# AN ALGORITHM FOR SOLVING QUALITY PROBLEMS, USING QUALITY TOOLS

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**Abstract:** In this work is has been developed an algorithm, to address shortcomings in communicating with customers and lack of coordination. As a support for this algorithm, there was created an Excel program which combines two of the tools proposed to solve the problem, respectively Ishikawa diagram and Pareto chart.

**Keywords:** *Quality tools, Ishikawa, Pareto*

## 1. Introduction.

The essence of solving quality problems is establishing, elaborating, identifying, implementing and monitoring the corrective / preventive actions for quality improvement. In the current standards (e.g. EN ISO 9004: 2010 and other specialty papers [1], [11], [13], [14], [15]) there are presented various models and methodologies to solve quality problems, to improve quality, respectively to establish, develop, identify, implement and monitor corrective / preventive actions. They vary in number, form, sequence, level of detail and content of stages, phases, tasks, steps, specific sequences, and by grouping them in stages. All of them are using a mixture of statistic and non-statistical quality tools, known also as The Seven Basic Tools of Quality and respectively as The Seven Management and Planning Tools.

In table 1 there is a briefing of these tools. There are presented the objectives of each one of these tolls, and some hints when to use them.

**Table 1:** *The quality tools*

| | NAME | OBJECTIVES | WHEN TO USE |
|---|---|---|---|
| FOR NUMERIC DATA (CLASSICAL / STATISTICAL TOOLS) | Control charts | Collecting and organizing data | Collection efficiency and ease of archiving |
| | Graphs | Quick Interpretation of the results of analysis | They are used for explanation, understanding, control, planning, etc.. |
| | Histogram | Viewing information concerning the process behavior | Quick comparison of the characteristics with the benchmark |
| | The PARETO chart | Viewing and deciding | Knowledge of major issues |
| | The Cause-And-Effect or ISHIKAWA Diagram | Analysis and visualization of Cause And Effect relationships | Identifying causes of problems and priorities |
| | The Scatter Diagram | Determination of relationships between groups of data | Quality control and inspection |
| | Check Sheet | Diagnosis and evaluation of process stability | For statistical control of processes |
| NON-NUMERIC DATA (TOOLS FOR QUALITY MANAGEMENT) | Prioritization Matrix | Identifying the main problems | Which is the problem? |
| | Affinity Diagram | | |
| | Interrelationship Diagram | Identifying the likely causes of the problem. | Why did it occur? |
| | Tree Diagram | Identify possible ways to solve the problem. | How to solve? |
| | Matrix diagram | Choosing the best solution. | Which option does have an effect ? |
| | Activity Network Diagram | Planning application of the solutions. | When and how to apply? |
| | Process Decision Program Chart | | |

## 2. The methodology of elaborating algorithms in using the tools to solve quality matters.

Based on the theme or problem to be solved (in planning, assurance, and quality control), the development of algorithms (strategies) for the use of methodological instruments in solving the quality problems (planning, assurance, control and quality improvement) suppose the browsing of a proposed synthetic methodology, depicted in Figure 1.

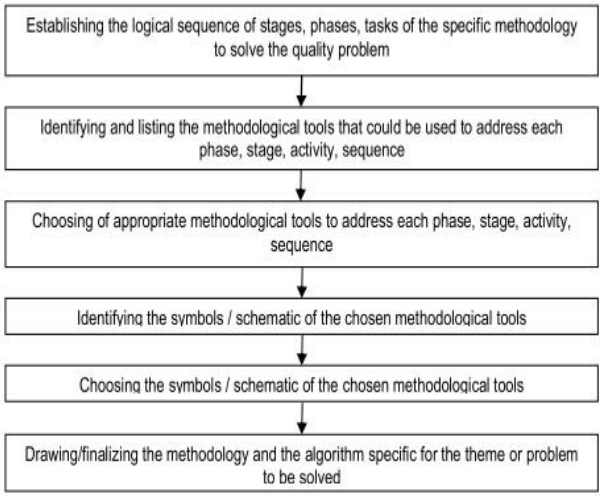


**Figure 1:** *The methodology of elaborating algorithms in using the tools to solve quality matters.*

The methodologies specific to the theme or problem to be solved, could be graphically represented in the following forms:

-ordered list of stages, phases, tasks, sequences and methodological tools;

-organization chart, flow chart, block diagram with rectangles and words;

-organization chart, flow chart, block diagram, with words and symbols or drawings of methodological tools;

-organization chart, flow chart, block diagram, with symbols or drawings of methodological tools;

-combinations of the previous forms.

To indicate logical relationships between the stages, phases, activities, sequencing methodology, respectively the methodological tools used to address each stage, arrows should be used.

The organizational charts, logic diagrams and block diagrams, as those presented below (figure 2), could be considered as a reference, as an example of a specific methodology to solve a quality problem [4], [17].

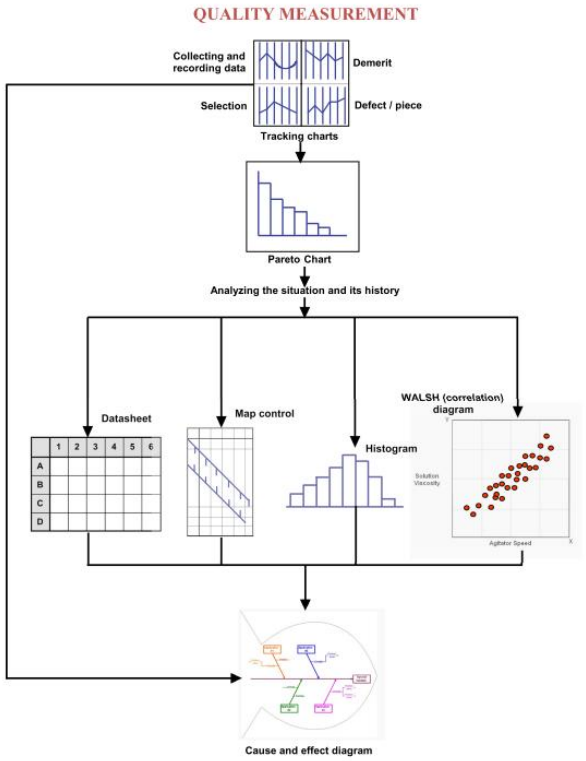


**Figure 2:** *Example of a specific methodology to solve quality problems*

### 3. Case study

For the case study considered in this paper, data regarding customers' complaints about a service department were collected. The data were collected during September 2008 - March 2009.

The proposed methodology for identifying, detailing and improving the causes of those complaints is as follows:

- collecting data (tables);
- sorting data in descending order, according to Pareto chart;
- identifying the causes that led to an increased number of complaints, with negative effects on the company image (using Ishikawa diagram)
- implementing the corrective and preventive actions, resulting from brainstorming activities;
- collecting a new set of data, in the same period of time as that when the initial data were collected, the difference between being a calendar year;
- building a new Pareto chart.
- comparing data and drawing the conclusions.

The algorithm is shown in Figure 3.

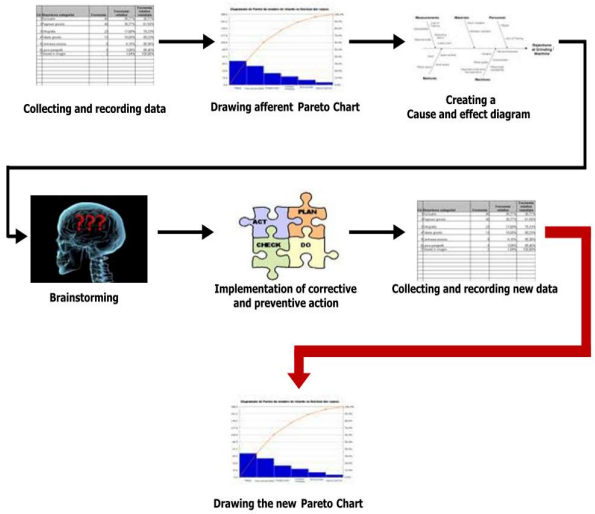


**Figure 3:** *The algorithm proposed*

As said before, for the case study considered in this paper, data regarding customers' complaints about a service department were collected. The data were collected during September 2008 - March 2009.

It is worth mentioning that during the data collection period, the register of complaints was kept by "the workers on the shelf" and the vendors.

As noted, most complaints have occurred during December-January, when the workload for commercial workers is significantly higher (inventories, closing the year, etc..,)

The main problems, as is about to see, are caused by the fact that there was not, at that time, a central dispatch for service problems, lack of competent people to solve problems or even to provide some relevant solutions. By competent people means specialists in this field, because, as already indicated, both the role of "dispatcher" and the "primary dealer" was performed by commercial workers, most of them mainly with basic knowledge of sales and technical matters. In addition, some of the claims submitted by service aimed at a new batch of heating products, just put on the market (it is late summer, early autumn 2008), which, as noted later, had not undergone enough testing.

### 3.1 Data collection

Data were taken from the book of suggestions and complaints and tabled.

**Table 2:** *Data collected between September 2008-March 2009*

| SERVICE COMPLAINTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | sep.08 | oct.08 | dec.08 | ian.09 | feb.09 | mar.09 | TOTAL |
| Staff skills | 3 | 2 | 7 | 4 | 1 | 3 | 20 |
| Informations provided | 34 | 28 | 17 | 12 | 31 | 28 | 150 |
| Treatment | 11 | 14 | 22 | 24 | 13 | 8 | 92 |
| Hours (working program) | 6 | 4 | 12 | 8 | 20 | 25 | 75 |
| Large number of formalities | 13 | 7 | 11 | 14 | 15 | 10 | 70 |
| Resolving time | 51 | 48 | 47 | 64 | 73 | 45 | 328 |
| Standby time | 8 | 7 | 12 | 13 | 6 | 4 | 50 |
| Lack of forms | - | - | 14 | - | - | - | 14 |
| Other causes | 2 | 1 | - | 2 | - | 2 | 7 |

According to the methodology, the next step being the establishment of a Pareto chart, in order to identify the most common problems, the data are arranged in descending order.

In Table 3 these data are arranged downward.

**Table 3:** *Arranged data*

| SERVICE COMPLAINTS | |
|---|---|
| TOTAL september 2008 - march 2009 | |
| Resolving time | 328 |
| Informations provided | 150 |
| Treatment | 92 |
| Hours (working program) | 75 |
| Large number of formalities | 70 |
| Standby time | 50 |
| Staff skills | 20 |
| Lack of forms | 14 |
| Other causes | 7 |

According to the typology of drawing a Pareto chart, the cumulative frequency of the recorded data must be calculated.

On the Internet there are a lot of Excel/Spreadsheet applications, freeware or shareware, that help in preparation of such diagrams. The only problem is that there is not an application that includes the same excel spreadsheet and a chart of data descending arranged, and the cumulative frequency table and the resulting Pareto diagram.

Figures 4 and Table 4 summarize the data collected and the cumulative frequencies and the Pareto diagram that shows further processing.

**Table 4:** *The data frequencies calculation*

| | | Limita procent cumulat: | | | 80% |
|---|---|---|---|---|---|
| Nr. Crt. | Causes | Defects (absolute frequency) | Cumulative absolute frequqncy | Relative frequency [%] | Cumulate relative frequency [%] |
| 1 | Resolving time | 320 | 320 | 37,87% | 37,87% |
| 2 | Informations provided | 210 | 530 | 24,85% | 62,72% |
| 3 | Treatment | 92 | 622 | 10,89% | 73,61% |
| 4 | Hours (working program) | 75 | 697 | 8,88% | 82,49% |
| 5 | Large number of formalities | 60 | 757 | 7,10% | 89,59% |
| 6 | Standby time | 53 | 810 | 6,27% | 95,86% |
| 7 | Staff skills | 18 | 828 | 2,13% | 97,99% |
| 8 | Lack of forms | 13 | 841 | 1,54% | 99,53% |
| 9 | Other causes | 4 | 845 | 0,47% | 100,00% |
| 10 | | | | | 100,00% |
| 11 | | | | | 100,00% |
| 12 | | | | | 100,00% |
| 13 | | | | | 100,00% |
| 14 | | | | | 100,00% |
| 15 | | | | | 100,00% |

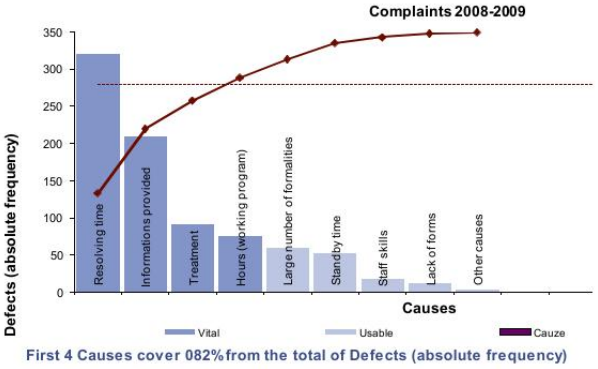


**Figure 4:** *The Pareto Chart*

Figure 5 shows the excel application developed by the authors of this paper to create Pareto charts, application used by students in the Quality Management applications.

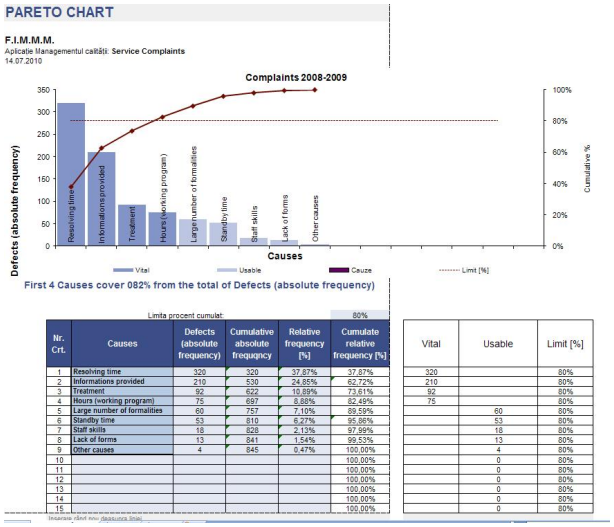


**Figure 5:** *Excel application*

When finished, the chart reveals that the most frequent complaints are of the type: time problem solving, information provided, treatment, working program.

So, looking at the graph, it appears that we first must operate on the four cases presented in the previous paragraph.

Therefore, after a brainstorming session, it was compiled a Ishikawa diagram, where we tried to find the factors (the *causes*) influencing the increasing number of complaints over the service department.

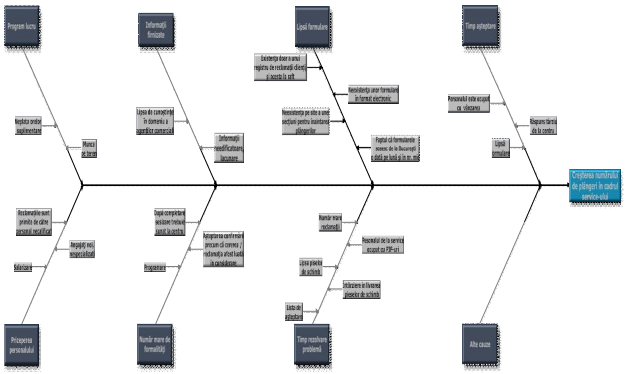

**Figure 6:** *The resulted Ishikawa diagram*

Therefore, following the chart analysis and discussions it had been established a set of measures:

• the founding of a central dispatch service, which:

- to receive complaints directly to a toll free telephone number,

- to allocate a time resolution of each complaint and at the end of this period to contact the complainant and find out the steps taken and the state of play in the case of larger problems;

• providing in each subsidiary stocks of spare parts, and in case of unique or the imported ones, ensuring the lowest possible delivery dates;

• allocation of the servicing to the collaborating firms;

• giving up some manufacturing companies whose products brings the number of complaints and guidance to other international companies;

• staff training in marketing;

• overtime (extra hours) payment.

So, being set all that, a new series of data was collected, over the same period of time, (ie September 2009 - March 2010), and after drawing a new Pareto chart, it was noted that these measures had the desired results, ie fewer complaints and complaints.

| SERVICE COMPLAINTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | sep.09 | oct.09 | dec.09 | ian.10 | feb.10 | mar.10 | TOTAL |
| Staff skills | - | - | 4 | 1 | - | - | 5 |
| Informations provided | - | - | 7 | 8 | 3 | - | 18 |
| Treatment | - | - | 9 | 3 | - | - | 12 |
| Hours (working program) | - | - | 8 | - | - | - | 8 |
| Large number of formalities | 6 | 12 | 21 | 19 | 7 | 9 | 74 |
| Resolving time | 2 | 1 | 8 | 6 | 2 | 1 | 20 |
| Standby time | - | - | 8 | - | - | - | 8 |
| Lack of forms | - | - | 7 | 3 | - | - | 10 |
| Other causes | - | - | 3 | 2 | - | - | 5 |

**Figure 7:***Data collected between September 2009 - March 2010*

After the data collecting, we proceeded to arrange them in descending order, as we did in the first step, according to Table 5 and, then we calculated the relative and cumulative frequency (Table 6).

**Table 5:***Data rearranged*

| SERVICE COMPLAINTS | |
|---|---|
| TOTAL september 2009 - march 2010 | |
| Resolving time | 74 |
| Standby time | 20 |
| Informations provided | 18 |
| Hours (working program) | 12 |
| Treatment | 10 |
| Large number of formalities | 8 |
| Lack of forms | 8 |
| Staff skills | 5 |
| Other causes | 5 |

**Table 6:** *The data frequencies calculation*

| | | | | | Limita procent cumulat: 80% |
|---|---|---|---|---|---|
| Nr. Crt. | Causes | Defects (absolute frequency) | Cumulative absolute frequqncy | Relative frequency [%] | Cumulate relative frequency [%] |
| 1 | Resolving time | 74 | 74 | 46.25% | 46.25% |
| 2 | Standby time | 20 | 94 | 12.50% | 58.75% |
| 3 | Informations provided | 18 | 112 | 11.25% | 70.00% |
| 4 | Hours (working program) | 12 | 124 | 7.50% | 77.50% |
| 5 | Treatment | 10 | 134 | 6.25% | 83.75% |
| 6 | Large number of formalities | 8 | 142 | 5.00% | 88.75% |
| 7 | Lack of forms | 8 | 150 | 5.00% | 93.75% |
| 8 | Staff skills | 5 | 155 | 3.13% | 96.88% |
| 9 | Other causes | 5 | 160 | 3.13% | 100.00% |
| 10 | | | | | 100.00% |
| 11 | | | | | 100.00% |
| 12 | | | | | 100.00% |
| 13 | | | | | 100.00% |
| 14 | | | | | 100.00% |
| 15 | | | | | 100.00% |

The application of the measures outlined above has led to a drastic decrease in complaints to the service department, as shown in Figure 8.

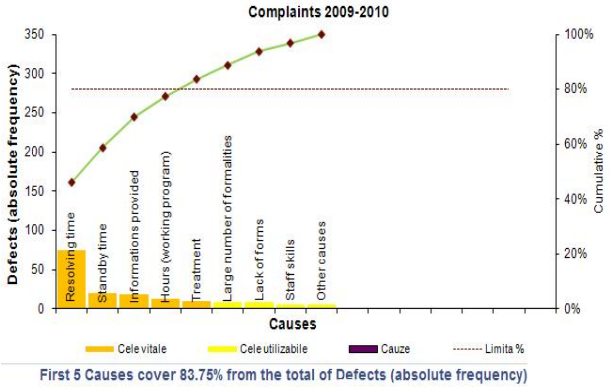


**Figure 8:** *Pareto chart for the data collected in the second phase*

The Excel application adds a plus, meaning that on a separate sheet there can be seen the two Pareto charts, the initial one and the final one, after applying the measures that have resulted from the first interpretation of Pareto charts.

As shown, the amount of complaints has dropped by almost 70%.

The application brings a benefit, meaning that, after the drawing of the first chart and after applying the necessary measures (as a result of brainstorming sessions and use of Ishikawa diagram), starting with the recording of a new data series for the same amount of time, introducing a new data series (e.g. at the end of each month), it can be observed, in real time, the effect of the implemented measures by comparing the two charts, so it could be applied in due time the inherent corrective or preventive actions.

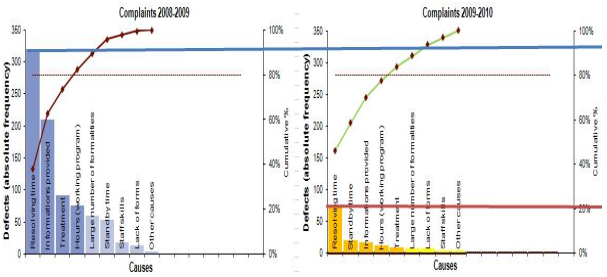


**Figure 9:** *Comparison of the two Pareto charts (the initial and the final ones)*

## 4. Conclusions

The elaboration of an algorithm for the use of methodological tools is helpful in solving quality problems, especially if supported by a program or software.

In this work, it has been developed such an algorithm, meant to solve the deficiencies in communications with clients, communication between subsidiaries and the lack of coordination.

In support of this algorithm an Excel application was created, which combines some of the tools proposed to solve these problems, in this case study as these two statistical tools, respectively the Ishikawa diagram and Pareto diagram.

The application brings a benefit, meaning that, after the drawing of the first chart and after applying the necessary measures (as a result of brainstorming sessions and use of Ishikawa diagram), starting with the recording of a new data series for the same amount of time, introducing a new data series (e.g. at the end of each month), it can be observed, in real time, the effect of the implemented measures by comparing the two charts, so it could be applied in due time the inherent corrective or preventive actions.

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