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Role of Quality Management Practices in Manufacturing Industry of Punjab—An Empirical Case Study

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ABSTRACT

Quality is highly demanded by the customer from the manufacturing organizations. In order to improve the quality of product manufactured, organizations are deploying QMPs (quality management practices). This study has been carried out in a medium-scale industry of Punjab. Questionnaire consisting of five different QMPs, as identified from literature, has been prepared to find out the importance of one QMP on other. From the relationship ranking of the QMPs, importance level of different QMPs has been measured using analytical hierarchy process and compromise ranking method. Results of investigation demonstrated that QMPs play a significant role in the performance of manufacturing unit under study. Top management leadership is effective in imparting training to the employees. Employee relationship plays an important role in improving the performance of employees of the organization.

Keywords: *analytical hierarchy, compromise ranking method, quality management practices, questionnaire and medium-scale industry*

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INTRODUCTION

Quality management (QM) has caught the attention of researchers and managers alike, as is evident from the large volumes of literature produced in the area and the constant claim by managers that their products and services are of superior quality. It is surprising, however, that in the midst of this quality movement, the research regarding the QM of research and development (R&D) activities of organizations is still in its infancy. (For this research, the acronym R&D includes the following activities: applied research, engineering and product and process design and development. The acronym R&D for this article does not imply nor include basic research.) Current research on quality in R&D includes case studies of successful quality in research activities [1]. Quality has become one of the most important drivers of the global competition today. Manufacturing technologies have continually gone through gradual but revolutionary changes [2]. Total quality management (TQM) can be defined as a holistic management philosophy aiming at continuous improvement in all functions of an organization to produce and deliver commodities or services in line with customers' needs or requirements by better, cheaper, faster, safer, easier processing than competitors with the participation of all [3].

Today's market and competitive pressures require companies to develop and maintain a high level of coherence between their strategy (objectives), action programs (implementation), practices (instantiation) and performance (realization). However, most research has failed to investigate the effect of these practices on performance, whilst perhaps even less is known about the extent to which they are indeed generic. Focusing on manufacturing practices and performance and defining best practices as the practices used by, and having significant effect on the performance of the best performing companies. The practice of quality management techniques can enable companies to improve internal efficiencies [4]. Because of an increasing pace and complexity of business environments, organizations no longer compete on processes but the ability to continually improve processes [5]. This study has been carried out in medium-scale manufacturing industry of Punjab to assess the importance of different quality management practices utilized by manufacturing organization under study. Multi-criteria decision-making techniques, namely Analytical Hierarchy Process (AHP) and VIKOR, have been applied to assess these practices and know the relationship between these parameters.

LITERATURE REVIEW

Gentili et al. [6] defined that TQM ought to go beyond the traditional meaning of the quality of a product or service; it should include not only customer satisfaction, but also efficiency, productivity, quality of work life, commitment and loyalty within the organization. It is also about more than just listening to the customer, which means that the organization ought to integrate its quality performance targets within its corporate social responsibility strategy.

Flynn and Saladin [7] systematically investigated the role of national culture in QM practices and found that Hofstede's national culture dimensions are related to performance on every quality management practice under Baldrige criteria, except for customer and market focus. Finally, the authors argued that the influence of a country's cultural values does not directly affect quality performance, but instead creates an environment for which QM will be more or less effective.

Vecchi and Brennan [8] presented the results of a survey administered across 23 countries that examines quality priorities, practices and performance by adopting Hofstede's national cultural framework. Data were collected in 2006 as part of the IV iteration of the International Manufacturing Strategy Survey. The methodology involved the use of a self-administered questionnaire to director/head of operations/manufacturing in best practice firms within the sector of firms classified by ISIC codes Divisions 28-35. The purpose of this study is to test the validity of the "culture-specific"' argument as an explanatory construct for explaining quality management. From the findings, it emerges that whereas differences in priorities can be affected by masculinity and uncertainty avoidance to a very small degree, all the four dimensions of culture significantly affect quality practice and three of the four dimensions affect performance to a greater extent.

Shahin and Debestani [9] conducted a case study in a service company to verify the relevance of each soft element to the implementation of TQM. The intangible factors have a significant relationship among themselves, but at distinct intensities. Leadership, relationship with clients, benchmarking and process improvement showed the best positive correlation. For the successful implementation of TQM, it is important to pay attention to these factors.

RESEARCH METHODOLOGY AND INSTRUMENT

The methodology adopted for the research is shown in Figure 1. For this study, a questionnaire has been prepared which consists of five-point Likert scale varying from weak relationship between QMPs to absolutely strong. The relative importance has measured from this Likert scale. Four respondents from the case company filled out questionnaire and decision is made on the basis of their viewpoint regarding these practices.

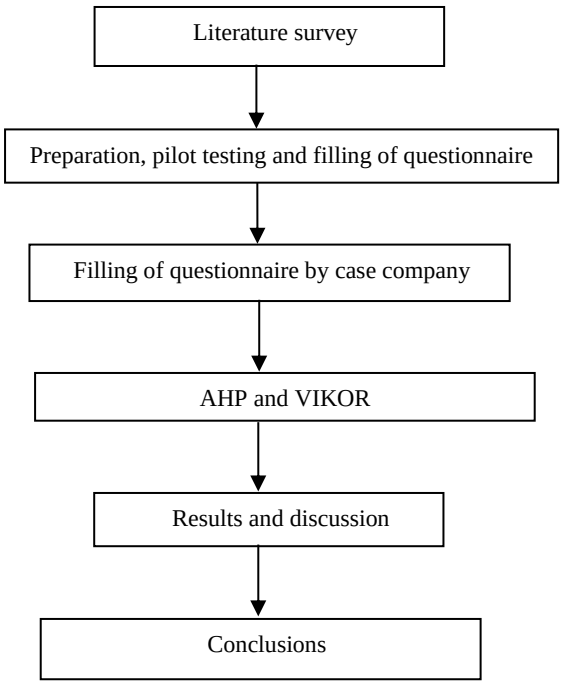

Fig. 1. *Research methodology.*

INTRODUCTION TO THE INDUSTRY AND QMPS UNDER STUDY

One of the leading companies of the automotive parts in Punjab is GS Auto Company Pvt. Ltd. It is spread over 20 acres. It is located at Bija village near Khanna, Ludhiana, Punjab. There are 500 workers in the unit and 45 staff members currently take part to develop product. In this unit, all types of leaf springs, jack rods, and packing of propeller shaft component, gun metal bush, ring, bracket and all casting items are manufactured.

Five QMPs including top management leadership (TML), role of the quality department (RQD), training (TRN), supplier quality management (SQM), and employees' relations (ER) are taken in the study as identified from literature.

RESULTS AND DISCUSSION

Content Validity of Constructs

Discriminant validity has been measured for various QMPs. Discriminant validity measures the degree to which a construct and its indicators are different from another construct and its indicators. Form (1979) suggests that, for discriminant validity, the square root of the average variance extracted (AVE) for a given construct should be greater than the absolute value of the standardized correlation of the given construct with any other construct in the analysis. The square root of AVE for each of the factor is shown in the diagonal cells, and the correlation coefficient of a factor with the other factors is shown in the non-diagonal cells of Table 1.

Table 1. *Results of discriminant validity.*

	TML	**RQD**	**TRN**	**SQM**	**ER**
TML	**0.97**				
RQD	0.567	**0.95**			
TRN	0.723	0.348	**0.87**		
SQM	0.456	0.298	0.542	**0.94**	
ER	0.578	0.437	0.456	0.398	**0.85**

The square root of AVE for each of the factors was greater than the correlation coefficient of that factor with the other factors, and this supported the discriminant validity of the determinants.

Analytical Hierarchy Process

Three-level hierarchy has been prepared to assess the importance and rank of different QMPs. Organization success is shown in Figure 2 at the top level, QMPs at middle level and outcomes at lower level.

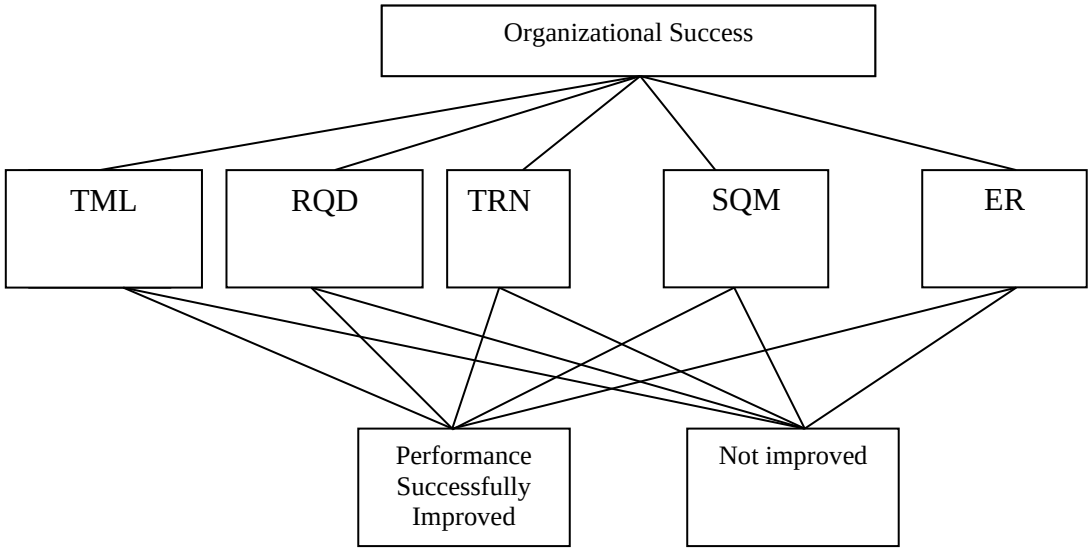

Fig. 2. *Three-level hierarchy for assessing the QMPs in the organization for strategic success.*

The various steps applied in AHP are as follows:

Step 1: Degree of preference

The degree of preference or intensity of the decision-maker in the choice of each pair-wise comparison used in this model is quantified on scale of 1–9. This scaling process can then be translated in priority weight (scores) for comparison of alternatives. Even numbers (2, 4, 6, 8) can be used to represent compromises among the preference above. The suggested numbers used in this model to express degree of preference are shown in Table 2.

Table 2. *Degree of preferences.*

Definition	Intensity of importance
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9
Intermediate values	2, 4, 6, 8

Step 2: Normalized matrix of different sub-objectives

After a pair-wise comparison matrix is obtained, the next step is to divide each entry in the column by the sum of entries in the column to get the value of normalized matrix. The value of normalized matrix is shown in Table 3. The normalized value r_{ij} is calculated by the below-mentioned formula:

$$r_{ij} = a_{ij} / \sum_{i=1}^{n} a_{ij}$$

Table 3. *Pair-wise comparison of different sub-objectives.*

	TML	RQD	TRN	SQM	ER
TML	1	1.16	7.58	9.5	5.66
RQD	1.16	1	9.33	7.25	4.25
TRN	7.58	9.33	1	14	5.5
SQM	9.5	7.25	14	1	9.5
ER	5.66	4.25	5.5	9.5	1
Total	24.9	22.99	37.41	41.25	25.91

Thus, the approximate priority weight (W_1, W_2, W_j) for each attribute is obtained as shown in Table 4.

$$W_j = 1/n \times \sum_{i=1}^{n} a_{ij}$$

Table 4. *Normalized matrix of sub-objectives.*

	TML	RQD	TRN	SQM	ER	Weight
TML	0.041	0.051	0.203	0.23	0.218	0.149
RQD	0.046	0.043	0.249	0.176	0.164	0.136
TRN	0.304	0.406	0.027	0.339	0.212	0.257
SQM	0.382	0.315	0.374	0.025	0.367	0.293
ER	0.227	0.185	0.147	0.23	0.039	0.165

Step 3: Do consistency check

The relative weights, which would also present the eigen values of criteria, should verify:

$A \times W_i = \lambda_{max} \times W_i \qquad i = 1, 2, \ldots, n.$

where A represents the pair-wise comparison decision matrix and λ_{max} gives the highest eigen value. Then the consistency index (CI), which measures the inconsistencies of pair-wise comparisons, is calculated as

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

The last ratio that has to be calculated is CR. Generally, if CR is less than 0.1, the judgments are consistent and acceptable. The formulation of CR is

$$CR = \frac{CI}{RI}$$

where random index (RI) denotes the average RI with the value obtained by different orders of the pair-wise comparison matrices. The values of consistency test are given in Table 5.

Table 5. *Consistency test.*

Maximum Eigen value	CI	RI	CR
5.06107	0.01526	1.12	0.0136

Step 4: Priority weights for alternatives with respect to attribute

The chance of a successful QMP implementation increases if attribute present is strong. Priority weights for alternatives (improved and unimproved) are measured to show the preference of the alternative with respect to an attribute. Thus, if the presence of an attribute is strong in the organization, it is more likely to be a success, compared to the presence of an attribute which is weak. Table 6 summarizes the result of evaluating the possible outcome of the implementation with respect to each attribute.

Table 6. *Decision index table.*

		Improved performance	Not improved	Priority weight
TML	Improved	1	3.3	0.7674
	Not Improved	0.3030	1	0.2326
RQD	Improved	1	3.64	0.7845
	Not Improved	0.275	1	0.2155
TRN	Improved	1	1.7	0.6296
	Not Improved	.5882	1	0.3704
SQM	Improved	1	2.626	0.7246
	Not Improved	0.38	1	0.2754
ER	Improved	1	1.366	0.5773
	Not Improved	0.732	1	0.4227

The weight evaluation for each alternative is multiplying the matrix of evaluation rating by vector of attribute weight and summing over the entire attribute.

Decision Index of Improved Performance: 0.7674 × 0.149 + 0.7845 × 0.136 + 0.6296 × 0.257 + 0.7246 × 0.293 + 0.5773 × 0.165 = 0.6904

Thus, Decision Index of Performance not Improved = 1 − 0.69 = 0.31.

This signifies the success rate of strategic implementation of CI approach is 69%.

Compromise Ranking Method

The VIKOR (the Serbian name is "Vlse Kriterijumska Optimizacija Kompromisno Resenje", which means multi-criteria optimization (MCO)) compromise solution method was first established and later promoted by Zeleny. The following multiple attribute merit for compromise ranking is developed from the L_p-metric used in the compromise programming method.

$$L_{p,i} = \{\sum_{j=1}^{M} (w_j [(m_{ij})_{max} - m_{ij}] / [(m_{ij})_{max} - (m_{ij})_{min}])^p\}^{\frac{1}{p}} \qquad (1)$$

where M is the number of criteria and N is the number of alternatives. The m_{ij} values (for i = 1, 2,…,N; j = 1,2,…,M) denote the

values of criteria for different alternatives. In the VIKOR method, $L_{1,i}$ and $L_{\infty,j}$ are used to formulate the ranking measures.

Step 1: Determine the value of E_i and F_i

$$E_i = \mathrm{L}_{1,i} = \sum_{j=1}^{M} w_j \left[(m_{ij})_{max} - m_{ij}\right] / \left[(m_{ij})_{max} - (m_{ij})_{min}\right] \quad (2)$$

$$F_i = \mathrm{L}_{\infty,i} = \mathrm{Max}^m \; of \; \{w_j \left[(m_{ij})_{max} - m_{ij}\right] / \left[(m_{ij})_{max} - (m_{ij})_{min}\right] \quad (3)$$

The values of E_i and F_i are shown in Table 7. Equation (2) is only applicable to beneficial attributes (whose higher values are desirable). For non-beneficial attributes (whose lower values are preferable), the term $[(m_{ij})_{max} - m_{ij}]$ in Equation (2) is to be replaced by $[m_{ij} - (m_{ij})_{min}]$. Hence, for non-beneficial attributes, Equation (2) can be rewritten as

$$E_i = \mathrm{L}_{1,i} = \sum_{j=1}^{M} w_j \left[\mathrm{m}_{ij} - (m_{ij})_{min}\right] / \left[(m_{ij})_{max} - (m_{ij})_{min}\right] \quad (4)$$

Table 7. *Values of E_i and F_i.*

E_{TML} = 0.064	F_{TML} =0.036
E_{RQD} = 0.043	F_{RQD}= 0.024
E_{TRN} = 0.054	F_{TRN}= 0.016
E_{SQM} = 0.0083	F_{SQM}= 0.0014
E_{ER} = 0.165	F_{ER}= 0.086

Step 2: Calculation of P_i values

$P_i = v\{(E_i - E_{i-\min})/(E_{i-\max} - E_{i-\min})) + (1-v)((F_i - F_{i-\min})/(F_{i-\max} - F_{i-\min})\}$

where E_i-max and E_i-min are the maximum and minimum values of E_i, respectively, and F_i-max and F_i-min are the maximum and minimum values of F_i, respectively. v is introduced as the weight of the strategy of "the majority of attributes" (or "the maximum group utility"). The value of v lies between 0 and 1. Normally, the value of v is taken as 0.5. The best alternative is the one having the minimum P_i value. The values of P_i and ranking of sub-objectives are shown in Table 8.

Table 8. *Values of P_i and rank of attributes.*

Values of P_i	**Rank**
P_{TML} = 1	5
P_{RQD} = 0.6558	4
P_{TRN}= 0.1468	2
P_{SQM} = 0.616	3
P_{ER} = 0.009	1

CONCLUSIONS AND LIMITATIONS

From the results and discussion, the following conclusions are drawn:

- The manufacturing organization under study has focused on employee relationship to enhance the performance of their employees.
- High success rate (69%) of quality management practices under study has been found.
- Training of suppliers plays a significant role towards maintaining the quality of their product.
- Role of quality department is highly influenced by the top management leadership. Training plays an important role in enhancing the quality or enhancing the role of quality department.
- Top management leadership is essential for effective training of employees for implementing QMPs.

The study contains limited aspects of QMPs. Sophisticated QMPs can be taken into consideration. There is a possibility of method variance as there are few respondents from case company.

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