly plants) were selected. Profiles of the four plants are subsequently exhibited.

Figure F.1
Toyota Indonesia Production and Logistics

Stamping Plant

There are two stamping plants under the umbrella of Toyota Indonesia, one is located in Sunter II and another one is in Karawang (see Figure F.1). Stamping process is the first stage of making cars. Here, sheets of steel are molded into car body parts such as frames and doors, as well as sub-assembly body parts (such as cabins, decks, chassis frames, etc.). Main products of stamping plants are bodies for Toyota vehicles (i.e., Innova, Fortuner, Etios Valco, Avanza, Rush, and Dyna). The plants are also produced service parts for various types of Toyota vehicles.

As displayed in Figure F.4, production process is started in a metal cutting center, in which the basic material (in a coil form) is cut to become sheets of plate. The sheets are then stored in a material warehouse. Some of the material are sheared into smaller sheets in a plate shearing machine, because of its process requirement. Subsequently, the plates are flowed to stamping machine, and press/stamping process is then performed. The scrap of this process (i.e., small pieces plate left over after the greater part has been used) will either be re-used to produce other stamping products or recycled as material for casting products. After the stamping process, finished goods are subsequently stored before its delivery to customers (i.e., Karawang vehicle assembly plants, CEVD, Astra Daihatsu Motor (ADM), and Hino Motor Manufacturing Indonesia (HMMI)).

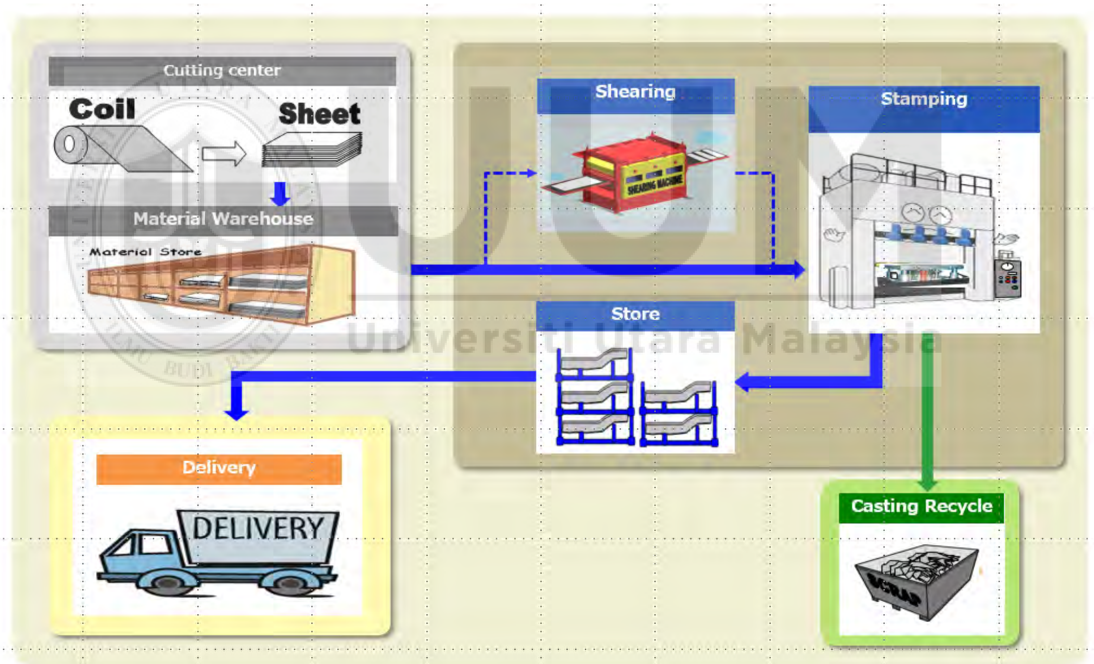

Figure F.4
Stamping Production Process

Production process in the stamping plant is characterized by batch production because of the needs of setup processes (i.e., dies change) in the early stage of every batch of product being manufactured.

Engine Production Plant

Toyota engine production was established on 1982 through Sunter Plant I. Various models of engine have been produced. In 1985, 5K engine model was produced and assembled. 7K engine model was successfully produced in 1995. In the same year, Toyota Indonesia started its first engine export to Japan. This success made Toyota Indonesia was assigned by its parent company (i.e., TMC) to produce TR engine model (used for Toyota Innova and Fortuner) in September 2004. Because of the high demand of domestic and global markets, the engine plant needs to increase its production capacity by constructing a new engine plant in Karawang. Its construction was begun on early 2014, and will start its operations in 2016.

Engines are produced through several production processes (see Figure F.2). The first process is casting, in which fusion of all basic engine material occurs. Five processes (i.e., core making, molding, melting, pouring, and finishing) are carried out in the casting plant. Quality of the basic materials are ensured through laboratory test to confirm metal structure, dimensions of engine block, and so on. Subsequently, the materials undergo machining processes to convert them to become main engine parts (i.e., cylinder block, cylinder head, cam shaft, and crank shaft). Lastly, the main and its supporting components are assembled to become an engine unit. Engines that have been completely assembled go through the process of quality assurance before being delivered to customers. Besides serving vehicle assembly plants, the engine plant also serves domestic and foreign markets.

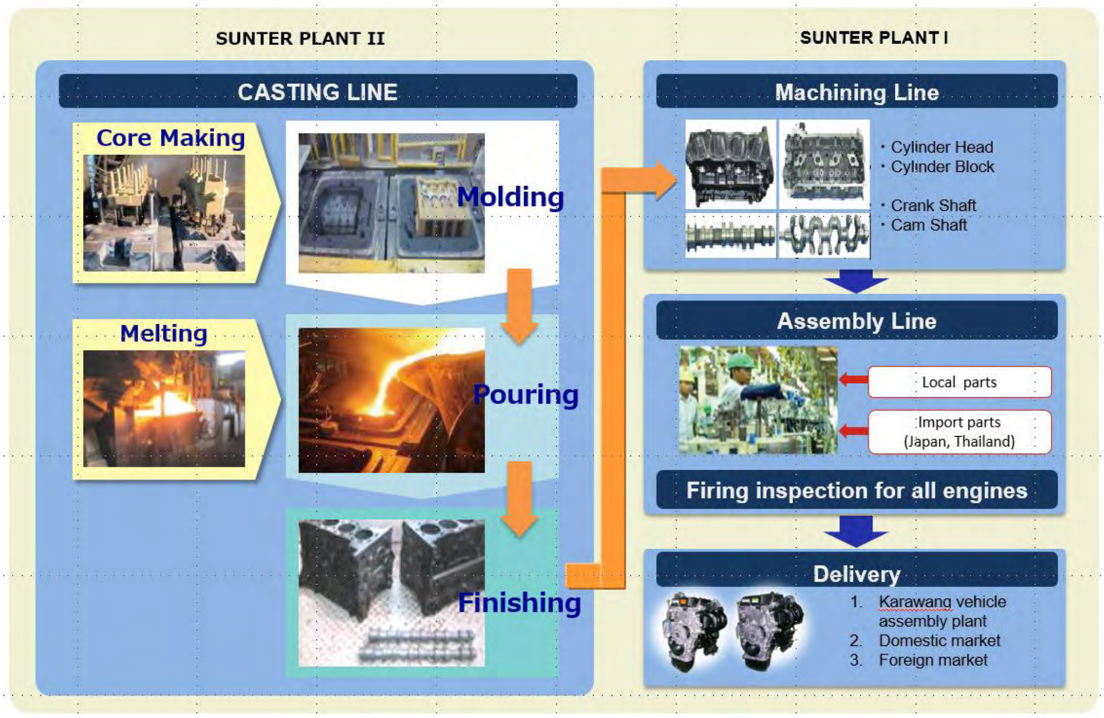

Figure F.2
Engine Production Process

Vehicle Assembly Plants

There are two vehicle assembly plants in Karawang, namely Karawang plant I and II. Karawang Plant I produces Innova and Fortuner, while the second plant produces Yaris, Vios, and Etios Valco. This classification is based upon the principle of group technology, whereby cars that have similar process requirements are produced at one plant at the same production line.

In general, manufacturing process of car is done through several stages as shown in Figure F.5. As explained above, the car-making process begins with stamping, or molding body part. Here, sheets of steel are molded into car body parts such as frames and doors, as well as sub-assembly body parts (such as cabins, decks, and chassis frames). The second stage is welding. Here, car body parts molded in the stamping plant are welded to become a complete car body. To ensure the high accuracy and precision, the welding shop is equipped with a main body jig, using the global body line that can process more than one model.

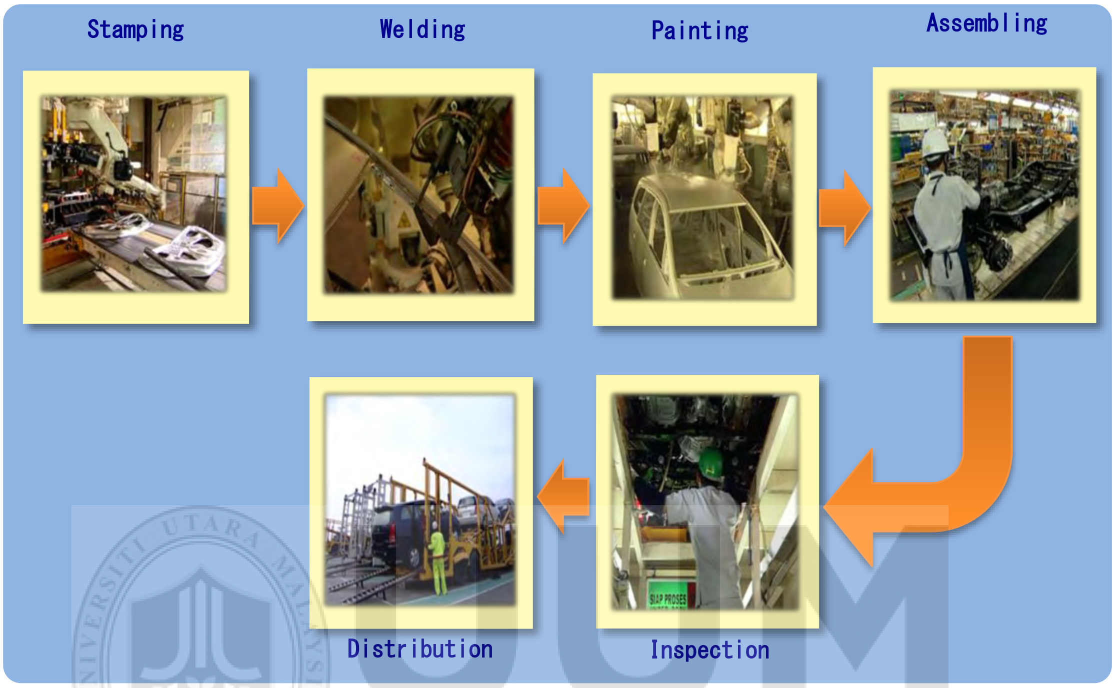

Figure F.5
Vehicle Assembly Process

After going through the welding process, the car body is transported to painting shop. The body will undergo electro deeping coating process to ensure the quality of anti-rust and gap filling process (chiller), so as not to leak when it rains or floods. After that, the car body will go through the process of primer coating and a top coat that uses a robotic system to ensure high-quality of paint, smooth and shiny.

From the painting shop, the car body is conveyed to assembling shop. Body is assembled with other parts such as engine, seats, wheels, lights, and others. JIT concept is strictly applied here. Parts to be assembled that come from suppliers must remain available in the required quantity and time. This is done by using kanban. Kanban gives instruction to produce and deliver the goods, as well as a visual control tool to check availability of the goods. The final gate of making car process is quality inspection. All cars undergo a final quality inspection process to achieve customer satisfaction. Drum test (speed test), break test, up to water leak test, must be passed by all the vehicles before being delivered to customers through Toyota dealers.

After the production process is finished, the next process is distribution to customers. Toyota upholds the principle of a fresh vehicle from factory through vehicle delivery quality improvement. Toyota vehicles are sent to two major markets, namely domestic and foreign markets. Currently, besides serving domestic market, Toyota Innova and Fortuner are exported to Asia Pacific and Middle East. Whereas Toyota Avanza, which is jointly produced with Astra Daihatsu Motor (ADM), is exported to Asia Pacific, Latin America, Africa, and Middle East. Vios, Yaris, and Etios Valco are currently serving domestic market.

Component Export and Vanning

Besides exporting cars in the form of complete knock down (CKD), Toyota Indonesia also exports various components of Toyota vehicles. Export of components is performed by a division, namely component export and vanning division (CEVD). Basic activities of CEVD are depicted in Figure F.3. Process is started with receiving parts from suppliers, followed by boxing, stacking, vanning, and shipment. Boxing is the process to arrange parts into boxes. Subsequently, stacking process is then performed by arranging the boxes into a pallet (which is commonly called as a module or case). After stacking process is completed, the modules are loaded into a container. This process is called as vanning. Finally, once the vanning process is completed, the container is then delivered to customers.

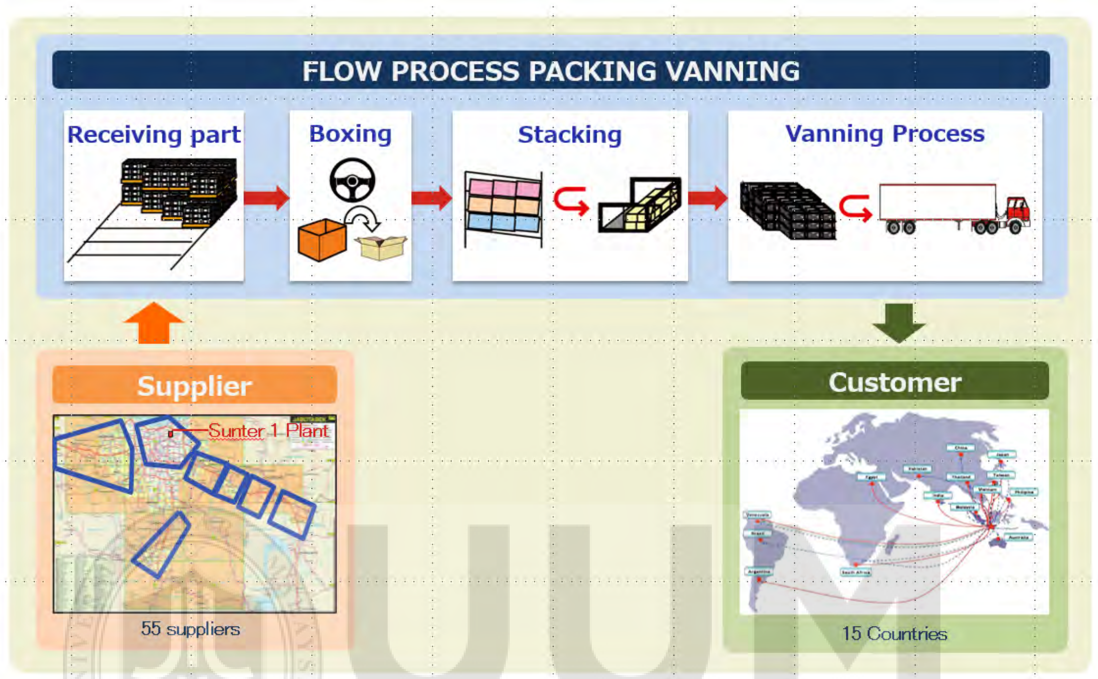

Figure F.3
Flow Process of Packing and Vanning

There are 1,700 over vehicle components that are currently exported to 15 countries around the world across four continents. They are Argentina, Brazil, Venezuela, South Africa, Egypt, Pakistan, India, China, Thailand, Malaysia, Japan, Taiwan, Vietnam, Philiphine, and Australia. The components are welding parts (i.e., body side panel, engine hood, etc.), engine assembly, and assembly parts (e.g., air filter, radiator, horn, speedometer, etc.). In the year 2013, CEVD exported more than 100,000 containers, with the highest export volume to Philiphine (i.e., 22%).

Appendix F: Letter for Qualitative Data Collection from OYA-GSB

OTHMAN YEOP ABDULLAH
GRADUATE SCHOOL OF BUSINESS
Universiti Utara Malaysia
06010 UUM SINTOK
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KEDAH AMAN MAKMUR • BERSAMA MEMACU TRANSFORMASI

UUM/OYAGSB/K-14
20 May 2014

MANAGER OF HUMAN RESOURCE MANAGEMENT
PT. TOYOTA MOTOR MANUFACTURING INDONESIA

Dear Sir/Madam

REQUEST FOR DATA COLLECTION

PROGRAMME : DOCTOR OF PHILOSOPHY
SUPERVISORS : ASSOC. PROF. DR. LIM KONG TEONG
ASSOC. PROF. DR. SITI NOREZAM OTHMAN

This is to certify that the following is a postgraduate student from OYA Graduate School of Business, Universiti Utara Malaysia. He is pursuing the above mentioned programme which requires him to undertake an academic study at an organization. The details are as follows:

NO	NAME	MATRIC NO.
1.	Gusman Nawanir	93557

In this regard, I hope that you could kindly provide assistance and cooperation for him to successfully complete his PhD Thesis entitled "Lean Manufacturing and Its Potential Benefits to Production Industry: A Case Study". All the information gathered will be strictly used for academic purposes only.

Your cooperation and assistance are very much appreciated.

Thanks you.

"SCHOLARSHIP, VIRTUE, SERVICE"

Yours faithfully

ROZITA BINTI RAMLI
Assistant Registrar
for Dean
Othman Yeop Abdullah Graduate School of Business

c.c - File

Universiti Pengurusan Terkemuka
The Eminent Management University

Appendix G: Application Letter for Qualitative Data Collection

UUM
Universiti Utara Malaysia

School of Technology Management and Logistics (STML)
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Fax: (604) 928 6860
www.uum.edu.my

20 May 2014

MANAGER OF HUMAN RESOURCE MANAGEMENT
PT. TOYOTA MOTOR MANUFACTURING INDONESIA

Dear Sir/Madam,

REQUEST FOR PARTICIPATION IN DOCTORAL RESEARCH

I am an Indonesian, who is now conducting a research as a fulfillment to complete the PhD program at the School of Technology Management and Logistics, Universiti Utara Malaysia. The research aims to explore how lean manufacturing, which is consistent with the just-in-time and Toyota Production System philosophy, improves organizational performance. The research will hopefully contribute to the deep understanding regarding the lean manufacturing and its potential benefits to production industry, and so the value of the study is the improvement of lean manufacturing implementation in a manufacturing company.

The Toyota Motor Manufacturing Indonesia is invited to participate and considered very suitable for the research, because the company has been implementing lean manufacturing philosophy in the production system since long time ago, and already been gaining valuable benefits on the improvement of organizational performance after its implementation.

The research is a qualitative study by employing case study method with interview and observation as main data collection techniques. During the interview, the informant will be asked questions about his/her opinions relative to his/her experience in implementing lean manufacturing within your company. The duration of the interview will be approximately 60 minutes. The interview will be undertaken at a time and location that is mutually suitable. In addition, the informant's name will not be used at all on all transcriptions and data collected. The informant will be referred to only by way of the pseudonym.

Under no circumstance whatsoever will the company and the informants be identified by name in this study, or in any publication thereof. Every effort will be made that all information provided will be treated as strictly confidential. All data will be coded and securely stored, and will be used for professional purposes only.

For your information, this research is conducted through a rigorous process, and it has been reviewed and approved by the review board of College of business, Universiti Utara Malaysia.

Thanks for your cooperation and participation.

Gusman Nawanir, M.Sc PhD Candidate	gsm1410@gmail.com s93557@student.uum.edu.my	+60164161410 +6049287056
Assoc. Prof. Dr. Lim Kong Teong Main Supervisor	ktlim@uum.edu.my	+6049286952
Assoc. Prof. Dr. Siti Norezam Othman Co-supervisor	norezam@uum.edu.my	+6049286954

The Eminent Management University

Appendix H: Approval Letter for Qualitative Data Collection

TOYOTA

PT. TOYOTA MOTOR MANUFACTURING INDONESIA
Head Office, Jl. Laks. Yos Sudarso, Sunter II
Jakarta 14330 - Indonesia
Phone : 62-021-651.5551 (Hunting)
Facsimile : 62-021-651.5327

No : 0255 /P&A/TIIND/ VI / 2014

To :
Mrs. Rozita Binti Ramli,
Assistant Registrar
for Dean
Othman Yeop Abdullah Graduate School Of Business,
Universiti Utara Malaysia, 06010 UUM SINTOK,
Kedah Darul Aman,
Malaysia

Field Coordinator	: Mr. Dimas M.	- P A D Sunter I
Mentor	: Mr. Yulza A.	- C E V
Cc	: Mr. Djatmiko E.S.	- P A D Sunter I

Dear Madam,

Re : Internship

Replies to your letter No : UUM/OYAGSB/K - 14, regarding your application for your student experience (internship) in Toyota Motor Manufacturing Indonesia, herewith we inform that your student can partake the internship :

Name	: Mr. Gusman Nawanir Matric No : 93557
Date of Internship	: August 4 - August 29, 2014
Time of Internship	: 7.00 AM - 3.00 PM
Place	: Component Export Vanning, Sunter I, Jl. Laks. Yos Sudarso, Sunter II, Jakarta Utara

Therefore, we expect his total participation in this schedule.
If you need further information, please don't hesitate to contact Mr. M.A. Siddiq, Phone +6221 6511210 (ext. 4265).

Sincerely Yours
Jakarta, June 16, 2014

Appendix I: Interview Consent Form

INTERVIEW CONSENT

Part 1: Research Description

Principal Researcher	:	Gusman Nawanir
Main Supervisor	:	Assoc. Prof. Dr. Lim Kong Teong
Co-supervisor	:	Assoc. Prof. Dr. Siti Norezam Othman
Research Title	:	Lean Manufacturing and Organizational Performance

Dear Informant,
You are invited to participate in a research that explores how lean manufacturing contributes to company's performance. The research will hopefully contribute to the deep understanding regarding the lean manufacturing and its potential benefits to organizational performance. The research is conducted by the principal researcher, Gusman Nawanir, a PhD candidate at the Universiti Utara Malaysia.

Your participation in this study requires an interview during which you will be asked questions about your opinions relative to your experience in implementing lean manufacturing within the company. The interview will be undertaken at a time and location that is mutually suitable. With your permission, the interview will be audio taped and transcribed, the purpose thereof being to capture and maintain an accurate record of the discussion.

Under no circumstance whatsoever will you be identified by name in this research, or in any publication thereof. Every effort will be made that all information provided by you will be treated as strictly confidential. All data will be coded and securely stored, and will be used for professional purposes only.

The research is to be submitted in fulfillment of the requirement for the degree of Doctor of Philosophy at the Othman Yeop Abdullah-Graduate School of Business, Universiti Utara Malaysia. The results of the study will be published as a thesis. In addition, information may be used for academic purposes in professional presentations and/or academic publications.

Part 2: Informant's Rights

1. I have read and discussed the research description with the researcher. I have had the opportunity to ask questions about the purposes and procedures regarding the study.
2. My participation in this research is voluntary. I may refuse to participate or withdraw from participation at any time without any effect to my job.
3. The researcher may withdraw me from the research at his professional decision.
4. Any information derived from the research that personally identifies me will not be voluntarily released or disclosed without my separated consent.
5. If at any time, I have any questions regarding the research or my participation, I can contact the researcher, *Gusman Nawanir*, who will answer my questions. The researcher's phone number is +60-164161410. I may also contact the researcher's main supervisor, Assoc. Prof. Dr. Lim Kong Teong at +60-49286952, or the researcher's co-supervisor, Assoc. Prof. Dr. Siti Norezam Othman at +60-49286954.

6. If at any time, I have comments or concerns regarding the research, or questions about my rights as a research subject, I should contact the Dean of Othman Yeop Abdullah Graduate School of Business Universiti Utara Malaysia at +60-49287130 or oyagsb@uum.edu.my.
7. Audio taping is part of this study. Only either the principal researcher or the members of the research team will have access to the written and taped materials. Please check one:
   (….) Only principal researcher can access the written and taped materials.
   (….) Principal researcher and the members of research team can access the written and taped materials.
8. I am willing to be interviewed by the researcher based on the following details:
   Day : ___________________________
   Date : ______/08/2014
   Time : ___________________________
   Place : ____

Informant's signature: _____________________________ Date: ____/ 08 /2014

Informant's name: ______________________________

Part 3: Researcher's Verification of Explanation

I, Gusman Nawanir, certify that I have carefully explained the purpose and nature of this research to ________________________________. He/she has had the opportunity to discuss it with me in detail. I have answered all his/her questions, and he/she provided the affirmative agreement to participate in this research.

Researcher's signature: ______________________________ Date: ____ / 08 /2014

Appendix J: Certification of Data Collection Completion

TOYOTA

PT. TOYOTA MOTOR MANUFACTURING INDONESIA
Jl. Laks. Yos Sudarso, Sunter II
Jakarta 14330 - Indonesia
Phone : 62-21-6515551 (Hunting)
Facsimile : 62-21-6515327

LETTER OF DECLARATION

No. 22 / TMMIN - PAD / Sunter I / VIII / 2014

Herewith we would like to declare that the below mentioned name:

Name	:	Gusman Nawanir
No. Matric	:	93557
University	:	Othman Yeop Abdullah Graduate School of Business, University – Utara Malaysia

Has finished his observation in **PT Toyota Motor Manufacturing Indonesia** For University Dissertation need on:

Period	:	August 04, 2014 ~ August 29, 2014
Division	:	Componen Export Vanning Division
Thema	:	Observation & Interview Related to Lean Production (TPS), Operations Performance & Business Performance
Result	:	Good

This letter of declaration has been made for the purpose of his study and related.

August 29, 2014
PPA Department

PT. TOYOTA MOTOR MANUFACTURING INDONESIA
JAKARTA INDONESIA

D.E. Sukaton
Dept. Head

Appendix K: Interview Protocol

Appendix K.1: Interview Protocol with Key Persons of Lean Manufacturing Implementation

INTERVIEW PROTOCOL

Research Title	Lean Manufacturing and Organizational Performance
Researcher	Gusman Nawanir
Research Questions	1. How is lean manufacturing implemented? 2. How does lean manufacturing improve operations performance? 3. How does lean manufacturing improve business performance?
Informant	Key persons of lean manufacturing implementation

General question	
1	As we know, the company is currently implementing the lean concept, what are the general terms used to represent it?
2	When did the lean initiative start off in the company?
3	What were the main objectives of its implementation?
4	How was this initiative started?
5	What and how was the process in adopting the lean concept undertaken by the company? Please describe the phases involved!
6	Who did actually start this initiative?
7	Please describe the situation in the company during the initial stage of lean introduction! And what about the current situation?
8	Does the mother's company implement lean in the same way with this company?
9	Who are the key persons involved in lean implementation in the company?
Lean Manufacturing Implementation	
1	Are all the units/departments implementing the lean manufacturing concept?
2	What are the lean practices that have been implementing in the company?
3	Why does the company focus on those practices?
4	What is the importance of each practice?
5	How does the company implement each of the practices? Please provide some examples! Any documentations that support your argument?
6	What are the guidelines used to implement the lean manufacturing?
Inter-relationship among lean manufacturing practices	
1	What are the relationships among the lean practices? Are they mutually supportive? Please provide some examples!
2	If the practices are mutually supportive, how should the practices be implemented? Must they be implemented simultaneously?
3	Does the company have the same emphasis to all the lean practices? Why?
4	Is it important that a practice be supported by other practices? Why? Please provide some examples!
The effect of lean manufacturing on company's performance	
1	How important is the lean implementation for the company's performance?
2	What are the potential benefits of lean implementation to company's performance?
3	How does lean improve operations performance (in terms of quality, manufacturing flexibility, inventory minimization, lead time reduction, productivity, and production cost reduction)?
4	How does lean improve business performance (in terms of profitability, sales, and customer satisfaction)?
5	To your opinion, if the practices are implemented in isolation (mutually exclusive among them), what are their effects on performance?

Appendix K.2: Interview Protocol with Manufacturing Manager/Lean Implementers/Lean Engineers

INTERVIEW PROTOCOL

Research Title	Lean Manufacturing and Organizational Performance
Research Questions	1. How is lean manufacturing implemented? 2. How does lean manufacturing improve operations performance? 3. How does lean manufacturing improve business performance?
Informant	Manufacturing Manager/Lean Implementers/Lean Engineers

General question	
1	What were the main objectives of lean implementation for production?
2	How was the lean initiative started?
3	Please describe the situation in the company during the initial stage of lean introduction! And what about the current situation?
4	Does the mother's company implement lean in the same way with this company?
5	Who are the key persons of lean implementation in the production?
Lean Manufacturing Implementation	
1	Are all the units/departments implementing the lean concept?
2	What are the lean practices that have been implementing in the company?
3	Why does the company focus on those practices?
4	What is the importance of each practice?
5	How does the company implement each of the practices? Please provide some examples! Any documentations that support your argument?
6	What are the guidelines used to implement the lean?
Inter-relationship among lean manufacturing practices	
1	What are the relationship among the lean practices? Are they mutually supportive? Please provide some examples!
2	If the practices are mutually supportive, how should the practices be implemented? Must they be implemented simultaneously?
3	Does the company have the same emphasis to all the lean practices? Why?
4	Is it important that a practice be supported by other practices? Why? Please provide some examples!
The effect of lean manufacturing on company's performance	
1	How important is the lean implementation for the company's performance?
2	What are the potential benefits of lean implementation to company's performance?
3	How does lean improve operations performance (in terms of quality, manufacturing flexibility, inventory minimization, lead time reduction, productivity, and production cost reduction)?
4	How does lean improve business performance (in terms of profitability, sales, and customer satisfaction)?
5	To your opinion, are there any direct effects of lean on business performance (in terms of profitability, sales, and customer satisfaction)?
6	To your opinion, if the practices are implemented in isolation (mutually exclusive among them), what are their effects on performance?
Additional Questions	
1	a. Based on your experiences, what are the important ingredient/factors in ensuring successful implementation of lean?
	b. How do those factors contribute to the successful implementation of lean?
2	a. What are barriers in implementing the lean initiative?

	b.	How does the company deal with the barriers/problems?
3	a.	In its implementation, what changes are required to realize the lean concept in the company?
	b.	How to deal with resistances to changes? What strategies that should be performed?
	c.	To deal with the resistances, what are the resources and programs needed?
4		What are the strategies to ensure that lean practices are properly applied?

Appendix K.3: Interview Protocol with Production Workers/Production Supervisors/Lean Implementers

INTERVIEW PROTOCOL	
Research Title	Lean Manufacturing and Organizational Performance
Research Questions	1. How is lean manufacturing implemented? 2. How does lean manufacturing improve operations performance?
Informant	Production workers/Production supervisors/Lean Implementers

Lean Manufacturing Implementation	
1	What are the lean practices that have been implementing in the production area?
2	Why does the production area focus on those practices?
3	What are the importance of each practice?
4	How does the production area implement each of the practice? Please provide examples! Any documentations that support your argument?
5	What are the guidelines used in the production area to implement lean initiative?
Inter-relationship among lean manufacturing practices	
1	What are the relationship among the lean practices? Are they mutually supportive? Please provide some examples!
2	If the practices are mutually supportive, how should the practices be implemented? Must they be implemented simultaneously?
3	Does the company have the same emphasis to all the lean practices? Why?
4	Is it important that a practice be supported by other practices? Why? Please provide some examples!
The effect of lean manufacturing on operations performance	
1	How does lean improve operations performance (in terms of quality, manufacturing flexibility, inventory minimization, lead time reduction, productivity, and production cost reduction)?
2	To your opinion, if the practices are implemented in isolation (mutually exclusive among them), what are their effects on performance?
Additional Questions	
1	What are barriers in implementing the lean in the production area?
2	How does the company deal with the barriers/problems?

Appendix L: Certification of Key Informant Review

KEY INFORMANT REVIEW

I have already reviewed the case study report provided by **Gusman Nawanir**, a PhD student from Universiti Utara Malaysia. The case study on lean manufacturing, operations performance, and business performance has successfully been conducted in Toyota Motor Manufacturing Indonesia from 4th to 29th August 2014.

Herewith, I would like to declare that the information provided in the report is valid and accurate.

The researcher is allowed to disclose all the information provided in the thesis in the following publication or forums:

- ☑ Journal Article
- ☑ Conference
- ☑ Seminar

Jakarta, 29 May 2015

Signature : [signature]

Name : YULTA ALFADLI

Position : DIVISION HEAD

Company's stamp : PT. TOYOTA MOTOR MANUFACTURING INDONESIA JAKARTA - INDONESIA

Appendix M: General Guideline for Lean Manufacturing Implementation

Document # **[ID]**	**General Guideline for Lean Manufacturing Implementation**	Date Printed:
Revision # **1.0**	Prepared By: **Gusman Nawanir**	Date Prepared:
Effective Date:	Reviewed By:	Date Reviewed:
Standard:	Approved By:	Date Approved:

Definition and Objective

Lean manufacturing is an approach synergistically addressing to improve operations performance and business performance through waste elimination. This guideline endeavors to provide a general guide on how lean manufacturing practices are implemented in the context of discrete manufacturing process industry.

The concept of holistic approach

Lean manufacturing practices should be implemented holistically in order to achieve maximum advantages of the implementation. Its potential benefits may not be fully realized until all the practices are implemented integrally and holistically.

This makes sense as the relationship among the practices tends to be mutually supportive and complement each other. Contribution of one practice to performance depends on its complementary practices. Adoption of one practice may positively influence the marginal return of another practice and vice-versa.

Schematically, the mutual supportive nature of the relationships is depicted in Appendix 1 of this guideline. The supporting/supported practices for each practice are highlighted in the "related practices" listed in the beginning of the respective guideline.

Scope

Discrete manufacturing process (job shop, batch, repetitive, and mass customization).

Contextual Factors

Even though all the lean manufacturing practices should be adopted holistically, the implementation is contingent upon contextual factors. At least, there are three factors that may influence the implementation of each practice of lean manufacturing, namely type of production process, technology used in the shop floor, and type of product. Hence, implementation of the practices should consider these contextual factors in order to ensure the proper implementation.

Abbreviations

FR: Flexible resources	SLP: Small lot production	QC: Quality control
CL: Cellular layouts	QS: Quick setup	TPM: Total productive maintenance
PS: Pull system	UPL: Uniform production level	SN: Supplier networks

Practice 1 Flexible resources	
Definitions	*Flexible resource* is a practice of lean manufacturing focusing on achieving manufacturing flexibility of the production system.
Purpose	To achieve manufacturing flexibility through the use of multi-functional machines and equipment, and multi-skilled employees.
Related practices	It is supported by CL, TPM, and QC. It supports CL, SLP, PS, UPL, QS, TPM, and QC.

1.1	**Multi-skilled employees** [3, 4]
1.1.1	Capability/skill mapping • Capability or skill mapping is used to assess how mastery an operator in performing their jobs within a production line. • It is developed based on the number of jobs in one production line. • For each job, all operators are leveled from 1 to 4, based on the pre-determined criteria. • Level 1 reflects the worker who has been trained of doing a particular job. Level 2 indicates the worker who has been able to work under supervision and familiar with the job. Level 3 indicates the worker who has been able to work independently, no defect produced by him/her during the last six months. Level 4 reflects a worker who has been skillful to work alone without any supervision and can teach the jobs to others.
1.1.2	Job rotation • Job rotation and promotion are done based on the capability/skill map. • If a worker has mastered a job, he/she would be transferred to another workstation with different jobs. • A production worker is promoted, if he/she has been multi-skilled.
1.1.3	Cross-training • Manufacturing workers must undergo a number of intensive training to be able to perform multiple jobs. • The company should have a department, which is responsible to plan and organize various trainings.
1.2	**Multi-functional machines and equipment** [3, 4]
1.2.1	Production line should be able to perform multiple processes and to produce the variety of products.
1.2.2	Machines, equipment, and tools could be used to perform several different jobs and operations.
1.2.3	When one machine is broken down, different type of machine should be used to perform the same jobs.

Practice 2 Cellular Layouts	
Definitions	*Cellular layout* is a practice of lean manufacturing that combines flexibility of process layout with efficiency of product layout based on the concept of group technology. *Flexible man-power line* is attaining flexibility in the number of workers at a shop floor to adapt to demand changes. It is to alter (decrease or increase) the number of workers at a shop floor when the production demand has changed.

	Takt time is the interval at which a product is moved ahead to next workstation, which is calculated by dividing available production time per day with production volume per day.
Purpose	To achieve manufacturing flexibility through flexibility of production layouts.
Related practices	It is supported by FR It supports FR, PS, SLP, and UPL.
2.1	**Flexible man-power line** [4]
2.1.1	Flexible man-power line principle should be adopted. So that, number of operators can be altered (increased or decreased) when production demand has changed (increased or decreased).
2.1.2	Number of workers should be adaptable to demand changes.
2.1.3	Number of workers is determined based on takt time.
2.1.4	Standard operating procedure, work instructions, standardized works, and other documents must be prepared.
2.1.5	Production workers must be able to perform multiple jobs and operations.
2.1.6	Deploy multi-process handling by multi-skilled workers.
2.1.7	On the production lines, workers should handle a number of different machines, equipment, and tools.
2.1.8	Machines, equipment, and tools should be flexible and are able to perform a number of different jobs and operations.
2.1.9	Machines, equipment, and tools should be easily moved from one location to another.
2.2	**Facility layouts** [2, 3, 4]
2.2.1	Workstations, machines, equipment, and tools are arranged into a sequence (in relation to each other) in order to support smooth flow of materials with minimum transportation, movement and delay.
2.2.2	Dissimilar activities (together with machines, equipment, and tools) should be grouped into workstation that processes families of product with similar requirements such as sizes, shapes, routing, processing, or demand.
2.2.3	Factory layout should be determined based on product families.
2.2.4	To eliminate material movements, the distance between workstations should be set closer.
2.2.5	Facility layouts should be easily rearranged to adapt to changes in volume, design, or product development.
2.2.6	Production lines are usually laid out in a U-shape to improve workers' efficiency.

Practice 3 Pull/Kanban System	
Definitions	*Pull system* is a production system that performs production based on customer demand. *Kanban system* is an information system that harmoniously controls the production of the necessary products in the necessary quantities at the necessary time in every process of a factory and also among companies. It is used to authorize production and material movement.
Purpose	To ensure that production and material movement are performed based upon customer demand.
Related practices	It is supported by FR, CL, SLP, QS, UPL, TPM, and SN. It supports SLP, UPL, and SN.

3.1	**Pull system** [1, 2, 3, 4]
3.1.1	Production and material movement should be performed just as needed, in the right quality, the right quantity and the right time based on customer request.
3.1.2	Produce only when requested by its users, move to where it is needed just as it is needed.
3.1.3	Production in a final workstation is pulled by customer demand, and production in a particular workstation is triggered by request (demand) from subsequent workstation.
3.1.4	Suppliers should deliver parts and materials directly to its point of use.
3.1.5	Warehouse is not mandatory because inventory is less required.
3.2	**Kanban system** [1, 2, 3, 4]
3.2.1	*Kanban* system should be applied to maintain the pull system runs smoothly.
3.2.2	A *kanban* authorizes for production and material movement.
3.2.3	Instruction and authorization are given through a kanban signal, such as cards, verbal signals, light flashing, electronic messages, empty containers, etc.
3.2.4	*Kanban* is also used as visual control tools, to prevent overproduction, to monitor progress, and to identify delays and processes that are too fast.
3.2.5	A *kanban* specifies material order points, how much it is required, from where it is ordered, and to where it should be delivered.
2.2.6	A *kanban* card contains a number of information, such as *kanban* number, part number, brief description of the product, type of container, quantity per *kanban*, supplier, and preceding and subsequent workstation.
3.2.7	In general, there are two types of *kanban*. [4] • Withdrawal *kanban* specifies the kind and quantity of product, which the subsequent process should withdraw from the preceding process. To withdraw parts and materials from suppliers, supplier *kanban* is used. • Production-ordering *kanban* specifies the kind and quantity of product which the preceding process must produce.
3.2.8	Electronic *kanban* (*e-kanban*) should be used to order parts from suppliers, without passing any *kanban* cards to the handlers responsible for moving parts and materials, but uses information technology to send order information to suppliers electronically. [4] • Order information stated in e-*kanban* is sent to the supplier. • Subsequently, the e-*kanban* is printed by supplier. • Afterwards, the suppliers will process the order. • Finally, supplier delivers the parts and materials based on the information provided in the *e-kanban*.
3.2.9	There are several types of *kanban*, such as express *kanban*, emergency *kanban*, job-order *kanban*, through *kanban*, common *kanban*. etc. [4]

Practice 4 **Small Lots Production**	
Definitions	*Small lot production* is a type of a production process that produces small quantity of product at a time, with ideal lot size is one. *Lot size* is a quantity of items that are produced together.
Purpose	To produce more frequent in small quantity of items together in a batch.
Related practices	It is supported by FR, QS, PS, QS, UPL, QC, and SN. It supports PS, UPL, and QC.
4.1	**Small lots production** [1, 2, 3, 4]
4.1.1	Lot size should be set as small as possible. A lean manufacturer should aggressively work on reducing production lot sizes.

4.1.2	Production should be performed more frequent in small lot size. The ideal lot size of one is preferable.
4.1.3	Flow of one type of item in large quantity together should be strictly avoided.
4.1.4	Small lots production can be achieved by shortening setup time, and multi-skilled operators who work in a multi-process handling line.
4.1.5	Supply parts and materials to a production line must be done in small quantity with frequent deliveries.

Practice 5 Quick Setups	
Definitions	*Quick setup* is a practice of lean manufacturing that focuses on reducing setup time in a production system. *External setup* is setup process that can be performed while production for previous products is still running. *Internal setup* is setup process that must be performed while the machine is stopped from the operations.
Purpose	To reduce machine's setup time.
Related practices	It is supported by FR, and TPM. It supports PS, SLP, and UPL.

5.1	**Setup time reduction** [2, 3, 4]
5.1.1	Shortening setup time is essential to support small lots production. Setup time must be shortened when lot size is reduced.
5.1.2	If there is a change in process requirements, machines' setup should be performed quickly.
5.1.3	Setup time must be shortened consistently in the entire production line.
5.1.4	All the equipment and tools must be put in normal storage location. So that, operators don't have any trouble in finding equipment and tools they need.
5.1.5	Operators must be trained on machines' setup activities to ensure that the setup processes are performed appropriately, and the operators are able to conduct their own machines' setups.
5.2	**Converting internal setup to external setup** [2, 3, 4]
5.2.1	There are two types of setup, namely internal and external setups. Both must be separated.
5.2.2	Most of the internal setups should be converted to external setup. So that, most of the setup processes are done while the machine is running and internal setup can be performed quickly.
5.2.3	To improve the current setup process, all the activities are evaluated. Standardized work document for each setup process is also evaluated.
5.2.4	To ensure the effectiveness of the setup process, all the non-value added activities, unevenness, and overburden are eliminated.
5.2.5	Based on the evaluation, the setup activities are converted, improved, simplified, or removed. Finally, all the setup activities are standardized.

Practice 6 Uniform Production Level	
Definitions	*Uniform production level* is a practice of lean manufacturing aiming to reduce variability at the production level caused by variability in customer demand.

	Production smoothing is a technique used to reduce variability at the production level caused by fluctuations in customer demand. It is a critical factor to create a lean manufacturing system because it is a key of achieving production stability. *Takt time* is an interval at which a product is moved ahead to next workstation, which is calculated by dividing available production time per day with customer demand or production volume per day.
Purpose	To reduce variability at the production level caused by variability in customer demand.
Related practices	It is supported by FR, PS, QS, UPL, TPM, QC, and SN. It supports FR, CL, PS, SLP, QC, and SN.

6.1	**Production smoothing** [3, 4]
6.1.1	Demand rate for all products is used as main input for production planning.
6.1.2	Fluctuation in demand rate that possibly causes waste must be avoided.
6.1.3	An accurate forecast should be emphasized to reduce production variability.
6.1.4	Production system should be managed by leveling and smoothing production by volume and product type/model to guard against variability of demand.
6.1.5	To reduce variability in production, all the product variances (such as styles, color, and other options) must be taken into account.
6.1.6	Composition of product being produced should be arranged based on the composition of demand.
6.1.7	Daily production of different product models should be arranged in the same ratio with monthly demand.
6.1.8	To adapt the increased demand, capacity of the production line must be increased. The following options can be done: • Temporary workers are hired, and each worker handles fewer machines. • Introducing early attendance and overtime, which can fill up unscheduled hours between the shifts.
6.1.9	In case of the decreased demand, number of machines handled by each worker will increase, because temporary workers should be dismissed. The unutilized workers can be transferred to other production lines, which have demand increased. They can also be allocated to conduct maintenance activities, quality control circle, training, etc.

6.2	**Mixed model production** [2, 3, 4]
6.2.1	Production should be consistently done for each type of product in accordance with the demand ratio per production period.
6.2.2	More than one product model should be produced from day to day. At least, some quantity of each product is produced every day.
6.2.3	The same amount of each item is produced each day, and items produced are mixed throughout the day in small quantities.
6.2.4	Each product is produced in a relatively fixed quantity per production period.
6.2.5	Production is done by repeating the same combination of products from day to day.
6.2.6	The ratio of daily production volume should be equal to the ratio of monthly production.
6.2.7	Some quantity of items should be maintained to respond to demand variances.
6.2.8	Three stages of mixed-model production: [4] • Produce in sequence, lumping the total quantity of each model needed each month together. • Produce in sequence, lumping the average quantity of each model needed each day together.

	• Produce each model one unit at a time, matching the pace to the takt time of each model.
6.3	**Uniform workload** [2, 3, 4]
6.3.1	Production process should be ensured running stably with the uniform workload from time to time.
6.3.2	Workloads should be maintained at the same level every day. Variability of everyday workload must be avoided.
6.3.3	For works that are performed on a conveyor, uniformity of workload is done by considering takt time.
6.3.4	All the workstations in the main production line should have the same takt time to ensure production smoothing.
6.3.5	To equate takt time, it is necessary to improve the production line by way of leveling workload in all workstations.
6.3.6	In the workstations with longer takt time, some of its activities should be relocated to other workstations.

Practice 7 Quality Control	
Definitions	*Quality control* is a procedure or set of procedures intended to ensure that a manufactured product adheres to a defined set of quality criteria or meets the requirements of the customer. *Autonomous defect control system* is an automated mechanism that in cases of abnormality happens, the machines will automatically stop. [2, 3, 4] *Line-stop alarm light* is an indicator board that shows that an abnormality occurs at a particular location. [2, 3, 4] *Mistake proofing* is a mechanism that helps an operator to avoid mistakes. Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. [2, 3, 4] *Go/NoGo* is a testing mechanism using two boundary conditions; pass and fail. The test is passed when the *Go* condition is met, and the *NoGo* condition fails.
Purpose	To ensure that the product is high in quality, no defect, no reject, and conforms to the required specification.
Related practices	It is supported by FR, SLP, UPL, and SN. It supports SLP and UPL.
7.1	**Autonomous defect control system** [1, 2, 3, 4]
7.1.1	Production workers should be authorized to stop production if serious abnormalities are occurred.
7.1.2	If the job is done by machine; once an abnormality occurs, the machine would automatically stop without any trigger from operators.
7.1.3	For most of the manual jobs, when an abnormality occurs, operators have authority to stop production line based on their own judgment by applying a switch button available at each workstation.
7.1.4	In cases of abnormality, operators should perform S-C-W (stop-call-wait). The S-C-W refers to an operators' responsibility to "stop" a process when abnormality occurs, "call" for requesting supports from the group leader, and "wait" for the support to arrive before proceeding.
7.1.5	Visual control systems (such as line-stop alarm light, call light, warning signal, etc.) are used as a mechanism to make problems visible. [2]

7.1.6	Line-stop alarm light has different colors to indicate the condition of a production line. Green light indicates normal operations. Yellow indicates a worker in the particular workstation is calling for help because of an abnormality. The yellow light will be lit once yellow button is applied by an operator. If trouble cannot be handled, a red light will come to show that production line has stopped.
7.1.7	When an abnormality occurs, operator can easily identify its source, and corrective actions can be taken immediately.
7.1.8	Mistake proofing and *Go/NoGo* mechanisms should be applied. They help an equipment, machines or operators to avoid mistakes.
7.1.9	With the mistake proofing mechanism, defects can be eliminated by preventing, correcting, or drawing attention to human errors as they occur.
7.2	**Built-in quality** [3, 4]
7.2.1	Implementing the built-in quality implies that all operators are responsible for all the jobs they do, and must ascertain the quality for each operation.
7.2.2	Those who are engaged in a manufacturing process are totally responsible for full quality assurance.
7.2.3	All the production workers must not receive defects, produce defects, and pass defects to the subsequent workstations.
7.2.4	Delivery of products to next workstation or customers must comply with specifications requested, in the right quantity, and no defects.
7.2.5	Self-inspection is a must for each operator before the product is passed to subsequent workstation. If an abnormality occurs, then autonomous defect control mechanism would be applied.
7.2.6	Any defects would never reach the subsequent process, because production workers must do everything right the first time.
7.3	**Quality checking** [2, 3, 4]
7.3.1	It is aimed to ensure a consistent quality of product conformance with predetermined specifications.
7.3.2	Quality checking should be done randomly with a sampling procedure, albeit some products may require total checking.
7.3.3	Inspection must be carried out according to the standard described on standard operating procedure (SOP) containing a detailed explanation of inspection activities that must be performed for every product.
7.3.4	The quality checking is done visually at the product's key point.
7.3.5	The results of quality checking should be recorded in a quality control sheet.
7.3.6	Statistical quality control is used only when an operation has been fully stabilized through careful maintenance of equipment and tools, and sporadic defects do not occur.
7.4	**Related activities**
7.4.1	To support quality control, the following supporting activities should be considered: • Quality focused teams (quality control circle) that meet regularly to discuss about quality issues. Through the meeting, quality problems can be arisen, strategies of problem solving can be designed accurately, and some suggestions can be addressed to management as an attempt to acquire superior quality. • Training for quality control activities. • Visual control boards, to describe current condition of a particular production line.

Practice 8 **Total Productive Maintenance (TPM)**	
Definitions	*TPM* is an approach to machines and equipment maintenance that strives to achieve perfect production (i.e., no breakdowns). *Predictive maintenance* is maintenance activities aimed to help in determining the condition of in-service equipment in order to predict when maintenance should be performed. *Preventive maintenance* involves periodic inspections and services to identify any potential failures and make minor adjustments to prevent major operating problems and breakdown maintenance occurred.
Purpose	To maximize effectiveness and readiness of all machines and equipment to perform all the production processes.
Related practices	It is supported by FR. It supports PS, SLP, and UPL.
8.1	**Predictive Maintenance** [1, 3]
8.1.1	Through predictive maintenance, the status of machines and equipment is clearly ensured before a breakdown occurs.
8.1.2	It is a complement of preventive maintenance. So that, the preventive maintenance can be accomplished before a breakdown.
8.1.3	Various tools, such as thermal imaging, vibration analysis, and so on, are used to predict when a breakdown may occur.
8.1.4	Predictive maintenance should not be performed only by maintenance technicians but also involving production workers.
8.2	**Preventive Maintenance** [1, 3]
8.2.1	Preventive maintenance is executed on machines or equipment to diminish possibility of its failing, which is done while they are still working.
8.2.2	To perform preventive maintenance effectively, its activities are grouped into two categories; (1) activities that should be performed by production workers (ownership/ autonomous maintenance), and (2) activities that must be carried out by maintenance technicians, which require special skills and tools.
8.2.3	Ownership maintenance • It is limited only for maintenance activities using human senses without special skills and tools. • Each operator is responsible for all the machines he/she operates. • It may avoid machines and equipment from severe damage and termination of the production process. • All operators should reserve a time to perform daily maintenance activities. • All operators should scrupulously clean their workspaces (including machines and equipment) to make unusual occurrences noticeable.
8.2.4	Periodic inspection must be dedicated to keep all machines and equipment are in a state of readiness to perform all the production processes.
8.2.5	Maintenance activities must have a set of complete guidelines, such as maintenance ledger, job instruction sheet, and maintenance *kanban*.
8.2.6	Maintenance ledger • It provides detailed information about machines and equipment, maintenance period, tools etc. • The maintenance period depends upon type of machines/equipment, and type of spare part.
8.2.7	Job instruction sheet • All the maintenance activities should be guided by job instruction sheet.

	• It provides instruction for each job in detail. Thus, it can be done by any operator.
8.2.8	Maintenance *kanban* • Maintenance *kanban* is used to instruct routine maintenance activities. • Each machine and equipment should have maintenance *kanban*. It informs about items that require checking in all machines and equipment. • At the beginning of every month, all *kanbans* are distributed to machines' operators. Based on the *kanban*, operators check the machine. Once completed, *kanban* will be placed into *kanban's* pigeonholes awaiting for next inspection as scheduled in *kanban.* • If any abnormality is detected, operator should report the problem together with possible corrective actions that have been or should be taken.

Practice 9 Supplier Networks	
Definitions	*Supplier network* is a strategic and mutual collaboration between suppliers and manufacturer with a goal of waste elimination. *Milk run delivery* is a delivery method for mixed loads from different suppliers. Instead of each of several suppliers sending a vehicle every week to meet the weekly needs of a customer, one vehicle visits each supplier on a daily basis and picks up deliveries for customer. *Jumbiki* is defined as pick in order of use. It is a delivery system that uses a fax order system according to patterns of production smoothing or products sequence passing through the main production line. In this system, parts are directly sent to the main line with the prior preparation of the sequence by suppliers according to the product to be assembled in the production line. *Jundate* is a method of delivery in which suppliers do not deliver parts directly to main assembly line. The parts must be prepared in sub line to combine a number of parts into a set form. It is frequently applied for large-volume parts that cannot be delivered in its original packaging to the main line, or parts containing a lot of components.
Purpose	To establish mutually supportive nature of relationship between manufacturer and its suppliers.
Related practices	It is supported by PS, SLP, and UPL. It supports PS, SLP, UPL, and QC.
9.1	**Long term and mutual relationship with suppliers** [1, 2, 4]
9.1.1	Implementation of lean manufacturing must be supported by good suppliers.
9.1.2	Manufacturer and its suppliers must be bound in a long-term relationship.
9.1.3	Manufacturer should… • Emphasize to work together with suppliers for mutual benefits. • Regularly solve problems jointly with suppliers. • Visit and observe problems of suppliers, and the problems should be resolved together.
9.2	**Suppliers' development programs** [1, 4]
9.2.1	To support production process, suppliers should be well developed. Development programs should be provided for all suppliers.

9.2.2	Suppliers must be developed in several aspects, ranging from production systems, internal production processes, logistics, and performance aspects (such as safety, quality, productivity, delivery, and so on).
9.2.3	Suppliers are encouraged to improve their performance.
9.2.4	To undertake supplier development, routine assessment on suppliers' performance should be performed.
9.2.5	The routine assessment should be undertaken by special divisions and should be supported by other divisions that deal directly with suppliers.
9.2.6	Development programs should be undertaken not only for new suppliers, but also for existing suppliers.
9.2.7	Suppliers are encouraged to implement the lean manufacturing system in their own companies.
9.2.8	Suppliers should be trained to implement the lean manufacturing system, and to follow rules of the game set by the manufacturer.
9.2.9	The implementation of the lean manufacturing system by suppliers should be evaluated and improved.
9.2.10	Competition among suppliers should be encouraged.
9.2.11	Suppliers' performance should be annually assessed. Annually, outstanding suppliers should be awarded.
9.2.12	To enhance suppliers' performance, orders are allocated based on their performance.
9.3	**JIT delivery from suppliers** [1, 4]
9.3.1	This activity is aimed to ensure that suppliers are able to deliver their products in the JIT basis (as promised, just as it is needed, in the right quantity, at the right time, and at the right place).
9.3.2	It can be realized through synchronization between manufacturer's production schedule and delivery schedule of parts and materials from suppliers.
9.3.3	Manufacturer should arrange the schedule of shipment to customers, as well as schedule for internal production process, and ordering to suppliers. All are scheduled down to the detail of time. This schedule is then communicated to suppliers. Suppliers will arrange their own schedule.
9.3.4	Meetings with suppliers should be held regularly to notify manufacturers' production schedule. Based on the schedule, suppliers arrange their production and delivery schedule, matching with the manufacturer's requirement.
9.3.5	The suppliers should be able to adapt to the demand change.
9.3.6	Milk run delivery system should be applied, to ensure that delivery from suppliers follows the JIT principles. Goods from suppliers should be received in small lot size with frequent deliveries. • Suppliers' addresses were geographically mapped. • The goods form suppliers who are located nearby to each other are picked by one truck provided by logistics partner. Hence, one truck collects goods from a number of suppliers. • The logistics partner delivers the goods to the manufacturer.
9.3.7	Suppliers must deliver their products to the point where it is required.
9.3.8	Besides milk run delivery; in an assembly line, *jumbiki* and *jundate* delivery system should be applied.
9.3.9	*Jumbiki* delivery system [4] • By applying *jumbiki*, suppliers deliver parts and materials based on production sequence at where they are going to be used. • Arrivals of parts and materials should be in line with sequence of the main body processed in the production line.

	• It can work well when delivery lead time from suppliers is shorter or at least equal to the speed of production along the assembly line. Hence, suppliers and manufacturer should be close proximity. • *Jumbiki* delivery system could be applied for large-size parts, unique items (uncommon parts), and parts with low delivery costs.
9.3.10	*Jundate* delivery system • In the *jundate* system, parts are prepared in a sub line by combining multiple components into a set form before its installation to the main part of the product.

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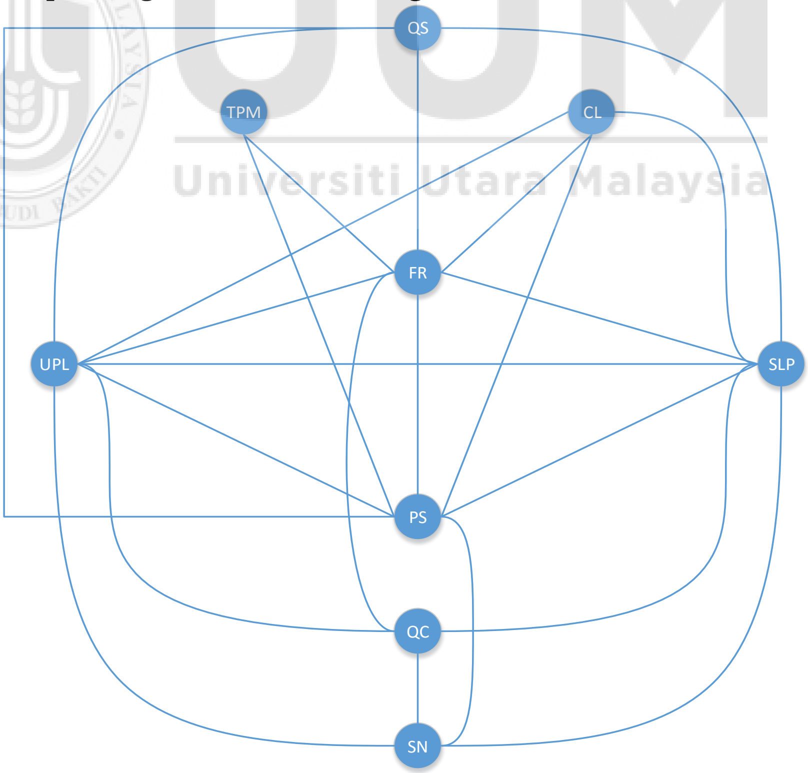
1. Cheng, T. C. E., & Podolsky, S. (1993). *Just-in-time manufacturing: An introduction* (1st ed.). Suffolk: Chapman & Hall.
2. Feld, W. M. (2001). *Lean manufacturing: Tools, techniques, and how to use them*. Florida: St. Lucie Press.
3. Hirano, H. (2009). *JIT implementation manual: The complete guide to just-in-time manufacturing*. Boca Raton, FL: CRC Press, Taylor & Francis Group.
4. Monden, Y. (2012). *Toyota production system: An integrated approach to just-in-time* (4th ed.). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Appendix 1

Inter-relationship among Lean Manufacturing Practices



Appendix 2
Forms/Records

Form #	Record/Form/Activity Name	Satisfies Clause
Required by Standard		
Other Forms/Records		

Appendix 3
Revision History

Revision	Date	Description of changes	Requested By