European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

Quality Tools, their excellence and their application From the perspective of quality professionals

Avesh Patil
Research Scholar, Doctoral Program, Karnavati University, Gandhinagar, Gujarat

Dr. Salim Shamsher
Sr.Dean, Karnavati University, Gandhinagar, Gujarat

Dr. Analjyoti Basu
Associate professor, Brainware University, Barasat, West Bengal

Dr. Sunil Patel
Professor, Karnavati University, Gandhinagar, Gujarat

Abstract:
Quality tools are used by all in personal as well as professional lives. The use however is not done based on the merit of the tool. The one generally available easily, or known to the user or the one that is in vogue is one that is used by the professional. It is surprising that a tool that carries so much importance for an organization and that can give a lot in return, is seldom chosen thoughtfully. The purpose of this paper is to assign a number to the tools that will provide guidance to the user on who to choose tools for the requirement. There is no claim made here to give a single tool for a given purpose, but the aim is to provide a set of tools that are good for a given actual level or the target level of quality the organization intends to achieve. The paper is divided into two distinct parts, first part tells about what all quality tools are used in the engineering industry explaining the use of the same and the second part deals with the rating of the tool. The rating tells that how good the tools are for improving a quality situation the organization has. The rating of the tools is done by actual inputs taken from the senior quality professional working mainly in automotive industry to understand how well a tool is and how it is used by them. Based on their experience, they have shared their rating on 1 to 10 scale. The rating of all is compiled to give a meaningful rating to each tool. The output of there search is in the form of list of the quality tools commonly used in the engineering – mainly automotive engineering industry with their rating that tells about the goodness of the tool in improving the quality of the product manufactured in the industry.

Keywords:
Quality Tools, Rejection, Supplier, Automobile Industry,

Introduction:
The purpose of this paper is to make people aware that there are multiple quality tools available and in use and quality professional can use one, that suits the purpose on the basis of scale provided in the paper.

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

Quality is one of the most used terms by humankind. And it is old as well. The Stone Age man too wanted to have quality tools to kill animals and for survival. Though it is so common and known for millennia's, defining quality is a task in itself and the "quality definition" of quality, which is defined by none other than ISO is: "The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs" [1]. The simpler definition of quality that 7 billion users perhaps will agree is "Fitness for use" defined by Juran (1950) [2]

Though the definition of quality is very old, the realization of need to improve quality was predominantly realized during or after World War II. Till then Europe and America were considered as the leaders in the creation of the good products and hence quality. It was Juran [2] who on the order of the US president worked with Japanese companies. It was around the same time, Prof. Ishikawa developed his way of looking at the quality, again in Japan. These two scientists changed the way world looked at the Quality.

Quality tools like quality, is age old entity. The hunter gatherer used touch feel as a method(tool) to understand the sharpness of the Stone Age tools. Over the period the tools got refined and added. The real boost in introduction or implementation of new quality tools came in 1950s. In the beginning the tools were simple to use and effective from the perspective of quality scenario then. The quality tools used by Ishikawa were very simple but gave a step improvement in the level of quality the Japanese firms were producing. On the base generated by Ishikawa, Juran generated a series of more advanced tools that transformed the Japanese industry so much so, that it took over US and European competitors in 80s. The late reaction by American companies, that later came up with revolutionary quality philosophies like Six Sigma was a recovery process.

Quality and Quality tools are interdependent. Historically a set of tools have helped an era to take a considerable jump in the level of quality or the way quality is maintained. There are tools and philosophies like 7 QC tools, CWQC, then TQM, Six Sigma that transformed the quality levels. However, the tools used in the early part of evolution are still used. They find takers to improve on the quality level. The reason for this is the quality level today, in those situations or companies, is in line with, what good companies had 50 years back.

It is worth a study, to understand how the Japanese transformation was made possible and if Ishikawa's work was necessary before Juran or if it would have not made any difference. The question is whether in 1960 and 70s, Sigma philosophy and its advance tools would have been useful.

Can you think of us of highly advanced tools that are making wonders today in the level of quality in 1980s. They probably might not have made sense then.
The answer lies in the statement by Hagemeyer, Gershenson (2006) [3] which says that the use of quality tool has to happen at proper time in the process.

There are many quality tools and techniques; at least 30 popular ones. However each of these find different application. They differ in the way they provide results. Some are very basic and some are very advance. The basic ones if applied by a highly effective (in terms of level of quality) organization is waste of efforts or time, whereas the high end tools used by an organization with

basic infrastructure and level of understanding of quality is waste of money spent on tools and will lead to failure.

Some parameters that are critical in selection of the tools are it's effectiveness in improving quality,Degree of difficulty (understanding and usage) and Cost
Which tool to be used when is a big question mark in the minds of the quality professionals or the business owners!
The effort is to explain how the quality tools can be stratified in to various levels so that the same could be used or implemented in the order of effectiveness to improve the quality.

Literature Review:
To understand how the various authors have looked at the Quality tools, its usage, excellence and application the author referred multiple papers and theses published and could get a lot of insight on these aspectsas mentioned below.

It was observed that there were quiet few authors who have studied the tools at an individual level like Shanmugaraja M (2014)[(1)]worked on a novel concept of using QFD and TRIZ. It was a successful effort to extend the Six Sigma beyond the known boundaries by unifying to high end quality tools that was never done before to form what the researcher called a TPE model. This helped the organizations to achieve expected level of service quality, productivity, and efficiency. He concluded that the TPD method resulted in productivity in the manufacturing industry and customer satisfaction in the service industry. The outcome provided reduced rejection of defect rate in manufacturing industry while the equivalent effect in the service industry was in the form of reduced customer complaint. Which means this fusion of high-end tools provides desirable results in the quality, which reduced the rejection by 95 to 99% and enable the rejection monitoring from percentage to the PPM.Similarly Keki Bhote (1991)[(2)] explained the use of Paired Comparison, Component Search, Variable search. This test served as a bible for the quality professionals in the later part of 90s and in 2000s. This did explain the way the tool to be used and also gave idea on where to use, but is more focused on the case studies.Another publication by Desai Y. P.(2019)[(3)]has a little extended scope wherein he tried to establish effect of four quality tools used in TQM on the product in radio frequency domain. The tools used were Pola Yoke, House of Quality (also called as Quality Function Deployment), Scatter diagram and Design of Experiments. These are some high-end tools and give a good perspective about how these would be affecting the quality of the product. He found out that the House of Quality (QFD) is a first step to understand the requirement of the customer and helps in defining right specification of the product that would suit the customer, is more a design tool rather than a quality improvement tools. Scatter diagram is a good tool to ensure the quality of the product over the lifetime by using regression analysis in tandem with the scatter plot. Poka Yoke is an effective tool to eliminate or avoid defect or give advance warning to the user or maker about the failure and that could help in minimizing the defects. Design of Experiment he says is used effectively to improve the quality once it gets up to a particular level. It uses the available data, works around it, and gives breakthroughs in breaking the status quo in the quality levels. Overall, he found these tools extremely important. This was an effort where in the author tried to give more insight on the use of tools.Magar, Shinde (2014) [(4)]in his effort on the basic quality tools the 7 Quality Control (7 QC)

Tools he explained how these could be used for Continuous Improvement in Manufacturing Processes

Then there were publications on the basics of the way Quality initiative takes footing at the grass root level in the form of use of ISO 9001 and formation of Quality Circles. Like, Abhay Kumar(1990)[6] studied very elementary attempts on the shop floors in the form of Quality Control Circles or simply Quality Circles (QCs) as an attempt to improve on the day-to-day issues observed by the worker. His work throws good light on the movement of involving the frontline workers in issue resolution. 6 years of existence of the Q C Circles was studied for this purpose from the Rourkela Steel Industry. He commented that the 94% of the suggestions were implemented and that speaks volume about the quality of the outcome. However, he has not much emphasized on the Quality Improvement Potential of these Q. C. Circles which is a major deliverable of this attempt.Similarly Dasgupta, Ranjan(2011)[5]made attempt to study the Q. C. Circle movement in Kolkata. He observed that the Q C Circle movement though beneficial is having varied level of implementation and results. His work was more on the organized attempt rather than the outcome.Where asBelsare, Mrunal Nitin's (2012) [7] work mainly focused on industry in and around Pune. It is based on the Quality Certification – ISO9001 – 2008 and focuses mainly on the HRS aspect. It gives a different perspective of the Quality System usage but does not really give a lot of benefit to the study of quality tools. Similarly Rosammal Elizabeth Jebarani, A's(2007) [8] work was basically about how QMS was employed in export-oriented manufacturing industries and had little to say about the effectiveness of the same in terms of the quality level or the improvements achieved in other business aspects.
All these studies were focused on how the basic quality systems and groups were established in a company, organization or region.

Then in line with the development of the Quality process in the organizations, the later part of the publications were focusing more on Total Quality Management (TQM). In research by Kulkarni G. R.(2017) [9] it is mentioned that the organizations she studied, are having a good understating of the TQM principles in both manufacturing and service industries and it has helped in developing the companies to achieve increasing level of performance. TQM as per her helps achieve business leadership by engaging and inspiring teams and by having customer sensitive responses.However as per the study conducted by Mani, T P (2012) [10] indicates that TQMhas two different perspective classical and contemporary and found that the current TQM efforts are practitioner oriented or a Quality Guru oriented and has worked on some 40 element factors and tried to provide new TQM principle as a concept and not as a total package. In line with this, literature review was done to understand how the TQM has helped the industry, In one such research Ray, Suryyanarayana(2011) [11] tried to study the use of Total Quality Management (TQM) in Indian industries. His research was based on the application of TQM and allied quality tools. However, his study has limited coverage on how the tools were able to improve the quality level. It was more on how the management or users perceive the tools and he conclude that the implementation of the TQM has a long way to go in making it a sustainable quality methodology.Mostafa Moballeghi(2007) [12]on the other hand in his study on TQM compared multiple companies on the extent to which the TQM culture was adopted. His work was to find out what helps effective implementation of TQM and he concluded that Top management support, long terms orientation and persistence, customer orientation, employee involvement and training were important factor on implementation and

sustainability of TQM process. However how far it helps in improving the quality level was not much defined in his work.

As the industry started moving towards the more advanced tools the work by the authros too reflected the change. The Six Sigma was the buzz word in the industry post 2000 and it started showing in the work by the scholars. For example, in research by Dilip Kumar (2020) [13] which had reference from a Six Sigma program in one prominent foundry in Agra to improve the quality of the casting and reduced rejection. He found that Six Sigma tool is very effective in studying the effect oof multiple factors in the foundry and how it helps in improving the quality and that gets side effects in the form of increased productivity, cost reduction and reduction in pollution level. At the end he said this approach helped in survival of foundry industry in Agra. He highly recommends the use of six sigma tool for quality improvement. Similarly,Abhay Kulkarni (2006) [14]studied Six Sigma effect on the performance of manufacturing sector in Pune. He confirmed that Six Sigma can provide high magnitude and sustainable results irrespective of type and size of the industry. The motivating factors to adopt the six-sigma methodology definitely is the improved level of quality but it gives cost reduction and customer satisfaction as added benefits. The focus of the companies moves from quality to cost reduction to customer satisfaction as they keep achieving the intended goals. He concluded his thesis with the guideline which speaks about achieving accuracy (quality), speed and agility to face the next level of business in the digital era. In similar lines, K. Srinivasan (2016)[15] in his research on use of DMAIC (Define – Measure – Analyze – Improve and Control) way of Six Sigma implementation and how it helped in achieving global quality levels by systematic use of the tool. He found that compared to the conventional tools, Six Sigma which is an improvement philosophy can yield you unfathomable depths in the quality improvements. The exercise gave results like 31000 DPMO reduced to 1500 and 780,000 to dead zero achieving Six sigma level of quality. This was against the backdrop of multiple tools being used earlier that has given results nowhere near to 6 Sigma and were able to go max to 3.5 sigma which by any standard was mediocre level. He recommended use of Six Sigma methodology of DMAIC to achieve world class levels of quality and defines this as the premier tool for quality improvements.

As the Six Sigma becomes more and more common, the industry moved a step forward to Lean Six Sigma, the same started appearing in the scholar's work. For examplePN Ramkumar (2020)[16]conducted systematic research on use of Lean Six Sigma to reduce improve the quality level of the Small and Mid-Size Enterprises (SME). He found that the use of Critical Success Factors (CFS) and that itself is a process that leads the Six Sigma exercise. In the process he found that the teams were able to do generate decisive knowledge on the process, issues, and possible solutions. With Lean Six Sigma to follow the team was able to improve on the quality level by 20% and cost reduction by equivalent amount. This was a clear study on the extent of improvement achieved by using a high-end quality tool. In another effort Mohan Prasad M(2020) [17]in his research has studied the effect of one of the quality tool in the form of Lean Manufacturing and its effect. He worked on the Pump Mfg. Industry but was related to Induction motor manufacturing. He tried to study how the tool help in quality and quantity but ends speaking more about the quantity. So this leaves a **gap** to study the effect of Lean Manufacturing in Quality.

Thus overall the work on the Six Sigma or Lean Six Sigma was in relation to the implementation in a particular company, location and also in other cases on how it has helped the one who is using it.

The Business Excellence Model that has Quality is each aspect of the business too has made its appearance in the work of some schloars like the work by Sedani, ChetankumarMathuradas(2011) [18] conducted detailed research on the quality practices and performance. In his study he covered Quality Certifications (ISO 9001), Total Quality Management (TQM) and has gone even farther to include the Business Excellence Model (BE) Certifications and to study the effect of these on the performance. He found that there is significant correlation between performance and the quality practices adopted by the organization. Whereas he commented that ISO 9001 though is a hygiene factor, it's length of existence in the organizations is not correlated to the performance, however doing away with it is not recommended. He also tried to correlate the relationship between having ISO 9001 certification before TQM implementation and before Business Excellence efforts and concluded that ISO 9001 does not aid in anyway in increasing the performance of TQM or BE. It's a big revelation that ISO needs to take account and do major grounds up change to help industry get benefit out of certification. His work related to the size of the organization, age of organization, technology set up also tried to relate to quality performance, but this is not in the interest of the topic here. This study however does not speak a lot on the quality levels keeping this important aspect of performance ignored.

Overall the work was done in relation to the individual quality tools, quality methodologies and quality systems leaving a large area that needs some work by scholars, which is in relation to the selection of tools.

Research Gap:

There has been a lot of study in quality tools and in quality systems at a standalone level. There were efforts to provide information on goodness of each tool and how to use it. The study of quality systems like ISO, QMS is there in plenty but is related to the method and not related to the outcome it generates. The Quality philosophies like TQM, 6 Sigma are also covered widely but are mainly related to singular achievements or how it was implemented in a company or region or a group of companies.

However, there is a void in terms of understanding which tool is good for which purpose. There is no study that would give some quantitative assessment of the tool such that the quality professional or decision maker can decide which tool to be used.

A. Selection of the topic:

Before selecting the topic of study based on the literature review, a survey was conducted to understand what are the parameters that affect the quality. The results are mentioned below.

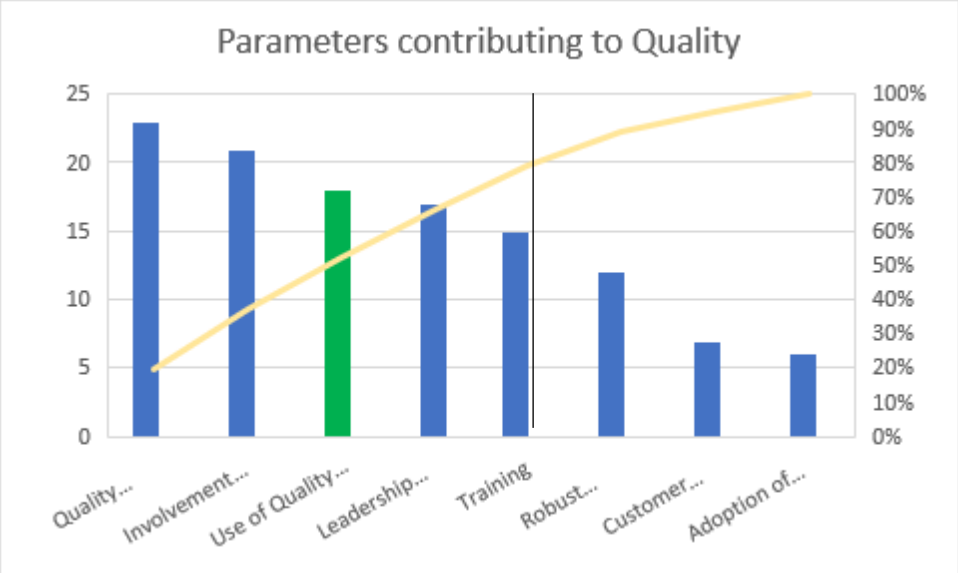
Table 1: Factors affecting the Quality

Sr. No.	Parameter	Number of votes
1	Quality Culture – Use of Quality Policy and Quality being part of the Vision and mission	23

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

2	Training	15
3	Use of Quality Tools	18
4	Involvement of the operators – the front-line people who are involved in the manufacturing or processing	21
5	Customer push on Quality	7
6	Leadership involvement in the Quality - Revies	17
7	Robust inspection and audit process	12
8	Adoption of business excellence model	6

Chart 1: Factors affecting the Quality



The topic of commonly used Quality Tools which is withing top 80% contributors and within top 3 reasons for Quality Level, became part of the study. The Quality Tools weredocumentedbased on the experience of the authors and was explained to the Quality Leaders and professionals from the Automobile Industry and their opinions are compiled together to explain the hierarchy of the tools. The list go amended after first five interviews and the previous respondents were contacted again to take their views on 3 Quality Tools added later. The hierarchy as explained by the Quality Professionals is done on the basis mentioned below:

1. Ability to improve quality by avoiding failures
2. Ability to resolve issues so that the failure does not occur
3. Overall process and systemic improvements that builds quality inherently

The experts have mentioned their opinion on the use and effectiveness of these tools in various situations they have come across and have provided rating in the form of 1 to 10 scale based on

their experience using those. This scale and the compilation of this information gives understanding on which tool to be used when.

The use of Quality tools is important as the study suggest and the research gap indicates lack of rating of these tools. These two are complimentary to each other, hence "Rating of Quality Tools" is decided as topic of this study.

Research Methodology:

The efforts to rate the tools is done in following steps

1. Make list of the quality tools know
2. Conduct survey and find out the ones that makes sense in including in the study. Keep option open to amend the list tools after a few initial interviews.
3. Rate the tools and statistically study the outcome to assign a number to each tool based on its perceived goodness.

List of quality tools

7QC tools, SPC, PokaYoke, House of Quality, Scatter plot, Paired comparison, What What-not analysis, Multi-vary Chart, Component search, Variable search, Regression analysis, Design of Experiments, TPS, TQM, 6 Sigma, FMEA, Gauge R&R, Axiometricdesigns, CTQ tree, Value stream mapping, TRIZ, Business process mapping, Chi Square test

Before understanding how these tools are rated, the article below explains what these tools are:

1. 7 QC tools – As suggested by Magar, Shinde(2014) [(4)] The 7 QC Tools are simple statistical tools used for problem solving. These tools were either developed in Japan or introduced to Japan by the Quality Gurus such as Deming and Juran. In terms of importance, these are the most useful. Kaoru Ishikawa has stated that these 7 tools can be used to solve 95 percent of all problems. These tools have been the foundation of Japan's astonishing industrial resurgence after the second world war. These tools are used by companies that are at a very elementary levels of quality
2. SPC – As mentioned in ASQ Journal [18] Statistical process control (SPC) is defined as the use of statistical techniques to control a process or production method.Statistical process control is generally used on mass produced components using a repeated process that can be made to deliver product conforming to the specifications, by following a process that ensures the components are checked at a particular period or interval and checked if these are falling between defined specifications (which could be other than the drawing specification) and if not corrective actions are taken to ensure they fall within those specs. This ensures that the effects are reduced or eliminated. These tools are used by companies that are striving for a world class quality and are used as stepping stone for moving in that direction.
3. PokaYoke – Called also as Mistake Proofing is a mechanism that avoids error or rejection or avoids passing on the non-compliant product to next stage. This ensures that the quality is built in the process rather than built by selection. A very high number of PokaYoke mechanisms used in an organization, ensures near defect free performance.
4. House of Quality– it is a philosophy that is used to convert stakeholders' requirement in to design specification or decide approach to be followed. John R. Hauser and Don Clausing(1988) [(19)]I their Harvard Business Review Paperof May 1988 say, "the house of

quality is a kind of conceptual map that provides the means for inter functional planning and communications. People with different problems and responsibilities can thrash out design priorities while referring to patterns of evidence on the house's grid". This basically is not a quality tool but an approach used by designers.

5. Scatter plot – this graph of a formation indicates relationship between two variables and hence tells a quality professional on what action needs to be taken for a dependent variable to be corrected by an experimental (which quality professional can alter) variable.
6. Paired comparison –In his book Titled World Class Quality, Bhote Keki, (1991) [(2)], mentioned Paired comparison as a tool that helps to reduce a list of possible cause to a family of likely causes.This is a problem resolution tool that helps in identifying root cause by elimination method. Here a multiple pairs of ok and not of products are compared for various parameters including drawing specification. A large number of pairs help in identifying root cause. This is seemingly simple tool that gives very high accuracy results and this tool canbe used by even novice operators.
7. What What-not analysis – It's a very basic but effective tool in which quality and design professionals observe two designs or two products – one working well and one not so well – and try to find out how these different on a particular criteria. E.g. One may observe design A has bend radius of 40 mm and B has 60 mm. design A has 1 mm thick tube and B has 0.8 mm, design A uses copper and B uses steel and so on. At the end you may come across a critical to quality parameter that is making difference. In the process you may seek support from using other tools to arrive at the conclusion.
8. Multi-vary Chart – it's an advance control chart that in addition to piece-to-piece variation considers within piece and time to time variation as well providing a larger picture of the scenario in hand
9. Component search – World Class Quality, Bhote Keki, (1991) [(2)], mentioned this tool as one that identifies a culprit component. This tool is very effective problem resolution tool that helps identify root cause by swapping one component at a time between a good and bad assembly or machine
10. Variable search – In his book, World Class Quality, Bhote Keki, (1991) [(2)] suggested this tool to be used after Paired Comparison, Component search to zero in on a specification of the component that is the real culprit. In his book, World Class Quality Using Design of experiments to make it happen, he suggested this tool to be the Rolls Royce in search of Red X.
11. Regression analysis – it is the analysis of the scatter plot that provide a relation between two variables to arrive at the most appropriate level of the control variable to get desired level of dependent variable
12. Design of Experiments – This many call as the king of problem solving tool which uses a structured experimentation with carefully selected levels of the components or variables that will give the most appropriate combination. The beauty of the tool is that the answer could be a level that was never tested! There are different types of DoE, one is the conventional DoE and other is the Shinin DoE, made popular by Keki Bhote, through his book World Class Quality, Bhote Keki, (1991) [(2)]
13. TPM – Avoids breakdown and rejection by a carefully structured maintenance procedure to avoid breakdown of machine and hence avoid rejection, improving quality

14. TQM – This is a quality philosophy that considers quality in everything you do. Made popular by Juran. In Juran's Quality Handbook, 5th Edition – Joseph Juran (1987)[20] defined a quality trilogy of quality planning, quality control, and quality improvement. He suggested Quality to be not part what we do today, but it starts from the birth of the part of mechanism or machine at design stage, followed by maintaining the quality at manufacturing stage that is today and improving it further by making continuous efforts to elevate the quality.
15. 6 Sigma – Comprehensive methodor philosophy that uses multiple tools in combination to arrive at world class quality. This tool took the industry by storm in 1990s after Motorola, Honeywell and General Electric made most use of it to deliver spectacular results in quality and subsequently financials. It is still considered as the philosophy to follow by many companies from all fields of manufacturing, process as well as service industry.
16. FMEA – this is a tool used by designers and process experts to identify source of errors and avoid those by proper design or proper process improving long term quality level
17. Gauge R&R – this again is not a quality tool but a hygiene factors that ensures that you produce right component using a capable inspection tools
18. Correlation – this is an attempt to establish relationship between two variables
19. Axiomatic design–this is not a quality tool and like House of Quality is a design methods to convert stakeholder requirements and reduces the number of attempts before arriving at the right one
20. CTQ tree – Critical To Quality has two meanings. One for customer and other for the product or process. What it means is the dimensions, process parameters that are important to maintain quality
21. Value stream mapping– This is a process improvement tool that lays foundation to the defect free process
22. TRIZ – This is a recent tool that is still evolving. IT is inventive problem solving tool to resolve complex quality issues.
23. Chi-squared test – this is a statistical tools that avoids you from getting carried away by the results at firt glance. It tells you if the difference in the two sets of data (generally one good or desired and other bad or undesired) is by natural variation (chance cause) or is the results of the parameters a professional is trying to study. This we removed later owing to difference of opinion amongst the professionals.
24. Business Process Mapping/Check sheet – this is not a quality tool but at the end it provides a process that will support quality by systematically designed process. This again was removed later owing to difference of opinion amongst the professionals.

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

How do we use these 20+tools? Which one to use?

This is done by involving the expert quality professionals from automotive industry. The rating is done by around 20 senior quality professionals with 15 to 35 years of experience based on how these tools have helped them in various scenarios to improve the quality level

The rating is done in 1 to 10 scale with one being little or no influence on quality.

2-3-4 are the ones that help you at the ground level to improve quality

5-6 have historically helped the companies and nations to improve the quality and move to a little less than the world class quality

7-8 are the tools that are predominantly used by expert quality professionals to take a step jump in to the world class quality

9-10 are generally the tools that are used only after all the other tools are well in use and are for very high level or complex situations and that distinguishes you (company) as one that is using truly world class tools and strategies on quality.

Data Collection and Data Analysis

Based on the inputs given by the quality professionals, following tools were selected for the study:

Table2: List of Quality Tools, Techniques, Methodologies and supporting tools

Sr. No	Quality Tools	Part of study
1	7 QC tools (Cause and Effect Diagram, Histogram, Scatter Plot, Check sheet, Control chart, Stratification, Pareto)	Yes
2	SPC	Yes
3	Poka-Yoke (Mistake Proofing)	Yes
4	House of Quality	Removed
5	Scatter plot	Yes
6	Paired comparison	Yes
7	What What-not analysis	Yes
8	Multi-vary Chart	Yes
9	Component search	Yes
10	Variable search	Yes
11	Regression analysis	Removed
12	Design of Experiments	Yes
13	TPM – Avoids breakdown n rejection	Yes
14	TQM	Yes
15	6 Sigma – comprehensive methodology	Yes
16	FMEA	Yes
17	Gauge R&R	Yes
18	Correlation	Yes
19	Axiomatic design	Yes
20	CTQ tree	Got added later
21	Value stream mapping	Got added later

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

22	TRIZ	Got added later
23	Business process mapping	Removed
24	Chi Square test	Removed

Note: Some unconventional tools that are not directly related to Quality but help indirectly like VSM, TPM, Axiometric design, CTQ tree, 5S are considered while discussing about quality tools. VSM, TRIZ, CTQ got added later.

Data collection on the selected tools

Identified quality professionals working in various automobile companies andauto component suppliers. Communication was sent to them, and initial inputs were taken on mail. Most of these were interviewed to understand how they have rated, and some ratings were corrected post discussion with their agreement. The changes were mainly due to inadequate knowledge of the tools and a few were due to wrong interpretation of the rating scale and due to different names given to the same tool. Correction was done, only after they agreed that the change is needed, and rating was done by taking their inputs.

Results and analysis

After capturing data, the authors found that each of tools has different rating and some of the ratings were very different than most of the other ratings. The data was then compared by multiple ways.

1. The average of all the tools rated by every person was found out. This was done to ensure that a person is notvery lean in assigning number or is very strict on doing so. The results are as shown in the chart 2 below

Chart 2: Average of all Quality Tools rating by individual QA professional

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

2. This is very much possible and is acceptable as well. However, an outlier may disturb the analysis hence Boxplot was done on the average rating and identified if there are any outliers. The result is as shown, with one outlier.

Chart 3: Quality Tools rating by QA professionals

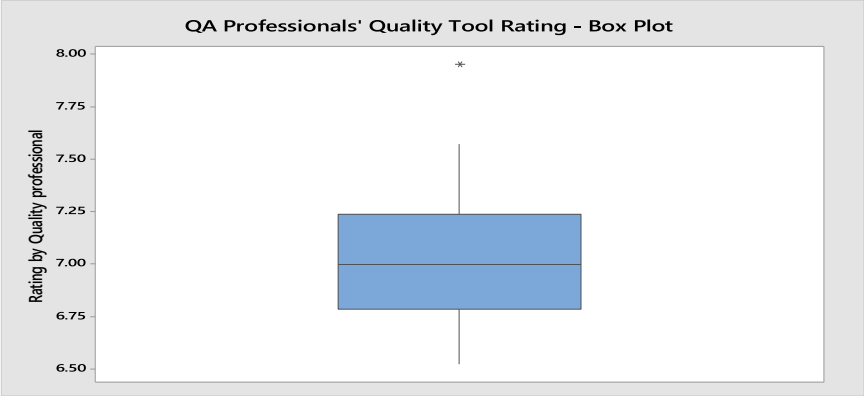
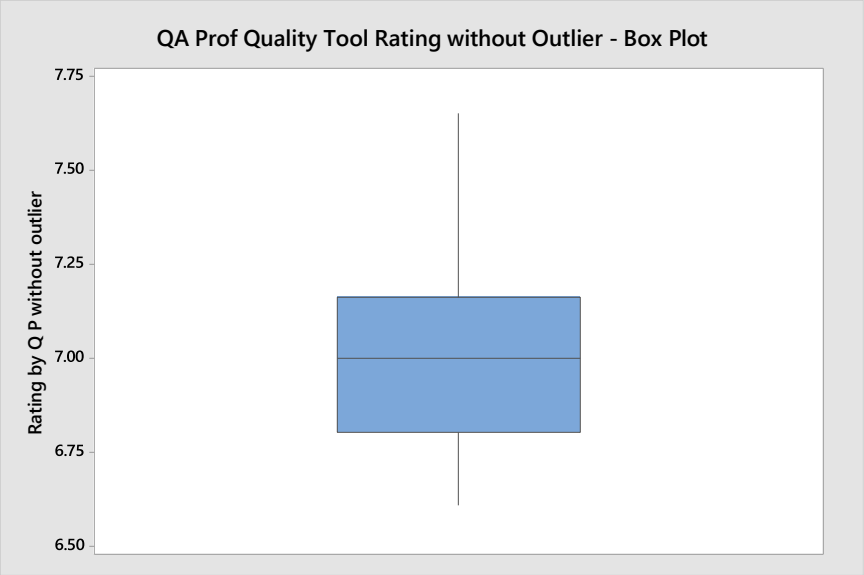


Chart 4: Rating without outliers



Reading of that assessor were removed and reviewed the box plot again, It showed no more outliers as can be seen in Chart 4.

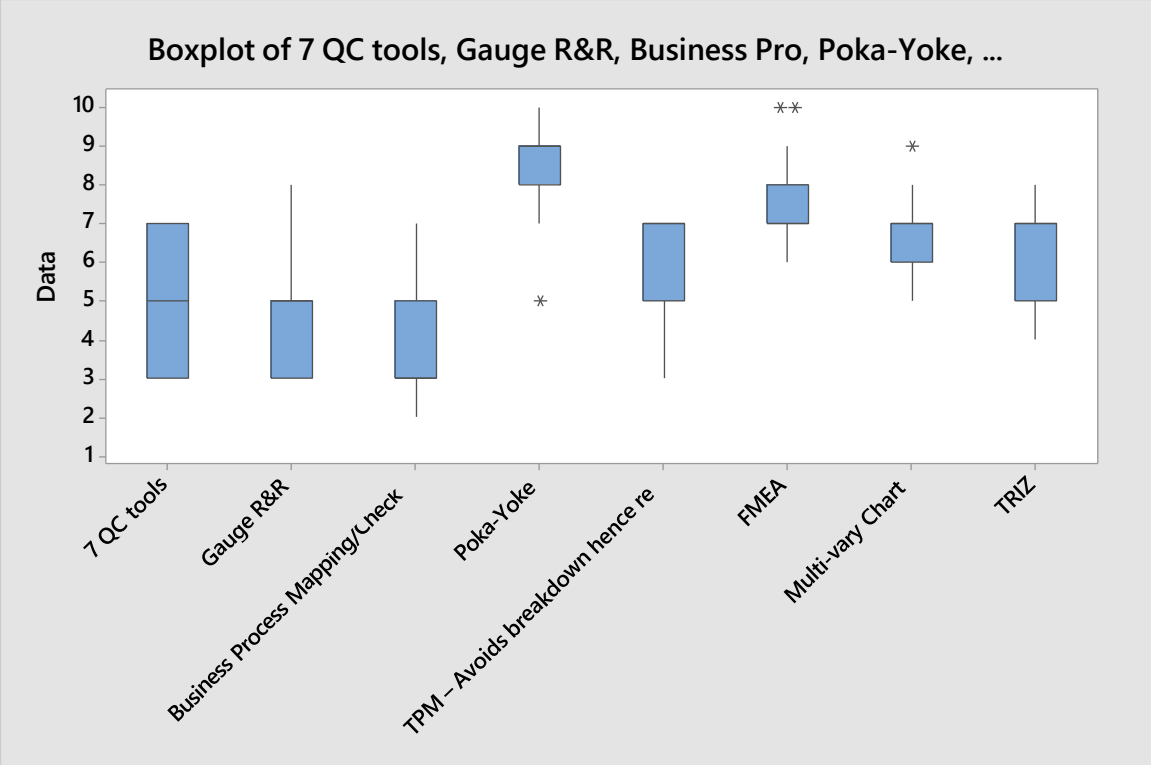
3. The authors then compared range of the rating for each tool and rating of the tools were scrutinized for tools having rating range equal to or more than 4. There were 7 such tools for which again Boxplot was done and removed rating that wereoutliers. The Boxplot of all these 8 tools are mentioned below

i. 7QC Tools
ii. Gauge R & R
iii. Business Process Mapping
iv. Poka Yoke

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

v.TPM
vi.FMEA
vii.Multivary chart
viii.TRIZ

Chart 5: Tools with Range for rating at 4 or more



4. The first analysis and the second analysis was then changed in sequence to see if there is any significant difference in the output, which was not observed.

How to arrive at the rating for each of the tool?

When the data is uniformly distributed, the best tool to use for arriving at the central tendency of the data is mean. While when the data is having a wide range and has some outliers, the Median is the best representative of the central tendency of the data. The authors also checked the difference between the mean and Median and the observations were not very different, increasing the confidence on the data analysis. The details of the mean and median difference are mentioned in the table below:

Table 3: Rating by the Quality Professionals

Sr. No.	Name of Quality tool or Systems	Median	Average
1	Business Process Mapping/Check sheet	3	3.44
2	Gauge R&R	5	4.72
3	7 QC tools	5	5.24
4	SPC	5	5.92

5	TPM – Avoids breakdown hence rejection	7	5.76
6	TRIZ	7	6.16
7	Multi-vary Chart	7	6.88
8	CTQ tree	7	6.92
9	Correlation	7	7.28
10	Axiomatic design	7	7.33
11	FMEA	7	7.40
12	Paired comparison	7	7.40
13	Value stream mapping	7	7.40
14	TQM	7	7.76
15	Design of Experiments	7	8.24
16	What What-not analysis	8	8.00
17	Variable search	9	8.40
18	Component search	9	8.44
19	Poka-Yoke	9	8.52
20	6 Sigma – comprehensive methodology	10	9.68

Implications of Study:

Based on the rating done following observations are derived. Some reputed Quality Experts were consulted while arriving at the implications.

1. In spite of professionals working in same field rate the tools, the rating vary by a big margin. When discussed in details with the professionals it was found that the rating was based on the exposure of the professionals to the tools and to the processes and systems of the organizations, they have worked in.
2. Some of the tools like Six Sigma have got consistently high rating and are the favorite tools or methodologies of the quality professionals
3. The aged old tool, 7 QC tools, though have got lower rating, the interview indicated widespread use of the tool.
4. The rating of SPC surprised the authors and after detailed discussions with the experts it was revealed that, with growth of technology and increase in the accuracy of the machines, process capability is inbuilt. The suppliers supplying to Auto OEs are definitely working on SPC, but it seems they get it inherently and they are now focusing on other tools to reduce rejection.
5. There are quiet few tools in the rating 7, which is the cluster of tools widely used in the industry except for TRIZ. A separate study might be needed to understand why.
6. Professionals had dispute over some tools if they at all are quality tools these include QFD, Gauge R & R, regression analysis etc. Authors have removed a few from the study.

At the end,it’s known that the quality tools are not the same and through this process one gets to know how to look at the quality tools from the applicability purpose. The quality managers can decide looking at the scale, which tool to use for which status the organization is. The article tells about the rating group like 3-4-5 or 7-8 and how these will have effect on the organization. Once the quality manager decides what level s/he is in and wants to go to, s/he can choose out of the rating and start the experiment. Remember this is not a foolproof solution but one that will surely give better results than a naïve attempt.

Once the quality scale is used across the organizations, and it will, the company can claim their quality levels by the use of quality tools and market itself as a progressive or world class player from the quality levels perspective. Even for winning the business they could provide a single number of the scale that describes the quality level of the organization.

Conclusion:

The quality tools have a varied degree of usage in industry and each tool has its own position in an organization or with a quality professional that can be different than other organization and the professional. The tools have evolved over the time. Some age-old tools have still maintained their significance. It is up to the quality professional on how they use these tools effectively. It was however very well understood during interviews that the use of the tools is not widespread andneeds more rigor for better spread and right usage.

Gaps and future scope:

Though a huge amount of work is done in the field of quality and the quality and quality tools gaps that needs some attention of future researchers. These are:

1. How to use the tools based on the rating.
2. The degree of difficulty of simplicity of use of the quality tools.
3. The sequence of usage of tools when you want to up your quality levels.
4. Matrix of tools useful for various industries. This will ensure that irrelevant tools will not be used by the quality professionals.
5. Combining a few tools together to give breakthrough performance.

References:

1. Shanmugaraja M (2014) – Quality improvement through the integration of Six Sigma QFD and TRIZ in manufacturing and service organizationshttp://hdl.handle.net/10603/26258
2. (2) Keki Bhote (1991) – World class Quality, UsinigDesign of Experiment to make it happen – Amacon American Management association
3. (3) Desai Y. P. (2019) –Use of Total Quality Management Tools to improve radio metric quality of Optical Remote sensing data product - http://hdl.handle.net/10603/269589
4. (4) Magar, Shinde (2014) – Application of 7 Quality Control (7 QC) Tools for Continuous Improvement of Manufacturing Processes - International Journal of Engineering Research and General Science Volume 2, Issue 4, June-July, 2014
5. (5) Kumar Abhay (1990) – Quality circles in India a case study of Rourkela steel planthttp://hdl.handle.net/10603/128801
6. (6) Dasgupta, Ranjan (2011) – Effectiveness of quality circles a study of some selected industrial enterprises in and around http://hdl.handle.net/10603/155897
7. (7) Belsare Mrunal Nitin. (2012) – Study the impact of ISO 9001 2008 certification on selected hrm practices of large-scale automobile industries in Pune region during the period 2002 to 2012http://hdl.handle.net/10603/219675
8. (8) RosammalelizabethJebarani, A (2007) – Quality management systems of export industrial units in Tamil Naduhttp://hdl.handle.net/10603/125357
9. (9) Kulkarni G. R. (2017) – Acritical study of total quality management in engineering industrieshttp://hdl.handle.net/10603/142431

10. (10) Mani, T P (2012) – Contemporary total quality management is indeed classicalhttp://hdl.handle.net/10603/105451
11. (11) Ray, Suryyanarayan (2011) – Tota quality management practices in India a study of selected companieshttp://hdl.handle.net/10603/156724
12. (12) Mostafa Moballeghi(2007) – Total quality management (TQM) implementation in automotive industry: a case study of selected firms in India http://hdl.handle.net/10603/15886
13. (13) Dilip Kumar (2020) – Exploring Sustainability Operational Excellence and Eco-Friendly Environment through Six Sigma in Foundrieshttp://hdl.handle.net/10603/323855
14. (14) Abhay Kulkarni (2006) – The Role of Six Sigma for Achieving Business Results in Manufacturing Sector With reference to Select Industries in Punehttp://hdl.handle.net/10603/155471
15. (15) K. Srinivasan (2016) – Investigations on achieving six sigma level quality through DMAIC phases in small size furnace manufacturing environmenthttp://hdl.handle.net/10603/196092
16. (16) Ramkumar P. N. (2020) – Some investigations of process and productivity improvements in small and medium enterprises through lean six sigma implementation
17. (17)Mohan Prasad, M (2020) – Investigations on the implementation of lean practices in Indian pump manufacturing industryhttp://hdl.handle.net/10603/340749
18. (18) Sedani, ChetankumarMathuradas(2011) - A model for adopting good quality practices in industries and assessing its impact on manufacturing practices and performancehttp://hdl.handle.net/10603/5398
19. (19) ASQ Journal https://asq.org/quality-resources/pub
20. (19) Hauser, Clausing (2018) – House of Quality Harward Business Review May 2018
21. (20)Joseph Juran (1987) – Juran's Quality Handbook, 5th Edition