

# Seven Tools for Quality Management and Control: Theory and Practice

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## ABSTRACT

This article attempts to consider the methods of quality management as a system of tools, to justify their theoretical and practical significance, to illustrate the possibilities of practical application on the basis of real examples. The article proved the active development of quality management systems in parallel with the development of production, enrichment of the experience of the world's leading enterprises. One of the most well-known methods of quality management was identified and justified – the ‘Seven Basic Quality Control Tools’. The article illustrates in detail the possibility of applying each of the instruments of this complex in the activities of production enterprises. Most of the tools reviewed are suitable for assessing the timing of activities, their sequence, the responsible agents, and the effectiveness of activities. Application of the method ‘Seven basic instruments of quality control’ contributes to rational organization of production and business processes of the enterprise, increase their stability and competitiveness in domestic and foreign markets.

**Keywords:** *quality, quality management, methods of quality management, instruments of quality management, quality control, quality of the project*

## 1. INTRODUCTION

*Statement of the problem in general terms and its relationship with important scientific and practical tasks.* Sustainable functioning and development of the enterprise’s quality management system requires mandatory use of objective and reliable information that allows you to make adequate management decisions regarding the quality of resources, production processes, manufactured products, and enterprise management. In turn, such decisions can be objectively made only if quality management tools are systematically applied.

The set of quality management tools is formed throughout the entire period of development of quality management and is quite diverse. Until now, the quality management system continues to actively develop in parallel with the development of production, and gets enriched by the experience of leading world enterprises. Under these conditions, the most famous method of quality management is the ‘Seven Basic Quality Control Tools’ method developed in Japan. This method allows to analyze the results of various processes and is the basis of the ‘Total Quality Management (TQM)’ system and the ‘Quality Function Deployment (QFD)’ system.

*Analysis of recent research and publications.* Thus, the works of such scientists as V.Ya. Belobragin, B.I. Gerasimov, V.V. Efimov, S.V. Mishchenko, S.A. Pakhomova, S.V. Ponomarev, O.S. Ponomareva, V.A. Samorodov, A.V. Trofimov et al., note that ‘the classification of quality management methods is represented by both individual and complex methods, as

well as theoretical foundations, concepts and systems. In contrast to complex methods, concepts and systems involve not only the application of a specific set of methods, but also the reform of the approach to managing an organization’ [1].

V.V. Efimov believes that ‘quality management methods can be divided into economic, organizational-administrative, socio-psychological and scientific-technical, integrated and research methods’ [2]. Its classification is specified by other authors (e.g., G.G. Azgaldov, I.Z. Aronov, D.I. Bark, L.M. Gatovsky, A.K. Kazantsev, G.A. Lakhtin, E.N. Mikheeva, A.A. Nikonov, A.G. Sergeev, K.F. Puzynya, A.I. Shcherbakov, etc.).

Thus, economic management methods are mentioned in the works of D.I. Barka, L.M. Gatovsky, A.K. Kazantsev, G.A. Lakhtin, A.A. Nikonova, K.F. Puzynya, A.I. Shcherbakov and ‘mean creation of certain economic conditions that encourage personnel of the enterprise to increase and ensure the necessary level of product quality’ [3].

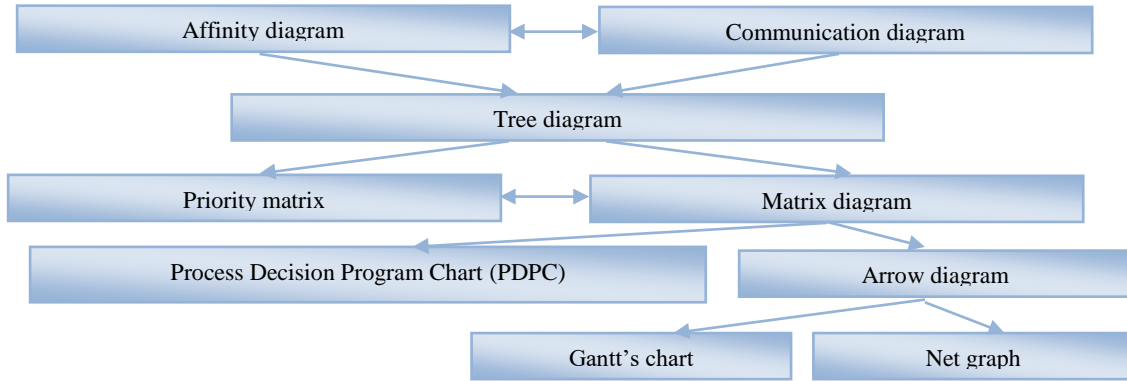
E.N. Mikheeva, describing organizational and administrative methods of quality management, notes ‘the mandatory implementation of directives, orders, instructions of the management aimed at improving and ensuring the necessary level of quality’ [4].

Socio-psychological methods (E.A. Bedrina, V.V. Bedrina, E. Belokorovin, N.A. Bonyushko, P. Watson, O. Vishnyakov, E.A. Gorbashko, M.A. Dremina, V.A. Kopnova, V. Krokhin, V.A. Lapidus, M. Molodov, D. Maslov, A.A. Semchenko and others) ‘affect the socio-psychological processes occurring in labor collectives and affecting achievement of quality goals: moral stimulation of high labor results, development of a corporate culture of the enterprise, ensuring a favorable psychological climate in the

team, promotion of self-discipline, responsibility and initiative of the staff' [5].

## 2. METHODOLOGY

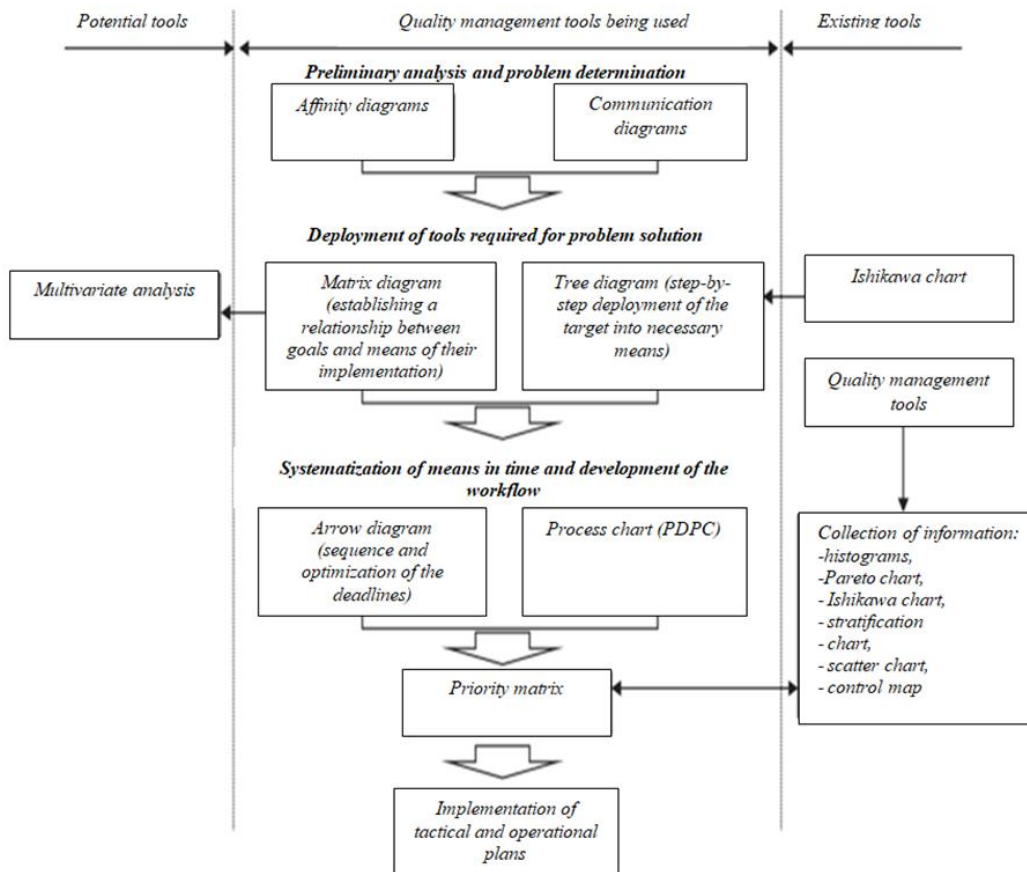
*Formulation of objectives.* Summarizing the accumulated scientific experience, the relationship was revealed and the interaction of seven new quality management tools was justified (Figure 1).



**Figure 1** Association of seven new quality tools

In this figure, the methods are interconnected and are in constant interaction. As a rule, such quality tools as stand-alone are rarely used. Usually they are used jointly (Figure

2), which is called the 'KJ' method, developed in the 50s of XX century by J. Kawakita.



**Figure 2** Joint use of quality tools

According to the ‘KJ’ method, information comes simultaneously from several sources: mass media, customer reviews, opinions of resource providers, competitors’ behavior, etc. From the entire array of information received, it is advisable to select only that which is relevant to the case.

Thus, it is advisable to specify the quality management tools and determine their capabilities and ways to solve problems. *Methods, techniques and technologies used in the study.* The study of quality management tools from a theoretical and practical point of view, predetermined the use of the following methods:

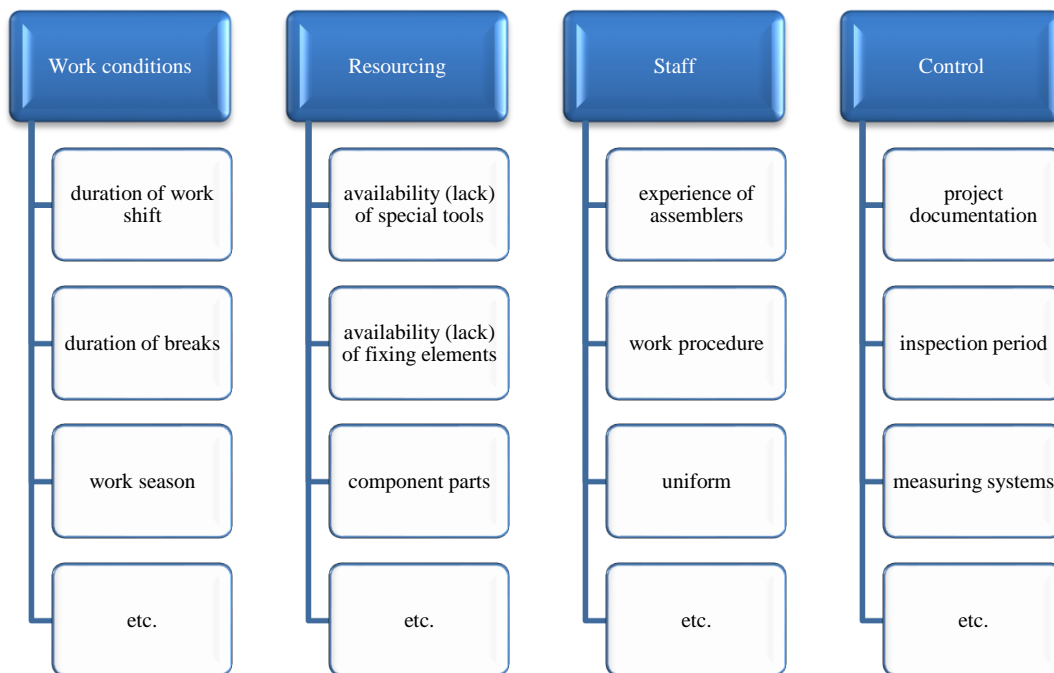
- evolutionary - in the context of research and development of quality management tools in parallel with the development of production and economy as a whole;
- systematic - when considering individual quality management tools, which affect functioning of a manufacturing enterprise, depending on the stage of the project;
  - project - allowing to build cohesiveness of the study, stages and implementation procedure;

- modeling - allowing to study the structure, properties, features of the development and interaction of quality management tools in accordance with the stage of the process.

It should be noted that in addition to the above methods, other methods such as expert survey and brain storming (brain attack) were also used. It should be clarified that the experts were the managers of the quality departments and specialists of such enterprises as JSC ‘Federal Scientific Production Center’ PO ‘Start’ named after M.V. Protzenko’, JSC ‘PO Elektropribor’, JSC ‘Penzyazhpromarmatura’, JSC NPP ‘Rubin’, JSC ‘Radiozavod’, JSC ‘Grabovskiy Automobile Plant’ and others.

### 3. RESULTS

*Statement of the main research material.* Thus, the ‘Affinity Diagram’ (a technical tool) is used in conditions of generating a large number of ideas and suggestions, which are combined into groups to formulate management decisions. An example of the Affinity Diagram method is shown in Figure 3.



**Figure 3** Example of the Affinity Diagram method

As an example, the problem of ensuring safe installation conditions of metal structures was simulated. Using the brainstorming method, experts identified possible causes of installation security breaches, and combined them into three groups. The grouping shown in Figure 3 is conditional. Presence of determining elements is justified in each group. Subsequently, the information obtained helps to identify

strengths and weaknesses in the practice of ensuring safety of installation and development of preventive measures.

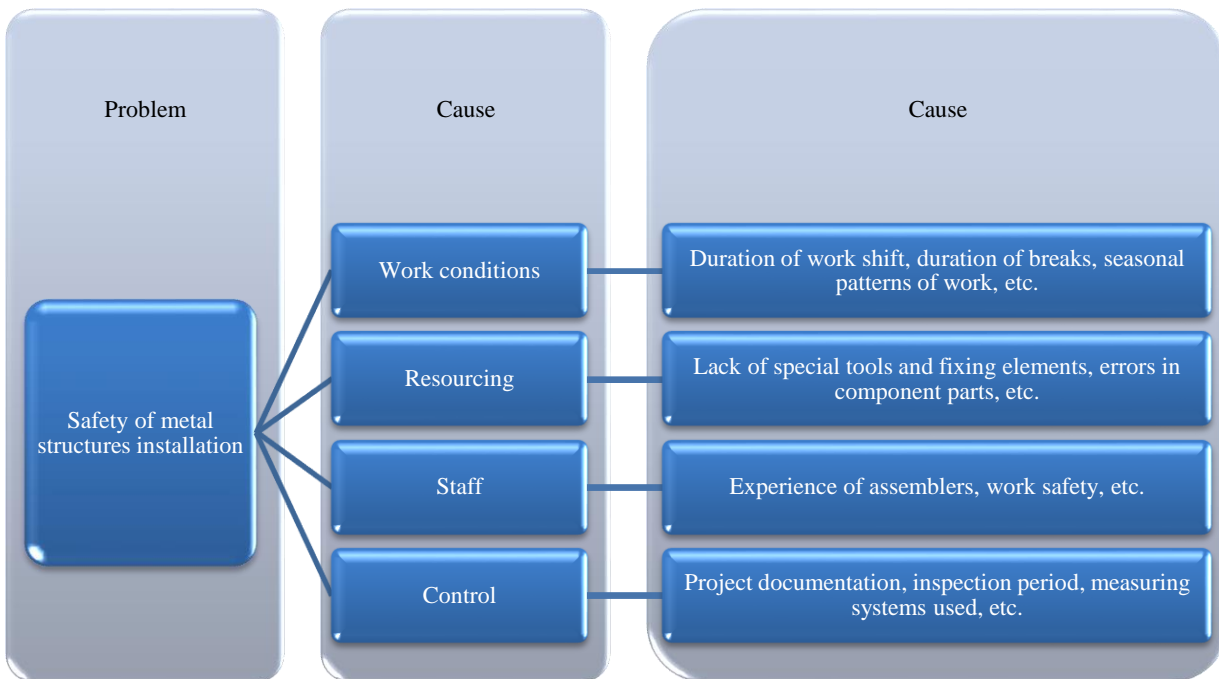
The ‘Connection Diagram’ method (a logical tool) is usually used to systematize a large amount of information, to identify logical relationships between different data. An example of the ‘Connection Diagram’ method can be illustrated using the ‘Deming Chain Reaction’ (Figure 4).



**Figure 4** An example of the ‘Connection Diagram’ method based on the ‘Deming Chain Reaction’

It can be assumed that this method has some similarities with the ‘Affinity Diagram’ and ‘Ishikawa Diagram’ methods, that it is built on the ‘cause-effect’ principle, and is often used to identify the causes and consequences of doing business.

The ‘Tree Diagram’ method (systematic diagram) is a systematic way of solving a problem, and meeting the interests of stakeholders. This method provides tactical planning in a certain sequence, which contributes to the formation of a system of strategic solutions to existing problems (Figure 5).



**Figure 5** ‘Tree Diagram’ example.

To illustrate an example of building a ‘tree diagram’, a previously simulated situation was used to solve the problem of ensuring safe installation of metal structures. A ‘tree diagram’ consists of a hierarchical structure of elements aimed at solving a problem.

The ‘Priority Matrix’ method (D. Eisenhower’s matrix, S. Covey’ square matrix) is a tool for identifying priorities in making managerial decisions. The ‘Priority Matrix’ method is also called the ‘S. Covey’s Time Management Matrix’. An example of such matrix is presented in Table 1.

**Table 1** ‘Priority Matrix’

Things to do	Urgent	Non-Urgent
<b>Important</b>	Emergencies; Urgent issues; Projects with an expiring deadline, etc.	Planning of new projects; Development of new contacts; Evaluation of results, etc.
<b>Unimportant</b>	Meetings; Social work, etc.	Phone calls, checking correspondence, e-mail; Entertainment; And other time-killing trifles

It can be assumed that the 'Priority Matrix' is a very relevant and important tool for time management, which allows rational planning of the business process. The 'Matrix diagram' method allows to identify the importance of relationships, usually hidden, i.e. explore the

essence of the problem. The specifics of building a 'matrix diagram' can be considered through the example of a simulated situation for building of an effective marketing policy (Table 2).

**Table 2** Example of the 'Matrix diagram' method

Effective marketing policy	Implementation						
	Variety of assortment	Price policy	Number of outlets	Promotion	Service	Staff	Etc.
Market research							
Customer research							
Competition analysis							
Market planning							
Etc.							

Based on the expert survey method, the matrix cells are filled in, ranking the connections and correlations between them according to three criteria: weak, medium, and strong connections. The advantage of this method, we can assume, is visibility of the connections between various aspects of the problem and possibilities of its solution.

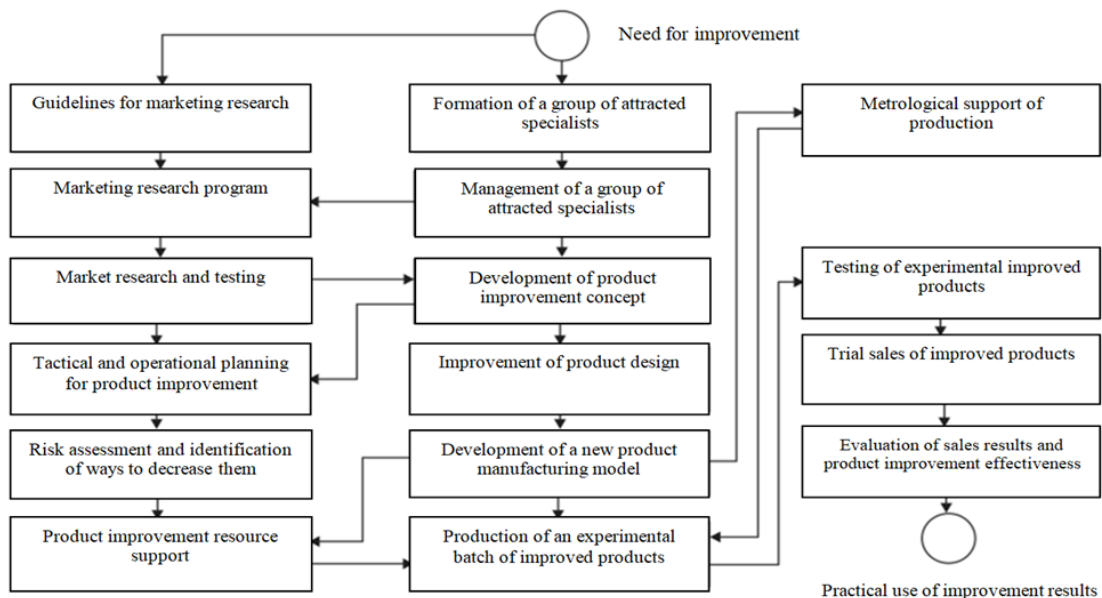
'Process Decision Program Chart (PDPC)' method is a tool for assessing the timing and feasibility of implementing production and business processes. The process chart is shown in Figure 6.



**Figure 6** Process Flow Chart

The PDPC method makes it possible to carry out preliminary planning and identifying a sequence of actions, analyzing problems that arise. It is advisable to consider practical application of the PDPC method.

Thus, Figure 7 shows an example of solving the problem of improving product quality by increasing the warranty period.



**Figure 7** Improving product quality through the PDPC method application

The presented illustration seems relevant at the stage of preliminary planning of quality improvement, as well as monitoring the sequence of solving the problem. Based on the PDPC chart, in the event of complex circumstances, it is possible to find ways to rationally resolve them.

Also, as an example, we can consider the process of organizing an advertising campaign of an enterprise (Figure 8).

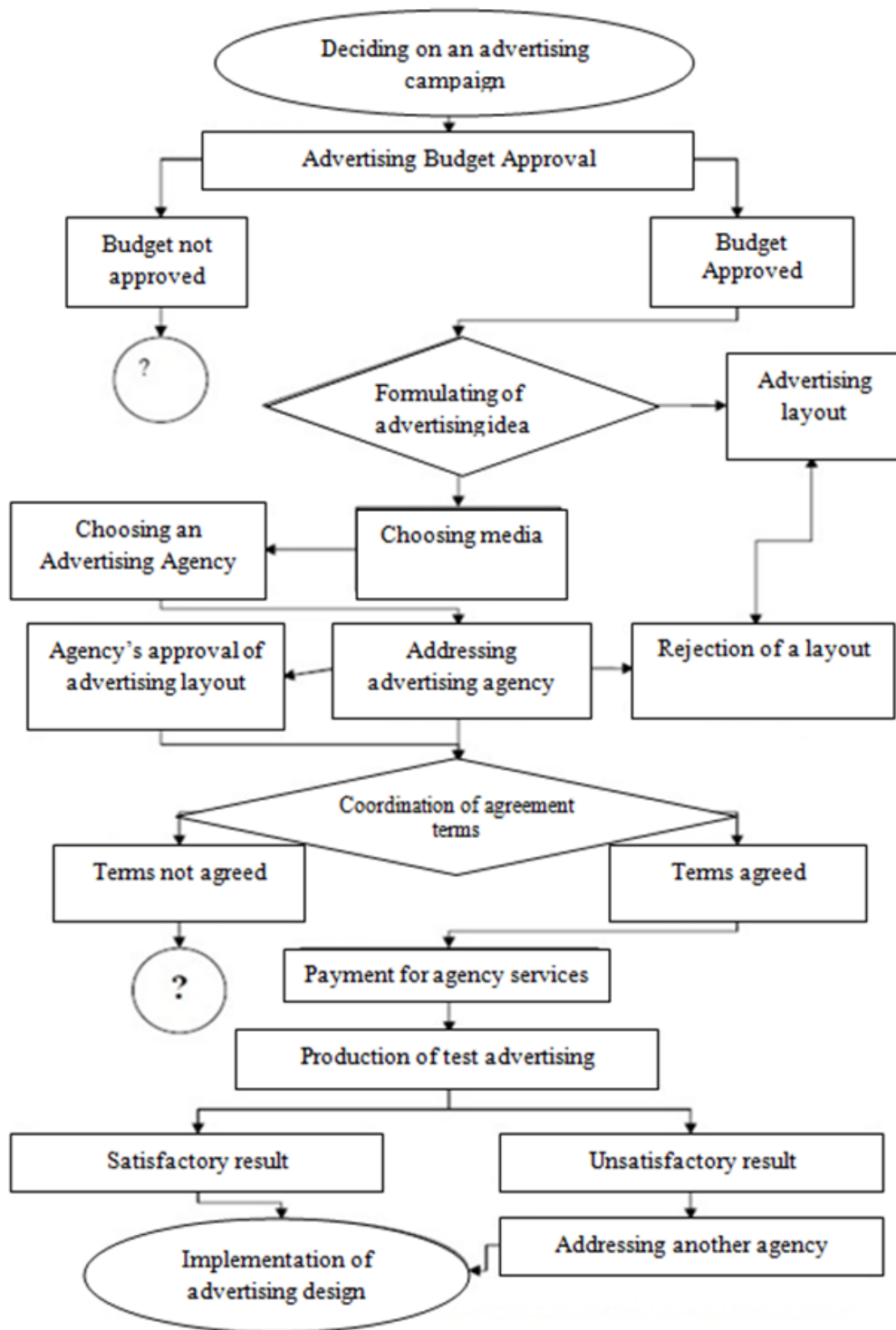


Figure 8 Example of advertising campaign arrangement process

This example illustrates the possibility of assessing the length of time needed to arrange events of an advertising campaign of an enterprise, the sequence of events, responsible providers, as well as evaluating effectiveness of the events.

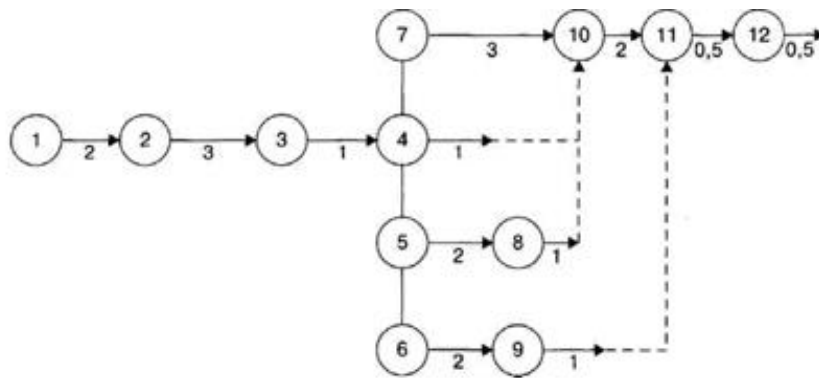
The PDPC method is close in meaning to the ‘Arrow Diagram’ method, which is also a diagram of the work sequence, the duration of it, and the distribution of responsibility. As a rule, the ‘Arrow Diagram’ method

inspires confidence that the planned time for the execution of work and operations is optimal and contributes to the rational arrangement of the production process. This method is usually illustrated in two forms: ‘Gantt’s chart’ and ‘Net graph’.

As an example of ‘Gantt’s chart’ and ‘Net graph’, we will look at a 12-month process of performing construction and installation works during construction of a turnkey house (Table 3, Figure 9, respectively).

**Table 3** Example of a ‘Gantt’s chart’

№	Operations	Months											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Foundation	→											
2	Shell			→									
3	Roof erection						→						
4	Electrical connections							→					
5	Water supply, wastewater disposal, heating							→	→				
6	Interior decoration of walls							→	→				
7	Glass fixing, erection of doors							→	→	→			
8	Exterior decoration of the house									→			
9	Internal painting									→	→		
10	Interior finish									→	→	→	
11	Final quality test ACW										→	→	→
12	Commissioning of the house											→	→



- operation (arrow length is proportional to the time)
- - - - - relationships between operations that do not take time (shows the order of operation completion)
- operation sequence number
- 2 → duration (in months) of a specific operation

**Figure 9** Example of a ‘Net graph’

A ‘Net graph’ is typically used to describe the relationship between operations and project phases. If necessary, warning and corrective actions can be developed.

As a rule, the ‘Gantt’s chart’ and ‘Net graph’ are used to control the duration of the project, and to achieve the goals of the project.

There are opinions in the scientific literature (for example, D.S. Ritter [6], the team of authors under the leadership of V.N. Azarova [7], V.V. Okrepilov [8], etc.), according to which, in addition to the analysis of processes, together with the 'Gantt's chart' and 'Net graph' methods, it is recommended to use others, such as 'Failure Mode and Effects Analysis (FMEA)', 'Benchmarking', 'Methods of ensuring, stimulating and quality control', etc.

*Comparison of the obtained results with those in other studies.* Analyzing the scientific literature, it can be noted that most publications are devoted to the consideration, as a rule, of one group of quality management methods. Thus, for example, Yu.P. Adler, I.Z. Aronov and I.Z. Shper offer to increase efficiency of production and project activities through tools such as 'Lean Production', process reengineering, the theory of learning organizations and 'knowledge management', creation of a flexible organizational structure, etc. [9]. E.A. Gorbashko [10] mentions such tools as the 'Affinity Diagram', 'Communication Diagram' and 'Matrix Diagram', M.V. Samsonova and V.V. Efimova [11] mention the 'Tree Diagram', etc. In this regard, this article attempts to consider quality management methods as a system of tools to substantiate their theoretical and practical significance, to illustrate the possibilities of practical application with real examples.

#### 4. CONCLUSIONS

*Research conclusions.* Thus, the conducted study allowed to draw the following conclusions:

- orientation of enterprise policies towards high quality involves active implementation of quality management systems and methods based on vast foreign experience;
- the most common method is the 'Seven Basic Quality Tools', which has significant relevance, theoretical and practical significance in terms of quality management;
- application of the 'Seven Basic Quality Control Tools' method contributes to the rational arrangement of production and business processes of the enterprise, increasing their stability and competitiveness in the domestic and foreign markets.

#### REFERENCES

- [1]. S.V. Ponomarev, S.V. Mishchenko, V.Ya. Belobragin, V.A. Samorodov, B.I. Gerasimov, A.V. Trofimov, S.A. Pakhomova, O.S. Ponomareva, *Product Quality Management. Tools and Methods of Quality Management: Study guide*, M.: RIA 'Standards and Quality'. 2005.
- [2]. Efimov V.V., *Means and Methods of Quality Management*. M.: KNORUS, 2007.
- [3]. Moiseev V.V. *Management Methods in Increasing Production Efficiency*, Scientific Journal of KubSAU. 2017. No 133. URL: <https://cyberleninka.ru/article/n/metody-upravleniya-v-povyshenii-effektivnosti-proizvodstva-1> (reference date: 02/18/2019).
- [4]. Mikheeva E.N., *Quality Management*. [https://studref.com/346600/menedzhment/upravlenie\\_k\\_achestvom](https://studref.com/346600/menedzhment/upravlenie_k_achestvom)
- [5]. Gribov V.D., *Fundamentals of Management*. [https://studme.org/42581/menedzhment/osnovy\\_upravlencheskoy\\_deyatelnosti](https://studme.org/42581/menedzhment/osnovy_upravlencheskoy_deyatelnosti)
- [6]. Ritter D.S. *Use of Universal Quality Management Methods in Education is Key to Academic Success // Selected Works of the 40th Congress of the European Organization for Quality*. Berlin, September 1996: Collection of translations from English. M.: GP - Ed. Office of the journal 'Standards and Quality', 1997.
- [7]. *Quality Management: Volume 2. Principles and Methods of Universal Quality Management*. Under the general editorship of Azarov V.N. M.: MSIEM, 2000.
- [8]. Okrepilov V.V., *Quality Management*. St. Petersburg: Science, 2003.
- [9]. Adler Yu.P., Aronov I.Z., Shper I.Z., *What has the current century in store? Management of the XXI century – continuation of a brief overview of main trends*, *Methods of quality management*. 2004. No. 1.
- [10]. Gorbashko E.A., *Quality Management: Study Guide*. - St. Petersburg: Peter, 2008, 384 p.
- [11]. Samsonova M.V., Efimov V.V., *Technology and Methods for Collective Problem Solving, Study Guide*. Ulyanovsk: UISTU. 2003, 152 p.