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# Product Design as a Critical Success Factor in TQM Organizations

Lakshmi Jagannathan
*Dayananda Sagar College of Engineering, Bangalore*

## Abstract

*Globally, the automotive industry is transforming itself- from the design studios, to the modular assembly to the new shop floor practices, to delight the customer. Perhaps the most dynamic change and also the biggest challenge in the automotive industry is its relationship with the customers. Increasingly customers are being given the opportunity to customize their purchases, including everything from exterior shape to the interior features. In order to comply to the requirements of the global customers, a constant vigil on product innovation through better and better design is the solution. TQM is recognized as a competitive edge worldwide. Especially in manufacturing sector in order to deliver better and better (Dean and Bowen, 1994).This paper tries to understand how the Indian auto component industry has delivered better products to customers' requirements by integrating the TQM philosophy into their processes. This study on TQM implementation in Indian auto component industries was focused on auto component manufacturing companies in and around Chennai, Tamilnadu. Primary data was collected from the quality managers and executives of QS 9000 / TS 16949 certified auto Component-manufacturing companies in Chennai. The data collection instrument was a structured questionnaire. Extensive review of literature established factors which were critical for TQM in organisations. Statistical analysis of these critical success factors was performed in order to understand the important drivers of TQM among certified auto component manufacturers. This study was an attempt to categorise the key drivers of TQM and evolve strategies to leverage the critical success factors to the organisational growth. Since the study was limited only to auto component manufacturers in and around Chennai, the study can be extended to other Indian auto component clusters, Pune and Gurgaon. Also an analogous study can be conducted among non-certified suppliers to original equipment manufacturers (OEMs), who are implementing TQM practices. Despite these limitations, however, the study does sheds light on the important Critical Success Factors (CSFs) on TQM, namely supplier quality management, process management and product design. Since the focus of this paper is on product innovation and design in the automotive industry, the role of product design as a very important critical success factor for TQM implementation is discussed in greater detail.*

***Keywords:*** *Critical Success Factors, Total Quality Management.*

## 1. Introduction

Post liberalization and new economic reforms in 1992, Indian auto industries in specific, started to gear up to meet the requirements of their global customers. The entry of foreign auto companies during the early 90's changed quality standards and impacted the complexity of the parts required by the Original Equipment Manufacturers (OEMs). The Indian component manufacturers had to be not only competitive globally, but also reduce their defect rates dramatically and master new technologies. In order to comply with the requirements of the global customers, a constant vigil on product innovation through better and better design was the solution. They started practicing TQM philosophy to compete and win. This paper tries to understand how the Indian auto component industry has delivered better products to customers' requirements by integrating the TQM philosophy into their processes and evolving better products to suit the customers. This empirical paper is based on a research conducted to study the critical success factors (CSFs) for TQM implementation in QS 9000 certified auto component manufacturing companies in and around Chennai, Tamilnadu.

## 2. Review of literature

The CSFs of TQM can be described as best practices or ways in which "firms and their employees undertake business activities in all key processes: leadership, planning, customers, suppliers, community relations , production and supply of products and services, and their use in benchmarking ……"(Australian Manufacturing Council, 1994, p.1). Identifying CSFs is the key for structuring environmental analysis and organisational strategies for successful implementation of TQM. There is an important link between environmental analysis and CSFs leading to organisational success (Digman 1990). The critical success factor analysis method has an important meaning to TQM through identification of core processes that are critical in Total quality management implementation. Also a quality management program needs to identify critical performance indicators or success factors to gauge its success.

Saraph et al.(1989) conducted a pioneering study to identify the CSFs of TQM that must exist in a business unit to achieve effective quality management. He also developed measures of each critical success factor and overall organisational quality management. Many empirical research studies followed after Saraph's work, in order to test and understand the TQM CSFs, viz., Anderson et al (1994), Rao et al.(1999) and Flynn et al (1995). From a review of all these studies, it can be concluded that most of the TQM CSFs are commonly proven in all the studies. Those common factors were chosen as the CSFs of the framework of this study.

The identified ten CSFs included in this study are : Top Management Commitment, Strategic Planning, Quality Measurement, Benchmarking, Training, HR Focus, Process Management , Supplier Quality Management, Customer Focus and Product Design.

The outcomes of TQM concentrate on the achievements of the organisation towards its stakeholders (those who have an interest in the organisation) and how they can be measured and targeted. Identifying the effect of TQM on organisational performance is an important body of TQM research. Most empirical research shows how TQM influences a wide extent of result, such as employee and customer satisfaction, product quality, economic results and so on (Dow et al., 1999). Thus the outcomes included in this framework are customer satisfaction, employee satisfaction, supplier satisfaction and operational performance.

## 3. Framework of the study

Among the most demonstrative philosophies of the TQM, Business Excellence Models such as the Malcolm Baldrige Award and the EFQM are well accepted, Saraph, Benson and Schroder (1989), Black and Porter (1996), Anderson, Rungtusanatham and Schroeder (1994). Among Excellence models, the Baldrige criteria is a conceptual framework that addresses the principal domains of TQM, is updated to reflect current thinking on TQM and is not limited to a single perspective Dean and Bowen (1994). Based on this perspective of literature and consensus was obtained from TQM experts, Malcolm Baldrige Award Criterion was adopted as the basis for the frame work of this study as shown in Diagram 1.

The logic behind this business excellence model is that by improving 'how the organisation operates' – the 'CSFs' – there will be an inevitable improvement in the 'results' (outcomes).

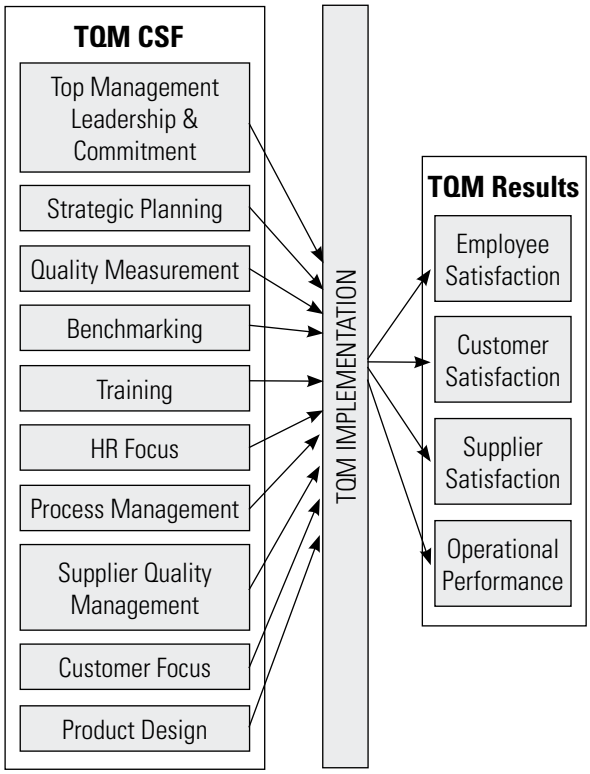


**Diagram 1 Framework of the Study**

## 4. Hypothesis of the Study

As this study tries to understand the importance given to these CSFs and Outcomes in certified auto component manufacturing companies, the null hypothesis formulated is as follows:

Ho: There is no difference in perceived level of importance of TQM CSFs and outcomes.

## 5. Research Instrument

Based on the review of literature, post identification of the CSFs and the outcomes, items were developed to measure each dimension (critical success factor / outcome) of the study. Totally fourteen dimensions, which were developed formed the research instrument (structured questionnaire). The respondents were asked to evaluate the emphasis of the various dimensions on a five-point scale.

## 6. Validity and Reliability of the Instrument

The instrument was empirically tested for validity by CFA (Confirmatory Factor Analysis), correlation and regression. The reliability was established by establishing Cronbach's coefficient alpha.

Individual items in the model have to be investigated to see how closely they represent the same construct (Ahire et al 1996). Then for unidimensionality checking, a measurement model is specified for each construct and CFA is run for all the constructs. The resulting Comparative Fit Index (CFI) is equal to the discrepancy function adjusted for sample size and usually ranges from 0 to 1, with a larger indicating better value fit. Recommended values for CFI are 0.9 and above (very good), 0.8 and above (good ) and 0.7 and above (satisfactory) (Hu and Bentler 1999). Since all the CFI values for this study were above 0.7 as shown in table 1, a satisfactory unidimensionality for the scales was established. This instrument has factoral validity because the items have loaded as they were hypothesized, when the items were constructed.

Since the measurement instrument was developed based on defined quality management practices of Saraph et al (1989), Powell (1995) and Samson and Terziovski (1999), it is therefore considered to have content validity. In the present study, as there are fourteen constructs, a total of 91 discriminant validity checks (that is 14C2 ) have been carried out. All the 91 tests were statistically significant at a level of 0.01, indicating that all the 14 constructs are distinct constructs – a strong demonstration of discriminant validity.

Reliability relates to the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trials (Carmines and Zeller 1979). Internal consistency is measured by calculating a statistic known as Cronbach's coefficient alpha (Nunnally 1978, Cronbach 1951). Coefficient alpha measures internal consistency reliability among a group of items combined to form a single scale. It is a statistic that reflects the

| No | Variable | No of Items | RMSEA | BFI | CFI |
|---|---|---|---|---|---|
| | **Critical Success Factors** | | | | |
| 1 | Top Management Leadership | 11 | 0.25 | 0.756 | 0.767 |
| 2 | Strategic Planning | 3 | 0.07 | 0.972 | 0.984 |
| 3 | Quality Measurement | 16 | 0.25 | 0.722 | 0.735 |
| 4 | Benchmarking | 4 | 0.15 | 0.888 | 0.904 |
| 5 | Training | 4 | 0.20 | 0.960 | 0.963 |
| 6 | HR Focus | 8 | 0.12 | 0.944 | 0.957 |
| 7 | Process Management | 11 | 0.30 | 0.780 | 0.787 |
| 8 | Supplier Quality Management | 9 | 0.24 | 0.883 | 0.890 |
| 9 | Customer Focus | 8 | 0.30 | 0.852 | 0.857 |
| 10 | Product Design | 11 | 0.22 | 0.865 | 0.874 |
| | **Outcomes** | | | | |
| 11 | Employee Satisfaction | 4 | 0.34 | 0.956 | 0.957 |
| 12 | Customer Satisfaction | 4 | 0.15 | 0.988 | 0.990 |
| 13 | Supplier Relationship | 3 | 0.00 | 0.974 | 0.998 |
| 14 | Operational Performance | 12 | 0.31 | 0.778 | 0.785 |

**Table 1 Results of Confirmatory Factor Analysis***

*EQS software (for Windows 6.0) was used to conduct the confirmatory factor analysis.

homogeneity of the scale. The value of Cronbach's alpha above 0.7 is usually acceptable (Nunnally 1978). The Cronbach's alpha values for this study were above 0.7 as shown in table 2.

Thus this testifies that all the scales are internally consistent and have acceptable reliability values in their original form.

### 7. Design and Methodology

Primary data were collected from certified auto component-manufacturing units in and around Chennai, Tamilnadu, India. Chennai was primarily chosen, as it is the leading auto component cluster, contributing to more than 45% of Indian auto component exports. It also has a concentrated auto industrial belt, which leading international major auto players have made their base. Among the 13 Indian Deming award winning companies, eight companies are based in Chennai thus driving a TQM culture in the Tamilnadu automotive industry. It has the largest number of ISO/QS Certified

| Construct | Cronbach's coefficient alpha (a) |
|---|---|
| Critical Success Factors | |
| Top management | 0.9303 |
| Strategic planning | 0.7119 |
| Quality measurement | 0.9705 |
| Benchmarking | 0.7002 |
| Training | 0.8186 |
| HR focus | 0.9164 |
| Process management | 0.9773 |
| Supplier quality management | 0.9708 |
| Customer focus | 0.9680 |
| Product design | 0.9754 |
| Outcomes | |
| Employee satisfaction | 0.9615 |
| Customer satisfaction | 0.9273 |
| Supplier relationship | 0.9416 |
| Operational Performance | 0.9839 |

**Table 2 Cronbach's Coefficient Alpha (a) Values**

automotive Companies in India (ACMA Report 2006).

The master list of certified companies was obtained from quality certifications bodies Bureau Veritas Quality International (BVQI) and Det Norse Veritas (DNV). Companies with more than two year of certification were only chosen for the study, as they would be able to assess any impact of the quality certification on TQM in their organizations. The respondents of this study were quality managers and executives who were working for more than three years in the company. Data was obtained from 135 certified companies, with a response rate of 43% .

## 8. Statistical Analysis

In order to identify the key CSFs and outcomes of TQM implementation, the descriptives (mean and standard deviation) of the collected data were obtained for all the ten CSFs and four outcome variables and the results are as shown in table 3.

## 9. Analysis and Discussion

It can be observed that among the CSFs, the respondents perceived supplier Quality Management(4.14) as the most important CSF of TQM implementation, closely followed by Process Management (4.10) and Product Design (4.01) . Whereas among outcomes, Supplier relationship (4.33) was perceived as the most important outcome of TQM implementation.

*Thus the hypothesis Ho is rejected.*

The focus on Supplier Quality Management (4.14) as the most important enabler of TQM implementation, can be attributed to the intent of the QS 9000 standard itself. The intent of the standard is to force automotive supplier organisations to build systems that prevent the occurrence of problems and allow for continuous improvement to prevent recurring problems Tom et al (2000). Companies select vendors based on an evaluation criterion. These 'supplier partners' team with the companies in meeting customer, government and safety requirements.

The enabler perceived to be second important was Process Management (4.10). QS 9000 standard is fundamentally based on ISO 9000 standard quality assurance standard. The primary focus in this standard is basically on standardising procedures and work flow, so as to have better process control. Thus the emphasis on supplier management and process management can be attributed to the intent of the QS 9000 standard itself (http://www.qs-9000.org ).

Focus on product design is also perceived to be a very important CSF for TQM implementation. Product Design is one of the most important non-price factors which determines the success of a product. As the product life cycle matures, more competitors enter the market and the chief role of design is in product differentiation; through quality, appearance, performance, ease of use, reliability, reparability and so on (Walsh et. al. 1992). Simply having a customer focus and acquiring customers may not be sufficient for success since customers can be easily lost if new entrants in the market attract them. Therefore companies must strive to attain customer loyalty and retention by understanding the customer requirements and designing products accordingly.

Product Design is seen as being relevant in today's Indian automotive industry, and the following factors also act as catalysts:

- World Bank and Indian EXIM policy (post liberalization) has favoured the opening up of markets through tariff reduction. This has exposed local producers to cheaper and better designed products, so firms are being challenged on both domestic and export markets.
- Particularly in the automotive industry , product characteristics such as design, frequency of new product introduction and quality are becoming increasingly important. Price competitiveness (while still important) is diminishing in priority (Kaplinsky, 2005).
- The newly industrialised countries of South East Asia have successfully used product design to produce competitive products for world markets.

Among the outcomes of TQM, Supplier relationship (4.33) was perceived as the most important outcome of TQM implementation. QS 9000 is a mandatory automotive standard to be complied with to become a

supplier to the OEM and tier 1 companies. It prescribes a dedicated team of quality suppliers. Supplier relationship was perceived as the most important outcome as they have built a strong supplier base. The least important outcome of TQM implementation was operational performance. Operational performance here implies shop floor performance in terms of productivity, set up time and others. This may be because of the fact the respondents were not able to correlate the shop floor performance to the TQM practices. This is substantiated by Flynn B.B., Schroeder R.G. and Sakakibara S.(1995), who feel that it is very difficult to detect statistically the direct effects of TQM by using outcome criteria such as operational performance. Thus further investigation needs to be done specifically in auto industry to understand the impact of TQM implementation on operational performance.

## 10. Limitations and Scope for Further Research

This study has some limitations, which may be considered for future research. Although the survey results were derived from a single industry, that is the Indian auto component industry, the study was restricted to companies in and around Chennai. Future research may collect data from other regions or auto clusters, Pune and NCR. In order to improve external validity of the instrument, additional studies would be needed, with increased sample sizes, geographical diversity, organisation type and so on.

The findings are based on the use of self-reported survey data, which may be affected by response biases. It is also important to validate if that other major constructs related to TQM implementation process (including communication, employee participation, degree of empowerment) should be added to the conceptual framework underlying this study.

It is proposed that future research be conducted in other types of organisations such as service and other manufacturing sectors, using a similar approach. New studies can be conducted to explore the relationship between the variables within the context of the country, location factors, culture, firm and industry type and other external and internal factors.

| Sl No. | CSFs | Mean | Standard Deviation |
|---|---|---|---|
| 1 | Top Management Leadership & Commitment | 3.73 | 0.27 |
| 2 | Strategic Planning | 2.71 | 0.47 |
| 3 | Quality Measurement | 3.52 | 0.19 |
| 4 | Benchmarking | 3.12 | 0.34 |
| 5 | Training | 3.53 | 0.25 |
| 6 | HR Focus | 3.83 | 0.21 |
| 7 | **Process Management** | **4.10** | **0.23** |
| 8 | **Supplier Quality Management** | **4.14** | **0.18** |
| 9 | Customer Focus | 3.98 | 0.23 |
| 10 | **Product Design** | **4.01** | **0.20** |
| **Outcomes** | | | |
| 11 | Employee Satisfaction | 4.13 | 0.36 |
| 12 | Customer Satisfaction | 4.31 | 0.23 |
| 13 | Supplier Relationship | 4.33 | 0.34 |
| 14 | Operational Performance | 3.93 | 0.22 |

**Table 3 Descriptives – Mean and Standard Deviation (N=135)**

## 11. Conclusions

Globally, the automotive industry is transforming itself- from the design studios, to the modular assembly to the new shop floor practices, to delight the customer. Perhaps the most dynamic change and also the biggest challenge in the auto industry is its relationship with the customers. Increasingly customers are being given the opportunity to customize their purchases, including everything from exterior shape to the interior features. Customers are not only looking for customisation, but also want speed of delivery. The 'order to delivery' time – is steadily reducing, in a sense the production process is shrinking! And of necessity, so is the design process, which is compelled to keep up with the velocity of consumer trends. In order to comply to the requirements of the "New Order Global Customer", product design has to be a dynamic process embedded in the TQM way of work life.

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