A comparative study of manufacturing practices and performance variables

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Abstract

The reported study was conducted to compare and contrast current manufacturing practices between two countries, Australia and Malaysia, and identify the practices that significantly influence their manufacturing performances. The results are based on data collected from surveys using a standard questionnaire in both countries. Evidence indicates that product quality & reliability is the main competitive factor for manufacturers. Maintaining a supplier rating system and regularly updating it with field failure and warranty data and make use of a product data management are found to be effective manufacturing practices. In terms of the investigated manufacturing performance, Australian manufacturers are marginally ahead of their Malaysian counterparts. However, Malaysian manufacturers came out ahead on most dimensions of advanced quality and manufacturing practices, particularly in the adoption of product data management, effective supply chains and relationships with suppliers and customers.

Keywords: **Manufacturing; Production; Quality & reliability; Australia; Malaysia**

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1. Introduction

The increasing pace of technological change and the accelerating globalisation of business have increased competition worldwide. Manufacturers are facing unprecedented levels of pressure resulting from competition from foreign products, new product introductions by competitors, rapid technological innovation and shorter product life, unanticipated customer shifts, and advances in manufacturing and information technology. Competitive advantage for many manufacturing companies now lies in their ability to effectively implement on-going product and process innovation, superior manufacturing, continual improvement of quality and reliability (Q & R) of existing products and developing a continual stream of quality new products. Market pressures have forced companies to look beyond cost and to emphasise speed, quality, agility and flexibility of their manufacturing facilities (Nahm et al., 2006, Yusuf et al., 2004).

As the importance of high quality production in establishing and maintaining a global competitive position is realized, there has been an increasing interest in manufacturing practices that lead to improved performance (Flynn et al., 1995). A large number of studies have examined the relationships between various manufacturing practices and the impact of such practices on quality performance (Anderson et al., 1995; Filippini, 1997; Flynn et al., 1995; Flynn et al., 1996; Forza and Filippini, 1998; Hendricks and Singhal, 2001; Ibusuki and Kaminski, 2007). Boston University Manufacturing Futures Group has been gathering data on manufacturing strategy practices in the United States, Western Europe, Japan and some other industrialized countries since 1981 (De Meyer et al., 1989;

Kim, 1996; Kim and Miller, 1992; Roth and Miller, 1992). Schroeder and his group is using survey data from the United States and other developed countries to determine which practices are associated with world-class manufacturing (Flynn et al., 1999; Flynn et al., 1997; Schroeder et al., 1992). Similarly, Voss of the London Business School has conducted many studies on manufacturing practices and performance in a number of European countries (Voss and Blackmon, 1996; Voss et al., 1995; Voss, 1993).

The term "world-class manufacturing" was first used by Hayes and Wheelwright (1985) to describe organizations which achieved a global competitive advantage through use of their manufacturing capabilities as a strategic weapon. They identified six critical practices, including development of the workforce, developing a technically competent management group, competing through quality, stimulating worker participation and investing in state-of-the art equipment and facilities and termed as world class manufacturing practices. Their study was based on practices implemented by successful large firms in Germany, Japan and U.S.A.

As global markets evolve, manufacturers are faced with continually changing market dynamics, new global markets and stressful competitive environments (Robinson and Malhotra, 2005; Mehra and Agrawal, 2003; Mehra and Inman, 2004). Manufacturing organizations today can no longer depend on previously proven quality practices, such as world-class manufacturing (Mehra and Agrawal, 2003). There are marked differences between "world class manufacturing practices" and those described by researchers more recently (Flynn et al., 1999). It can be seen that world-class manufacturing in its original form is no longer applicable in today's manufacturing environment. Although, many

researchers have tried to incorporate new developments in 'world class manufacturing', there is no consensus on the modifications proposed.

A review of the literature shows that the majority of the empirical work can be characterized by a narrow focus and tends to establish relationships between a few key constructs and performance (Benson et al., 1991; Bozarth and McDermott, 1998; Flynn et al., 1994, Ward et al., 1995). For example, Fynes and Burca (2005) studied the effects of the design quality on quality performance and Flynn and Flynn (2005) studied the effect of the supply chain on quality management. However, consideration of the complete manufacturing process in quality improvement has not received sufficient attention from the research community.

Despite the increasingly global environment in which many manufacturers compete, there is some evidence that cultural differences contribute to fundamentally different manufacturing strategies (Samson and Ford, 2000; Voss and Blackmon, 1998). Most of the works referenced above have been based on the experiences of manufacturing firms in the USA, Europe (western) and Japan. There is, therefore, a need for studies to be reported of the findings from other countries especially rapidly developing countries.

In this paper, attempts are made to fill gaps found in the literature. A comparative study has been conducted between Australia and Malaysia, two countries largely ignored in the literature. Some important manufacturing practices that have not been previously widely reported are investigated. The relationships between manufacturing practices and

manufacturing performance measures are presented in order to assess the effectiveness of the practices within manufacturing industries. Competitive objectives for the Australian and Malaysian manufacturers are identified and compared with that of some other countries available in the literature.

2. A general comparison of economic and manufacturing indices of Australia and Malaysia

Australia and Malaysia have almost the same size of population (around 20 million). However, in terms of the economic and manufacturing indices, there are large differences between these countries. An overview of the relative positions of the Malaysian and Australian manufacturing sectors is presented in Table 1. The structural transformation of Malaysia's economy over the last decades has been spectacular. From being the world's largest producer of rubber and tin, Malaysia is today one of the world's leading exporters of semiconductor devices, computer hard disks, audio and video products and room air-conditioners (MIDA, 2004a). Growth is driven particularly by the manufacturing and services sectors. Manufacturing is the fastest growing sector, having expanded by 9.8 per cent in 2004 (MIDA, 2004a).

[Table 1 to be inserted about here]

In Australia, too, the manufacturing industry contributes the largest share to GDP (10.8% in 2002-03) (ABS, 2005b). This was followed by the property and business services industry (10.2%). However, it can be seen from Table 1 that Australia lags Malaysia in many of the indicators of the contribution of manufacturing. Moreover the impact of manufacturing in Australia is continually falling.

3. Overview of manufacturing industries in Australia and Malaysia

Manufacturing plays a major role in the Australian economy, with levels of contribution to gross domestic product (GDP) and employment considerably exceeding other individual sectors. Yet, perhaps the most distinctive feature of manufacturing is its changing role in the Australian economy. Presently, the manufacturing sector faces competition in both the domestic and international markets. The impact of this intense competition and structural changes appear to be having negative effects on the Australian manufacturing sector. In the 1960s, manufacturing accounted for 25% of gross domestic product. By the early twenty-first century, this had diminished to 12%, and looks set to decline further (Productivity Commission, 2003). Similarly, between 1992-93 and 2002-03 manufacturing industry's share of total employment declined by 2.4% (Productivity Commission, 2003).

A substantial portion of the Australian manufacturing sector is constituted by branch plants of foreign companies (Samson and Ford, 2000). Most of the developed countries, such as USA, France, Italy, Germany, Japan, and some newly industrialised countries, like Korea and Malaysia, have their own automobile companies. However, there are no domestically owned automobile companies in Australia. The automobile companies in Australia are owned by foreign parent companies, namely GM, Ford, Toyota and Mitsubishi. Parent companies regularly review the competitiveness of their branch plants based on cost, quality and productivity and decide whether to relocate their plants to other countries. In the past, Nissan, Volkswagen, Chrysler and other foreign

manufacturers have withdrawn manufacturing facilities from Australia. In recent times, the Australian plants of Mitsubishi have come under scrutiny and the local operations were given some specific targets and a timeframe to meet them. Not only automobile companies, but branch plants of other foreign industries are always being scrutinized, and hence survival is a constant issue.

Many smaller local supplier companies have grown depending on large manufacturers owned by foreign owners. For example, in Australia there are over 200 automotive component manufacturers, around 500 small firms manufacturing parts for these component producers, and a number of other firms that provide specialist automobile services (ABS, 2005a). Although some of these parts manufacturers have adopted advanced manufacturing practices and have succeeded in not only satisfying the local automakers but also in recent times have successfully exported to Asia, Europe and the USA, many of them depend only on the demand of local automakers. Therefore, closure of any of these major automakers will have a widespread effect.

On the other hand, the structure of the Malaysian economy has achieved a remarkable change after independence in 1957. It moved from a simple agriculture-based economy to an industrial economy. The manufacturing sector has played a decisive role in Malaysia's economic success, contributing significantly to output, investment, employment, and exports. The share of the manufacturing sector in GDP jumped from 14% in 1970 to 32% in 2004 (DOS, 1976-1995; MIDA, 2005). The manufacturing sector has now become the main contributor to the Malaysian GDP and also has increased its share of employment

from 8.7% in 1970 to 29% in 2004. Another important structural change has been achieved in the export composition, where the manufacturing share has increased sharply in the last three decades.

Despite its spectacular achievements, Malaysia is facing some challenges too in the manufacturing sector. The main challenges are to improve competitiveness, quality and on time delivery (OTD) to global markets, while competing against imports from cheaper sources in the domestic market (Mahmood, 2000). Together with the manufacturing boom, labour costs have increased dramatically as the large manpower demand from manufacturing has created an acute labour shortage. Malaysia has attempted to tackle this problem by recruiting people from overseas sources. As at July 2004, there were about 1.3 million registered foreign workers, constituting 12 per cent of the total employment in the country (Business Times, 2004). Despite these efforts, manufacturing costs are continuously increasing. Having technical and marketing skills is yet another challenge for the Malaysian manufacturing sector. To stay competitive and ensure future growth, the Malaysian manufacturing sector has to move up the value chain, by producing technology-intensive goods, engaging in R&D activities, increasing product quality and improving productivity (Mahmood, 2000). Malaysia has performed well on some measures of competitiveness, but there is certainly a lot more room for improvement.

In view of increasing concerns over manufacturing practices and competitiveness, the authors have been motivated to conduct a study to understand the current manufacturing practices of Australian and Malaysian manufacturers and identify the areas for further

improvement. The reason for selecting Australia and Malaysia for this study is that they appear to offer manufacturing sectors in contrasting positions. Malaysia's growth in manufacturing, contribution of manufacturing to GDP and total exports and employment in manufacturing sector all are on an upward trend. On the other hand, the opposite picture is dominant in Australia.

Manufacturing companies that consider locating plants in particular countries consider many factors including the economic, political and business environment, as well as the workplace culture, labour cost, local practice norms and technological base, conditions and norms of manufacturing practices and the impact of these on manufacturing performance. The implications of not achieving a positive outlook in these factors are clear, namely the loss of the wealth-creating manufacturing sector to countries which do successfully implement these practices. Hence, it is worthwhile to study the comparative differences between countries in terms of the manufacturing practices and performance that exist in the two countries.

The rest of this paper is organized as follows: next research methodology and data analysis techniques adopted for this study is presented; then the results and relevant discussions are presented using a wide range of manufacturing practices and performance measures, with the aim of understanding specifically the nature of the manufacturing sectors of the two countries and identifying practices that significantly influence the manufacturing performances; finally, conclusions are drawn.

4. Research methodology

4.1 Questionnaire design and survey

The carefully designed questionnaire reported in this paper underwent rigorous evaluation by the research team. Having designed the survey form, pilot testing was conducted with two manufacturers in Melbourne, Australia. These manufacturers were selected as the University of Melbourne already had non-disclosure agreements (NDA) with them. It was thought that as these manufacturers were protected, they would provide feedback without any reservation. The testing was used to assess the questionnaire for:

- Whether the questionnaire measures what it is supposed to measure
- How easy the questionnaire is to complete and which concepts are unclear or out of the respondents' range of knowledge and responsibilities.

The piloting was carried out using face-to-face interviews mainly with managers involved in manufacturing and quality control. In one case, the quality manager, customer manager and production manager attended the meeting and in the other case the quality manager and manufacturing manager were present in the discussion. Interviews took place in the respective manufacturing facilities. The researchers sent the questionnaire (by email) to the quality managers beforehand so that they had sufficient time to read and prepare for discussion. The duration of each of the interviews was about one hour.

Based on their responses, certain modifications were made to the questionnaire. The lessons learnt from the pilot test such as the need for straightforward questions, were incorporated into the final questionnaire. The modified questionnaire was further tested by seven academics at The University of Melbourne.

The questionnaire contained two major sections. The aim of the first section was to build up a profile of the manufacturing company for later comparisons. The second part contained questions covering six major areas of manufacturing practice; namely, Competitive factors, Advanced quality practices, Supplier relationships, Quality and reliability practices, Field data and information exchange, and Product data management. The response scales varied; most were Likert scales (1-5 point scales), others were rankings, and some were requests for percentage estimates, such as product yield rate. For items measured on 1-5 Likert scales, 5 represents strongly disagree, least important or strongly deteriorated whereas 1 implies strongly agree, most important or strong improvement. As well, a 3 is represented as modest or neutral. For the performance measures, like production capacity utilisation, product yield rate, customer return rate and on time delivery, respondents were requested to mention the current level as a percentage.

The improved questionnaire was mailed to a cross-section of selected manufacturers all over Australia. A total of 1000 manufacturers were randomly selected from two databases; namely, Joint Accreditation System of Australia and New Zealand (JAS-ANZ, 2003) and Kompass Australia (Kompass, 2003). However, the authors ensured that they

were truly manufacturers, not importers. Demographic representation was also taken into consideration. Quality managers were requested to complete the questionnaire, as the task of dealing with quality and reliability issues is a quality manager's major responsibility.

In Malaysia, the questionnaire was slightly modified by one of the authors who is affiliated to the Faculty of Business Administration, University of Tun Abdurrazzak (UNITAR), to suit the Malaysian perspective. It used Malaysian Ringgit in place of Australian dollars and a different cover page and a cover letter. The modified questionnaire was sent to 500 selected manufacturers. Manufacturers were selected from a database provided by the Malaysian Industrial Development Authority (MIDA, 2004b). Because of budget and resource constraint, Malaysian study involved half the numbers of companies compared to the Australian study. Attention was again paid to ensure that the participants are truly manufacturers and to ensure demographic representation.

In Australia, among the 1000 questionnaires[1] sent, forty questionnaires were returned because the recipient had changed address or the business had closed. Some of the respondents reported that their company no longer was in manufacturing and had started importing from overseas. One hundred and sixty-five valid responses were received from the post-out with an overall response rate of 17.2%.

In Malaysia, nine questionnaires were returned undelivered. Seventy-two responses were received from the survey with an overall response rate of 14.7%. Although the response rate was lower than in Australia, it was still better than or comparable with some other

[1] a copy of the questionnaire can be obtained by emailing the corresponding author

studies such as Koch and McGrath (1996) at 6.5%, Reed at el. (2002) at 7%, McDougall et al. (1994) at 11% and Gilgeous and Gilgeous (2001) at 15.4%.

4.2 Data analyses

As the main purpose of this analysis was to compare the differences between Australian and Malaysian manufacturing practices and performances, the most appropriate statistical tool was analysis of variance (ANOVA) (Samson and Ford, 2000). Although the mean and standard deviation are the most basic tools for statistical analysis, they are inadequate for measuring statistically significant differences. Although ANOVA is generally considered suitable for continuous (dependent) variables, many studies have successfully used ANOVA for ordinal type data such as from the Likert scale (Samson and Ford, 2000; Sharma, 2003; Sohal et al., 1999; Sohal et al., 2001).

It was critical to ensure the content validity and reliability (internal consistency) of the questionnaire. Validity generally determines whether the measuring instrument is indeed measuring what it purports to measure and reliability refers to consistency (Hair Jr. et al., 1998). Content validity is a judgement, by experts, of the extent to which a question truly measures the concept it was intended to measure. Content validity cannot be determined statistically; it only can be determined by experts and by reference to the literature (Gable, 1994). It was mentioned earlier that the questionnaire was vigorously tested by several academic and industry experts. Validity of the questionnaire was thus demonstrated. The authors hypothesise that another way of justifying content validity is

the active participation of the respondents in the survey and their opinions about the content. In this study serious participation of the respondents was demonstrated by the number of additional comments provided by the respondents. The last page of the questionnaire was blank and open for additional comments. About 25% of the respondents spent time providing valuable comments and many of them were regarding the appropriateness of the survey. One respondent's comment was "we currently have a business consultant and a quality management system consultant to help us with many of the areas discussed or questions asked in this survey. We believe this is the way to better manufacturing, leading to higher customer satisfaction". Another respondent was so enthusiastic about the appropriateness of the study that he wrote, " I'd like to talk to the survey analyst to discuss the context".

Standard procedure to statistically determine the instrument reliability is the determination of Cronbach's coefficient alpha. Cronbach's coefficient alpha is the most widely used test of internal consistency (Bryman and Cramer, 1999; Flynn et al., 1995; Henry, 1998). Moreover, data reliability requires that instruments measuring the same concept should be sufficiently different from other instruments. That means, although the questions should be consistent, they should not be repetitions of the same question. The *F* test in reliability analysis is used to measure the uniqueness of the variables. Significant *F* values indicate that each of the variables employed to measure a concept is unique and not a repetition of another variable.

Reliability tests were conducted for all the variables studied as a measure of the internal consistency of the research instrument employed to measure concepts. Results of the reliability tests are presented in Table 2. A minimum α value of 0.60 for variables is indicated as identifying that the variables are internally consistent and are good measures of the concept studied (Yusuf et al., 2004). All the variables studied have significant *F* values ($p<0.05$) and all but two variables for Australia and one variable for Malaysia have α values higher than 0.6. 'Sources of field data' has an α value of 0.521 for Australia and 'Product data management' has an α value of 0.546 for Australia and 0.552 for Malaysia. They are within the range of 0.5-0.6, which is acceptable for exploratory studies (Anderson et al., 1995; Ward et al., 1998).

Results indicate that the variables studied are internally consistent and each of the variables is unique and not a repetition.

[Table 2 to be inserted about here]

5. Results and discussion

While the central interest was in the differences in strategy, practice and performance between Australian and Malaysian companies, this section begins with profiles of the companies that responded to the questionnaire. It then has discussions of a number of the key findings from the survey. The survey instrument was split into a number of sections and the results are presented here by sections. Mean values for each question are

presented with interesting features of the results being described, along with any significant differences identified between the two groups established via an ANOVA test.

5.1 Demographic characteristics of the responding organizations

An assessment was made to check the extent to which the participating organisations were similar to the population of manufacturing industry in both countries. This was done by comparing size (in terms of number of employees and annual financial turnover) and geographical locations of these participating organizations. The distribution of the size of participating companies is an important measure of their representativeness. Organizations are usually classed as small, medium and large (ABS, 1999). There is no consensus on a universal method to ascertain the size of organizations (Reynolds et al., 1989; Ratnatunga and Dixon, 1993). Usually, two indicators are taken as proxies for size; namely, the number of employees and the annual sales revenue (Reynolds et al., 1989). Both of these measures of organizational size were used in this study. For manufacturing organizations in Australia, organizations with 1-100 employees are regarded as small businesses, 101-250 employees as medium and 250 plus employees as large (Singh 2003). Hence, the three response categories in the questionnaire represented small, medium and large manufacturers, respectively. Similarly, participating organizations were categorized into three classes in terms of sales revenue. These were '<A$10M', 'A$10M-A$50M' and '>A$50M'. As no reference on the size categories of the Malaysian manufacturers was available, the same scale was used for the size of the companies for fair comparison.

The distribution of manufacturers in terms of number of employees and annual revenue for both Australia and Malaysia is presented in Table 3.

[Table 3 to be inserted about here]

The distribution of the Australian respondent manufacturers was compared with the national distribution reported by Singh (2003) to check the representative nature of the respondents. Results are also presented in Table 3 for comparison. It can be seen that results are fairly close. Because of unavailability of any reference on the size of Malaysian manufacturers, no comparison was possible but the spread of company sizes appears typical of a fast growing sector with a significant proportion of start up firms.

Geographical distributions of the Australian and Malaysian responding manufacturers were compared to the geographical distributions of Australian (ABS, 2004) and Malaysian (MIDA, 2004b) manufacturers, respectively. Results show that both Australian and Malaysian responding companies fairly represent the geographic spread of manufacturers in Australia and Malaysia, respectively.

Considering both the demographic location and size of the organizations, it can be concluded that the Australian respondents are representative of the manufacturers of Australia. As no reference was found on the size of Malaysian manufacturers, no comparison was possible. However, considering the demographic representation, it can be argued that the surveyed manufacturers represent the Malaysian manufacturing sector. The authors acknowledge the limitations in this assumption.

5.2 Comparison of manufacturing practices

5.2.1 Competitive factors

Identifying manufacturers' competitive priorities and manufacturing practices is considered a key element in manufacturing strategy research. In the present study, a list of competitive factors was prepared with the knowledge of the literature and the pilot study conducted earlier (Karim et al. 2005). The respondents were asked to rate the importance of a list of competitive factors that impact on the competitive advantage of their company on a Likert scale ranging from 1 for strong agreement to 5 for strong disagreement.

The results are summarised in Table 4. Australia ranked company reputation as the number one competitive factor and product Q & R as number two. However, mean scores of these two factors are close (1.48 and 1.54 respectively). A cross tabulation in SPSS shows that these two factors are highly related. A chi square value of 45 and significance value of 0.000 strongly supports the complete dependency of these two factors. On the other hand Malaysia ranked product Q & R as the number one competitive factor and company reputation as number two. The difference for company reputation in mean scores between these two countries is minimal and statistically insignificant. However, the difference of emphasis on product Q & R is statistically significant. Malaysian manufacturers placed significantly greater importance on product Q & R compared to their Australian counterparts.

Malaysian manufacturers also put significantly more importance on marketing compared to Australian manufacturers. Although price is still an important factor (2.14 & 1.84 < 3 (neutral)) for manufacturers in both countries, its position in rank order is number 5 and 4 for Australian and Malaysian manufacturers, respectively. Malaysia put significantly (F-sig.= 0.02) more importance on price compared to Australia. It is understandable, as Malaysia is a newly emerging industrial country (Mahmood, 2000) and has to compete harder in the international market, it put significantly more (compared to Australia) emphasis on marketing and price. Australian manufacturers put heavy emphasise on design and manufacturing capability. It can be concluded that compared to Australian manufacturers Malaysian companies put significantly more importance on product Q & R, marketing and price.

[Table 4 to be inserted about here]

To place the results for Australia and Malaysia in a wider international context, a comparison was made with results from the world's leading industrialised countries. In Table 5, the top five competitive objectives of Australian and Malaysian companies are compared with the US, Europe, and Japan as reported by Kim (1996). In Kim's study quality and reliability were considered as separate factors but in this study these two were considered as one factor as these are now closely interrelated. It can be seen that other than Japan, all countries placed product quality and reliability on top of the competitive priority list (although Australia put company reputation on top, it was shown earlier that this is highly correlated with product Q & R). Japanese manufacturers believe that they have attained sufficient level of product quality and now they emphasise cost reduction

(ASQ, 2006). However, product reliability still is the 2nd most important competitive factor for Japan.

The authors acknowledge the limitation of comparing with Kim's findings as that study was conducted in 1996. However, Kim's previous 3 studies (in 1990. 1992, 1994) also showed that product reliability and conformance quality were the two top competitive factors for USA manufacturers (Kim, 1996). A recent study (Adam et al., 2001) also reported that the main competitive factor for US manufacturers is quality. Kayis and Kara (2005) have suggested that competition for quality will continue to increase worldwide.

As most of the leading manufacturers consider product Q & R as the main competitive factor, it can be concluded that the companies must produce high quality product in order to capture a market share in the competitive market.

[Table 5 to be inserted about here]

It is interesting that the importance of product Q & R and price given by Malaysian manufacturers is the same as that of US and European firms yet on time delivery (OTD) is not in the top five factors for Malaysia unlike these other countries. However, a mean value 2.00 indicates it is still an important factor for Malaysia manufacturers. It can also be seen that both Australia and Malaysia put similar emphasis (mean values of 2.01 and 2.00, respectively) on OTD and there is no significant differences ($p=0.925$) between the two countries.

5.2.2 Advanced quality practices

The respondents were requested to show the level of agreement to the advanced quality practices listed in Table 6 on a scale between 1 and 5. It can be seen that mean values for all these practices are well below 2.5. This shows that most companies in both countries employ quality practices suggested in the questionnaire. The pattern of emphasis is generally the same for both countries. Companies placed strong emphasis on practices like awareness of customer requirements, emphasis on quality during design, systematic review of contracts and Q & R estimation during design. Statistically significant differences in emphasis between the two countries exist in Q & R estimation, awareness of design team about manufacturing capability and limitations and awareness of customer requirements with Malaysians placing greater importance on each of these practices than their Australian counterparts.

[Table 6 to be inserted about here]

5.2.3 Supplier relationships

Effective supplier relationships have a great importance in modern manufacturing. Suppliers know more about the supplied components than the manufacturers {Jammernegg, 2007 #730} {Luo, 2007 #731}. They have valuable information for product quality improvement purposes. Effective supplier relationships are essential to reduce the procurement lead-time for components and eventually to ensure timely delivery of manufactured products.

As reflected in Table 7, Malaysian manufacturers appear to have more effective relationships with their suppliers. They have significantly outperformed Australian manufacturers in some of what are regarded as good supply chain practices by using a supplier rating system, updating the rating system using field and warranty data and sharing information with suppliers. They have lower incidences of abandoning their suppliers on quality ground. They have significantly better control of incoming parts as well. It is hypothesised that these practices helped them have better relationships with suppliers and resulted in significantly lower incidences of severing relationships with suppliers on the grounds of poor quality of delivered goods.

[Table 7 to be inserted about here]

5.2.4 Evaluation of suppliers

The respondents were requested to express the level of agreement to the criteria of selecting and evaluating component suppliers. Table 8 shows the comparative results. Malaysian manufacturers ranked price as the main criterion and then product Q & R as the second. Australian manufacturer ranked product Q & R as the number one criterion and capability to supply according to demand as second closely followed by delivery time. However, preference for using product Q & R and delivery time as selection criterion by the Australian firms is not significantly different from their Malaysian counterparts. But preference for price as a criterion by Malaysian companies is significantly higher than by Australian manufacturers. It seems that Malaysian manufacturers try to reduce product cost by sourcing components with a balance between

price and quality. On average, manufacturers in both countries place a much lower importance on the reputation of the supplier than any of the other listed criteria.

It is interesting that manufacturers consider their own company reputation as an important competitive factor but they consider their supplier's reputation as the least important factor for selection. To clarify this, the authors discussed this issue with a few respondents. The manufacturers indicated that many of the components suppliers are not the manufacturer of the components, rather traders. They source the components from different sources (including foreign suppliers) and the manufacturers may not even have any contact with component manufacturers. Because of these factors, company reputation is not considered as an important criterion as others.

[Table 8 to be inserted about here]

To explore the relationship between supplier evaluation method (Table 8) and use/update of supplier rating system (SR) (Table 7), ANOVA was carried out between users and non-users of supplier rating systems and between updaters and non-updaters of their rating systems for both Malaysia and Australia. The results are presented in Tables 9 and 10, respectively.

[Table 9 to be inserted about here]

[Table 10 to be inserted about here]

As can be seen in Table 9, Australian manufacturers who have a supplier rating system ranked Q & R as their number one criterion for their suppliers whereas the manufacturers who do not have a supplier rating system ranked price as the number one criterion. Companies with SR also placed more emphasis on company reputation, delivery time and suppliers' capability to meet demand compared to the companies without SR. That means the companies with SR are not only conscious of the quality of the incoming components but also take into account the suppliers' performance history (reputation), capability to deliver on time and volume flexibility of the suppliers in selecting suppliers. This is in line with the manufacturers' own competitive objectives shown in section 5.2.1.

Similar trend to the above was found for updaters of supplier rating systems (Table 10). The companies who update their SR place more emphasis on product Q & R and the companies who have a supplier rating system but do not update regularly place more emphasis on price than any other criteria. It is interesting that companies who do not have a SR and companies who have a SR but do not regularly update it show the similar trends. It can be hypothesised that the SR should be regularly updated otherwise there will be hardly any difference between having and not having such a system.

Statistically highly significant differences were observed in product Q & R and capability to supply according to demand between users and non-users of SR and in product Q & R, capability to supply according to demand and delivery time between updaters and non-updaters of SR. It seems that companies mainly use product Q & R and capability to supply according to demand in forming a supplier rating system and during updating

delivery time is also significantly taken into consideration. It can be an important message to the component suppliers that they have to ensure their product Q & R, should be able to deliver according to demand and must ensure on time delivery to remain on the manufacturer's priority list.

In Malaysia, too, except for company reputation, users of SR have placed more emphasis on all the criteria compared to the non-users of SR. However, both users and non-users of SR consider price as the main criterion. The companies who regularly update SR place more emphasis on Q & R compared to the non-updaters. On the other hand non-updaters of the SR place higher emphasis on price compared to the updaters. However differences were not statistically significant. In fact most of the Malaysian manufacturers (89%) systematically practise supplier ratings. So the proportion of non-users is not significant. This could be one of the reasons for not finding any statistically significant difference between practices of users and non-users of SR. A similar conclusion is applicable for updaters and non-updaters of SR.

To investigate how the supplier rating system benefited the manufacturers, an ANOVA was carried out for manufacturing performances between the two groups. The results are presented in Table 11. Here all the manufacturers from two countries were considered together.

[Table 11 to be inserted about here]

It can be seen that manufacturers who practice SR outperformed the non-users of SR in all the performance indicators studied. The users of SR have significantly improved their product quality, performed significantly better on OTD and received significantly fewer number of faulty products from the customers. They also have better product yield rates. Similar results were obtained for updaters and non-updaters of SR.

5.2.5 Manufacturing and Q & R practices

Comparison of the adoption of manufacturing and Q & R practices by the manufacturers in the two countries is presented in Table 12. In quality and reliability practices, Malaysian manufacturers place significantly more emphasis on prediction of possible manufacturing difficulties and product failure causes, awareness of the manufacturing people about the quality and reliability targets of a product and recording test results and failure data for future use. They use statistical process control (SPC) more intensely than Australian manufacturers. Although both countries scored almost the same for 'product inspection and test are done as part of quality control', Malaysian manufacturers are more motivated to keep these records not only to satisfy their customers but for future use.

On the other hand Australian manufacturers practice failure mode and effect analysis (FMEA) marginally more than their Malaysian counterpart although the difference is not statistically significant. However, Australian manufacturers are reluctant to involve customers and suppliers in FMEA. It could be deemed contradictory here as Malaysian firms, compared to Australian firms, scored lower (higher practice) in analysis of potential failure causes but scored higher (lower practice) in FMEA. In fact potential

failure analysis or predicting failure need not necessarily be in FMEA form. Moreover, FMEA is more related to automobile industries (Dale and Shaw, 1991) and automotive is one of the major industries in Australia (ABS, 2005a).

[Table 12 to be inserted about here]

The results show that Australian manufacturers are more systematic in estimating product reliability. They take into account consideration of handling, storage, packaging and delivery methods more seriously than Malaysian counterparts in estimating product quality. Moreover, they are significantly more careful about the calibration of their test equipment.

Results show that Australian manufacturers face more difficulties with 'no fault found' ('Often customer returned goods are tested and found good') compared to their Malaysian counterparts. The literature reports that differences in test/use methods are the main reasons for 'no fault found' problem. Because of this mismatch, a customer may find a product 'faulty' but manufacturer's test may find it good (no fault found). Malaysian manufacturers have significantly less problem in this regard. In other words, there are fewer mismatches in test/use methods between manufacturers and customers. Related to this may be the lower score of Australian manufacturers on 'If found good, customer returned goods are sent back to the customer'. It was demonstrated earlier that Australian manufacturers have less effective relationships with suppliers. The literature reported that one of the main reasons for mismatch in use/test methods is inadequate communication between customer and manufacturer (Brombacher, 1996). Results

indicate that Malaysian manufacturers have more effective communication and relationships with customers and suppliers whereas Australian manufacturers are wedded to traditional relationships.

5.2.6 Reason for failure analysis

Respondents were asked why they practice failure analysis such as FMEA. The comparative results are shown in Table 13. It can be seen that manufacturers of both countries placed customer satisfaction as the number one reason for using FMEA. This is a significant shift in the attitudes of the manufacturers from earlier studies. Dale and Shaw (1991) reported that the main reason for practicing FMEA was contractual requirements from customers. Malaysian manufacturers place significantly higher importance on customer satisfaction. A clear distinction can be drawn between Australian and Malaysian manufacturers in terms of 'mandatory requirement of customer' and 'improve product quality'. Australian manufacturers placed 'improvement of product quality' as the 2nd most important reason for practicing FMEA, whereas Malaysian manufacturers consider it as the least important factor. On the other hand Malaysia placed 'mandatory requirement of customer' as the 2nd most important factor but Australian manufacturers placed it at number 6. As well, Australian manufacturers do not consider 'on time delivery' a factor for practicing FMEA (score 2.62>2.5). These differences are statistically significant. A general conclusion from these results could be that the failure analysis of Malaysian manufacturers is mainly driven by the requirements of the customers whereas the Australian manufacturers' intention to perform failure

analysis is to improve product quality. For Malaysian firms other important reasons (compared to their Australian counterparts) for performing failure analysis are process improvement ($p<0.05$) and improvement in on time delivery ($p<0.05$).

[Table 13 to be inserted about here]

5.2.7 Field data and information exchange

ANOVA results for 'Field data and information exchange' are presented in Table 14. In general, practices related to field data and information exchange were found to be similar across the two nations. The only significant difference was the mismatch between testing procedures at customer sites and at the manufacturer's. Malaysian companies reported that that there were fewer mismatches. More Australian companies appear to encourage customers to provide feedback, measure customer satisfaction and have channels to collect field performance data; however, these are not statistically significant distinctions. Also they do not appear to have led to more effective communications with customers.

[Table 14 to be inserted about here]

5.2.8 Product data management

As shown in Table 15, Malaysian manufacturers are significantly more likely to use a product data management (PDM) system and automatic collection of manufacturing information. As a consequence, Malaysian manufacturers have reported large data bases compared to Australia. The manufacturing process is complex and multi-faceted, requiring substantial amounts of information to combat uncertainty and equivocality (Koufteros and Marcoulides, 2006). The literature reports that modern manufacturing is

abundant with manufacturing and quality data and this data is difficult to analyse manually (Russ et al., 2005, Karim et al., 2006). Malaysian manufacturers agree on this fact significantly more than their Australian counterparts.

[Table 15 to be inserted about here]

The respondents were asked about the data they record as part of their PDM system. It should be mentioned here that only the manufacturers who adopted a PDM system are considered for the analysis reported in this section. ANOVA results are shown in Table 16. In all but one of the areas Malaysia scored lower (companies more likely to use data source) and other than 'corrective action report', 'failure data from testing, production and field', 'number of failures in functional test' and 'the fraction of customer complaints within the warranty period' all differences are statistically significant and in favour of Malaysia. This is relevant to the results presented in Table 15. Australia only outperformed Malaysia in corrective action reports and this is not statistically significant. This is also consistent with results presented earlier.

[Table 16 to be inserted about here]

5.3 Manufacturing Performance

Respondents were asked whether the quality level of their manufactured products had improved over the previous 2 years. They were also requested to mention the degree of improvement they had made. Figure 1 shows the results. All Malaysian respondents reported that they managed to make at least some improvement in product quality.

However fewer (32%) of them managed to record strong improvement in quality compared to the Australian companies (37%). About 11% of Australian firms reported that they did not make any progress in quality.

[Figure 1 to be inserted about here]

Table 17 presents the comparison of the manufacturing performance of Australian and Malaysian manufacturers. Malaysian companies reported 82% of their manufacturing capacity utilized compared to 76% for Australian manufacturers. The product yield level of Australian processes is higher than Malaysian processes. The Australians have an average product yield of 89% compared to 87% for Malaysian manufacturers. In terms of return of faulty products Australian manufacturers have lower returns (2%) compared to their Malaysian counterparts (3.5%) and this is statistically different. On OTD, both countries have almost the same level of performance.

Although manufacturers in Malaysia have lower product yields and higher customer return rates, all the manufacturers continually improving their product quality (Figure 1). It is hypothesized that their adoption of advanced quality and manufacturing practices helped them to manage continuous improvement. However, they are sourcing cheaper components probably because of price pressure. It is thought that cheaper components slowed the pace of continuous improvement.

[Table 17 to be inserted about here]

6. Conclusions and future research

The present study was undertaken to investigate the current manufacturing practices adopted by Australian and Malaysian manufacturers and their effectiveness. Results suggest that product price has become a relatively less important factor for both Australian and Malaysian manufacturers today and product quality & reliability has emerged as the main competitive factor. In fact, the world market has become a battleground for quality & reliability.

FMEA was developed as a systematic and analytical quality planning tool for identifying potential failures at the product and process design stages. This study has revealed that FMEA has extended its scope from the initial objective. The manufacturers surveyed in both countries consider customer satisfaction as the number one reason for performing FMEA. Use of a supplier rating system is found to be a very effective method. The users of SR have significantly better performance in quality improvement, OTD, product yield and field return of faulty products compared to non-users of SR. A supplier rating system helps manufacturers in sourcing quality components and eventually producing quality products. However, it is necessary to regularly update the supplier rating systems with filed and warranty data to get maximum benefit from it.

Newly emerging industrialized Malaysia appears to be significantly ahead of Australia on many facets of advanced quality and manufacturing practices. Malaysian manufacturers place significantly more emphasis on practicing advanced quality practices compared to

their Australian counterparts. They also outperformed Australian manufacturers in effective manufacturing practices like prediction of possible manufacturing difficulties and product failure causes, awareness of the manufacturing people about Q & R target of a product, preserve and use of production, test and field failure data, use of SPC etc. Malaysian manufacturers also appear to have more effective relationships with their suppliers.

Although Malaysia is still lagging behind Australia in manufacturing performance, they are likely to outperform Australia if Australia remains with the current state of manufacturing practices. However, it appears that they are emphasizing more price than quality of the components they use. Probably together with quality requirement, they are under price pressure as well and they try to satisfy that by sourcing cheaper components. Quality components are essential to ensure a quality product. With cheaper components (probably not with best quality) it will be hard to achieve significant product quality improvement. Moreover, they are lagging in using FMEA, a systematic quality improvement tool. It is thought that because of these reasons, the pace of continuous improvement may slow.

While this study focuses on Australian and Malaysian manufacturing industries, the observations are relevant, if not directly applicable, to other countries as well, since the basic manufacturing and Q & R problems are generic. In particular, apparent links between performance and adoption of certain practices will hold globally.

The findings of this study have implications for a number of groups with vested interests in the field of manufacturing practices. These include practicing managers, policymakers and researchers. Major implications are described below. Implications for researchers will be discussed in the context of future research possibilities.

Identifying competitive priorities is an important step in operations management. Porter suggests that every organisation must determine its competitive priorities first because a single firm cannot do well in all competitive dimensions (Porter 1985). This study has identified that product quality & reliability is the main competitive factor in the global market. Under the changing circumstances, the organization must deliver a reliable product to ensure customer satisfaction. Organisations can build competitive advantage through superior manufacturing, but sustaining the competitive advantage over time requires comparable skills in continual improvement of Q & R of existing product and developing a continual stream of quality new products. Hence, long-term competitiveness is increasingly dependent on how well a company can continuously improve its product Q & R by fostering organizational learning, manufacturing strategies and utilising individual and group knowledge within and outside the company.

Policymakers in Australia commonly blame production cost due to high wages as the main reason behind Australia's decreasing manufacturing sector. However, the practical situation appears completely different. Manufacturers think that price is not as an important factor as others as long as product quality is ensured. Moreover, because of manufacturing automation product costs due to wages is becoming insignificant. Many countries in the world have higher labour cost than Australia but have dominant

manufacturing sectors (Japan for example). This is a significant feedback for the policymakers in Australia and other developed countries. They have to design policies to minimize the manufacturing drawbacks found in this study and to change the manufacturing culture. For example, it is found that manufacturer-supplier relationships are not effective probably because of lack of trust. Policy makers may work on how to change this traditional manufacturing culture.

On the other hand, Malaysian manufacturers consider price as the primary factor in selecting component supplier although main competitive objective of the manufacturers is product quality & reliability. There are several drawbacks in following this policy. Suppliers selected through the competitive bidding process have no incentive to improve the quality once a contract has been awarded (Manoochehri, 1985). Selection of suppliers based on high quality rather than cost encourages the provision of high quality components. Therefore, suggestion for Malaysian manufacturing managers is to change their policy and emphasise quality in selection component suppliers for the benefit of long-term competitiveness.

The results of this study open opportunities for future studies in some of the areas described below:

- Further studies can be conducted to investigate the reasons for price becoming a relatively less important factor. Not many studies have looked into this matter. Moreover, 'price' also should be precisely defined. It should be investigated whether manufacturers consider price as only the sales or purchase price and

whether they take into account transportation costs, quality costs, inventory costs etc.

- Future research can study the reasons why some manufacturers seem wedded to traditional supplier relationships and recommend ways to move towards a relationship with suppliers characterized by interdependence and cooperation.

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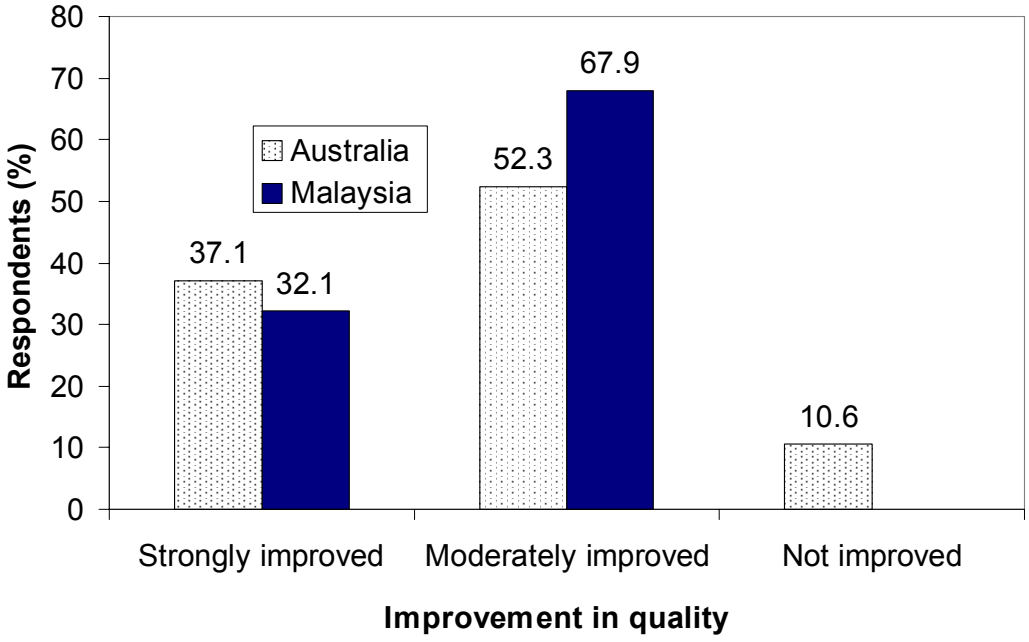

Figure 1: Improvement in quality; comparison between Australia and Malaysia

Table 1: Comparison of economic and manufacturing indices of Australia and Malaysia (ABS, 2004; ABS, 2005b; Productivity Commission, 2003; MIDA, 2004a; MIDA, 2005).

	Australia	Malaysia
GDP [2003]	US$522.4 billion	US$103.7 billion
Per capita income [2003]	US$21,950	US$4,235
Unemployment [2004]	5.9%	3.4%
Inflation rate [2004]	3%	1.4%
Export/Import [2003]	0.91	1.06
Annual GDP growth [2004]	3.7%	7.1%
Contribution of manufacturing to GDP	10.8% [2003]	31.6% [2004]
Contribution of manufacturing to exports	31% [2003]	78.4% [2004]
Contribution of manufacturing to total employment	11.9% [2003]	29% [2004]
Growth of manufacturing sector	0.3% [2003]	9.8% [2004]

Table 2: Reliability of constructs used in the survey

	Australia			**Malaysia**		
	α	**F**	**p**	**α**	**F**	**p**
Competitive factors	0.621	32.62	0.000	0.637	11.43	0.000
Advanced quality practices	0.791	9.98	0.000	0.754	5.13	0.000
Supplier relationship	0.888	11.43	0.000	0.767	6.60	0.000
Supplier evaluation	0.639	34.32	0.000	0.756	25.69	0.000
Q & R practices	0.838	56.23	0.000	0.851	34.48	0.000
Reason for failure analysis	0.832	17.55	0.000	0.749	14.87	0.000
Field data and information exchange	0.877	20.78	0.000	0.89	6.27	0.000
Sources of field data	0.521	41.33	0.000	0.678	4.75	0.001
Product data management	0.546	20.84	0.000	0.552	11.17	0.000
Data recorded in PDM	0.886	20.31	0.000	0.855	9.20	0.000

Table 3: Distribution of Australian and Malaysian manufacturers (according to size)

Question	Elements	Australia		Malaysia (present study) (%)
		Present study (%)	Singh study (%)	
No. of employee	1-100	75	77.1	52.8
	101-250	14.4	14.5	13.9
	250+	10.6	8.4	33.3
Annual Revenue	Less than10M	49.4	53.8	60.7
	10-50M	33.3	35.9	21.4
	More than 50M	17.3	10.3	17.9

Table 4: Means and ANOVA significance for competitive factors

	Australia	Malaysia	F Sig.
Marketing	2.30	1.76	.000
Company reputation	1.48	1.46	.760
Product quality and reliability	1.54	1.32	.014
Design and manufacturing capability	1.78	1.97	.100
On time delivery	2.01	2.00	.925
Price	2.14	1.83	.020

Table 5: Comparison of competitive priorities (degree of importance)

	US	Europe	Japan	Australia	Malaysia
1	Conformance quality	Conformance quality	Low price	Company reputation	Product Q & R
2	Product reliability	Product reliability	Product reliability	Product Q & R	Company reputation
3	On-time delivery	On-time delivery	On-time delivery	Design and manufacturing capability	Marketing
4	Low price	Low price	Fast delivery	On time delivery	Price
5	Fast delivery	Fast delivery	New products speed	Price	Design and manufacturing capability

Table 6: Means and ANOVA significance for advanced quality practices

	Australia	Malaysia	F Sig.
Emphasis to quality during design	1.79	1.75	.76
Q & R estimation during design	1.99	1.74	.05
Awareness of customer requirements and priorities	1.66	1.39	.00
Systematic review of contract	1.95	1.63	.01
Awareness of design team about man. capability and difficulty	2.00	1.85	.04
Effective communication during design of a new product	2.14	2.02	.28
Use of field failure and manufacturing data during design	2.11	1.88	.38

Table 7: Means and ANOVA significance for supplier relationship

	Aust	M'sia	F Sig.
Inspection of incoming parts and record of results	2.22	1.67	.000
There is a supplier rating system in use	2.19	1.88	.032
This supplier rating system is updated	2.43	2.17	.081
Field and warranty data is used to update the supplier rating	2.57	2.09	.001
Suppliers share information to improve their product quality	2.62	2.26	.010
Organisation benefits from the feedback from suppliers	2.30	2.26	.771
Organisation uses supplier feedback in its new designs	2.44	2.20	.081
Organisation abandoned suppliers because of failure to improve quality	2.07	2.48	.002
Awareness of the quality level of incoming parts	2.00	1.84	.146

Table 8: Means and ANOVA significance for supplier evaluation

	Australia	Malaysia	F Sig.
Product quality and reliability	1.58	1.43	.093
Price	1.84	1.33	.000
Company reputation	2.35	2.42	.151
Delivery time	1.75	1.55	.069
Capability to supply according to your demand	1.70	1.47	.021

Table 9: ANOVA test of differences between user and non-user of supplier rating system

	Product quality and reliability		Price		Company reputation		Delivery time		Capability to supply according to demand	
User/non-user of SR	User	Non-user	User	Non-user	User	Non-user	User	Non-user	User	Non-user
Australia	1.45	1.85	1.86	1.83	2.34	2.39	1.68	1.89	1.61	1.89
Sig.	0		0.83		0.729		0.112		0.029	
Malaysia	1.37	1.75	1.29	1.5	2.05	2	1.51	1.88	1.46	1.63
Sig.	0.071		0.316		0.821		0.154		0.408	

Table 10: ANOVA test of differences between updater and non-updater of supplier rating system

	Product quality and reliability		Price		Company reputation		Delivery time		Capability to supply according to demand	
Updater/ Non-updater	Updater	Non updater	Updater	Non updater	Updater	Non updater	Updater	Non updater	Updater	Non updater
Australia	1.38	1.86	1.88	1.81	2.33	2.36	1.63	1.94	1.55	1.92
Sig.	0		0.601		0.793		0.011		0.002	
Malaysia	1.4	1.53	1.38	1.21	2.02	2	1.63	1.37	1.53	1.33
Sig.	0.424		0.286		0.905		0.166		0.155	

Table 11: ANOVA test of differences in manufacturing performances between user and non-user of supplier rating system (Scale for quality improvement 1= strong improvement, 3= neutral, 5= strong deterioration)

	Use SR	Do not use SR	Sig.
Improvement in quality in previous 2 years	1.7	2.0	0.054
Production yield rate (%)	90.7	88.6	0.429
Customer return rate of faulty product (%)	2.8	4.2	0.024
On time delivery (OTD) (%)	86.7	76.8	0.005

Table 12: Means and ANOVA significance for Q & R practices

	Aust	M'sia	F Sig.
Have a programme to assess and monitor the Q & R of products	1.87	1.81	.590
Have a written quality policy	1.60	1.53	.511
Careful review of customer requirements	1.79	1.72	.559
Analysis of potential manufacturing difficulties and failure causes	2.14	1.82	.015
Awareness of the manufacturing people about quality and reliability target of a product	1.88	1.65	.035
Review and milestone meetings are held	2.29	2.33	.779
The organisation uses FMEA	2.78	2.81	.847
Customers and/or suppliers are involved in FMEA	3.12	2.83	.068
Use of SPC by the organisations	2.97	2.51	.007
Product inspection and test are done as part of quality control.	1.63	1.67	.619
Results of the above tests are recorded	1.81	1.47	.005
Record kept of personal experiences in manufacturing and quality control	2.50	2.28	.113
Often customer returned goods are tested and found good	2.57	3.39	.000
If found good, customer return goods are sent back to the customer	2.38	2.88	.001
Consider handling, storage, packaging and delivery methods in estimating reliability of product	2.04	2.85	.000
Calibration of equipment used	1.54	1.82	.006

Table 13: Means and ANOVA significance for reason for failure analysis

	Australia	Malaysia	F Sig.
Mandatory requirement from customer	2.19	1.43	0.002
Improve product quality	1.81	2.36	0.005
Improve customer satisfaction	1.79	1.28	0.003
Process improvement	1.92	1.52	0.037
Reduce the number of product recalls	2.13	2.08	0.821
Reduce warranty claims	2.11	1.96	0.541
Improve 'on time delivery'	2.62	1.83	0.007

Table 14: Means and ANOVA significance for field data and information exchange

	Aust	M'sia	F Sig.
Field failure and/or warranty claim data is collected and recorded	1.86	1.78	.472
The database is regularly updated	2.06	1.85	.105
Customers are encouraged to provide feedback	1.78	1.94	.076
Customer feedback is valuable in improving the product quality	1.65	1.68	.749
Organisation measures the customer satisfaction	1.96	1.99	.834
Field data is required to accurately predict the product reliability	2.28	2.23	.705
There is an established channel to collect field and /or warranty claim data	2.10	2.28	.173
Design and quality control people have access to this database	2.14	1.94	.129
The communication system between customers and suppliers is effective	2.16	1.99	.137
Test procedure of the company and the customer is same	2.61	2.21	.004

Table 15: Means and ANOVA significance for product data management

	Aust	M'sia	F Sig.
Use a product data management (PDM) system	2.87	2.51	.032
There is an automatic data collection system	3.00	2.41	.001
Volume of database is huge and difficult to analyse manually	3.44	2.76	.000

Table 16: Means and ANOVA significance for data records

	Aust	**M'sia**	**F Sig.**
Customer specification requirements	1.85	1.45	.023
Production reports	1.98	1.61	.025
Corrective action reports	1.69	1.73	.790
Milestone meeting minutes	2.31	1.91	.045
Results of FMEA	2.52	1.97	.011
Results of Reliability tests	2.46	1.85	.003
Failure data from testing, production and field	2.08	1.97	.519
Machine variables used during production	2.73	2.12	.004
Number of failures in functional test	2.37	2.03	.097
The fraction of customer complaints within the warranty period	2.29	1.94	.084

Table 17: Comparison of manufacturing performance between Australia and Malaysia

	Australia	Malaysia	Sig.
Product capacity utilisation	76.16	82.26	0.112
Production yield rate	89.29	87.28	.195
Customer return rate	2.12	3.42	.000
On time delivery (OTD)	84.23	84.98	.756