CRANFIELD UNIVERSITY

CHAY TICK FEI

A BOTTOM-UP LEAN IMPLEMENTATION STUDY AT A MALAYSIAN AUTOMOTIVE PARTS MANUFACTURER

SCHOOL OF APPLIED SCIENCES

MSc by Research Thesis
Academic Year: 2013 – 2014

Supervisors: Dr Yuchun Xu and Professor Ashutosh Tiwari
April 2014

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ABSTRACT

The aim of this research was to investigate shop floor employees' involvement (including supervisory staffs) in lean implementation or Kaizen activities at a Malaysian automotive parts manufacturer leading in lean; and to propose a bottom-up lean conceptual model and its implementation roadmap to provoke involvement of shop floor employees in Kaizen. The research was carried out in five phases. First, the focus areas of Kaizen at Toyota and the critical success factors that would influence the extent of shop floor employees' involvement in Kaizen activities were identified via literature review. Second, a case study was carried out at a Malaysian automotive parts manufacturer (known as Company A) with 7-years of intensive lean experience. The research data were collected via a semi-structured interview with the Lean Coordinator of the company, and a survey which addressed to different levels of internal stakeholder from top management to operators. Third, analyses on the extent of shop floor employees' Kaizen involvement at Company A and the influences of each critical success factor were carried out. Fourth, a bottom-up lean conceptual model and its implementation roadmap incorporating the critical success factors were developed. Fifth, the proposed lean model and its implementation roadmap were validated by lean experts from both academia and industry. As a result, the study found the shop floor employees' extent of involvement in Kaizen at Company A was low. The identified critical success factors namely F1 – *top management's commitment*; F2 – *shop floor employees' commitment and technical capability*; F3 – *the stage of lean transformation*; and F4 – *shop floor responsibilities assignment* were found to have significant influence on the extent of 'Employee Involvement'. Being awarded as a Model Company in Malaysian automotive industry, Company A had yet to commence their transition to bottom-up approach phase in their lean journey although they had already enjoyed the early benefits of lean. The proposed model would thus serve as a general guideline to help the company or the Malaysian automotive industry in large in bottom-up approach lean implementation.

Keywords: lean production, lean thinking, Kaizen, employee involvement, bottom-up, framework, model, barrier, Malaysia, MAJAICO, SME, developing country

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LIST OF ABBREVIATIONS

5S	*seiri, seiton, seiso, seiketsu,* and *shitsuke*
7-WASTES	Transportation, Inventory, Motion, Waiting, Over-processing, Over-production and Defects
GTS	Grasp-The-Situation
JIT	Just-in-Time
LPS	Lean Production System
MAJAICO	Malaysia-Japan Automotive Industry Cooperation
MJEPA	Malaysia-Japan Economic Partnership Agreement
MYR	Malaysian Ringgit
PDCA	Plan-Do-Check-Act
SME	Small and Medium Enterprise
SMED	Single Minute Exchange of Dies
SOP	Standard Operation Procedure
TPS	Toyota Production System
VSM	Value Stream Mapping
WIP	Work-in-Progress

1 INTRODUCTION

This chapter introduces the research background and an overview of the history of lean adoption amongst Malaysian automotive parts manufacturers. It includes the motivation behind to carry out this study.

1.1 Research background

The term - Lean Production System was first introduced by John Krafcik (1988) in his article, "*Triumph of the Lean Production System*" and was made popular all over the world by Womack *et al.* with their publication, "*The Machine That Changed The World*" in 1990. Founded in automotive industry, the implementation and development of Lean or Toyota Production System has gone beyond manufacturing industry where lean philosophy is now widely applied in service industries such as healthcare, banking, education and so on.

Despite it has been over 30 years available of literature about Lean or Toyota Production System and existence of Japanese transplants all over the world; the success rate of lean transformation is still very low, even in developed countries such as the US and UK (Pay 2008, Bhasin 2012a). One of the main reasons was failure in engaging shop floor employees (including supervisory staffs) in lean or Kaizen activities (Coetzer, 2006, LEI, 2007, Mohanty *et al.*, 2007, Gagnon *et al*., 2008, Sim and Rodgers, 2009, Sokalski *et al*., 2010, Bhasin, 2012a).

Although there are countless of books and articles now widely available in the market and research arena in explaining how to apply and use lean tools, techniques, and practices; how to reorganise work flows according to lean principles; how to encourage 'Employee Involvement'; sharing of successful lean implementation experiences; proposing solutions for various problems and barriers to becoming lean, etc.; however industrial practitioners still failed to succeed or sustain their lean transformation and failed to engage their employees in lean or Kaizen activities. What are the reasons behind the failure in lean adoption and to engage shop floor

employees? What are the key factors should one consider when engaging shop floor workers into lean transformation? What are the right approaches to involve shop floor associates along the lean journey?

1.2 Lean Production System in Malaysian automotive industry

The research on implementation of Just-in-Time (JIT, one of the pillars of lean production system) in Malaysian automotive industry could be traced back to the 1980s. The study by Abdul Hamid *et al.* (1988) found that JIT concept was not fully implemented in Proton (Malaysian largest automobile manufacturer) and in its local parts suppliers. Piles of inventory were still found in the vendors' factories and no initiatives were taken to reduce them. Some of the vendors had had doubts on the feasibility of the JIT concept. Amongst the reasons were – no mutual trust between buyers and suppliers, unsuitable Malaysian culture to adopt JIT, the workers were not committed to strict JIT requirements and lack of understanding about JIT, to name a few (Abdul Hamid *et al*., 1988). Nonetheless, the same problems were found remained unsolved in another study which was also done at Proton by Simpson *et al.* (1998). Proton and its suppliers were still far behind from achieving full strategic JIT in the Japanese sense (Simpson *et al.,* 1998).

In the early 2000s, to enhance the competitiveness of local automotive industry, Malaysian government has taken all the necessary actions to increase the quality and productivity of local vehicle production (MAI, 2011a). Tapping on the Look East Policy, Malaysian government had opened the door for local manufacturers to learn the Japanese way in operating business. To cultivate lean thinking amongst the local automotive parts manufacturers, the government introduced MAJAICO programme in 2006 (MITI, 2007).

The Malaysia-Japan Automotive Industry Cooperation (MAJAICO) was formed under Malaysia-Japan Economic Partnership Agreement (MJEPA) between both governments. It aimed to develop and enhance the capabilities and competitiveness of Malaysian automotive industry through capacity building programmes offered by Japan (MITI, 2007). Amongst the 10 programmes introduced, SME Corp. Malaysia[1] was

appointed to undertake the 5-years MAJAICO-A1 programme (The Automotive Technical Experts Assistance Programme) which was initiated in July 2006. The objective of this programme was to improve the performance of Malaysian automotive parts manufacturers by introducing continuous improvement activities via implementation of Lean Production System (LPS) under the guidance and consultation from Japanese lean experts. A total of 87 automotive parts manufacturers had participated in this programme with 220 projects were successfully implemented from 2006 until 2011 under the consultation and direct involvement of more than 60 Japanese lean experts (SME. Corp, 2010, MAI, 2011a, 2011b).

From June 2011 onwards, the mandate to further entice more participation of Malaysian automotive parts manufacturers in adopting lean philosophy was officially transferred from SME.Corp Malaysia to Malaysia Automotive Institute (MAI). MAI was tasked to manage the Post MAJAICO LPS Programme, which is a continuity of the MAJAICO-A1 programme for another four years until 2015. Different from the previous MAJAICO-A1 programme, local experts are expected to provide consultation and direct involvement in the setup of lean system in the participated companies while Japanese experts only play the role as observers and advisors throughout the programme. The local experts are selected from Proton, Perodua[2] and MAJAICO LPS Model Companies which have acquired vast experience in lean implementation projects during the MAJAICO-A1 programme. They would then form the nucleus for further multiplication of local LPS professionals and act as the backbone in ensuring the continuity of LPS programme and the success of lean transformation in Malaysian automotive industry in future (MAI, 2011a, 2011b).

Note 1: Small and Medium Enterprise Corporation Malaysia (SME. Corp Malaysia) is the central point of reference for information and advisory services for all SMEs in Malaysia.

Note 2: After Proton, Perodua is the second largest Malaysian national car manufacturer.

1.3 Research motivation

As reported in previous studies, the barriers of lean implementation faced by Malaysian companies (including automotive parts manufacturers) were mainly human related issues such as lack of skills, attitude problems, lack of commitment from both top management and workers, and so on (Wong *et al*., 2009, Nordin *et al.*, 2010, Wong and Wong, 2011a). Meanwhile, with the introduction of MAJAICO-A1 programme, the Malaysian automotive parts manufacturers were given a proper channel to learn and apply lean concepts under direct guidance of Japanese lean experts. The participated companies in the programme were anticipated to have had gained invaluable experience and lessons from the Japanese, especially those pioneer companies which took part since 2006. These companies' commitment in adopting lean could be reflected from their early participation in the MAJAICO programme. Hence, it was anticipated that the success rate of lean transformation of these companies would be higher. With strong commitment, the negative impact of the human related barriers mentioned above was expected to be lesser and their shop floor employees' involvement in the lean activities was expected to be higher.

With the intention to learn more issues about 'Employee Involvement' in lean transformation, it has drawn the attention of the author to study in-depth about the approach of Malaysian company in lean implementation, their current stage in lean transformation and the critical success factors that influence the extent of shop floor employees' involvement in lean activities.

The expected benefits of the study:

It could create an understanding about Malaysian automotive parts manufacturer's approach in lean implementation and their perceptions of 'Employee Involvement'. It would discover the critical success factors of 'Employee Involvement' in Malaysian manufacturer hence provide clues for future improvement. It would propose a bottom-up lean model to encourage more shop floor employees' involvement into Kaizen or lean activities with the aim to instil Kaizen mind and culture at the shop floor.

Chapter summary

This chapter had introduced the research background of this study and an overview of the research history of Lean Production System implementation in Malaysian automotive industry. The research motivation to carry out this study ended this chapter.

2 LITERATURE REVIEW

2.1 Introduction

The research on lean production system has been overwhelming over the past decades especially after the publication of "*The Machine That Changed The World"* by Womack *et al.* in 1990. Different outcomes were encountered by practitioners when adopting lean in the industries; some had successfully enjoyed the benefits, while others still failed to grasp the idea of lean. Focusing on the shop floor employees, this chapter reviews:

- The principles of lean which advocate the importance of 'Kaizen' and 'Employee Involvement'.
- The fundamental problems and barriers that hinder shop floor employees' involvement into lean transformation.
- The analysis of lean implementation frameworks.

In the searching of published literature about lean production system, a structured approach was adopted. The following knowledge databases were browsed through thoroughly: *Scopus, Emerald, EBSCOhost, Science Direct* and *Google Scholar*. The searching also included those relevant literatures which were very much useful for this study and were cited in the earlier reviewed articles and books. The earliest publication found was written by Sugimori *et al.* published in 1977 and the latest were the publications in 2013. The main keywords used including *'lean'*, *'lean production'*, *'lean manufacturing'*, *'lean thinking'*, *'toyota production system'* with supplementary keywords such as *'barrier'*, *'employee engagement'*, *'worker engagement'*, *'supervisor'*, *'team leader', 'model'* and *'framework'*.

2.2 Lean Production System

Inspired by Sakichi Toyoda, the father of Toyota Automatic Loom Works; and, Henry Ford, the founder of Ford Production System, Taiichi Ohno and his associates had spent over 30 years since the 1950s, step by step invented and developed Toyota

Production System (hereafter TPS) (Sugimori *et al.*, 1977, Holweg, 2007). After the major research project of International Motor Vehicle Programme (IMVP) which was carried out by Massachusetts Institute of Technology in 1979, TPS was subsequently termed as Lean Production System by John Krafcik (1988) and made popular over the world by Womack *et al.* with their famous best-selling book, "*The Machine That Changed The World"* published in 1990. Their research found a significant difference in production performance (especially in terms of productivity and quality) between the Japanese and Western auto manufacturers (Womack *et al.* 1990, Sohal and Egglestone, 1994). It has then raised the attention of researchers from the West thereafter, from worldwide to study the concepts and implementation of Just-in-Time (one of the pillars of TPS), and Toyota or Lean Production System over the last three decades.

2.2.1 The definitions of Lean Production and Lean Thinking

Krafcik (1988) and Womack *et al.* (1990), described Lean Production as

"*…uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever-growing variety of products."*

In system thinking perspective, the concept of Lean Thinking was further introduced by Womack and Jones (1996). In their point of views, Lean Thinking

"*… provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruptions whenever someone requests them, and perform them more and more effectively. It provides a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customer with exactly what they want."*

In other words, Lean Production or Lean Thinking focuses on supplying exactly what the customer wants, in the form and quantity that they desire, free of defects, meet the exact timing, at the lowest cost and most dependable delivery with minimal waste throughout the whole process (Rother and Shook, 1998, Kocakullah *et al.* 2008).

The five core principles brought up by Womack and Jones in 1996 further identified the characteristics and sequences of Lean Thinking as follows:-

i) Specify value from the view of customer.

ii) Identify the value stream by lining up value-creating actions and eliminating every step that does not create value (or waste).

iii) Create flow over the value-adding activities without interruptions.

iv) As flow established, let the downstream customers pull value from the preceding process.

v) Pursue perfection when the above steps naturally lead to greater transparency in the process and enable people to discover and eliminate hidden waste in it for further improvement sake.

According to the Production System Design Laboratory of MIT (2000), Lean Production is

"… aimed at the elimination of waste in every area of production including customer's relations, product design, suppliers' networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less space to become highly responsive to customer demand while producing top quality products in the most efficient and economic manner possible."

Despite the variation in definitions and descriptions of Lean terminologies, most researchers had however mutually pointed out that lean is a customer-oriented manufacturing management philosophy; and continuous improvement is the

foundation of lean thinking to relentlessly strike out any non-value added activities or waste in every process; eventually delivers only the true value of what the customer wants. It will then lead to cost reduction in production which is the initial goal of TPS (Ohno, 1988, Dennis, 2007). More importantly, in the process of continuous improvement, an organisation would eventually evolve into a self-learning organisation which is the ultimate goal of Lean or Toyota Production System (Womack and Jones, 1996, Liker 2004).

2.2.2 Kaizen – The foundation of lean

It is known that at the birth place of Lean Production System, Toyota, people seeks perfection (Ohno, 1988, Japanese Management Association, 1989). As quoted from Taichii Ohno, *'The true cost is the size of a plum seed'* supported that waste is still widely exist, even at Toyota. At Toyota, the pursuit of perfection is the Kaizen (continuous improvement) activities that persistently and systematically done by everyone; every day in every task they do (Dennis, 2007). The intensive study of TPS by Spear and Bowen (1999) revealed that Kaizen happens in every activity and process; operation performance is challenged every day and therefore enables the company to continuously innovate and scientifically improve. Liker (2004) advocated that continuous improvement is a total philosophy that strives for perfection and sustains Toyota on daily basis. Shingo (1989) also discovered that continuous improvement is accepted as a natural part of work in Toyota, which people thoroughly eliminate waste via fundamentally improves every single process and operation. Shingo reiterated that *'the Toyota Production System is said to be so powerful that it could squeeze water from a dry towel'*. This undoubtedly explains that Kaizen is the building block of all the Lean or Toyota Production System methods that people are using today (Productivity Press Development Team, 2002).

Emiliani (1998a) further justified that the first four core principles as defined by Womack and Jones (1996) interact in a 'virtuous circle' to enable the pursuit of perfection. There are endless opportunities for improvement in all areas by

systematically eliminating waste and subsequently reducing the costs of operating in all aspects. It provides the customers with product and service at the maximum value yet at the lowest price. Perfection can never be achieved, though. Its pursuit is a long term goal worth striving because it provides the people in the company a common direction, while maintaining constant vigilance against waste at the same time.

According to Lewis (2000), productivity savings gained by Kaizen and waste elimination could build the foundation of sustainable competitive advantage of a company. Furthermore, under certain circumstances, growing profits through cost cutting is unlikely to sustain but must be balanced with sales growth through Kaizen and innovation in production processes and new product development (Dimancescu *et al.*, 1997, Hanson and Voss, 1998, Bateman, 2002, Bhasin and Burcher, 2006). Bhasin and Burcher (2006) further affirmed that lean should be viewed as a long term journey and from the standpoint of continuous improvement. Effective continuous improvement would not only deliver operation performance improvements but a positive corporate culture change at the company (Lee-Mortimer, 2006).

2.2.3 People-centred production system – Engaging shop floor employees into lean transformation

Toyota Production System is a people-centered production system (Japanese Management Association, 1989). This is indeed true. Taichii Ohno (1988) advocated that workers were his most valuable resources. It was the contribution of workers' skills, knowledge, experience and creativity to solve Toyota's problems and the solutions that have subsequently made up the Toyota or Lean Production System today (Dennis, 2007). As shown in Figure 2-1, the 'heart' of Lean Production System is the involvement of workers - the flexible and motivated team members who continuously perform Kaizen to improve the way in performing daily tasks.

Besides, Koenigsaecker (2009) mentioned that the two pillars that support TPS are the concept and practice of Kaizen and the power of 'respect for people'. At Toyota, the concept of 'respect for people' means a lot. It involves designing a system in order to

motivate workers to actively participating in any improvement initiative, teaching them and equipping them with all the necessary tools and resources for Kaizen; as well as motivating the workers to use them every day. In short, Kaizen through people's involvement is the fundamental approach to inculcating lean culture in a company.

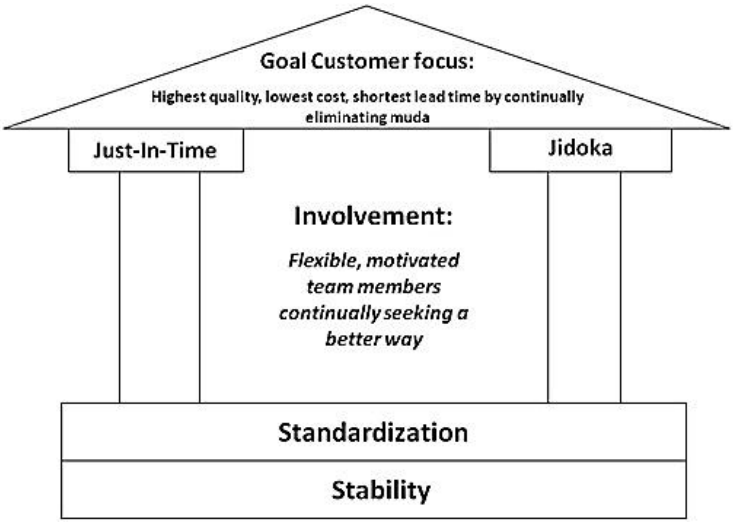

Figure 2-1: Basic Image of Lean Production (*adopted from Lean Production Simplified, Productivity Press, New York, 2007 by Pascal Dennis)*.

The research by Spear and Bowen (1999) investigated the invisible elements or the DNA of Toyota Production System. They discovered that Toyota in fact unconsciously teaches its workers the scientific ways to solve problems and systematically carry out Kaizen. This approach indirectly creates a community of scientists. They further explained that any improvement in Toyota must be made in accordance with the scientific methods (example PDCA cycles); and most importantly, under the guidance of a coach or a teacher, it could also be carried out at the lowest possible level in the organisation i.e. the shop floor workers.

Kaizen needs people's development and active involvement of the shop floor employees (Sugimori *et al.*, 1977, Womack and Jones, 1996, Liker, 2004, Jørgensen *et al.*, 2004). In lean factory, abnormality or problem found at the shop floor is the opportunity for developing improvements based on effective problem solving approaches. Therefore, as the firsthand witness of production events, shop floor

employees are playing an important role in production improvements and contributing a high degree of influence to the body of knowledge (Olivella *et al.*, 2008).

Case study carried out in an Australian lean practitioner by Sohal (1996) also revealed that the right attitude and serious commitment by everyone in the organisation are essential to lean. Involvement of front-line employees in planning, implementation and evaluation of changes in improvement would not only develop their ability to learn but also encouraging them to continuously looking for opportunities to improve.

Another case study done by Gunasekaran *et al.* (2000) in a French-owned SME (an auto parts manufacturer) located in England discovered that the involvement of front-line employees from the beginning in the implementation of JIT/Kanban in SMEs is one of the critical success factors to succeed a lean transformation programme. It should start with education and training of employees along with strong management commitment and support. Gradual and activity-based implementation of small Kaizen is essential, especially in SMEs, to encourage buy-in from the employees and boost their morale during the change process.

Papadopoulou and Ozbayrak (2005) pointed out that encouraging buy-in and gaining trust from the workforce is the paramount to lean transition's success, as lacking of trust tends to create fear and anxiety amongst the employees for not having continual employment as well as psychological pressure that they would have to perform new tasks which might be out of their knowledge and ability. Besides the open communication between management and employees to prevent distrust, workforce empowerment and ownership of improvement are critical as well and should not be apart from the lean implementation programme. Therefore, bottom-up approach improvement initiative and involvement of workforce in Kaizen activities as well as problem-solving processes are essential to lean transformation (Jogada *et al.*, 2013).

2.3 Problems and barriers in engaging shop floor employees into lean transformation

2.3.1 General context

Japanese Management Association (1989) urged that lean production is derived from humanity thinking and lean could not be regarded as just a set of tools and techniques for production improvement. Human aspects of motivation, empowerment and respect are very important as well. Without incorporating human dimensions of leadership, employees' engagement and positive behaviour as well as culture, any early Kaizen effort would be faded away and lean programme is unlikely to sustain (Hines *et al.*, 2008).

Nonetheless, in lean transformation, it always comes with organisational change (Womack and Jones 1996, Karlsson and Åhlström, 1996). For many people, organisational change is associated with feelings of insecurity, uncertainty, fear and anxiety. It often leads to lacking of buy-in or even worse, resistance from employees. The most common type of resistance is in the aspect of technical competency where employees fear that they do not have the right skills and capabilities to carry out new tasks or lack of confidence to manage their works after changed. Fear of lossing control or threat to *status quo,* especially amongst senior workers or supervisory staffs is also the common barrier that impedes employees' buy-in (Hines *et al.*, 2008).

Achanga *et al.* (2005) referred people related issues such as employees' skills and expertise, organisational culture and leadership are among the critical success factors in lean implementation. Their study found that in contrast with large organisations, most UK SMEs did not see a supportive organisational culture as an essential platform for lean implementation. Despite employing people with low skills levels, management was not committed on workers development by providing training and other skill enhancement programmes for both personnel and organisational Kaizen.

In the survey carried out by Sim and Rodgers (2009) which to investigate the barriers of involvement amongst the employees in improvement activities of a *Fortune 500* manufacturing plant located in the Eastern USA found that, the management had

failed in the area of coaching, communication and support when carrying out Kaizen programme. The finding pointed out that lack of commitment by the management team had caused the occurrence of other issues as listed below:

i) Lack of effective communication throughout various levels in the organisation including providing feedback to employees and sharing of success stories.

ii) Employees did not feel valued to offer suggestions for process improvement. They were also skeptical about the reward system or support from management.

iii) Employees did not receive adequate and appropriate trainings. They were not provided with trainings on how to implement the improvement tools.

iv) Employees were uncertain about their job security.

v) In the aspect of local or on-the-job training by experienced senior workforce to new workers, veterans' expertise was often under-utilised.

In a case study in Australia, Sohal (1996) stressed that it is difficult to convince senior operators to change the way they work. It is difficult to change workers' working behavior for it is almost equal to change their personal attitude. But, this is fundamentally crucial to lean success. Stepping back to old habits is another common barrier to lean transformation if there is a lack of discipline on the shop floor to persistently improve the old working methods. Therefore, education and persistent training at the shop floor is critical to overcome the difficulties above. Meanwhile, the study also found that classroom type trainings did not actually address the problems workers face daily and also difficult to equip the supervisory staffs with the ability to lead and coach their subordinates.

Similarly, findings in the case study by O'hEocha (2000) on the influence of 5S practices to employees' attitudes showed that 5Ss practices started well in the respondent company however the effort was faded away in certain areas due to loss of interest and discipline at the shop floor. The company failed to fully enjoy the benefits of 5S at the plant-wide as some employees were reckoned to have attitude problems, and did

not put in much effort in the 5S improvement programme. Nonetheless, lack of support from the supervisors and managers was the reason as well. Some of them perceived the involvement of shop floor employees in improvement programme (such as 5S) as a threat to loss of power when their subordinates were entitled with decision making power without involvement of their superiors.

The studies by Gagnon and Michael (2003) and Gagnon *et al.* (2008) about employees' strategic alignment with company's strategic change revealed that the absence of strategic knowledge, commitment and strategic alignment in the employees would cause low level of employees' involvement and their desire to change. Thus, it would cause the failure of lean transformation. One of the common failure signs found was poor response from the employees in reciprocating to top management's proactive steps towards building a lean company. Their studies further proved that employees' individual trust to their management could influence their commitment. Open and honest communication with employees during a strategic change would foster trust and commitment from the workers. In addition, mutual trust could be achieved by developing a set of objectives made known to everyone. It could help to promote change awareness and strategic knowledge amongst the employees. Besides, playing the role as shop floor leaders, supervisory staff was found to be an important element in ensuring strategic alignment between the management and workers. They were the central contributors to cultivating positive working attitude amongst the workers (Dirks and Ferrin, 2002, Gagnon *et al.*, 2008).

In 2007, a survey conducted by Lean Enterprise Institute (LEI, 2007) to nearly 2500 respondents discovered that out of thirteen factors, the top five obstacles that hindered lean implementation were:

i) Middle management resistance – 36.1%

ii) Lack of implementation knowhow – 31%

iii) Employee resistance – 27.7%

iv) Supervisor resistance – 23%

v) Lack of crisis – 17.7%.

On the other hand, another survey was carried out by Bhasin (2012a) to explore the factors which contributing to low success rate of lean transformation in the UK. The feedback from 68 manufacturing organisations of different sizes showed that the top three barriers of lean implementation were:

i) Insufficient supervisory skills;

ii) Employees' attitude; and

iii) Insufficient workforce skills.

To validate his preceding survey results, Bhasin (2012a) subsequently carried out seven case studies on different groups of managers. He further confirmed that '*insufficient supervisory skills'* and '*workforce skills'* in doing lean were among the top five barriers against lean transformation.

In his case study, Sokalski *et al.* (2010) claimed that due to lack of education and empowered employees in Kaizen, the earlier success of Kaizen efforts in the respondent company had progressively faded away. It was mainly caused by no further action in following up the Kaizen activities by the employees. The Kaizen concept did not gain much buy-in from the employees because they were forced to follow without being informed the purpose of Kaizen. Moreover, the study revealed that commitment from top management alone was not enough to sustain a Kaizen initiative; a company should share their vision with the employees.

To be able to thriving in competitive environment, an organisation should learn to be adaptive, innovative and flexible. The employees' ability to learn is the critical factor in this aspect. Even at Toyota, becoming a learning organisation through relentless reflection *(hansei)* and Kaizen is still an ongoing process (Liker, 2004). A research by Alan Coetzer (2006) which studied about employees' learning in small manufacturing firms in New Zealand had several noteworthy findings. He noticed that employees in

SMEs had limited access to trainings, this including on-the-job trainings and there was lacking of incentives to learn. The employees' learning potential had, however enhanced because they had the opportunities to handle a wide range of work activities (mainly because they were from SMEs). For learning purpose, employees would prefer their leaders to be their influence models. Nevertheless, as revealed in the study, the employees perceived their supervisors as either were not keen or did not have the ability and skills in supporting their learning.

Other than that, the ESPRC funded research which conducted by Conti *et al.* (2006) with the aim to study the effects of lean production on workers' job stress in UK discovered that workers would prefer a formal and organised programme for developing process improvement instead of giving them the autonomy to make process changes informally. Absence of task support from peers and supervisors, lack of team working, doing work for absent workers, being blamed for defects and resources removal (e.g. removal of line workers) could be stressful at work for workers. Other factors found to cause pressure at work were lack of adequate tools, ergonomic difficulty at work station, cycle time decreasing and working longer than desired hours. The drawback of stressful workers would eventually turn to other problems such as absenteeism, high turnover and so on which might directly hinder the Kaizen initiatives.

2.3.2 Malaysian context

In Malaysia, several surveys and case studies were carried out to investigate the extent of lean manufacturing implementation in Electronics and Electrical industries (Wong *et al.*, 2009, Wong and Wong, 2011a) and in automotive industries (Nordin *et al.*, 2010). The common resistances that they found in lean transformation were mainly the 'people' factors such as attitude problems, lack of discipline, lack of technical knowhow of lean implementation and lack of commitment from top management. Wong and Wong (2011a) found that workers resisted lean implementation mainly due to lack of awareness and understanding about lean concepts. They misunderstood that

implementing lean would increase their workload instead of helping them to work better via Kaizen. Also, lack of discipline and determination in change always caused the employees to stepping back to old working habits. Equally important, the employees viewed lean as yet another improvement programme but not a long term Kaizen philosophy.

2.3.3 Problems and barriers - Summary

In a nutshell, the common problems or barriers faced by lean practitioners while trying to engage shop floor employees into lean transformation or Kaizen activities are summarised in Table 2-1:

#	Problems and barriers	Authors
1	Lack of sharing and understanding about the total vision of lean system thus creating fear or disinterest among the employees. (the missing link between the management and the front-line workers)	O'hEocha (2000), Gagnon and Michael (2003), Conti *et al.* (2006), Hines *et al.*(2008), Gagnon *et al.*(2008), Sim and Rodgers(2009), Sokalski *et al.*(2010), Nordin *et al.* (2010), Wong and Wong (2011a)
2	Lack of confidence in the top management's promise and commitment.	O'hEocha (2000), Achanga *et al.*(2005), Sim and Rodgers (2009), Wong *et al.* (2009), Nordin *et al.* (2010), Sokalski *et al.* (2010)
3	Lack of employees' buy-in and the required discipline to change and sustainability, as well as employees' attitude problems.	Sohal(1996), O'hEocha (2000), Gagnon and Michael (2003), LEI (2007), Gagnon *et al.*(2008), Sim and Rodgers(2009), Sokalski *et al.*(2010), Nordin *et al.* (2010), Wong and Wong (2011a), Bhasin (2012a)
4	Lack of technical knowhow about lean implementation.	Sohal(1996), Achanga *et al.*(2005), Coetzer(2006), LEI (2007), Hines *et al.*(2008), Bhasin (2012a)
5	Inadequate and inappropriate trainings and employees' development programmes.	Sohal (1996), Achanga *et al.*(2005), Coetzer(2006), Sim and Rodgers(2009), Wong *et al.* (2009), Sokalski *et al.*(2010)
6	Lack of shop floor leadership to manage the problems shown above.	Sohal (1996), O'hEocha (2000), Dirks and Ferrin(2002), Coetzer(2006), Conti *et al.*(2006), LEI (2007), Hines *et al.*(2008), Gagnon *et al.*(2008), Sim and Rodgers(2009), Wong *et al.* (2009), Sokalski *et al.*(2010), Bhasin (2012a)

Table 2-1: Summary of problems and obstacles in engaging shop floor employees into Lean or Kaizen activities

2.4 Lean implementation frameworks

2.4.1 Introduction

After reviewing over 30 lean implementation frameworks, Anand and Kodali (2009, 2010) found that there were some drawbacks in the lean frameworks which contributing to low success rate in lean transformation. Yet, there are some considerations which Anand and Kodali (2009, 2010) did not include in their studies. Hence, it is hypothesised that the existing lean frameworks are still suffered from various weaknesses. In other words, the focus areas of these frameworks did not address the problems that lean practitioners faced. Consequently, this section aimed to investigate and analyse the shortfalls in the current lean implementation frameworks (or implementation plans of lean) through literature review and analysis. To carry out this study, the following objectives were formulated:

- To determine whether the current lean frameworks emphasise on the importance of shop floor employees' initiatives in lean implementation.

- To identify whether the current lean frameworks aimed to develop employees with the capability in carrying out improvements.

- To determine whether the current lean frameworks are able to provoke practitioners with the capability in building up their own way towards lean.

2.4.2 Purpose of framework

According to Yusuf and Aspinwall (2000), a '*framework*' answers *'how-to'* questions and helps to act as a guide in a methodology implementation. Anand and Kodali (2010) defined '*framework*' from an organisational perspective as *'a guiding torch that helps a manager in providing necessary direction during the change management programmes that are implemented in an organisation'*. In short, a 'framework' explains '*what constitute a change management programme*' or it discusses about '*how to carry out the implementation of a change management programme*'. It also consists of various

elements or blocks, which an organisation needs to follow, when trying to implement a new methodology or changing its current way of functioning.

Therefore, in promoting lean and providing the means of implementation, a framework is normally adopted by researchers with the aim to provide technical knowhow about lean and the milestone towards lean transformation.

2.4.3 Review of lean production implementation frameworks

Different types of lean production framework were proposed by researchers worldwide. Anand and Kodali (2009, 2010) argued that most of the lean production frameworks were categorised as *'design/conceptual framework'* which considered only *'what constitute Lean'* but very few emphasised on *'how to implement Lean'*. In their studies, the frameworks were compared in the following dimensions:

i) Number of elements;

ii) Purpose of framework;

iii) Comprehensiveness;

iv) Abstractness; and

v) Degree of clarity in role definition.

The shortcomings in the lean frameworks that Anand and Kodali (2009, 2010) discovered were:

i) Within the implementation category of lean production framework (there were six models in this category), none of the frameworks had given clear descriptions about the sequences and steps to implement the framework.

ii) None of all the studied frameworks had linked the lean elements to the internal stakeholders or functional departments in an organisation.

These shortcomings in the frameworks were considered as the critical factors contributing to *'lack of understanding'* among the practitioners on how to implement lean (Anand and Kodali, 2009, 2010). Hence, to close the gaps they identified, Anand and Kodali (2009) further proposed two frameworks, a design/conceptual framework which constituted 65 lean elements; and an implementation framework with 10 stages where each stage contained different tools or practices. These 65 elements were differentiated according to various decision levels such as operational, tactical and strategic with different internal stakeholder identified at each level. Furthermore, in every stage of the 10 implementation stages, the practices were grouped so that the elements in each early stage will be the prerequisites to the later stage.

Notwithstanding, several thoughts were out of their considerations.

First, besides the identified *'What'* and *'How'*, another important dimension which the practitioners should consider is *'Why'*. *'Why'* brings the reason behind the implementation of the tools or practices of lean. The dimension of *'Why'* requires practitioners to understand and think about the problems they face, their capabilities and resources, shop floor employees' or even managers' skills to solve the problems. Without the ability to understand the reason, the practitioners would be merely *'followers'*. It would not stimulate the learning desires and enhance the ability of the people. Thus, the problem of *'lack of skill'* or *'lack of technical knowhow'* about lean would not be solved. From this sense, it might hence cause uncertainties amongst the practitioners about the feasibility of the framework or even the lean production system itself. Even if the practitioners however would have enjoyed the initial success by implementing the framework, without growth in the capability or skills of the shop floor employees in carrying out improvements, the lean transformation is unlikely to be sustained or happened.

Second, their implementation framework was rather presented as *'one-best-way'* and was weak in contingency sense. Lack of contingency is one of the criticisms against lean implementation which had been highlighted by Hines *et al.* (2004). The internal and external situations vary from a company to another even though they are from the

same industry and same size; following a rigid framework would not bring solutions to the problems a company faces. Again, without brushing up the employees' problem solving capability (including the managers') and without 'reasoning' the framework, the lean transformation efforts and initial success of a company is going to fade away.

Third, pertaining to the parameter of *'number of elements'* or *'comprehensiveness'* of a framework, Anand and Kodali (2009) argued that the more elements included in a framework, the better it would explain lean production implementation. However, it raises a question here - will it become too complex and confuse the practitioners?

The analytical studies of lean production frameworks pioneered by Anand and Kodali (2009, 2010) opened the door for further research in this area. The frameworks which were reviewed by them would not be discussed again. This section would discuss the newly discovered frameworks proposed by other researchers after the studies done by Anand and Kodali (2009, 2010). Two of the analysis criterions of Anand and Kodali (2009, 2010) with additional two criteria which were overlooked by them would be adopted in this analysis:

i) How to implement (descriptions of steps or sequences of implementation);

ii) Why (the reason of adoption of the elements, tools, techniques or practices);

iii) 'Who' are the targeted internal stakeholders to use or apply the lean TTPs that were proposed in the framework; and

iv) What is the approach of the implementation (top-down or bottom-up).

Since it was to analyse the frameworks of *lean implementation*, *lean adoption*, or *lean transformation*, literatures that focus on the other areas such as training provision (Tan *et al*., 2012), lean assessment (Saurin *et al*., 2011, Malmbrandt and Åhlström, 2013), lean product design (Wang *et al.*, 2012) and the framework which serves as a reference for waste identification (Sternberg *et al.*, 2013) would not be discussed here.

The following frameworks will be reviewed and analysed based on the four criteria mentioned above. A summary of the analysis will be presented at the end of this section.

a) Framework proposed by Upadhye *et al.* (2010)

- Lean manufacturing system implementation framework for MSME (Medium Size Manufacturing Enterprise)

Descriptions of the framework:

The aim of the framework proposed by Upadhye *et al.* (2010) was to improve the readiness of a manufacturing company to supply quality products at the right time, quantity and price as required by its customers. The TTPs were grouped into three main areas i.e. shop floor practices, inventory and human resources management. Weaknesses or potential problems in an organisation at each area were highlighted with remedials and improvement suggestions.

Comments:

Generally, this framework was categorised as a *'conceptual/design'* framework which constituted only *'What'* TTPs were in the framework without clear instruction or flow of its implementation. However, several major potential problems such as machine breakdowns and minor stops, long set-up time, etc. were highlighted in their study with recommended TTP for each of them.

The framework showed that the *'prerequisite'* consideration of the TTPs was not taken into account. Which TTPs should be used first and which TTPs should be applied later were some of the instances. The *'reason'* of adoption for each TTP was not clearly discussed. Take the problem of high work in progress and long lead time for example, the suggested solution for the problem was to use *'one-piece-flow'*. Nevertheless, before heading to the solution to adopt *'one-piece-flow'*, what was the cause of high work in progress and long lead time? Why *'one-piece-flow'* should be adopted or what was the purpose of *'one-piece-flow'*? What was the prerequisite condition of *'one-*

piece-flow'? By giving some of these cues, it could help to stimulate the learning ability of the practitioners and enhance their understanding on the use of each TTP. Lastly, the suitable or recommended candidates from the company to apply the proposed TTPs were not highlighted in their study. In other words, the internal stakeholders of the company were not linked to the application of the proposed TTPs.

b) Framework proposed by Rose *et al.* (2010)

- A proposed conceptual framework for lean implementation in SME

Descriptions of the framework:

The proposed framework by Rose *et al.* (2010) aimed to help SMEs in improving their performance especially in the area of inventory level, cycle time, delivery time, and product quality. Several success factors such as management leadership and commitment, quality management, employee empowerment, employee involvement, training and education, continuous improvement, teamwork, effective communication, evaluation and measurement, organisation's structure and culture change were considered when proposing their framework. The TTPs were grouped into three main categories i.e. basic, intermediate and advanced. And, the external factors such as supports from the government, supplier, customer and consultant were regarded as crucial elements in lean transformation.

Comments:

Similarly, this framework was another *'conceptual/design'* framework which constituted only *'What'* TTPs to be used without descriptions of '*How*' to implement the TTPs.

The *'prerequisite'* consideration of the TTPs was also not considered and reasons of the TTPs' selection were not included as well. However, the TTPs were grouped according to its difficulty and complexity to help the practitioners in TTPs selection according to

their capability and available resources. Lastly, the relevant internal stakeholder for each of the proposed TTP was not taken into their consideration when designing this framework.

c) Framework proposed by Van Aken *et al.* (2010)

- A framework for designing, managing and improving Kaizen event programmes

Descriptions of the framework:

The framework proposed by Van Aken *et al.* (2010) aimed to assist an organisation in systematic design, management and assessment of short-term rapid improvement projects or Kaizen events in a company. Differ from previous proposed Kaizen event frameworks, it was developed for design and management of multiple Kaizen events within a programme and it could be used as an assessment tool[1] as well.

Note 1: Since the main focus of this study is to review 'implementation' frameworks, hence the assessment part of this framework will not be discussed here.

In the implementation part, this framework consisted of four main process areas, A. Plan, B. Implement, C. Sustain, and D. Support; with embedded sub-processes and practices within each main process area. The first process area, A. *Plan* was intended to provide the company a systematic approach to identify suitable Kaizen event candidates, define portfolio of Kaizen events, and develop the initial scope and project charter for each selected event. The second process area, B. *Implement* constituted mainly the planning and implementation process of a Kaizen event programme, as well as its follow-up activities. The third process area, C. *Sustain* encompassed two sub-processes which were results review and results sharing. These sub-processes were intended to increase the sustainability (in long term) of the enacted changes and improvements made from the executed Kaizen event(s). The forth process area, D. *Support* was intended to create an organisational infrastructure to promote and support the execution of the Kaizen event programme. It encompassed three sub-processes i.e. educating employees, mechanisms of managing the Kaizen programme, and motivating employees.

Comments:

In general, it was not a lean adoption framework as it was mainly designed for Kaizen event or improvement project implementation. However, it could exist or could be applied within any lean transformation programme. The aim of this framework was for Kaizen event or project based improvement activity. This type of Kaizen is known as organised Kaizen activity in Toyota which normally executed on a large scale basis (hence, it is also known as big Kaizen event) by engineers, chief leaders and group leaders; via top-down approach (Shimizu, 2004, Pardi, 2007). So, this framework was designed for higher level managers to plan and oversee the execution of big Kaizen projects. But at the technical level, issues such as *how* to execute a Kaizen event (for example from problem identification, problem solving to problem prevention) was not discussed in detailed by Van Aken *et al.* (2010). Since this type of Kaizen event was normally done in small group basis ranging from 3 – 15 selected people (Rusiniak, 1996, Laraia, 1998), if carelessly implemented, not everyone in the company would be benefited or developed (technically and mentally) throughout the process in long term basis. As it is already known that total involvement is the fundamental factor to transform an organisation to become a learning organisation like what happens in Toyota (Flinchbaugh, 2003, Liker, 2004, Hines *et al.*, 2008), the discussion on approaches of how to nurture the *right skills* and the *right mindset* to every employee in order to sustain the Kaizen culture in long term basis were however not discussed as well though the third process area, C. *Sustain* was purposely emphasised in the framework.

d) Framework proposed by Amad-Uddin (2011)

- A conceptual lean manufacturing system framework and its implementation in SME and LE

Descriptions of the framework:

By considering different aspects of strengths and weaknesses in both Large Enterprises (LEs) and Small and Medium Enterprises (SMEs), Amad-Uddin (2011) proposed another

conceptual lean production framework which was claimed as easy to understand and implement, with both *'What'* and *'How'* criterions existed in the framework. The TTPs were grouped into quality focus, manufacturing focus and technology practices with potential area of wastes highlighted. Leadership and lean planning were taken into considerations as well. The objectives of the framework were to reduce cost, improve delivery accuracy and quality, as well as value added per employee. Adopted from Rose *et al.* (2010), the success factors and external factors were included into the framework as well.

Comments:

Yet it was another *'conceptual/design'* framework despite Amad-Uddin (2011) claimed that the framework constituted *'how to implement'* criterion, but there was no clear instructions and descriptions on the implementation sequences. There was no *'prerequisite'* sense and no *'reasoning'* consideration in the TTPs selection. Unfortunately, the TTPs were not mapped according to the strengths and weaknesses of both the LEs and SMEs which had been highlighted. Lastly, the relevant internal stakeholder for each of the proposed TTP was not considered.

e) Framework proposed by Wong and Wong (2011b)

- Lean manufacturing implementation framework

Descriptions of the framework:

The framework proposed by Wong and Wong (2011b) had several valuable features. First, the foundation of the framework was designed based on the famous five lean principles by Womack and Jones (1996) and several prerequisites such as stability, standardisation and discipline of workers were considered essential when implementing the framework. Second, continuous improvement in the following fourteen key areas i.e. scheduling, inventory, material handling, equipment, work processes, quality, layout, employees, suppliers, customers, safety and ergonomics, management and culture, and product design were included in the framework. Third,

the framework was built based on worker involvement in the activities of continuous improvement above. The activities would be started from understanding the condition of current state and moving towards the desired future state. Forth, the TTPs were grouped as prerequisite, basic and advanced level based on their complexity in implementation.

Comments:

The framework indeed comprised most of the important elements of lean i.e. from lean principles, lean activities, and TTPs' groups, to consideration of different improvement areas in a manufacturing organisation at the macro level. For advanced lean practitioners, this could be quite a good reference for the practitioners to plan, check and oversee their lean implementation at the enterprise level. However, by looking at the micro level, for instance, the implementation of any particular TTP for production improvement, it still lacked of an image and the descriptions for practitioners (especially beginners) to understand the TTPs, when to use the selected TTP, why and what is next the step, and how the selected TTP would bring an organisation towards its lean vision. This criterion was highlighted by Anand and Kodali (2009 and 2010), which – the *'How'* aspect of a framework that should demonstrate the sequences of implementation. In a proposed framework, the sequence of the TTPs, their relationship (such as prerequisites) and the reason of adoption should be brought to surface hence provide the user (especially the shop floor employees) a clear and understandable image about its implementation. It would eliminate or prevent the barrier of 'lack of technical knowhow by shop floor employees' in lean adoption.

f) Framework proposed by Anvari *et al.* (2011)

- A proposed dynamic model to leanness

Descriptions of the framework:

Anvari *et al.* (2011) proposed a five phase lean implementation framework namely initial investigation, preparation, focus on a specified pilot, expand to whole

organisation, and the final phase, perfection. The aim of the framework was to provide a contingency approach or a dynamic lean pathway for different types of industries grounding at *'understanding your current state and your desired future state'*.

Comments:

This framework was clearly a 'project' based *'implementation'* framework rather than a conceptual model. For example, after the top management were prepared and committed for lean adoption, the implementation phase would start from establishing a lean team and working on a pilot project at a selected value stream. Once the pilot project was well established, expand the improvement effort to the next value stream and thereafter to the whole organisation.

The milestone of lean transformation presented by Anvari *et al.* (2011) was not new which similar approach had been presented by several lean consultants such as Feld (2001), Carriera (2005) and Koenigsaecker (2009). Nevertheless, their efforts in categorising those previous studies on lean transformation into 22 steps and three stages, namely preparation stage, design stage and implementation stage must not be overlooked, especially the first two stages which normally neglected by researchers in proposing a lean framework. Elements such as *'recognising the need for change'*, *'analysing the business for improvement opportunities'*, *'identifying indicators to measure performance'*, and *'creating a feedback mechanism'* are especially important in setting the direction for a lean journey (Hines and Taylor, 2000).

In addition, the framework presented biases towards top-down approach and carried out on discrete project basis which the implementation initiatives were mostly from the top management. For example, from establishing a pilot line to spreading the lean implementation to the whole organisation and across the boundary to external stakeholders, the activities were all initiated from the management level of the organisation. The transformation was likely to be executed by Kaizen team on Kaizen events basis (Van Aken *et al*., 2010). This is feasible at the initial stage in a lean transformation initiative but it is unlikely to sustain a lean enterprise without the transition of top-down approach into bottom-up approach in improvement activities

(Womack and Jones, 1996, Liker 2004). This transition makes every manager and shop floor leader a *sensei* or coach in improvement activities and every worker a proactive industrial engineer (Spear and Bowen, 1999, Flinchbaugh, 2003). This is particular important to transform an organisation into a self-learning organisation with everyone empowered and capable in continuous improvement.

Back to the comparison criteria by Anand and Kodali (2009, 2010), the implementation framework presented by Anvari *et al.* (2011) was indeed a good project based model with five stages of transformation to lean. Nonetheless, presented as a transformation plan at the enterprise level, the *'Why'* or *'reasoning'* criterion of the selection of TTPs at the micro level such as production level was not highlighted in their study.

g) Framework proposed by Wanitwattanakosol and Sopadang (2011)

- A proposed framework for lean manufacturing implementation in small and medium enterprises

Descriptions of the framework:

The lean production conceptual framework by Wanitwattanakosol and Sopadang (2011) was aimed for high-variety low volume manufacturer especially SMEs to achieve made-to-order capability. The framework contained two-phases with three interrelated components in the first phase. First component, re-engineering the business activity of an organisation with computer simulation software; second, applying value stream mapping to evaluate the process and identify waste; third, evaluating the supply base of an organisation. Second phase would be performing Just-in-Time production schedule by using ant colony optimisation algorithms with simulation tool.

Comments:

This is a conceptual framework for lean supply chain optimisation management rather than for shop floor production management. However, in high-variety low volume manufacturing environment, the management of supply base is very important to keep

the manufacturer operates at made-to-order fashion. Computer simulation, value stream mapping and Just-in-Time scheduling method are among the suitable TTPs to be used in this context. But how to integrate the lean supply chain and lean production was not deeply discussed in this study. Lastly, the relevant internal stakeholder for each of the proposed TTP was not considered.

h) Framework proposed by Vinodh *et al.* (2011)

- A lean sigma framework for automotive valves manufacturers

Descriptions of the framework:

The lean sigma framework proposed by Vinodh *et al.* (2011) incorporated Six Sigma methodology, DMAIC (Define, Measure, Analyse, Improve and Control) with lean TTPs such as value stream mapping, waste elimination, set-up reduction and etc. First, *Define* phase identified the goals and value of a project. It included value stream mapping of current state to identify value and waste in the streamline of activities. Next, *Measure* phase established the baseline metrics for measurement. The metrics were crucial to the next three phases to ensure improvement outcomes meet the identified problems. Third, *Analyse* phase involved root-cause analysis to trace the critical contributory factors to the problems defined. Fourth, *Improve* phase generated solutions based on the identified root causes to the problems. It involved establishing improvement ways to achieve future state. The last phase, *Control* phase was to sustain the improvement gains. A control plan and documentations of improvement were needed to ensure the sustainability of the improvement over time.

Comments:

Similar to organised Kaizen event execution (Shimizu, 2004, Van Aken *et al.*, 2010), this framework would be executed on project basis to solve a specific problem, as shown in their case study to improve the first-time-right; the improvement initiative was directed from top (i.e. management, engineers) to bottom (i.e. those selected shop floor associates into the event) (Vinodh *et al.*, 2011). For 'how' to implement the

framework, the steps were clearly described. By following the DMAIC improvement cycle, the lean TTPs were grouped and executed in phases. Selection of lean TTPs and the reason behind using the selected TTPs were also apparently and evidently shown in their case study. Again, if project based improvement activity is carelessly implemented, the beneficiaries will be only those involved in the event. Especially at the shop floor, not all the employees will be benefited throughout the process.

i) Framework proposed by Bortolotti and Romano (2012)

- A lean management framework for service sector

Descriptions of the framework:

In their study to investigate the use of lean management methodology in pure service sector (with almost total absence of material flow), Bortolotti and Romano (2012) derived a framework to evaluate and analyse the process of waste elimination and automation implementation (via Information System mechanisms) in service sector activities. The framework consisted of two main phases which were known as '*Lean first*' and '*then Automate'*. The idea of '*Lean first*' was using the lean tool, value stream mapping to map and identify waste in the streamlines of service activities. After the value and waste in the 'current state' of a streamline were determined, a 'future state' map would be designed by process re-mapping in conjunction with waste elimination. In the second phase '*then Automate*', both manual operations and automated processes would be re-evaluated. The portion of manual operations would need to be further reduced by improving the software user-interface, control and automation. In the last step, the improvement would be monitored and controlled with pre-defined metrics to ensure it is sustainable. For further improvement, another cycle of '*Lean first then Automate*' could be started again if necessary.

Comments:

Generally, it was also a framework for process improvement similar to Kaizen event execution (Van Aken *et al.*, 2010), which to be carried out on project basis. It was

however useful not only in service sector, but in manufacturing environment to re-evaluate and improve any manual or semi-automated machine and equipment. From the technical view, by looking at the steps of improvement, this framework was designed for technical personnel such as software developer or engineers who work in automation arena. It could serve as guidelines for them to follow when re-design and improve the service or production activities. In the sense of *how to implement*, it did clearly describe the flow of implementation. From the *reasoning* or '*why*' aspect, it showed that automation should be applied at the value-added activities after wastes had been eliminated. If not, problems might arise and thus slow down the flow or create more errors in the process. Since this study focused on service sector, not many lean TTPs that used in manufacturing sector were discussed or included in the framework.

j) Framework proposed by Suhartini *et al.* (2012)

- A proposed Kaizen framework of Set-Parts Supply implementation in assembly line

Descriptions of the framework:

The lean system Kaizen framework shown by Suhartini *et al.* (2012) was adopted from production system by Proton, the Malaysian auto-manufacturer. Proton Production System (hereafter PPS) was based on the principle of Toyota production system and built at the foundation of waste elimination at the shop floor operation. There were four fundamental principles in PPS: (a) visual management and philosophy; (b) stable and standardise process; (c) Just-in-Time (JIT) and *Jidoka;* and, (d) *Kaizen,* also known as continuous improvement.

From the case study of set-parts supply implementation at Proton Tanjong Malim assembly plant, Suhartini *et al.* (2012) presented a typical improvement or Kaizen event in the trim and final shop. To avoid unsystematic shop floor management, Proton decided to implement set-parts supply where the set of parts were put on the trolley and pushed to the assembly line. This problem solving and improvement framework shown in the case study was based on the principles of PPS and it was

started from Gemba Walk to understand the real situation at the shop floor. Problem solving tools such as 5-why, Fishbone diagram and PDCA to evaluate and analyse the problem were carried out next. Time and motion study at the assembly line and takt time were re-studied. Size and number of rack and trolleys were studied to cope with the takt time. Kanban and visual tools were designed to attach with the trolleys. Poka-yoke was designed to improve the flow of trolleys and ergonomics of workers.

Comments:

As an improvement implementation framework, this framework indeed presented the flow of a Kaizen event and its implementation biases towards top-down approach. The stages of the implementation and the TTPs to be used were clearly shown in the framework. It is understood that this framework was just part of the PPS and was applied in a particular situation as shown in the case study Suhartini *et al.* (2012). However, it did represent a well-designed, systematic problem solving and improvement methodology which is the foundation of a lean system execution at the manufacturing floor.

k) Frameworks proposed by Salimi *et al.* (2012)

- A lean manufacturing framework for Malaysian automotive and heavy machinery industries

Descriptions of the framework:

Salimi *et al.* (2012) presumed that application of lean TTPs would improve the operation performance of an organisation and the application of TTPs was different from industry to industry. The purpose of their study was to identify the preferences of TTPs in between automotive and heavy machinery industries to prevent the general problems of unstructured lean implementation without priority in the selection of TTPs. The TTPs identified at each of the industries would assist the managers in selection of TTPs and implementation of lean production system.

Comments:

As a summary, the framework of lean TTPs selection by Salimi *et al.* (2012) did not include the implementation aspect (i.e. how to implement) but just merely a bundle of TTPs identified. Also, the relevant internal stakeholder for each of the proposed TTP was not highlighted.

l) Framework proposed by Syed Ahmad (2013)

- A lean culture instillation framework

Descriptions of the framework:

The conceptual framework proposed by Syed Ahmad (2013) aimed to instil lean culture in an organisation. People's mind-set and daily continuous improvement activities were the foundation to build Toyota's lean culture. Other identified factors that would affect the nurturing of lean culture were organisational culture, national culture and the working culture of people.

Comments:

The study by Syed Ahmad (2013) however did not discuss much about the *'people's behaviour'* which is the most important factor in changing an organisation's culture into lean (Emiliani 1998a, 1998b, Hines *et al.* 2008). Also, how to relate the lean TTPS and lean culture instilling was not discussed in his study as well, though it is understood that daily improvement activities is one of the foundation to build Toyota's lean culture (Shingo, 1989, Dennis, 2007).

m) Framework proposed by Karim and Arif-Uz-Zaman (2013)

- A lean implementation framework for manufacturing organisations

Descriptions of the framework:

Karim and Arif-Uz-Zaman (2013) summarised all the essential components of lean implementation into a single framework and developed a systematic lean

implementation methodology based on the lean principles of Womack and Jones (1996). Their main objective was to implement lean tools in manufacturing processes as well as to develop continuous improvement techniques within organisations. Organisation context considerations such as production type, order volume and demand quantity, and etc. needed to be considered when selecting the appropriate lean implementation strategies. Lean improvement performance metrics were selected and incorporated into their framework.

In the first phase of the framework, *Value Proposition*, a company has to consider its own organisation and production characteristics such as product type, product life cycle, order volume and etc. This was important to ensure the implementation of the selected lean strategies and TTPs able to meet company's goals. Cross functional lean team would then be formed. Their main task was to organise people and resources to implement lean. In the second phase, *Value Stream*, performance metrics such as time, cost, quality and flexibility were to be established. The next step was to use value stream mapping and time-motion study to identify waste in production processes and operations. In the third phase, *Flow*, waste minimization was the core objective. The selected lean TTPs should help to reduce waste and must not increase other non-value-added activities at the same time. The selections of the right TTPs at the right time, within project budget and suit the company's characteristics were crucial. During the TTPs implementation, operation performance was needed to be re-evaluated continuously to ensure the selected TTPs or strategies meet company's objectives. The fourth phase, *Pull* was to ensure smooth flow of products with minimum non-value-added activities. In the final phase, *Perfection*, the culture for continuous improvement techniques would be developed and every staff related to process has to change their mind and attitude.

Comments:

In their study, Karim and Arif-Uz-Zaman (2013) emphasised that the selection and formulation of lean strategies and TTPs should always fit the company's production characteristics. They advocated that lean practitioners should consider the '*why*'

dimension when selecting lean TTPs. Lean practitioners should understand their own situation and should know the reason behind the application of each lean TTP. The implementation flow of this framework was biased towards top-down approach which is similar to the execution of Kaizen event under the lead of a steering team (Van Aken *et al.*, 2010). Though the last phase of the framework emphasises perfection and long term sustainability of lean by organising more Kaizen activities but how to ensure everyone especially shop floor employees are benefited or influenced from the lean transformation hence change their working attitude was not discussed in the study.

n) Framework proposed by Jagoda *et al.* (2013)

- A continuous improvement model for productivity improvement

Descriptions of the framework:

The conceptual framework proposed by Jagoda *et al.* (2013) aimed to improve productivity continuously particularly via bottom-up approach. There were five important implementation elements with three critical inner steps within each element. These three inner steps were *activities*, *behaviour* and *outcome*. In the first element at the macro level, *Focus*, it was essential to identify target of improvement (even for the production supervisors and workers) to pursue. The next element, *Measure*, it was to develop metrics to ensure practitioners stay focus at the direction towards the earlier define improvement target. Metrics also served as feedback on performance and informed the practitioners about their position along the direction towards their targets. The third element, *Communicate* determined the effectiveness of an improvement programme. The ability of an organisation in transmitting accurate, relevant and understandable information among its employees reflected the effectiveness of an improvement programme. Well-established communication channels in an organisation could accelerate the speed of improvement thus built sustainability into the process. In the fourth element, *Innovation and Improvement*, the passion and involvement of all the employees were important. Highly motivated employees with adequate problem solving skills were the foundation of any

improvement programme to achieve its objectives. The last element, *Evaluation* required a reflection and revisiting of the previous actions. By evaluating the progress of improvement at regular intervals, adjustments could be made on an on-going basis. Since these five elements at the macro level recurred in repeating sequences or in cycles, the *Evaluation* element would normally become the activator to start again another improvement cycle by reviewing the previous improvement steps. When implementing these five macro elements, Leadership was the core element towards the success of the improvement programme. The employees need to be led and coached throughout the whole improvement cycles. Leadership created a more controlled environment hence reduced chaos and overall lost time during the improvement implementation.

Comments:

Though the main theme of the framework proposed by Jagoda *et al.* (2013) was not about lean production system, but it was a good example or reference to be used by lean practitioners. Different from the previous discussed frameworks, this was the only framework emphasised on bottom-up approach improvement which was often neglected by previous researchers. Towards total involvement in improvement as advocated by Toyota, this framework could serve as guidelines for lean practitioners to develop and involve their workers in lean activities, if integrating with lean philosophy or lean principles. Several lean practices such as waste identification and elimination at the production line, 5S, set-up reduction, total productive maintenance and other TTPs which require greater involvement of shop floor employees could be incorporated into this framework and serve as guidelines for lean practitioners. But above all, employees' problem solving capabilities, waste identification and elimination skills should be developed at the first place.

2.4.4 Summary of the frameworks analysis

The analysis of the frameworks in Section 2.4.3 is summarised in Table 2-2.

No	Authors	Year	Analysis Criterions			
			'How'	'Why'	'Who'	Top-down / Bottom-up
1	Anand and Kodali	2009	Yes	No	Yes	Top-down
2	Upadhye *et al.*	2010	No	No	No	Top-down
3	Rose *et al.*	2010	No	No	No	Top-down
4	Van Aken *et al.*	2010	Yes	No	Yes	Top-down
5	Amad-Uddin	2011	No	No	No	Top-down
6	Wong and Wong	2011b	Yes	No	No	Top-down
7	Anvari *et al.*	2011	Yes	No	No	Top-down
8	Wanitwattanakosol and Sopadang	2011	No	No	No	Top-down
9	Vinodh *et al.*	2011	Yes	Yes	No	Top-down
10	Bortolotti and Romano	2012	Yes	Yes	No	Top-down
11	Suhartini *et al.*	2012	Yes	No	No	Top-down
12	Salimi *et al.*	2012	No	No	No	Not shown
13	Syed Ahmad	2013	No	No	No	Top-down
14	Karim and Arif-Uz-Zaman	2013	Yes	Yes	No	Top-down
15	Jagoda *et al*.	2013	Yes	No	No	Bottom-up

Table 2-2: Summary of the framework analysis

2.5 Research Gap

Lean is a people-centred production system based on the concepts of 'Employee Involvement' and Kaizen (Koenigsaecker 2009). 'Employee Involvement' is the most important element to instil lean culture in an organisation and to succeed any lean transformation (Dennis, 2007, Hines *et al*., 2008, Koenigsaecker, 2009). Ironically, the identified problems and barriers in lean system adoption were mainly centred at *'company had failed to engage shop floor employees'*. One of the most common barriers in lean transformation was *'lacking of skill or technical knowhow'* in practicing lean or Kaizen amongst the shop floor employees, including supervisory staffs (Coetzer, 2006, LEI, 2007, Mohanty *et al.*, 2007, Gagnon *et al.*, 2008, Sim and Rodgers, 2009, Sokalski *et al.*, 2010, Bhasin, 2012a). After reviewing 15 lean frameworks, it was found that top-down approach was however the main focus of the literatures; bottom-up approach emphasising more on the shop floor employees' initiatives in carrying out lean or Kaizen activities have been overlooked.

After consolidating the problems, barriers and weaknesses found in the literature review, the research gap for this study was identified:

- *The previous studies about lean implementation were focused on top-down approach while bottom-up approach has been neglected. It had caused the problems such as company had failed to engage shop floor employees into lean activities and workers were lacking of technical knowhow to practice lean.*

To close the gap, a study about bottom-up approach lean implementation is needed to investigate how to encourage shop floor employees' involvement in lean or Kaizen activities.

In order to understand *how* to do the above, the question was further boiled down to:

- *What are the key areas in Kaizen should a company focuses in order to involve shop floor employees into the improvement activities?*

- *What are the critical success factors that determine the extent of 'Employee Involvement' in the mentioned Kaizen areas? (or why the extent of 'Employee Involvement' in high or low?)*
- *What are the approaches (how) to encourage bottom-up Kaizen initiative from the shop floor employees; and to instil Kaizen mind and culture at the shop floor?*

Chapter summary

This chapter had described in detailed what Lean Production System is and also explained why Kaizen and 'Employee Involvement' are the two fundamental elements of lean. It also unveiled the problems and barriers that the lean practitioners encountered when trying to engage shop floor employees into lean transformation in both general and Malaysian context. The chapter continued with the review of lean implementation frameworks and identification of their weaknesses. Lastly, by consolidating the problems and weaknesses above, this chapter ended with the research gap identified for this study.

3 AIM, OBJECTIVES AND RESEARCH METHODOLOGY

3.1 Introduction

This chapter first presents the aim and objectives of this research. It explains as well why Company A was selected as the respondent company for the case study; followed by the research methodology to explain how this case study was carried out.

3.2 Aim and Objectives

3.2.1 Research aim

Lean is a people-centred production system based on the concepts of 'Employee Involvement' and Kaizen. The aim of this research was to investigate shop floor employees' involvement (including supervisory staffs) in lean implementation or Kaizen activities in a Malaysian automotive parts manufacturer leading in lean; and to propose a bottom-up lean conceptual model and its implementation roadmap to provoke involvement of shop floor employees in Kaizen.

3.2.2 Objectives

1. To identify the focus areas of Kaizen at Toyota and the critical success factors that would influence the extent of shop floor employees' involvement in Kaizen activities.

2. To investigate the extent of shop floor employees' involvement (including supervisory staffs) in Kaizen activities at the identified focus areas of Kaizen in a Malaysian automotive parts manufacturer.

3. To evaluate the critical success factors that influence the extent of shop floor employees' involvement (including supervisory staffs) in Kaizen activities at the identified focus areas of Kaizen in a Malaysian automotive parts manufacturer.

4. To propose a bottom-up lean conceptual model and its implementation roadmap to provoke involvement of shop floor employees in Kaizen for Malaysian automotive parts manufacturers.

5. To validate the proposed bottom-up lean conceptual model and its implementation roadmap by lean experts from both academia and industry.

3.3 Research methodology

3.3.1 Choice of research method

The aim of this study was to investigate shop floor employees' involvement (including supervisory staffs) in a company's lean or Kaizen activities. The intention was to explain *why* the employees' involvement is *high* or *low*. This type of *explanatory* study is suitable to be carried out via case study (Yin, 2009). Besides, case study is also often used to illustrate problems and to indicate good practices from people's experiences so the data it presents would be strong in reality (Cohen et al., 2000, Blaxter *et al*., 2006). Thus, it could help the author to probe deeply and to analyse intensively the critical success factors that would influence the shop floor employees' level of Kaizen involvement which were important in formulating a lean model. With the reasons given above, case study method was chosen for this research.

3.3.2 Case study targeted company – Company A

The case study was carried out at a Malaysian automotive parts manufacturer (known as Company A) with 7-years of intensive lean implementation experience. As mentioned in Section 1.2, there were total 87 companies participated in the 5-years MAJAICO-A1 programme. Company A was the overall winner of the 2-years MAJAICO LPS Model Company Programme (2009 – 2011, *as part of the MAJAICO-A1 programme*), out of 13 selected Model Companies.

The 2-years MAJAICO LPS Model Company Programme was the Malaysian government's project to select good performance companies in lean implementation to be the role models for other companies in the automotive industry in future. As one of the objectives of MAJAICO programme, local lean trainers from the Model

Companies would be teaching other automotive parts manufacturers in lean implementation in future years (MAI, 2011a, 2011b). By learning the way the Model Companies in lean adoption, the success rate for those companies which new in lean could be assured. Thus, the approaches of lean implementation for those new companies in lean would be similar or identical to the Model Companies.

The selected company was the critical case for this study as it was the best Model Company (as an overall winner) in lean implementation amongst the Malaysian automotive parts manufacturers and able to represent the Malaysian automotive industry in large. Besides, since other manufacturers (new in lean) would replicate or learn the approach of Model Companies in lean implementation, what happened to the Model Companies along their lean journey might be happened to others. Thus, the generalisation of the findings from this study could be assured.

3.3.3 Research plan

Table 3-1 shows the research plan to carry out this study which consists of five phases based on the research objectives in Section 3.2. In each phase, the key tasks were planned with the desired deliverables.

Phases	Key tasks	Deliverables
1. To **identify** the **focus areas of Kaizen at Toyota** and the **critical success factors** that would influence the extent of shop floor employees' involvement in Kaizen activities.	- Task 1.1 – **Literature review** to identify the focus areas of Kaizen at Toyota and the critical success factors of 'Employee Involvement'.	- Kaizen focus areas and critical success factors identified. (see more details in explanations below)
2. To **investigate** the **extent of shop floor employees' involvement** (including supervisory staffs) in **Kaizen activities** at the identified focus areas of Kaizen in a Malaysian automotive parts manufacturer.	- Task 2.1 – Based on the reviewed literature, **formulate a theoretical framework** to show the relationship between the critical success factors and the extent of 'Employee Involvement'. The framework would serve as the base for questionnaire development. - Based on these identified lean theories, **formulate research propositions** for further investigation on the mentioned relationship.	- A theoretical framework with research propositions formulated. (*The research propositions focussed on how each critical success factor would influence the extent of 'Employee Involvement'*.)

	-Task 2.2 – **Develop survey and interview questionnaires** - to investigate the extent of shop floor employees' involvement in Kaizen; and - to investigate the influences of the critical success factors to the extent of shop floor employees' involvement in Kaizen.	- Interview and survey questionnaires which addressed to different group of respondents based on different investigation dimensions developed. (see explanations below)
	-Task 2.3 – **Validate the questionnaires** by lean experts.	- Questionnaires validated and finalised.
	-Task 2.4 – **Carry out the survey and interview** using the developed questionnaires at the targeted company.	- Data collected via survey on the extent of shop floor employees' involvement and the influences of each critical success factor; via interview to collect data about the approach of lean adoption by the targeted company.
	- Task 2.5 – **Analyse the survey results** - to compare the extent of shop floor employees' Kaizen involvement.	- Comparison of the extent of shop floor employees' Kaizen involvement (*see explanations below*)
3. To **evaluate the critical success factors that influence the extent of shop floor employees' involvement** (including supervisory staffs) in Kaizen activities at the identified focus areas of Kaizen in a Malaysian automotive parts manufacturer.	- Task 3.1 – **Analyse the interview results** – to investigate the approach of lean implementation of the targeted company.	- Reasons (*why*) for the selection of lean adoption approach; and *how* they implement lean.
	- Task 3.2 – **Analyse the survey and interview results** – to **evaluate the influences** of the **critical success factors** to the extent of shop floor employees' involvement in Kaizen.	- Influences of each critical success factor analysed.
	- Task 3.3 – **Validation of the empirical findings and results analyses** by experts.	- Empirical findings and results analyses validated.
4. To propose a **bottom-up lean conceptual model and its implementation roadmap** to provoke involvement of shop floor employees in Kaizen for Malaysian automotive parts manufacturers.	- Task 4.1 – By incorporating the critical success factors, **devise a bottom-up lean conceptual model and its implementation roadmap.**	- A bottom-up lean conceptual model and its implementation roadmap formulated.
5. **To validate** the proposed **bottom-up lean conceptual model and its implementation roadmap** by lean experts from both academia and industry	- Task 5.1 – **Validate the lean model and its implementation roadmap** by lean experts.	- Validated bottom-up lean conceptual model and its implementation roadmap.

Table 3-1: Research plan

The following describes the key tasks implemented for each phase in the research plan.

Phase 1:

Task 1.1: Literature review was carried out for 2 purposes: First, to identify the focus areas of Kaizen at Toyota i.e. to find out suitable Kaizen areas for the involvement of supervisory staffs and production operators. Second, to identify the critical success factors that would influence the extent of involvement of the shop floor employees in Kaizen or lean activities.

Deliverables: *(Extracted from Section 4.2)*

10 Kaizen Focus Areas

K1 - Workstation Safety Kaizen
K2 - Operation Standard Kaizen
K3 - Quality and Efficiency of Work Kaizen
K4 - Workers' Interest and Adaptability at Work Kaizen
K5 - Production Output Quality (vs defects) Kaizen
K6 - Quality of Working Environment Kaizen
K7 - Production Workstations or Cell Layout Kaizen
K8 - Time of Production Kaizen
K9 - Waste of Input / Output Kaizen
K10 - Number of Workers Reduction Kaizen

Critical Success Factors of 'Employee Involvement'

F1 - Top management's commitment
F2 - Shop floor employees' commitment and technical capability
F3 – The stage of lean transformation
F4 - Shop floor responsibilities assignment

Phase 2:

Task 2.1: By consolidating the lean theories reviewed from literatures, a theoretical framework was formulated to show the relationship between each critical success factor to the extent of 'Employee Involvement'. It functions as the cornerstone and guidelines for questionnaire development and the investigation subsequently. Four main propositions* were formulated based on the identified critical success factors.

The propositions* were formulated based on lean theories which focussed on how each critical success factor would influence the extent of 'Employee Involvement'.

For example:- *High level of top management's commitment will have positive influence on the shop floor employees' (including supervisory staffs) degree of involvement in Kaizen (or continuous improvement) activities.* (see Chapter 4 for more details).

Task 2.2: The data collection was divided into two main streams i.e. survey and interview. The formulated theoretical framework was transformed and deployed into smaller, questionable and measureable investigation

dimensions*.

(Different investigation dimensions for *the extent of involvement in Kaizen activities* at the identified Kaizen focus areas; and each *critical success factor* were identified before drafting the questionnaires.)

Questionnaires for both survey and interview were then developed and designed by distributing the investigation dimensions to the targeted group of respondents (internal stakeholders) according to their job roles.

Investigation dimensions* *- For instance, when trying to probe top management's commitment, the focuses of investigation were divided into different dimensions such as training provision, policy deployment, communication channel, etc. And these dimensions would be also addressed to different group of respondents (i.e. HR, Engineers, Shop floor employees) for the sake of multiple sources of inputs (see Section 4.3 for more information).*

Targeted group of respondents (interview) *– Lean Coordinator*

- The interview questions mainly covered the investigation on critical success factor, F3 – the stage of lean transformation. Questions were related to their approach of lean implementation, their lean journey, and issues about 'Employee Involvement' in their lean approach.

Targeted group of respondents (Survey) *– Top management, HODs / Middle managers, HR, Engineers, Supervisory staffs and Production operators.*

- The survey questions mainly covered the investigation on the extent of involvement in Kaizen activities, and the influences of other critical success factors (F1, F2, F4), besides F3.

For more information, refer to Section 4.3.

Task 2.3: The questionnaires together with the theoretical framework were reviewed and validated by lean experts to ensure its validity. Comments from reviewers were taken with amendments on the questionnaires.

Task 2.4: Survey questionnaires were sent to the targeted company. Due to internet accessibility and IT literacy constraints (mainly amongst the shop floor employees), the questionnaires were prepared in hard copies.

Two weeks after receiving the answered survey questionnaires, a semi-structured interview was subsequently conducted with the Lean

Coordinator to find out in details about their approach of lean and their current stage of lean transformation. After the interview, a report with the interview contents was sent to the Lean Coordinator for his clarification and permission to use in thesis.

The data collected from both survey and interview were interpreted and grouped according to the relevant critical success factors.

Task 2.5: By analysing the survey results, the extent of shop floor employees' involvement in each Kaizen focus area of the targeted company was compared internally between each hierarchy and externally with Toyota's practices.

Phase 3:

Task 3.1: By analysing the interview results, the approach in lean implementation adopted by the targeted company were evaluated; whether top-down with leadership from the management or bottom-up initiative by the workers (on the aspects of *why* the approach was selected and *how* it was implemented).

Task 3.2: By analysing both the survey and interview results, the influences of each critical success factor on the shop floor employees' extent of Kaizen involvement were evaluated.

Task 3.3: The empirical findings and results analyses were validated by two experts from academia and a Malaysian lean expert to ensure its validity and results reliability.

Phase 4:

Task 4.1: Based on the critical success factors, a bottom-up lean conceptual model and its implementation roadmap were developed by incorporating the critical success factors.

Phase 5:

Task 5.1: A lean expert from academia and two lean experts from Malaysian industry were selected to validate the proposed model and its roadmap. The validation focused on the rigorousness of the model and feasibility of the roadmap. Comments given by the reviewers were noted for future improvement.

Chapter summary

This chapter explained the research aim and objectives as well as the research methodology adopted for this project. Since it was explanatory type of study, case study was opted for the research. It explained as well why the case study was carried out at Company A. It also described how this research was carried out in five main phases in order to achieve the research objectives.

4 THEORETICAL FRAMEWORK AND QUESTIONNAIRE DEVELOPMENT

4.1 Introduction

Section 4.2 of this chapter illustrates how the theoretical framework and the research propositions were formulated; while Section 4.3 presents the overall methodology of how the questionnaires for this study were developed based on the theoretical framework.

4.2 Formulation of theoretical framework and research propositions

To carry out this case study, it was necessary to establish a theoretical framework based on lean theories which served as a cornerstone and guidelines for questionnaire development and its subsequent investigation. This theoretical framework aims to create an understanding of the causal relationship between the critical success factors of 'Employee Involvement' and the extent of shop floor employees' involvement in Kaizen activities.

According to Yin (2009), a previously developed theory could be used as a template to link the empirical results of a case study. This mode of generalisation is called *analytical generalisation*, which is not generalisation to a defined population that has been sampled, but to a wider applicability theory. This is another reason to establish the theoretical framework.

In establishing the theoretical framework, the focus areas of Kaizen at Toyota that could demonstrate the level of 'Employee Involvement' (Section 4.2.1) and the critical success factors that would influence the extent of 'Employee Involvement' were discovered (Section 4.2.2) via literature review. Thereafter, four main research propositions based on the relationship between the extent of 'Employee Involvement' in Kaizen and the influences of the critical success factors were subsequently formulated.

4.2.1 Kaizen focus areas

In order to probe the shop floor employees' extent of involvement in Kaizen activities, it was necessary to identify the focus areas of Kaizen at Toyota which could demonstrate *'the extent of involvement'*. Kaizen focus areas at Toyota are fundamentally divided into three main groups (Shimizu, 2004, Pardi, 2007). First, the **Top-down** or **Big Kaizen** – improvement activities for '*reducing number of workers'* and *'reducing the waste of input or output'*; these Kaizen normally do not involve front line employees and carried out when there is introduction of any new model or new styling. These Kaizen are carried out via top-down approach with leadership of top management and the involvement of engineers and senior supervisors. These Kaizen would normally decelerate to cease when improvement at the new production line moves toward stabilised. Second, the **Bottom-up** or **Small Kaizen** – activities of improvement on *'workstation safety'*, *'operation standard'* and *'quality or interest of work'*; these small Kaizen activities are usually carried out at team scale by team leaders and front line workers . These Kaizen activities have low or no impact on productivity. The third group of Kaizen**, Hybrid Kaizen** – improvement to '*reduce the time of production*', to improve *'output quality'*, *'layout of the line'* and *'quality of the working environment'* – are still carried out by front line workers but with active control of supervisors and engineers.

The above Kaizen focus areas identified by Pardi (2007) would be used in the survey questionnaire to gauge *the extent of involvement in Kaizen activities* of the employees at the targeted company for this study. To create a common understanding on the Kaizen focus areas amongst the respondents, the definition for each of the Kaizen focus area was clearly defined as follows:

*To prevent ambiguity in the survey questionnaires which would confuse the respondents, one of the bottom-up Kaizen areas – the improvement on '**quality or interest of work**' was further divided into two areas in this study, namely: '**quality and efficiency of work**' and '**workers' interest and adaptability at work**' (see **K3** and **K4** at explanations below).*

In short, the identified **10-Kaizen focus areas** were summarised as below:

K1 Workstation Safety Kaizen

- Kaizen to improve safety at work area such as improving work motions / ergonomics, removing potential hazards, etc.

K2 Operation Standard Kaizen

- Kaizen to improve production operation standard i.e. Standard Operation Procedure (SOP), Standard Work Sheets, information of working and inspection methods (control points and check points), etc.

K3 Quality and Efficiency of Work Kaizen

- Kaizen to improve work methods hence increase work quality, work efficiency and improve productivity (more value added motion than waste) such as better ergonomics or work motion, to prevent unnecessary motion and over-processing. It includes Kaizen to improve the use of (and design or modify of) tools and equipment.

K4 Workers' Interest and Adaptability at Work Kaizen

- Kaizen to improve workers' interest and adaptability at work such as improve on-the-job trainings to enhance workers' skills and working methods, improve multi-skill trainings and encourage job rotations to improve worker's flexibility and work varieties (richness in value).

K5 Production Output Quality (vs defects) Kaizen

- Kaizen to improve production output quality i.e. minimising defects by identifying abnormalities and reducing variation in process control, working methods, and machine fitness, etc.

K6 Quality of Working Environment Kaizen

- Kaizen to improve quality of working environment such as 5S and workplace organisation. Example, it will reduce the waste of time in looking for missing parts, or tools and equipment. It also includes cost reduction in the usage of direct production materials or components, consumable items (such as cutting tools, oils, etc.) for running the production.

K7 Production Workstations or Cell Layout Kaizen

- Kaizen to improve the layout design of production workstations, manufacturing cells or production line with the aims to improve parts or product flow, to prevent material handling or transportation wastes and excess inventory as well as overproduction.

K8 Time of Production Kaizen

- Kaizen to reduce processing / cycle time and set-up time by removing waste of over-processing, unnecessary motion, waiting, material handling and transportation.

K9 Waste of Input / Output Kaizen

- Kaizen to eliminate waste of input from and output to each production workstation or production line (*i.e. transportation waste of material handling, waste of waiting, unnecessary motion and excess inventory*).

K10 Number of Workers Reduction Kaizen

- Kaizen to improve productivity by optimising the number of workers required in a work cell or production line.

Note:
Kaizen K1 – K4 are classified as Bottom-up or Small Kaizen.
Kaizen K5 – K8 are classified as the Hybrid Kaizen.
Kaizen K9 – K10 are classified as Top-down or Big Kaizen.

4.2.2 Critical success factors of shop floor employees' involvement in Kaizen activities

As the findings via literature review, the identification of the four main critical success factors that would influence shop floor employees' level of involvement in Kaizen is presented in this section. It includes as well the formulation of the research propositions.

F1 - Top management's commitment

Top management's commitment is always the primary factor and the most significant to be considered in encouraging shop floor employee's involvement in lean activities (Boyer, 1996, Soriano-Meier and Forrester, 2002, Achanga *et al*., 2005, Hines *et al.*, 2008). Their commitment could be reflected from the following dimensions:

Training provision – Commitment of top management would affect training provision (Boyer, 1996, Coetzer, 2006, Sim and Rodgers, 2009). Less training would be provided if shop floor employees' development and involvement is perceived as less important (Achanga *et al.*, 2005). In return, the technical competencies of supervisors and workers would remain low and this would indirectly limit their extent of involvement in continuous improvement or Kaizen activities.

Communication channel – Commitment of top management would affect the establishment of communication channels between shop floor and management (Worley and Doolen, 2006, Sim and Rodgers, 2009). Not only does the information about company's latest update could not reach the shop floor employees, but also the voice and needs from shop floor could not be delivered to the management, if the top management is not committed to involve shop floor employees in company's improvement programme (Sim and Rodgers, 2009).

Policy deployment – Top management's commitment could also be reflected from the concept of *Hoshin Kanri* or Policy Deployment which they have to assign individual targets for each value stream down to the lowest possible level in the organisation's hierarchy i.e. shop floor employees. It is to ensure the whole organisation's direction is aligned with the vision of the top management (Gagnon *et al.,* 2008, Cudney, 2009).

Reward system – Top management's commitment in 'Employee Involvement' could be shown as well from the establishment of reward system and competitions (with

rewards) to stimulate shop floor associates' participation in company's improvement activities (Hines *et al*., 2008, Sim and Rodgers, 2009).

Career prospect – Lean transformation always comes with organisational change and the change might create fear amongst the shop floor employees (Hines *et al*., 2008). Hence, lack of top management's commitment in ensuring shop floor employees' career continuity and prospect would make the workers sceptical about their job security (Conti *et al.,* 2006, Hines *et al*, 2008, Sim and Rodgers, 2009).

Genchi Genbutsu – The crucial aspect about leadership and commitment is the direct involvement of managers or top management members in lean transformation. Their presence at the shop floor in leading lean or Kaizen activities is very important (Emiliani and Stec, 2004, Careira, 2005, Koenigsaecker, 2005, Bodek, 2008). Managers must not merely rely on reports or data provided by their subordinates instead they have to practice 'go to see', or known as *Genchi Genbutsu* in Japanese (Ohno, 1988, Koenigsaecker, 2009).

Kaizen activities deployment – In the aspect of employees' involvement in group problem solving activities, top management's commitment to engage shop floor employees into Kaizen would determine the flourish of quality circle and suggestion system activities of a company (Boyer, 1996).

Proposition 1*: Top management's commitment to involve shop floor employees (including supervisory staffs) in lean activities will have significant influence on shop floor employees' extent of involvement in Kaizen (or continuous improvement) activities.*

1a) *High level of top management's commitment on 'Employee Involvement' will have positive influence on shop floor employees' (including supervisory staffs) extent of involvement in Kaizen (or continuous improvement) activities.*

F2 - Shop floor employees' commitment and technical capability

a) Shop floor employees' commitment

Shop floor employees' commitment could be examined via the following dimensions:

Learning motivation and willingness to involve – Shop floor employees' motivation in learning and willingness to involve in lean would determine their extent of involvement in the company's improvement activities (Hines *et al*., 2008).

Production stability – Production stability would however affect shop floor employees' commitment (particularly the supervisory staffs) to practice or plan continuous improvement activities. If they spend most of their working time engaging in disturbances handling and progress chasing in fire-fighting manners, it would swallow up their valuable time to get involved in Kaizen activities (Lowe, 1993, Delbridge and Lowe, 1997). As advocated by Dennis (2007), standardisation is the foundation of improvement and it is built upon production stability. If the production is not stable i.e. machine is not reliable, worker' skill is low and material supply performance is not consistent; then daily activities of shop floor employees would be stuck in progress chasing and disturbance handling. Their role would be identical to 'buffer of the uncertainty'. Stability in 4Ms could free up the supervisory staffs and workers to contribute their effort and experience in planning, designing and participating the improvement activities of a company (Lowe *et al*., 1997, Morris *et al.*, 1998, Lowe *et al*., 2000, Dennis, 2007). This aspect must be handled with care.

Understanding of lean – Shop floor employees' understanding on the purpose of lean (which would help them work better) and the concept of waste would increase their commitment and buy-in to be involved in lean (Sokalski *et al*., 2010, Wong and Wong, 2011a).

b) Shop floor employees' technical capability

Shop floor employees' technical capability could be examined via the following dimensions:

Employees' confidence on their own technical capability – The worry of lacking of right skills to handle new tasks after lean transformation is the common barrier faced by shop floor employees (Hines *et al*., 2008). Given this circumstance, without confidence on their own technical competency would then hinder their initiative to be involved in Kaizen activities. Thus, workers should be taught on how to carry out Kaizen or improvement tools and activities (Achanga, 2005, Coetzer, 2005, Sim and Rodgers, 2009).

Utilisation of problem solving skills - How Toyota fosters Kaizen mind and skills to their workers is by unconsciously teaching them the problem solving tools such as PDCA, A3, GTS (Grasp-The-Situation) and 5-Whys (Spear and Bowen, 1999, Liker, 2004, Yamamoto and Bellgran, 2010). Only when the workers are competent in problem solving, their degree of involvement in Kaizen would be higher.

Educational background and local labour market – Besides internal training scheme of a company, the educational background and entry skills of supervisory staffs and workers would affect their confidence and level of technical competency to carry out Kaizen or lean activities (Lowe *et al*. 2000, Mason 2000, Seppla 2004). This indirectly refers to the quality of local labour market whether good workers are easily to be recruited.

Proposition 2*: Shop floor employees' (including supervisory staffs) commitment and technical capability will have significant influence on their extent of involvement in Kaizen (or continuous improvement) activities.*

2a) *High level of shop floor employees' (including supervisory staffs) commitment will have positive influence on their extent of involvement in Kaizen (or continuous improvement) activities.*

2b) *High level of technical competencies (such as problem solving skills) amongst shop floor employees (including supervisory staffs) will have positive influence on their extent of involvement in Kaizen (or continuous improvement) activities.*

F3 – The stage of lean transformation

The stage of lean transformation – As advocated by Womack and Jones (1996), top-down approach leadership in lean implementation is inevitable at the initial stage of lean transformation journey. However, it should be eventually changed to bottom-up approach by involving more shop floor employees and equipping them with the ability of problem solving and waste elimination to perform daily improvements.

The approach in lean implementation – Along their lean transformation journey, the selection of lean approach of a company would affect the level of involvement of shop floor employees in lean implementation (Lee and Jo, 2007). If the approach selected is solely to improve production performance i.e. productivity, quality, delivery; but not to empower worker and develop worker, the extent of shop floor employees' Kaizen involvement would be low.

Proposition 3*: The stage of lean transformation of a company will have significant influence on shop floor employees' (including supervisory staffs) extent of involvement in Kaizen (or continuous improvement) activities.*

3a) *High level of involvement of shop floor employees (including supervisory staffs) in Kaizen (or continuous improvement) activities will be expected when the company reaches the stage of transition from top-down leadership to bottom-up initiatives in continuous improvement.*

F4 - Shop floor responsibilities assignment

Shop floor responsibilities assignment – One of the factors contributing to the extent of 'Employee Involvement' is the responsibilities assigned to supervisors and workers. For example, if shop floor employees (especially supervisory staffs) are only assigned with direct production tasks without exposure to other technical responsibilities such as quality improvement, autonomous maintenance, preparation of Standard Operation Procedures, etc, this will limit their opportunities to learn new skills and to contribute in process improvement (Lowe 1993, Delbridge and Lowe, 1997, Delbridge *et al*, 2000). As shop floor leaders, the responsibilities of supervisory staffs or senior workers should not only focus on achieving production output targets but also to develop workers and carrying out improvements (Imai, 1997).

Work organisations at the shop floor – In lean working environment, workers should be organised in teams. Job rotations within the team or amongst the workers should be encouraged and carried out in a prescribed interval such as every hour, every shift, or every day (Karlsson and Ahlstrom, 1996, Forza, 1996, Olivella *et al*., 2008). This practice would train the workers to become multi-skilled and enrich their work contents.

Proposition 4*: Shop floor responsibilities assignment to shop floor employees (including supervisory staffs) will have significant influence on their extent of involvement in Kaizen (or continuous improvement) activities.*

4a) *Shop floor responsibilities assignment which involve and empower shop floor employees (including supervisory staffs) in more value-added activities such as improvement planning, daily machine maintenance, preparation of Standard Operation Procedures, etc. will have positive influence on their extent of involvement in Kaizen (or continuous improvement) activities.*

At a glance, the theoretical framework of the critical success factors that would influence shop floor employees' extent of involvement in Kaizen activities is summarised in Figure 4-1.

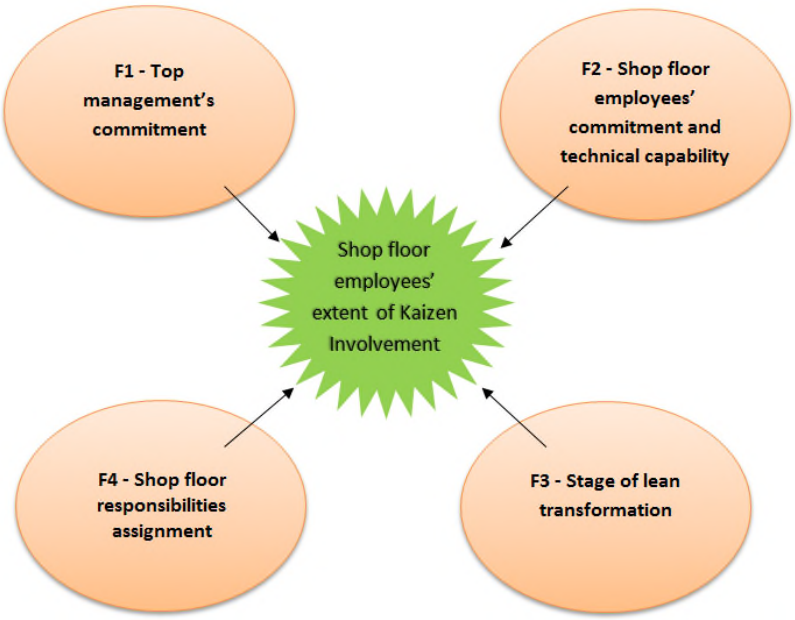

Figure 4-1: Theoretical framework of the critical success factors that would influence shop floor employees' extent of involvement in Kaizen activities

4.3 Questionnaire development

Section 4.3 presents the overall questionnaire development methodology for this study.

4.3.1 Dimensions of investigation

In order to carry out this empirical study, the developed theoretical framework needed to be transformed and deployed into smaller, questionable and measureable investigation dimensions. It was to ensure the empirical findings would be able to explain the influences of the critical success factors to the extent of 'Employee Involvement' hence a sensible conclusion could be drawn. For this reason, every dimension of investigation for both the ***extent of involvement in Kaizen activities*** (*see Part A*) and the ***critical success factors*** (*see Part B*) was defined.

Part A: Investigation dimensions for the extent of involvement in Kaizen activities:

This part of investigation was aimed to show an overview picture of *the extent of involvement* of each group of internal stakeholder in Kaizen activities at a company.

The investigation was divided into three main dimensions (see Table 4-1):

Where – where (or what) are the Kaizen activities

Who – who are the internal stakeholders involved in the Kaizen activities

How – how the internal stakeholders are involved in the Kaizen activities

Investigation dimensions for the extent of involvement in Kaizen activities:		
Dimension of 'Where' 10 Kaizen Areas K1 - Workstation Safety K2 - Operation Standard K3 - Quality and Efficiency of Work K4 - Workers' Interest & Adaptability at Work K5 - Production Output Quality (vs defects) K6 - Quality of Working Environment K7 - Production Workstations or Cell Layout K8 - Time of Production K9 - Waste of Input / Output K10 - Number of Workers Reduction	**Dimension of 'Who'** The questionnaire would investigate the '*level of involvement*' in Kaizen of the following internal stakeholders: i) Middle managers / HOD* ii) Production engineers iii) Production supervisory staff (supervisors and line leaders) iv) Production operators v) Specialist departments (i.e. Kaizen Team, QA/QC department, Maintenance & Engineering department) *HOD* - Head of department*	**Dimension of 'How'** The types of *'involvement'* were divided into 3 main categories: i) **Initiate** or suggest a Kaizen ii) **Lead** a Kaizen activity iii) Actively **participate** (as part of the problem solving team)

Table 4-1: The investigation dimensions for the extent of involvement in Kaizen activities

To explain in detail, the involvement types were divided into three main categories:

a) **Initiate** (or suggest) – *Identify and suggest the needs or opportunities for improvement (via formal suggestion system or informal / ad hoc basis).*

b) **Lead** the Kaizen process – *Lead the problem solving and improvement process (such as activities in small improvement team or quality circles).*

c) Actively **Participate** (as part of problem solving team) – *Actively participating in problem solving and improvement process (such as activities in small improvement team or quality circles).*

This part of survey questionnaire would be addressed to the **Engineers** of the targeted company for this study (see its explanations in Page 71, Section 4.3.2).

Measurement: **5-point Likert scale** would be utilised to measure the *extent of involvement in Kaizen activities* (see *Example Question 1* below).

Example Question 1:

Workstation Safety Kaizen (K1) – *Kaizen to improve safety in work area such as improving work motion or ergonomics, removing potential hazards etc..*

*a) Who **initiate** the Kaizen to improve safety at production workstation?*

Example of Selections of Answers:

i) Production Managers / HOD

5.Very frequent	*4.Frequent*	*3.Sometimes*	*2.Seldom*	*1.Not at all*

ii) Production Engineers / Executives / Officers

5.Very frequent	*4.Frequent*	*3.Sometimes*	*2.Seldom*	*1.Not at all*

iii) Supervisory Staff

5.Very frequent	*4.Frequent*	*3.Sometimes*	*2.Seldom*	*1.Not at all*

iv) Production Operators

5.Very frequent	*4.Frequent*	*3.Sometimes*	*2.Seldom*	*1.Not at all*

v) Specialist Departments (Example. HR (Safety officers), QA/QC personnel, Maintenance personnel, Engineering/Kaizen Team)

5.Very frequent	*4.Frequent*	*3.Sometimes*	*2.Seldom*	*1.Not at all*

*b) Who **lead** the Kaizen to improve safety at production workstation?*

*c) Who are **involved** in the Kaizen to improve safety at production workstation?*

*The similar **Selections of Answers** above would be given to the respondents for Questions b and c for each Kaizen area from K1 to K10.*

End of Example Question 1

For more details about the questions, see (Section A.2.5 of Appendix A).

Part B: Investigation dimensions for the critical success factors:

With reference to Section 4.2.2, the investigation dimensions for the critical success factors were identified and presented in Table 4-2.

Critical Success Factors	Investigation dimensions
F1 - Top management's commitment	**The investigation dimensions for F1 were as follows:** - Training provision - Communication channel - Policy deployment - Reward system - *Genchi Genbutsu* - Workers' career prospect - Deployment of Kaizen activities
F2 - Shop floor employees' commitment and technical capability	**The investigation dimensions for F2 were as follows:** **Shop floor employees' commitment** - Shop floor employees' learning motivation and willingness to involve - White-collared employees' perceptions of shop floor employees' learning motivation and willingness to involve - Production stability – 4Ms & 1E - Shop floor employees' understanding of lean and waste concepts **Shop floor employees' technical capability** - Shop floor employees' confidence on their own technical capability - White-collared employees' perceptions of shop floor employees' technical capability - Extent of problem solving skills utilisation and trainings attended - Educational background of shop floor employees and local labour market condition
F3 - The stage of lean transformation	**The investigation dimensions for F3 were as follows:** - The lean journey (until the current stage of lean transformation) - The approach of lean implementation - 'Employee Involvement' in lean transformation
F4 - Shop floor responsibilities assignment	**The investigation dimensions for F4 were as follows:** - Work organisation at shop floor - The extent of lean practices and activities - Shop floor responsibilities assignment • Production management tasks • Quality related tasks • Machine maintenance tasks • People management responsibilities • Off-the-line improvement tasks

Table 4-2: The investigation dimensions for the critical success factors of 'Employee Involvement'

<u>Some additional information to further explain the contents of Table 4-2</u>

- For **F2**, the *production stability* would be tested via the aspects of 4Ms and 1E: Man, Machine, Method, Material and Environment:

Man	*'Reliability' of workers on handling disturbances, their attendance to work, and ability in replacement of absentees.*
Machine	*'Reliability' of the major machineries without major breakdown which would cause line stop.*
Method	*'Reliability' of the parameters and settings stated in the SOP; for example, whether machine or process setup activities are always within the allocated time, without further calibrations or trial and error.*
Material	*'Reliability' of the delivery and quality of the suppliers' parts.*
Environment	*5S condition of the workplace*

- For **F3** which to find out *the stage of lean transformation* of a company, questions on their approach in lean implementation were considered when preparing the questionnaires. For instance, the reason they adopted lean, how lean was carried out, and how lean effort was spread across the production lines, and so on.

  Since the questions asked about *how* they adopt lean, it included as well *how* they involved shop floor employees in lean adoption (see Table 4-2 for the dimension of *'Employee Involvement' in lean transformation* in the factor F3).

- For **F4**, this part of questionnaire would first investigate how the workers were organised at the workplace (*work organisation*). For example, were they grouped in teams and having job rotations within the team at a prescribed interval?

  Second, the *extent of lean practices or activities* might have impact on shop floor responsibilities assignment hence it was included in the questionnaire. For instance, if a company implements Total Productive Maintenance which advocates autonomous maintenance (carried out by operators), it would affect the types of daily responsibilities assigned to workers where they have to perform some routine machine maintenance tasks.

  Lastly, the questionnaire would ask about how the following shop floor responsibilities were assigned amongst the internal stakeholders as follows:

Shop floor responsibilities	*Internal stakeholders*
-Production management tasks *-Quality related tasks* *-Machine maintenance tasks* *-People management & development* *-Off-the-line improvement tasks*	*-Engineers* *-Supervisory staffs (supervisors, line leaders)* *-Production Operators* *-Specialists Departments (QA/QC dept., Maintenance and Engineering dept., HR dept. etc)*

4.3.2 Strategies of data collection based on the dimensions of investigation

Selection of targeted respondents - As mentioned, this was a multifarious study. Due to richness in information, it was impossible to enclose all the questions for the entire investigation dimensions into only a homogenous set of questionnaire and addressed it to all the respondents. It would be too lengthy and time consuming for the respondents to answer all the questions. The questionnaires were thus divided into different sections customised for each targeted respondent groups who should be at the right position to answer. For example, Head of Department was aimed to answer the questions related to *F4: shop floor responsibilities assignment* and *production stability*; while Engineers were targeted for the questions related to *the extent of involvement in Kaizen activities.* The questionnaires should be distributed as evenly as possible to each targeted respondent group according to their ability in answering.

Choice of data collection – In the selection between interview and survey, the characteristics of each investigation dimension were considered in order to obtain optimum empirical findings to support the propositions. For example, semi-structured interview was opted for the factor, F3 – *the stage of lean transformation* because it involved lean approach of the targeted company, or *how* the company implemented lean. To address such a discovery oriented type of question with rich and deep data, interview method was selected instead of survey. Meanwhile, survey was chosen to gauge *the extent of involvement in Kaizen activities* (Table 4-1) and the influences of the other critical success factors, besides F3. This method would be less time consuming especially when the data has to be obtained from different targeted groups

of respondents. To sum up, both survey and semi-structured interview were adopted in order to provide a general picture about 'Employee Involvement' and lean transformation of a company.

Table 4-3 shows how the investigation dimensions were to be distributed to the suitable targeted respondents according to their job roles and positions in the company. It shows as well how the data were to be collected i.e. via survey or interview.

The selection of targeted respondent was important to ensure the information would be provided by the people at the right position.

Table 4-4 and **Table 4-5** show the final distributions of the questionnaires after rearranging the contents of Table 4-3 according to the targeted respondents.

Critical Success Factors	Investigation dimensions	Strategies for data collection These columns show how the data were to be collected from the targeted respondents according to the investigation dimensions and its method i.e. via survey or interview. **Distribution of the investigation dimensions**:	**Targeted Respondents**	**Method**
F1 – Top management's commitment	**The investigation dimensions for F1 were as follows:** - Training provision - Communication channel - Policy deployment - Reward system - *Genchi Genbutsu* - Workers' career prospect - Deployment of Kaizen activities	**i) Top management's commitment to encourage 'Employee Involvement' in lean** *This part of investigation included the following dimensions:* - General perception on their commitment *(CO1 – CO3)* - Training provision *(T1 – T6)* - Communication channel *(CC1 – CC2)* - Policy deployment *(PD1 – PD3)* - Reward system *(RW1 – RW2)* - *Genchi Genbutsu (GGB)* - Workers' career prospect *(CAR)*	Top management	Survey (5-point Likert Scale)
		ii) Shop floor employees' perceptions of top management's commitment. *This part of investigation included the following dimensions:* - Training provision *(SE_T1 – SE_T3)* - Communication channel *(SE_CC1 – SE_CC2)* - Policy deployment *(SE_PD1)* - Reward system *(SE_RW1 – SE_RW2)* - *Genchi Genbutsu (SE_GGB)* - Workers' career prospect *(SE_CAR1 – SE_CAR2)*	Supervisory staffs & Production operators	Survey (5-point Likert Scale)
		iii) Company's worker development policy - Training provision	HR Department	Survey (5-point Likert Scale)
		iv) Deployment of Kaizen activities at shop floor - Deployment of Kaizen activities	Engineers	Survey (Yes/No)
F2 – Shop floor employees' commitment and technical capability	**The investigation dimensions for F2 were as follows:** **Shop floor employees' commitment** - Shop floor employees' learning motivation and willingness to involve	**i) Supervisory staffs' perceptions of their own commitment and capability to contribute in lean** - Supervisory staffs' learning motivation and willingness to involve *(SUP_CO1 – SUP_CO6)* - Supervisory staffs' confidence on their own technical capability *(SUP_SKL1 – SUP_SKL2)*	Supervisory staffs	Survey (5-point Likert Scale)
		ii) Production operators' perceptions of their own commitment and capability to contribute in lean - Production operators' learning motivation and willingness to involve *(OPR_MUDA, OPR_CO1 – OPR_CO6)*	Production operators	Survey (5-point Likert Scale)

	- White-collared employees' perceptions of shop floor employees' learning motivation and willingness to involve - Production stability – 4Ms & 1E - Shop floor employees' understanding of lean and waste concepts **Shop floor employees' technical capability** - Shop floor employees' confidence on their own technical capability - White-collared employees' perceptions of shop floor employees' technical capability - Extent of problem solving skills utilisation and trainings attended - Educational background of shop floor employees and local labour market	- Production operators' confidence on their own technical capability *(OPR_SKL1 – OPR_SKL4)*		
		iii) Top management's perception of shop floor employees' commitment and capability in problem solving - Top management's perceptions of shop floor employees' learning motivation and willingness to involve *(MOTIV_1, 5S_OPR, MUDA_SUP, MUDA_OPR)* - Top management's perceptions of shop floor employees' technical capability *(SKILL1, SKILL2, SKILL_SUP, SKILL_OPR)*	Top management	Survey (5-point Likert Scale)
		iv) Engineers' perception of shop floor employees' commitment and capability in problem solving - Engineers' perceptions of shop floor employees' learning motivation and willingness to involve *(MOTIV_1, 5S_OPR, MUDA_SUP, MUDA_OPR)* - Engineers' perceptions of shop floor employees' technical capability *(SKILL1 – SKILL5, SKILL_SUP, SKILL_OPR)*	Engineers	Survey (5-point Likert Scale)
		v) Supervisory staffs' perception of production operators' commitment and capability in problem solving - Supervisory staffs' perceptions of operators' learning motivation and willingness to involve *(MOTIV_OPR, MUDA_OPR)* - Supervisory staffs' perceptions of operators' technical capability *(SKILL_OPR1-SKILL_OPR3)*	Supervisory staffs	Survey (5-point Likert Scale)
		vi) Production stability – 4Ms & 1E - *MAN, MACHINE, MATERIAL, METHODS, ENVIRONMENT,QUALITY AND LEADTIME*	HODs/Middle Managers	Survey (5-point Likert Scale)
		vii) Shop floor employees' understanding of Lean Production System and 7-Wastes concepts *Respondents were required to state the purpose of lean and example of waste (via open-question)*	Supervisory staffs & Production operators	Survey (Open-question)
		viii) Problem solving tools utilisation and attended problem solving trainings - PDCA, A3, 5-Whys, Fishbone diagram, Value stream mapping, 7QC Tools, Six Sigma (DMAIC)	Engineers	Survey (Both 5-point Likert Scale and Yes/No)
		ix) Educational background of shop floor employees* and local labour market condition - Survey questions for *local labour market condition* were prepared in 5-point Likert Scale; - Survey questions for *educational background of shop floor employees* were prepared in both open-question and customised multiple selections.	HR Department	Survey (5-point Likert Scale, open-question & customised multiple selections.)

F3 – The stage of lean transformation	**The investigation dimensions for F3 were as follows:** - The lean journey (until the current stage of lean transformation) - The approach of lean implementation - 'Employee Involvement' in lean transformation	**i) The lean journey (until the current stage of lean transformation)** **ii) The approach of lean implementation** **iii) 'Employee Involvement' in lean transformation**	Lean Coordinator	Semi-structured interview
F4 – Shop floor responsibilities assignment	**The investigation dimensions for F4 were as follows:** - Work organisation at shop floor - The extent of lean practices and activities - Shop floor responsibilities assignment	**i) Work organisation at shop floor** - Team organisations, job rotations, setup reduction practices etc.	HODs/Middle Managers	Survey (5-point Likert Scale and customised multiple selections)
		ii) The extent of lean practices and activities - *Lot size reduction, setup time reduction, Total Productive Maintenance, cycle time reduction, inventory level reduction, one-piece flow, pull, bottlenecks removal, pokayoke, waste elimination.*	HODs/Middle Managers	Survey (5-point Likert Scale)
		iii) Shop floor responsibilities assignment - Production management tasks *(PROD_1 – PROD_3)* - Quality related tasks *(QUA_1 – QUA_4)* - Machine maintenance tasks *(MTCE_1, MTCE_2)* - People management responsibilities *(PPL_1 – PPL_5)* - Off-the-line improvement tasks *(OFFL_1 – OFFL_3)*	HODs/Middle Managers	Survey (5-point Likert Scale)

Table 4-3: The distribution of the investigation dimensions to the suitable targeted respondents and the selection of data collection methods

Table 4-4 and Table 4-5 below show the final distributions of the questionnaires after rearranging the contents of Table 4-3 according to the targeted respondents.

#	Respondents	Distributions of the questionnaires
1	Top management	i) Top management's commitment to encourage 'Employee Involvement' in Lean ii) Top management's perception of shop floor employees' commitment and capability in problem solving iii) Open questions – Perceptions of the importance of 'Employee Involvement' and perceptions of the feasibility of 'Employee Involvement' in the company
2	HOD/Middle managers	i) The extent of lean practices and activities ii) Work organisation at shop floor iii) Shop floor responsibilities assignment iv) Production stability – 4Ms & 1E v) Production performance measurement* vi) Open questions – Perceptions of the importance of 'Employee Involvement' and perceptions of the feasibility of 'Employee Involvement' in the company
3	HR Dept.	i) Company's worker development policy (from the perspective of HR Department) ii) Local labour market condition iii) Educational background of shop floor employees
4	Engineers	**i) The extent of involvement in Kaizen activities (see Table 4-1)** ii) Deployment of Kaizen activities at shop floor iii) Problem solving tools utilisation and attended problem solving trainings iv) Engineers' perception of shop floor employees' commitment and capability in problem solving v) Open questions – Perceptions of the importance of 'Employee Involvement' and perceptions of the feasibility of 'Employee Involvement' in the company
5	Supervisory staffs	i) Supervisory staffs' perceptions of their own commitment and capability to contribute in lean ii) Supervisory staffs' perceptions of top management's commitment iii) Supervisory staff's perception of production operators' commitment and capability in problem solving iv) Supervisory staffs' understanding of Lean Production System and 7-Wastes concepts v) Open questions – Perceptions of the importance of 'Employee Involvement' and perceptions of top management's commitment
6	Production operators	i) Production operators' perceptions of their own commitment and capability to contribute in lean ii) Production operators' perceptions of top management's commitment iii) Production operators' understanding of Lean Production System and 7-Wastes concepts iv) Open questions – Perceptions of the importance of 'Employee Involvement' and perceptions of top management's commitment
Remarks: *Production performance measurement* - To show an overview about the company's production performance over the past three years on the aspects of quality, cost, productivity and delivery.*		

Table 4-4: The distributions of the survey questionnaires according to the targeted respondent groups

#	Respondents	Distributions of the questionnaires
1	Lean Coordinator	i) The lean journey (until the current stage of lean transformation) ii) The approach in lean implementation iii) 'Employee Involvement' in lean transformation

Table 4-5: The distributions of the interview questionnaire

Some additional information to further explain the contents of Table 4-4

- Engineers (Production Engineers)

In an organisation's hierarchy, Engineers (here, it is referred as Production Engineers) are the working group who work closely with shop floor employees while they also involve in management's decision making activities. Their appearance and mobility at production floor is considered the highest among white-collared employees. In the middle of company's hierarchy, they have the most opportunities to communicate with people from top (management) to bottom (shop floor workers). This enables them to know exactly the extent of involvement of each group of internal stakeholders in the Kaizen activities (see Table 4-1). With this reason, Engineers were targeted to answer the *extent of involvement in the Kaizen activities,* the *deployment of Kaizen activities at shop floor*, and also questions related to their perceptions of shop floor employees' technical capability and commitment; as well as *problem solving tools utilisation and attended problem solving trainings*.

- Open questions

At the final part of all the questionnaires, two open questions were prepared. It aimed to probe the opinions from respondents about the importance of 'Employees Involvement' to their company, its feasibility at their workplace (this question was enclosed to *Top management, HODs/Middle Managers, Engineers*) and top management's commitment on 'Employee Involvement' (for *Supervisory Staffs* and *Production Operators*).

4.3.3 Considerations of questionnaire design

Once the investigation dimensions and the targeted respondents had been defined, before heading to draft the questionnaires, the following considerations were taken into account:

- **Language** - English is not the first language for most Malaysian especially blue-collared factory workers (including supervisory staffs). Therefore, the questionnaires addressed to shop floor employees were translated into Malay language which is the national language of Malaysia.

- **General rules** for how to design good questionnaire such as easy to understand, clear, uniform and etc. were also taken into consideration. The objective of the questionnaire, deadline for feedback and statement of privacy protection were also enclosed at the cover page for each set of questionnaire.

4.3.4 References when drafting the questionnaires

To ensure *construct validity*, well-recognised lean literatures were referred when drafting and designing the questionnaires. The questionnaires were carefully designed with reference to the studies by Boyer (1996), Karlsson and Ahlstrom (1996), Golhar *et al*. (1996), Forza (1996), Delbridge *et al*. (2000), Sanchez and Perez (2001), Shah and Ward (2003), Lee (2004), Taj (2005), Shah and Ward (2007), Olivella *et al*. (2008), Rahman *et al*. (2010), according to the relevant investigation dimensions as presented in Table 4-2.

4.3.5 Scoring methodology and results judgement for survey questionnaires

Scoring methodology for survey questionnaires

Refer to Table 4-1 and Table 4-3, the measurements on *the extent of involvement in Kaizen activities*, *shop floor responsibilities assignment*, *the extent of lean practices and activities* and *the extent of problem solving tools utilisation* were based on 5-point Likert scale as follows:

5 Very frequent	*4 Frequent*	*3 Sometimes*	*2 Seldom*	*1 Not at all*

On the other hand, the measurements on the respondents' commitment and their perceptions of 'Employee Involvement', *production stability*, the opinions of HR about the *company's worker development policy* and *local labour market condition* were based on 5-point Likert scale as follows:

5 Strongly agree	*4 Agree*	*3 Somewhat agree*	*2 Disagree*	*1 Strongly disagree*

Refer to Appendix A for more about the questionnaire design.

Results judgement for survey questionnaires

For data interpretation and analysis, average scores for the items in each of the investigation dimension would be measured according to the scales as shown in Table 4-6. The same scale system was utilised by Bhasin (2012b) in his study about strategy in lean adoption.

Average score	***Scales***
4.5 – 5.0	*Strongly agree / Very frequent*
3.5 – 4.4	*Agree / Frequent*
2.5 – 3.4	*Somewhat agree / Sometimes*
1.5 – 2.4	*Disagree / Seldom*
1.0 – 1.4	*Strongly disagree / Not at all*

Table 4-6: Scale for judgement

From the author's subjective judgement, for the questions related to respondents' commitment and perceptions, *production stability*, opinions of HR about the *company's worker development policy* and *local labour market condition*; average score of 3.5 and above would be considered as '***committed***', '***agreed***' or '***stable***'.

Similarly, for the questions related to *the extent of involvement in Kaizen activities*, *the extent of lean practices and activities, problem solving tools utilisation* and *shop floor responsibilities assignment*; average score of 3.5 and above would be considered as '**frequent**' or '**in large extent**'.

Take an example from *production stability*, if the *delivery performance of supplier* was rated (by the respondents – the HODs/Middle Managers) with average score of 3.7; then the delivery performance of supplier would be considered as ***'stable'***.

The objectives of this research were to investigate the extent of shop floor employees' involvement in Kaizen and to evaluate the critical success factors that would influence the extent of 'Employee Involvement' such as commitment of people; thus the author reckoned that only variables with average score of 3.5 and above could provide strong and valid indicators to support the propositions.

4.3.6 Questionnaire validation

To enhance the questionnaires' validity, validation by lean experts was sought once the early draft was established. Two academics from Cranfield University with extensive lean production knowledge and two industrial experts with breadth of lean implementation experience from Malaysia were invited to review the questionnaires. Malaysian lean experts were chosen not only due to their knowledge and experience in lean but also their familiarity of Malaysian culture. For validation, attached together with the questionnaires were the research aim, objectives and the defined theoretical framework. Comments and suggestions given by the reviewers were noted for necessary amendments.

Chapter summary

This chapter first described how the theoretical framework and the four main propositions of the research were formulated. It explained as well how the investigation on the extent of involvement in Kaizen and its critical success factors were divided into smaller, questionable and measurable investigation dimensions. Prior to drafting the questionnaires, it explained as well how the investigation dimensions were distributed according to the targeted respondents and also the selection of data collection methods i.e. survey and interview. Besides, other considerations to design a good questionnaire were taken into account such as selection of language, question format, etc. The chapter listed as well the literatures that were referred when drafting the questionnaires; and explained the defined scoring methodology and results judgement adopted for the survey questionnaires. Lastly, the questionnaires were validated by lean experts.

5 DATA COLLECTION AND COMPANY INFORMATION

5.1 Introduction

This chapter first explains how the data were collected from Company A. It continues with the background information about Company A and also the targeted respondents.

5.2 Data collection

After receiving confirmation, Company A had appointed two representatives as liaisons for this project. They were the Lean Coordinator (at the position as a Senior Manager) and the senior executive from Human Resources Department (thereafter HR). The background information of the company such as workforce formation was provided by the HR and the number of targeted respondents for the survey were then finalised. Survey questionnaires in hard copies were then dispatched to the company.

After two weeks receiving the answered survey questionnaires, a semi-structured interview to investigate F3 – *the stage of lean transformation* of the company had been carried out via teleconferencing with the key informant, the Lean Coordinator. Some important supporting documents had been given by him via emails during the interview such as their project presentation files with information about their lean approach and lean journey. The interview lasted about three hours. Lastly, a report which documented the contents of interview was sent to the Lean Coordinator for his verification and permission to use in the thesis.

5.3 Company background information

Incorporated since 1980, Company A was one of the largest automotive shock absorber manufacturers located in Peninsular Malaysia. It was wholly owned by Malaysian with total number of employees ranging from 210 – 220 people. Its turnover per annum fell in the range of $25 million to $31 million (USD). Its main products were Strut (ST), Telescopic Shock Absorbers (SA), Gas Spring (GS), and PERFORMAX Shock Absorbers; with manufacturing capacity of about 200,000 units of SA and 100,000

units of GS. Its total number of customers exceeds 20 car manufacturers in the world and their main customers were Perodua, Toyota and Proton.

5.3.1 Organisation chart

Figure 5-1 shows the organisation chart of Company A. There were three manufacturing operational departments, i.e. the Production Department, Quality Assurance (QA) Department and Plant Engineering and Maintenance Department which reporting to the Deputy General Manager. There was a special department known as LPS Department which fully in-charge of lean production system planning and execution; and led by a senior manager i.e. the Lean Coordinator. Since 2012, the responsibilities of this department had been widen and they were later serving not only to Company A, but to other subsidiaries within the Suspension Division of the holding company. This department was later known as Manufacturing Kaizen Unit (MKU).

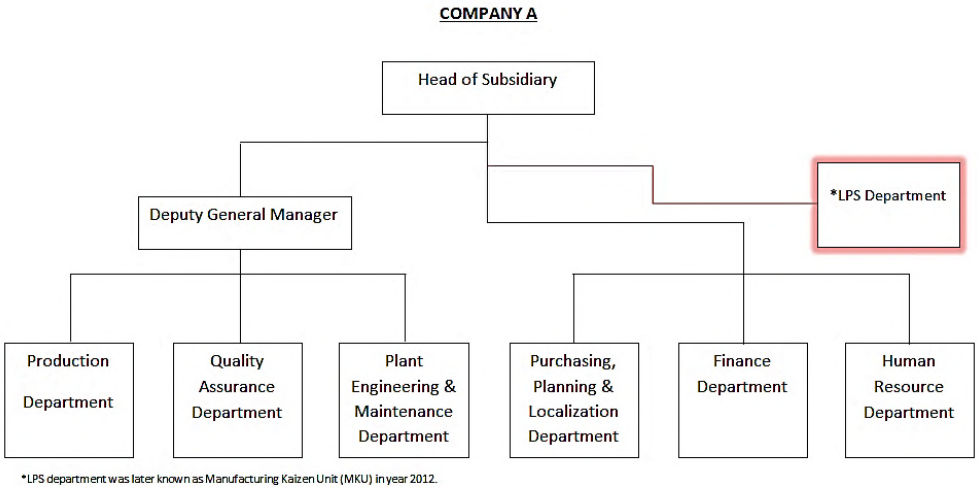

Figure 5-1: Organisation chart of Company A

5.3.2 Workforce background

The basic information about the workforce background of Company A which provided by the Human Resource Department is presented in Table 5-1:

Average age of employees	38 year-old
Average length of service	15 years
Job security	Layoffs are rare
Average annual personnel turnover	Less than 1%
Composition of production operators	51% - Malaysians 49% - foreign labours (from Nepal and Bangladesh)
Composition of officers, supervisors, and line leaders	All Malaysians
Employment term	All the local employees (Malaysian) were employed on full-time basis. Foreign labours were on contract basis. No part-time workers were hired.
The changes of the ratio between **indirect employees** (i.e. QC Inspector, Maintenance Technicians) and **direct production employees** (i.e. supervisors, line leaders, operators from Production department) in recent 3 years.	Stayed the same

Table 5-1: Workforce background of Company A

5.3.3 Educational background and recruitment of shop floor employees

Basic education

In percentage, the highest qualification for the following groups of employees in basic education is presented as follows:

	Supervisors	Line leaders	Operators
Basic education			
Primary school	-	-	-
*Secondary school (*PMR or equivalent)*	-	-	30%
*Secondary school (*SPM or equivalent)*	100%	100%	70%
Total	**100%**	**100%**	**100%**

**** PMR** (Penilaian Menengah Rendah, in Malay language) Lower Secondary Assessment (in English), is a Malaysian public examination taken by all Form Three students in secondary schools throughout the country.*
****SPM** (Sijil Pelajaran Malaysia, in Malay language) Malaysian Certificate of Education (in English), is a national examination taken by all Form Five students in secondary schools throughout the country. SPM is equivalent to the O-Level.*

Note: If an employee is having a SPM certificate, then his/her highest qualification is SPM though he/she has a PMR certificate as well.

Table 5-2: Basic education qualification of shop floor employees

Tertiary and vocational education qualification

In percentage, the highest qualification for the following groups of employees in vocational or tertiary education is presented as follows:

	Supervisors	Line leaders	Operators
Without Vocational or Tertiary education	**70%**	**100%**	**100%**
With Vocational or Tertiary education			
Vocational school / courses (with vocational certificate)	-	-	-
College education (with certificate or diploma)	**30%**	-	-
University education (with degree)	-	-	-
Total	**100%**	**100 %**	**100%**

Table 5-3: Tertiary and vocational education qualification of shop floor employees

Table 5-2 and Table 5-3 above indicate that all the supervisors and line leaders were at least having 5-years of secondary school education background (after receiving 6-years of primary school education) with *SPM* certificate. Besides, only 70% of the production operators or general workers (including the foreign labours from Nepal and Bangladesh) had obtained *SPM* certificate or its equivalent. All the lines leaders and operators had no vocational certificate or college education background. Only 30% of the supervisors had attended college to pursue higher qualification such as diploma after secondary school.

Recruitment of employees and career prospect

All the line leaders in Company A were promoted from experienced operators. The positions of supervisors were opened for both internal and external applications as well as internal promotions. From the information given, 70% of the supervisors were promoted internally from the position of operators or line leaders, without vocational or higher educational qualification. In addition, the experienced and accountable supervisors would be given opportunity to promote to the position of 'Officer'. In Company A, an Officer stayed at the same hierarchy level and had the same authority with an Engineer. Nonetheless, Engineer was normally external hired with tertiary educational qualification.

5.3.4 Production performance

Table 5-4 shows the production performance of Company A. At a glance, most of the answers given by the respondents (the HODs / Middle managers) indicated that Company A was in the trend of improvement over the past three years (from 2010 – 2013). For example, productivity was increased; manufacturing cycle time, lead time and cost were reduced. These were the benefits enjoyed from the MAJAICO LPS Model Company Programme (2009 – 2011) and the Kaizen projects which implemented in collaboration with their customers (see Section 6.3.1 for more details).

#	For Question 1 – 6: How has the following changed at your production over the past 3 years?	Respondents – HOD/Middle managers		
		M1	M2	M3
1	Finished-product first-pass quality yield:	Improved 1 - 20%	Improved 1 - 20%	Stayed the same
2	Scrap and rework costs:	Stayed the same	Decreased 1 - 20%	Stayed the same
3	Productivity, defined as dollar volume of shipments per employee:	Increased 21 - 40%	Increased 21 - 40%	Increased 1 - 20%
4	Per unit manufacturing costs, excluding purchased material:	Decreased more than 20%	Decreased 1 - 20%	Decreased 1 - 20%
5	Manufacturing cycle time:	Decreased 1 - 10%	Decreased 11 - 20%	Stayed the same
6	Customer lead-time:	Decreased 21 - 40%	Decreased 21 - 40%	Stayed the same
7	What is the average availability of major machineries/equipment? (Plant uptime)?	Unknown	96 - 100%	76% - 90%
8	What is the average setup time (in minutes) for major machineries/equipment?	16 - 30 minutes	10 - 15 minutes	10 - 15 minutes

Table 5-4: Production performance measurement

5.3.5 Workforce composition of Production Department

Position	Number of Employees
Manager/ Assistant Manager	1 (Assistant Manager)
Officers / Engineers	4
Supervisors	7
Line Leaders	6
Production Operators	141

Table 5-5: Workforce composition of Production Department

The aim of this study was to investigate shop floor employees' involvement (including supervisory staffs) in Kaizen activities. To carry out this research, **Production Department** was targeted. Table 5-5 shows that Production Department of Company A was led by an Assistant Manager who directly reported to the Deputy General Manager. There were total 4 staffs at the level of Officers or Engineers. As mentioned, the Officer was having the same authority with the Engineer. Hence, to standardise the term for this group of employee, *Engineer* (which is also referring to the *Officer*) would be used thereafter in this report. On the other hand, there were total 13 Supervisory Staffs (i.e. 7 x Supervisors and 6 x Line Leaders) and 141 Production Operators in this department.

5.4 Brief descriptions of the selected respondents

The respondents were targeted according to Table 4-4 and Table 4-5. Below are the brief descriptions about the respondents:

Lean Coordinator

The main liaison of this study, the Lean Coordinator had 11 years of industrial experience and had served Company A for 10 years. He held the position as a Senior Manager when this study was carried out. Chairing the MKU (previously known as LPS department), he planned and led all the lean activities of Company A throughout these 7-years of their lean transformation journey.

HR Senior Executive

The HR Senior Executive was also one of the main liaisons of this research. All the company's background and workforce composition information were provided by her. She had served the industry for 23 years in which 22 years were contributed to Company A, hence she was qualified to answer the questionnaire about her company's worker development policy and Malaysian labour market condition.

Top management

Regarding the survey questionnaire addressed to top management, there were 3 respondents in this category i.e. the Head of Subsidiary, the Deputy General Manager and the Lean Coordinator. Their years of service at Company A were ranging from 8 years to 19 years. The survey response rate for this group of respondents was 100%.

HOD / Middle Managers

There was only an Assistant Manager who led the Production Department, thus Production Planning and Control (PPC) manager was also targeted for the survey. In order to hear more voices, the Lean Coordinator who worked closely with the department was also targeted. To sum up, there were 3 people for this group of respondents. Their years of service at Company A were ranging from 8 years to 19 years. The survey response rate was 100%.

Engineers

There were total 4 Engineers who worked in the Production Department. Four of them were targeted for the survey and their average year of service at Company A was 13 years ranging from 1 year to 30 years. The survey response rate was 100%.

Supervisory staffs

All the supervisors and line leaders of the Production Department (13 people) were targeted for the survey. Their average length of service in this company was 18 years ranging from 11 years to 28 years. The survey response rate was 100%.

Production operators

There were total 141 operators working for the Production Department with almost half of them (49%) were foreign labours who might not understand the survey questions in both English or Malay language. Hence, only those local Malaysian operators were targeted. There were total 10 respondents agreeable to participate in the survey and their average length of service in this company was 12 years ranging from 4 years to 18 years. The survey response rate was 100%.

Chapter summary

This chapter briefly described how the research data was collected. Besides company's information, the workforce composition and their educational level as well as career prospect in the company were also presented. Lastly, the information about the targeted respondent groups was reported.

6 EMPIRICAL FINDINGS

6.1 Introduction

This chapter first presents the extent of shop floor employees' involvement in Kaizen activities. It continued with the findings on F3 – *the stage of lean transformation* which obtained via interview with the Lean Coordinator. Survey findings on other critical success factors would be subsequently presented in Section 6.4 – Section 6.6.

6.2 The extent of shop floor employees' involvement in Kaizen activities

The respondent of this part of survey was the Engineers. The mean score (the degree of involvement) for each group of internal stakeholder i.e. HODs / Middle Managers, Engineers, Specialist Departments, Supervisory Staffs and Production Operators in every involvement category (*initiate, lead, and participate*) in each Kaizen area (K1 – K10) was calculated based on the 5-point Likert scale given in the questionnaire. The results are shown in Figure 6-1 – Figure 6-5. Based on these results, the mean score for every Kaizen involvement by each internal stakeholder was further calculated. This was done by averaging the mean scores of the three involvement categories for each Kaizen area and results are shown in Figure 6-6. The purpose was to show an overall picture about the degree of involvement by all the internal stakeholders.

HODs / Middle Managers

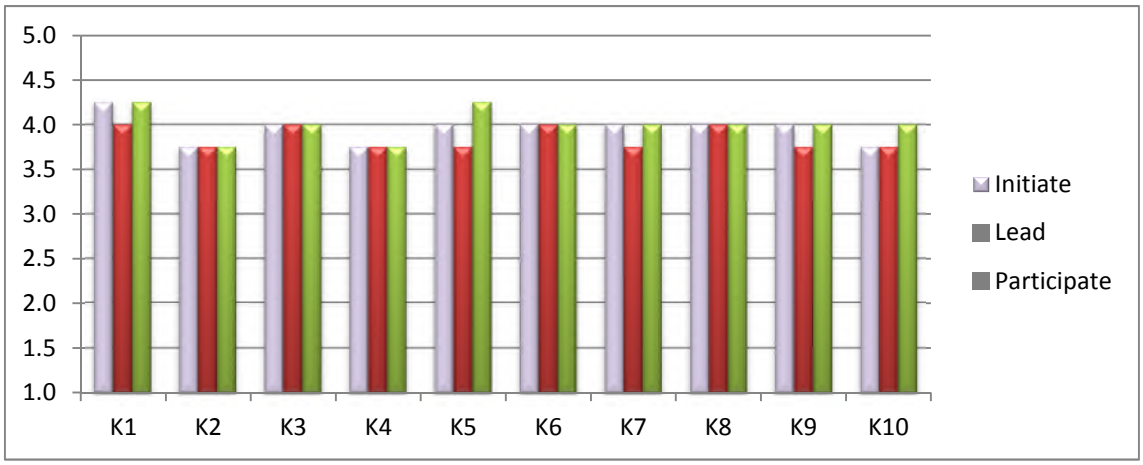

Figure 6-1: Middle managers' degree of Kaizen involvement

Engineers

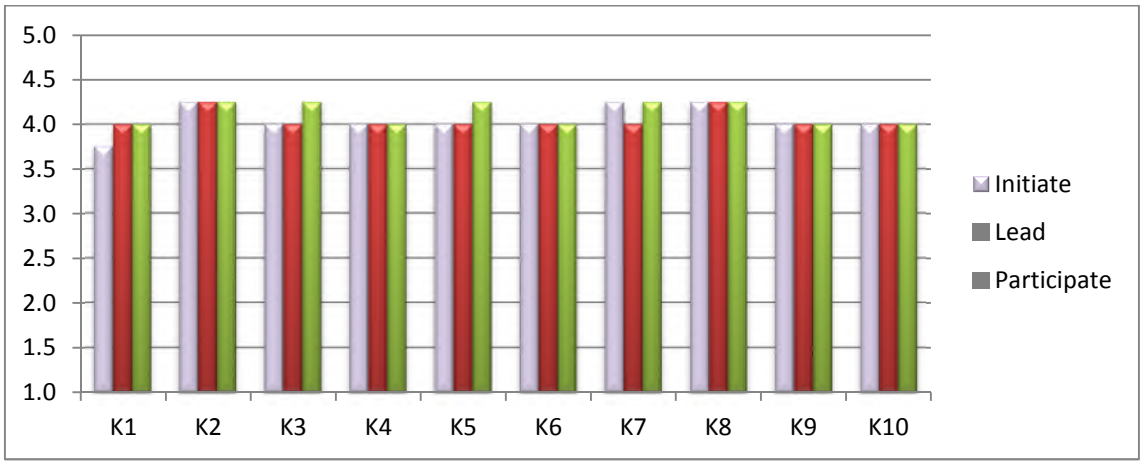

Figure 6-2: Engineers' degree of Kaizen involvement

Specialist departments

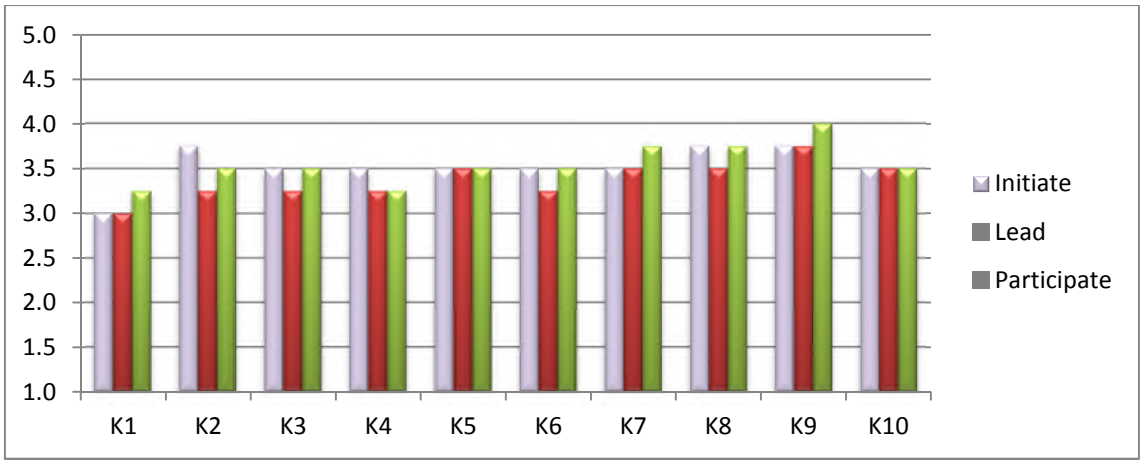

Figure 6-3: Specialist departments' degree of Kaizen involvement

Supervisory staffs

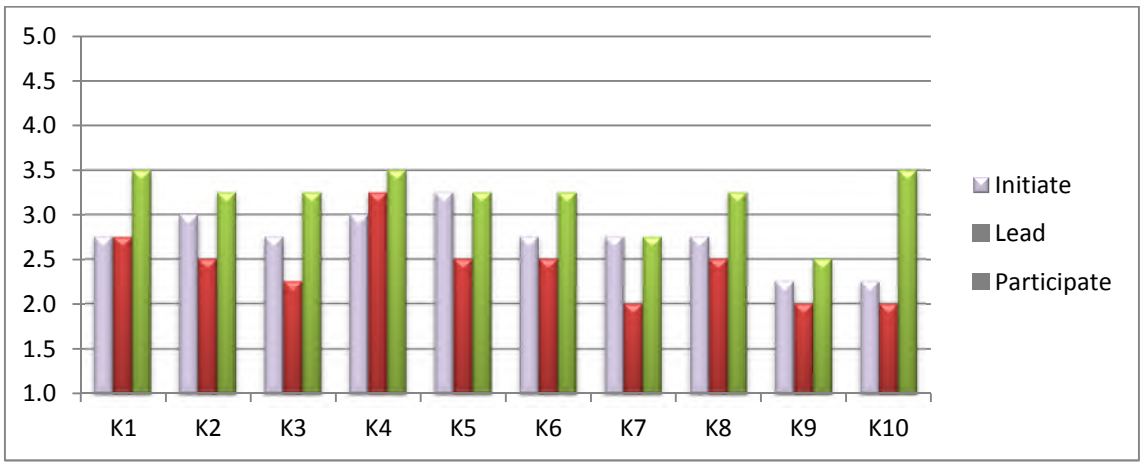

Figure 6-4: Supervisory staffs' degree of Kaizen involvement

Production operators

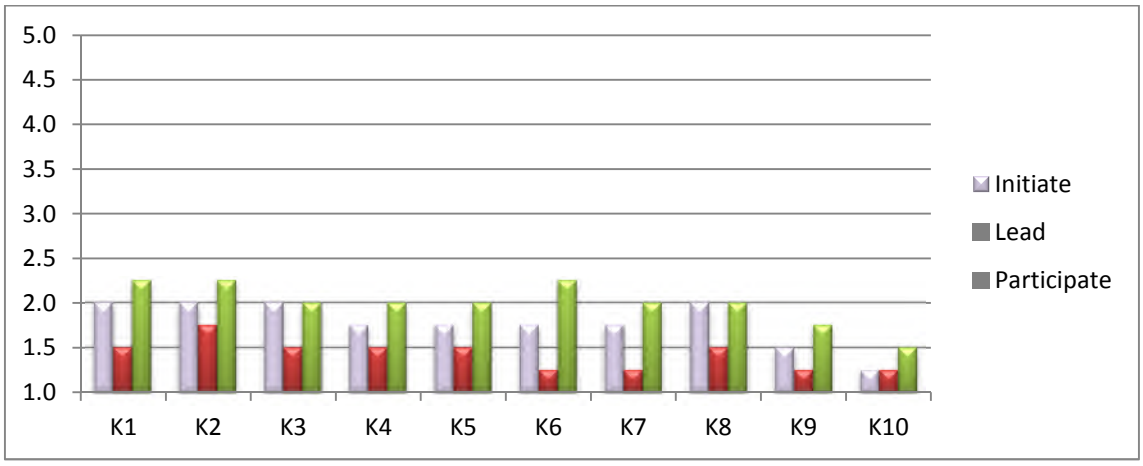

Figure 6-5: Production operators' degree of Kaizen involvement

Overview

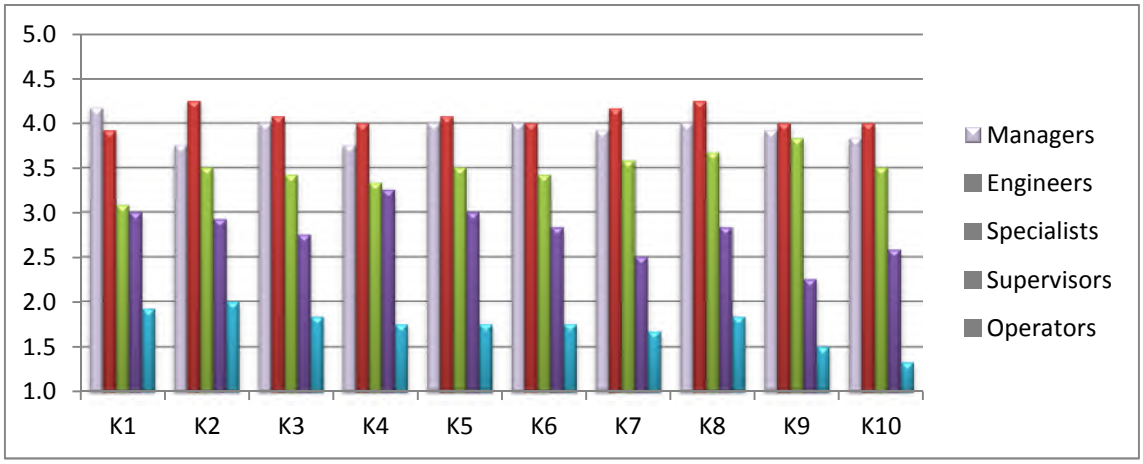

Figure 6-6: The degree of Kaizen involvement by all the internal stakeholders

An obvious impression of top-down approach was shown in the way of lean adoption at Company A. As shown in Figure 6-6, for Engineers' level of involvement, the mean scores for all Kaizen areas (besides K1) were greater or equal to 4.0, which were in the range of '*Frequent*', (see Table 4-6 for the measurement scales). For HODs/Middle Managers (shown as *Managers* in Figure 6-6), their degree of involvement was also amongst the highest; which the mean scores for the five Kaizen areas (K1, K3, K5, K6 and K8) were greater or equal to 4.0 while the mean scores of the remaining Kaizen areas were greater than 3.5, which were also in the range of '*Frequent*'. As shown in

Figure 6-1 and Figure 6-2, white-collared employees (HODs/Middle Managers and Engineers) had always initiated the Kaizen activities including Bottom-up Kaizen areas. For example, the improvement at K2, K7, K8 were always initiated by Engineers; while K1 was by the Managers. Meanwhile, for Specialist departments (known as *Specialists* in Figure 6-6), their degree of involvement was considered high especially at K2, K5, K7, K8, K9 and K10 (see Figure 6-3) which the mean scores were greater or equal to 3.5. This could be due to Kaizen Team (which teamed up by the members from LPS department) was categorised into this group in the questionnaire.

On the other hand, the level of involvement by shop floor employees (*Supervisory Staffs* and *Production Operators*) in Kaizen was relatively low with all the mean scores lower than 3.5, particularly the Production Operators. As shown in Figure 6-6, operators' degree of involvement was averagely lower than 2.0 in all 10 Kaizen areas, which is considered '*seldom'* involved. Meanwhile, for Supervisory Staffs, besides K4 (*workers' interest and adaptability at work*), most of the mean scores for other Kaizen areas fell in between 2.5 to 3.0 (in the range of '*sometimes'*). As further shown in Figure 6-4, the mean scores for Supervisory Staffs' involvement in the '*participating*' category for all the Kaizen areas were apparently higher than '*initiating*' and '*leading*'. These figures show that the mode of involvement for Supervisory Staffs was mainly the '*participants*' but not much holding the role as leaders.

To sum up, the findings above show that the involvement of shop floor employees in Kaizen activities was low at Company A, particularly the Production Operators.

6.3 The stage of lean transformation (F3)

The investigation of F3 – *the stage of lean transformation* was carried out via interview with the Lean Coordinator. Due to it covered lean journey, lean approach adopted and also issues on how they involve shop floor employees throughout their lean journey which could provide a general picture of how lean was implemented in Company A; empirical findings of F3 is therefore first presented before other critical success factors.

6.3.1 Lean journey of Company A

The reason to adopt lean

Prior to adopting lean, Company A had encountered several issues at their production such as complicated production flow, high WIP, labour intensive production, long lead time, etc. Aiming to reduce cost and improve cash flow as well as customer satisfaction, one of the directors from the holding company encouraged the management of Company A to participate in the MAJAICO-A1 programme in 2006.

Their first 6-months MAJAICO-A1 programme commenced from July 2007 until December 2007. The targeted area for improvement was their strut (ST) production line. It was selected because there were many problems lying in the processes. On the other hand, its high profitability potential after improvement could boost the confidence of their senior management on the feasibility of lean concept.

The approach of lean adoption

A cross-functional Kaizen team which consisted of 5 – 6 members was formed and multiple Kaizen projects at the Strut production lines were carried out under the guidance of Japanese lean experts. On-the-job trainings focussed on Just-in-Time to improve flow were intensively facilitated by the Japanese experts to the Kaizen team such as the application of material and information flow chart (also known as value stream mapping), layout improvement, small-lot production, production levelling, quick changeover, Kanban system and so on. The role of the Japanese was also to train several key personnel from Company A to be the in-house experts.

The initial success at the Strut production line was immediately realised at the year end of 2007. Significant improvement results were shown after the flow of the production line had been improved. Both the WIP and lead time were substantially reduced 88%. Productivity improvement also achieved as the average output per day had increased 7% along with 27% of reduction of number of workers; while total number of machines used was reduced 46%. With better layout and better machine utilisation, space saving was also realised with 62% of reduction in floor occupation.

Experience acquired and lessons learned in the first MAJAICO-A1 programme by the Kaizen team were immediately applied at their self-initiated *Yokoten*[1] project to improve the flow of Gas Spring production line in 2007. This *Yokoten* project was in-house driven and managed by the Kaizen team without involvement from the Japanese experts. Besides, the initial benefits enjoyed from the first MAJAICO-A1 programme had encouraged Company A to further conducted another two 6-months MAJAICO-A1 programmes consecutively in 2008, i.e. to improve the layout and flow at their Telescopic Shock Absorbers (SA) production line (from January until June 2008); and to initiate pull system their part supply area for Strut production line (from July until December 2008).

After having almost two years of experience in four lean projects implementation, Company A had subsequently embarked on their next major programme, the MAJAICO LPS Model Company Programme from 2009 until 2011. As a programme and competition requirement, they had thus established the LPS Department with three full-time members; and crafted their own production system model, APS (see Figure 6-7). At the same time, Company A had also completed another three big improvement projects hand-in hand with their customers[2] (local automotive manufacturers) in 2009 and 2010. With tremendous improvement shown, Company A had turned out to be the overall winner in the 2-years MAJAICO LPS Model Company Programme in 2011, out of 13 selected model companies and overall 87 companies in the 5-years MAJAICO-A1 programme. In summary, the lean journey of Company A is presented in Figure 6-8.

Note 1: Yokoten is a horizontal deployment process for sharing learnt lessons and experience gained laterally across an organization.
Note 2: Due to confidentiality, the customers were known as Customer X, Y and Z in Figure 6-8.

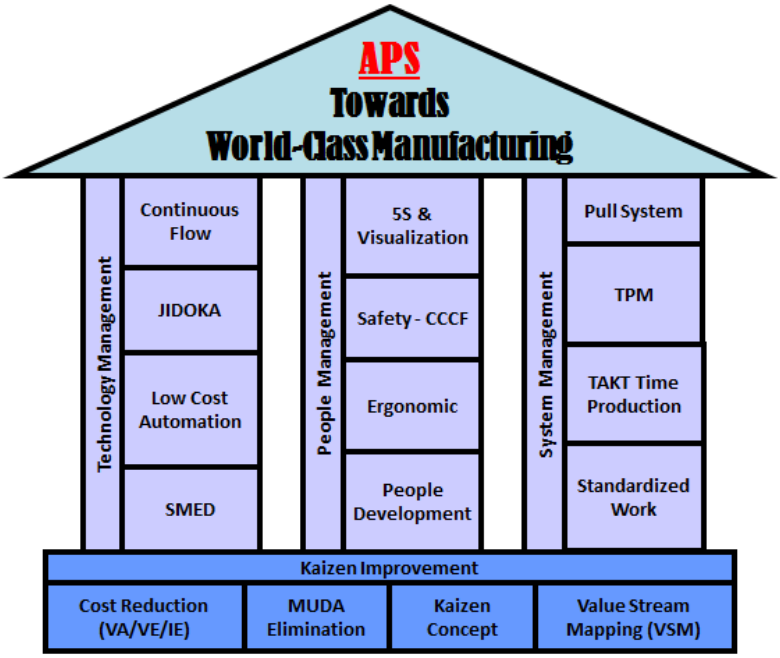

Figure 6-7: Lean House of Company A

6.3.2 'Employee Involvement' in lean adoption

This section extracted several important points during the interview with the Lean Coordinator.

Is there any suggestion system exists in your company? Is there any reward or target set for the workers? Is the implementation of suggestion system successful?

The implementation was less successful. Perhaps the reward had not motivated the workers with 1.00 MYR (about $0.30 USD) for each suggestion raised. Initial target set for each worker was 10 suggestions per employee per year, however it was not successfully implemented due to the previous lean focus of the company was on Top-down Kaizen projects which had greater impact on productivity improvement and cost reduction.

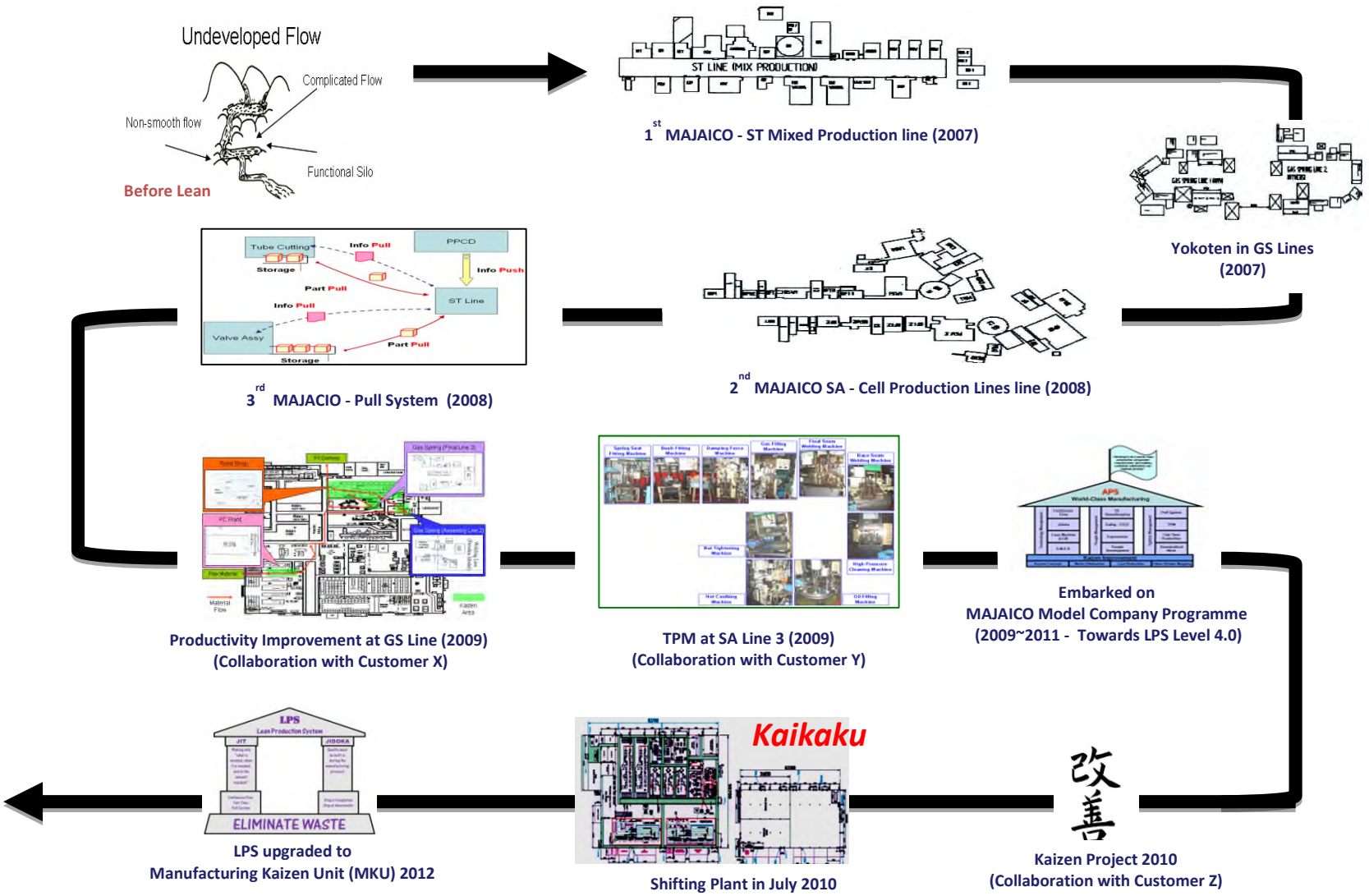

Figure 6-8: Lean journey of Company A

Is there any Quality Circle activity exists in your company?

Quality Circle or Small Group Activity (SGA) was less successful as well because Top-down Kaizen activities by cross functional Kaizen team with greater impact on productivity improvement was the company's focus. Although Quality Circle activities were in its most active state which constituted as many as 7 – 8 teams during the MAJAICO LPS Model Company programme (2009 – 2011); however it left only one team (with their focus on the improvement of visualisation and 5S practices) which was still active when this study was carried out.

Do you involve shop floor employees in Kaizen event or lean project?

Shop floor employees who worked at the selected production area for Kaizen project were chosen to be involved in the project. Nevertheless, their involvement was mainly to provide information on the working methods and information about the processes. Similarly, after improvement projects were done, in order to execute or implement the new methods, only those workers who worked at the selected project area would be trained with new skills, such as Single-Minute-Exchange of Dies (SMED).

What were the trainings regarding lean production which had been provided to the shop floor workers?

The trainings were mainly based on – basic lean concepts such as the concept of 7-wastes, lean awareness, 5S, standardised work; and Just-in-time or production flow related such as Heijunka and Kanban system. Kanban system knowledge had to be delivered to the workers because they were the process owners and they had to know how the system works. Special training on other lean techniques (based on the APS model) would be conducted for those who were selected to involve in Kaizen projects.

Do you conduct any survey to understand shop floor employees' needs?

The Lean Coordinator responded that they think it was not necessary to conduct surveys. Morning market was their primary channel to have discussion with the

workers' representatives on daily issues. In fact, one of the purposes of the suggestion system was to hear workers' voice besides the purpose for improvement suggestions.

Is learning new skill one of the criteria in operators' performance appraisal? For teambuilding purpose, how does your company motivates workers?

Learning new skills was one of the criteria for operators' performance appraisal. As one of the criteria of TS16949, skills charts were posted at the shop floor to monitor workers' skill level. About workers motivation, Company A hold celebration with the Kaizen members each time when a project was successfully done. Besides, every month the company would throw a birthday party to employees who were born in the same month.

At the shop floor, what is the main challenge against 'Employee Involvement'? Do you think it is possible to involve general workers (or production operators) where almost half of them are foreign labours?

Reluctant force that existed in the company was one of the challenges to 'Employee Involvement'. Some of the employees had not only resisted to change but tried to influence others not to follow the new methods or practices. Another challenge was technical competency amongst the workers. Language barrier was the main issue for the foreign labours to understand and comprehend what was being taught, especially technical topics. This was also the main reason which contributed to low technical competency amongst the foreign workers.

Do you see any clue or sign that your company is already in the transition towards bottom-up approach improvement?

Reluctant force was in the trend of reducing and the workers had witnessed the benefits of lean after improvements were successfully realised. It was possible for the transition to bottom-up approach initiative in improvement by encouraging more shop floor employees to involve. However, shop floor workers' low technical competency was the first issue to solve. After MKU had put their focus on other subsidiaries, the availability of competent successors of the LPS Department to lead and coordinate

future lean activities at Company A was another issue to look into. Another clue or perhaps a 'need' for the transition to bottom-up approach was – the company found there was no improvement shown in the production performance when there was no Kaizen project. Hence, there was a need to involve more people at the companywide to initiate and implement Kaizen activities.

Concluding remarks for the interview

Barriers were still encountered by Company A during this stage of lean transformation. It was mainly resistance or reluctance force (also known as anchor-draggers) from the people who resisted to change. However, direct action against the anchor-draggers was not taken by the company. Rather, their management believed that by providing more trainings and creating awareness to all employees, they would appreciate the benefits of lean and its philosophy. Indirectly, this would be able to enhance the positive energy at shop floor so that the negative influence from the anchor-draggers would be reduced. Their approach was seen to be effective from the opinion of the Lean Coordinator. The reluctance force was under controlled and in the trend of reducing. Nonetheless, this was also the major challenge of the Lean Coordinator on how to continually enhance the positive atmosphere at Company A when they had to move their focus in helping other subsidiaries to adopt lean. This was because the successors of the LPS Department in Company A were not ready to take up the mandate to sustain lean at the company.

Lean was viewed as an endless journey by Company A. Though appearing as the overall winner in the MAJAICO LPS Model Company programme, there were still reluctant force and weaknesses found in their process. With their next goals to build-in quality (Jidoka) into process and to establish pull system into CKD (Completely Knocked-down) supply parts, tremendous effort was still expected to transform the company becomes a true lean organisation.

6.4 Top management's commitment (F1)

This part of survey was to investigate top management's commitment to involve shop floor employees into lean activities. The survey findings are presented in Section 6.4.1 until Section 6.4.4; and the descriptions of the findings are presented in Section 6.4.5.

6.4.1 Top management's commitment to encourage 'Employee's Involvement' in Lean

Figure 6-9 shows the feedback from top management on their commitment to engage shop floor employees (including supervisory staff) in company's improvement activities.

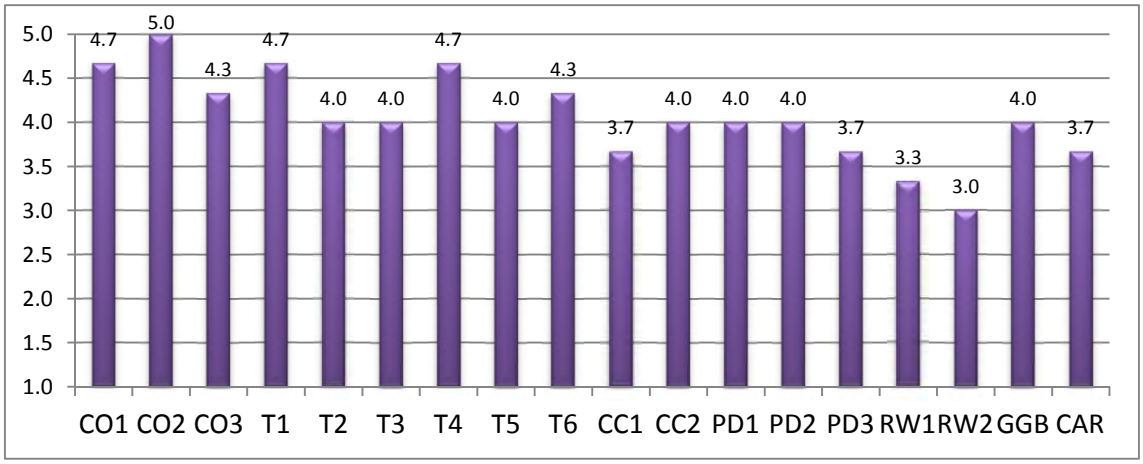

Figure 6-9: Top management's commitment on 'Employee Involvement'

Besides, in the open-ended question addressed to top management which asked about the importance of 'Employee Involvement' in lean activities, some of the responses given are shown as follows:

"…Yes. It is very important to involve all levels. To sustain the lean system, everyone should have a clear understanding on the purpose and benefits of doing lean system and how the whole system works. So the level of employees' involvement is critical to the success of the lean activity…"

"…Yes. Because no matter what system we install, they are the ones who use it…"

The responses show a common understanding existed amongst the top management on the importance of shop floor employees' involvement in lean activities to the company.

6.4.2 Company's worker development policy – from the perspective of HR Department

This part of survey was addressed to the Senior Executive from Human Resource (HR) department. It focussed on the company's worker development policy and training provision. See her feedbacks in Table 6-1:

#	Questions	*Responses
1	We have a set of internally conducted long term worker development programme to formally and systematically develop our **production operators and line leaders** (i.e. compulsory trainings related to technical / supervisory skills). *(The programme is always conducted timely according to the schedule.)*	Agree (4)
2	We have a set of internally conducted long term worker development programme to formally and systematically develop our **officers and supervisors** (i.e. compulsory trainings related to technical and management skills). *(The programme is always conducted timely according to the schedule.)*	Agree (4)
3	We have worker development scheme or budget allocated for **production operators and supervisory staff** to attend trainings / workshops. (Supervisory staffs are referred as Supervisors and Line Leaders)	Agree (4)
4	The above budget for worker development is always fully utilised.	Agree (4)
5	Our managers or experienced technical staffs are keen to share their personal experience and knowledge (formally or informally) in knowledge sharing sessions or on-the-job trainings.	Agree (4)
6	Our production **operators and supervisory staff*** are very keen to attend the above development programmes. *(Example, the response /attendance to the trainings is very encouraging)*	Agree (4)
*The responses were based on 5-point Likert scale		

Table 6-1: Training provision of Company A from the perspective of HR Department

6.4.3 Deployment of Kaizen activities at shop floor - from the perspective of Engineers

This part of survey aimed to gauge top management's commitment on 'Employee Involvement' via deployment of Kaizen activities at shop floor. It was addressed to Engineers. Table 6-2 shows the feedback from the respondents.

#	Descriptions	E - Enginners			
		E1	E2	E3	E4
1	Is there any formal suggestion system presence in your department for all production operators and supervisory staffs to contribute ideas, suggestions or opportunities for operation performance improvement including safety and workers' motivation?	No	No	No	**Yes**
2	Is there any target set for **production operators** to measure their contribution to improvement ideas and suggestions?	No	No	**Yes**	No
3	Is there any target set for **supervisory staffs** to measure their contribution to improvement ideas and suggestions?	No	No	**Yes**	No
4	Is there any reward system (financially or non-financially) or competition to encourage improvement suggestions from production operators and supervisory staff?	No	No	No	No
5	Is there any **quality circle** (voluntary based) or small improvement team activities (normally participated by production operators and led by supervisors/engineers) presence in your department?	**Yes**	**Yes**	**Yes**	No
6	Is there any **target** set for the improvement teams / quality circles in	**Yes**	**Yes**	**Yes**	**Yes**

	improvement activities?				
7	Is there any **competition** to encourage the improvement teams' contribution in production improvement?	No	No	No	No
8	What is the **percentage (%)** of production operators and supervisory staff involved in the quality circles or small improvement teams?	41-60	< 40	41-60	< 40
9	In average, how **frequent** do members of quality circle or improvement teams formed by production operators and supervisory staff having meeting in a month?	Every 2 weeks	Every month	Every month	None

Table 6-2: Shop floor Kaizen activities deployment

6.4.4 Shop floor employees' perceptions of top management's commitment

Figure 6-10 shows the feedback of Supervisory Staffs and Production Operators on their perceptions of top management's commitment on 'Employee Involvement'. Open-ended question was also enclosed to further grasp their opinions.

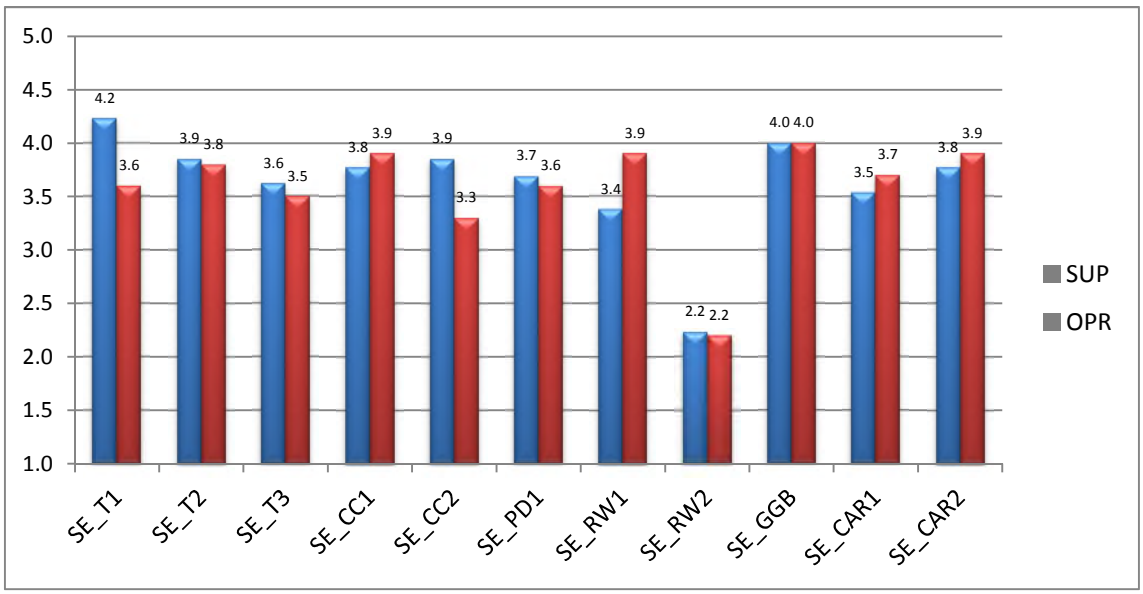

Figure 6-10: Shop floor employees' perceptions of top management's commitment

<u>Open Question:</u> In general, do you think your company's management is ACTIVELY and KEEN to involve the production operators and supervisors in company's improvement or lean activities? Why?

<u>Listed below are some of the opinions from the Supervisory Staffs:</u>

> *"…Yes. It is stated in the company's policy to involve operators and supervisors to improve productivity and reduce rejects…"*

"… Interested. Management always provide us trainings/workshops for our improvement on the understanding about improvement. Management always visit the shop floor to find out and understand our difficulties…"

"…Interested. Company is committed to involve operators and supervisors which can be seen when they provide trainings such as time study, pull system, etc.."

"…Less interested. Only certain operators and supervisors are selected to be involved in the improvement projects. Not everyone is involved…"

"…Interested. They always provide us training such as pull system, cycle time calculation, 5S, 7-waste concept. Management team always visit the production line…"

"…Interested. This is because every morning management will have a morning briefing to inform the latest information and other issues of the factory…"

"…Interested. They do provide trainings and they do implement SMED. But they do not understand what had exactly happened at the production line. Sometimes, certain system could not be followed because our superiors told us not to follow. Our superiors were aware of problem but did not know how to settle. What they did was just blaming us…"

"…Interested. Company provides training and workshops to operators. Management advises and teaches operators in improvement activities. Workers are also interested to learn…"

"…Not everyone from the management team is interested when certain (improvement) system is implemented. It causes the system could not be fully implemented because the initial determined system standards or methods could not be followed…"

Listed below are some of the opinions from the Production Operators:

"…The company is keen to involve production operators and supervisors into improvement because it is stated in the company's policy…"

"…Interested. Because supervisors do provide us the company information, request from the management and problems that we face…"

"…50-50. *However, management team do presence at the shop floor to find out the problems at the production…"*

"…Yes and all the workers have to follow the company's policy to ensure the achievement of company's goal towards zero defects…"

6.4.5 Descriptions of findings

As shown in the mean scores given for the items *CO1 – CO3* in Figure 6.9 and top management's feedback in open questions, they perceived shop floor employees' involvement was crucial to their success in lean. Their commitment on worker's development can be seen from the aspect of training provision. Besides high scores rated for the items *T1 – T6* (about training provision in Figure 6-9), the feedback given by HR on workers' development policy (see Table 6-1) of the company shows that top management devoted much attention to the trainings of employees. From the perspective of shop floor employees, they were also satisfied with the trainings they had received from the company which the scores given for items *SE_T1* to *SE_T3* were all above or equal to 3.5 (see Figure 6-10).

In the aspect of *communication channel* (information provision), high scores given in items *CC1* and *CC2* in Figure 6-9 show that top management was willing to share information with the shop floor. Operators were satisfied with the information provision about company's latest updates with mean score of 3.9 for *SE_CC1* (Figure 6-10). However, operators were comparatively less agreeable (with mean score of 3.3) that top management were always having dialogue sessions with the workers. According to the remark given by a respondent from top management, morning market was their main channel to deliver message and hear daily problems from shop floor. This could be due to morning market involved only supervisory staffs (but not every worker); and the supervisory staffs were the 'medium' to deliver company's updates to the operators. Hence, operators were disagreeable that their management always had dialogue sessions with them.

In the aspect of *Policy Deployment* (or *Hoshin Kanri*), it was stated in their company's policy to involve shop floor employees into lean or Kaizen activities. This is proven from the workers' feedback in the open questions. On the other hand, managers showed their commitment via always presence at the shop floor when attending to problems and leading improvement activities. Overall, shop floor employees were

satisfied with this form of leadership or *Genchi Genbutsu* practiced by their managers (with mean score of 4.0 rated for *SE_GGB* in Figure 6-10).

As for *Career Prospect*, HR mentioned that layoffs were rare and the average length of service of the employees was 15 years (Table 5-1). Shop floor respondents were satisfied with their job security and career prospect at Company A (with mean scores of greater or equal to 3.5 rated for items *SE_CAR1* and *SE_CAR2* in Figure 6-10). It has been the company's good practice to promote well-performed supervisors to the position of Officers although most of their entry point was operators (see Section 5.3.3)

However, there were some drawbacks on top management's commitment which are worth mentioning here. Their commitment on 'Employee Involvement' had yet to be fully transformed into practice. First, according to the feedback given by Engineers, 75% of them reckoned that there was no suggestion system in the company and no target set for shop floor employees on number of suggestions made (Table 6-2). Majority of them also referred that there was no quality circle activities existed in their company. In addition, there was no competition to stimulate and encourage shop floor employees' participation in improvement activities (refer to Table 6-2 and item *SE_RW2* in Figure 6-10).

Second, top management themselves reckoned that they did not always measure and reward shop floor employees for their contribution to company's improvement and their initiative in learning new skills (with means scores of 3.3 and 3.0 for items *RW1* and *RW2* respectively, in Figure 6-9). Interestingly, production operators were satisfied with the reward system with mean score of 3.9 rated for the item SE_RW1 in Figure 6-10 (*and supervisory staffs were moderately satisfied with mean score of 3.4 which slightly below the threshold of 3.5*). Perhaps, the perceptions and level of satisfactions on the standard of reward were different between hierarchies. For example, for motivation purpose, the company would every month hold a birthday party for all the employees who were born in the same month (see Section 6.3.2). This type of non-

monetary reward perhaps had satisfied the shop floor employees as they felt being respected.

Third, some minor voices from shop floor employees given in the open question are noteworthy as well. One of them revealed that only certain people from the shop floor were selected to involve in the improvement activities, but not everyone. Besides, some of the middle management staffs were trying to influence others not to follow new system. Sometimes workers were being blamed for making mistakes without proper guidance and firm instruction in following new system from their superiors. It had demotivated the shop floor employees.

6.5 Shop floor employees' commitment and technical capability (F2)

This part of the investigation was to study shop floor employees' commitment and technical capability to involve in lean activities. The survey findings are presented in Section 6.5.1 until Section 6.5.9; and the descriptions of the findings are shown in Section 6.5.10.

6.5.1 Supervisory Staffs' perceptions of their commitment and capability to contribute in lean

Figure 6-11 shows the feedback of the Supervisory Staffs on their commitment and capability to contribute in lean. Open-ended question was also enclosed to further grasp their opinions. Their replies on the open-ended question are shown in next section, Section 6.5.2.

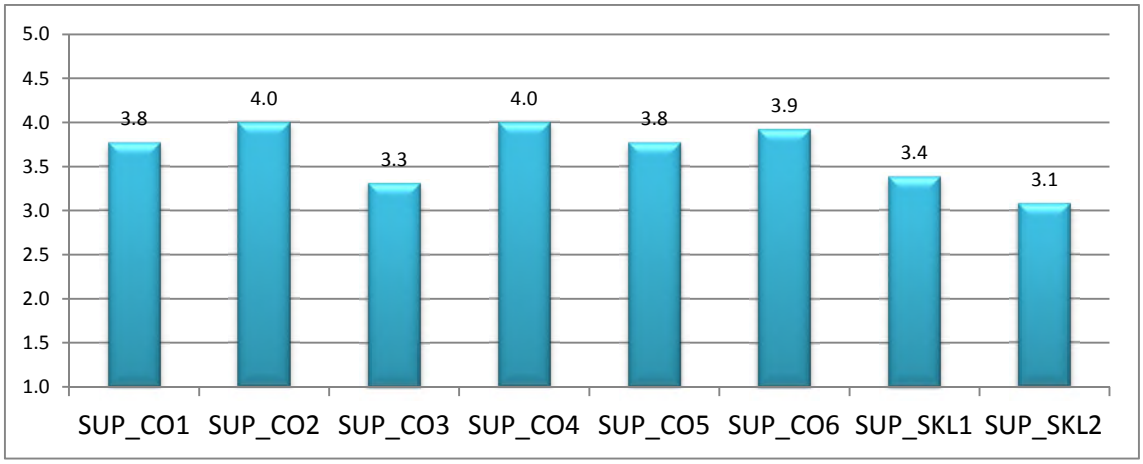

Figure 6-11: Supervisory Staffs' perceptions of their capability and commitment to contribute in lean transformation

6.5.2 Production Operators' perceptions of their commitment and capability to contribute in lean

Figure 6-12 shows the feedback of the Production Operators on their commitment and capability to contribute in lean. Open-ended question was also enclosed to further grasp their opinions.

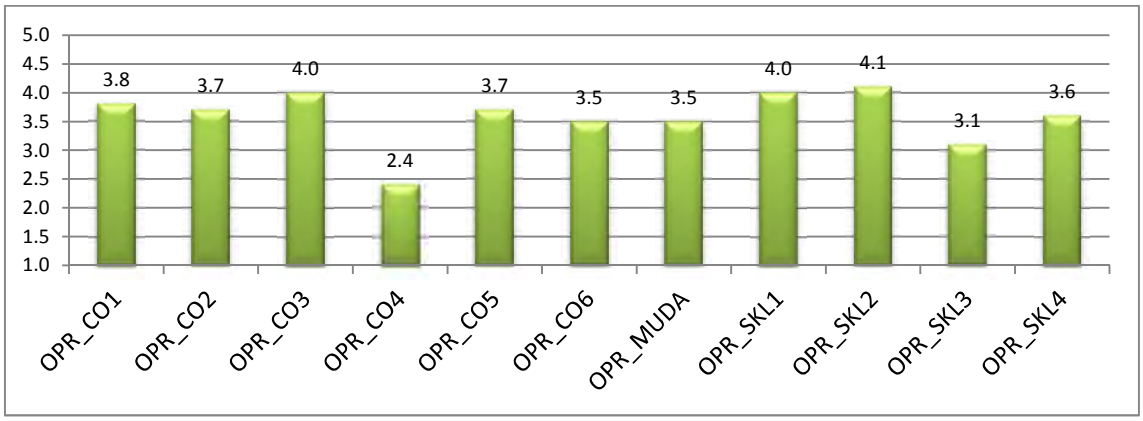

Figure 6-12: Production Operators' perceptions of their capability and commitment to contribute in lean transformation

Open-ended questions

In order to hear opinions from shop floor employees on the importance of 'Employee Involvement', the following open-ended question was prepared:

Question: *In general, do you think the involvement of the production operators and supervisors in company's improvement or lean activities is IMPORTANT to your department or company? Why?*

Listed below are some of the opinions from the Supervisory Staffs:

> *"…Important. Because we have to know/understand lean production system so that we can handle problem when it happens…"*
>
> *"…Important. It creates a way which the top management can work together with shop floor employees to improve productivity…"*
>
> *"…Important. If we are involved, they will teach us how to improve productivity and quality. It hence eases our works…"*
>
> *"…Important. The operators and supervisors understand well the production activities and we can contribute to the improvements…"*
>
> *"…Important. It is because operators and supervisors are the people who carry out the production tasks…"*
>
> *"…Important. It is because operators and supervisors are the people who carry out production tasks. They know how the problems happened…"*

Listed below are some of the opinions from the Production Operators:

> *"…Important. Because production staffs understand well the processes and understand how the production problems happened…"*
>
> *"…Important. Because we are experienced with the production processes…"*
>
> *"...Important. We can improve our knowledge and gain our experience in Kaizen..."*

6.5.3 Top management's perceptions of shop floor employees' commitment and capability in problem solving

Figure 6-13 shows the perceptions of the Top management on shop floor employees' commitment and capability in problem solving.

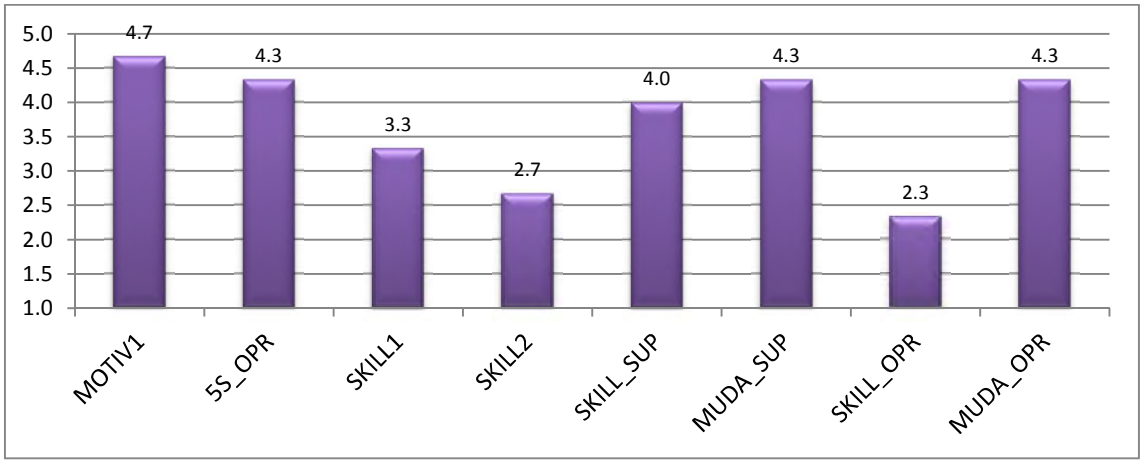

Figure 6-13: Top management's perception of the shop floor employees' commitment and capability in problem solving

6.5.4 Engineer's perceptions of shop floor employees' commitment and capability in problem solving

Figure 6-14 shows the perceptions of the Engineers on shop floor employees' commitment and capability in problem solving.

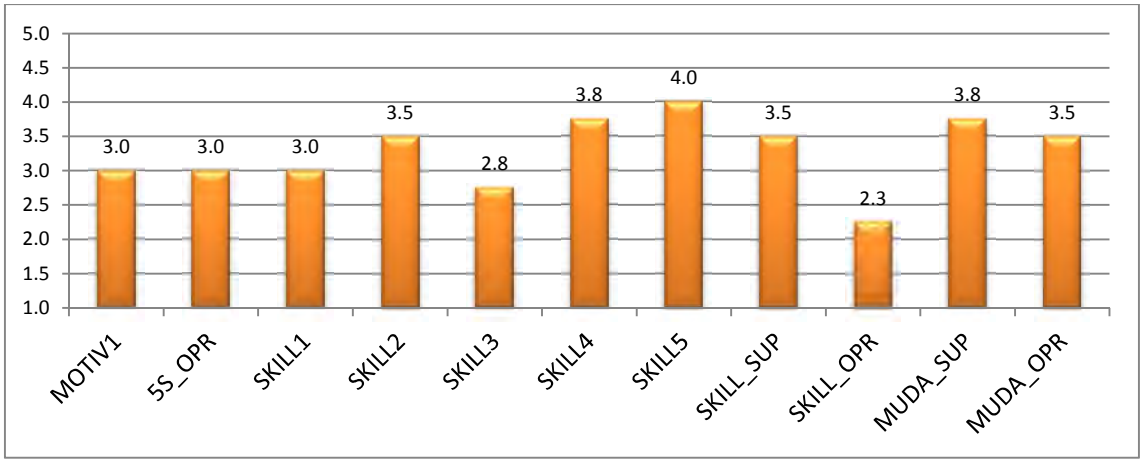

Figure 6-14: Engineer's perception of the shop floor employees' commitment and capability in problem solving

6.5.5 Supervisory Staffs' perceptions of Production Operators' commitment and capability in problem solving

Figure 6-15 shows the perceptions of the Supervisory Staffs on Production Operators' commitment and capability in problem solving.

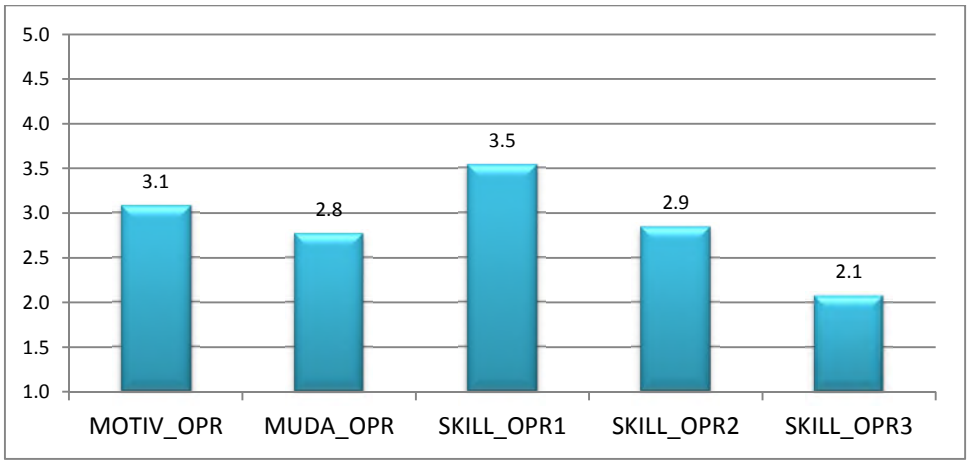

Figure 6-15: Supervisory Staffs' perception of the production operators' commitment and capability in problem solving

6.5.6 Production stability – 4Ms & 1E (from the perspective of HODs / Middle managers)

Figure 6-16 shows the *Production Stability* at Company A which investigated via the aspects of 4Ms & 1E i.e. *Man, Machine, Materials, Methods*, and *Environment*.

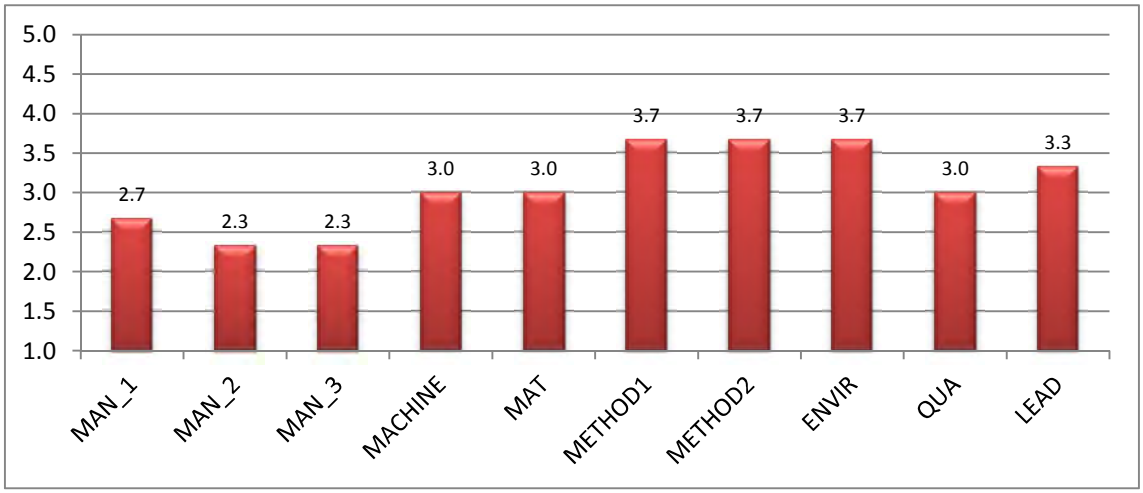

Figure 6-16: Production stability

6.5.7 Shop floor employees' understanding of Lean Production System and 7-Wastes concepts

To study the shop floor employees' understanding 7-Wastes and Lean concepts, the open-ended questions below were enclosed:

Shop floor employees' understanding of 7-wastes concept

Question: In your opinion, please give an example activity that you think it is Waste or Non-Value Added activity. (Example activity* – can be any process or operation perform in the line, by the workers or machines):*

Listed below are some of the examples from the Supervisory Staffs:

"…Too much of reworks…"

"…Defective part is a waste because it wasted operators' effort and CKD parts…"

"…Material handling of pushing trolleys from pick up bay to production line is too far…"

"…Newly purchased machines and dies have a lot of problems which create rejects of high cost…"

"…Operators spend a lot of time on material handling from a workstation to another…"

"…Do quality inspection on the behalf of suppliers. Parts from the suppliers came with a lot of quality issues that affected the smoothness of our production…"

Listed below are some of the examples from the Production Operators:

"…The distance to push trolleys from final line to paint shop is too long…"

"…The unsolved problem in machines is the cause of defective products…"

"…Machine improvement should be carried out so that I don't have to press so hard during working…"

"…Material handling from a place to another in long distance…."

"…Product sorting to sort out defective parts…"

Shop floor employees' understanding of Lean Production System

Question: *In your opinion, please briefly explain what is Lean Production System or Lean Manufacturing System? Or in other words, what is the purpose of Lean?*

Listed below are some of the examples from the Supervisory Staffs:

> *"…Number of workers reduced while output is maintained at the same level (productivity improvement). 5S improved. Batch size reduced and production line is neater…"*
>
> *"…To ease our work and improve productivity…"*
>
> *"…It is a system to improve quality of product. It provides us an opportunity to learn the new way to improve productivity…"*
>
> *"…This system smoothen the production flow, avoid waste and improve quality…"*
>
> *"…It is a system for space saving, reduce waste and provide accurate delivery to customer…"*
>
> *"…Production following demand. Reduce WIP and easy to calculate. Work is easier when WIP reduced…"*

Listed below are some of the examples from the Production Operators:

> *"…To improve productivity and reduce cost…"*
>
> *"…Reduce reject and increase output…"*
>
> *"…Improvement in 5S. The supply method in boxes with defined quantity eases the process of work…"*
>
> *"…Shop floor is more organised. Reduce WIP. Incoming of CKD parts following Kanban and it follows demand…."*
>
> *"…To improve the process flow. Before implementing lean, our process flow is very complicated. Now 5S is improved, WIP is reduced…"*

6.5.8 Problem solving tools utilisation and attended trainings

This part of investigation was addressed to the Engineers. Besides problem solving tools utilisation, the questionnaire also included the trainings that the Engineers, Supervisory Staffs and Production Operators had attended. See the results in Figure 6-17 and Table 6-3.

The extent of problem solving tools utilisation

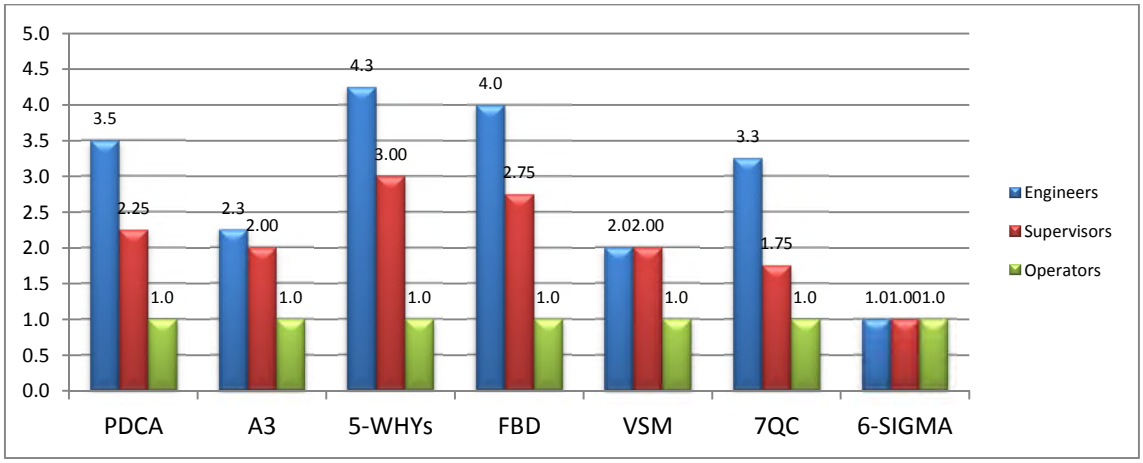

Figure 6-17: The extent of utilisation of problem solving tools

(The scale for Figure 6-17 was purposely adjusted from 0.0 to 5.0 so the bars with scores 1.0 are visible)

The attended problem solving skills trainings

No	Descriptions	Respondent - Engineers			
What are the TRAININGS on the following problem solving and improvement skills' have the **Engineers/Officers** in your department attended?		***E1**	**E2**	**E3**	**E4**
1	PDCA	Yes	Yes	Yes	Yes
2	A3	Yes	No	Yes	Yes
3	5-Whys Analysis	Yes	Yes	Yes	Yes
4	Fishbone Diagram and Brainstorming	Yes	Yes	Yes	Yes
5	Value Stream Mapping (VSM)	Yes	No	Yes	Yes
6	7 QC Tools (Pareto Charts, etc)	Yes	Yes	Yes	Yes
7	Six Sigma (DMAIC)	No	No	No	No
What are the TRAININGS on the following problem solving and improvement skills' have the **Supervisory Staffs** in your department attended?		**E1**	**E2**	**E3**	**E4**
1	PDCA	Yes	Yes	Yes	Yes
2	A3	No	No	Yes	No
3	5-Whys Analysis	Yes	Yes	Yes	Yes
4	Fishbone Diagram and Brainstorming	Yes	Yes	Yes	Yes
5	Value Stream Mapping (VSM)	No	No	Yes	No
6	7 QC Tools (Pareto Charts, etc)	No	No	Yes	Yes
7	Six Sigma (DMAIC)	No	No	No	No

What are the TRAININGS on the following problem solving and improvement skills' have the **Production Operators** in your department attended?		**E1**	**E2**	**E3**	**E4**
1	PDCA	No	No	No	No
2	A3	No	No	No	No
3	5-Whys Analysis	No	No	No	No
4	Fishbone Diagram and Brainstorming	No	No	No	No
5	Value Stream Mapping (VSM)	No	No	No	No
6	7 QC Tools (Pareto Charts, etc)	No	No	No	No
7	Six Sigma (DMAIC)	No	No	No	No

Table 6-3: The attended problem solving skills trainings

6.5.9 Local labour market condition

According to the feedback given by the HR Executive, good and qualified employees were difficult to be employed from the local labour market. See Table 6-4:

#	**Questions**	***Responses**
1	Good and qualified production operators are easily recruited from labour market.	Strongly Disagree (1)
2	Good and qualified supervisors or officers are easily recruited from labour market.	Disagree (2)
3	Technical / engineering position candidates such as engineer or technician are easily recruited from labour market.	Disagree (2)
*The responses were based on 5-point Likert scale		

Table 6-4: Local labour market

6.5.10 Descriptions of findings

Shop floor employees' commitment

The supervisory staffs and production operators perceived themselves as committed to be involved in company's improvement activities (with mean scores greater than 3.5 for *SUP_CO1, SUP_CO2* in Figure 6-11; and *OPR_CO1, OPR_CO2* in Figure 6-12). However, their commitment was challenged by unstable production as they had to spend most of their working time on disturbance handling (with mean scores of 4.0 and 3.7 for *SUP_CO4* and *OPR_CO5*, respectively). Although being engaged in progress chasing or disturbance handling, they still believed that improvement in production would reduce their over-time work (with mean scores of 3.8 and 3.5 for *SUP_CO5* and *OPR_CO6*, respectively).

Although top management perceived shop floor employees' motivation and team spirit to involve in improvement activities was high (with mean scores of 4.7 for *MOTIV1*, and 4.3 for *5S_OPR* in Figure 6-13). However, the perception of engineers on the same item was not as high as the top management's (with mean score of 3.0 rated for both *MOTIV1* and *5S_OPR* in Figure 6-14). Similarly, supervisory staffs also did not reckon that their operators were keen to learn and willing to involve in improvement (with mean score of 3.1 for *MOTIV_OPR*, Figure 6-15).

From the feedback of HODs / Middle managers in the aspect of *production stability*, the scores for items related to *Man* were relatively low (see Figure 6-16). The HODs were not satisfied with the attendance of shop floor employees (with mean score of 2.3 for *MAN_2*). On the other hand, machine fitness or availability was moderately satisfied by the managers with mean score of 3.0 given to *MACHINE* (at the level of *somewhat agree*). The same score was given on the supplies of parts to the production. They perceived the level of quality and delivery performance of the suppliers had yet to meet their expected standards (*MAT*).

The scores given to the aspect of working methods were amongst the highest. The HODs perceived that information stated in the Standard Operation Procedures was reliable and accurate (with mean score of 3.7 for *METHOD1*). The methods of work had been made easy for the workers. They also reckoned that their setup activities were reliable and setup operations were always carried out within the allocated time slot without further calibration or trial and error on parameter settings (with mean score of 3.7 for *METHOD2*). On the other hand, the respondents perceived the working environment at the shop floor was well-organised and workers did not spend their time in chasing of missing parts and tools (mean score of 3.7 for *ENVIR*). To sum up, the stability in terms of their production quality and lead time was less stable by the HODs with mean scores of 3.0 and 3.3 given to the items *QUA* and *LEAD* respectively. This is the outcome from the relatively unstable *MAN*, *MACHINE* and *MATERIAL.*

In open question, all the supervisory staffs and production operators acknowledged their involvement in lean or Kaizen activities was crucial. As process owners, they

believed themselves had better knowledge on the production processes thus they were able to give improvement suggestions. Besides, some of the respondents (particularly supervisory staffs) perceived that they had to involve and learn how the new system works so that they would be able to cope with difficulty at work or when leading workers to carry out production tasks after a new system installed.

In addition, all the supervisory staffs and operators were able to give examples of wastes that they could identify at their workplace; and also able to briefly explain the concept of Lean Production System when answering the open questions. This tallies with the perceptions from the top management and engineers that they believed their shop floor employees were able to identify visible wastes at their workplace (with mean scores of greater or equal to 3.5 rated for the items *MUDA_SUP* and *MUDA_OPR* in both Figure 6-13 and Figure 6-14). However, it is questionable that the supervisory staffs had different opinions where they considered their operators were less capable in identifying waste (with mean score of 2.8 for *MUDA_OPR*, Figure 6-15).

Shop floor employees' technical capability

In the aspect of technical capability, given the means scores for items *SKILL1* and *SKILL2* in Figure 6-13; and items *SKILL1* in Figure 6-14 were lower than 3.5; both the top management and engineers perceived their shop floor employees (supervisory staffs and production operators) were not competent. It tallies with the feedback given by the HODs / Middle managers that major involvement of supervisors and engineers were still needed to solve daily production problems where the capability and authority of line leaders and operators were limited in handling disturbances (with mean score of 2.7 rated for *MAN_1*, Figure 6-16). The HODs perceived their production workers were lack of multi-skill and yet to be reliable in replacement of absentees (with mean score of 2.3 for *MAN_3*).

From the perspective of engineers, their subordinates (including supervisory staffs) always referred to them without recommending solutions for the difficulties and problems found at work (with mean score of 2.8 rated for *SKILL3*). Nevertheless, they

still believed that supervisors and operators should be trained to share some of their workload including carrying out improvement (with mean scores greater than 3.5 for *SKILL4* and *SKILL5*, Figure 6-14).

In addition, almost all the respondents (including operators themselves) perceived learning basic problem solving skills such as 5-Whys and Fishbone Diagram was difficult for production operators with mean score lower than 3.5; while not difficult for supervisory staffs (see *OPR_SKL3* in Figure 6-12, *SKILL_OPR* and *SKILL_SUP* in both Figure 6-13 and Figure 6-14, *SKILL_OPR3* in Figure 6-15). Whereas, supervisory staffs themselves reckoned learning the mentioned skills were not very difficult with mean score of 3.4 (*which slightly lower than threshold of 3.5*) rated for item *SUP_SKL1* in Figure 6-11.

In terms of training, only engineers were given opportunities to attend almost all the trainings of the problem solving tools besides Six-Sigma (Table 6-3); while supervisory staffs were only sent for trainings of 5-whys, PDCA and Fishbone Diagram. For operators, they had neither applied any of the listed problem solving tools nor attended any training for these tools (Figure 6-17, and Table 6-3).

Although the engineers and supervisory staffs reckoned their operators as incompetent in problem solving and were unable to provide solutions for problems found (mean score of 2.8 for *SKILL3* in Figure 6-14 and mean score of 2.9 for *SKILL_OPR2* in Figure 6-15); however almost all the production operators still reckoned themselves as being able to see clues for improvement at the production; and giving improvement suggestion to their superiors (with mean scores of 3.6 and 4.1 for *OPR_SKL4* and *OPR_SKL2*, respectively in Figure 6-12). This situation is explainable. The respondents (production operators) of this survey were having averagely 12 years of working experience at Company A. As senior workers, to identify problem and giving idea for improvement should not be a problem for them.

6.6 Shop floor responsibilities assignment (F4)

This part of study was to investigate the assignment of shop floor responsibilities to the shop floor employees. It included work organisations and extent of lean practices implementation at the shop floor of Company A. HODs/Middle Managers were the targeted respondents.

6.6.1 Work organisation at the shop floor

The survey feedback for the *work organisations* is given in Table 6-15:

No	Questions	Respondents – Middle Managers		
		M1	M2	M3
1	Are all the production operators organised in teams (or work in groups)?	Team with TL	Team with TL	Team with TL
2	All our production operators are frequently trained to perform a variety of direct production tasks so that they are multi-skilled and cross-trained for job rotation and able to fill in for others if necessary.	Frequent	Sometimes	Sometimes
3	Our production operators change direct production tasks almost:	None	Every Month	None
4	Our production operators and production supervisory staffs are frequently trained in set-up time reduction (or techniques of SMED / Single Minute Exchange of Die).	Seldom	Sometimes	Sometimes
5	We always improve our quality self-inspection methods (example poka-yoke devices) at each workstation with the aim to reduce the number of QC inspectors at the end of the line.	Sometimes	Sometimes	Sometimes
6	Is learning new skills one of the evaluation criteria in operators' performance appraisal?	No	Yes	Yes
Remarks: Answers for Question 1, 2 & 4 were based on 5-point Likert scale, ranging from 1 (Not-at-all) to 5 (Very Frequent). TL – Team Leader				

Table 6-5: Work organisations at the shop floor

As shown in Table 6-5, only one respondent replied that their production workers were frequently trained to perform a variety of production tasks or cross-trained for job rotation. Moreover, two out of three responded that their production workers did not change their production tasks at all; while another respondent answered that workers' tasks were being changed only once a month. Apart from direct production tasks, the production workers were not frequently trained in set-up time reduction or techniques of SMED. Similarly, the improvement at the error proofing devices (known as *poka-yoke* in Japanese) or quality self-inspection methods was not carried out frequently.

6.6.2 The extent of lean practices and activities

Figure 6-18 shows that most of the listed lean activities had been implemented to quite a great extent at Company A with mean scores greater than 3.5. However, the implementation of Total Productive Maintenance (TPM), and poka-yoke were comparatively low. This finding tallies with the result shown in Table 6-5 where error-proofing techniques implementation was not the focus of Company A in their lean implementation agenda.

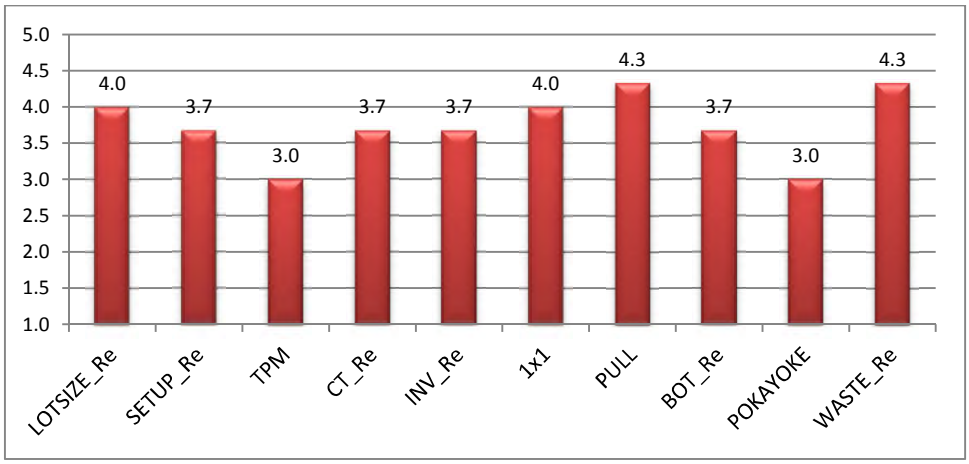

Figure 6-18: The extent of lean practices and activities

6.6.3 Shop floor responsibilities assignment

Figure 6-19 to 6-21 show the assignment of shop floor responsibilities at Company A:

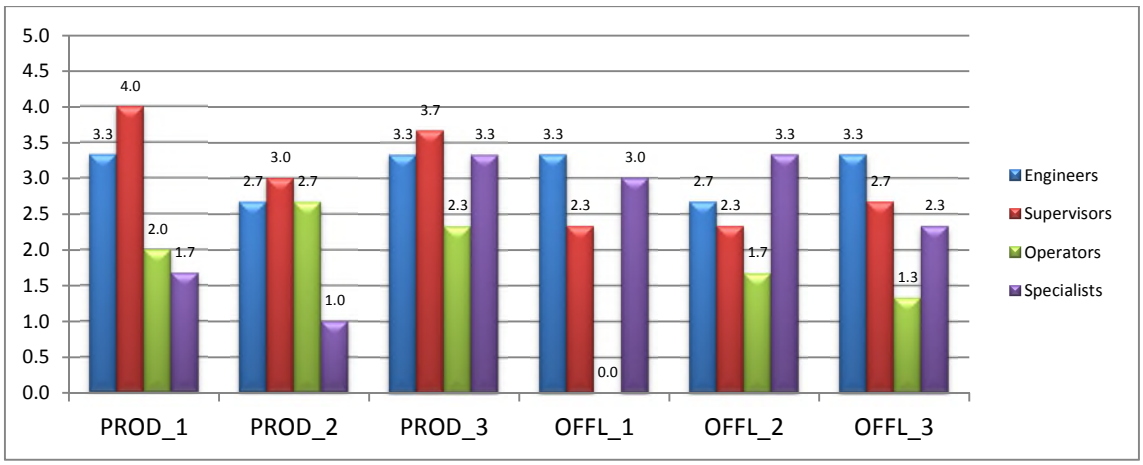

Figure 6-19: Production Management and Off-The-Line Improvement responsibilities

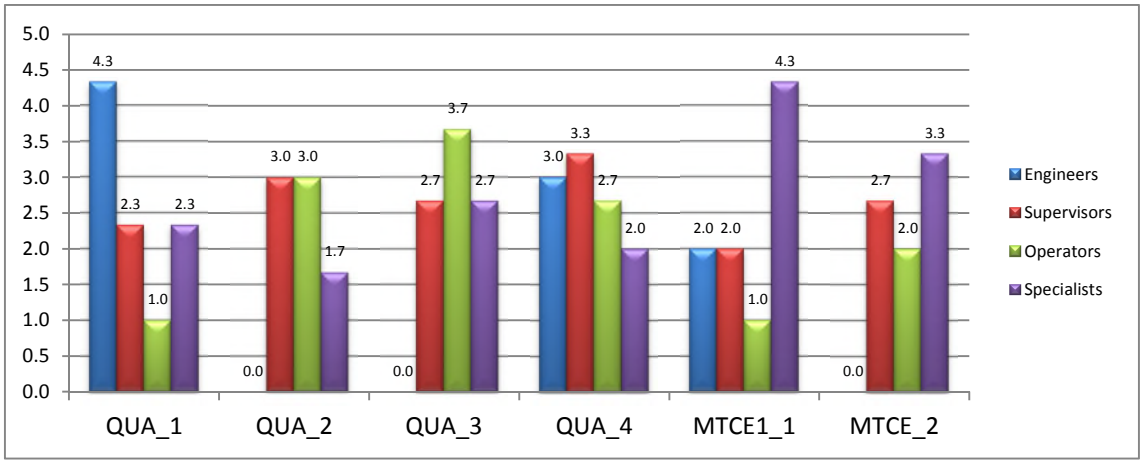

Figure 6-20: Quality and Machine Maintenance responsibilities

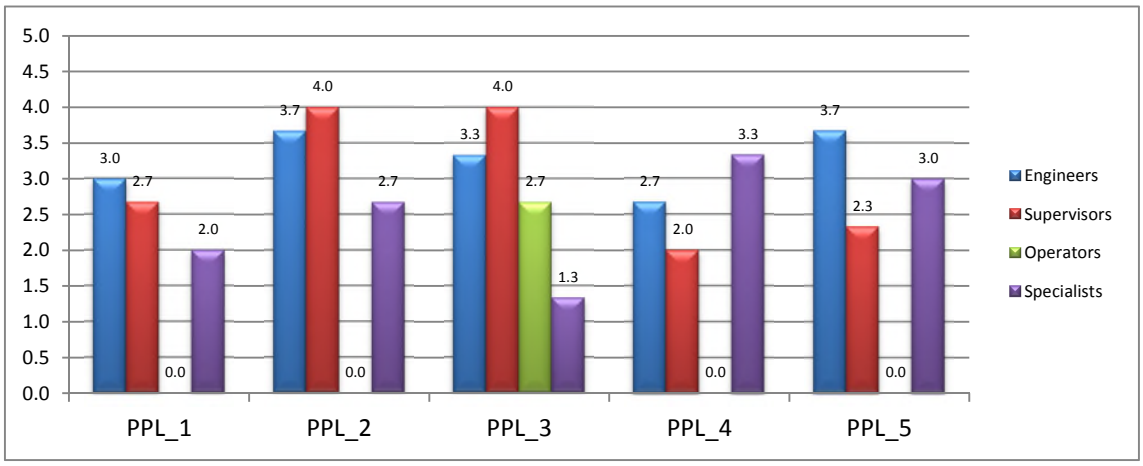

Figure 6-21: People Management and Development responsibilities

(The scales for Figure 6-19 – 6-21 were purposely adjusted from 0.0 to 5.0 so the bars with scores 1.0 are visible)

(Note: For some of the responsibilities, in the selection of answers (i.e. the internal stakeholders), some of the selections were excluded from question thus results of 0.0 for some items were shown in Figure 6-19 – Figure 6-21. Example, for the responsibility of *QUA_2 - product repair and rework*, it was illogically to be carried out by Engineers, so the selection of 'Engineers' was excluded from the choices in the questionnaire.)

As shown in Figure 6-19, supervisory staffs were the main players in production management related tasks. For example, they were frequently responsible for work scheduling and work allocations within the production line (with mean score of 4.0 for *PROD_1*); they were also the first respondents to address the production disturbances together with production engineers and specialist departments such as maintenance department (*PROD_3*). Meanwhile, specialist departments were playing the largest

role amongst the staffs at off-the-line improvement activities such as planning and designing of new working methods or techniques (with mean score of 3.3 for *OFFL_2*); while production engineers were the main actors at designing or experimenting new process parameters (with mean score of 3.3 for *OFFL_3*). The results show that the participation of shop floor employees particularly production operators in off-the-line improvement activities was relatively low.

On the other hand, preparation of Standard Operation Procedures or Standard Work Sheets was most of the time solely handled by production engineers (with mean score of 4.3 for *QUA_1*, Figure 6-20); while the supervisory staffs were given with the authority on the decision to stop production line when there were abnormalities occurred (with mean score of 3.3 for *QUA_4*).

On the aspect of machine maintenance, maintenance department was not only responsible for repair tasks when machine broke down (with mean score of 4.3 for *MTCE_1*); but also had to bear the responsibility for daily line-side maintenance such as greasing, oiling, cleaning of filters, to name a few (with mean score of 3.3 for *METCE_2*). Surprisingly, the responsibility of supervisory staffs and operators at this area was relatively low. It tallies with the finding in Figure 6-18 where TPM was not fully implemented.

HR Department was mainly responsible for planning and organising long term workers development programme (with mean score of 3.3 for *PPL_4,* Figure 6-21). Besides, engineers were the main facilitators in guiding and assisting the small group problem solving activities such as Quality Circles together with specialist department (with mean scores of 3.7 and 3.0 respectively for *PPL_5*); while supervisory staffs hold the responsibility of teaching operators the skills of direct production tasks supporting by engineers (with mean scores of 4.0 and 3.3 respectively for *PPL_3*).

Chapter summary

This chapter had presented the picture on the extent of shop floor employees' involvement in Kaizen. It had also delivered the information about Company A's approach in lean adoption and their stage of lean transformation (*all about F3*) as well as some issues about 'Employee Involvement' which obtained via interview with the Lean Coordinator. The survey findings for the aspects of other critical success factors were also presented in the following sequence: F1 – *top management's commitment*; F2 – *shop floor employees' commitment and technical capability*; and, F4 – *shop floor responsibilities assignment*.

7 RESULTS DISCUSSION AND PROPOSED LEAN MODEL

7.1 Introduction

Based on the empirical findings, this chapter first discusses the evaluation of the critical success factors that would influence the extent of Kaizen involvement amongst the shop floor employees; followed by generalisation of the results by comparing the lean implementation approach of Company A with another Malaysian automotive parts manufacturer. It also introduces the proposed bottom-up lean conceptual model and its implementation roadmap. Lastly, this chapter is ended with the validation of this research and the model.

7.2 The evaluation of the critical success factors

7.2.1 Comparison of the extent of Kaizen involvement

Take Toyota practices as benchmark, their management including engineers and senior supervisors generally do not involve in bottom-up Kaizen which are K1 – K4, but they mainly take care of top-down Kaizen i.e. K9 and K10 activities and also partially involve in the Hybrid Kaizen (Shimizu, 2004, Pardi, 2007, Marksberry *et al.*, 2010). On the contrary, engineers or managers of Company A were actively engaging themselves in all the Kaizen areas with least involvement from the shop floor employees particularly the production operators. Moreover, these white-collared employees were the people who frequently initiated all the Kaizen activities including K1 – K4 which ideally should be initiated by the shop floor employees via suggestion system. For instance, *K1 – Workstation Safety* and *K3 – Quality and Efficiency at Work* which comprising work motions or ergonomics improvement should be logically initiated and practiced by the supervisory staffs and operators because they were the process owners who knew their daily tasks better than others. This indirectly shows that suggestion system and quality circle (or small problem solving group which normally participated by shop floor employees) activities at Company A were not implemented to its fullest potential. It could be one of the causes of low level Kaizen involvement amongst the shop floor

employees. To further study other causes, the following subsections will discuss the influences of each of the critical success factors.

7.2.2 Top management's commitment (F1)

As shown in Section 6.4, top management of Company A acknowledged the importance of 'Employee Involvement'; and they were particularly committed on 'Worker Development' which could be shown from the aspect of training provision. Shop floor employees were also satisfied with the trainings provided by the company. As for career prospect, workers were in fact enjoying their career continuity at the company. They would be given opportunities to promote to executive position as an 'Officer' if equipped with good leadership and communication skills after accumulating sufficient technical skills at the production. In addition, managers' leadership shown at the shop floor via the practice of *Genchi Genbutsu* had won over recognition from employees that the company was committed to lead the workers in lean activities. However, their commitment on 'Employee Involvement' had yet to be fully realised. First, it was obviously shown from the aspect of Kaizen deployment activities at the shop floor. The quality circle activities which formed by operators and led by team leaders or supervisors were not flourished at Company A. This 'channel' aimed to involve workers into Kaizen was not firmly established and organised. Second, the indeterminate implementation of suggestion system also reflected the blemish of top management's commitment in encouraging workers to contribute improvement ideas to company. Although initially there was a target of ten suggestions per employee per year established at the shop floor, however it had not been determinedly implemented. In addition, there was no guideline or a system designed to assist or educate workers in raising ideas. As stated by one of the engineers in open question: "…*Involvement of production operators and supervisory staffs is important for improvement. Sometimes they have ideas for improvement but did not know how to deliver it. Actually, management can take some ideas from the workers and interpret them to become feasible and effective in implementation* …" Third, the weakness of their reward system in which $0.30 USD per suggestion did not actually stimulate workers' willingness to contribute ideas. Fourth, as some of the respondents

(particularly the supervisory staffs) commented in the open question, not everyone was given opportunity to involve in the previous Kaizen activities; only those selected were involved. It reflected some disappointment from the shop floor.

To sum up, the above findings supported that Company A had yet to fully transformed their vision on 'Employee Involvement' into practice. Therefore, without high level of top management's commitment to engage shop floor employees into continuous improvement activities, shop floor employees' extent of Kaizen involvement was low. ***Proposition 1a*** is accepted.

7.2.3 Shop floor employees' commitment and technical capability (F2)

Shop floor employees' commitment

With reference to Section 6.5, both the supervisory staffs and production operators had rated themselves as willing to involve in Kaizen activities. From their opinions given in the open questions, they perceived lean production or Kaizen would simplify the production work flow hence ease their work. They also believed that their involvement was crucial because as process owners, they knew how and what should be improved at the production line. In addition, they were willing to be involved because they wanted to learn how to perform Kaizen and how a new system works so that they could cope with the situation when problems occurred. However, their commitment was disputed by the condition of production stability as they reckoned that disturbance handling had swallowed up most of their working time. Take the list of waste that they identified at work as examples, they had to do defective parts sorting on behalf of suppliers; the unsolved machines' problems had created a lot of rejects; the new machines and dies which were not in good condition had generated defective parts, to name a few. (This is supported from the feedback given by the HODs/ Middle managers on the aspect of MACHINE and MATERIAL*, see Figure 6-16). Such non-value added activities or waste were surrounding them. Therefore, this could be the reason why the engineers and supervisory staffs perceived their workers as not

committed to be involved in improvement activities but in fact they were spending their time and effort engaging in non-value added occurrences.

MATERIAL - In his explanation during interview, the Lean Coordinator clarified that they had recently changed a new supplier which the suppliers' performance on delivery and quality was not stable.*

The findings above show that high level of commitment in Kaizen involvement from the supervisory staffs and production operators could not be fully demonstrated or realised because they were engaged in production disturbance handling in most of their working time. As a consequence, their extent of Kaizen involvement was low. ***Proposition 2a*** is accepted.

Shop floor employees' technical capability

From the feedback given by the top management, HODs/Middle managers and engineers; all the white-collared employees perceived their shop floor employees (especially production operators) were lack of technical capability (see Figure 6-13, Figure 6-14, Figure 6-16). Even production operators themselves reckoned that learning basic problem solving skills was difficult for them (see *OPR_SKL3* in Figure 6-12).

As shown in the company's workforce composition in Table 5-1, half of the operators were foreign labours and language barrier was the main problem in training delivery (see Section 6.3.2). It was also noticed that good quality workers were difficult to be recruited from the local labour market (Table 6-4); with only 70% of the operators had completed their five years secondary school education without vocational or technical background, whereas the remaining 30% had only finished their three years lower secondary school education. The low entry point undoubtedly had far-reaching influence on the shop floor employees' self-confidence and competency in problem solving. This is why the production operators perceived learning basic problem solving skills was difficult for them.

In the aspect of problem solving skills trainings, none of the production operators had been trained to use the problem solving tools while the supervisory staffs had only attended trainings of PDCA, 5-Whys and Fishbone Diagram. It could be their low technical or educational qualification had caused the management yet to include them into such trainings.

Meanwhile, in the open question asking about the importance and feasibility of 'Employee Involvement' in their company, one of the engineers commented: "…*In my opinion, to involve shop floor employees into improvement or lean activities in my department or company is feasible but not now. If we train and provide lean knowledge to the operators as well as the management staffs; and also to let them realise the benefits of lean, I believe my company can do very well in lean production at the end*…" This statement further supported that low technical capability amongst the shop floor employees particularly the production operators had hindered their involvement in lean activities. However, Company A (in the statements given by the Lean Coordinator during interview and the feedback from the engineers in survey, see Figure 6-14) still believed that workers could be trained to become competent in carrying out improvement activities. It is evidenced from the feedback given by the operators with average 12 years of working experience who were able to identify waste and clues for improvement at their workplace as a result of trainings given by the company.

As a summary, at the moment when this study was carried out, the involvement of shop floor employees in Kaizen activities was low due to they were lack of technical competency particularly in problem solving. ***Proposition 2b*** is accepted.

Why is technical competency of shop floor employees important to a lean manufacturer in this aspect? In their case study to compare supervisory staffs' roles and responsibilities in three factories which located at Britain, Mexico and Japan respectively, Lowe *et al.* (2000) found that production operators without technical education background were restricted from promotion to supervisory level at Mexican factory; whereas their supervisory staffs were hired externally from local graduate market with technical qualification. Meanwhile, the operators in Japanese plant were

high school graduates from their education system which emphasised on high level of numeracy and literacy. More importantly, these workers would only be eligible for promotion to the level of group leader after five years of steady work performance and intensive on-the-job training. In contrary, lack of availability of suitably qualified workers (compared to Mexican factory) and poor internal training scheme (compared to Japanese factory) had caused the supervisory staffs at British factory less competent in taking up technical and shop floor management responsibilities compared to their counterparts.

7.2.4 The stage of lean transformation (F3)

As shown in Section 6.3, the approach of lean implementation of Company A was top-down and project based via leadership of management and LPS department. The Kaizen project was usually first centred at waste elimination via inventory reduction and value stream flow reorganisation at a targeted production line. It subsequently followed by establishment of Pull-based production according to customer's demand or Takt time. The improvement efforts would be continued until a saturated condition achieved. Their approach was exactly following the five core lean principles of Womack and Jones (1996) as shown in Figure 7-1.

Figure 7-1: Five core lean principles

Once the Pull or Kanban system had been established and most of the visible waste had been eliminated at the previous targeted line, Company A applied the same manner to reorganise other value streams laterally across all the production lines via the practice called *Yokoten*. The process was mainly managed and carried out by LPS Department and dedicated cross-functional Kaizen teams under the consultation from external lean experts. Shop floor employees' participation was mostly to provide information about how the old methods functioning which served as basic information

for the Kaizen teams to carry out improvement. Although without active involvement of shop floor employees or even supervisory staffs in the above Kaizen projects, substantial improvement gain on productivity still could be realised by the few members of Kaizen teams. This was why top-down Kaizen improvement was their focus when implementing lean throughout their first seven years of lean transformation. It also indirectly answered why quality circle and suggestion system were not dedicatedly implemented by far.

The reasons or logics behind their approach in lean implementation shown above (or in Section 6.3) were reasonable. First, none of them from the company knew about lean production system at the initial phase of lean transformation. To convince all top management members on the feasibility of lean practices, top-down Kaizen project at a pilot line was their selection. Only with visible improvement on productivity and cost reduction (or in hardware aspect, for example, better layout), all the top management members would be confident on lean practices and let lean philosophy continued to develop in the company. Second, lean adoption requires changes in organisation and work routines (Hines *et al*., 2008). This stage was critical to the success of their lean journey in which reluctant force existed amongst the middle management or other employees would drag down their efforts to involve more people and handicap their initial success. Hence, to further gain the buy-in from middle management and other employees, improvement results via Kaizen projects (or Kaizen blitz) by the dedicated Kaizen teams were the only 'tool' to eliminate the sceptical about lean amongst the middle management and shop floor employees. Third, a large number of internal lean trainers are needed to lead and guide shop floor employees in Kaizen activities when it is to begin the bottom-up approach lean implementation. To foster a cluster of experienced internal lean trainers (started by the members of LPS Department and Kaizen teams), it was only feasible via hands-on learning by executing lean projects. Therefore, the reasons above explained why at the crossroad junction to choose whether to develop people and culture first; or to directly apply lean practices to see immediate results; Company A had chosen the latter. Once people had built their confidence on lean concepts, only then it was possible to develop everyone to be lean

practitioners by involving them into lean projects and expanding the number of lean projects.

Given the facts above, ***Proposition 3a*** is accepted for which prior to the stage of transition from top-down leadership to bottom-up initiative, top-down Kaizen would be the focus of a company thus the involvement from shop floor employees in continuous improvement activities would be low.

7.2.5 Shop floor responsibilities assignment (F4)

Lean production is always inseparable from the practices of multiskilling (with job rotation) and worker empowerment amongst the shop floor workers (Womack *et al*., 1990, Forza, 1996, Karlsson and Ahlstrom, 1996, Olivella *et al*., 2008). Surprisingly, job rotations at Company A were rare and multi-skill training was infrequent (see Table 6-5). Besides, the extent of Total Productive Maintenance (TPM) practice which emphasises on autonomous maintenance or line-side maintenance usually performed by operators was relatively low compared to other lean practices. The findings in Figure 6-18 tally with the interview statement given by the Lean Coordinator in which Just-in-Time was their focus in lean implementation in their first seven years of lean journey.

In the aspect of shop floor responsibilities (Figure 6-19 – Figure 6-21), it was noticed that supervisory staffs' involvement in the responsibilities of preparation of SOP (*QUA_1*), daily line-side maintenance (*MTCE_2*), planning of workers' long term development programme (*PPL_4*), teach and guide workers in quality circle activities (*PPL_5)*, off-the-line improvement activities (*OFFL_2* and *OFFL_3*) were comparatively lower than engineers and specialist departments. In comparison to Toyota Astra Motor in Indonesia, preparation of SOP, workers' development, leading and facilitating quality circles and off-the-line improvement activities were mainly the responsibilities of supervisory staffs (Imai, 1997). On the other hand, operators of Company A were solely assigned with direct production works and product rework or repair with least

involvement in other technical tasks such as work allocations within team (*PROD_1*) as part of worker empowerment, improvement on production operation methods (*OFFL_2*), and daily line-side maintenance (*MTCE_2*). This explains why there was no any changes in the past three years on the ratio of indirect employees (i.e. QC inspector, Maintenance technicians) and direct production employees (production operators and supervisory staffs) (see Table 5-1).

Given the findings above, shop floor employees (particularly the supervisory staffs) of Company A were mainly assigned with direct production tasks but with least involvement in the technical responsibilities and job rotations. This had limited their exposure to be multi-skilled and learn more about their tasks (via preparation of SOP and job rotations), leadership (via work allocations within team and facilitating quality circles), condition of machine and equipment (via autonomous maintenance), implementation of Kaizen (via off-the-line improvement activities), and so on. As a consequence, their ability to be multi-skilled and knowledge about their work environment, machines' functions and performance, as well as Kaizen methods were limited hence restricted their extent of involvement in Kaizen activities. Therefore, ***Proposition 4a*** is accepted.

7.3 Comparison of the lean approach of Company A with another Malaysia automotive parts manufacturer

This section focuses on the comparison of lean implementation approach between Company A and another automotive parts manufacturer located in Malaysia which would be known as Company B hereafter in this study. The lean approach of Company B was obtained from the case study of Muslimen *et al*. (2011).

Items	Company A	Company B
Headquarter	Malaysia	Japan
No. of employees	210 - 220	1200
Achievement in Lean Production System	Overall winner of MAJAICO LPS Model Company programme (2009 – 2011)	Toyota Production System Model Company by MAJAICO (2007)
Lean approach	- Project based. Similar to the 5 stages shown in Figure 7-1. - Performed by Kaizen team with 5 – 6 members. - Centred at waste elimination and Just-in-Time to improve flow. - Improvement from one area (or a production line) to the next area in project basis.	- Project based. Similar to the 5 stages shown in Figure 7-1. - Performed by Kaizen team with 5 – 6 members. - Centred at waste elimination and bottleneck removal. - Improvement from one area (or a production line) to the next area in project basis.
Lean consultant	- External Japanese experts during MAJAICO projects execution	- Internal Japanese experts from Japan headquarter

Table 7-1: Comparison of lean approach of Company A and Company B

Having the similarity as being awarded by MAJAICO as Model Company, the lean approach of both companies were in fact identical. First, Japanese lean experts' assistance was needed at least in their first few projects until their internal lean trainers were capable to lead improvement projects. Second, their lean implementation was emphasised on project based and their Kaizen projects were carried out by dedicated cross-functional Kaizen team which consisted of 5 – 6 members only. Third, their approach of lean implementation was similar to the five core lean principles (Figure 7-1); centred at waste elimination and to improve flow. Fourth, lean improvements were carried out laterally across all the product value streams on project basis.

The findings above show that 'Employee Involvement' was not their focus in lean implementation especially at the initial phase; instead Kaizen project which carried out by a cross-functional team with a few members was their selection. The reasons for such approach being selected at Company A (as mentioned in Section 7.2.4) perhaps happened to Company B as well (the aspect of reasons for lean adoption was however not covered by Muslimen *et al*.).

Being awarded as Model Company, their approach in lean implementation would be adopted by other automotive parts manufacturers in Malaysia because their internal lean experts would coach and provide consultancy to other companies, as part of the objectives of the MAJAICO programme (see Section 1.2 and Section 3.3.2). Therefore, what happened to Company A along their lean journey would most likely happen to other manufacturers in the same industry in future. Therefore, the critical success factors on 'Employee Involvement' identified in this study are generalisable to other automotive parts manufacturers in Malaysia.

7.4 The proposed bottom-up lean conceptual model

7.4.1 Introduction

The implementation style of Company A and Company B in fact very much similar to the approaches of most of the proposed lean frameworks or models reported in previous studies (see Section 2.4.3) with the following characteristics:

- The approaches were mainly focussed on top-down leadership while bottom-up initiative was often neglected.
- The approaches were in project basis via Kaizen Event execution which involved only cross-functional teams (not everyone was involved).
- The approaches were mainly focussed on facilities or hardware improvement (for example layout, working methods, production flow, etc.), soft-element such as companywide workers' capabilities development, lean thinking and culture inculcation amongst shop floor employees had not been emphasised.

To close the research gap, this section aimed to propose a bottom-up lean conceptual model and its implementation roadmap not only for Company A but for Malaysian automotive parts manufacturers as a whole.

7.4.2 Development of the model

In formulating the model, the following considerations were deemed important:

- To close the research gap, the model has to overcome the problems encountered in the studies about barriers to engage shop floor employees in lean transformation (see Chapter 2).
- The model has to incorporate the identified critical success factors of 'Employee Involvement' in lean transformation to ensure its feasibility and successfulness.

7.4.3 Strategy in proposing the model

The proposed model consists of two main parts:

- The first part is a conceptual model to present the elements that are needed to initiate bottom-up approach activities; and,
- The second part proposes a roadmap for its implementation.

7.4.4 The bottom-up lean conceptual model

Figure 7-2 shows the proposed bottom-up lean conceptual model.

The aim of the model is to instil Kaizen mind to shop floor employees and provoke their initiative to involve into company's improvement programmes. It is very important to develop the thinking and skills of shop floor employees as they are the future shop floor leaders.

As the cornerstone, top management's commitment is the inevitable prerequisite towards successfulness of the implementation of this model. In this aspect, managers especially have to be committed in playing important supporting role before other activities could be commenced. As the catalyst, their active involvement and commitment could influence the motivation of others to succeed the bottom-up approach lean implementation.

Next, production stability and operations standardisation are required as well in advance when implementing the model. Without a stabilised production system,

everyone at the shop floor would be engaged in disturbance handling and progress chasing. It would not only eat up their precious working time but also distract their focus to involve in Kaizen, especially the supervisors. Since perfect production system without disturbances is impossible to achieve in reality, perhaps line leaders and operators should be trained in advance to handle shop floor disturbances so that supervisors and engineers would have more time in off-the-line improvement planning activities. As recommended by Dennis (2007), stability starts with visual management and 5S practices. 5S system sets as a foundation for standardisation and Total Productive Maintenance (TPM) which are the fundamental elements for stability at Method and Machine of 4M. Hence, 5S workplace management is crucial for production stability.

The assignment of responsibilities to shop floor employees also served as the foundation to encourage and expose them to improvement activities. If merely assigning workers to handle direct production tasks without other technical responsibilities such as autonomous maintenance or setup reduction activities; this will not only restrict them to pick up new skills but also their potential to contribute in Kaizen. This is a severe human waste according to Taiichi Ohno (1988). However, shop floor responsibilities reassignment has to be managed with caution and carried out in phases. Managers need to ensure workers are provided with adequate trainings before assigning them with new technical tasks.

By strengthening the above prerequisites, the next emphasis should be on the focus areas of Kaizen at Toyota. Listed in the two pillars of the model are all the Kaizen areas that involve operators at Toyota to contribute to the company via bottom-up approach (Pardi, 2007). Focusing on waste elimination, these Kaizen are identified as workable, feasible and reachable by Toyota workers at their workplace. For more definition about these Kaizen areas, see Section 4.2.1.

Centred at ‘Employee Involvement’, the model devotes particular care to the problem solving skills and tools needed by shop floor employees and activities that would encourage their buy-in and involvement (see Figure 7-3). The commonly used problem

solving tools amongst the shop floor employees at Toyota are *5-Whys, PDCA, A3 Reports, Grasp-The-Situation (GST), Pareto Chart,* and *Time and Motion study* (Spear and Bowen, 1999, Liker, 2004, Dennis, 2007); while Toyota workers are actively involved in the Kaizen activities such as quality circle and suggestion system (Imai, 1999, Shimizu, 2004, Pardi, 2007). However, the key to 'Employee Involvement' is the availability of internal lean trainers. They are the ones to closely coach the workers in the utilisation of the tools and facilitate the Kaizen activities. Without sufficient number of competent internal trainers, the transition to bottom-up approach improvement would be difficult.

Finally, several understandings about lean or Kaizen mind needed to be instilled to everyone at companywide especially during this bottom-up approach phase which emphasise more on lean thinking development amongst the employees. To overcome the challenges and barriers along the journey, a saying from Womack and Jones (1996) should be always kept in mind - '*Two steps forward and one step backward is OK; No steps forward is not OK*'. Setback in lean implementation should not be viewed as a failure, instead a lesson and a driving force for the next improvement initiative. Kaizen is based on constant effort; although improvement made by Kaizen is small but it is incremental and it has enormous impact in building Kaizen culture in an organisation. Apart from that, from the aspects of *muri* (unreasonableness) of the 3M concept and 'Respect for People', management should establish a system to develop and motivate workers to actively participating in improvement activities by teaching them and equipping them with all the necessary tools and resources. Workers should not be blamed for making mistakes if such as a system does not exist. Lastly, the perception of *Job* is no longer equal to *Work*; but it is equal to *Work + Kaizen* (Liker and Balle, 2013). Responsibilities of shop floor employees should not be restricted to only handling direct production tasks, but they should be exposed to Kaizen on how to improve their work and working environment.

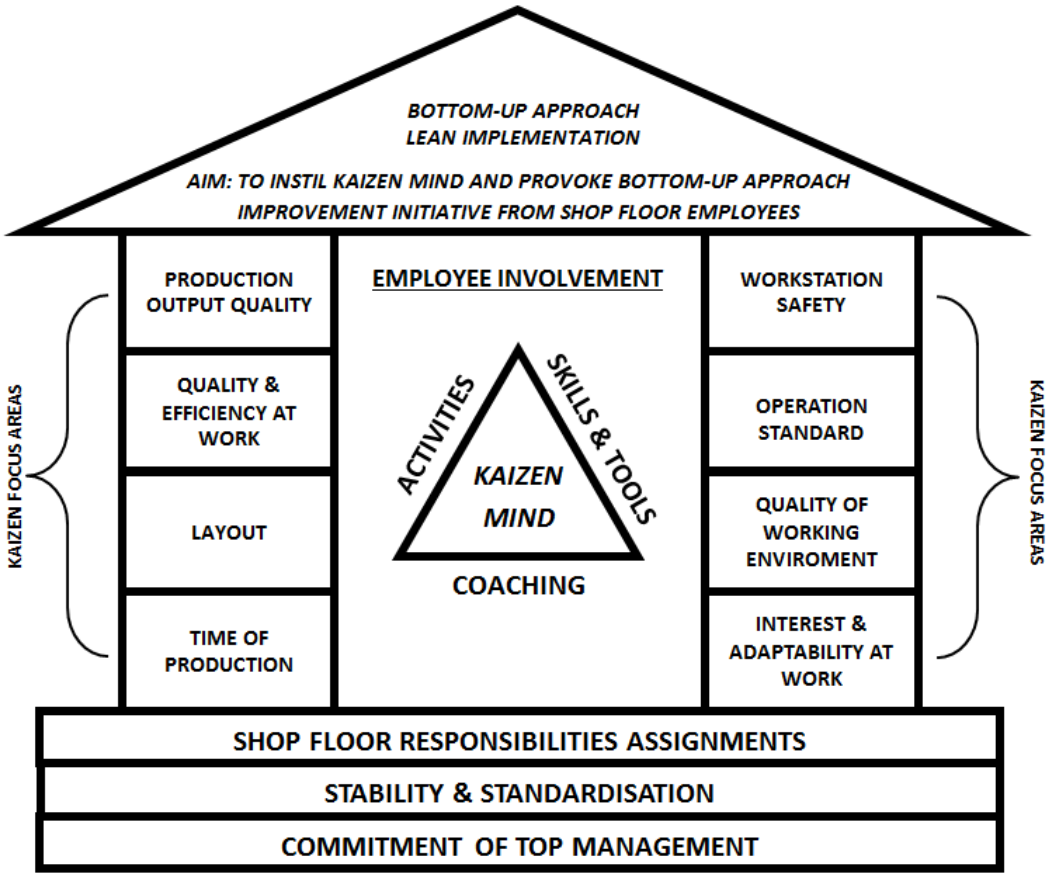

Figure 7-2: The conceptual model of bottom-up approach lean implementation

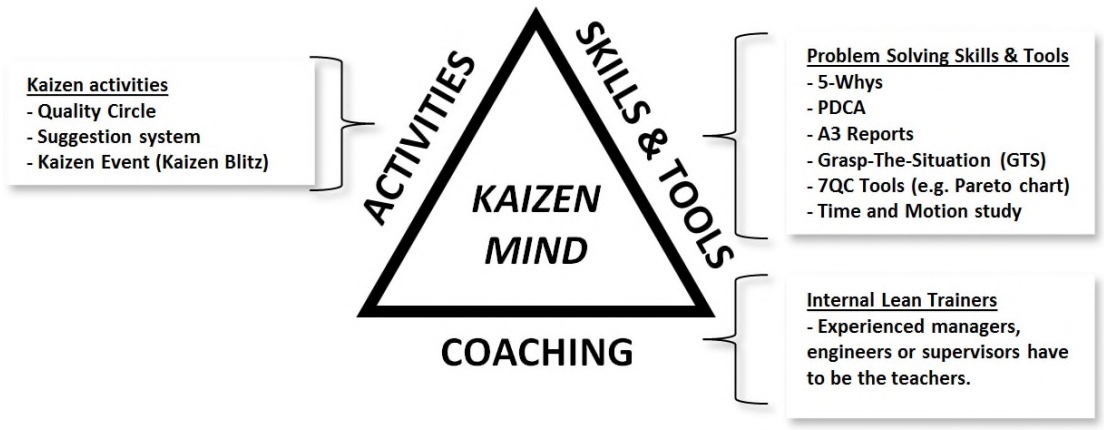

Figure 7-3: Kaizen Triangle

7.4.5 The proposed roadmap

Figure 7-4 shows the proposed roadmap to implement the bottom-up lean conceptual model. It is a long term programme which emphasises more on workers' development. It consists of four main stages. To succeed the programme, top management's commitment and support should be presence throughout the whole journey.

In the first stage, managers have to establish a long term plan on 'Worker Development' and 'Total Involvement'. They have to specify which Kaizen focus areas are suitable for employees to concentrate their efforts when looking for improvement opportunities. They have to review and adjust company's reward system and remuneration package to ensure it is compatible with workers' contribution. As the main actors of bottom-up approach improvement, shop floor employees' skills level and difficulties at work must be known in advance so that trainings could be planned according to their needs. It could be done via survey.

In the second stage, experienced managers or lean steering committee have to standardise the steps of application of all the problem solving tools and document them in company's training materials. Previous example projects with demonstration on the application of the problem solving tools should be enclosed in the training materials. In order to closely guide the shop floor workers in Kaizen activities, a large number of internal lean trainers are needed. Serve as the nucleus for reproducing lean coaches, the lean steering committee have to be committed in teaching the managers, engineers and supervisors. Meanwhile, the operators and line leaders need to be equipped with the skills and authority in managing disturbances at the production. This is to free up the supervisors and engineers for more engagement in Kaizen training. As mentioned in section 7.4.4, managers need to re-assign the shop floor responsibilities with the aim to expose the workers to handle more technical tasks. In this stage as well, managers need to establish an effective suggestion system which including a cross-functional review team and a transparent reward system.

In Stage III, workers have to be organised in teams with team leaders. There has to be at least one or two quality circles exist in each team under the guidance of experienced

team leader or supervisors. This is the stage mainly to train workers in the application of problem solving tools and how to carry out improvement in team via quality circle. Close supervision for the quality circle activities are needed from the internal lean trainers. In forming quality circle, a good practice is to include members with prior Kaizen experience in the team. They can improve the efficiency of the activities. At the same time, workers must be taught where to look for improvement idea and how to raise a suggestion. A briefing about the reward system is important as well to motivate the workers in contributing ideas. Throughout this stage, survey has to be conducted regularly to understand workers' learning progress and the weaknesses in the current practices. The information is valuable for future improvement in the training materials.

The last stage, *Perfection*, it is an endless journey. The previous Kaizen and training efforts have to be reviewed and improved continuously. While enhancing the quality, the number of quality circles should be increased by involving new members. Number of internal lean experts would be increased when more and more people have accumulated their knowledge and experience in the Kaizen activities. When these activities are full-blown, top management can consider conducting annual competition to set as a platform for workers to present their improvement works and also an opportunity for them to gain recognition. In striving for perfection, the lean thinking and Kaizen mind as mentioned in section 7.4.4 should be instilled amongst the workers. The best practice in lean cultural building is to make the people realise the lean philosophy via continuously involving them in Kaizen and relentlessly making improvement.

Stage I: Planning	Stage II: Preparation	Stage III: Deployment and Training	Stage IV: Perfection
1. Responsibilities and roles of top management: -Set vision – Set a 5-years vision with progressive annual goals aimed at 'Total Involvement' and 'Worker Development'. -Kaizen focus area – Specify the Kaizen focus areas (as shown in the two pillars of the model in Figure 7.2) for shop floor employees to concentrate when looking for hidden waste and improvement opportunities. -Survey – Survey to find out the operators and supervisory staffs' skill level in problem solving for training planning purpose. -Reward system – Top management have to review their reward system. It has to be transparent and compatible with workers' contribution; and in both monetary and non-monetary forms. -Remuneration package – Top management have to review their remuneration package as the shop floor responsibilities would be re-organised and workers would be given more responsibilities.	**1. Standardisation of tools and training materials:** -Standardisation – Standardise all the problem solving tools especially its methods of application so that everyone speaks the same language. -Preparation of training materials – Prepare training materials which documenting the application of all the necessary tools and example projects. **2. Preparation of internal lean trainers:** -Train the lean trainers – Experienced managers (and members of lean steering committee) should act as the core team to generate more internal lean trainers (engineers and supervisors) to support workers in Kaizen in future. **3. Shop floor responsibilities re-assignment:** -Operators and line leaders – Train them to handle disturbances at production (to release the engineers and supervisors); and to take up more technical responsibilities such as autonomous maintenance, preparation of SOP, etc. -Supervisors – Supervisors should handle more improvement projects (as part of the trainers' training) and take up more responsibilities in off-the-line improvement planning activities. **4. Suggestion system:** -Suggestion system – Establish the rules of suggestion system and a suggestions review team. Simplify and standardise the method for raising a suggestion and establish a transparent reward system.	**1. Work organisation** -Team – Organise the workers in teams with team leaders. Each team needs to have 1 or 2 quality circles. **2. Trainings** -Kaizen focus area – Introduce the workers the Kaizen focus areas with example project for each focus area. -Problem-solving tools – Teach the workers the application of the standardised tools. -Coaching – Internal lean trainers need to closely guide and teach the quality circle activities. Teach the workers the problem solving tools and where to focus when looking for improvement idea. -Quality circle – At initial stage, workers should be shown with demonstrations on how to carry out a typical improvement project. Ideally, members of a quality circle should consist of 1 to 2 workers with prior experience in Kaizen. They can improve the efficiency of the activity. -Suggestion system – Teach the workers how to raise a suggestion and brief them about the reward system. -Survey – For improvement sake, regularly conduct survey to update their skill level, difficulties at work and in learning.	**1. Review and improve the past effort** -Quality circle and suggestion system – Continuously review and improve the quality of these activities; Expand the number of quality circles by involving more new members. -Training materials – Continuously review and improve the standardised problem solving tools and training materials. -Internal Lean Trainers – Continuously upgrade the skills of the trainers and increase the number of trainers. -Competition – Conduct annual competition (with reward) for quality circle and suggestion system to stimulate more involvement and more improvement. **2. Culture building** -Kaizen mind – Everyone should be fostered with the right understanding about lean and Kaizen. -Sustain all the above – Keep everyone involved in the activities above and continuously make improvement – is the only practical way of lean cultural building.
Estimated Duration – 6 Months	**Estimated Duration – 2 years**	**Estimated Duration – 2 years**	**Estimated Duration – Endless journey**
The estimated duration depends on the complexity of production characteristics and the size of the organisation.			

Figure 7-4: A proposed roadmap for bottom-up approach lean implementation

7.5 Validation by experts

The validation was divided into two main categories:

- 7.5.1 – Validation of the empirical findings and its analysis
- 7.5.2 – Validation of the proposed bottom-up lean conceptual model

7.5.1 Validation of the empirical findings and its analysis

The empirical findings and its discussion were validated by three experts below:

- *Reviewer_1*, an academic with extensive experience in lean production and Six Sigma from Cranfield University;
- *Reviewer_2*, a PhD student from Cranfield University who has extensive experience in empirical research;
- *Reviewer_3*, a Malaysian lean expert with more than 15 years holding managerial position in the manufacturing industry.

(Prior interview via phone call with Reviewer_3, an email which attached with the draft of Chapter 3 – Chapter 7 was sent to him; followed by a phone call to explain to him how the results were obtained and analysed. After a week, another phone call was further made with him to obtain his opinions about this research)

All the reviewers acknowledged that the overall findings of this research were valid and reliable. From *Reviewer_1*'s point of view, the findings had proven each critical success factor has positive influence on to the extent of employees' involvement in Kaizen activities. Whereas, *Reviewer_3* believed that the findings reflected the reality of lean adoption in most of the Malaysian companies with his years of experience in manufacturing sector. From his opinion, shop floor employees should be given more opportunities to involve in Kaizen and they should be assigned with more technical tasks. He also felt the element of 'bottom-up approach' is very crucial to sustain lean in the long run.

7.5.2 Validation of the proposed bottom-up lean conceptual model

The proposed model and roadmap were validated by three lean experts as follows:

- *Reviewer_1* – same as the *Reviewer_1* above;
- *Reviewer_2* – the Lean Coordinator of Company A; and
- *Reviewer_3* – same as the *Reviewer_3* above.

Validation questions

The aim of the model is to instil Kaizen mind to shop floor employees and provoke their initiative to involve into company's improvement programmes. It is very important to develop the thinking and skills of shop floor employees as they are the future shop floor leaders. In order to achieve the above aim,

a) Has the model covered most of the necessary elements of Kaizen? (or is this model rigorous?)
b) How understandable is this model?
c) - How workable/feasible is this model? (This question was addressed to *Reviewer_1*)
   - How workable/feasible is this model to Malaysian manufacturers? (This question was addressed to the Lean Coordinator and *Reviewer_3*)
d) Any comment on the benefits and/or drawbacks of this model?
e) Suggestion for improvement (if any).

(Prior interview via phone call with the Lean Coordinator and Reviewer_3, an email which attached with the proposed model and its roadmap together with explanations were sent to each of them, a week in advanced. The purpose was to let them go through the contents so the interviews would be easier to carry out.)

a) Validation by academic, *Reviewer_1*

The interview with *Reviewer_1* lasted for about 40 minutes. Overall, *Reviewer_1* commented that this model is understandable and considered rigorous which it covered almost all the Kaizen related elements. However, the roadmap should ensure

early success to maintain consistent commitment from all parties, particularly the top management. Incremental improvement (although with small impact to production performance) should be realised along the implementation journey. Example of initial success could be from 5S practices to show some positive changes at the shop floor and to encourage workers to sustain their effort in continuous improvement. In addition, he suggested the key responsibilities for each key role should be demonstrated so everyone knows what to do.

b) Validation by Lean Coordinator of Company A

The Lean Coordinator replied his comments via email about four days after receiving the validation invitation email. A telephone call was further made with him to confirm the comments he had made. In general, he reckoned that the model is rigorous and it has covered most of the Kaizen elements. He recommended that some elements of Just-in-Time could be added into the model. After clarification made with him via the phone, the Kaizen areas - '*Time of Production*' and '*Layout*' in fact are related to Just-in-Time elements; which emphasise on flow improvement and waste elimination. In addition, he felt that the model is easy to understand and it focuses on the importance of top management's commitment and production stability which are crucial for lean success. He believed the model is feasible and the proposed roadmap was described and explained in detailed. Lastly, he felt the proposed timeline in the roadmap is reasonable for workers' development purpose which it takes time to train internal lean trainers.

c) Validation by Malaysian lean expert, *Reviewer*_3

Reviewer_3 replied his comments via email about a week after receiving the validation invitation email. A telephone call was also further made with him to confirm the suggestions he had made. In his comments, he reckoned that the model is generally understandable and should be workable for Malaysian manufacturers. The proposed implementation roadmap is also reasonable - which it started with commitment from

management and training of the workers especially in-house trainers. He had further made four suggestions for improvement as follows:

- Suggestion 1 – to add in 5S practices into the model as it is fundamental and should be done by workers before any improvement starts.
- Suggestion 2 – besides quality improvement, sometimes it is possible to include workers into productivity (quantity) improvement activities.
- Suggestion 3 – besides internal training, trainings from external professional bodies would be helpful for additional knowledge.
- Suggestion 4 – knowledge sharing between organisations (suppliers and customers) would be helpful.

Regarding Suggestion 1, although 5S was not listed in the model, however, 5S is the fundamental element for production stability which should be carried out by workers (production stability is the prerequisite for the model, see Section 7.4.4). For Suggestion 2, Kaizen area of '*Time of Production*', '*Layout*', and '*Quality and Efficiency at Work'*, are in fact related to productivity improvement. These two clarifications were made with him in the phone. However, *Reviewer_3*'s Suggestion 3 and 4 would be helpful for the proposed model implementation and improvement. These two suggestions could be inserted into Stave IV of the implemented roadmap.

Chapter summary

After the comparison of the extent of Kaizen involvement of each internal stakeholder, this chapter discussed the influences of each of the critical success factors to the 'Employee Involvement'. The chapter continued with the generalisation of the results by comparing the approach of lean implementation of Company A with another Malaysian manufacturer. The second half of the chapter introduced the proposed bottom-up lean conceptual model and its implementation roadmap. The validation of this research and the lean model ended this chapter.

8 RESEARCH CONTRIBUTIONS, CONCLUSIONS, LIMITATIONS AND FUTURE WORKS

8.1 Introduction

This chapter first presents the research contributions of this study followed by the quality of this research. It continues with the conclusions of this study. The limitation of this study with future works will be presented at the end of chapter.

8.2 Research contributions

8.2.1 Theoretical implications

1) This study revealed that each identified critical success factor, namely F1 – *top management's commitment*, F2 – *shop floor employees' commitment and capability*, F3 – *the stage of lean transformation*, and F4 – *shop floor responsibilities assignment* has positive influence on the extent of Kaizen involvement amongst the shop floor employees.

2) The reasons of selection of the lean approach of Company A (*which focused on top-down approach and involved only a few cross-functional team members*) from their beginning of lean journey until this study was carried out (which explained in Section 7.2.4) had pointed out that even after 7-years of intensive lean implementation, Company A still suffered with the issues of low competency of successors for their LPS Department (see Section 6.3.2), low employee involvement, and lack of technical capability amongst the shop floor associates. This finding indirectly unveiled the answer to one of the problems found in the literature reviews i.e. *lack of technical know-how amongst the shop floor employees* in lean implementation. Employees' knowledge in lean has inseparable relationship to their extent of involvement in Kaizen activities; and the latter would be determined by the company's approach selection in lean implementation.

   Nevertheless, both Company A and Company B had proven that they still could be '*lean*' (being awarded as Model Company) even though their top-down approach

lean projects were only carried out by a few members who formed the Kaizen team, with minimal involvement from the shop floor associates. Anyway, to sustain their early lean success and to strive for perfection, involvement of shop floor employees is inevitably needed in the later stage of their lean transformation journey.

3) As mentioned in Chapter 2, most of the proposed lean frameworks were emphasised on top-down implementation but bottom-up approach had been neglected. To close the gap, this study had proposed a bottom-up lean conceptual model and its implementation roadmap by incorporating the identified critical success factors.

8.2.2 Managerial implications

1) For a conventional mass production manufacturer to set out their lean journey, the approach of Company A in lean adoption explained in Section 6.3.1 could be served as a reference. To involve shop floor employees in large is difficult without prior knowledge in lean and strong internal lean trainers. The reasons given in Section 7.2.4 explain why top-down approach was Company A's selection (mainly for lean learning purpose) from the beginning of their lean journey until this study was carried out.

2) Workers are the future shop floor leaders. Shop floor responsibilities assignment has inseparably relationship with employees' skill development and Kaizen involvement. Line leaders and operators should be trained and empowered to handle production management tasks, preparation of SOP and autonomous maintenance; while the roles of supervisors should be elevated to manage workers' development and off-the-line improvement activities such as production and process improvement, guide and facilitate quality circle activities, encourage suggestions, etc.

3) Quality and quantity of in-house lean trainers are the important elements in supporting 'Employee Involvement' during bottom-up improvement phase. LPS steering committee or managers and other key personnel with extensive lean experience have to be the first to serve as the nucleus of an organisation in generating more internal lean trainers. Lean culture could only be instilled in a workplace by involving more people to hands-on practice all types of Kaizen activities.

4) Lean is an endless journey. Involvement from shop floor employees is very important via bottom-up initiative Kaizen to sustain lean benefits which have been realised during top-down approach phase. They should be given opportunity to practice Kaizen via quality circle and suggestion system with the aim to foster Kaizen mind and culture at the shop floor. They are the future shop floor leaders after all for sustaining the competitiveness of a company.

5) *Genchi Genbutsu* – a good practice shown by the managers at Company A while leading problem solving or improvement activities had won the recognition from their shop floor employees on the management's commitment and seriousness in lean implementation. It should be practiced by all managers of all companies including non-lean practitioners.

6) Training – In dealing with anchor-draggers, Company A hold the belief that training was the only effective way to resist the negative influence from anchor-draggers. They had not taken any direct action to remove the anchor-draggers but believed that by relentlessly providing training and creating awareness to the workers, it could enhance the positive energy at the shop floor; so that negative influence from the anchor-draggers would be reduced. Their approach was seen to be effective when this study was carried out (see Section 6.3.2).

8.3 Quality of the research

The quality of this research was examined from the aspects of reliability, internal validity, construct validity and external validity.

Reliability

To ensure *reliability*, a study has to demonstrate that its general rules and procedures of investigation could be replicated in order to get the same findings. Thus, the procedures and flow of data collection should be documented (Yin, 2009). In assuring *reliability* for this research, Chapter 3, Chapter 4, Chapter 5 and Appendix A which contain the general rules, investigation procedures, and the questionnaires for data collection were precisely documented; so that other researchers could replicate this study following the same procedures and the same results could be obtained.

Internal validity

Internal validity of this study would be secured if correct conclusions could be drawn from the causal relationship between the identified critical success factors and the level of 'Employee Improvement', based on the empirical findings. To ensure *internal validity*, the propositions were developed and managed with care. As shown in Chapter 4, the propositions express that those identified factors would positively or otherwise influence the extent of employee involvement; the propositions however do not indicate that certain factor alone would cause the successfulness (*high* or *low*) of 'Employee Involvement'. The propositions also do not indicate that certain factor(s) would be more influential than the others. Without care, it might lead to wrong conclusion made. Moreover, the questionnaires and the theoretical framework had been validated by both academics and industrial experts. Thus, the possibility of lacking *internal validity* is considered low in this research.

Construct validity

Construct validity refers to the degree to which a test measures what it claims, or purports, to be measuring (Brown, 1996). In ensuring *construct validity*, several actions were taken. First, different dimensions to investigate each critical success factor were

identified via literature review with the sake to link the data collection questions to the propositions (see Section 4.3.2). Second, as mentioned in Section 4.3.4, relevant studies were referred when preparing the questionnaires. Operational measures utilised in previous researches were adopted for *production performance measurement* and *the extent of lean practice and activities* in this study. Third, as shown in Section 4.3.2, the ideas of *data triangulation* and *within-method triangulation* were utilised when designing the questions so that the empirical findings would be based on more than a single source of evidence (multiple sources of evidence from different groups of respondents were obtained). For example to probe *F1-top management's commitment*, besides top management's self-perceptions on their own commitment, voices from shop floor employees, HR and engineers were heard as well. Fourth, to ensure the respondents could understand the intention of each question, simple language was used. In addition, the questionnaires for the blue-collared employees were translated into Malay language, which is the mother tongue for most Malaysian. Lastly, the questionnaires were validated by academics and the mentor of this project from the university to enhance its effectiveness and validity.

External validity

As mentioned in Section 4.2, a previously developed theory could be used as a framework to link the empirical findings of a case study. It is known as *analytical generalisation* (Yin, 2009). In this study, *external validity* can be assured because its results can be generalised to a wider applicability theory, which is the four main propositions stated in the theoretical framework. The critical success factors stated in the propositions which would affect the extent of shop floor employees' involvement in Kaizen activities were originated from extensive review on the literature of lean production system.

Moreover, the generalisability of a case study can be increased by strategic selection of critical case (Mikkelsen 2005, Blaxter *et al*., 2006). As mentioned in Chapter 3, Company A was the overall winner of the MAJAICO LPS Model Company programme. On the other hand, the targeted company in the study of Muslimen *et al.* (2011) which

was another Model Company awarded by MAJAICO having a lot of similarities in the their approach of lean implementation. Hence, the generalisability of this study has been enhanced.

8.4 Conclusions

1) The investigation on the extent of involvement in the activities of the identified 10 Kaizen focus areas at Company A (a Malaysian LPS Model Company in lean implementation awarded by MAJAICO) found that their shop floor employees' extent of involvement (including supervisory staffs) in the activities of all the Kaizen areas was low, even for Bottom-Up Kaizen i.e. K1 – K4.

2) From the data analysis, it was found that all the identified critical success factors have significant influence on the shop floor employees' extent of Kaizen involvement at Company A. Below is the summary:
   i) ***F1 - Top management's commitment*** – The top management had yet to transform their vision on 'Employee Involvement' into practice by determinately implementing the quality circle and suggestion system activities. This is why the involvement of shop floor employees in the company's Kaizen activities was low.

   ii) ***F2a - Shop floor employees' commitment*** – The shop floor employees were committed to be engaged in the Kaizen activities. However, their commitment was sometimes being challenged by disturbances at the production. They had to spend their working time at the non-value added activities which caused by unstable MACHINE condition and MATERIAL supplies from suppliers. Without full commitment, their level of involvement in Kaizen activities was low.

F2b - Shop floor employees' technical capability – The shop floor employees were lack of knowledge on problem solving skills and relatively poor in absenteeism replacement. The production operators had not attended any problem solving skills training while supervisory staffs had attended only PDCA, 5-whys and Fishbone diagram related trainings. Being lack of ability in replacing absenteeism also exposed that job rotations amongst the workers were rare. With lack of technical capability, their level involvement of Kaizen activities was low.

iii) ***F3 – The stage of lean transformation*** – This study confirmed that for a conventional mass manufacturer to begin their lean journey, top-down approach lean implementation is unavoidable at the initial stage; 'Total Involvement' from the shop floor employees is however impossible. Their focus of lean implementation was on top-down Kaizen projects which led by their LPS department. This type of Kaizen projects involved only a few key personnel selected into the Kaizen teams (5 – 6 people per team) with least involvement from the shop floor employees. This is why even after 7-years of intensive lean implementation, Company A still suffered with the issues of low competency of successors for their LPS Department (see Section 6.3.2), low employee involvement, and lack of technical capability amongst the shop floor associates.

iv) ***F4 - shop floor responsibilities assignment*** –The study revealed that their shop floor employees (including supervisory staffs) were mainly assigned with direct production tasks without much exposure to other technical responsibilities. Moreover, job rotations amongst the workers were rare. These were amongst the reasons causing low technical competency of the workers. Without much exposure to other technical responsibilities, it had limited the shop floor employees' involvement in Kaizen.

3) As one of the research gaps which identified in Section 2.4, besides the one proposed by Jagoda *et al.* (2013), most of the identified lean (or Kaizen) frameworks or models were focussed on top-down implementation. To close the gap, a bottom-up lean conceptual model and its implementation roadmap were proposed in this study (see details in Section 7.4). Aiming to instil Kaizen mind to the shop floor employees, this model has incorporated the above critical success factors and attempted to address all the problems in engaging employees into lean activities found in the literature review.
   - The aim of this model is to provoke 'Employee Involvement' and to nurture Kaizen mind amongst the workers.
   - Besides top management's commitment, production stability and shop floor responsibilities assignment are the cornerstones for this model.
   - Centred at 'Employee Involvement', the key to success on the implementation of this model is *'coaching'*, utilisation of the problem solving tools and the availability of '*internal lean trainers'* (see Figure 7.3, *Kaizen Triangle*).
   - Capability building programmes to develop a cluster of internal lean experts is needed before the phase of 'bottom-up approach' which involves all shop floor employees starts.
   - Only with competent internal lean trainers, the on-the-job training to teach and guide workers in Kaizen activities and utilisation of problem solving tools are feasible.
   - The only way to instil Kaizen mind and foster lean culture amongst the workers is via hands-on experience in Kaizen and relentlessly making improvements.

4) The proposed bottom-up lean conceptual model and its implementation roadmap have been validated by lean experts from both academia and industry.

8.5 Research limitations and future works

1) The survey was targeted to local Malaysian operators only due to the concern of quality and reliability of the survey. Foreign operators were not targeted due to their language barrier to understand the contents of survey. In future, further investigation can be targeted to foreign operators in order to get more comprehensive view.

2) The 10-Kaizen focus areas (Section 4.2.1) were carefully defined by the author with reference to the study of Pardi (2007) and had been validated by lean experts during the questionnaire validation (see Section 4.3.6). The survey results on *the extent of involvement in Kaizen activities* have been compared with Toyota's practice which available in the study of Pardi (2007). However, due to the lack of clear definition, *K3 - quality and efficiency of work* and *K4 – workers' interest and adaptability at work* are recommended to have further study to confirm.

3) Final validation of the proposed bottom-up lean conceptual model and its roadmap via real implementation at a company is a long term study and not possible to be done in this one year study. It is recommended to have a further study via practical implementation to put its feasibility to the test and also to provide insights for further improvement.

4) As per the suggestion given by *Reviewer_1* for the proposed lean model (see Section 7.5.2) which to include the key roles of all the internal stakeholders that involved in the implementation; this research however did not focus on the roles of all the internal stakeholders, especially white-collared employees (engineers and above) but it covered only shop floor responsibilities assignments. A future study could be carried out to comprehensively investigate the roles of managers, engineers, and shop floor associates in a Malaysian lean manufacturer and the findings could be used to further support the proposed model.

- End of Chapter 8 -

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APPENDICES

Appendix A - Questionnaires

A.1 Interview Questions

Lean journey and the approach of lean adoption

1) *Since when did your company start to adopt LPS?*
2) *What has motivated your company to adopt LPS?*
3) *How long it took to complete the first MAJAICO-A1 project in your company?*
4) *Where was the first project implemented in your company?*
5) *What were the criteria in choosing the first project area?*
6) *Can you briefly describe how did you kick-start the first MAJAICO-A1 project?*
7) *Who were involved in the first project? What were their roles?*
8) *What was the role of the Japanese consultants in the project implementation?*
9) *What were the trainings provided by the consultants? How were the trainings being conducted?*
10) *What were the benefits enjoyed from the first MAJAICO-A1 lean project?*
11) *What was the impact of the first MAJAICO-A1 lean project to the company?*
12) *What was your lean adoption approach – would you choose to develop people first at the companywide (the soft element) or improve the hard element first, i.e. improve the production flow via improvement project which involves only a few people? How effective is your approach?*
13) *How did you apply the lessons learnt in the first MAJAICO-A1 lean project?*
14) *After the first MAJAICO-A1 lean project, how did your company expand the lean transition to other areas?*
15) *How many major lean projects were subsequently completed?*
16) *After several years of lean adoption (or several major lean projects completed), did you start to craft (or have your already crafted) your own lean production system model (or your own way to adopt lean)?*

Current stage of lean transformation and future targets in lean

1) *What is the current lean transformation stage of your company?*
2) *Do you still encounter any barrier in lean adoption at this stage? How would you overcome the barrier?*
3) *What is your main challenge in lean transformation at this stage?*
4) *What is your company's next target in lean?*

Employee Involvement

1) *In the aspect of Hoshin Kanri (or policy deployment), was there any target assigned to the shop floor employees (including supervisory staffs)?*
2) *Is there any suggestion system exists in your company? Is there any reward or target set for the workers? Is the implementation of suggestion system successful?*
3) *Is there any Quality Circle activity exists in your company?*
4) *Do you involve shop floor employees in Kaizen event or lean project?*
5) *What were the trainings of lean production which had been provided to the shop floor workers?*
6) *Do you conduct any survey to understand shop floor employees' needs?*
7) *Is learning new skill one of the criteria in operators' performance appraisal?*
8) *For teambuilding purpose, how does your company motivates workers?*
9) *At the shop floor, what is the main challenge against 'Employee Involvement'? Do you think it is possible to involve general workers (or production operators) where almost half of them are foreign labours?*
10) *In short, do you see any clue or sign that your company is already in the transition towards bottom-up approach improvement***?**

A.2 Survey questionnaires

Following the investigation dimensions according to the respondents as listed in Table 4-3, the questionnaires were prepared accordingly as shown in this section. The information of cover page for each of the questionnaires was standardised and is shown as below:

A.2.1 Cover page information

Targeted Respondents: *Top management / HOD or Middle managers / Human Resource Department / Engineers / Supervisory staffs / Production operators*

Privacy Protection

1. The information you provide will be used for research purposes only.
2. The researcher respects your privacy and keeps all the information you provide **ANONYMOUS**.
3. The information about your company will be kept **ANONYMOUS**.

Options in answering the questions:

Should you choose to go through the questions with the researcher, Chay via SKYPE, kindly contact him at t.chay@cranfield.ac.uk or chaytf@acd.tarc.edu.my.

The deadline for this survey is _____

Aim:
The goal of this questionnaire is to investigate shop floor employees' involvement (including supervisory staffs) in lean implementation activities in a Malaysian automotive parts manufacturer.

Please indicate your:

Years of service in industry:	
Years of service in this company:	

Reminder: To obtain reliable survey outputs, please be reminded to answer all the questions as ***how it is happening*** *in your company but NOT* ***how it should be happening****.*

Instruction: Please answer ALL the questions with complete answer.

A.2.2 Questionnaire for top management

Part 1: For Question 1 – 26:
Please Indicate your level of agreement or disagreement following 5-point Likert scale, ranging from 5 = Strongly agree (or Very frequent), to 3 – Somewhat agree (or Sometimes), to 1 = Strongly disagree (or Not at all).

1. (CO1) In production or process improvement, involvement of all production operators and supervisory staff* is crucial and their opinions are always taken into serious consideration.
   Note: Supervisory staff in this questionnaire is referred to as all the production supervisors, shift supervisors, line leaders, process leaders, etc. They are ranked above the production operators.*
2. (CO2) Without active involvement of production operators and supervisory staff, the production or process improvement is difficult to succeed or sustain.
3. (CO3) In continuous improvement, our aim is to include all production operators and supervisory staff in our improvement teams and actively involve them in improvement activities.
4. (T1) We require all our production operators to undergo trainings on performing multiple tasks in the production process. (We require our operators to multi-task.)
5. (T2) We require all our supervisory staff to undergo supervisory skills and leadership trainings.
6. (T3) We continuously improve the trainings to suit the needs of all production operators and supervisory staff.

7. (T4) We continuously enhance all our production operators' and supervisory staff's knowledge on the concept and techniques of lean production through trainings, visual aids, knowledge sharing activities, etc.
8. (T5) We are confident and able to transform all our shop floor employees' mindset and working behaviour to adapt in lean environment regardless of their origin culture and background.
9. (T6) We are willing to invest in our production operators and supervisory staff because we believe they will appreciate and contribute to the company in return.
10. (CC1) Information of company's latest development and performance updates in market are consistently displayed at the shop floor and regularly channelled to all production operators and supervisory staff*.
11. (CC2) We always conduct dialogue sessions with shop floor employees or surveys to understand their needs* and difficulties at work. (Example of needs* - skills required, working aids and types of trainings they need, etc)
12. (PD1) The job scopes and responsibilities of production operators and supervisory staff are precisely documented in company's formal management system.
13. (PD2) We have established and deployed targets for improvement to all the shop floor employees particularly supervisory staff.
14. (PD3) We have devised and always improve our strategies to help and motivate all production operators and supervisory staff to achieve the improvement targets. (such as via competitions in improvement activities)
15. (RW1) We always measure and reward production operators and supervisory staff for their contribution to company's improvement.
16. (RW2) We always measure and reward production operators and supervisory staff for their initiatives in learning new skills and taking up new responsibilities.
17. (GGB) In carrying out production related problem solving or improvement activities, our managers always go to the shop floor to study the problems in detailed besides reading the reports or data provided by subordinates.
18. (CAR) If supervisors are equipped with good leadership and communication (both written and verbal) skills, they will be given opportunity to promote to managerial or executive position in the company after gaining enough operation experience at the shop floor regardless of their education level.
19. (MOTIV1) The team spirit of all production operators and supervisory staff is high in contributing to company's improvement.
20. (5S_OPR) All our production operators HABITUALLY practice 5S at their work place as it is part of their daily routine without instruction from superiors. (Everything has its own place, tools/parts missing is rare)
21. (SKILL1) All our production operators and supervisory staff are always keen to learn and technically ready to involve themselves in production improvement activities.
22. (SKILL2) All our production operators and supervisory staff are technically competent in problem solving which enable them to contribute in improvement in the areas of quality, productivity, safety & morale.
23. (SKL_SUP) Learning/applying basic problem solving skills (e.g. 5-Whys & Fishbone diagram) is NOT difficult for supervisory staff.
24. (MUDA_SUP) All our supervisory staff understand the concept of 7 wastes and able to identify visible waste* at their workplace.
25. (SKL_OPR) Learning/applying basic problem solving skills (e.g. 5-Whys & Fishbone diagram) is NOT difficult for production operators.
26. (MUDA_OPR) All our production operators understand the concept of 7 wastes and able to identify visible waste* at their workplace. (Visible waste*- Example, operators understand wait/delay is waste, they perceive defects / rework is waste, etc)

Part 2: Open Questions:

1. In general, do you think the involvement of all production operators and supervisory staff in company's improvement or lean activities is **IMPORTANT** to your company? **Why**?
2. In general, do you think the involvement of all production operators and supervisory staff in company's improvement or lean activities is **FEASIBLE/WORKABLE** in your company? (What are the **drivers** and **barriers**)?
   (Your opinions can be derived from the view of company's policy and commitment, organisation culture, workers' willingness, workers' skills level, production stability, and other potential factors that related.)

End of question

A.2.3 Questionnaire for HOD / Middle managers

Part 1: Lean Practices / Activities

*Please **CIRCLE** the suitable answer for each of the following shop floor practices:*

Question:
To what extent (in the scale of 1-5) the following practices/activities (Item 1-10) are implemented in your department?

#	Code	Operational performance measure	Scale				
			To great extent				Not at all
1	LOTSIZE_Re	Reducing production lot size	5	4	3	2	1
2	SETUP_Re	Reducing setup time/using SMED* techniques	5	4	3	2	1
3	TPM	Implementing Total Productive Maintenance (TPM)	5	4	3	2	1
4	CT_Re	Cycle time reduction	5	4	3	2	1
5	INV_Re	Reducing inventory level (WIP or finished parts)	5	4	3	2	1
6	1X1	Continuous/one piece flow	5	4	3	2	1
7	PULL	Using pull-based production system/kanban	5	4	3	2	1
8	BOT_Re	Removing bottlenecks	5	4	3	2	1
9	POKAYOKE	Using error proofing techniques/Pokayoke	5	4	3	2	1
10	WASTE_Re	Eliminate waste	5	4	3	2	1

SMED - Single Minute Exchange of Dies*

Part 2: Work Organisation and Shop Floor Responsibilities

Work organisation – Work teams and multi-skilled workers

1. Are all the production operators organised in teams or (work in groups)?
   (Team with team leader / Team without team leader / No team structure / In transition towards team organisation)

2. All our production operators are frequently trained to perform a variety of direct production tasks* so that they are multi-skilled and cross-trained for job rotation and able to fill in for others if necessary. *(Direct production tasks - example parts assembling, machines operating, packaging, material handling, etc)*
   (Strongly agree / Agree / Somewhat agree / Disagree / Strongly disagree)

3. Our production operators change direct production tasks almost:
   (Every hour / Every day / Every week / Every month / None)

4. Our **production operators** and **production supervisory staff*** are frequently trained in set-up time reduction (or techniques of SMED / Single Minute Exchange of Die).
   (Strongly agree / Agree / Somewhat agree / Disagree / Strongly disagree)

   *Note: **Supervisory staff*** in this questionnaire is referred to as all the production supervisors, shift supervisors, line leaders, process leaders, etc. They are ranked above the production operators.*

5. We always improve our quality self-inspection methods (example poka-yoke devices) at each workstation with the aim to reduce the number of QC inspectors at the end of the line.
   (Strongly agree / Agree / Somewhat agree / Disagree / Strongly disagree)

6. Is learning new skills one of the evaluation criteria in operators' performance appraisal?
   (Yes / No)

Shop Floor Responsibilities

For Question 7 to 23:

Please indicate the level of involvement for the following shop floor responsibilities by each group of staffs in your company according to 5-point Likert Scale, ranging from 5 = Very frequent, to 3 = Sometimes, to 1 = Not at all.

For Example:

Question: **Work scheduling and work allocation within team / cell / production line are the responsibilities of?**

i. Production / Process Engineers*

5.Very frequent	**4.Frequent**	**3.Sometimes**	**2.Seldom**	**1.Not at all**

ii. Supervisory Staff

5.Very frequent	**4.Frequent**	**3.Sometimes**	**2.Seldom**	**1.Not at all**

iii. Production Operators

5.Very frequent	**4.Frequent**	**3.Sometimes**	**2.Seldom**	**1.Not at all**

iv. Specialist Departments (Example. Production planner)

5.Very frequent	**4.Frequent**	**3.Sometimes**	**2.Seldom**	**1.Not at all**

Production related management

7. (PROD_1) Work scheduling and work allocation within team / cell / production line are the responsibilities of?
   *Notes: **Production / Process Engineers*** in this questionnaire is referred to as those **Engineers / Executives / Officers** who are assigned within your own department or work closely with your department and they are responsible for the production performance and process improvement at your department.*
8. (PROD_2) Machine set-up operation (when product mix changeover) at the production line is the responsibility of?
9. (PROD_3) In solving daily production problem, who is the first line respondent to production problems?
   (such as chasing on shortages of parts, managing line stops for quality problems <troubleshooting and rectification>, handling on the problems of unplanned absences, smoothing productions when workers are behind the pace or toilet reliefs, and other fire-fighting occurrences)

Quality related

10. (QUA_1) Preparation of production Standard Operation Procedures or Standard Work Sheets is the responsibility of?
11. (QUA_2) Product repair and rework is carried out by?
12. (QUA_3) Identification of defective parts (with / without poka-yoke) is the responsibility of?
13. (QUA_4) Decision to stop production line when there are abnormalities (such as quality or machine problems) is the responsibility of?

Machine maintenance related

14. (MTCE_1) Repair or recover machines when breakdown occurred is carried out by?
15. (MTCE_2) Daily line-side maintenance is carried out by?
    (Normally it is done before production or without stopping the machine during production. Example: lubrication, sensor mounting adjustment, cleaning or replacement of filters, screw tightness, etc.)

People responsibilities

16. (PPL_1) Production operators' appraisal (which will affect worker's promotion, pay and bonus) is the responsibility of?
17. (PPL_2) Production operators' attendance recording and monitoring of general shop floor discipline (such as following factory rules and regulations) are the responsibilities of?
18. (PPL_3) Teaching (on-the-job) operators the skills of direct production tasks is the responsibility of?
19. (PPL_4) Planning and organising long term training programmes for shop floor workers' development.
20. (PPL_5) Acting as senior facilitator to promote, guide, assist and give advice on quality-circle and group problem solving activities at the shop floor. *(Assist and give guidance in quality-circle or problem solving activities to meet targets)*

Off-the-line responsibilities

21. (OFFL_1) Establishing and upgrading current production standards by continually establishing new and higher targets.
22. (OFFL_2) Improvement on production operation methods. (Design new poka-yoke techniques, improvement of visual aids, etc)
23. (OFFL_3) Production or process parameters improvement by experiment. *(such as task re-combinations to achieve optimal cycle time for highest productivity, identify best process parameters settings to improve first-pass yield, exercise of set-up reduction, etc.)*

Part 3: Production Stability at Your Department

For Question 1 – 10:

Please indicate your level of agreement or disagreement following 5-point Likert scale ranging from 5 = Strongly agree, to 3 = Somewhat agree, to 5 = Strongly disagree for the following statements about production stability at your department.

1. (MAN_1) Our operators, line leaders or process leaders are well trained and reliable to handle daily production queries and problems such as quality issues, machine breakdown, etc. without major involvement from supervisors and engineers.
2. (MAN_2) The attendance to work of our operators and supervisory staff is reliable with minimal unplanned absenteeism*. *(unplanned absenteeism* including sick leave)*
3. (MAN_3) All our production operators and supervisory staff are multi-skilled and reliable in replacement of absentees.
4. (MACHINE) The major machineries and equipment in our plant are well maintained and reliable (without causing line stop).
5. (METHOD1) The process parameter settings and information in the SOP (Standard Operation Procedures) are reliable. *(Settings are made to easy, without trial and error / extra effort in calibration at every early shift or every product mix changeover)*
6. (METHOD2) Our setup activity (when product mix changeover) is reliable. *(which means set up time is always within the allocated time slot in production schedule; and effort is being taken to reduce the setup time)*
7. (MAT) The quality and delivery of the incoming parts from our suppliers (internal or external) is reliable.
8. (ENVIR) Our house-keeping (5S) is well-maintained and chasing for missing parts / tools is rare.
9. (QUA) Our product quality is reliable and percentage of rework and scrap is in the trend of reducing.
   (Product defect is kept to minimum; and all the employees do NOT spend a lot of time in rework and other non-value added activities due to defects)
10. (LEAD) Our production lead time is reliable and always meets delivery schedules.
    (*Workers seldom work overtime to meet delivery targets)*

Part 4: Performance Measurements

For Question 1 – 6 only: How has the following changed in your DEPARTMENT over the past three years?

1. Finished-product first-pass quality yield:
   (Improved more than 40% / Improved 21 – 40% / Improved 1 – 20% / Stayed the same / Declined 1 – 20% / Declined more than 20%)
2. Scrap and rework costs:
   (Increased more than 20% / Increased 1 – 20% / Stayed the same / Decreased 1 – 20% / Decreased 21-40% / Decreased more than 40%)
3. Productivity, defined as dollar volume of shipments per employee:
   (Increased more than 80% / Increased 41 – 80% / Increased 21 – 40% / Increased 11 – 20% / Increased 1 – 20% / Stayed the same / Decreased 1 – 10% / Decreased more than 10%)
4. Per unit manufacturing costs, excluding purchased material:
   (Increased more than 20% / Increased 11 – 20% / Increased 1 – 10% / Stayed the same / Decreased 1-20% / Decreased more than 20%)
5. Manufacturing cycle time:
   (Stayed the same / Decreased 1 – 10% / Decreased 11 – 20% / Decreased 21 – 50% / Decreased 51 – 75% / Decreased more than 75%)
6. Customer lead-time:
   (Increased more than 20% / Increased 1 – 20% / Stayed the same / Decreased 1 – 20% / Decreased 21 – 40% / Decreased more than 40%)

For Question 7 – 8: Please answer as the current performance status in your department:

7. What is the average availability of major machineries/equipment? (Plant uptime)
   (Unknown / 0% - 75% / 76% - 90% / 91% - 95% / 96% - 100%)

8. What is the average setup time (in minutes) for major machineries/equipment?
   (We Do Not Measure / more than 61 / 29 - 60 / 16 - 30 / 10 - 15 / 0 - 9)

Part 5: Open Questions:

1. In general, do you think the involvement of all production operators and supervisory staff in company's improvement or lean activities is **IMPORTANT** to your company? **Why**?

2. In general, do you think the involvement of all production operators and supervisory staff in company's improvement or lean activities is **FEASIBLE/WORKABLE** in your company? (What are the **drivers** and **barriers**)?
   (Your opinions can be derived from the view of company's policy and commitment, organisation culture, workers' willingness, workers' skills level, production stability, and other potential factors that related.)

End of question

A.2.4 Questionnaire for Human Resources department

For Question 1 – 9:
Please indicate your level of agreement or disagreement following 5-point Likert scale ranging from 5 = Strongly agree, to 3 = Somewhat agree, to Strongly disagree for the following statements about the local labour market and your company's worker's development policy.

Local labour market
1. Good and qualified **production operators** are easily recruited from labour market.
2. Good and qualified **supervisors or officers** are easily recruited from labour market.
3. Technical / engineering position candidates such as **engineer or technician** are easily recruited from labour market.

Company's worker development policy
4. We have a set of internally conducted long term worker development programme to formally and systematically develop our **production operators and line leaders** (i.e. compulsory trainings related to technical / supervisory skills).
   (The programme is always conducted timely according to the schedule.)
5. We have a set of internally conducted long term worker development programme to formally and systematically develop our **officers and supervisors** (i.e. compulsory trainings related to technical and management skills).
   (The programme is always conducted timely according to the schedule.)
6. We have worker development scheme or budget allocated for **production operators and supervisory staff*** to attend trainings / workshops.
   Supervisory staff refers to supervisors, line leaders*
7. The above budget for worker development is always fully utilised.
8. Our managers or experienced technical staff are keen to share their personal experience and knowledge (formally or informally) in knowledge sharing sessions or on-the-job trainings.
9. Our production **operators and supervisory staff*** are very keen to attend the above development programmes.
   (Example, the response /attendance to the trainings is very encouraging)

End of question

A.2.5 Questionnaire for Engineers

Part 1: Deployment of Kaizen Activities at Shop Floor
For Question 1 – 6:
Please select 'Yes' or 'No' for each question:

Suggestion system
1. Is there any formal suggestion system presence in your department for all **production operators** and **supervisory staff*** to contribute ideas, suggestions or opportunities for operation performance improvement including safety and workers' motivation?
   *Note: **Supervisory staff*** in this questionnaire is referred to as all the production supervisors, shift supervisors, line leaders, process leaders etc. They are ranked above the production operators.*
2. Is there any target set for **production operators** to measure their contribution to improvement ideas and suggestions?
3. Is there any target set for **supervisory staff** to measure their contribution to improvement ideas and suggestions?

4. Is there any reward system (financially or non-financially) or competition to encourage improvement suggestions from production operators and supervisory staff?

Workers problem solving group

5. Is there any quality circle (voluntary based) or small improvement team activities (*normally participated by production operators and led by supervisors/engineers*) presence in your department?
6. Is there any target set for the improvement teams / quality circles in improvement activities?
7. Is there any competition to encourage the improvement teams' contribution in production improvement?
   (Every 3 months / Every 6 months / Every year / None)
8. What is the percentage of production operators and supervisory staff involved in the quality circles or small improvement teams?
   (81% - All / 61% - 80% / 41% - 60% / Less than 40% / None)
9. In average, how frequent do members of quality circle or improvement teams formed by production operators and supervisory staff having meeting in a month?
   (Every week / Every 2 weeks / Every month / None)

Part 2: The Extent of Involvement in Kaizen Activities

Explanations:

Focussing on 10 key Kaizen (continuous improvement) areas at the shop floor, this section aims to discover the degree of participation by main shop floor actors in the Kaizen activities.

For each Kaizen area, the participations are categorized into 3 main types:

a) **Initiate*** (or suggest)

- Identify and suggest the needs or opportunities for improvement (via formal suggestion system or informal / ad hoc basis).

b) **Lead**** the Kaizen process

- Lead the problem solving and improvement process (such as activities in small improvement team/group and quality circles).

c) Actively **involve***** (as part of problem solving team members)

- Actively involve in problem solving and improvement process (such as activities in small improvement team/group and quality circles).

Instruction:

For Question 1 – 10:

Please indicate the degree of participation in the activities for the following Kaizen areas by each group of staffs in your company according to 5-points Likert scale ranging from 5 = Very frequent, to 3 = Sometimes, to 1 = Not at all.

Please answer all the questions.

1. K1 - Workstation Safety Kaizen
   - Kaizen to improve safety at work area such as improving work motion/ergonomics, removing potential hazards, etc.
      a) Who **initiate*** the Kaizen to improve safety at production workstation?
      b) Who **lead**** the Kaizen to improve safety at production workstation?
      c) Who are **involved***** in the Kaizen to improve safety at production workstation?

2. K2 - Operation Standard Kaizen
   - Kaizen to improve production operation standard, i.e. Standard Operation Procedure (SOP), Standard Work Sheets, information of working and inspection methods (control points and check points), etc.
      a) Who **initiate*** the Kaizen to improve and revise production operation standard at each production workstation or production line?
      b) Who **lead**** the Kaizen to improve and revise production operation standard at each production workstation or production line?

c) Who are **involved*** ** in the Kaizen to improve and revise production operation standard at each production workstation or production line?

3. K3 - Quality and Efficiency of Work Kaizen

- Kaizen to improve work methods hence increase work quality, work efficiency and improve productivity (more value added motion than waste) such as better ergonomics or work motion, to prevent unnecessary motion and over-processing. It includes Kaizen to improve the use of (and design or modify of) tools and equipment.

a) Who **initiate*** the Kaizen to improve work quality and work efficiency at each production workstation or production line?
b) Who **lead**** the Kaizen to improve work quality and work efficiency at each production workstation or production line?
c) Who are **involved*** ** in the Kaizen to improve work quality and work efficiency at each production workstation or production line?

4. K4 - Workers' Interest and Adaptability at Work Kaizen

- Kaizen to improve workers' interest and adaptability at work such as improve on-the-job trainings to enhance workers' skills and working methods, improve multi-skill trainings and encourage job rotations to improve worker's flexibility and work varieties (richness in value).

a) Who **initiate*** the Kaizen to improve workers' skills and interest at work at each production workstation or production line?
b) Who **lead**** the Kaizen to improve workers' skills and interest at work at each production workstation or production line?
c) Who are **involved*** ** in the Kaizen to improve workers' skills and interest at work at each production workstation or production line?

5. K5 - Production Output Quality (vs defects) Kaizen

- Kaizen to improve production output quality i.e. minimizing defects by identifying abnormalities and reducing variation in process control, working methods, and machine fitness, etc.

a) Who **initiate*** the Kaizen to improve production output quality at each production workstation or production line?
b) Who **lead**** the Kaizen to improve production output quality at each production workstation or production line?
c) Who are **involved*** ** in the Kaizen to improve production output quality at each production workstation or production line?

6. K6 - Quality of Working Environment Kaizen

- Kaizen to improve quality of working environment such as 5S and workplace organization. Example, it will reduce the waste of time in looking for missing parts, or tools and equipment. It also includes cost reduction in the usage of direct production materials or components, consumable items (such as cutting tools, oils, etc.) for running the production.

a) Who **initiate*** the Kaizen to improve quality of working environment at each production workstation or production line?
b) Who **lead**** the Kaizen to improve quality of working environment at each production workstation or production line?
c) Who are **involved*** ** in the Kaizen to improve quality of working environment at each production workstation or production line?

7. K7 - Production Workstations or Cell Layout Kaizen

- Kaizen to improve the layout design of production workstations, manufacturing cells or production line with the aims to improve parts or product flow, to prevent material handling or transportation wastes and excess inventory as well as overproduction.

a) Who **initiate*** the Kaizen to improve layout of production workstations, cells or production line?
b) Who **lead**** the Kaizen to improve layout of production workstations, cells or production line?
c) Who are **involved*** ** in the Kaizen to improve layout of production workstations, cells or production line?

8. K8 - Time of Production Kaizen

- Kaizen to reduce processing/cycle time and set-up time by removing waste of over-processing, unnecessary motion, waiting, material handling and transportation.

a) Who **initiate*** the Kaizen to improve set-up time and processing time at each production workstation or production line?
b) Who **lead**** the Kaizen to improve set-up time and processing time at each production workstation or production line?
c) Who are **involved***** in the Kaizen to improve set-up time and processing time at each production workstation or production line?

9. K9 - Waste of Input / Output Kaizen
   - Kaizen to eliminate waste of input to and output from each production workstation or production line (*i.e. transportation waste of material handling, waste of waiting, unnecessary motion and excess inventory*).
   a) Who **initiate*** the Kaizen to eliminate waste of input to and output from each production workstation or production line?
   b) Who **lead**** the Kaizen to eliminate waste of input to and output from each production workstation or production line?
   c) Who are **involved***** in the Kaizen to eliminate waste of input to and output from each production workstation or production line?

10. K10 - Number of Workers Reduction Kaizen
    - Kaizen to improve productivity by optimizing the number of workers required in a work cell or production line.
    a) Who **initiate*** the Kaizen to reduce the number of workers of a work cell or production line?
    b) Who **lead**** the Kaizen to reduce the number of workers of a work cell or production line?
    c) Who are **involved***** in the Kaizen to reduce the number of workers of a work cell or production line?

Part 3: Skills Equipped and Training Attended

1. To what extent the below TOOLS/TECHNIQUES/PRACTICES that your department staff normally used in problem solving? Please **CIRCLE** the answers.

i. Production Engineers / Executives / Officers

Problem solving tools / techniques / practices	**Scale**				
	To great extent				**Not at all**
PDCA	5	4	3	2	1
A3	5	4	3	2	1
5 Whys / Why-Why Analysis	5	4	3	2	1
Fishbone Diagram and brainstorming	5	4	3	2	1
Value Stream Mapping (VSM)	5	4	3	2	1
7QC Tools (Pareto Chart, etc)	5	4	3	2	1
Six Sigma (DMAIC)	5	4	3	2	1

ii. Supervisory Staff

Problem solving tools / techniques / practices	**Scale**				
	To great extent				**Not at all**
PDCA	5	4	3	2	1
A3	5	4	3	2	1
5 Whys / Why-Why Analysis	5	4	3	2	1
Fishbone Diagram and brainstorming	5	4	3	2	1
Value Stream Mapping (VSM)	5	4	3	2	1
7QC Tools (Pareto Chart, etc)	5	4	3	2	1
Six Sigma (DMAIC)	5	4	3	2	1

iii. Production Operators

Problem solving tools / techniques / practices	**Scale**				
	To great extent				**Not at all**
PDCA	5	4	3	2	1
A3	5	4	3	2	1

5 Whys / Why-Why Analysis	5	4	3	2	1
Fishbone Diagram and brainstorming	5	4	3	2	1
Value Stream Mapping (VSM)	5	4	3	2	1
7QC Tools (Pareto Chart, etc)	5	4	3	2	1
Six Sigma (DMAIC)	5	4	3	2	1

2. What are the TRAININGS on the following problem solving and improvement skills' have your department staff attended? Please **CIRCLE** the answers.

   i. Production Engineers / Executives / Officers

Problem solving tools / techniques / practices	**Yes**	**No**
PDCA	Yes	No
A3	Yes	No
5 Whys / Why-Why Analysis	Yes	No
Fishbone Diagram and brainstorming	Yes	No
Value Stream Mapping (VSM)	Yes	No
7QC Tools (Pareto Chart, etc)	Yes	No
Six Sigma (DMAIC)	Yes	No

   ii. Supervisory Staff

Problem solving tools / techniques / practices	**Yes**	**No**
PDCA	Yes	No
A3	Yes	No
5 Whys / Why-Why Analysis	Yes	No
Fishbone Diagram and brainstorming	Yes	No
Value Stream Mapping (VSM)	Yes	No
7QC Tools (Pareto Chart, etc)	Yes	No
Six Sigma (DMAIC)	Yes	No

   iii. Production Operators

Problem solving tools / techniques / practices	**Yes**	**No**
PDCA	Yes	No
A3	Yes	No
5 Whys / Why-Why Analysis	Yes	No
Fishbone Diagram and brainstorming	Yes	No
Value Stream Mapping (VSM)	Yes	No
7QC Tools (Pareto Chart, etc)	Yes	No
Six Sigma (DMAIC)	Yes	No

Part 4: Engineers' Perception of Shop Floor Employees' Commitment and Capability in Problem Solving
For Question 1 – 11:
Please indicate your level of agreement or disagreement for the following statements according to 5-point Likert scale ranging from 5 = Strongly agree, to 3 = Somewhat agree, to 1 = Strongly disagree.

1. (MOTIV1) All our production operators and supervisory staff are willing to work hard for improvement and keen to learn. (Overall, the team spirit towards improvement in the shop floor is high)
2. (5S_OPR) All the production operators HABITUALLY practice 5S at their workplace as it is part of their daily routine without instruction from superiors. *(Everything has its own place, tools/parts missing is rare)*
3. (SKILL1) All our production operators and supervisory staff are technically competent so it is easy to lead and engage them in improvement activities.
4. (SKILL2) The production operators and supervisory staff always come to me when they found difficulties or inappropriateness of working methods and standards. *(Example, inappropriateness in Standard Operations Procedure*).
5. (SKILL3) The production operators and supervisory staff always come to me with their solution suggestions to the difficulties or inappropriateness they found at working methods and standards.
6. (SKILL4) I should delegate part of my daily on-the-line production handling related responsibilities to production operators and supervisory staff as I think they are capable OR they should be trained to share the workload.

7. (SKILL5) We should engage production operators and supervisory staff into process improvement activities as I think they are capable OR they should be trained to share the workload.
8. (SKILL_SUP) Learning/applying basic problem solving skills (e.g. 5-Whys, Fishbone diagram) is NOT difficult for all **supervisory staff.**
9. (SKILL_OPR) Learning/applying basic problem solving skills (e.g. 5-Whys, Fishbone diagram) is NOT difficult for all **production operators.**
10. (MUDA_OPR) All the **production operators** understand the concept of 7 wastes and able to identify visible waste* at their workplace. *(Visible waste*- Example, they understand wait/delay is waste, they perceive rework is waste, etc)*
11. (MUDA_SUP) All the **supervisory staff** understand the concept of 7 wastes and able to identify visible waste* at their workplace.

Part 5: **Open Questions:**

1. In general, do you think the involvement of all production operators and supervisory staff in company's improvement or lean activities is **IMPORTANT** to your company? **Why**?
2. In general, do you think the involvement of all production operators and supervisory staff in company's improvement or lean activities is **FEASIBLE/WORKABLE** in your company? (What are the **drivers** and **barriers**)? *(Your opinions can be derived from the view of company's policy and commitment, organisation culture, workers' willingness, workers' skills level, production stability, and other potential factors that related.)*

End of question

A.2.6 Questionnaire for Supervisory staffs (English)

Part 1: Supervisors' Perception and Commitment

For Question 1 – 24:

Please indicate your level of agreement or disagreement for the following statements according to 5-point Likert scale ranging from 5 = Strongly agree (or Very frequent), to 3 = Somewhat agree (or Sometimes), to 1 = Strongly disagree (or Not at all).

1. (SE_T1) I am always given sufficient opportunities to attend trainings to learn the skills that I need at work.
2. (SE_T2) I found the trainings provided by the company always suit my needs at work.
3. (SE_T3) I am equipped with sufficient leadership and technical skills for improvement activities from the internal and external trainings supported by the company.
4. (SE_CC1) My workers and I are always given sufficient information about company's latest development and next improvement target.
5. (SE_CC2) Management always conducts dialogue sessions with shop floor workers (including supervisory staff) or surveys to understand our needs* and difficulties at work. *(Example of needs* - skills required, working aids and types of trainings we need, etc)*
6. (SE_PD1) I am always given new target for production and process improvements.
7. (SE_RW1) I am satisfied with the reward system from management in encouraging shop floor employees (production operators and supervisors) to actively contribute themselves in improvement activities. *(The reward is always compatible with my contribution to the company)*
8. (SE_RW2) Our company always conducts competitions* (with rewards) in improvement activities for shop floor employees. *(Competitions here refer to those open for supervisors, process leaders/line leaders and operators to take part)*
9. (SE_GGB) Our managers are always shown as the leaders in production improvement activities and present themselves at the shop floor while leading us in the improvement activities.
10. (SE_CAR1) If I am equipped with good leadership and communication skills, I will be given opportunity to promote to managerial or executive position (such as officer, manager) in the company after gaining enough operation experience at the shop floor.
11. (SE_CAR2) Workers will NOT lose their jobs after production or process is improved.
12. (SUP_CO1) I would definitely involve myself in improvement activities such as process and quality improvement, etc. if opportunities are given. *(This is because I want to learn new skills)*
13. (SUP_CO2) As a supervisor, I am very clear with my work responsibilities and assignments given.

14. (SUP_CO3) I am always given sufficient time to complete my daily production tasks. (Example, meeting production target without having to work over-time)
15. (SUP_CO4) In most of my working time, I am engaged in disturbance handling at the production line such as progress chasing due to product quality problems, machine problems, lateness, part shortages and etc. in fire-fighting manner.
16. (SUP_CO5) Improvements in production or process will reduce our over-time work.
17. (SUP_CO6) In my formal work responsibilities, I am requested to teach my workers problem solving and improvement skills.
18. (SUP_SKL1) Learning/applying basic problem solving skills (e.g. 5-Whys and Fishbone diagram) is NOT difficult for **me.**
19. (SUP_SKL2) I do able to see the opportunities or clues for improvement in the manufacturing process and production problem.
20. (MOTIV_OPR) My workers are willing to work hard for production improvement and keen to learn new skills. *(The team spirit towards improvement at the shop floor is high)*
21. (MUDA_OPR) My workers (operators) understand the concept of 7-Wastes and THEY ARE able to identify visible waste* at their work place. *(Example of visible waste*- wait/delay is waste, overproduction is waste, etc)*
    Note: 7-wastes are: Transport, Excess Inventory, Wasted Motion, Wait/Delay, Overproduction, Overprocessing, Defects.
22. (SKILL_OPR1) My workers always come to me when they found difficulties or inappropriateness in working methods and standards. (Example, errors/abnormalities in *Standard Operations Procedure, SOP*).
23. (SKILL_OPR2) My workers always come to me with their solution suggestions to the difficulties or inappropriateness they found in working methods and standards.
24. (SKILL_OPR3) Learning/applying basic problem solving skills (e.g. 5-Whys and Fishbone diagram) is NOT difficult for **my workers (operators).**

Part 2: Open Questions

1. In your opinion, please give an **example activity*** that you think it is Waste or Non-Value Added activity.
   (Example activity – can be any process or operation performed in the line, by the workers or machines)*
2. In your opinion, please briefly explain what is Lean Production System or Lean Manufacturing System? Or in other words, what is the purpose of Lean?
3. In general, do you think the involvement of your production operators and supervisors in company's improvement or lean activities is **IMPORTANT** to your department or company? Why?
4. In general, do you think your company's management is **ACTIVELY and KEEN** to involve your production operators and supervisors in company's improvement or lean activities? Why?
   (Give your opinion from the view of company's policy, provision of trainings/courses, commitment and attitude of management, leadership of managers and engineers in improvement activities, attitude of workers, and other potential factors)

End of question

A.2.7 Questionnaire for Supervisory staffs (Malay)

Bahagian 1: Persepsi dan Komitmen Penyelia

Untuk Soalan 1 – 24:

Sila pilih jawapan anda untuk menunjukan tahap persetujuan anda mengikuti 5-point Likert scale bermula dari 5 = Sangat Setuju (atau Sangat Sering), 3 = Agak setuju (atau Kadang-kadang), 1 = Sangat tidak setuju (atau Tidak pernah) atas kenyataan-kenyataan berikut:

1. (SE_T1) Saya selalu diberikan peluang yang cukup untuk menghadiri latihan/kursus yang dibekalkan oleh syarikat bagi menguasai kemahiran yang diperlukan untuk menjalankan tugasan harian saya.
2. (SE_T2) Latihan/kursus yang dibekalkan oleh syarikat memenuhi keperluan saya atas kemahiran yang diperlukan untuk menjalankan tugasan harian saya.
3. (SE_T3) Dengan pembekalan latihan/kursus daripada pihak pengurusan, saya dilengkapi dengan kemahiran memimpin and teknikal yang cukup untuk menjalankan acara penambahbaikan pengeluaran (*production improvement*).
4. (SE_CC1) Saya dan pekerja-pekerja saya selalu diberikan maklumat terkini tentang perkembangan terbaru syarikat dan sasaran penambahbaikan (*improvement target*) syarikat yang seterusnya.
5. (SE_CC2) Pihak pengurusan selalu mengadakan sesi dialog dengan kalangan pekerja kilang (termasuk penyelia) ataupun menjalankan *survey* untuk memahami keperluan* atas kerja kami.
   (Keperluan sepertinya kemahiran yang dikendaki, latihan, bantuan kerja yang diperlukan, dan sebagainya)

6. (SE_PD1) Saya selalu diberikan sasaran (*target*) baru dalam acara penambahbaikan pengeluaran dan peningkatan taraf process dalam kilang.
7. (SE_RW1) Saya amat puas hati dengan sistem ganjaran yang diberikan oleh pihak pengurusan untuk menggalakkan semua pekerja (termasuk penyelia) untuk menyumbang usaha dalam aktiviti-aktiviti penambahbaikan (*improvement*).
   (Ganjaran yang diberikan selalu setimpal dengan penyumbangan kami)
8. (SE_RW2) Syarikat kami selalu mengadakan pertandingan-pertandingan* (berganjaran) dalam acara penambahbaikan untuk pekerja-pekerja dalam kilang (termasuk penyelia-penyelia). *(Pertandingan* tersebut terbuka untuk disertai oleh penyelia, line leaders, dan operator-operator)*
9. (SE_GGB) Pengurus-pengurus (*manager*) selalu hadir di tapak kilang (*factory shopfloor*) untuk memimpin kami dalam aktiviti-aktiviti penambahbaikan pengeluaran (*production improvement*).
10. (SE_CAR1) Sekiranya saya mahir memimpin and berkomunikasi, saya akan diberikan peluang kenaikan pangkat sebagai pegawai/pengurus selepas mengumpul pengalaman yang cukup dari segi penyeliaan dan pengurusan proses/pengeluaran kilang.
11. (SE_CAR2) Pekerja-pekerja kami TIDAK AKAN dibuang kerja selepas prestasi pengeluaran dan proses kilang ditingkatkan.
12. (SUP_CO1) Saya pasti akan melibatkan diri saya dalam aktiviti-aktiviti penambahbaikan pengeluaran (*production improvement*) dan peningkatan taraf proses sekiranya peluang diberikan oleh pihak pengurusan.
    (kerana saya hendak belajar kemahiran-kemahiran baru)
13. (SUP_CO2) Sebagai penyelia, saya sangat jelas dengan tanggungjawab dan tugas saya seperti yang diberikan oleh pihak atasan.
14. (SUP_CO3) Saya selalu diberikan masa yang cukup untuk menyelesaikan tugas harian saya dalam pengeluaran/pembuatan kilang.
    Contoh: Saya tidak perlu kerja lebih masa (*over-time*) untuk mencapai sasaran pengeluaran (*production target*).
15. (SUP_CO4) Dalam kebanyakan masa kerja saya, saya terikat dengan kerja-kerja pengendalian gangguan di garis pengeluaran (*production line*) seperti mengejar pengeluaran kerana masalah kualiti produk, masalah mesin, kelewatan, kekurangan *parts* dan sebagainya.
16. (SUP_CO5) Selepas prestasi pengeluaran dan proses ditingkatkan, ia akan mengurangkan KEKERAPAN kami untuk bekerja lebih masa (*over-time*).
17. (SUP_CO6) Dalam tanggungjawab rasmi seharian, saya dikehendaki oleh pihak pengurusan untuk mengajar pekerja saya tentang kemahiran-kemahiran penyelesaian masalah dan penambahbaikan (*problem solving and improvement skills*).
18. (SUP_SKL1) Mempelajari/mengamalkan kemahiran penyelesaian masalah yang asas (contoh: 5-Whys, Fishbone diagram) adalah TIDAK SUSAH bagi **saya**.
19. (SUP_SKL2) Saya selalu dapat MENGESAN tanda-tanda untuk meningkatkan prestasi pengeluaran dan proses atau tanda-tanda untuk menangani masalah-masalah yang berkaitan dengannya.
20. (MOTIV_OPR) Pekerja saya sanggup bekerja kuat demi meningkatkan prestasi pengeluaran kilang dan mereka berminat untuk belajar kemahiran baru.
21. (MUDA_OPR) **Pekerja saya (operator)** tahu/faham konsep *7 Jenis Waste* dan mereka dapat membeza atau mengesan *waste* yang nyata/ketara dalam kerja - kerja harian.
    (Contoh *waste** yang nyata seperti *delay/wait*, penghasilan lebih *(overproduction)*, dan sebagainya*)*
    Nota: 7 Jenis wastes adalah: Transport, Excess Inventory, Wasted Motion, Wait/Delay, Overproduction, Over processing dan Defects.
22. (SKILL_OPR1) Pekerja saya selalu tampil berjumpa dengan saya apabila mereka mendapati kesusahan atau ketidaksesuaian atas cara kerja atau *standard* kerja yang kurang sesuai dalam SOP .
    (Contoh: ketidaksesuaian / kesalahan dalam *Standard Operations Procedure,* SOP).
23. (SKILL_OPR2) Pekerja saya selalu tampil berjumpa dengan saya dengan cadangan penyelesaian apabila mereka mendapati kesusahan atau ketidaksesuaian atas cara kerja atau *standard* kerja SOP yang kurang sesuai.
    (Pekerja-pekerja dalam kilang semua bersemangat untuk bermaju)
24. (SKILL_OPR3) Mempelajari/mengamalkan kemahiran penyelesaian masalah yang asas (contoh: 5-Whys, Fishbone diagram) adalah TIDAK SUSAH bagi **pekerja-pekerja (operator) saya.**

Bahagian 2: Soalan terbuka

1. Pada pendapat anda, sila berikan **SATU CONTOH AKTIVITI*** yang anda berasa itu adalah WASTE atau aktiviti yang TIDAK menambah NILAI.
   (Contoh aktiviti yang diberikan mungkin terjadi pada proses pembuatan, gerakan kerja operator atau mesin)*
2. Pada pendapat anda, sila terangkan secara ringkas apakah itu *Lean Production System* atau *Lean Manufacturing System*? Ataupun, apakah tujuan Lean system?

3. Secara umumnya, adakah anda rasa **PENGLIBATAN** kalangan operator dan penyelia-penyelia dalam aktiviti-aktiviti penambahbaikan (*improvement*) atau *lean production system* dalam kilang adalah **PENTING** untuk syarikat anda? **Kenapa**?
4. Secara umumnya, adakah anda rasa pihak pengurusan syarikat anda **BERMINAT** untuk melibatkan kalangan operator dan penyelia-penyelia dalam aktiviti-aktiviti penambahbaikan (*improvement*) atau *lean production system* di syarikat anda? **Kenapa**?
   (Huraikan pendapat anda dari segi: polisi syarikat, latihan/kursus yang dibekalkan, komitmen daripada pihak atasan, sikap dan kepimpinan pengurus /managers atau engineers, sikap-sikap pekerja, dan faktor-faktor lain yang berkenaan.)

End of question

A.2.8 Questionnaire for Production operators (English)

Part 1: Operators' Perception and Commitment

For Question 1 – 22:

Please indicate your level of agreement or disagreement for the following statements according to 5-point Likert scale ranging from 5 = Strongly agree (or Very frequent), to 3 = Somewhat agree (or Sometimes), to 1 = Strongly disagree (or Not at all).

1. (SE_T1) I am always given sufficient opportunities to attend trainings to learn the skills that I need at work.
2. (SE_T2) I found the trainings provided by the company always suit my needs at work.
3. (SE_T3) I am equipped with sufficient technical skills for improvement activities from the internal and external trainings supported by the company.
4. (SE_CC1) I am always given sufficient information about company's latest development and next improvement target.
5. (SE_CC2) Management always conducts dialogue sessions with shop floor workers or surveys to understand our needs* and difficulties at work. *(Example of needs* - skills required, working aids and types of trainings we need, etc)*
6. (SE_PD1) I am always given new target for production and process improvements.
7. (SE_RW1) I am satisfied with the reward system from management in encouraging production operators to actively contribute themselves in improvement activities. *(The reward is always compatible with my contribution to the company)*
8. (SE_RW2) Our company always conducts competitions* (with rewards) in improvement activities for shop floor employees. *(Competitions here refer to those open for supervisors, line leaders and operators to take part)*
9. (SE_GGB) Our managers are always shown as the leaders in production improvement activities and present themselves at the shop floor while leading us in the improvement activities.
10. (SE_CAR1) If I am equipped with good leadership and communication skills, I will be given opportunity to promote to managerial or executive position (such as officer, manager) in the company after gaining enough operation experience at the shop floor.
11. (SE_CAR2) I will NOT lose my job after production or process is improved.
12. (OPR_CO1) I would definitely involve myself in improvement activities such as process and quality improvement, etc. if opportunities are given. *(This is because I want to learn new skills)*
13. (OPR_CO2) I am willing to work hard for production improvement and keen to learn new skills.
14. (OPR_CO3) I am very clear with my work responsibilities and assignments given.
15. (OPR_CO4) I am always given sufficient time to complete my daily production tasks. (Example, meeting production target without having to work over-time)
16. (OPR_CO5) In most of my working time, I am engaged in disturbance handling at the production line such as progress chasing due to product quality problems, machine problems, lateness, part shortages and etc. in fire-fighting manner.
17. (OPR_CO6) Improvements in production or process will reduce our over-time work.
18. (OPR_MUDA) I understand the concept of 7-Wastes and I am able to identify visible waste* at my work place.
    (Example of visible waste- wait/delay is waste, production of defects is waste, etc)*
    Note: 7-wastes are: Transport, Excess Inventory, Wasted Motion, Wait/Delay, Overproduction, Overprocessing, Defects.
19. (OPR_SKL1) I always consult my supervisors or line leaders if I found difficulties or inappropriateness in working methods and standards. (Example, errors/abnormalities in *Standard Operations Procedure, SOP*).
20. (OPR_SKL2) I always suggest to my supervisors or line leaders with my solution suggestions to the difficulties or inappropriateness that I found in working methods and standards.

21. (OPR_SKL3) Learning/applying basic problem solving skills (e.g. 5-Whys and Fishbone diagram) is NOT difficult for **me.**
22. (OPR_SKL4) I do able to see the opportunities or clues for improvement in the manufacturing process and production problem.

Part 2: Open Questions

1. In your opinion, please give an **example activity*** that you think it is Waste or Non-Value Added activity.
   (Example activity – can be any process or operation performed in the line, by the workers or machines)*
2. In your opinion, please briefly explain what is Lean Production System or Lean Manufacturing System? Or in other words, what is the purpose of Lean?
3. In general, do you think the involvement of production operators in company's improvement or lean activities is **IMPORTANT** to your department or company? Why?
4. In general, do you think your company's management is **ACTIVELY and KEEN** to involve production operators in company's improvement or lean activities? Why?
   (Give your opinion from the view of company's policy, provision of trainings/courses, commitment and attitude of management, attitude and leadership of managers and engineers in improvement activities, attitude of workers, and other potential factors)

End of question

A.2.9 Questionnaire for Production operators (Malay)

Bahagian 1: Persepsi dan Komitmen Pekerja-pekerja

Untuk Soalan 1 – 22:

Sila pilih jawapan anda untuk menunjukan tahap persetujuan anda mengikuti 5-point Likert scale bermula dari 5 = Sangat Setuju (atau Sangat Sering), 3 = Agak setuju (atau Kadang-kadang), 1 = Sangat tidak setuju (atau Tidak pernah) atas kenyataan-kenyataan berikut:

1. (SE_T1) Saya selalu diberikan peluang yang cukup untuk menghadiri latihan/kursus yang dibekalkan oleh syarikat bagi menguasai kemahiran yang diperlukan untuk menjalankan tugasan harian saya.
2. (SE_T2) Latihan/kursus yang dibekalkan oleh syarikat memenuhi keperluan saya atas kemahiran yang diperlukan untuk menjalankan tugasan harian saya.
3. (SE_T3) Dengan pembekalan latihan/kursus daripada pihak pengurusan, saya dilengkapi dengan kemahiran teknikal yang cukup untuk menjalankan acara penambahbaikan pengeluaran (*production improvement*).
4. (SE_CC1) Saya selalu diberikan maklumat terkini tentang perkembangan terbaru syarikat dan sasaran penambahbaikan (*improvement target*) syarikat yang seterusnya.
5. (SE_CC2) Pihak pengurusan selalu mengadakan sesi dialog dengan kalangan pekerja kilang ataupun menjalankan *survey* untuk memahami keperluan* atas kerja kami.
   (Keperluan sepertinya kemahiran yang dikendaki, latihan, bantuan kerja yang diperlukan, dan sebagainya)
6. (SE_PD1) Saya selalu diberikan sasaran (*target*) baru dalam acara penambahbaikan pengeluaran dan peningkatan taraf process dalam kilang.
7. (SE_RW1) Saya amat puas hati dengan sistem ganjaran yang diberikan oleh pihak pengurusan untuk menggalakkan semua pekerja untuk menyumbang usaha dalam aktiviti-aktiviti penambahbaikan (*improvement*).
   (Ganjaran yang diberikan selalu setimpal dengan penyumbangan kami)
8. (SE_RW2) Syarikat kami selalu mengadakan pertandingan-pertandingan* (berganjaran) dalam acara penambahbaikan untuk pekerja-pekerja dalam kilang.
   (Pertandingan tersebut terbuka untuk disertai oleh penyelia, line leaders, dan operator-operator)*
9. (SE_GGB) Pengurus-pengurus (manager) selalu hadir di tapak kilang (*factory shopfloor*) untuk memimpin kami dalam aktiviti-aktiviti penambahbaikan pengeluaran (*production improvement*).
10. (SE_CAR1) Sekiranya saya mahir memimpin and berkomunikasi, saya akan diberikan peluang kenaikan pangkat sebagai pegawai/pengurus selepas mengumpul pengalaman yang cukup dari segi penyeliaan dan pengurusan proses/pengeluaran kilang.
11. (SE_CAR2) Saya TIDAK AKAN dibuang kerja selepas prestasi pengeluaran dan proses kilang ditingkatkan.
12. (OPR_CO1) Saya pasti akan melibatkan diri saya dalam aktiviti-aktiviti penambahbaikan pengeluaran (*production improvement*) dan peningkatan taraf proses sekiranya peluang diberikan oleh pihak pengurusan.
    (kerana saya hendak belajar kemahiran-kemahiran baru)

13. (OPR_CO2) Saya sanggup bekerja kuat demi meningkatkan prestasi pengeluaran kilang dan saya berminat untuk belajar kemahiran baru.
14. (OPR_CO3) Saya sangat jelas dengan tanggungjawab dan tugas saya seperti yang diberikan oleh pihak atasan.
15. (OPR_CO4) Saya selalu diberikan masa yang cukup untuk menyelesaikan tugas harian saya dalam pengeluaran/pembuatan kilang.
    Contoh: Saya tidak perlu kerja lebih masa (*over-time*) untuk mencapai sasaran pengeluaran (*production target*).
16. (OPR_CO5) Dalam kebanyakan masa kerja saya, saya terikat dengan kerja-kerja pengendalian gangguan di garis pengeluaran (*production line*) seperti mengejar pengeluaran kerana masalah kualiti produk, masalah mesin, kelewatan *parts*, kekurangan *parts* dan sebagainya.
17. (OPR_CO6) Selepas prestasi pengeluaran dan proses ditingkatkan, ia akan mengurangkan KEKERAPAN kami untuk bekerja lebih masa (*over-time*).
18. (OPR_MUDA) **Saya** tahu/faham konsep *7 Jenis Waste* dan saya dapat membeza atau mengesan *waste* yang nyata/ketara dalam kerja - kerja harian.
    (Contoh *waste** yang nyata seperti *delay/wait*, penghasilan lebih (*overproduction)*, dan sebagainya*)*
    Nota: 7 Jenis wastes adalah: Transport, Excess Inventory, Wasted Motion, Wait/Delay, Overproduction, Over processing dan Defects.
19. (OPR_SKL1) Saya selalu tampil berjumpa dengan penyelia ataupun line leader apabila saya mendapati kesusahan atau ketidaksesuaian atas cara kerja atau *standard* kerja yang kurang sesuai dalam SOP .
    (Contoh: ketidaksesuaian / kesalahan dalam *Standard Operations Procedure,* SOP).
20. (OPR_SKL2) Saya selalu tampil berjumpa dengan penyelia dengan cadangan penyelesaian saya apabila saya mendapati kesusahan atau ketidaksesuaian atas cara kerja atau *standard* kerja dalam SOP yang kurang sesuai.
21. (OPR_SKL3) Mempelajari/mengamalkan kemahiran penyelesaian masalah yang asas (contoh: 5-Whys, Fishbone diagram) adalah TIDAK SUSAH bagi **saya**.
22. (OPR_SKL4) Saya selalu dapat MENGESAN tanda-tanda untuk meningkatkan prestasi pengeluaran dan proses atau tanda-tanda untuk menangani masalah-masalah yang berkaitan dengannya.

Bahagian 2: Soalan terbuka

1. Pada pendapat anda, sila berikan **SATU CONTOH AKTIVITI*** yang anda berasa itu adalah WASTE atau aktiviti yang TIDAK menambah NILAI.
   (Contoh aktiviti yang diberikan mungkin terjadi pada proses pembuatan, gerakan kerja operator atau mesin)*
2. Pada pendapat anda, sila terangkan secara ringkas apakah itu *Lean Production System* atau *Lean Manufacturing System*? Ataupun, apakah tujuan Lean system?
3. Secara umumnya, adakah anda rasa **PENGLIBATAN** kalangan operator dalam aktiviti-aktiviti penambahbaikan (*improvement*) atau *lean production system* dalam kilang adalah **PENTING** untuk syarikat anda? **Kenapa**?
4. Secara umumnya, adakah anda rasa pihak pengurusan syarikat anda **BERMINAT** untuk melibatkan kalangan operator dalam aktiviti-aktiviti penambahbaikan (*improvement*) atau *lean production system* di syarikat anda? **Kenapa**?
   (*Huraikan pendapat anda dari segi: polisi syarikat, latihan/kursus yang dibekalkan, komitmen daripada pihak atasan, sikap dan kepimpinan pengurus /managers atau engineers, sikap dan kepimpinan penyelia, dan faktor-faktor lain yang berkenaan.)*

End of question

- End of Appendices -