

QualyTools: an online collection of tools for quality management and control

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Abstract

Quality practitioners use a varied set of tools to diagnose, stabilize, improve and control business processes and aid in decision making. Most of the tools are well known and several implementations exist across statistical software packages or other software, and online resources. While some tools are generic (e.g. a histogram) other tools are more specific to quality (e.g. a control chart), but they are often integrated into expensive software bundles that are of little use for quality practitioners.

We developed an application (*QualyTools*) that integrates a set of essential tools for quality management and control. These tools cover common needs and include distribution analysis (histogram and scatter plots), Pareto charts, control charts, and capability analysis. The tools were implemented in an application developed using the R *shiny* package and framework. The collection was published online and can be freely used. We also kept the application code open to collaboration, by means of a GitHub repository.

The primary objective of the application is to provide an integrated, efficient and accessible solution for statistical and visual analyses, allowing users to transform data into relevant information to support decision making. The tools can be a resource for practitioners and quality management students.

Keywords: Quality Tools, Statistical Process Control, R shiny, Open Source

1 INTRODUCTION

In ISO 9004, the quality of an organization is defined by how its characteristics meet the expectations of stakeholders, aiming to achieve sustained success [1]. To accomplish this, an organization must apply the quality management principles: customer focus, leadership, people engagement, process approach, improvement, evidence-based decision making, and relationship management [2].

Some quality tools are widely used, and Kaoru Ishikawa is often credited for stating that “95% of process problems can be rectified using the 7 Basic tools of Quality” [3]. The same study found that the main advantage of Ishikawa’s tools was to provide a structured approach to problem solving and help to solve the problems by clear definition, measurement and analysis phases. The study also found that, although the Ishikawa tools were mainly used in manufacturing, they were also applied to other sectors, such as IT and finance.

A literature search reveals that the tools are still widely applied, mainly in manufacturing, but also in other areas, such as healthcare [4], education [5] or finance [6], among many other examples.

One of the main drives for the implementation of this project was the lack of freely available similar tools. To our best knowledge, there is no other collection of tools like the one that was developed. For a long time, the American Society for Quality (ASQ) offers a collection of quality tools templates, implemented as computer worksheets for each individual tool [7].

2 METHODOLOGY

For implementing the tools we used the **shiny** framework [8] that itself is implemented as a package for the R language [9]. The R language is a general language for statistical computing and the **shiny** package provides an easy way to develop web user interfaces and dashboards.

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Additionally, some additional R packages were used, with the most relevant being **qcc** [10], for creating control charts and conducting process capability analysis. This package facilitates the calculation of basic statistics for each sample group, as well as generating control charts that highlight the Western Electric rules violations [11], assisting in the visual interpretation of alerts or nonconformities.

The implementation phase focused on integrating analytical tools while prioritizing usability and accessibility. Finally, the application was tested using simulated datasets to evaluate performance, accuracy, and user experience, leading to iterative improvements.

The open-source model promotes flexibility, technological innovation, and collaboration, allowing for continuous improvement of the application through community contributions. In addition to its relevance in education and research, the growing adoption of open-source technologies, such as Artificial Intelligence and Blockchain, reinforces its importance in developing inclusive and accessible technological solutions [12]. This work presents the development, functionalities, and potential impact of *QualityTools* in the context of quality management. The application is available online [13] and the source code can be accessed on a GitHub repository [14].

3 RESULTS

The application integrates a set of important quality management tools, offering specific functionalities for various areas in quality and statistical process control: data distribution analysis (histogram and normality), correlation analysis, Pareto analysis, control charts and capability analysis.

The tool allows the user to input their data by means of a comma separated values (CSV) file, allowing different file formats.

The distribution analysis tool allows for the assessment of data distribution in two ways: visually, through the histogram and the quantile-quantile plot, and numerically, through statistical tests for normality (Kolmogorov-Smirnov (Lilliefors corrected) and Shapiro-Wilk). These methods help ensure that the distributions meet the expected requirements, providing a robust analysis of how well the data fits a normal distribution.

In the correlation analysis tool, we again use visual and numerical items. We use the scatter plot and the Spearman correlation test to characterize the relationships between variables. This allows the user to identify significant associations, making it easier to understand how different factors combine and relate.

For the Pareto analysis, the tool builds the standard Pareto chart for the user to identify the critical factors contributing to process issues, following the Pareto principle to highlight the most impactful areas, where improvements would result in the greatest benefits to overall process performance.

For process monitoring the application provides control charts. The charts provided are the $\bar{X}R$ (average and range) chart and the $\bar{X}S$ (average and standard deviation) chart. With the help of these charts, the user can monitor the behavior of processes, identifying variations that may indicate quality issues and the need for interventions.

In the process capability analysis tool, the user can input specification limits and access different capability indexes like C_p or C_{pk} , providing a way to measure the process performance and its ability to stay within the established parameters. The capability calculations and the control charts rely on the **qcc** package.

For illustration purposes, **Erro! A origem da referência não foi encontrada.** provides a glance at the user interface of the application.

4 CONCLUSIONS

This tool was developed as part of an academic graduation project and implemented a set of tools for quality management and control that we deem relevant and useful. As part of future work, we identified some areas that could be improved or expanded.

For data input, other formats can be added and an option for manually inputting small sets of data, either by typing or by pasting. In the distribution analysis, we only consider the Normal distribution, but other distributions could be added. The same applies to the correlation analysis, where we only considered the linear trend, but other types of relationships could be analyzed. For control charts, many types of control charts are missing, notably, control charts for attributes, as only two control charts were

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implemented. The Pareto diagram could be enhanced by automatically identifying less relevant items and grouping them into an “others” or similar category, to avoid a cluttered visualization.

At the level of the user interface, a relevant feature would be the possibility to generate print quality plots in some convenient format, such as Adobe PDF or images, that could be downloaded. Another area of improvement would be the formatting of the numeric outputs because they are displayed in R raw text format.

Because we made the tool open source, further development will be carried out via the GitHub repository, encouraging community contributions to steer the evolution of the project.

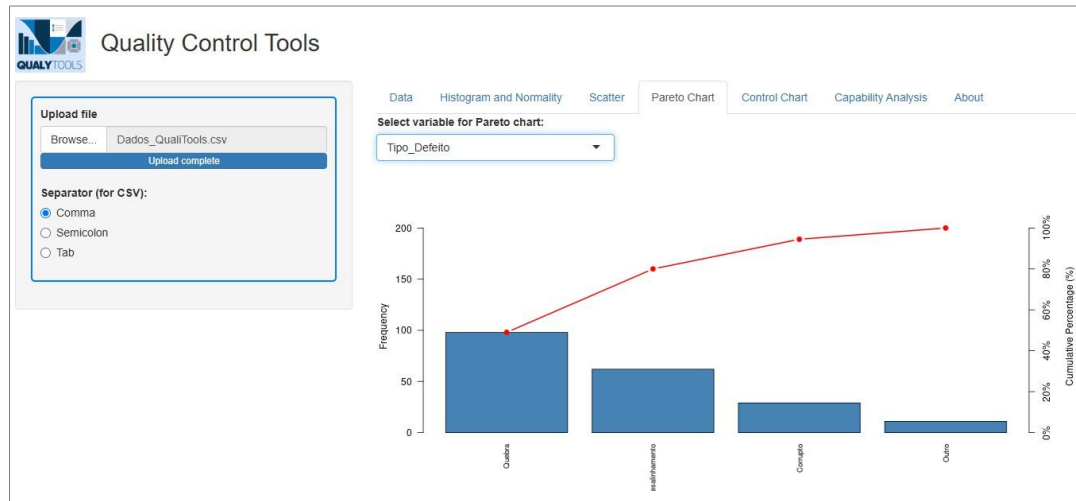


Figure 1. A glance at the QualyTools user interface.

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