CHAPTER 5

EXECUTIVE SUMMARY

This chapter of the study is segmented into two broad heads. The first head highlights the major findings of descriptive statistics and the second head throws a light on the major findings of statistical analysis.

5.1 FINDINGS OF DESCRIPTIVE STATISTICS

1) There has been a marked increase in the awareness of the term World Class Manufacturing (WCM) to an almost universal level over the last 5 years. It was evident from the study that all the manufacturers located in and around Chennai are aware of World Class Manufacturing System (WCMS) and are found to have implemented at least any one of WCM practices, principles and techniques at least one year ago (Table A 3.7).

2) Those respondents who had heard of the term WCM were asked to give a brief description of what they understood it to mean. All respondents were able to give a good explanation of what they felt WCM was, with the majority (more than 7 out of 10 manufacturing companies) linking it to ‘Product quality is of paramount importance’, ‘Having a culture of continuous improvement throughout the whole company’, ‘Improving efficiency and productivity of the organization’, ‘Responding quickly to the changing needs of the customers’, ‘Empowering employees to be involved and take responsibility’ and ‘Following lean manufacturing principles’ (Table 4.1).
3) Table A 3.8 shows increased confidence and optimism among manufacturers in their attitudes to WCM and their ability to achieve the world class status. 41.6% of respondents intend to achieve world class manufacturing within a year or two, which may be ambitious over the period. 21.6% believe that WCM is great in principle but very difficult to achieve it in practice. A massive two out of ten manufacturing companies felt that WCM was a realistic goal that they aim to achieve in the long term. 13.6% of respondents regarded it as being nothing more than jargon, with no real substance to it and 3.2 per cent didn’t know enough to comment about WCM principles.

4) The survey brought out that ‘improving quality’ with the highest mean score of 4.10 was the most widespread current key business activity identified in manufacturing firms taking part in the survey. Linked to this, ‘new product development’ with the mean score of 3.68 and ‘optimizing materials flow around the factory’ with the mean score of 3.44 have claimed second and third position respectively, in terms of their importance in the world class journey. Investment in new technology solutions (mean=1.96) is a low priority, but this seems to be for financial reasons rather than need (Table 4.2).

5) Regarding the lean initiatives considered to be a key focus in the journey towards becoming world class, the ‘kaizen’ with a mean response of 4.26 was observed to be the most significant and widespread key lean initiative at present implemented by manufacturing firms in Chennai to achieve competitive edge in their business operations. Linked to this, ‘removal of wasteful processes’ (mean = 3.91) and ‘kanban’ (mean = 3.62) were also found to be the most significant key lean practices of the Chennai manufacturers (Table 4.3).
6) Definitions of lean are very detailed highlighting the increased knowledge of the topic within the manufacturing sector. All respondents were able to give a good explanation of what they felt lean was, with the majority (more than 6 out of 10 companies taking part in the survey) linking it to the ‘improved efficiency and process’, ‘removal of waste’, ‘reduced costs’, ‘reduction in non-value added processes’ and ‘lead time reduction’. Significantly, although ‘inventory reduction’ and ‘workforce reduction’ are often thought to be a consequence of efficiency initiatives, less than a half of respondents linked them to lean manufacturing. (Table A 3.9).

7) It is perhaps surprising to see a significant 17.6 per cent of respondents claiming to have achieved lean manufacturing already and 23.2 per cent believe they are very close to being lean. While a quarter (25.6 per cent) think they are quite close to being lean, a respectable 20.0 per cent, however, are not afraid to admit that they are a long way off. A little more realism here, with only 13.6 % admitted they would never be lean (Table A 3.10).

8) Quality is clearly high on most agendas and quality management in general is well developed throughout manufacturing. There has been a significant move towards the achievement of official certification of quality. More than half of respondents (59.2%) have achieved and strive to improve ISO standards and certificates and a further nearly one quarter (24.8%) use a combination of own assessment and ISO certification. Surprisingly, only 8% are working towards attaining ISO certification and nearly 5% have no quality management strategy. Accordingly, a very small minority (3.2%) have own assessment audits (Table A 3.11).
9) Regarding the extent of implementation of TQM Principles by manufacturers in their journey towards excellence, ‘Customer focus’ is still at the top of the agenda for most manufacturers, with a highest mean response of 3.82. Followed by, ‘management commitment’ came second with a mean of 3.72, ‘continuous process improvement’ came third (mean=3.54) and ‘training and education’ and ‘empowerment and teamwork’ were the fourth (mean=3.52) and fifth (mean=3.40) currently focused TQM Principles by the manufacturing companies (Table 4.4).

10) Almost a quarter of manufacturers (24.8%) who responded said they need to buy some new IT applications which will assist them in the journey of world class. Nearly 22% felt they had everything they needed already, almost 21% have felt that they needed better integration of what they had and 19.2% needed to upgrade their existing IT systems. A smaller proportion (nearly 14%) felt they had to rip everything and start all over again (Table A 3.12).

11) It was clear from the study that the ‘design systems (e.g., CAD, CAE)’ was considered to be the most powerful IT system/application currently implemented by the manufacturers with a highest mean value of 3.98. Followed by, MRP (mean=3.90), ERP (mean=3.63), FMS (mean=3.62), and EDI (mean=3.14) were considered to be the key IT Systems/Applications by manufacturing firms in Chennai to implement WCM principles and techniques effectively. It is also interesting to note that most companies appear somewhat disenchanted with the new IT applications. Demand planning/forecasting systems (e.g., APS), Product Lifecycle Management (PLM) and Manufacturing Execution Systems (MES), admittedly a relatively new application, had the lowest take up of any of the IT applications with the mean response of less than 2.50 (Table 4.5).
12) Overall Equipment Effectiveness (OEE) is widely used in world class companies to measure the performance of a single piece of equipment or an entire factory as a combined percentage of three factors: availability, performance rate and output quality. In our study, the respondents were requested to indicate their level of agreement with the eight maintenance practices currently focused by the manufacturers. Of these maintenance activities, the practice of ‘keeping the equipment at its highest productive level by maintenance crew’ was rated top (mean=3.79) among key maintenance practices to be focused by manufacturing firms in Chennai for improving their equipment effectiveness and maintenance. Furthermore, Total Productive Maintenance (TPM) was found to be one among the top agenda with a mean response of 3.03 as a company’s approach to maintenance for improving equipment effectiveness and productivity (Table 4.6).

13) Nearly 27.2 % of respondents report that at best some of their supply chain partners are well down the road in the active pursuit of WCM principles, 21.6 % have reported that most of their suppliers had stated looking into the active pursuit of world class manufacturing principles, but are not very far down the road. 19.2 % have said that few of their suppliers are looking into it. 12% knew that most of their suppliers had done nothing at all in this respect. Surprisingly, 10.4% were able to say that most of their supply chain partners are advanced in this respect. Worryingly, 9.6 % do not know what their suppliers are doing in respect to WCM (Table A 3.13).

14) Communication in the supply chain has some way to go. The table confirms the varied range of supplier relationships experienced by manufacturers. It is no surprise that most companies appear to have a fairly wide range of different supplier relationships. Understandably, full
collaborative relationships are in the majority with nearly 35.2% of manufacturing companies saying that they are having with majority of their suppliers and 3 out of 10 companies saying that they are having with some their major suppliers. More than 30% of respondents have only occasional or unstructured exchange of information. Close examination of these responses showed that no particular sector seemed to be more advanced than any other (Table A 3.14).

15) When manufacturers were asked to elaborate on the detail of how they were helping their suppliers to improve, ‘meeting with the suppliers to discuss improvements’ was found to be the most important practice adopted by Chennai manufacturers with a highest mean response of 4.08. On the other side, ‘investing time and money in helping suppliers to improve processes’ (mean=2.10) was the least adopted practice of supplier improvement (Table 4.7).

16) As respondents were allowed to indicate their level of agreement with the company’s approach to ensure employee skills, it is found that ‘training is ad hoc and on the job’ was found to be the company’s key approach with the mean (4.23) in response to ensuring employee skills. The other important company’s approaches to ensure employee skills were found to be ‘running an apprenticeship scheme for beginners’, ‘running sufficient training schemes for improving skills of employees’, ‘constantly monitoring the skills of the employees’, ‘recruiting the staff who are already qualified’, ‘employing unskilled staff for unskilled work’ and ‘training staff constantly, offering internationally recognized qualifications, exposures and skills’ (Table 4.8).
17) This study uses seven competitive performance indicators to evaluate the competitiveness of each manufacturing plant as: quality improvement, costs reduction, delivery speed, constant innovation, improvement of efficiency, flexibility in operations, and affordable price. Among them, ‘quality improvement’ was at the top of the agenda with a higher mean score of 3.98 to be focused largely by manufacturing companies. However, all the competitive performance indicators were found to have a mean response of greater than 3.0 and were recognized as the core of manufacturing capabilities that leads to the competitiveness of manufacturing firms in the global market (Table 4.9).

18) The results of the study clearly indicated that drivers of WCM positively affect the implementation of the WCM techniques by manufacturing firms. Having described the realization of the benefits from the implementation of WCM principles, improved product quality (mean=12.215), increased customer satisfaction (mean=11.532), and increased employee involvement (mean=9.517) were found to be the potential benefits that emerge from the implementation of WCM principles and techniques out of 12 significant WCM benefits chased by the manufacturers in Chennai (Table 4.10).

19) The survey also showed that the barriers of WCM negatively affect the implementation of the WCM techniques by manufacturing firms. The highest scoring potential barrier that might prevent or delay the application of WCM principles among Chennai manufacturers was found to be ‘investment costs’ (mean= -11.981). Followed by, nature of manufacturing facility (mean= -10.090) and the lack of understanding of the WCM approach throughout the company (mean=-9.902) were found to emerge as potential obstacles/barriers among the manufacturing firms in Chennai (Table 4.10).
20) Given the very positive findings relating to the application of WCM practices, principles and techniques elsewhere in this report, it is perhaps surprising at first sight to see a significant quarter of respondents (25.6%) have allowed themselves the accolade of having achieved WCM status already. A little more realism here, with a respectable 24% were not afraid to admit that they are a long way off in the journey of achieving the world class status. Just 22.4% believe they are very close towards becoming a WCM company, while 19.2% think they are quite close to becoming WCM company. But on a more positive note, only 8.8% admitted they would never be the WCM company. Not surprisingly, as companies have stated to wrestle with the application of WCM principles and techniques, they have become increasingly aware of the amount of work and change involved and the size of the gap they have to bridge. Perhaps it is because, as this study clearly highlights, manufacturers now have a greater knowledge of WCM, they are clearer about where they stand in relation to the achievement of world class performance. The road to world class manufacturing is clearly a long one for Chennai manufactures, but at least their objectives and expectations are clear (Table A 3.15).

21) The majority of manufacturing companies currently focused on the implementation of WCMS report satisfactory progress, with almost 6 out of 10 respondents participated in the survey have reported that their companies are effectively implementing WCMS. Nearly a quarter have said they have implemented WCMS partially. On the positive side, only 16% have responded that they were not effectively implementing WCMS in their firms (Table A 3.16).
5.2 FINDINGS OF STATISTICAL ANALYSIS

1) An internal consistency analysis of measurement scales was performed separately using the SPSS Statistics 17.0 for each concept variable as well as for the complete construct using Cronbach’s alpha. The reliability coefficients ranged from 0.877 to 0.891 for WCM Practices, 0.955 to 0.961 for Key Business Priorities, 0.925 to 0.937 for Lean Initiatives, 0.965 to 0.970 for TQM Principles, and 0.911 to 0.920 for IT Systems/Applications. The recommended minimum Cronbach’s alpha coefficient reliability of 0.70 (Nunnally, 1978) was used to test the reliabilities of each factor. The reliability test was highly satisfied as the reliability coefficients are higher than the threshold 0.70. Thus, the concept variables and research constructs with the alpha value of more than 0.70 show an adequate level of reliability (Table 4.13).

2) Independent samples t-tests were carried out to investigate the sector-wise responses to the major indicators/variables of the research constructs (i.e., WCM Practices, Lean Initiatives, TQM Principles, IT Systems/Applications, and Maintenance Practices) considered to be the key for the implementation of WCMS in the manufacturing firms and revealed that there was a significant difference among most of the indicators of the research constructs considered for the implementation of WCMS by small, medium and large scale manufacturing firms. This would indicate that the mean scores of the WCM principles and techniques implemented by medium scale companies are better than that of the small scale companies and the mean scores of the WCM principles and techniques implemented by large scale companies are better than that of the medium scale companies (Tables 4.23, 4.24, 4.25, 4.26, 4.27, 4.28, 4.29, 4.30, 4.31 and 4.32). The research variables, which would give no statistical significant difference at 5% level of significance are summarized below:
a) In the WCM Practices Construct, the variables ‘modern factory layout and production process’ and ‘Management Information System (MIS)’ were not significant at 5% (p>0.05) between small and medium scale manufacturing firms. This would mean that there is not sufficient evidence to reject the null hypothesis and conclude that the mean responses of small and medium scale manufacturing firms do not differ significantly in terms of the implementation of these two variables (Table 4.23)

b) In Lean Initiatives Construct, the variable ‘5S Principle’ (Seiri, Seiton, Seiso, Seiketsu and Shitsuke), a housekeeping practice, was found to be not significant at 5% (p>0.05) between medium and large scale companies. This indicates that there is not enough evidence to reject the null hypothesis and we could not find out any significant difference between medium and large scale companies in the implementation of 5S principle (Table 4.26).

c) In the IT Systems/Applications Construct, there is no significant difference existed in the mean of ‘design systems (e.g., CAD, CAE)’ used by small and medium scale manufacturing firms and in the mean of ‘HR or other back office systems’ used by medium and large scale manufacturing firms in the journey toward achieving manufacturing excellence. Therefore, there is not enough evidence to reject the null hypothesis for these two IT System variables (Table 4.29).

d) In the Maintenance Practices Construct, the statistical results indicate that there were no significant differences between medium scale and large scale sectors in the mean scores of three maintenance practices such as ‘involvement of employees in improvement of equipment performance’, ‘performance of
routine and preventive maintenance tasks by the employees’ and ‘keeping the equipment at its highest productive level by maintenance crew’. Hence, there is enough evidence to accept the null hypothesis. Therefore, it can be concluded that no significant differences existed in these practices performed by medium scale and large scale sectors at 0.05 significant level (Table 4.32).

3) One way ANOVA technique was applied to find the significant differences among demographic profile of the manufacturing companies with regard to the implementation of WCMS (i.e., WCM Practices, Lean Initiatives, TQM Principles, and IT Systems/Applications) and concluded that there were significant differences among demographic characteristics of manufacturing firms on the implementation of the WCM Practices, Lean Initiatives, TQM Principles, and IT Systems/Applications at 5% level of significance, except the demographic characteristic of ‘years of existence’ on the implementation of WCM Practices and TQM Principles (Tables 4.33, 4.34, 4.35, 4.36, 4.37 and 4.38).

4) One way ANOVA test was also carried out to investigate whether there are any significant differences among small, medium and large scale manufacturing plants with regard to the achievement of competitive advantage. It was found that there exists a significant difference among the small, medium and large scale manufacturers on the achievement of competitive advantage from the application of WCMS at 1% level of significance (p<0.01). Based on the results, we can conclude that large scale manufacturers were able to achieve the seven competitive priorities more effectively from the application of WCM principles and techniques than the medium and small scale manufacturers (Table 4.39).
5) Three multiple regressions were performed to test the hypothesis $H_3$. The first regression analysis was carried out with the Lean Initiatives, TQM Principles, and IT Systems/Applications as independent variables and Implementation of WCMS as dependent variable. The results of first regression analysis denote that the three variables influence manufacturers’ attitudes toward implementing the WCMS. Further, positive sign of $\beta$ values shows that there is a significant positive relationship between WCMS Implementation and Lean Initiatives, TQM Principles, and IT Systems/Applications (Tables 4.14, 4.15 and 4.16).

6) The second regression analysis was carried out with the WCM Practices, Lean Initiatives and IT Systems/Applications as independent variables and Competitive Advantage (or Operational Performance) as dependent variable. The results of second regression analysis show that the three variables influence manufacturers’ attitudes toward achieving competitive advantage in the manufacturing operations from the implementation of WCMS. Further, the positive sign of $\beta$ values shows that there is a significant positive relationship between Competitive Advantage (CA) and WCMS (i.e., WCM Practices, Lean Initiatives and IT Systems/Applications) (Tables 4.17, 4.18 and 4.19).

7) The third regression analysis was carried out with ten attributes of WCM as independent variables and World Class Status (WCS) as dependent variable. The results of third regression analysis indicate that except three WCM attributes (namely, improved productivity and efficiency, management information system and integrated supply chain), all the seven attributes of WCM can influence manufacturers’ attitudes toward achieving world class status in their manufacturing operations. Further, the positive sign of $\beta$ values shows that there is a significant positive
relationship between ten attributes of WCM and World Class Status (WCS) (Tables 4.20, 4.21 and 4.22).

8) **Structural Equation Modeling (SEM)** was conducted by using AMOS 18.0 to assess fitness of the path model based on the proposed hypotheses. Four structural equation models were carried out to test the proposed hypotheses. In the first SEM, the significant path on Competitive Advantage (CA) exists strongly from TQM Principles by registering a high coefficient of 0.51. The results of first SEM portray that there is a high interrelationship between Lean Initiatives and TQM Principles (0.77) (Figure 4.1 and Table 4.40). In second SEM, the significant path on World Class Status (WCS) strongly exists from extent of WCM Implementation by recording a relatively high coefficient (0.54). The results of second SEM indicate that there is a high interrelationship between Lean Initiatives and TQM Principles (0.77) (Figure 4.2 and Table 4.41)

9) In third SEM, the significant path on Competitive Advantage (CA) strongly exists from TQM Principles by registering a high coefficient of 0.57 and from the WCM Practices by registering a moderate coefficient of 0.41. This should be because of the high interrelationship (0.94) between WCM Practices and TQM Principles. In WCM Practices Construct, the indicator ‘Agility’ provides the highest loading (0.84) on the implementation of WCM Practices. In TQM Principles Construct, the indicator ‘Cross-Functional Teams (CFTs)’ and ‘Empowerment and Teamwork (ET)’ provide the highest loading of 0.92 each on the implementation of TQM Principles. In Competitive Advantage (CA) Construct, the indicator ‘Quality Improvement’ provides the highest loading (0.95) to achieve the competitive edge in the manufacturing operations (Figure 4.3 and Table 4.42).
10) In fourth SEM, the significant path on Competitive Advantage (CA) strongly exists from the applications of Lean Initiatives by registering a high coefficient of 0.83 and there is a low coefficient (0.10) existed between Competitive Advantage (CA) and Applications of IT Systems. This should be because of the high interrelationship (0.67) between Lean Initiatives and IT Systems/Applications. The results of fourth SEM show that the indicator ‘Six-Sigma’ provides the highest loading (0.94) on the research construct ‘Lean Initiatives’, the indicator ‘MRP’ provides the highest loading of 0.86 on the research construct ‘IT Systems/Applications’, and the indicator ‘Quality Improvement’ provides the highest loading (0.95) on the research construct ‘Competitive Advantage (CA)’. (Figure 4.4 and Table 4.43).