

# PREPARATION OF METHODS AND TOOLS OF QUALITY IN REENGINEERING OF TECHNOLOGICAL PROCESSES

Milan Erić, Ph.D.<sup>1)</sup>, Miladin Stefanović, Ph.D.<sup>2)</sup>, Nikola Stevanović

**Abstract:** *Solutions variety of the technological processes in the general case, requires technical, technological and economic parameters, and it is the result of the projecting new ones or re-engineering existing ones. In order to effectuate the proper evaluation and selection of optimal variants of the technological process, it is necessary to accomplish proper selection of technical, technological and economic parameters of a previous specific study of their impact in the evaluation of variations and re-engineering process. For this purpose, they used tools and methods of quality, Ishikawa diagram and Pareto method. This allows control of the engineering and economic processes under control actions in order to accomplish the same, in the direction that best suits to the enterprise.*

**Keywords:** *Pareto methods, Ishikawa diagram, technological processes, soft reengineering*

## 1. Introductory considerations

To project quality technological process does not mean only to determine the schedule of technological operations including time frames, with the aim to transform raw material in the final product. Technological process should be optimal from the technological aspect. Meaning that it should include a rational schedule of technological operations, with the appropriate tools and accessories, which always should be in the mode for optimal utilization. It should also, transform material into final (desired) shape, for the shortest time at minimal costs (machinery, power, tools, etc.) and with satisfactory quality. Variability of the technological process means that a product or goods can be developed in several ways. Variability can be observed from two aspects. First is also the issue of how to form varieties of the technological process and what caused them, and the second shows how to select the optimal or any other variety from the set of solutions or alternatives.

Identification of production-technological problems, generating alternatives and choosing the optimal solution requires the engagement of the overall potential of engineers, the knowledge and skills. The problem of generation and selection of optimal solutions is not only a technological nature. This problem is much wider and it is followed with the appropriate economic and financial processes. The selection of technological solutions must take into account their contribution to achieve the development objectives of an

enterprise (increase profitability, reduce costs, introduction of new products and new technologies, improvement of the position in the market, etc.).

Technologist (project engineer, ekspert) uses information for decision-making, whether in a given moment either in the form of potential options. Decisions are based on an action that represents a choice between two or more alternatives (varieties), with purpose to solve the problem. Fundamental assumption of the entire process is based on fact that problems dictate the procedures of providing the decision. If the problem does not exist, there is no purpose for consideration, nor is there, the relevant alternative for the same.

The problem can be defined as a blank space ('gap') between what is expected or what was expected and the current, the actual state (Picture 1).

Expectations are usually presented in the form of given goals, results, or specific standards. Pre-existing condition represent a value, expressed in selected metric, which refers to the operating system performance, (the so-called metrics of execution). Structure for detection of the problem must include a mandatory filter tolerance, which determines if the gap's, in relation to the expectations, are high enough to cause the reaction of those who decide in other words, the project engineer. The purpose of the filter tolerance is reflected in the design of a good support system, to ensure the rejection of consideration of those

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1) dr Milan Erić, Mašinski fakultet Kragujevac, Sestre Janjić 6, mail: ericm@kg.ac.rs

2) dr Miladin Stefanović, Mašinski fakultet Kragujevac, Sestre Janjić 6, mail: miladin@kg.ac.rs

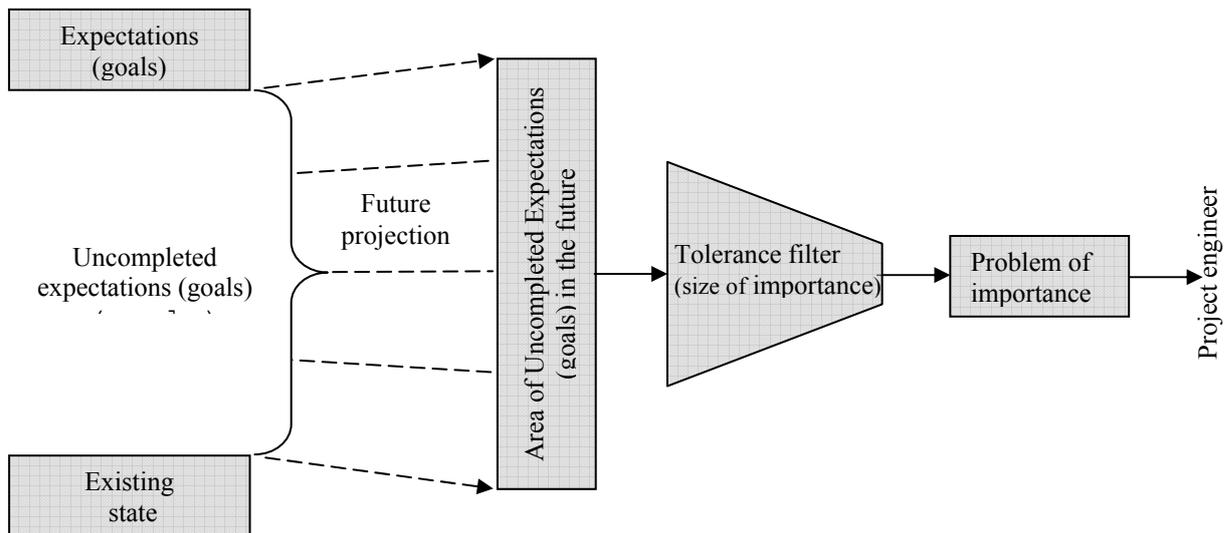
problems that do not represent significant deviations from the given goals or adopted expectations, and which are related to the problem. For this purpose will be used the Ishikawa diagram and Pareto analysis.

Detection of the problem involves four elements / components for identification as follows:

- measurability expectations (goals, results and standards);

- mechanisms for measuring the performance of the existing system;
- tolerance filter for ranking and separation of significant and insignificant problems;
- The prediction of future trends in work.

Experienced and capable project engineers don't wait for problem to happen. They are using prediction systems, intelligent systems and other techniques to detect potential problems.



**Picture 1** Standardized structure of the problem

Cycle of problem solving is very important in the process of analysis and design in the projection of the technological process. Cycle of problem solving is built of several components (Picture 2) such as:

↳ **Input resource** (represented by a number 1 in Picture 2): Input resources for the production process include material, energy, equipment, work (human resource), information, etc. The size and scope of resources is crucial for the efficiency of the production process.

↳ **Production process** (Number 2 in Picture 2): Management combine resources in the form that will best help to get the desired results. Example: A worker (human resource) is assigned to a particular machine (resource, equipment) for the production of a component (material resource) apparatus (output product).

↳ **Output product / service** (Number 3 on Picture 2): Output product or service represent specific result of the production process. Cycle output can be more products, services, or by-products.

↳ **Objectives / standards** (Number 4 on Picture 2): The company has its own expectations, which are related to the output product / service of the

production process. There are defined / intended or values and standards for each characteristic of a output product / service, that you can refer to the size, weight, capacity, etc..

↳ **Detection of the problem** (Number 5 on Picture 2): This mechanism involves and includes the analysis of the causes of the problem.

↳ **Creating alternatives** (Number 6 on Picture 2): When project engineer detects a problem first you need to take the search for real alternatives to repair and / or redesign of production (technological) process. Each of the alternative tests to determine their contribution in improving the achievement of goals and / or standards.

↳ **Decision-making** (Number 7 in Picture 2): Based on the analysis, one of the alternatives is selected for the implementation of corrective action.

↳ **Decision publication** (Number 8 in Picture 2): Designer communicates its decision in the form and content that is understandable and acceptable to those who need to carry out such decision on the production level.

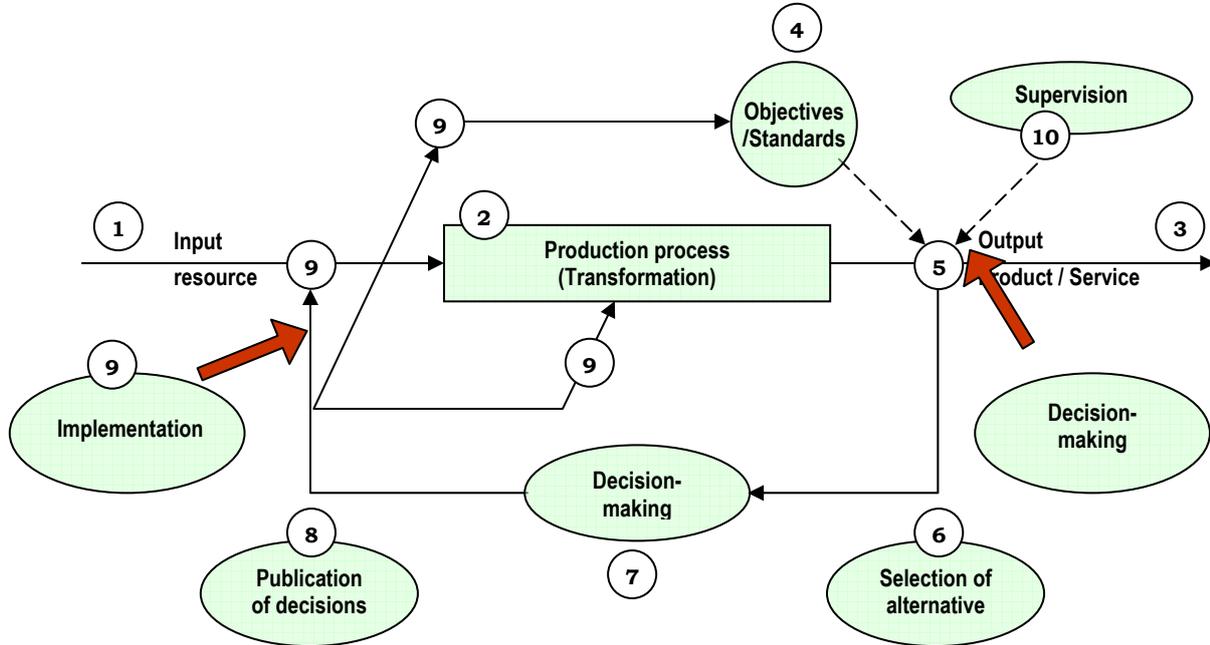
↳ **Decision implementation** (Number 9 in Picture 2): Some of the ways to make the decision

are:

- changes in size and scope of input resources;
- changes in productive (technological) production process;

- changing the goals / values, or standards leading them to better compliance with reality.

↳ **Supervision monitoring** (Number 10 in Picture 2): Managers oversee the process to check and make sure that the problem is solved.



Picture 2 Cycle of problem solving

## 2. Methods and tools of quality in the re-engineering of the technology processes

Methods and quality tools are a set of knowledge about the collection, organization, analysis, synthesis, interpretation, display and control data for the purpose of realizing the needs and requirements of users for products and services. For the analysis of influential parameters in the technological processes and their re-engineering has been used Ishikawa diagram and Pareto method.

**Ishikawa diagram** is a tool that graphically shows the relationship between the effects and all factors that influence the result, and helps to be a visual (intuitive) way to identify, sort and display possible causes of problems or characteristics of the system. **Ishikawa diagram** should be used when you need to:

- Identify all the possible influences on a problem,
- Sort and establish relations between the interactions that occur in a process,
- Analyze the existing problems in order to take corrective actions.

Structure showing that the diagram offer is the basis of the methodic and systematic consideration

and thinking. Advantages and benefits that offer the use of Ishikawa diagram are:

- helps identify the key causes of problems or characteristics of the system using the structural approach,
- format, which show cause consequential relations is easy to read,
- identify all possible causes of deviations in the process,
- systemizes and increases knowledge about the process,
- identify areas where there are needs to collect data for further studies.

Ishikawa diagram is created in several steps or phases:

- 1) Identify and clearly define the result or consequence of that analysis
- 2) Identified consequence is write on the right of the diagram spine
- 3) Identify the main causes that affect the consequence, which is studied. In this way, are defined the main branches of the diagram, or categories. Under the categories are classified various causes that influence the observed consequence, such as methods, materials, machines, people, management, environment, etc.
- 4) For each main category identify other factors that may be causes. It is necessary to identify what the more possible factors and connect

them as branches of the main categories. The same cause may occur in several categories; in this case, specify it in all places where it occurs.

- 5) Identify the causes of a new level and manage it according to the categories.
- 6) For each branch of diagram to assess and enter weighted coefficient. To each branch of diagram give coefficient from 1 to 9, which indicates the importance of the influence of the causes to which are coefficient assigned. In the evaluation, a higher coefficient is assigned to a stronger influence.
- 7) Analyze the diagram. See the branches on the same level, and on the basis of their coefficients calculate the relative coefficient (expressed in % and represents the percentage impact of the branches of the same level.) Most influential is the cause of which has the highest relative coefficient. Branches with the largest relative coefficients are the branches that will be affected by correction measures.

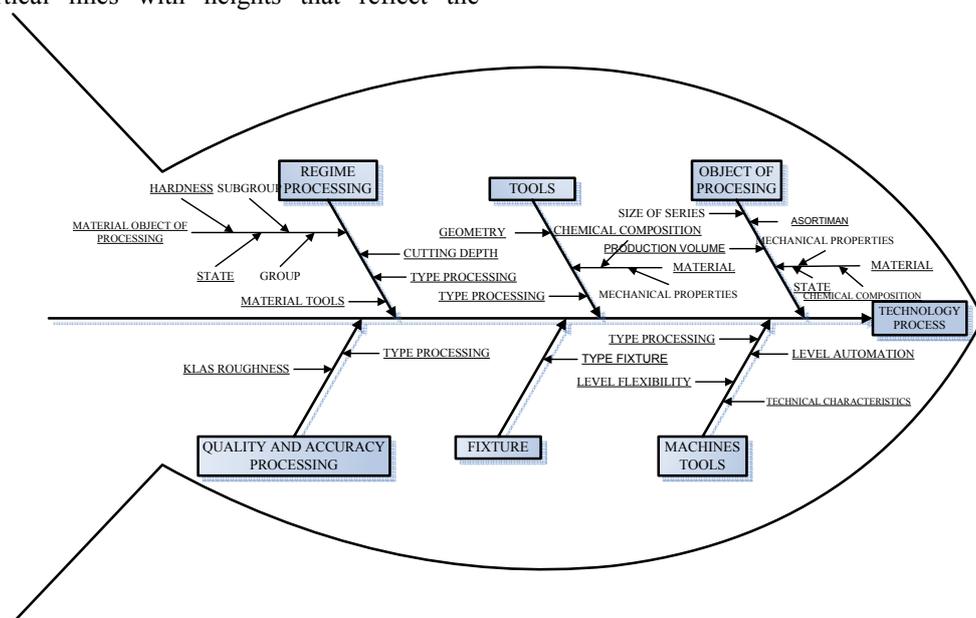
**Pareto method** is a practical tool that allows the improvement of production, with extraction of the biggest errors that occur in a process. Focusing the biggest error, and not pouring resources, energy and time on the removal of less important errors which customer may not even notice, and which corrections costs more than damages caused by their appearance. Foundation of the Pareto method is the Pareto diagram, which represents a number of vertical lines with heights that reflect the

frequency or impact of the problem. Lines are allocated by the drop in the amount in the order from right to the left. Categories that are represented with higher lines on the left are more important than ones on the right. Chart was named by Pareto principle, which says that 80% of trouble comes from the 20% problems. It is important to note that the problems doesn't have to be errors, but it must be considered in much wider range of negative influence on the process that is viewed. In the re-engineering of technology processes this method is defined with the following semantics: separate the operations of technological processes which parameter defined with Ishikawa a chart, have the maximum or minimum values.

### 3. Koncept primene metoda i alata kvaliteta u reinženjeringu tehnoloških procesa

Variations of technological processes occur as a consequence of the large number of possible combinations of input parameters, and their relations (the order), which differently affect the output characteristics of the technological process. For a technological process, theoretically can be defined a large number of variations.

In order to reduce the number of variants of the technological process, to the rational measure, as an additional tool and a tool for making decisions about what inputs to change, it will be used the Ishikawa diagram. Starting Ishikawa diagram of technological process is shown in the picture 3.



**Picture 3** Ishikawa diagram of technological process

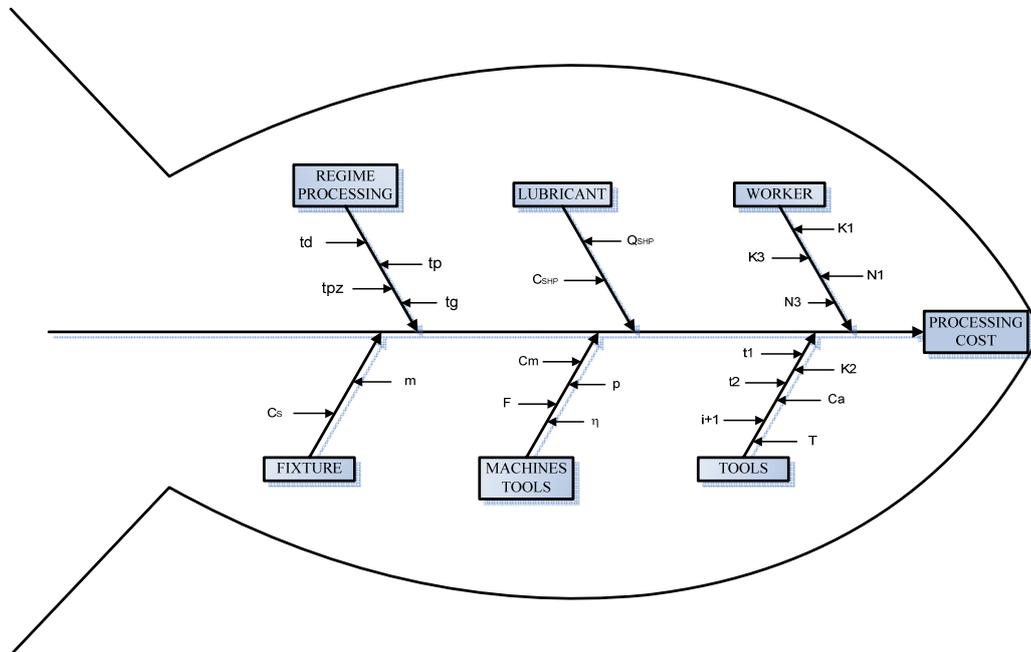
Graphic structure of the elements and parameters of technological process, allows one intuitive way to identify the most influential elements and

parameters. Based on the analysis of a technological process, to each branch of the diagram, by level, is assigned one influence coefficient. On the basis of the influence

coefficients is calculated relative coefficient in percentage (%). By varying parameters of the elements or branch, with the greatest relative coefficient define the variation of the technological process. For more complex cases of the technological process, when it is not possible to safely determine the most influential parameters from Ishikawa diagram, use the Pareto method. In this case, relative coefficients are entries for the Pareto diagram and on the basis of the diagram the most influential parameters are determined. Parameters for the valuable techno-economic analysis of varieties are selected to be calculated on the basis of input parameters (parameters of the processing regime, order and concentration of operations, time norms, parameters related to cutting tools, equipment and machine), which directly affect the technological process. The cost

of processing, time of production and productivity are the output parameters, which should complete picture of the variation of the technological process. Based on this assessment, personal experience and evaluation, project engineer-technologist makes the final decision on the variety that will be implemented. Selected output parameters directly affect the complex economic parameters such as productivity, efficiency, effectiveness and the very cost of products / parts.

As well as the choice for the most influential parameters on formatting varieties in concrete technological process, and for output parameters can be used Ishikawa and Pareto diagram. In *Picture 4* is showed a Ishikawa diagram of processing costs, as a consequence, and parts of which costs depend of, as cause.



**Picture 4** Ishikawa diagram of processing cost

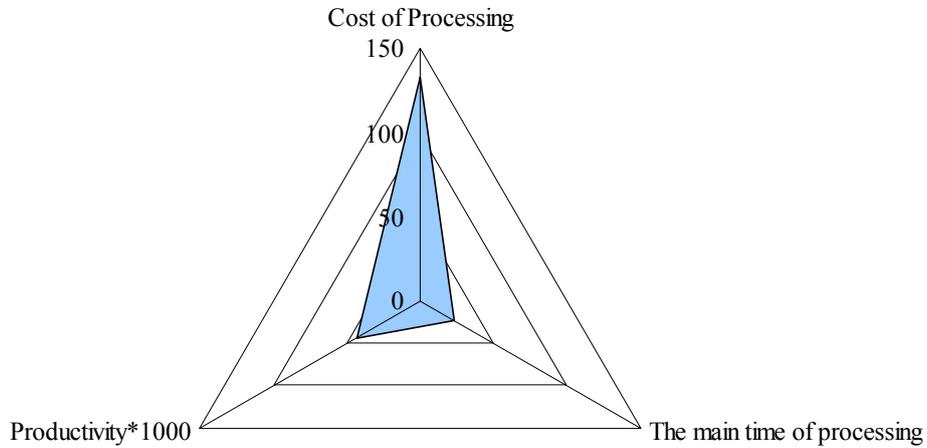
Verification of the methodology, models and showed concept of the application of the tools of quality in re-engineering technological processes, is carried out in the real example of the already existing technological process in production of coupling for homo-kinetic joint.

On the basis of entered values of parameters and loaded technology database, the calculation of the main processing time, productivity and cost of processing on the basis of mathematical models involved in the re-engineering methodology of the technological processes, the same are stored in specific analytic databases. The analysis of data (Picture 5) organized in OLAP cubes is executed. Next activity of proposed methodology is the analysis of the technological process and the

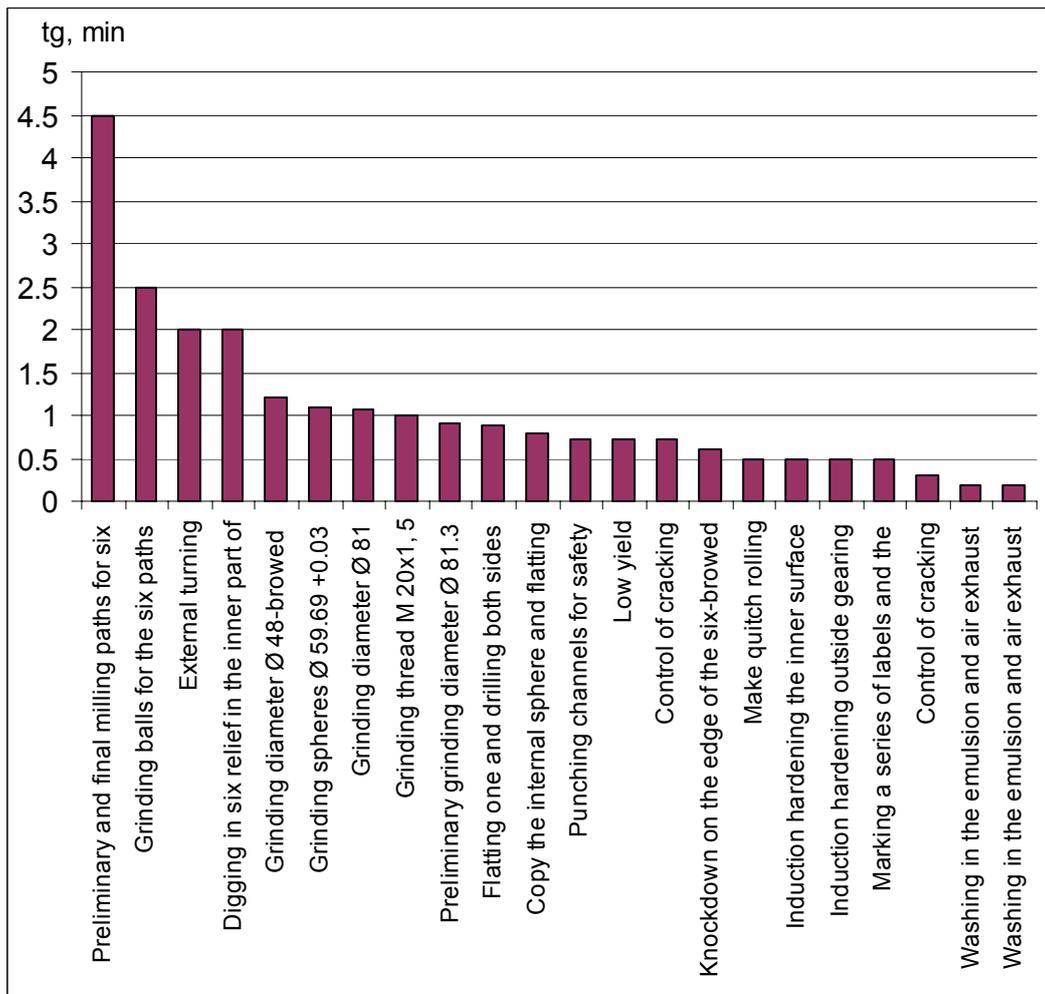
results of calculations. For this purpose, it will be used Ishikawa and Pareto diagrams. For the achievement of goals of the technological process re-engineering, it should properly define weight coefficients for all influential elements and parameters in the specific technological process. Weight coefficients should be determined by the problems that affect the processing time, processing costs, quality, flexibility and other parameters of technological process. After that, according to the overall influential elements and their significance, using Pareto method, follows selection and implementation of elements and changes of parameters in the technological process. In other word, in analysis of the Ishikawa diagram (Picture 3 and 4) of influential parameters in the technological process, and the results obtained for the normative time and processing

costs, as the individual operations and for complete part, identify and separate the most influential parameters and for them make Pareto diagram.

Pareto diagram of main time, for the technological process in production of coupling of the homo-kinetic joint, is shown in the picture 6



Picture 5 Radar chart of output parameters of the model variation 1



Picture 6 Pareto diagram of main production time of development of technological process for coupling production of homo kinetic joint

Number of operation	Name	Processing time, h/kom	Processing time, min/kom
90	Preliminary and final milling paths for six balls	0.0750	4.500
210	Grinding of six ball paths	0.0416	2.496
20	External turning	0.0333	1.998
80	Digging in six relieves in the inner part in order to relieve milling cutters	0.0333	1.998

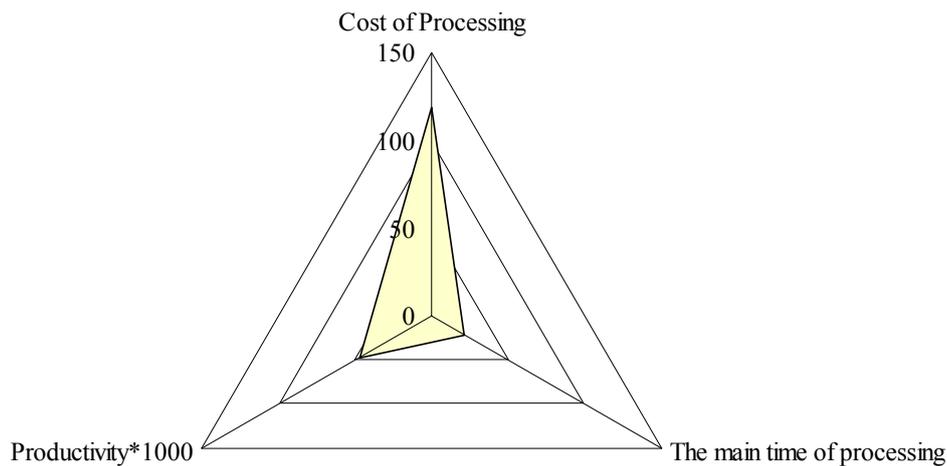
On the basis of Pareto first four operations with longest main time of production are abstracted for analysis as follow:

First iteration and generating of variations of the technological process in production of coupling of the homo-kinetic joint using soft re-engineering includes analysis and possible assumptions regarding selected tools and processing regimes. For the proposed changes, it is necessary to generate a new variation of the technological process in production of coupling of the homo-kinetic joint (variant 2) and

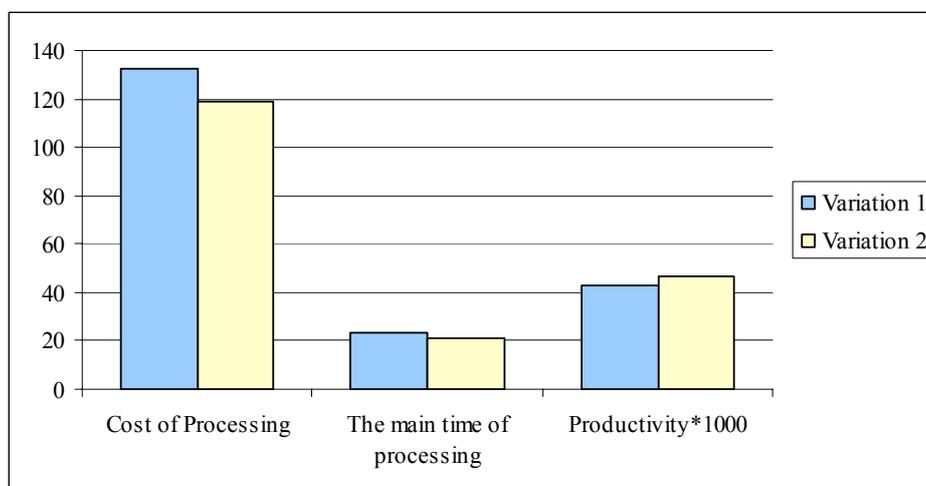
calculated parameters related to the time norms, processing costs and productivity.

It should be noted that the subject of changes and expected improvements, can be any parameter that affect the technological process and lead to measurable changes in output, and which are related to costs, time, quality and productivity.

Based on the new generated variation of the technological process, as well as for the first variation, analysis of data has been done which are graphically shown in the picture 7.



Picture 7 Radar chart of output parameters of the model variation 2



Picture 8 Comparative presentation of output parameters of the model variants

Based on the obtained results, comparative presentation of the variation data (Picture 8) and analysis of the same has been carried out.

Based on the value analysis of output parameters for both variants of the technological process in production of coupling of the homo-kinetic joint leads to the following conclusion: with implementation of soft re-engineering in the technological process of variations 1 and obtained variations 2 there was a reduction of processing costs for 11.70%, reduction of the main processing time for a 10.70%, and productivity was increased for 9:30%. This analysis follows the decision on implementation of soft re-engineering.

## CONCLUSION

Presented concept in implementation of methods and tools of quality is part of the methodology of technological process re-engineering. The basic idea of applying is the reduction of a large number of possible combinations of input parameters with significant influence on the output characteristics of the technological process, to the rational measure which would reduce the number of variants of the technological process. Presented concept, you should enable finding and introduction of the new, better solutions that will ensure effective and efficient technological processes, production and business.

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