DEFECT REDUCTION THROUGH CUSTOMER-VENDOR COLLABORATION IN KAIZEN

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Declaration

I hereby declare that the Final Year Project entitled "**Defect reduction through customer-vendor collaboration in Kaizen**" submitted by me to Universiti Sains Malaysia; is a record of an original work done by me under the supervision of Ir. Dr. Chin Jeng Feng, senior lecturer of School of Mechanical Engineering at Universiti Sains Malaysia. This paper is submitted in the partial fulfillment of the requirements for the award of the degree of Manufacturing Engineering with Management. I further declare that this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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Date :

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Abbreviations

BSM	Bose Systems Malaysia
COPQ	Cost of Poor Quality
DOE	Design of Experiments
DPPM	Defective Parts Per Million
ERP	Enterprise Resource Planning
JIT	Just-in-Time
LM	Lean Manufacturing
MRB	Material Review Board
NRT	Noise Reduction Technology
OEM	Original Equipment Manufacturer
PDCA	Plan, Do, Check, Act
QM	Quality Management
QN	Quality Notification
SAP	Systems Applications Products
SCM	Supplier Competency Model
SMART	Specific, Measurable, Attainable, Relevant, Time Bound
SRM	Supplier Relationship Management
TPS	Toyota Production System
TSI	Transaction-Specific Investment
WIP	Work In Progress

Abstrak (Bahasa Malaysia)

Pembuatan Kejat bertujuan untuk menghilangkan pembaziran operasi dan memaksimumkan nilai produk dari perspektif pelanggan. Kertas ini mengkaji aktiviti penambahbaikan Kaizen sepanjang sepuluh minggu bersama pelanggan-pembekal untuk mengurangkan tanda sapu, suatu kecacatan kosmetik biasa pada pembungkusan plastik. Walaupun bukan kritikal, kerja-kerja pemeriksaan dan penyusunan yang dilibatkan bukanlah nilai tambah. Faktor-faktor penyumbang termasuklah pemprosesan dan pengendalian oleh kedua-dua pembekal dan pelanggan. Kerja pengendalian memerlukan tahap sensitiviti tertentu. Beberapa langkah tindakan telah dilaksanakan dan pengendalian bahan dan penentuan kecacatan untuk kedua-dua belah pihak telah diselaraskan. Keputusan berkumpul menunjukkan penurunan kecacatan yang ketara. Model hubungan pelanggan-pembekal Rašković et al. (2012) telah digunakan untuk meningkatkan pemahaman elemen-elemen penting yang mempengaruhi kejayaan kajian kes.

Kata kunci: *projek industri, latihan, pembuatan kejat, kaizen, penambahbaikan rantaian bekalan dan pembekal.*

Abstract

Lean manufacturing (LM) aims to eliminate operational waste and to maximize product value from customer perspective. This paper investigates ten-weeks customer-vendor joint Kaizen improvement activity to reduce rub mark, a common cosmetic defect on plastic packaging. Whilst noncritical, the entailing inspection and sorting are non-value added. There are assorted of contributing factors, including processing and handling by both vendor and customer. The handling of work requires certain level of sensitivity. Several countermeasures have been implemented and material handling and defect determination at both sides have been standardized. Results gathered showed significant decrease of the defects. Rašković et al. (2012)'s customer-vendor relationship model was used to enhance the understanding of critical elements influencing the success of the case study.

Keywords: *industry project, internship, lean manufacturing, kaizen, supply chain and vendor improvement.*

1. Introduction

Global competition compels organizations to search for better vendors and engage them to meet customer demand. Lean enterprises would consider lean principles in selecting their vendors to constantly improve efficiency and relationship with the vendors for long term business. Lean is actually another activity for relationship with vendor (Kshirsagar et al., 2014). It improves productivity and brings performance in benefits to both parties. A supply chain which can provide Just-in-Time (JIT) production can help eliminate all kind of waste in the process and reduce cost of supply processes by keeping inventory in a minimum level (Sánchez & Pérez, 2001). Lean knowledge would be transferred and problem solving related to the supply issue would be handled collaboratively.

Responsiveness to customer demand is an important property to make a company to be competitive it is affected by the aspects of price, product differentiation, delivery time, and the lead time of material replenishment (Magnusson & Simonsson, 2012). Lead time is defined as the time from an order is delivered to a vendor to when that order arrives at the customer's site. Vendor plays an important role in decreasing lead time hence provides increased competitiveness of the customer. A project aiming at rub marks reduction for thermoform trays is conducted in a three stages framework. The first stage is locating target vendor and getting the top management commitment of the chosen vendor to conduct the joint Kaizen improvement project. This stage is mainly determined by the potential of attaining a cooperative way between both companies. The second stage concerns about initiating the project, which is important for executing the project as well as for implementing the resulting solutions. The final stage of the framework measures the process performance and describes a process for how the customer-vendor relationship should be managed. The framework utilizes a set of lean tools and these tools are used in a combined way to provide an effective process for Kaizen improvement with the aim of decreasing rub marks defect.

Nevertheless, survey conducted by Nordin et al. (2010) revealed that the predicament by firms in adopting lean tools that concern with vendors. In contrast to internal lean improvement, similar cross-firm undertaking has to additionally reconcile differences in organization culture, business interest and commitment. Contemporary literature provides ample references to theories, models and breakdown of elements useful to explain the cause or motivation factor affecting customer-vendor relationships. This manuscript deviates from this focus by offering a valuable case study appertaining to a customer-vendor joint Kaizen activity. The objective of the case study is to resolve a constant cosmetic defect in raw material. The root cause could be varied along the process chain from vendor to customer. Kaizen is a continuous improvement team exercise based on lean philosophy. In addition to the elaborated coverage of Plan-Do-Check-Act (PDCA) and its refined steps, the structured communication and project management, gradual accumulation of rapport and bilateral efforts were also investigated as they are instrumental to the project success.

This paper starts with the introduction of the PDCA methodology. The Plan stage will be described in section 2 and followed by Do stage in section 3. Section 4 will present about Check stage and Act as the last stage in PDCA will be presented in section 5 and followed by conclusion.

2. Literature review

2.1 Lean manufacturing

Lean Manufacturing (LM) is one of the most popular paradigms in manufacturing and service industries to respond to the fluctuating and competitive business environment. The paradigm at first was proposed by Toyota, during 1950's which was famously known as Toyota Production System (TPS). TPS primarily strikes for cost reduction by eliminating non-value activities (Rohania & Zahraeea, 2015) and maximizing the resource utilization and product value (Sundar et al., 2014, Hartini & Ciptomulyonob, 2015). LM therefore requires a gradual process of deep-rooted change in the organizational culture (Maasouman & Demirli, 2015). Five key principles underpinning LM (Womack & Jones, 2003): 1) define value from the perspective of the customer, 2) determine the value streams, 3) achieve flow, 4) schedule production using pull, and 5) seek perfection through continuous improvement. A set of lean tools often assist in the identification and elimination of waste, such as one piece flow, autonomation/ Jidoka, Poka Yoke etc. LM ultimately improves quality, cost, delivery, and customer satisfaction, and profitability (Hartinia & Ciptomulyonob, 2015, Sutari, 2015). Evans & Wolf (2005) suggested that Toyota's processes have a few characteristics that enable their success, namely pervasive collaboration tools that have common standards and are compatible with one another, visibility and visual control not fogged by analysis, trust to share intellectual property without fear of abuse, modular view of teams and processes and flexible planning to keep goals aligned with customer needs and encouragement of teams as a vehicle to solve problems.

One of the major lean tools for continuous improvement is Kaizen. Deming described Kaizen simply as "Improvement initiatives that increase successes and reduce failures" (Sundar et al., 2014). Kaizen means continuous improvement by involving every employee from the top to the production floor. Kaizen helps company to eliminate problems by separating problems into smaller parts that ease the company to find the corresponding solution and improvements. Root cause of inefficiencies is determined and effective countermeasures are applied once the process stability is established (Sundar et al., 2014). In a higher dimension, Kaizen is the management driven element which contributes to the cultural change in the workplace. The success of the Kaizen depends on employee perception, adaptation, team work, leader engagement, motivation, initiative, and training. Kaizen is based on a belief in people's inherent desire for quality and worth, and management has to believe that it is going to "pay" in the long run (Choomlucksana et al., 2015). Nordin et al. (2010) showed that, Kaizen is found to be one of the leading lean practices among all of the lean practices in Malaysian manufacturing industries.

2.2 Vendor management and engagement

Based on Nagurney et al. (2010)'s viewpoint, the importance of vendor relationships may be seen as the "backbones of economic activities in the modern world". Veludo et al. (2006) further emphasizes that vendor relationships is a key to organizational competitiveness, performance and long-term success of companies. Vendor management represents an essential supply chain capability as it affects product specifications and innovation, delivery performance, cost, and quality (Nagurney et al., 2010). OESA-McKinsey (2003) studied that 80 percent of the waste in the automation industry was due to poor vendor management, such as misinterpretation of product specifications, poor understanding and/or manufacturing of complex parts, and ineffective coordination of capacity and demand.

Rehberg (2003) discussed that the spectrum of vendor relationships ranges from traditional relationships to partnerships and alliances. A traditional relationship uses short-term contracts based primarily on price, including preferred vendors, certified vendors and prequalified vendors. Strategic partners and strategic alliances are marked by long-term arrangements, large volume commitments, and joint product development and planning efforts. This relationship relies on mutual trust and support, sharing of information and teaming for continuous improvement. The relationships with vendors consists of Type I, Type II and Type III depending on either short term or long term planning, the spans of divisions or areas involved and the level of integration between both organizations. Most of the partnerships will be Type I and only few of them will have a Type III partnership. Booth (2014) differentiates different relationships by flow of information between each business. There are two types of relationship which are bow-tie relationship and diamond relationship. The bow-tie relationship is characterized by a restricted access to information and limited number of contacts between customer and vendor. On the other hand, diamond relationship is defined by an informed access and many contacts between both sides.

Bensaou (1999) used four types of buyer-vendor relationships for vendor portfolio management i.e., market exchange, captive buyer, strategic partnership and captive vendor based on contextual factors and management variables. The risk and cost must be considered when developing an extensive network of vendor partnerships. The risk normally lies in either under-designing or over-designing relationships. Rehberg (2003) identified three relationship models for managing vendor relationships: Partnership Model, Operational Complexity and Market Sophistication, and Vendor Portfolio Management. The selection of the model depends on the nature of the product and environment. He later proposed Supplier Relationship Management (SRM) which is built upon collaboration, integration and trust. SRM defines how a company interacts with its vendors and provides a structured way for firms and vendors to enhance their relationships, increase profitability, and ultimately provide improved products and services to the end users. Mould & Starr (2003) examined partnership relationships from the perspective of the intricacy of components in the supply chain and the factors that influence how components are bought and sold. A firm needs to determine appropriate vendor relationship to pursue based on the level of operational complexity and market sophistication. The firm also needs to consider business objectives and strategies, technology infrastructure, process integration and organization. Lambert (2003) assessed the drivers, facilitators, and components that lead to successful partnership outcomes and measure how well the partnership is meeting the expectations and provided feedback critical to managing and improving the partnership. The four types of vendor relationships identified in this model ranging from arm’s length through partnerships, joint ventures and vertical integration.

Iyer et al. (2009) and Helper (1991) studied that there are significant differences between U.S. and Japanese vendor management based on the case study in auto Original

Equipment Manufacturer (OEM) industry. U.S. vendor management model is characterized by price-based competition for vendor selection, high level of sole sourcing, low information exchange, low commitment, and easy switching among vendors if problems arise. This kind of relationship is considered adversarial. By contrast, the Japanese model uses close relationships which emphasizes on the competition over quality, delivery and engineering capability among vendors rather than price, long-term relationships with many vendors, high level of information exchange, high commitment, and working with existing vendor to solve problems. The Japanese model is marked by the adoption of lean principles in manufacturing. Their vendors are allowed to involve in product design and development but will be subjected to tight monitoring during manufacturing to ensure stable component performance and quality (Clark & Fujimoto, 1994). As compensation, buyer will absorb part of the business risk for the vendors based on the intensity of the relationship. Iyer et al. (2009) showed that, 90 percent of Japanese auto vendors won renewal of their contracts as compared to only 71 percent of vendors for U.S. auto OEMs.

Toyota's model in managing vendors is the benchmark used throughout the world for "lean" thinking (Iyer et al., 2009). Vendor relationship is one of the lean practices (other four practices are process and equipment, manufacturing planning and control, human resources, and customer relationship) and it can be further measured in four lean practices which involve JIT delivery, Vendor quality level, Vendor involvement in quality improvement program, and Vendor involvement in product design and development.

Toyota's vendor performance is consistently superior compared to other OEMs. The approach used by Toyota to identify and engage with a vendor is superior to the approaches chosen by other OEMs (Planning Perspectives, Inc., 2006). Toyota supply chain management achieves balance and efficiency by focusing on V4L principles which are variety, velocity, variability and visibility (Iyer et al., 2009). Toyota makes sure that variety of components produced by vendors is consistent with their flexibility. Velocity of the parts flow is achieved between the buyer and vendors. Variability of orders to vendors is stabilized through communication of planned volumes in advance via JIT pickups and by limiting the amount of day-to-day fluctuation in orders. Finally, visibility of all processes at both vendor and Toyota side is approached by discussing problem occurred in situ. For Toyota, vendors must be flexible to respond to daily order changes without building Work In Progress (WIP) ahead.

Marks & Barkman (2007) suggested developing vendors using a Lean Competency Model. The Supplier Competency Model (SCM) describes that how companies interact in five criteria categories: Quality, Delivery, Financials, Operational Excellence and General Performance Measure. By utilizing the Lean Vendor Competency Model, gap analysis can be charted and action plan can be drawn to bridge the disparity. Marks & Barkman (2007) proposed vendors and customers work collaboratively to define waste elimination goals. As a cross-organization wide philosophy, Lean enlists all parties to eliminate waste and identify the value added activity. Value stream and relationship management skill requirements bring SCM the concept of cross functional and cross-organizational team approaches. Collaborative approach provided a “sense of partnership, shared goals and rewards, and open and unfiltered lines of communication” (Stallkamp, 2006).

3. Research methodology

The Kaizen follows the four phases consecutively which are Plan, Do, Check and Act (PDCA) originated from lean concept. PDCA is a Deming improvement cycle deploying twelve steps to continually identify and eliminate sources of waste and variation that reduce value provided to customers for continual improvement. Figure 1 illustrates PDCA as a repetitive four-stage model for continuous improvement. Steps include define and breakdown problem, grasp current condition, set a target condition, conduct root cause and gap analysis and identify potential countermeasures in Plan stage; develop and test countermeasures, refine and finalize countermeasures and implement countermeasures in Do stage; measure process performance in Check stage; refine, standardize and stabilize the process, monitor process performance and evaluate results and share learning in Act stage. From here, continuous quality improvement is achieved by iterating through the PDCA cycle and building up achieved progress through standardization.

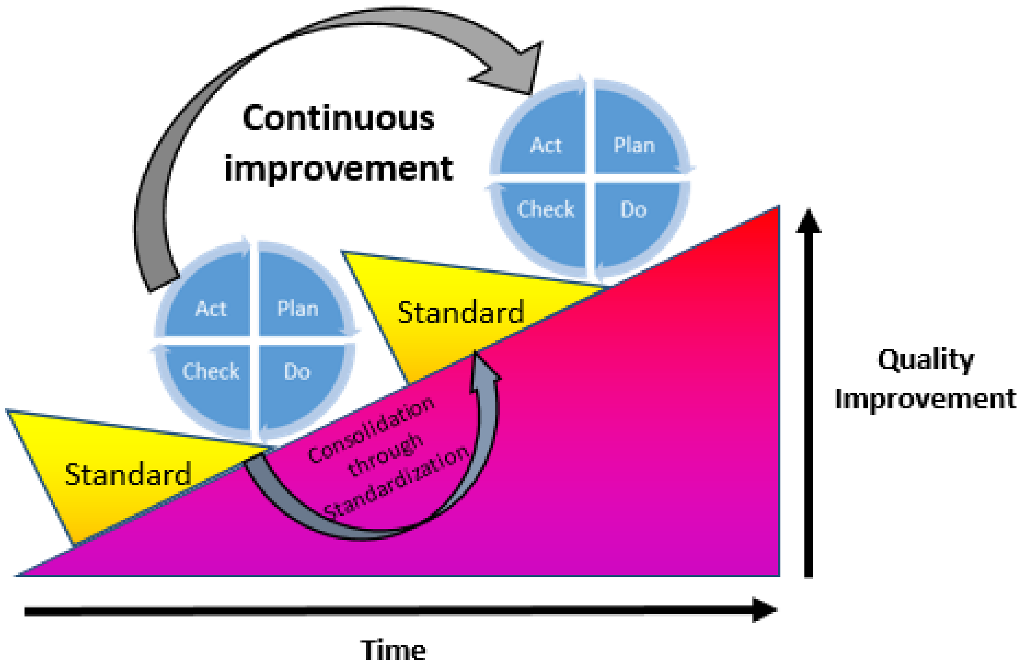


Figure 1. Depiction of the PDCA repetitive four-stage model

3.1 Plan stage

The first stage, Plan, starts with defining the problem to establish a common understanding of the problem, a problem is clearly defined by the impacts and effects of the thermoform trays rejection and is further broken down into smaller problems to make it more manageable. The assumptions made about what causes the problem is verified by grasping the current condition, data is collected and compiled in a Pareto chart to prioritize the cause with the largest potential. Simultaneously, the needs and requirements are incorporated into a target condition and a SMART (Specific, Measurable, Attainable, Relevant, Time Bound) goal is established in order to clarify the performance gap that the problem causes, and the extent of the required improvements for both Bose Systems Malaysia (BSM) and the vendor to set the magnitude and standard for the project. After specifying the target condition it is important to establish potential root causes driving the rub marks defect, a cause and effect (also known as fishbone) diagram is useful for this purpose. After causes have been verified, solutions are to be developed and approved by the management.

3.2 Do stage

The second stage, Do, encompass steps require to develop and test countermeasures, the countermeasures are further refined and finalized by using Effort versus Impact matrix based on their relative impact given the effort required, and the shortlisted countermeasures are implemented to solve the chosen problem. This stage requires commitment from the vendor because the vendor might be unwilling to make the changes if the project was started with a low level of commitment from the vendor.

3.3 Check stage

The third stage, Check, comprehends measuring the process performance of the implemented changes to track the effects of the changes. Data is collected and visualized by a run chart in order to measure the success of the project.

3.4 Act stage

The fourth stage, Act, comprises consolidating the experience gained from the improvement process to avoid the same problem from reoccurring by refining, standardizing and stabilizing the process. The process performance is continually monitored by the run chart to make sure that the improvements are convincingly retained. The results are then evaluated and similar practices are shared among all plastic packaging production lines in vendor site such as BOWIE thermoform trays. This is an important stage to ensure even more successful customer-vendor joint projects in the future.

4. Case study

Bose Systems Malaysia (BSM) is an assembly plant located in Penang producing speakers, amplifiers and earphones. The processes include surface-mount technology, through-hole technology and assemblies. The company has been practicing lean six sigma for years with a well-defined kaizen program for different organizational levels.

5. Plan stage – studying cosmetic defects and customer-vendor collaboration in BSM

The tenet (SMART goal) of the project was set together with the vendor as reducing the rejection of PECAN thermoform tray from rub marks defect. PECAN as one of the popular selling in-ear earphone products in BSM was packaged onto the thermoform tray for protection at station 16 of Noise Reduction Technology (NRT) cell. The PECAN thermoform trays, as shown in Figure 2 was manufactured by vendor Texchem-Pack. These thermoform trays, arrived to BSM in cartons have been screened before shipment. BSM would conduct cosmetic inspection through C=0 Zero Acceptance Number Sampling Plans. The sampling plan was tied in with the lot size and “C=0” represents that there is no defect can be found in the accepted sampling size. The inspection was visualized under sufficient lighting condition in quality lab and based on a packaging cosmetic specification. Inspected lots was stored in warehouse and only delivered when the NRT cell orders for assembly process. The operators in the station 16 would run another round of thermoform tray visual inspection cosmetically. Upon detection of defect, the operator needed to fill in corresponding defects report. The part was then removed from the process and delivered to Material Review Board (MRB) for disposal on the following day. Corresponding Quality Notification (QN) and Quality Management (QM) orders would be created in System Applications Products (SAP) where it is an Enterprise Resource Planning (ERP) system used to create and manage corrective actions. A specific QN type (e.g., vendor complaint) calculated and reported a vendor score pertaining to a quality, delivery, late vendor corrective action, or service incident. QM order was then created in order to initiate a corrective action against the vendor and capture costs associated with a particular issue.

Figure 2. The interior view of in-ear retail box

Rub marks were found on the thermoform trays as the most common type of cosmetic defects contributing to product rejection. The entailing inspection and sorting were non-value added activities. The contributing factors were potentially manifold, including during processing and handling in both vendor and customer sites such as material handling method, manufacturing process and gauge template for rub marks identification. The top three defects found on the PECAN thermoform tray are shown in Figure 3 and the total number for each defect were collected and compiled in a Pareto chart as shown in Figure 4. The total counts are represented in descending order by bars and the cumulative total is represented by the line. The result of study showed that the top three defects composed approximately 94.10% of the total cosmetic defects of PECAN thermoform tray and rub marks defect was the highest (71.56% of total defects). The rub marks defect which contributed to about 72% of the total number of rejection would be prioritized and targeted in this project based on the 80/20 rule. From this we can achieve 80% of results by focussing the effort on 20% of all causes for the problem.

Figure 3. The top 3 defects on PECAN thermoform tray

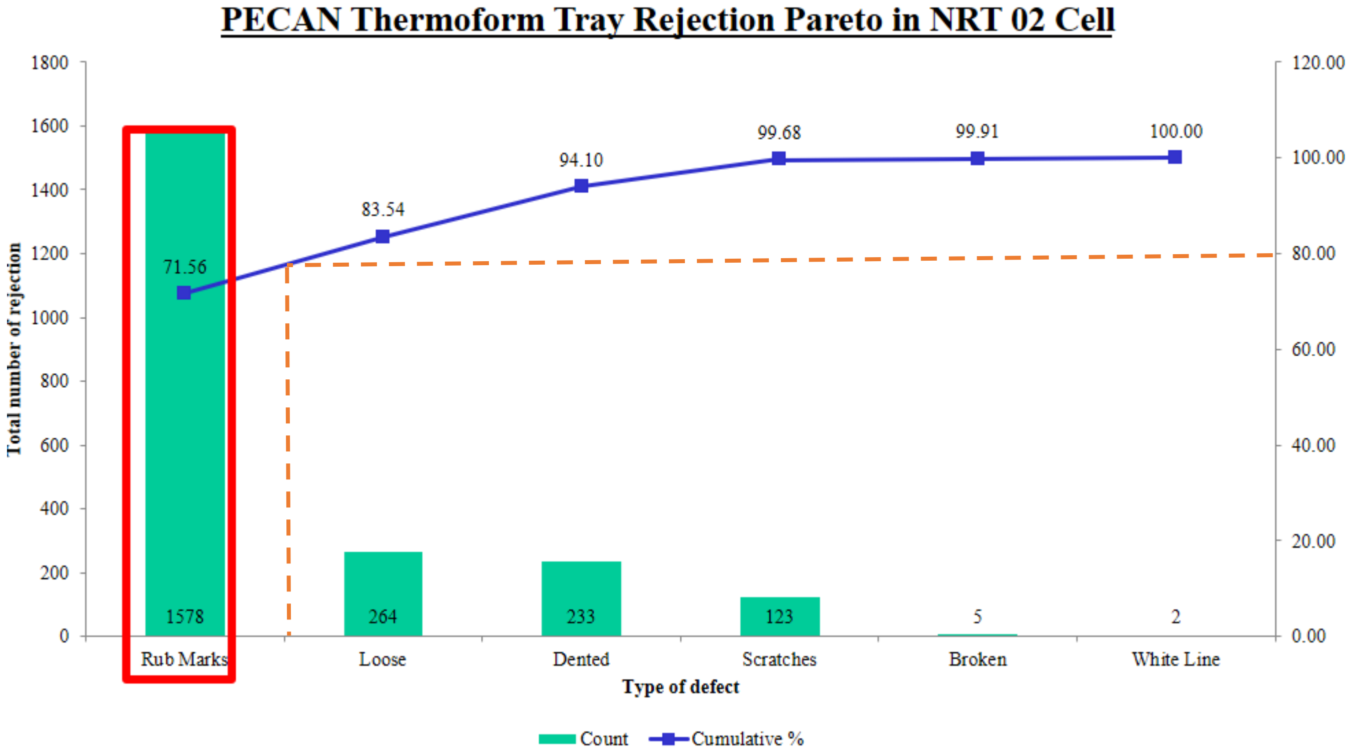
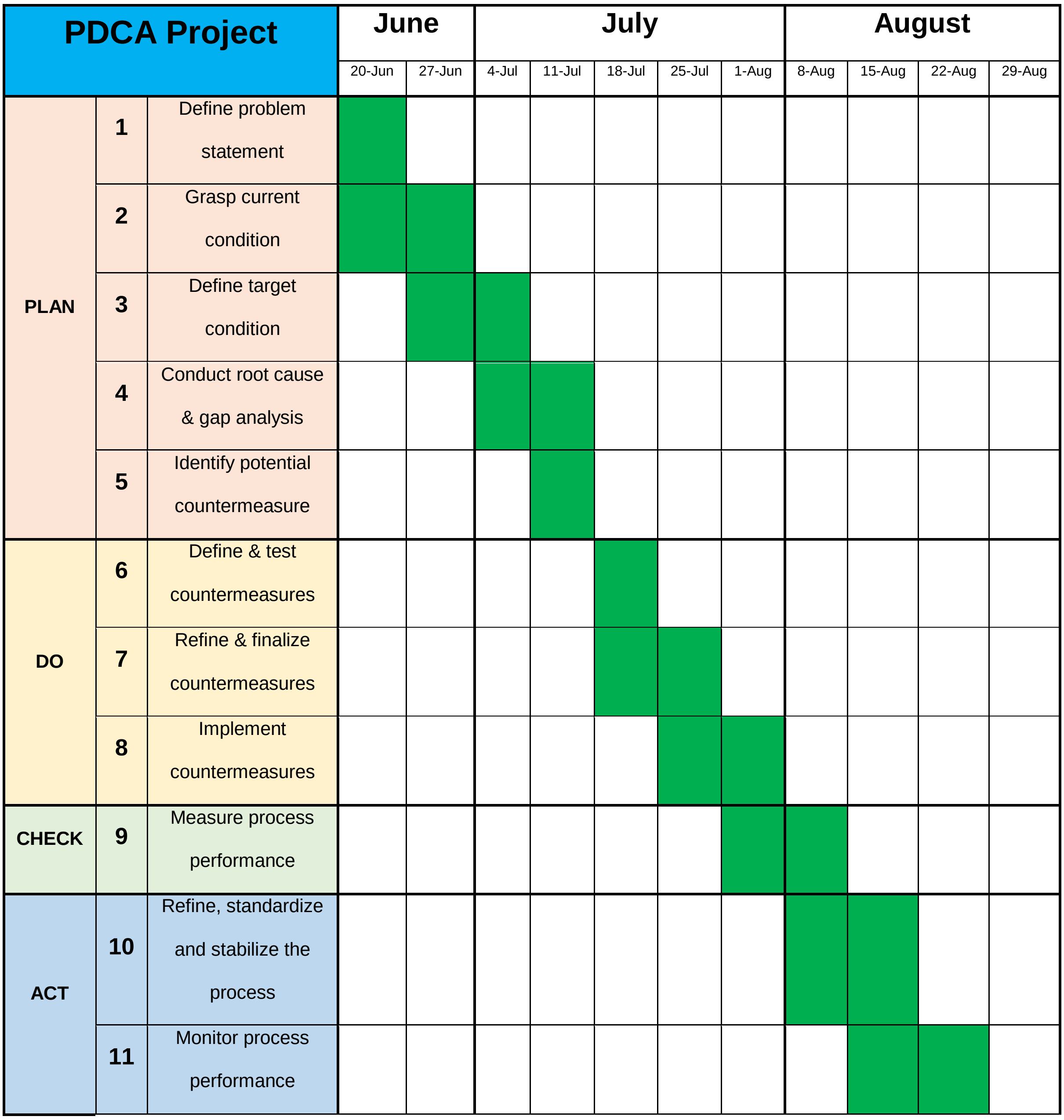


Figure 4. The Pareto chart for the PECAN thermoform tray rejection

The occurrence of defect resulted stoppage and hence lowered the production efficiency in NRT cell. The vendor side also incurred Cost of Poor Quality (COPQ) due to rejection.

A core team was formed consisted of team members from BSM and the vendor side. Three members from BSM internal process department (supply chain quality engineer, material review board technician and process control engineer) and two members from the Quality Assurance Team of the vendor side (quality assurance engineer and production leader) were included. Team members were assigned tasks related to their job scopes (e.g., supply chain quality engineer attended quality-issued discussion with vendor counterparts). The project was executed according to Gantt chart in Figure 5.



	12	Evaluate result & share learning											

Figure 5. The PDCA project Gantt chart

The occurrence of the rub marks was collected from July 2015 to July 2016, as presented in Figure 6. The occurrence of the rub marks was random and irregular. In addition, inspection and sorting activities in station no.16 also has been considered as non-value added activities.

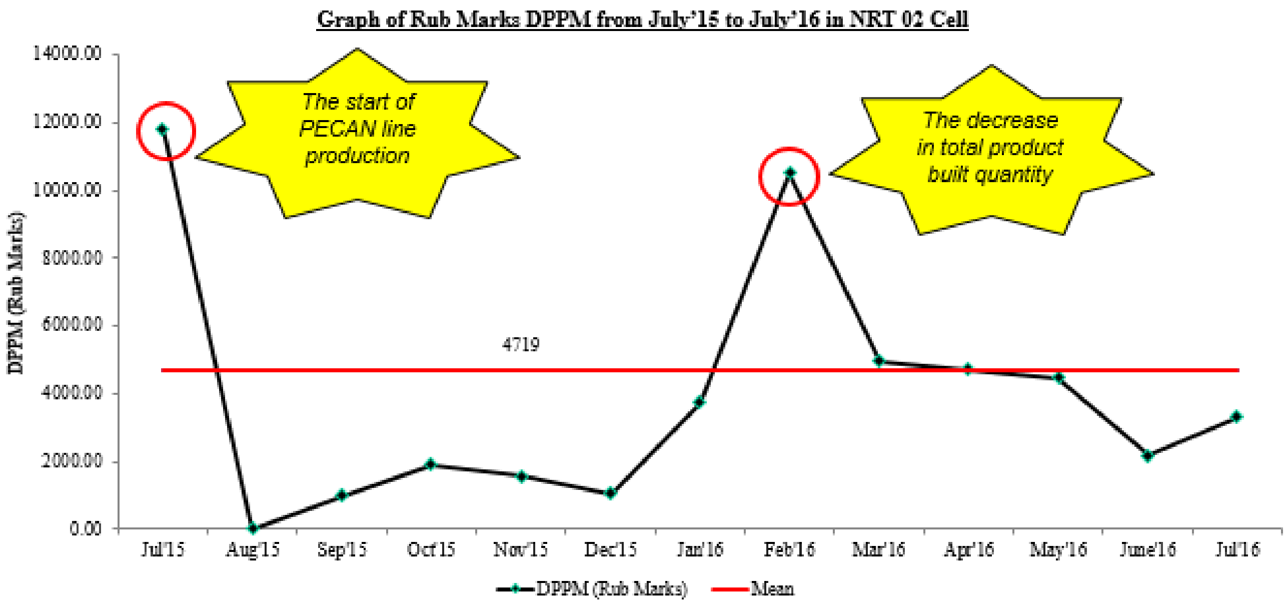


Figure 6. The count of rub marks for PECAN for 1 year

First, the process flow of the thermoform tray was established as shown in Figure 7. The root cause analysis was conducted by the joint team using fishbone diagram which breaks down the root causes into six categories: man, machine, measurement, materials, method and environment.

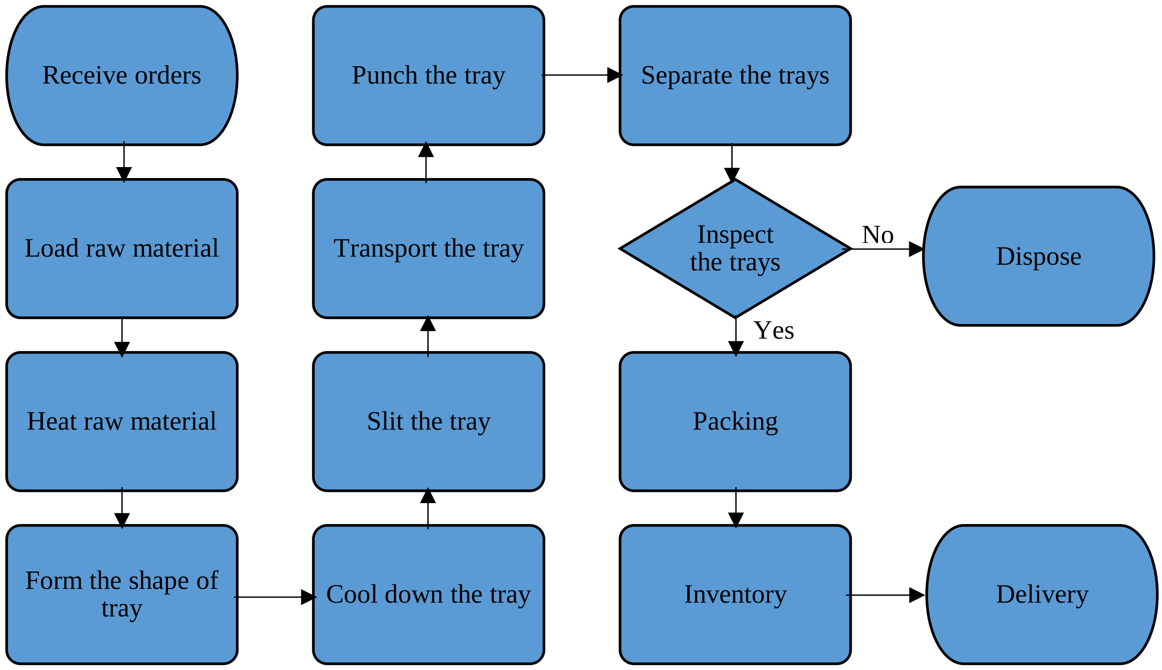


Figure 7. The process flow for thermoforming tray in vendor site

In the fish bone diagram (Figure 8), twelve possible causes had been identified and classified into controllable (C), noise (N) and experimental (X). Only controllable causes were considered because they are open for solution. Noise causes were excluded because of their solutions were not under any process control mechanism and for the experimental cause the feasibility needed further manipulation via Design of Experiments (DOE) method under experimental condition.

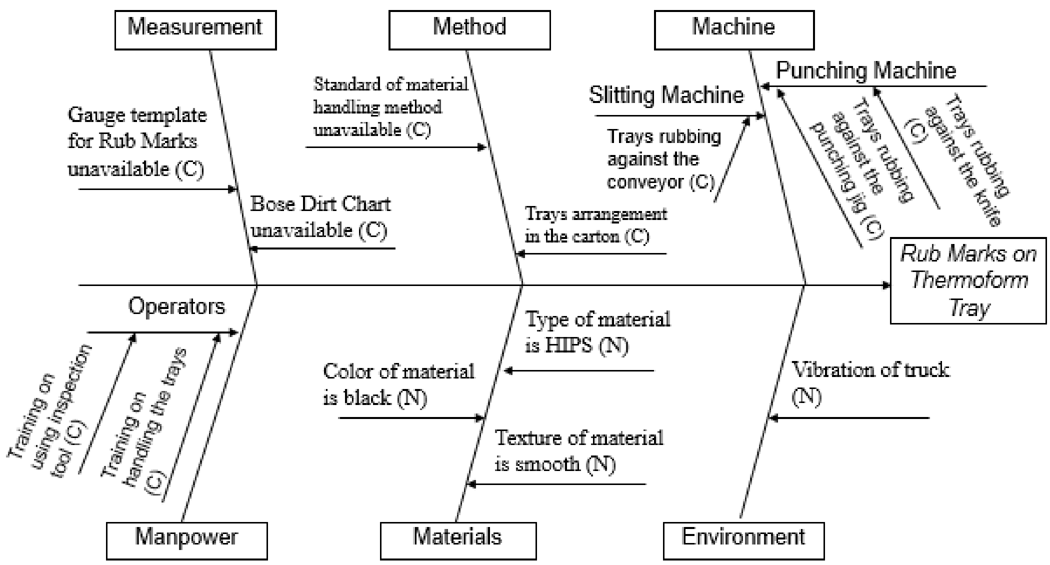


Figure 8. The fish bone diagram for root cause analysis

The root cause verification for the cause of vibration of truck was conducted to verify its influence to the problem and its relations to the cause of trays arrangement in the carton to reduce the influence. A 660 pcs of trays packed and sealed in a single carton underwent 100% quality screening. The carton was tracked during loading, travelling and unloading from vendor site to BSM. The carton was unpacked and trays underwent full inspection on the rub marks. Only one of such defect was detected which was 1515.15 in term of Defective Parts per Million (DPPM). The remaining lot was then transferred under observation to NRT cell for product assembly. No defect was detected subsequently. The cause of vibration of truck was hence been verified since the data proved that it would cause rub marks occurrence with a certain impact of 1515.15 DPPM. Relevant countermeasure in conjunction with trays arrangement in the carton was to be developed.

An Effort versus Impact matrix was developed (Figure 9) to gauge the impact of addressing these controllable causes in relation to the effort required. Priority was given to the causes falling into the quadrant (green-highlighted) delineating achievability with high impact and low effort. The causes on the quadrants low impact and low effort or high impact and high effort would be considered based on management discretion and dependability with other factors.

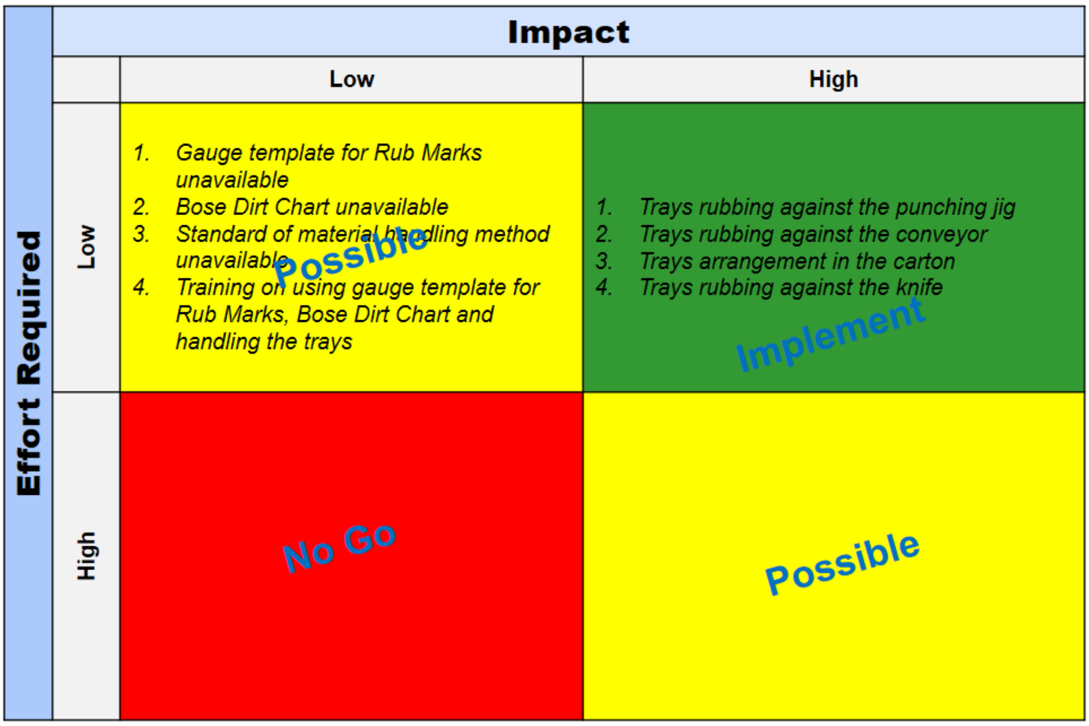


Figure 9. Effort vs Impact matrix for potential countermeasure identification

Eight potential countermeasures have been identified in accordance to the shortlisted root causes listed in the matrix. Cloth plug and special designed feed sprues would target to resort root causes belong to the machine factors. Gauge template for rub marks and material handling method would improve the measurement and method factors. The provision of training would sustain the changes. The thickness of rubber guide for slitting machine and number of trays per row would be adjusted to target the trays arrangement factors and the details will be further explained in sections 4.2.2 and 4.2.6.

A detailed list for the implementation of the finalized countermeasures consists of the person in charge was tabulated as shown in Table 1.

Issue	Countermeasure	Person-in-charge *Position*	Date (Week)
Trays rubbing against the punching jig	Use cloth plug to wrap the punching jigs.	Nordiana *Vendor QA Engineer* Mohammad *Vendor Production Leader*	05/08/2016 (Week 7) to 05/08/2016 (Week 7)

Trays rubbing against the conveyor	Feed sprues with designed height surrounding the tray flange to prevent rubbing against conveyor	Nordiana *Vendor QA Engineer* Mohammad *Vendor production leader*	05/08/2016 (Week 7) to 05/08/2016 (Week 7)
Gauge template for Rub Marks unavailable	Provide gauge template for Rub Marks in vendor side	Nordiana *Vendor QA Engineer* Mohammad *Vendor Production Leader* Khor Li Sing *Team Leader* Ahmad *Supplier Quality Engineer*	08/08/2016 (Week 8) to 10/08/2016 (Week 8)
Bose Dirt Chart unavailable	Provide Bose Dirt Chart for vendor side	Khor Li Sing *Team Leader* Ahmad *Supplier Quality Engineer* Umi Mahirah *MRB Technician* Siti Fatimah *Process Control Engineer*	08/08/2016 (Week 8) to 10/08/2016 (Week 8)
Standard of material handling method unavailable	Standardize material handling method in vendor side	Khor Li Sing *Team Leader* Ahmad *Supplier Quality Engineer* Nordiana *Vendor QA Engineer* Mohammad *Vendor Production Leader*	08/08/2016 (Week 8) to 10/08/2016 (Week 8)

Training on using gauge template for Rub Marks, Bose Dirt Chart and trays handling	Provide training on standard practice in vendor side	Nordiana *Vendor QA Engineer* Mohammad *Vendor Production Leader* Khor Li Sing *Team Leader*	10/08/2016 (Week 8) to 17/08/2016 (Week 9)
Trays arrangement in the carton	Increase number of trays per row from 65 to 75 in a carton	Nordiana *Vendor QA Engineer* Mohammad *Vendor Production Leader* Khor Li Sing *Team Leader*	15/08/2016 (Week 9) to 15/08/2016 (Week 9)
Trays rubbing against the knife	Increase the thickness of rubber guide so that it is higher than knife	Nordiana *Vendor QA Engineer* Mohammad *Vendor Production Leader*	15/08/2016 (Week 9) to 15/08/2016 (Week 9)

Table 1. List of finalized countermeasures implemented

6. Do stage – developing and implementing countermeasures

Implementation was carried out both on vendor and BSM sites. The less effective countermeasures were omitted and the rest were refined and finalized. Finalized countermeasures were then implemented as follows:

6.1 Prevention of rubbing against the punching jigs

The two contact points of the punching jig were wrapped with cloth plug as shown in Figure 10 to reduce the friction during punching.