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# Building Models for a Scientific Approach to Problem Solving in Production Systems

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**Abstract**: The paper presents a model of scientific approach to problem solving. The model is based on a gradual approach, preparation, resolution, verification and improvement of solutions. Each of the steps in the process of solving a problem or task requires thorough consideration and analysis after which the question "satisfied?". The affirmative answer points to the next, while the negative requires further analysis or a return to one of the previous steps. The presented approach can be successfully used to solve problems and tasks in economic systems and in scientific research in general. The presented model confirmed its simplicity and practicality in concrete scientific research.

**Keywords:** improvement; model; process; problem; scientific approach

## 1 INTRODUCTION

Disturbances in the functioning of any process are common. Simply put, there are no ideal processes that turn inputs into exits without difficulty. The difference between the ideal and the real is often called an imbalance or problem. These phenomena cause negative reactions in employees and in economic terms they are unacceptable because they are associated with various wastes. In addition to the above, it is important to emphasize that the functioning of any process can always be improved. Regardless of whether it is a noticeable disorder that requires quick resolution or a decision to improve an activity or process, there is always a problem that requires action. A systematic approach to these actions requires a defined order of execution, i.e. a way of solving problems. The process approach to these and similar activities has proven to be the most effective, and that is problem-solving technology.

The most general problem can be called any imbalance in the work environment [1]. This is, for example, the problem of loss in business as an imbalance between income and expenditure, environmental pollution as an imbalance between environmental aspects, the problem of quality as an imbalance between the defined and achieved level of quality, etc.. Eliminating this imbalance requires activities in order to achieve the desired goals, so the term problem is often said to be an obstacle on the way to the goal [2].

## 2 BRIEF VIEW AND DESCRIPTION OF THE MODEL

The knowledge about the meaning of the correct approach to solving problems began to grow a few decades ago, which there are records in the literature, so these insights began to be used in our country. By applying these other people's, well-known technologies, experiences have also grown in our country, which have been incorporated into the existing knowledge of our experts and scientists in various institutions. Figure 1 shows one of the possible approaches for solving more complex problems, which is adapted for specific needs related to problem solving in production systems.

As with other methods and procedures that solve problems, the presented model should not omit the sequence phase. Otherwise, it is possible to expect new problems and difficulties and the solution of the primary problem [2, 3] is questionable. These phases (Fig. 1), as well as the associated activities, can be called by other names, but in any case, it is necessary to include all the listed contents and apply their sequence to solve a specific problem. 7 stages are observed in the process of solving, where after each stage the logical question "satisfied?" is asked. The answers can be "yes" and "no." If the answer is yes, it is moved to the next stage, and if it is negative, it is necessary to return to one of the previous ones. The method is based on the studious study of each stage during the problem-solving process where the smallest omission results in additional engagement of people and resources. This problem approach allows you to look at and solve problems through dominant factors and their interactions and does not allow the solver to move away from the problem being solved, which enables the realization of set goals through selected criteria and benchmarks.

### 2.1 Noticing the Problem of Research

The "Problem Spotting" phase in the context of the troubleshooting process is shown in Fig. 2, showing inputs, tools and techniques and outputs as well as flowcharts.

The term "problem" is not clear. As a term, it is used on different occasions and takes on different meanings, which is evident in everyday conversation, and in discussions of experts and scientists of different fields. All this can result in occasional misunderstandings and difficulties in understanding the term "problem". In linguistic terms, the problem arises where doubt, uncertainty and difficulty arise to which there is no immediate answer [1]. In this paper, the problem implies a theoretical or practical question that requires a solution. To put it more simply, the "problem" is the gap between the current and the eager state. In doing so, desires are tied to the goals that are desired to be achieved.

To identify and understand problems, there must be information, data or events. For example, in the papers [2, 3] it is stated that there must be:

- someone who has a problem, which is an individual or group that is dissatisfied with some condition;
- their desire, that is, they need to know what they want, as opposed to what they have;
- system and working environment and
- the possibility of choosing a solution, i.e. alternate directions of action.

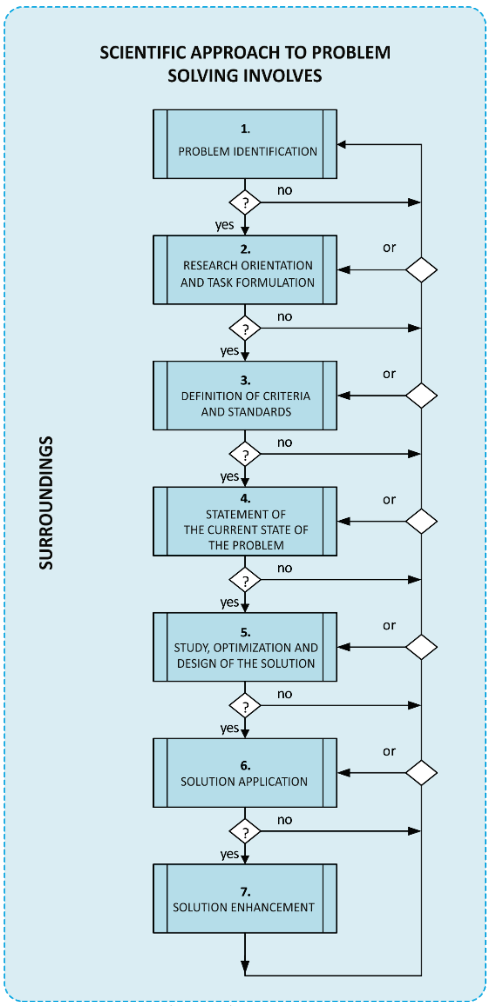


**Figure 1** Method of scientific approach to problem solving

## 2.2 Problem Orientation and Task Setting to Solve

The logical continuation of the work after noticing the problem is to orient the problem and set the task. Orientation is the orientation of the "solver" about the problem that has been observed. This means, in other words, that the solver(s) must perform: scientific, professional, personal, temporal, financial and other types of orientation in order to transform successfully the problem into a task [4]. The "Problem Orientation and Research Task Setup" phase in the context of the problem-solving process is shown in Fig. 3, showing a process that has input, activity and its output.

While the first stage is devoted to the problem and the area in which it is located, the problem orientation phase considers the knowledge needed to solve successfully the problem. The concept of orientation is taken from geography according to which orientation is orientation in nature, which means that using the concept of orientation for the purpose of solving problems means determining where the problem is in the available knowledge, and what knowledge is needed to solve the problem. For these reasons, the first part of this stage is also called problem orientation. The scientific and professional orientation of the solver is to look at the perceived problem in order to declare it a professional or scientific problem. In addition, it is very important to position the problem in segments of science with which it could have points of contact or its solution would require specific knowledge.

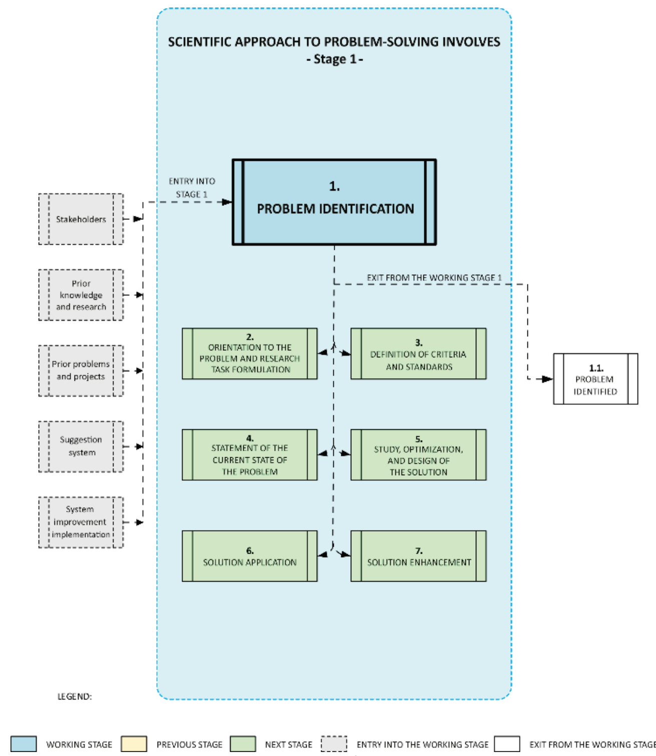


**Figure 2** Activities in the phase of spotting research problems

The theoretical basis of the orientation of the problem is its versatility, completeness, novelty, merit, optimality and correctness [4, 5].

## 2.3 Defining Criteria and Criteria for Research

After the orientation about the problem has been carried out, or already during its execution, a comparison of the results is made with the results of the problem detection phase. The increase in the knowledge of the problem acquired in the phase of orientation enables its better perception so that it can be concluded whether the realized activities satisfy or not. In case of a negative answer to this question, it is necessary to supplement or repeat the previous activities. This control activity can be repeated until satisfaction is achieved. Only after that, it is recommended to define the criteria and criteria with which to start the research (Fig. 4).

Criteria are the value points of view based on which the assessment or assessment of the state of fulfillment of the set objectives or the achievement of the results achieved is carried out [5, 6]. If, for example, the cost of the life cycle or the reliability of a product are important criteria of excellence, then the manufacturer who achieves lower costs and greater reliability for the production of the observed product will undoubtedly be more successful. The criteria enable comparability of products and services as well as solutions obtained by studying a specific problem in essential elements and properties based on predefined and objectified ways, methods and procedures. A better product or solution that meets the criterion function to a greater extent [6]. Closely related to the criteria are the benchmarks. They represent quantitative or value statements to determine the degree of fulfilment of certain criteria. If, for example, the criterion is the distance of point A from point B, then the scale can be millimeters, centimeters, meters, kilometers, nautical miles but also light years, depending on the level of observation.

In general, it can be said that the chosen criteria in some research and problem solving should enable [2]:

- easier choice of alternatives,
- evaluation of the validity of alternatives,
- comparison of alternatives, and
- defining the procedure for collecting data.

The criteria should be compatible with the benchmarks and they clearly state the degree of its realization [6].

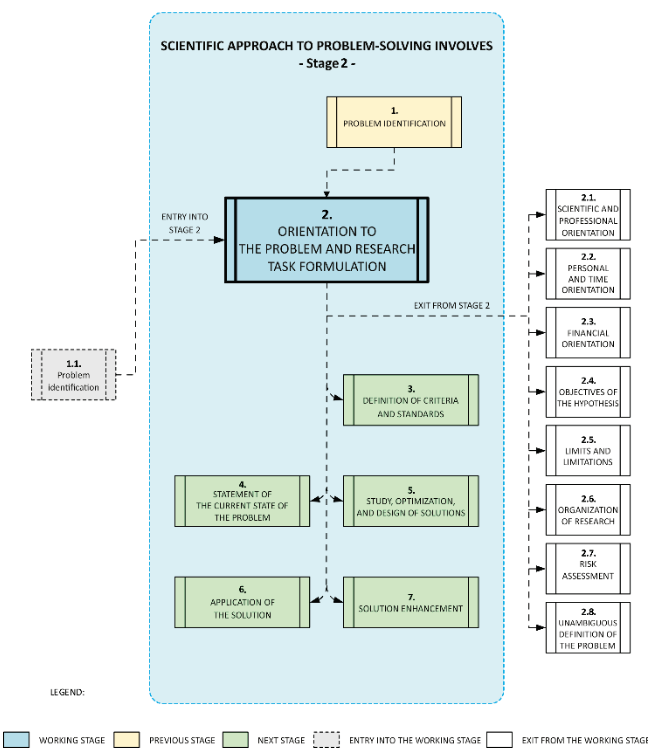

**Figure 3** Process of orientation on the research problem and setting a research task

## 2.4 Determination of the Current Situation of the Problem

The three stages described above represent a preparation for solving the problem. This is followed by stages that represent the process of solving it. The first of the stages in this resolution process is the determination of the existing situation of the problem (Fig. 5).

The goal of this phase is:

- Get the starting state, i.e. the starting point, so that the new solutions are no worse than the existing ones.
- To enable the organization (work environment) to learn the objective truth about the problem.
- Prepare the environment to accept the new solution.
- To gain a good basis of knowledge about the problem being solved [7, 8].

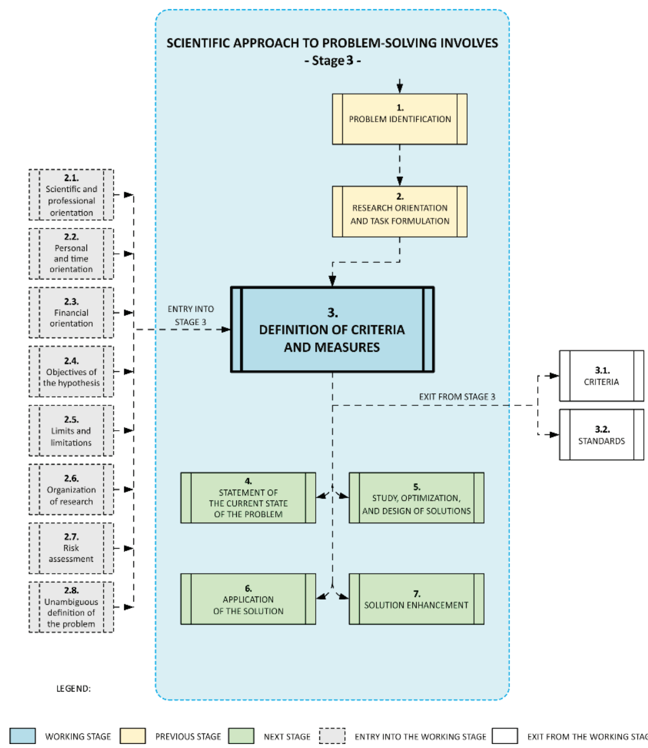

**Figure 4** Showing the stage of defining criteria and scales

The finding of the current situation on the problem is usually carried out through three procedures, namely [9]:

1) Activities of elaboration of the procedure for recording the current state of the problem,
2) Data collection, i.e. recording the current state of the problem, and
3) Identifying the achievements of others (previous research on the problem and similar activities).

## 2.5 Study, Optimization and Design of the Solution

The study or analysis of the existing state of the problem is carried out for a more complete cognition, i.e. to increase knowledge about the problem, and the primary goal is to find a connection between cause and effect according to the selected criteria and benchmarks (Fig. 6), which will serve in choosing and shaping a solution. In other words, at this stage of the paper, the aim is to determine as accurately as possible which factors, in this particular case, are the causes of the problem, how they work, whether they are connected and how, from where they appear, what enhances and what reduces their impact – their description and the way they act are determined. Very often, the concepts of cause and effect are confused because it is easier to determine the consequences (they are visible) than the causes, so sometimes solutions are built on the basis of consequences and suboptimal or even wrong solutions are obtained [10, 11, 12].

Study is the stage where influential factors on the consequence are determined, that is, the observed problem that is being solved. Symbolically this can be depicted as:

$$Y = a + bx_1 + cx_2 + dx_3 + ex_1x_2 + fx_1x_3 + gx_2x_3 + ... \quad (1)$$

where is: $Y$ – consequence (expressed through the selected criterion and ion); $x_1, x_2, x_3$ – influencing factors (example for three influential factors); $a, b, c, d, e, f, g$ – coefficients that indicate the influence of a factor or their interaction.

During the study of the problem (analysis and synthesis), there are more possibilities for its solution. Some of the possibilities are mutually exclusive. Other options for solving the problem, not any of them being excluded, are incorporated into a possible variant. In this way, a very large number of variants are obtained. According to the criteria and benchmarks adopted, it is necessary to evaluate each variant [13, 14].

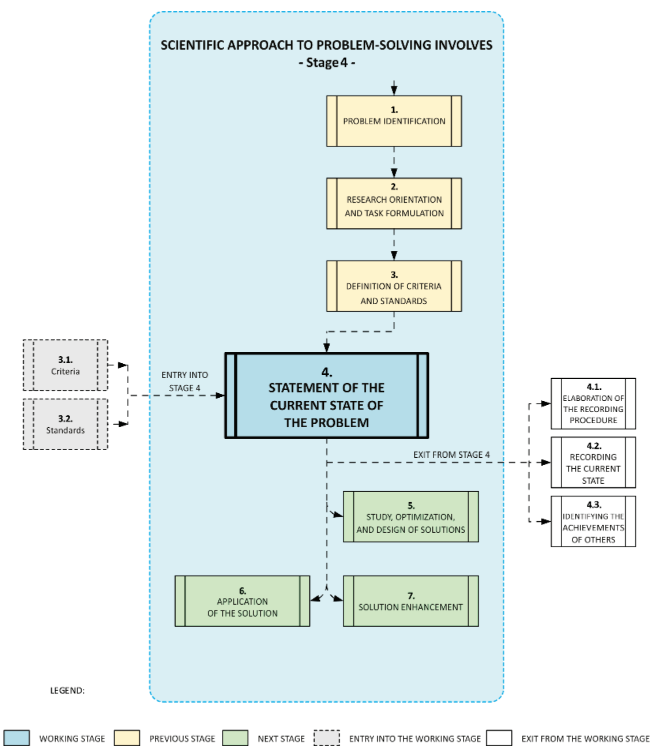

**Figure 5** Statement of the existing situation about the problem

Based on the conducted evaluation, the best variant (solution optimization) is adopted. The adoption of the conceptual variant is carried out in order that each proposed variant is not fully developed with all the elements, which would significantly extend the work and research time. The design of the solution is in fact the grooming of the chosen variant. In other words, writing, drawing, photocopying, etc. This is where the project, that is, the solution gets its form. A larger number of contributors can also be involved in the realization of this stage in order to form a solution as soon as possible.

## 2.6 Application of the Solution

Without the application, there is no true solution to the problem [15] Otherwise, the problem remains solved, and the goals and other settings that were defined at the very beginning of the work cannot be realized. For these reasons, this stage can be declared as the most significant, the most difficult but also the "most beautiful" if it succeeds (Fig. 7).

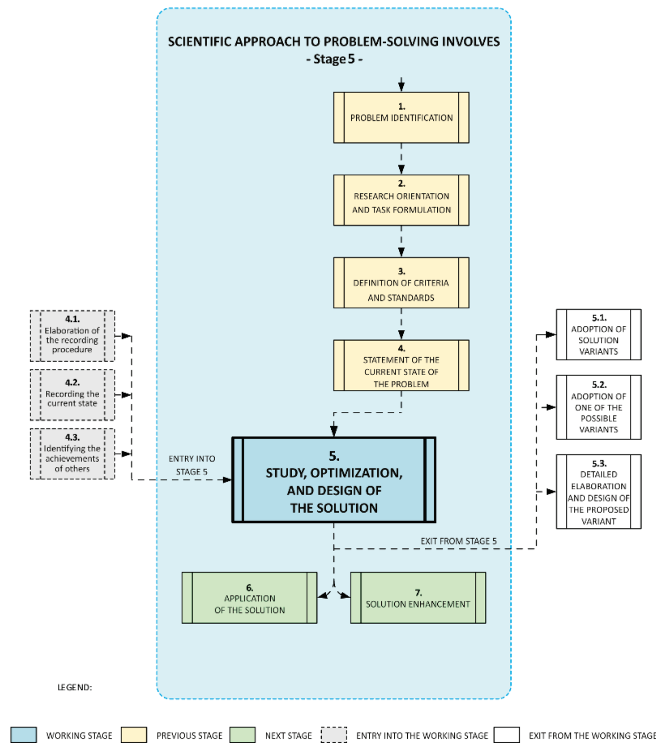

**Figure 6** The stage of problem study, optimization and design of a new solution

The significance of this phase is great and requires adjustment of the procedures of the previous stages so that all activities undertaken in them must have a projection in these activities, i.e. they must be treated in such a way that there is a vision of implementing the solution in advance [16, 17].

## 2.7 Improving the Solution

At this stage, shortcomings and omissions in the applied procedures are observed and you become aware that it could be done better. This stage of the work represents the improvement of research in all its stages (Fig. 8).

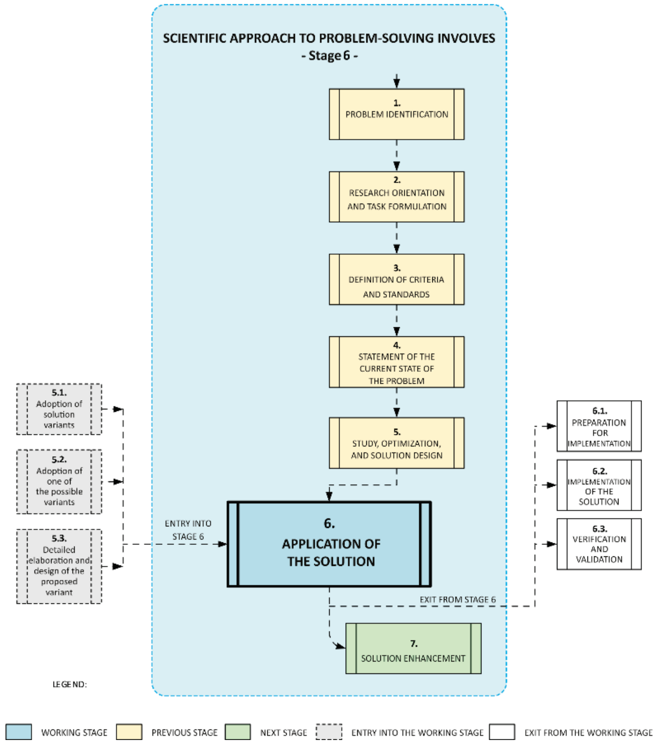

**Figure 7** Application phase of a new solution

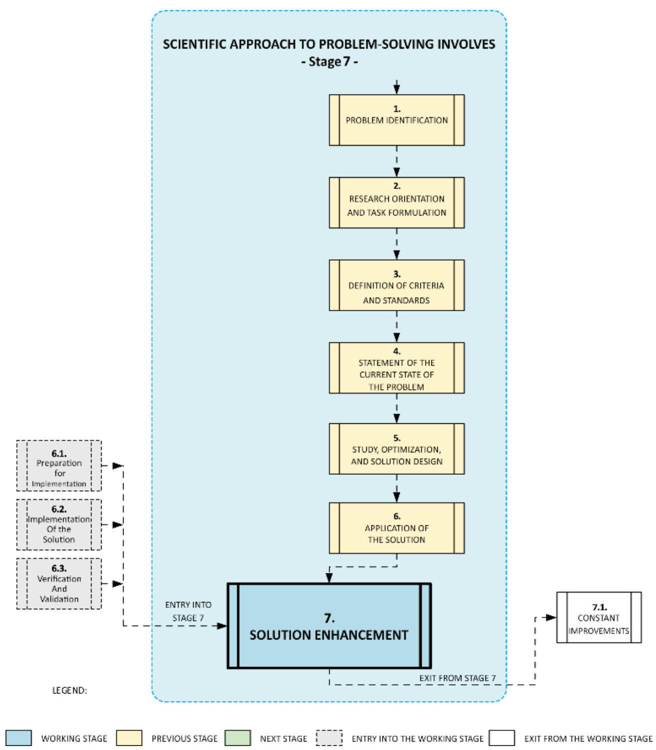

**Figure 8** Stage of improving the results of work

The essence of the improvement of the solution is to monitor its application in practice, in order to reasonably, step by step, find a way to apply the solution better, easier and more economically [18]. It should be borne in mind that no solution is the best solution. There is always a better solution, that is, a better way. Therefore, it needs to be continuously sought and improved [19, 20].

## 3 CONCLUSION

The presented methodology is one of the possible solutions for successful problem solving in business systems on a scientific basis. Verification and validation was carried out on several practical problems where simplicity and effectiveness were confirmed. In the paper, it was not possible to describe all the details related to practical application as well as its theoretical background. Adjustments of the presented approach are possible according to specific situations, but taking into account its basic principles and stages of realization. Improvements to the shaped method are the reality expected of scientists because of its concrete application. Reference [3] shows the application of the described method from a research perspective. Authors of the article used the above-mentioned method in their professional work to solve the problem of improving machine maintenance and reducing production losses.

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