

## QUALITY IMPROVEMENT IN PRODUCTION PROCESS

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**Abstract:** Quality is a certain degree of excellence and is one of the important factor in realization of the production process. Evaluation of the quality excellence in production project management is connected with a process of making changes in particular phases of project realization. The thesis proposed in the article is: the effective quality improvement based on implementation of the quality management method contributes to achieve the planned quality in the production project.

**Keywords:** management, quality, production process

### 1. INTRODUCTION

Evolution of theory and practice in management reviewed in the scope of evolving currents and concepts is oriented on changes in the scope of functioning or an organization and undertaken actions, which are related with focus on perfection. Development of management, in a philosophical approach, may be also interpreted as improvement and it is related to a positive change, assessed in a utilitarian and ethical scope. Most generally, improvement can be explained as a goal-achieving activity, whereas a term „improvement” in praxeology, as science on efficient activity deriving from philosophy of practicality, is reviewed in an activity-oriented aspect of perfection. Perfection is viewed in an objective and evaluating approach. Objective significance of perfection refers to a given characteristics, which an object possesses to a highest possible degree. However, in an evaluating meaning - an object is perfect with a view to a given characteristics attributed to a given entity, if for this entity it is valuable when this object possesses a given characteristics in a defined degree (Pszczolowski, 1978). The objects may include undertaken actions, e.g. in a form of projects and their products. Therefore, a perspective of modern management is improvement. If an object are manufacturing projects, then the improvement of quality has fundamental significance for a success of a project, as well as an organization. In an article a following thesis was formed – effective improvement of quality based on using management methods in a manufacturing project.

## 2. CONCEPT OF QUALITY IMPROVEMENT IN A PROJECT

Particular significance is paid to a development of a concept of continuous improvement in a context of implementation of submitted and unique enterprises, such as projects. H. Kerzner explains the perfection in project management in a context of success measured in a scope of a single project, as well as an organization (Kerzner, 1998), whereas, the main scopes of improvement in project management IPMA includes: people and goals, processes and resources and results of a project (Project Excellence Baseline, 2016). Project, as an action of a unique and temporary character (A Guide to PMBOK, 2013; Crosby, 1986) is described by basic parameters, i.e. meeting the requirements, time and cost (Deming, 1982). Meeting the requirements refers to quality requirements concerning the project. Quality in professional literature has various interpretations. Most generally, quality is perceived as a degree of adjustment of a given object to expectations of an object. P.B. Crosby [Crosby, 1986; PN-EN ISO, 2001; Radin and Coffee, 1993], E.W. Deming (Deming, 1982; Yoon and Lasarus, 1993), defining quality, draw the attention to such elements as: compliance with requirements, reliability, cost. More, precisely, quality is interpreted in a product, usability, usability, value and normative approach. One should perceive, that normative quality is of universal character, this type of quality unites other types of approach, explaining quality as a collection of inherent properties of meeting requirements (Juchniewicz, 2019). Therefore, what is the project quality? – project quality can be defined simply, as capability to meet requirements specified at every stage of its implementation. Project quality is affected by many interlinked elements, such as:

- surroundings – political, economic, institutional, technical, social and cultural,
- preparation and implementation of a project, therefore the application of methods and methodologies of project management.

In production projects, despite criticism, the Total Quality Management (*TQM*) can be applied (Kozień, 2017; Kozień, 2018a). *TQM* is a philosophy of continuous improvement engaging the resources of project organization with a purpose of creation and delivery of value to a client. *TQM* assumed culture of improvement based on principles and tools supporting its application (Kozień, 2002). The significant principles which should be observed in a production process include: client-orientation, involvement of people (formation of interdisciplinary teams oriented on cooperation), procedural approach, continuous improvement. The advantage of *TQM* is a vast scope of instruments, which is used in quality management. For example, the tools which can be used to secure quality requirements in a production process may include: 5 WHY, FMEA, 5S, Kanban, Pareto Diagrams, Histograms.

## 3. QUALITY IMPROVEMENT IN A PRODUCTION PROCESS

Problem of quality improvement will be discussed, based on a project of innovative detail, which is of key importance for improvement of production project. A company, caring for high quality of detail implemented a project management methodology including the following actions in distinguished phases of its implementation:

1. Planning phase includes the preparation of technical project of detail according to the approved parameters. On a basis of the prepared technical documentation a team of specialists assesses a degree of difficulty in producing a detail, material out of which the detail will be manufactured and the machine park. The effect of the designing phase is a documentation describing schemes and methods of detail

production. Employees of research and construction department participate in this phase.

2. Phase of innovative workmanship of a detail concerns the preparation of material from which the detail is to be made, next – a programmer begins programming a machine for this purpose, uses CAD-type software: Alibre Design CAD 3D and Solidworks. The software makes it possible to generate a g-code necessary for correct operation of the machine as well as to define a time of detail processing, material, moreover makes it possible to foresee errors in software, if any, using a stimulator. Next, after downloading the software onto a machine the detail is processed. This phase involves quality control department employees, who – using tests, measurements, checking of technical requirements for characteristics of detail defined in a phase of designing – confirm the compliance of detail with the required technical parameters. In a situation when the quality control shows discrepancies of the detail in relation to the technical documentation, an improvement phase is entered.
3. Improvement phase involves an identification of a problem, i.e. the arising discrepancies in detail workmanship using selected methods and concepts of quality improvement in a production process. Continuous improvement is treated as a procedure of actions leading to obtaining a standard. For this purpose, the Shewhart-Deming cycle (PDCA) is used as a solution systematizing improving actions, and also selected methods and techniques improving quality in a production process are used.
4. Phase of completion means the mounting of a detail and launching the production process.

In the production process for the purpose of identification of problems of discrepancies revealed in a process of production of ball screws a design team was appointed. The most basic goal of the team was the improvement of quality of a machining process. A design team applied the method 5WHY for detection of the reasons of a problem. As a result of the conducted analysis the reasons of the arising operating defects turned out to be problems with overburdening the employees, a lack of precision of a machine, a flow of information. Next, a design team, using the method: Failure Mode and Effect Analysis (FMEA) in a project, defined a coefficient of risk level  $WPR$  (1) of appearance of potential defects (Kozień, 2017).

$$WPR = Z \cdot R \cdot W \quad (1)$$

where:

$Z$  - significance of a defect due to the effects which arise as a result of implementation of a production process,

$R$  - risk of appearance of a defect or a reason for a defect,

$W$  - possibility of diagnosis of a cause before this causes a defect.

Parameters ( $Z$ ,  $R$ ,  $W$ ) are specified in a scale from 1-10.  $WPR$  coefficient constitutes a reason to establish a ranking of reasons due to their criticality.

As the main causes of defects of a detail in a production process the imprecision of a machine was indicated, as well as employees' errors. Whereas, a ranking of causes of defects defined using the FMEA analysis, with consideration to their criticality from the point of view of effectiveness of project implementation, indicated the priority actions (marked according to their order in the Table 1), connected to the renovation of a

machine and training for employees. The significant pro-quality action is also the provision of occupational safety and hygiene (Kozień and Kozień, 2019). Improving actions were connected with additional costs. Assuming the keeping of the time for project implementation the gradient of costs was increased by 25.600 units. Increase of a cost of project arising from a renovation of a machine or training of employees in a scope of mechanical processing and implementation of quality procedures in juxtaposition with real increase of orders in relation to delivery to clients of a detail with full quality is advantageous to the development of a company (Kozień and Kozień, 2018).

Table 1

FMEA analysis for the process of machining the ball screw.

Lp	Potential defects	Potential effects	Z	Potential reasons for defects	R	W	WPR	Recommended actions
1.	Loose strips under the bearing	Use of elements of a machine	9	Low precision of a machine	9	5	405	Renovation or purchase of a new lathe
2.	Too high diameter of the kingpin	Impossible to mount	9	Low precision of a machine	9	4	324	Renovation or purchase of a new lathe
3.	Imprecise outline of a thread	Mounting more difficult	8	No measurement reference standard	6	4	192	Establishment of controlling standards
4.	Matte surface	Non-esthetical appearance	5	Unsuitable processing parameters	4	1	20	Controlling of a selection of parameters

Source: own work

Company management connects a strategy of development of a company with continuous improvement of quality in implemented production projects. Moreover, a company, caring for its development, implements the principles of perfection of an organization defined by the European Foundation for Quality Management (*EFQM*) (Kozień and Kozień, 2019), especially connected with responsibility a sustainable future (Kozień and Kozień, 2018), building partnership, managing by processes, adding value for customers, nurturing creativity and innovation. Applying the above principles denotes the dimensions of the contemporary approach to perfection, and also brings a company closer to the so-called perfect organization.

#### 4. CONCLUSIONS

Improvement of quality in a production process is intrinsically connected with introduction of changes. The borderline between the notions of „improvement” and „introduction of changes” is not acute, because reaching a definite degree of a given characteristics requires the introduction of changes, and therefore justifies a need to manage a change focused on improvement. Improvement means the improvement of effectiveness, which can be defined in a technical, economic, praxeological and

behavioral dimension. The approaches to improvement differ with their scope depending whether they relate to an organization, concepts of management, actions, etc., implemented in a form of projects. Improvement of quality in management of projects is different and depends on a kind of project, which for a reason of its uniqueness requires the application and adjustment of current methods, definition of principles and specific requirements of quality. This requires an individual approach to a problem of quality improvement in a production project, which in a final effect contributes to its success as the entirety. Quality improvement in projects is a philosophy introduced by people's pursuit of perfection. This tendency of people to improve themselves allows for improvement of actions undertaken by them. Global philosophy of quality improvement is a part of organizational culture and quality management styles based on norms (European style), marketing (American style), kaizen (Japanese style). Improvement of quality of a production process is a continuous process, which is essential from a point of view of efficiency of project implementation and development and strengthening of a competitive position of a company.

In addition to organizational activities (Maszke et al., 2018; Kielbus and Karpisz, 2019), new technologies are a source of improvement in quality. The main basics for new technologies are new or significantly modified materials, taken from nature - phytochemistry/biotechnology (Skrzypczak-Pietraszek and Pietraszek, 2012) - or produced by industry through structural (Bara et al., 2016) or surface layer modification (Ulewicz and Selejdak, 2018; Radek et al., 2018), or through special protection against corrosion (Klimecka, 2018) and vandalism (Radek et al., 2018). Additionally, quality may be improved by more precision control of components lifetime what requires specific models (Osocha, 2018) and methods (Pietraszek et al., 2018).

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