AUTOMOTIVE PARTS MANUFACTURING INDUSTRY: UNRAVELING THE EFFICACIOUS QUALITY FRAMEWORK

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Abstract
This paper puts forth the strategic importance of statistical quality improvement for automotive stamped parts manufacturing process. The review on the Malaysian automotive parts suppliers reveals that the automotive stamped parts suppliers are facing with quality-related problems. Intense pressures for quality improvement are actually experienced by automotive parts suppliers to stay-tuned in competitiveness and to build a long-term relationship with automotive manufacturers. The automotive parts suppliers in Malaysia are urged to contribute towards enhancing the overall quality of national car. While empirical studies have shown that statistical concepts are crucial to good quality management and key in dealing with manufacturing processes, there has been inadequate emphasis on the deployment of statistical approach in quality practice among these suppliers. This paper proposes a conceptual framework for statistical quality improvement in automotive parts manufacturing. The practical implications of applying the statistical thinking methodology towards continuous quality excellence are also highlighted.

Keywords: Quality improvement, conceptual framework, statistical quality control, automotive stamping industry
1. Introduction

High quality is now an innate need and a leading operating priority in all types of organizations be it manufacturing or services. It is the key orientation towards enabling organizations in facing rapid changes in the marketplaces. Changes in the marketplace can arise from different aspects such as increasing variety of customer demands, new and ingenious innovation in production techniques as well as changes in market condition due to globalization and increasing international trade between nations. Within the automotive manufacturing industry, the trend has been increasing product variety and short product life cycles (Cerkovic, Vickery, & Droge, 2000). In the meantime, consumer knowledge and product requirements have increased extensively with the exploding access to information and technology (Ernst & Young Global Automotive Center, 2010). Undeniably, the automotive parts manufacturers need to be more competitive in terms of cost and quality and being able to build long term relationship with automotive manufacturers.

The objective of this study is to expound on the importance of statistical approach in the pursuit of quality enhancement of automotive parts manufactured. This study firstly examines the historical background of the Malaysian automotive industry by highlighting the inception of two national cars which have become the pride of the nation. Secondly, this paper explores on the challenges faced by the Malaysian automotive subsidiary industry and the opportunities laid down by these challenges. The following section accentuates the potential role for the automotive suppliers to play at the international level by pointing out the importance of quality excellence as the key success factor. This study progresses to give some insights on the overriding importance of statistical tools and techniques as the cornerstone of quality improvement for automotive manufacturing process. This study, then, proposes a conceptual framework based on statistical approach for quality improvement in automotive parts manufacturing. The final section probe into the implications on the operating practice as the resolution to the quality quest of the local automotive parts suppliers before the concluding statements.

2. A Malaysian case

2.1 Brief history

Malaysia has come a long way since the last two decades to build up a real image of national car manufacturer within the global automotive industry. The journey of Malaysian automotive industry began with episodes of local assemblies to the inception of the first national car project undertaken by Perusahaan Otomobil Nasional Berhad (PROTON) in 1985 and a second national car project, Perusahaan Otomobil Kedua Sdn Bhd (PERODUA) in 1993. These two major local car manufacturers have significantly provided new impetus to the development of local auto parts and components manufacturing industry. This development is a part of an integrated capabilities in Malaysian automotive manufacturing which include local design, engineering capabilities, and full scale manufacturing operation (Mohd Nor, 2006).

The subsidiary automotive parts and components industry has witnessed a subsequent tremendous increase in number of local manufacturers. For instance, at the end of 2005, there were more than 590 automotive component manufacturers supplying to PROTON and PERODUA (MITI, 2005). Of this figure, 227 were PROTON vendors (32 tier one vendors), 161 PERODUA vendors and the rest of the vendors supply to both PROTON and PERODUA. More than 70% of the component manufacturers are Malaysian-owned, mainly small to medium sized industries (SMIs), locally or foreign-owned or joint-ventures (JVs) and many have tie-ups with several Japanese companies (Lim, 2003). The increase in sales volume of locally manufactured vehicles has equally contributes to the growth of market size of the auto-parts manufacturing industry. For example, when total sales volume of vehicle increased by 3% from 2004 to 2005, the market size for the auto-parts manufacturing industry surged to RM 8.36 billion in 2005 from RM 6.1 billion and RM 6 billion in 2003 and 2004 respectively (MITI, 2005).

The expansion of automotive and auto parts manufacturing industry has a profound impact on the economic contribution in terms of employment and revenues generation. Under the employment sector, the automotive manufacturing alone has provided around 2.5% of the total employment in Malaysia in 2005 and for the same period, the employment opportunities in the sector was estimated to be around 50,000 (Mohamed, Cha, Chin, & Ayeb, 2006). More importantly, the growth in automotive manufacturing industry has spurred strategic development of linkages between Malaysian main and subsidiaries industries, new entrepreneurs, industrialists, financiers and service providers (Leete, 2007; Mohd Najib, 2006). A study on the linkages within automotive sector reveals that the emergence of automotive manufacturing industries in Malaysia has led to the growth in
the number of the SMI suppliers. The SMI suppliers have significant role in producing equivalent local contents for PROTON and PERODUA, which substitute the previously imported components (Hassan et al., 2006). There are several factors which have contributed to the tremendous growth of SMIs. One for the important factor is the need to meet the demand for various components by the national automotive manufacturers following an increase in the total production of local automotive vehicles. The other factor which fosters the growth of local SMI automotive suppliers is direct government support through two policy instruments, namely, the Local Material Content Programme (LMCP) and the Vendor Development Programme (VDP) (Leete, 2007). Under LMCP, the national car manufacturers are required to substitute imported components with locally produced equivalents. Aggressively pursued VDP has helped to spur the growth of SMI suppliers by guaranteeing markets for the outputs produced by them. Financial and technical assistance are also offered by the parent company and the Malaysian government. For example, the Industrial Adjustment Fund (IAF) is set up to encourage the suppliers to develop greater international linkages (Mohd Najib, 2006). Apparently, the increased number of local automotive suppliers is evident with the impressive number of firms nurtured under PROTON’s VDP. When PROTON was first started in 1985, there were only 17 local parts manufacturing firms but the number has increased to 188 by 1998. In the same year, PROTON has sourced out 228 parts to domestic suppliers and now the number has reached to a total of 4,319 parts. In 2007, 350 firms are reported as being outsourced by PROTON to produce components and parts for the Malaysia’s automotive sector (Leete, 2007).

2.2 Challenges and opportunities

The saga of Malaysian automotive industry is not without challenges. Not only the challenges come from within its locality, the local automotive industry is also facing challenges at the global arena. Apart from the radical process of consolidation and liberalization portraying the introduction of ASEAN Free Trade Agreement (AFTA) and World Trade Organization (WTO), the industry is also hit by the rapid technological changes, alliances and acquisitions (Mohd Najib, 2006; Mohd Nor, 2006). The scenario of acquisitions and mergers among the global automotive players also has resulted in a reduced number of vehicle manufacturers. Worse still there is an increased price competition from the automotive manufacturers from the low wage countries like China and India (“The challenges of globalization,” 2008). The changing landscape in the global automotive industry witnesses a global production shift from the high labor cost countries (for example, Germany, US, Japan, Canada, UK, France, Italy) to the lower and ultra lower labor cost industries Mexico, Thailand, Russia, India and Indonesia including Malaysia, (Mohamed, et al., 2006).

The inevitable rapid changes in the global landscape of automotive industry must not only be seen as challenges but also as opportunities because many of the major international manufacturers are actually outsourcing their component sectors. Despite the reduced number of the major vehicle manufacturers, the component manufacturing industries have actually shown a substantial growth (“The challenges of globalization,” 2008). The future shift and wind of change provide signals to the Asian automotive players which includes Malaysia, to enter the world market rather than solely producing for the local market (Mohamed et al., 2006; Vairangkar, 2006; “The challenges of globalization,” 2008). In fact, due to the lower operating cost factor, the local parts manufacturers are opened to the opportunity to develop substantial exports by establishing international linkages with the international vehicle manufacturers (Mohd Nor, 2006). At the local marketplaces, the suppliers could reap the opportunity for larger market share and take the lead in supplying to the domestic demand following the increased trend in the domestic sales of national vehicles. The Malaysian domestic sales of vehicles have experienced a series of peaks and troughs over the past two decades. For instance, after a slight fall in sales for the year 2009 in comparison to 2008, the sales are expected to improve in 2010 (MITI, 2010). Apparently, for the first nine months of 2010, the total national vehicle sales volume has increased by 14% compared to the same period of 2009. Further analysis on the domestic sales of passenger vehicles by brand name of the same period January to September 2009 to 2010 show that sales volume of the two national automotive manufacturers, PERODUA and PROTON, has grown by 14.8% and 8.9% respectively due to the improved economy in that duration. Figure 1 illustrates the trend in sales volume of commercial vehicles and passenger cars in Malaysia for the period January 2005 to September 2010. Although Proton and Perodua are making only passenger type of vehicles and not commercial vehicles, this figure shows the general increasing trend of the Malaysian vehicle sales volume. Figure 2 illustrates the domestic sales of passenger vehicles by brand name in Malaysia from January to September for the year 2009 and 2010.

Given the opportunity of larger market for automotive part supplies, the Malaysian automotive parts suppliers ought to venture into gaining the competitive edge, aiming for larger market penetration and to play a serious role in the global automotive industry. The strategy to achieve these objectives is by producing high quality
automotive parts at competitive cost. Having said these, the local car manufacturers need to enhance the quality of their processes, and the quality of their automotive parts so as to meet the demand for high quality supplies in both local and global marketplace.

3. Quality quest in automotive parts manufacturing

In dealing with quality, many automotive parts manufacturers have at least applied a number of quality approaches embedded in quality management systems or quality frameworks. Total Quality Management (TQM) and the certification of international quality standardization (ISO) are among the widely applicable systems. TQM puts emphasis on continuous process and systems improvement as a means of achieving customer satisfaction to ensure long term company success. Similarly, the ISO aims at continuous improvement supported by the fundamental principles of total quality. Six Sigma methodology is a process improvement methodology that goes far beyond problem solving featuring the five-stage improvement framework: Define–Measure–Analyze–Improve–Control (DMAIC) (Evans & Lindsay, 2005; Pande & Holpp, 2002). TQM and the ISO certification are the heavily promoted quality management frameworks and are seen as important quality milestones of an organization (Idris, et al., 1996; Kanapathy & Jabhoun, 1998).

In the quest of quality panacea for the automotive parts manufacturing, one has to define quality objectives in the context of automotive body manufacturing. One of the main quality objectives in automotive body manufacturing is to meet the dimensional integrity and functionality between automotive stamped parts and the assemblies of automotive vehicle body (Hammett, Baron, & Smith, 2000). Dimensional integrity is a critical process characteristic in automotive body manufacturing where automotive sheet metal parts are welded together into subassemblies. Subsequently, the sub-assemblies are welded together to produce the skeleton vehicle body. Nonetheless, dimensional integrity cannot be achieved when automotive dimensional measurements deviate from their nominal specifications or even larger than what is allowed by their design tolerances. Typically, when dimensional integrity are not met, this indicates the presence of ‘excessive’ variations. ‘Excessive’ variations or deviations in stamped automotive parts are the cause of variations in assembly dimensions. Several studies in automotive stamping process claim that it is the excessive variations in stamped automotive parts that hinder good fits in automotive parts and their subassemblies (Guzman & Hammett, 2003; Hammett, et al., 2000; Kuzma-Smith, 2000; Yang & Trewn, 2004).

In manufacturing context, essentially, ‘quality is inversely proportional to variability’. As such, reduced variability is the quality objective of manufacturing operation (Montgomery, 2005). This modern definition of quality purports the importance of variation reduction as to increase the quality characteristic of a product. With reduced variation, more products meet quality conformance and this leads to less scraps and less rework. Consequently, cost can be reduced and the manufacturing operator competitive edge can be derived from its value-added quality product. By studying variations in the manufacturing process, the potential sources of variation that have the greatest impact on the process can be identified to improve the quality of automotive parts (Montgomery, 2005; Montgomery & Runger, 1999). In most cases, variations can only be described and better understood through statistical methods (Makrymichalos et al., 2005). As such, statistical concepts are the key in dealing with manufacturing processes and their inherent variation problems hence is crucial to good quality management (Evans & Lindsay, 2005).

3.1 Attitude towards statistical approach to quality improvement

Until now, empirical evidence indicates lack of statistical application to quality improvement among the Malaysian local automotive suppliers. As has been revealed in a study, the Malaysian automotive suppliers do not use statistical methods as their major approach for quality improvement (Noviyarsi & Sha’ri, 2004). Evidently, there is lack of awareness on the importance of statistical approach to process control among the SMI automotive suppliers (Hassan, et al., 2006; Jafri, Sha’ri, & Ismail, 2007; Lim, 2003; Mohd Nizam et al., 2009; Salimah, 2001). Even though many automotive suppliers apply the basic process control techniques like check sheet, cause-and-sheet diagram, histogram, Pareto diagram and control charts to monitor the manufacturing process, these suppliers generally perceived the statistical quality tools and techniques as the least important issues for them to deal with (Hassan, et al., 2006).

Despite the existing applications of basic process control techniques by the local automotive SMI suppliers, there is no clear indication of improvement in the quality of locally manufactured automotive parts. After being in the industry for almost three decades, the local automotive parts suppliers, particularly, the SMIs, are still reported to be bogged down with the longstanding issue of low quality products (Leete, 2007). Additionally,
there are pressures for the local SMI suppliers to improve on the overall quality of parts supplied to the Malaysian pioneer car manufacturer (Wan Mohamed, Cha, & Chin, 2006; Mohd Najib, 2006; Mohd Nor, 2006). The quality of these automotive parts has been reported as the withholding issue among the SMI automotive suppliers or the local vendors (Adnan, Mohd Sharif, & Awaluddin, 2006; Leete, 2007; Wan Mohamed, 2008). A fairly recent study reveals that 56.4% of the SMIs automotive suppliers admit facing problems related to poor quality of their own products (Hassan, 2006). As revealed in a study, the higher level of wastage in the locally produced automotive parts due to process rejects are associated to lower input in R&D by the Malaysian automotive part vendors (Mohamed, 2008). Although quality has been set as high in the lists of manufacturing priorities by the local suppliers, yet problems still exist in the quality of automotive parts. Higher level of wastage and process rejects among the Malaysian local automotive suppliers does not go unnoticeable and has actually added cost to these suppliers (Mohamed, 2008). This could explain why the cost to the local manufacturers of original equipment manufactured parts and components (OEM) are still higher even though these manufacturers supply higher percentage of OEMs to the national car producer. The local automotive parts manufacturing suppliers could reduce their costs when the quality of their product is improved. With the policy of increased localization for cheaper car model, these part suppliers need to improve on quality and reduce cost. There is a critical need for the local suppliers to look for the more effective quality enhancement tools and methodologies. Therefore, this study recommends for the automotive parts supplier to harness the powerful statistical methods as part of their quality improvement initiatives.

4. The proposed quality framework

Although statistical methods are not meant to replace the other quality approaches embedded in the quality management systems, there is a need to have a combination of quality tools for an effective quality control and improvement efforts (Ryan, 2000). To re-emphasize the importance of statistical orientation in deriving continuous quality improvement within automotive parts manufacturing, a conceptual framework is proposed here. This framework is derived from the work done by several quality advocates.

Deming’s philosophy of quality improvement have stressed on the role of quality as the management function and broaden the responsibility of defining quality not only to manufacturing departments but other departments too (Garvin, 1988). Thus, other than the manufacturing process control, the other two building blocks of quality management are continuous improvement and customer orientation. More recent quality promoters give attention on how to achieve the quality that they perceived in a management context and embedded in frameworks. The concept of Total Quality coined by Feigenbaum set up a people-focused management system aiming at continual increase in customer satisfaction (Evans & Lindsay, 2005). Snee (1990) models the concept of Total Quality under three levels of activity i.e. strategic, managerial and operational. Snee (1990) further associates the three levels with statistical thinking, in which, the strategic level is associated to the concept of quality; the managerial level relates to statistical process control procedure and the lowest operational level is associated to the statistical tools and techniques to be applied. Total Quality concept further progresses into the concept of Total Quality Management (TQM). In a similar tone, TQM put emphasis on continuous process and systems improvement as a mean of achieving customer satisfaction to ensure long term company success.

Henceforth, the quality conceptual framework for improvement in automotive parts stamping emphasizes on achieving quality by employing the manufacturing-based quality definitions within a TQM framework. In line with manufacturing-based definition of quality, the framework is further expanded under the notion that quality means meeting the conformance to requirements or degree to which a product conforms to design and specification. Conformance is the degree to which a product’s design and operating characteristics meet the pre-established standards. As the heart of quality improvement of manufacturing process, variations reduction fits into the quality objective of automotive manufacturing to achieve dimensional integrity and functionality of stamped body parts through the assembly work (Guzman & Hammet, 2003). Figure 3 illustrates the conceptual framework of quality analysis.

5. Practical implication

This study implies the need for statistical thinking in quality paradigm of quality practitioners within the automotive parts manufacturing industry. Statistical thinking method provides the methodology towards continuous quality excellence through several key concepts. The key concepts are; to view work as a process, to
use data as guide to decisions and to recognize and respond to the omnipresence of variations. Having said this, the most important idea for the automotive suppliers to grasp is to reduce the variations that could possibly caused by man, material, machine, method or environment. Variations will affect the quality of automotive manufacturing process and ultimately deteriorate the quality of automotive parts. As such, the correct estimation of process variation is the most crucial in determining the acceptable level of process performance under normal condition. The understanding on variation and how it can be reduced to ultimately improve quality can be achieved through the application of statistical methods. The customary or naturalization of application of statistical methods for quality improvement is imperative to the automotive parts suppliers.

As mentioned earlier, the application of basic process control techniques like check sheet, cause-and-sheet diagram, histogram, Pareto diagram and control charts is common to many of the automotive suppliers. These techniques are the basic tools under statistical process control (SPC). Setting up of the SPC system itself, serves as a practical guideline to naturalization of statistical methods application. Under this guideline, some of the steps involved are determining which process to monitor, identifying what variables to monitor, determining the appropriate chart to be applied and establishing data collection. Effective data collection including sampling work should be planned once the selection of quality variables has been finalized. Careful planning for data collection should be made on how and where data can be collected, who will be responsible, how often data should be collected, who would do the inspection and review the results and who is responsible for taking the corrective action. In a control charting procedure, it should only involve the most appropriate parameter to be monitored as not everything can be monitored. Therefore, the critical part to quality (CTQ) variables is the prime candidate. In sequence, these variables will determine the variation from which the process will be monitored. In short, the application of basic statistical process control tools is already within the process control framework of many automotive suppliers. Unfortunately, there is a huge gap on how these statistical techniques can be optimized so as to achieve the competitive quality level. Henceforth, the study strongly recommends for a revisit study on the statistical approach to quality improvement for automotive stamped parts manufacturing where the SPC methods could be integrated with the other existing quality practice such as FMEA, Kaizen etc.

With the upcoming policy development on improving the quality of automotive parts, ISO/TS 16949 i.e. the International Quality Systems Standard for Automotive Suppliers, the exposure to statistical oriented approach to quality improvement is the most appropriate. Increased statistical knowledge of automotive suppliers could provide avenue towards achieving the ISO/TS 16949 compliant for defect prevention; reducing the magnitude of variations and waste in supply chain and encouraging improvement in customer satisfaction. The study could also support for the introduction and enforcement of mandatory standards for parts and components as the step towards improving the quality of locally manufactured parts and components. With increased competitiveness and exports due to the enhanced quality and value added of their products, the local automotive suppliers should be welcomed to take advantage of the new measures of substantial tax exemption on statutory income for certain percentages of their value of increased exports in Malaysia ("Update: New National Automotive Policy ", 2009). Specifically, under the Malaysian New Automotive Policy Review for continued development of the domestic automotive industry, the integration of techniques could give further insights to best practices ("Update: New National Automotive Policy," 2009).

6. Conclusion

The present scenarios on competitiveness and automotive parts or product quality issues of the Malaysian automotive manufacturing industry as depicted in this article. Despite the changing landscape in the global automotive industry, the Malaysian automotive suppliers have a bigger opportunity to supply to the international market as well as catering to the domestic demand for national cars which is ever increasing. Plausibly, these local parts manufacturers could foster the growth of the national automotive industry and economy. The effort towards increasing growth to automotive industry and economy, definitely deserve further work and considerations on improving the quality of automotive parts produced by these suppliers. In this paper, the emphasis has been made on the application of statistical tools and techniques in their quality paradigm although many of the suppliers have put lesser emphasis on this aspect of quality improvement due to lack of knowledge and awareness on the benefits to be reaped from statistical approach to quality improvement. This study proposes a conceptual framework for statistical quality improvement for automotive parts manufacturing, and generally expounds practical implications of quality improvement efforts to the automotive suppliers.
Figure 1: Malaysian Annual Sales of vehicles by type, 2005-2010 (until September 2010) (MITI, 2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>Passenger Cars</th>
<th>Commercial Vehicles</th>
<th>Total Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>416,692</td>
<td>135,624</td>
<td>552,316</td>
</tr>
<tr>
<td>2006</td>
<td>366,738</td>
<td>124,030</td>
<td>490,768</td>
</tr>
<tr>
<td>2007</td>
<td>442,885</td>
<td>44,291</td>
<td>487,176</td>
</tr>
<tr>
<td>2008</td>
<td>497,459</td>
<td>50,656</td>
<td>548,115</td>
</tr>
<tr>
<td>2009</td>
<td>486,342</td>
<td>50,563</td>
<td>536,905</td>
</tr>
</tbody>
</table>

| Jan-Sept'09 | 361,793 | 36,157 | 397,950 |
| Jan-Sept '10 | 408,450 | 44,799 | 453,249 |

Figure 2: Malaysian Domestic Sales of Passenger Vehicles by Make, 2009 and 2010 (January – September) (MITI, 2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>Perodua</th>
<th>Proton</th>
<th>Toyota</th>
<th>Honda</th>
<th>Nissan</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 (Jan-Sept)</td>
<td>122,858</td>
<td>110,265</td>
<td>47,838</td>
<td>29,575</td>
<td>17,450</td>
<td>361,793</td>
</tr>
<tr>
<td>2010 (Jan-Sept)</td>
<td>141,111</td>
<td>120,173</td>
<td>52,781</td>
<td>34,104</td>
<td>19,725</td>
<td>408,450</td>
</tr>
</tbody>
</table>
Figure 3: Conceptual framework of statistical quality improvement study for automotive stamped parts
References


