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The Role of Quality Planning and Quality Improvement Tools in Improving the Quality of Products among the Manufacturing Sector of Punjab, Pakistan

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Abstract: Quality tools play an important role in any quality management program. The focus of the current study was to understand quality tools related to the quality planning and quality improvement in the context of Pakistani manufacturing sector. The study is based on two objectives. The first objective is to identify which quality tools are most frequently utilized by the local manufacturing sector. The second objective is to see the role of quality tools in quality improvement among the manufacturing firms. A survey questionnaire based on the previously developed measures was set, and through random sampling, data was collected from 84 survey participants, belonging to the thirty manufacturing firms located in Punjab. The results suggest that the flow charts, quality circles, statistical process control, team building methods and suggestion box are among the most utilized quality tool. Other quality tools, such as, Pareto analysis and House of quality, were not used, which are utilized very frequently in the sample firms. Furthermore, results based on the regression analysis show that the use of quality tools including supplier audit, quality circles, and the suggestion box has positive and significant effects on the quality improvement among the Pakistani manufacturing firms. The results show that the use of quality tools is highly important and has significant implications in the management, quality department, and the HR function.

Key words: Quality tools, Quality improvement, ISO9001, Manufacturing, Pakistan.

INTRODUCTION

Organizations mostly utilize ISO9001, the total quality management, or some national quality framework for implementing a quality improvement program in organizations. Different broad principles, such as, the role of leadership, customer focus, employee involvement and development, are emphasized in the literature (Beckford, 2016; Oakland, 2014). These principles are mostly based on the work of quality gurus, such as, Deming, Juran, Crosby, Feigenbaum, and Ishikawa, who contributed significantly in the quality management (Ehie and Gilliland, 2016; Ross, 2017). As a part of the quality management program, organizations also have to utilize some operational level tools which are frequently referred to quality tools. These tools help mostly during the production problem for identification and removing sub-standard quality products or processes (Magar and Shinde, 2014; Silva *et al*., 2013).

Different types of quality tools are available which are utilized by different organization, for example, house of quality, supplier audit, team building method, flowchart, quality circle and so on (Ehie and Gilliland, 2016; Kanji, 2002; Oakland, 2014; Wu and Jang, 2014). The use of quality tools helps in improving the quality of the products, processes, early detection of faulty products, and bringing an overall improvement in the organization (Oakland, 2014; Lim *et al*., 2017; Wu and Jang, 2014). The use of these quality tools varies from context to context and may produce different benefits. In the current study, the focus is on the quality of tools, which are mostly utilized by the Pakistani manufacturing sector and their role in bringing improvement in the quality of products and processes.

The key problem, this study is focusing on, is the use of quality tools, especially the planning and improvement related quality tools. Mostly, the studies related to the quality tools focus on the single quality tool and its benefits. The problem is that different organizations use different quality tools and often staff lacks good understanding of these quality tools. Furthermore, the role of these quality tools in terms of quality improvement is also not clearly understood. Current study involves the investigation of identification of commonly used quality tools and their association with quality improvement. The objectives of the study are;

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- To identify which quality tools are commonly utilized by the manufacturing sector.
- To evaluate the role of commonly used quality tools in bringing improvement of product's quality.

Quality tools

Based on the the review of the literature, ten quality tools were identified which are frequently utilized by the manufacturing firms and are related to the quality planning and quality improvement. House of Quality or quality function deployment is one of the quality tool, mostly used for the product design (Beckford, 2016; Dubey and Gunasekaran, 2015; Novokreshchenova *et al*., 2016; Oakland, 2014). Quality function deployment is used for identifying the customer requirements and translating them into technical standards, so that the product design meets the requirements of the customers (Pakdil and Kurtulmusoglu, 2014). Supplier audit is another famous quality tool, which is about making a thorough evaluation of the capabilities of the supplier in order to get the quality input. Supplier audit may take a different form, such as inspection of products, arranging a regular meeting with suppliers, reviewing supplier's performance data, and monitoring the supplier's quality certification status (Li and Lee, 2015; Ross, 2017). Team building is another quality tool which is about the development of teamwork among the task participants (Oakland, 2014; Purushothama, 2010; Ross, 2017). For a good team development, team design should be based on small numbers along with the presence of complementary skills among the team members, good leadership and team's focus on true purpose (Oakland, 2014). Commonly utilized team building methods such as training and outdoor games are also beneficial.

Flowchart is another quality tool which helps in identifying the sequence of activities (Kanji, 2002). It provides a bird-eye view of how an organization transforms input into the output (Silva *et al*., 2013). The benefit of flowchart is that it enables the identification of production-related problems, bottlenecks, and other quality related issues (Magar and Shinde, 2014). Quality circle is another commonly used quality tool that is used to increase an employee's involvement in organizational decision making to enhance the quality (Beckford, 2016). The strength of quality circle is that it enhances worker's input into the organization's decision-making process and may benefit in terms of improving the quality (Magar and Shinde, 2014).

Pareto chart analysis is another commonly utilized quality tool that presents data in a ranked form and shows the frequency of occurrence in a descending manner (Magar and Shinde, 2014; Oakland, 2014). Benchmarking is a useful quality tool, commonly found in ISO9001 and total quality management related literature (Ross, 2017). It is based on the premise that good things can be observed in other organizations or organizational units and can be copied to own organization (Ross, 2017; Silva *et al*., 2013). Statistical process control is also a highly useful quality tool. It is about using statistical methods for identifying problems and stopping faulty products in the production. Different type of statistical methods, such as, check sheets, histogram, bar charts, scattergram, dot play and tally chart, are available, which can be used as a statistical process for control (Lim *et al*., 2017; Magnus, 2016).

Five-Whys is another simple quality improvement tool. It is based on the brainstorming by quality improvement team who attempts to identify the root causes of a problem (Oakland, 2014). It is also used for determining the cause-effect relationships for a particular problem or for a failure event. In many cases, it possibly generates the corrective action and enables avoidance of failure or mistakes in future (Fonseca, 2015; Psomas and Antony, 2015; Ross, 2017). Suggestion scheme is another quality tool which is used for involving employees on a regular basis for bringing improvement in quality (Beckford, 2016). Once suggestions are received from employees, they are evaluated for their adequacy. If found suitable, then these suggestions are implemented, thus providing a mechanism to tap the creativity of employees in day to day matters (Lasrado *et al*., 2015). The strength of most of the quality tools is that it provides input from employees and customers and improves the quality of the products and processes. A drawback of these quality tools is that they are often expensive to implement and consume resources. Furthermore, the implementation of quality tools requires greater investment in employees training so that they can learn the use of quality tools.

Benefits of using quality tools

The use of quality tools is important since it helps in implementing any quality management program and achieving ISO9001 certification. The benefits of using quality tools include improved process and minimized production losses (Beckford, 2016; Ehie and Gilliland, 2016; Lim *et al*., 2017). Other benefits of using quality tools include a low level of rework, better process flow, reduced wastage of time, saving on raw material and labor, and competitive advantage (Magnus, 2016; Wang *et al*., 2013). At a broader level, the implementation of quality tools may help the organization in improving the quality of products which further leads to profitability (Purushothama, 2010). A higher quality of the products is also associated with greater customer satisfaction (Magar and Shinde, 2014; Wu and Jang, 2014). It is clear that the use of quality tools results in favorable outcomes.

MATERIALS AND METHODS

Design of the study

The design of the current study is based on the quantitative approach since it is more suitable for the

nature of current study and the type of research question and objectives posed. Furthermore, the design is based on cross-sectional (collecting data at one point in time), and non-experimental (in natural settings). Based on the research design, the survey method was used for data collection.

Data collection is based on a survey adapted from the previously developed measures. The quality tools were measured by ten items representing a single item for each quality tool and adapted from Liebesman (2002). Quality improvement is measured by 5 items and adapted from Katerina (Katerina, 2002). Further, demographic and organizational related information was also included in the survey.

Participants

The focus of the study is the manufacturing sector in Punjab, Pakistan, so the population of the study is all manufacturing organizations located in the Punjab province. Since, the population is large and very much unknown; therefore, the sampling approach was used. A sampling frame of manufacturing firms located in the four cities, including Lahore, Rawalpindi, Sialkot and Faisalabad, was selected. In these cities, there is a heavy manufacturing base. From these cities, 30 manufacturing firms were selected where a total of 150 surveys on a random basis were distributed. A total of 150 questionnaires were distributed among 30 manufacturing organizations. A total of 84 respondents replied making a response rate of 56%.

Reliability is about whether measures used are free from error and that they produce consistent results (Sekaran and Bougie, 2016). A common method of measuring reliability is internal consistency, test-retest, and split half method (Creswell and Clark, 2017). The Cronbach alpha based on the internal consistency method was used for calculating the reliability of the survey measure adapted. In this survey, quality tools were measured by 10 items which had Cronbach alpha of 0.857; while, quality improvement was measured by 5 items having Cronbach alpha of 0.823. Overall, both variables had Cronbach alpha above 0.70, rendering the reliability as satisfactory (Sekaran and Bougie, 2016; Zikmund *et al*., 2017).

Validity, on the other hand, is about the extent to which an empirical measure adequately reflects the real meaning of the concept under discussion. Validity needs to be established for measures which are newly developed or adapted from previous sources (Zikmund *et al*., 2017). Different subjective methods, such as, face validity, content validity; or the quantitative method, such as, the confirmatory factor analysis are available for testing the validity. This study relied on the face validity and the content validity. For face validity, survey items were checked whether they were adequately representing the underlying concept by the researcher. Content validity was established by comparing the survey items with the literature and taking the opinion of a university professor. Furthermore, to improve the reliability and validity, the pilot study was used.

RESULTS AND DISCUSSION

Demographic characteristics of the survey participants

The demographic characteristics of the survey participants are given in Table 1.

Table 1: Demographic characteristics of survey participants.

Label	Categories			
Gender	Male	Female		
	68	16		
Age group	18 to 25 years	25 to 40 years	40 to 60 years	
	36	41	7	
Educational level	Intermediate or less	Bachelor	Master or above	
	1	65	18	
Work experience	Less than 1 year	1 to 5 years	5 to 15 years	Above 15 years
	8	29	37	10

Based on Table 1, there was a total of 84 survey participants out of which, 68 were male, and 16 were female. Age wise, 36 participants belonged to the age group of 18 to 25 years; 41 belonged to 25 to 40 years; and 7 belonged to the 40 to 60 years. In terms of education, 1 participant had the qualification of intermediate or less; 65 had bachelor qualification; and 18 had master or above qualification. In terms of work experience, 8 participants had less than 1 year of work experience; 29 had 1 to 5 years of work experience; 37 had 5 to 15 years of work experience; and 10 had above 15 years of work experience.

Descriptive statistics

The descriptive statistics was used to identify which of the quality tools were frequently utilized by the sample firms. The results of the descriptive statistics are given in Table 2.

Table 2: Quality tools-descriptive.

Quality tool	Mean	SD
Flow charts	4.25	1.028
Quality circles	4.01	1.024
Statistical process control (SPC)	3.83	1.128
Team building methods	3.79	1.019
Suggestion box	3.73	1.165
Five Whys	3.65	1.035
Benchmarking	3.39	0.957
Supplier audits	3.17	1.118
House of quality (QFD	2.93	1.333
Pareto analysis	2.41	1.173

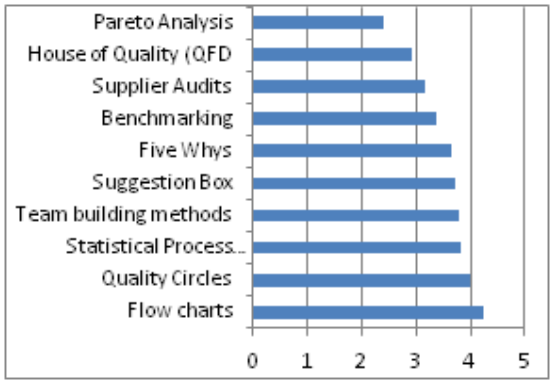

Fig. 1: Descriptive statistics - Quality tools.

Table 3: Regression.

	Model 1	Model 2
ISO certification dummy	0.088	-0.152
Organizational size (Medium)	-0.058	-0.141
Organizational size (Large)	0.075	0.027
House of quality		-0.028
Supplier audits		0.141**
Quality circles		0.175**
Pareto analysis		-0.083
Benchmarking		0.002
Statistical process control		0.033
Five Whys		0.065
Suggestion box		0.319***
R	0.071	0.764
R square	0.005	0.584
Change in R square		0.579
F statistics	0.134	9.182***
DW statistics		1.740

Independent variables: House of Quality, Supplier Audits, Quality Circles, Pareto Analysis, Benchmarking, Statistical Process Control, Five Whys, Suggestion Box

Dependent variable: Quality Improvement

Control variables: ISO Certification (1=Yes, 0=Otherwise), Organizational Size 1 (1=Medium, 0=Otherwise), Organizational Size 2 (1=Large, 0=Otherwise)

N=84, ***=P<0.001, **=P<0.01, *=P<0.05

The first objective of the study was to identify which quality tools were frequently utilized by the sample manufacturing firms. The results given in the descending form in Fig. 1 and Table 2 show that the flowcharts is the most commonly utilized quality tool (M=4.25, SD=1.02); followed by quality circle (M=4.01, SD=1.02); statistical process control (M=3.83, SD=1.12); team building method (M=3.79, SD=1.01); suggestion box (M=3.73, SD=1.16); five whys (M=3.65, SD=1.03); benchmarking (M=3.39, SD=0.95); supplier audit (M=3.17, SD=1.11); house of quality (M=2.93, SD=1.33); and finally, Pareto analysis (M=2.41, SD=1.17).

Regression analysis

For the second research objective which was about testing the effects of the use of quality tools on the improvement of the quality of products the regression framework was used. For this purpose, first, ten quality tools as independent variables were used. However, due to a large number of independent variables, the problem of multicollinearity was encountered, as VIF of two variables exceeded the critical value (>2). Therefore, the two independent variables were dropped, i.e., team building method and Pareto analysis from further analysis. Next, the regression was re-run and the underlying assumptions were checked for normality of error term, no multicollinearity, homoscedasticity, and the no autocorrelation. All these assumptions were satisfied in the data. The results of the regression are given in Table 3.

As shown in Table 3, in model 1, the control variables including ISO certification and organizational size of large and medium were entered. In the second model, the independent variables of use of quality tools were included. Results indicate that the use of quality tools along with the control variables explained up to 58.4% change in the dependent variable of quality improvement based on R square. Furthermore, the overall model is fit and significant (Fstat = 9.18, P < 0.05). The beta values indicate that on the dependent variable of quality improvement, the use of house of quality is having negative and insignificant effects (β= -0.028, P>0.05); supplier audit is having positive and significant effects (β=0.141, P<0.05); quality circle is having positive and significant effects (β = 0.175, P < 0.05); Pareto analysis shows negative and insignificant effects (β = -083, P>0.05); benchmarking is having positive but insignificant effects (β=0.002, P>0.05); statistical process control is having positive and insignificant effects (β=0.033, P>0.05); Five whys are having positive and insignificant effects (β=0.065, P>0.05); and suggestion box is having positive and significant effects (β= 0.319, P<0.05). Overall, these results indicate that use of quality tools is highly important for quality improvement especially the supplier audits, quality circles, and the suggestion box which turned out to be the most important quality tools based on this data.

The first objective of the study was to identify the commonly used quality tools in the manufacturing sector of Punjab, Pakistan. The results indicate that the commonly used quality tools are flowcharts,

quality circles, statistical process control, team building methods, and suggestion box, while, Pareto analysis, the house of quality and supplier audit are among the last three utilized quality tools. Since, there is no such similar study conducted in the Pakistani context, so a comparison of results could not be made. However, it is clear that flowchart and quality circles are highly useful as emphasized in the literature (Beckford, 2016; Ehie and Gilliland, 2016; Kumar and Sharma, 2017; Oakland, 2014; Ross, 2017). The flowchart is useful, since it provides a graphical representation of the process and has greater diagnostic value. Further, the quality circle provides a useful way of employee involvement. The statistical process control is a part of most of the quality programs, such as, ISO9001 framework. The positive role of the use of quality tools for the quality improvement is found in this study and is also established in earlier studies (Lim *et al*., 2017; Purushothama, 2010; Novokreshchenova *et al*., 2016; Wu and Jang, 2014). Overall, these results are consistent with the literature and signify the role of quality tools for bringing improvement in the quality in the manufacturing sector in the local context of Punjab, Pakistan.

CONCLUSION

The following conclusion can be made:

- Commonly utilized quality tools among the Pakistani manufacturing sector are flowcharts, quality circles, statistical process control, team building method, and the suggestion box.
- The use of quality tools is positively associated with quality improvement.
- Individual quality tools including supplier audit, quality circles, and the suggestion box have positive and significant effects on quality improvement.
- Hence, the use of quality tools is important and should not be ignored by the management of the manufacturing sector.

Based on the findings, it is recommended that the management of the manufacturing sector in Pakistan should give greater attention to the implementation of quality tools. Staff and management should also be trained for proper utilization of different quality tools. Quality control department should also give attention to the use of quality tools, especially the statistical process control, supplier audit, quality circles, and the suggestion box. The HR function should also customize the manufacturing staff training and incorporate the use of quality tools into the induction and training programs. Government and its subsequent agencies should also provide subsidized training and support to the local manufacturing organizations for better adoption of the quality tools. The description of quality tools, their uses, case studies, etc. should also be included in the curriculum of programs which are related to quality management.

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Competing interest

The author declares that he has no competing interests.

REFERENCES

Beckford, J., 2016. Quality: A critical introduction. Routledge.

Creswell, J.W. and V.L.P. Clark, 2017. Designing and conducting mixed methods research. London: Sage publications.

Dubey, R. and A. Gunasekaran, 2015. Exploring soft TQM dimensions and their impact on firm performance: some exploratory empirical results. Int. J. Prod. Res., 53(2): 371-382.

Ehie, I.C. and D.L. Gilliland, 2016. Use of quality management tools to analyse delivery exceptions in the motor carrier industry: a case study. Int. J. Prod. Qual. Manage, 19(1): 1-20.

Fonseca, L.M., 2015. From quality Gurus and TQM to ISO 9001: 2015: a review of several quality paths. Int. J. Qual. Res., 9(1): 167-180.

Kanji, G.K., 2002. Measuring business excellence. London: Routledge.

Katerina, D., 2002. The true motives behind ISO 9000 certification, their effect on the overall certification benefits and long term contribution towards TQM. Int. J. Qual. Reliab. Manage., 19(2): 151-169.

Kumar, V. and R.R.K. Sharma, 2017. An empirical investigation of critical success factors influencing the successful TQM implementation for firms with different strategic orientation. Int. J. Qual. Reliab. Manage., 34(9); 1530-1550.

Lasrado, F., M. Arif and A. Rizvi, 2015. The determinants for sustainability of an employee suggestion system. Int. J. Qual. Reli. Mgt., 32(2): 182-210.

Li, C. and H. Lee, 2015. Sourcing under supplier responsibility risk: the effects of certification, audit and contingency payment. Stanford University Graduate School of Business Research Paper No. 15-61. Doi:10.2139/ssrn.2689835

Lim, S.A.H., J. Antony, Z. He and N. Arshed, 2017. Critical observations on the statistical process control implementation in the UK food industry: A survey. Int. J. Qual. Reliab. Manage., 34(5): 684-700.

Magar, V.M. and V.B. Shinde, 2014. Application of 7 quality control (7 QC) tools for continuous

improvement of manufacturing processes. Int. J. Eng. Res. Gen. Sci., 2(4): 364-371.

Magnus, H.A., 2016. Interrupted time series versus statistical process control in quality improvement projects. J. Nurs. Care Qual., 31(1): E1-8.

Novokreshchenova, A.O., A.N. Novokreshchenova, and E.S. Terehin, 2016. Improving bank's customer service on the basis of quality management tools. Eur. Res. Stud. J., 19(3): 19-38.

Oakland, J.S., 2014. Total quality management and Operational Excellence: text with cases. Oxford: Routledge.

Pakdil, F. and F.B. Kurtulmusoglu, 2014. Improving service quality in highway passenger transportation: a case study using quality function deployment. Eur. J. Trans. Infrastruct. Res., 4: 376-393.

Psomas, E. and J. Antony, 2015. The effectiveness of the ISO 9001 quality management system and its influential critical factors in Greek manufacturing companies. Int. J. Prod. Res., 53(7): 2089-2099.

Purushothama, B., 2010. Effective implementation of quality management systems. 1st Edition. Pages 168.

Ross, J.E., 2017. Total quality management: Text, cases, and readings. 3rd Edition. Routledge. Pages 568.

Sekaran, U. and R. Bougie, 2016. Research methods for business: A skill building approach. 7th Edition. John Wiley and Sons. Pages 448.

Silva, D.A.L., I. Delai, M.A.S. Castro and A.R. Ometto, 2013. Quality tools applied to cleaner production programs: a first approach toward a new methodology. J. Clean. Prod., 47: 174-187.

Wang, L.R., Y. Wang, Y. Lou, Y. Li and X.G. Zhang, 2013. The role of quality control circles in sustained improvement of medical quality. Springerplus, 2(1): 141.

Wu, S.I. and J.Y. Jang, 2014. The impact of ISO certification on consumers' purchase intention. Total Qual. Manage. Bus. Excell., 25(3-4): 412-426.

Zikmund, W.G., S. D'Alessandro, H. Winzar, B. Lowe and B. Babin, 2017. Marketing Research. Asia-Pacific Edition: Cengage AU.