Część IV. Zarządzanie wybranymi obszarami działalności organizacji

Nowoczesne Systemy Zarządzania

EVALUATION OF QUALITY IN PROJECT MANAGEMENT

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Abstract: The article discusses the problem of quality evaluation. Evaluation is a response to the desire for unequivocal evaluations and comparisons, and ultimately, objectification of project value and quality. Transition to the 'measurable' world forces the contractor's need to become aware of the factors conditioning the value and the quality of project processes and outcomes and the need for their comprehensive and coherent validation.
Keywords: system, project, quality, evaluation, quality criteria.

Introduction

Quality is a generalised systemic feature for any operational systems. The quality of design projects and the entire design organisation (design systems) may be perceived in the perspective of:

a) quality assurance, i.e. the shaping of the design process (ex-ante), modelled on the quality of resources,
b) product quality assessment (ex-post), i.e. the assessment of results of project activities (of the outcome/product).

Project quality is a function of many variables (Zaskórski, Woźniak, Szwarc, Tomaszewski, 2013, p. 239-268). It consists of all internal and external elements of the design system which have a direct or indirect influence on the project outcome. Project quality should be subjected to objectification, evaluation and validation, taking into account such quality determinants as:

a) scope, budget and duration of the project,
b) resources, including design tools,
c) risk and method of estimating and controlling the risk.

Primarily, project quality should reflect the achievement of objectives set for the design project. Each feature (attribute) of the project affects the level of quality. In order to evaluate the project, you should aim at determining measurable, dominant indicators for each attribute of the project, which is not an easy task.

1. Attributes of project quality

The project is finalised once the customer requirements have been met. Satisfaction with the resulting product is a major determinant of the quality of the product and the whole design system. Completion of each project should involve assessment of the level of:

a) achievement of all the objectives of the project and expectations of the potential customer,
b) compliance with adopted norms and standards,
c) compliance with prescribed project budgets and schedules,
d) risk, i.e. if the risk has been maintained at an acceptable level.

Such assessment requires review of the final documentation for each stage of the implemented project or the agreed milestones, and for instance, the so-called exception reports. The quality of design projects should be a global criterion to be used in the assessment of projects (processes), performance (product) and in the assessment of the product's life (its use by the customer). Each design process is identified as a group of processes implemented in different areas. The product quality is significantly determined by the quality of the design processes. Quality monitoring and assessment requires constant action and appropriate expenditure on pro-quality activities (e.g. cost of removing causes and effects of poor quality). In the evaluation of the quality of each project (and in particular, the so-called economic projects), you should consider such quality attributes as:

a) product quality, including the level of customer/user satisfaction with the result of project activities,
b) quality and efficiency of the design process and the accuracy of the assessment of customer requirements (determination of customer requirements and the degree of mapping (reflecting) such requirements in design solutions),
c) usefulness of control of individual design processes (internal control, audits of product compliance with the requirements, meetings with customers),
d) functionality and the level of application/operation of standards, models and norms,
e) reliability of activities (defectiveness of outcomes, number of returned items, claims, complaints, etc.),
f) quality costs (including cost of resources, cost of efficiency of project work organisation, etc.),
g) effectiveness of operation of the quality management system (ex-post),
h) effectiveness of surveillance and monitoring of non-compliance (control of risks and budgets, changes, corrective action, usefulness of pro-quality procedures, etc.).

Quality requires systematic monitoring and recording of its attributes at each stage of the project. The proper evaluation of quality, as a generalised systemic criterion, requires the adoption of appropriate measurements and the use of reliable information on the implementation (completion) status and obtained results. Thus, project quality management is directly related to the process of collecting data and creating databases for each quality attribute, and initiation of analytical and decision-making procedures in the area of quality assurance for project processes and products/outcomes.

2. Identification of quality criteria in project management

The quality criteria for the project should define the quality of the project outcome against the background of conditions of implementation of the entire project and adopted requirements to be met by the product. Accordingly, the criteria for quality evaluation should encourage elimination of the causes of poor quality and allow for the acceptance, or improvement, of results of operations, reduction or elimination of customer dissatisfaction and uncontrolled changes.

In most cases, the criteria for project quality assessment are heterogeneous as their individual groups may relate to different areas of the project. Specialised literature defines different groups of quality criteria (Szczepańska-Woszczyna, 2009, 56-57) which are targeted at:

a) the object of the project, which may be a consequence of the intended use of the product and the resulting property thereof,
b) the manufacturing process, which is related to performance conditions or conditions of implementation of the manufacturing process (the quality of resources, tools, available technology, etc.),
c) the process of use, dominated by the efficiency of operation of the object being improved or expected outcomes of the utilisation process,
d) social acceptance and economy conditioned by economic benefits resulting from project features/design outcomes.

This perception of quality criteria grouping indicates their multithread and multidimensional nature, which means that the quality criteria of the project should take into account not only the quality of the outcome of the action and its pro-quality attributes but also the quality of design processes which determine the quality of such outcome. The greater the scope and complexity of the project, the greater the expectations for quality and the need for demonstration of implementation cost and time. Objectification of quality assessment requires reference to the existing "patterns" (standards as well as analytical and historical data).

Individual groups of criteria (by the so-called quality "dimensions") may create a comprehensive picture of project quality, however, quality criteria related to the design object (product or service) demonstrate its usability and functionality at the adopted level of fulfilment of requirements. On the other hand, the quality criteria of processes implemented within the project focus on the quality of the design process in the context of the quality of both designing entity and resources available in the project. This often entails a higher level of direct costs, and accordingly, reduced management costs and reduced overall costs of project implementation (in particular, in the context of expenditure on project maintenance, designer supervision, etc.). These criteria allow for the assessment of the effectiveness of individual processes and their components during their implementation and after their completion (including their interrelationship). The time and the level of costs incurred in the implementation of individual phases of the design process is directly related to the complexity of the project and has a direct influence on the level of quality of the project outcomes/products.

In quality validation, we can make references to our own or adopted quality "patterns" (norms and standards). It is also possible to determine quality criteria for the project based on previously completed projects (our own or third party projects), which provide historical data for undertaken project activities. In this case, references are made to quality criteria resulting from the so-called good practices and our own experience (drawing conclusions on the basis of errors made and their consequences, using risk analysis methods).

The quality of the project is viewed through the prism of the quality of the design outcome (product or service). **Q**ex-post may be evaluated through the function – '*f*' – of measurable attributes of the project, such as usability, functionality, reliability and efficiency, as well as project risks (Zaskórski et al, 2013, p. 64), and other quantifiable attributes (such as coherence, completeness, vitality, potential for development/openness of solutions, etc.), and consequently:

$$\mathbf{Q}\text{ex-post} = f\,(\text{U, F, R, E, VaR, } \ldots)$$

where:
U stands for product/outcome usability,
F stands for product/outcome functionality,
R stands for product/outcome reliability,
E stands for efficiency of use/operation of the product,
VaR stands for risk and other systemic features.

Each of these attributes requires a separate, objectified evaluation, and by using the weighting factors for the individual quality attributes, it is possible to determine (estimate) the quality assessment result for the product (in the adopted scale, e.g. by point or percentage, as compared to the "ideal" level ensuring 100% fulfilment of customer/client/user requirements). Incomplete fulfilment of such requirements, in comparison to the adopted product attributes/elements (taken into account in the assessment) reduces the overall assessment result.

The quality of the project viewed through the prism of the quality of the design process – **Q**ex-ante – is usually described by the quality function '*g*' which depends on the time, resources and the scope/complexity of the project (Figure 1), namely:

$$\mathbf{Q}\text{ex-ante} = g\ (t, B, Z),$$

where:
t stands for delivery (implementation) time
B stands for budget
Z stands for project scope (structural complexity).

This may, for instance, entail that the increase in the scope (complexity) of the project may result in the increased project implementation time and/or budget.

As already mentioned, quality is becoming a general (universal) systemic criterion for project solutions. Therefore, the selection of methods and techniques of quality management should contribute to the enrichment and disambiguation of quality perception. The analysis of available methods and techniques – from purely descriptive ones, such as the Deming Circle (the so-called PDCA, i.e.: plan-do-study--act, and then evaluate and deploy best practices), the so-called quality cycles/wheels demonstrating development of competence of each performer and their influence on the resulting product, to such methods as House of Quality, i.e. QFD (Quality Function Deployment) method – indicates their broad spectrum and the need for adjustment to specific project activities. It seems, however, that quality evaluation models should emphasise the possibility to determine measurable quality indicators or to prioritise quality factors/attributes (Figure 2). There are both universal and dedicated models, resulting from internal or external experience of individual project/design organisations. The following models may be classified as universal:

a) standardised project triangle,
b) QFD,
c) FMEA,
d) Design of Experiments.

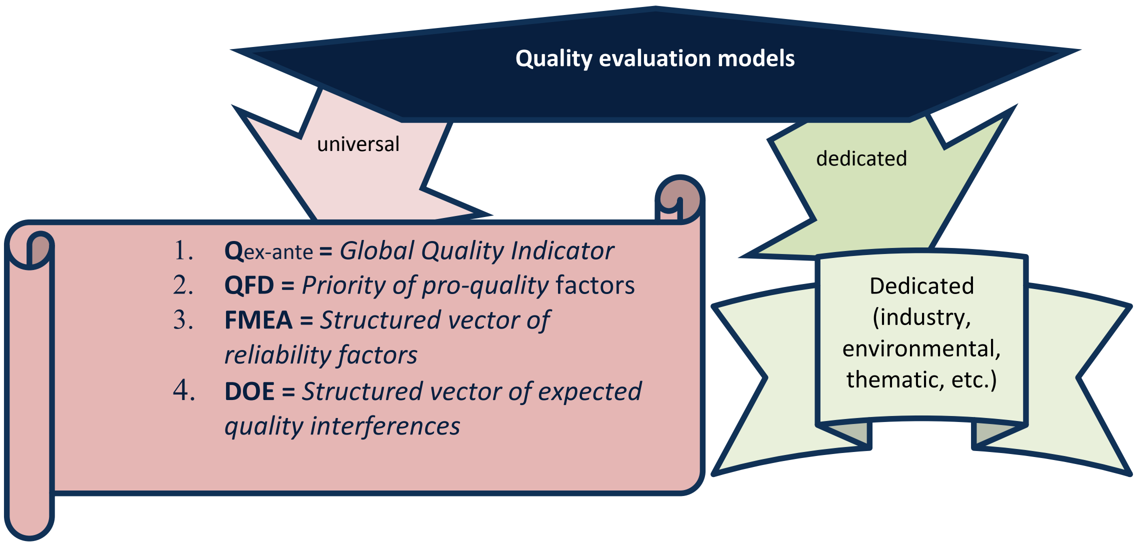

Figure 2. Selected quality evaluation models

Author's own elaboration

The standardised project triangle model is based on the logical dependence shown in Figure 1. It follows that quality expectations are located at a level designated by the project triangle, described in terms of time, complexity (scope) and budget. The Q field of the Project Triangle (as per Heron's model), (Barańska, Kamiński, et al, ed. Zaskórski, 2015, p. 120), described on a clearly graduated (standardised) length of its sides (a, b, c – representing: time, scope, resources {budget, costs}) – may be a numerical estimate of the expected global quality level (planned quality indicator) in the project:

$$\boldsymbol{Q} = \sqrt{p(p-a)(p-b)(p-c)} = \frac{\sqrt{(a+b+c)(a+b-c)(a-b+c)(-a+b+c)}}{4}$$

where:

– a, b, c: are sides of the Project Triangle (Figure 1, including: time, scope/complexity, resources – expressed by a measure of relative value, in relation to maximum or normative values for such attributes for the given class of projects implemented within a design organisation/ a design portfolio);

– half the perimeter of the Project Triangle:

$$p = \frac{1}{2}(a+b+c)$$

The final evaluation of quality – ***J*** – may be a reference of the resulting quality level (the Q' field of triangle – described by resources actually used, implementation time and completed project scope, i.e. sides a', b', c') to the expected/planned level:

$$\boldsymbol{J = Q'/Q \; x \; 100\%}.$$

The House of Quality (QFD – Quality Function Deployment) model translates the needs and expectations of customers (product users) into product (product, service or outcome) features at all stages of the design/project. In this model, efforts are made to identify priorities for pro-quality factors from the point of view of implementation possibilities in the project (available resources), in the context of customer needs. This method may be described as a method for matching quality functions (Wawak, 2006, p. 133). The QFD method is based on employee involvement, whereby the QFD team appointed to implement the project has to answer fundamental questions about the potential client/user/customer and their requirements/assumptions/expectations (wishes) and the manner (mode) of catering for their needs.

This model involves development of a QFD diagram which depicts correlations between customer needs and technical features (construction, technology, organisation, etc.) of the product (design outcome). The number of fields in the QFD diagram depends on the complexity and the nature of the task and the objective pursued. The purpose of the method is to align the expectations and the needs of the customer (client, user) with the specifications of the product (product or service). Therefore, there is a need for 'dimensioning' (determining) user requirements in line with the operational and technical parameters of the designed outcome, taking into account available technological capabilities and the priority level of individual features, and their interrelationships.

In the QFD model, all the characteristics (features) of the product or service, and the relationship between the aforementioned customer needs and product technical parameters – produce an image of multidimensional correlations.

Accordingly, the basic tool applied in the QFD method is the so-called correlation matrix which maps the nature and complexity of the project as well as its objectives. This method and the technique of using it is already widely known. The problem lies in the identification of quality factors (attributes), their organisation and prioritisation, as well as evaluation in accordance with the adopted scale. Definition of customer needs and expectations (Lock, 2009, p. 24-43) and determination of their significance/priority, and subsequently, determination of technical (technological and functional) parameters of the designed product and the relationship between customer needs and such parameters – may form a basis for valuation and evaluation of quality in terms of planning, and eventually, in terms of evaluation of resulting quality. Literature frequently differentiates among three correlation levels, namely: strong, medium and weak, to be determined in the manner adopted by the analytical team. However, with the progress of the design work, such correlations may be specified in more detail, using a more detailed scale, which eventually will contribute to highlighting pro-quality factors. Another important assumption of this method is reference to the level of profitability of our design projects by comparing the designed product/service to those offered by competitors. The evaluation of technical parameters and indicators of technical complexity forms the basis for assessment of profitability and implementation possibilities (capabilities) in the specific product or service design, taking into account the global quality criterion.

In general, we may say that the primary function of the QFD method is to raise awareness of the complexity of the process of quality evaluation and validation at each stage of the design, and to identify factors affecting the quality level (generation of a vector of pro-quality factor priorities, Figure 2). Therefore, it can be concluded that the QFD model is of fundamental nature, i.e. may form a basis for, and may be further creatively developed in any design system.

The FMEA model highlights a pro-quality analysis (Failure Mode and Effects, i.e. analysis of effects and defects) in accordance with the systemic understanding of quality, and supports the process of quality evaluation. This method emphasises the fact that quality is strongly determined by the level of reliability of project activities and outcomes. Accordingly, it is a qualitative analysis of reliability, designed to increase the level of detection of potential defects and errors occurring in the early stages of product design through the analysis of the causes and consequences of errors (development of an organised vector of reliability factors). This allows for the identification and minimisation of costs of poor quality products, which increase with the progress of the project, according to the formula: 1-10-100. This method is suitable for design and manufacturing organisations which advocate the policy of continuous improvement of processes and resources. Such an approach enables the organisations to develop their products taking into account the Deming Circle or Quality Cycle methods.

The main objectives that can be achieved using the FMEA method (Wolniak, Skotnicka-Zasadzeń, 2010, p. 69) include:

- subjecting the product or the process to analysis, and then, based on analysis results, introducing changes or new solutions in order to eliminate the source of defects;
- identification of actions that could eliminate, or at least limit, the possibility of occurrence of potential errors;
- consistent and permanent elimination of defects (weak spots) of the product, its construction or manufacturing process through identification of the actual causes of such defects and application of adequate preventive measures; however, the effectiveness of such measures must be verified;
- documentation of each process (FMEA documentation may be used in the implementation of subsequent tasks related to TQM, e.g. with regard to diagnostics and maintenance (thus, this type of documentation can prevent occurrence of potential defects in the future);
- creation of a database for corrective action.

Typically, the literature differentiates between two types of FMEA analysis: product/design FMEA (*Design FMEA*, *DFMEA*; this method facilitates identification of both strengths and weaknesses of the product at the stage of its design) and process FMEA (*Process FMEA*, *PFMEA*; identification of factors that may interfere with the product manufacturing processes).

FMEA analysis is normally performed at the stage of planning and design (project) development. First of all, the analysis consists in the identification of potential defects of the product/design or process that may have a negative impact on the manufacturing process, usability, functionality, etc. The defect can be described by probability (risk) of its occurrence and the significance (severity) of the defect for the potential customer and the product of these factors (risk rate indicator), the value of which is used in the preparation of the list of the most critical causes (higher value of the indicator entails an increase in the criticality of the identified defect or its cause). Preparation and maintenance of relevant documentation is an important element of FMEA (introduction and supervision of preventive measures). Such documentation contains details of persons responsible for the implementation of corrective measures and seeks to determine estimated efficiency of such measures by redefining risk levels.

Introduction of changes may contribute to the elimination or minimisation of the risk of use of defective products by potential customers, for defects assigned with a high degree of risk during the FMEA analysis. Thus, we may significantly reduce such risks. The experience gained in subsequent trials, increases the probability of detecting such defects and enhances the quality of the product/design or the manufacturing process.

Design of Experiments Model (DOE = Design of Experiments) emphasises the fact that quality primarily involves the desire to consciously control the design and manufacturing process. Hence, DOE consists in the search for and identification of such desired conditions (external and internal interference parameters, including those which are controllable to a limited degree), (Hamrol, 2008, p. 391) for selected processes in order to maintain their maximum possible resistance to external interference understood as cause of errors. As a result, we are able to define an organised vector of interference with the excepted quality level, and subsequently, to aim at reducing the cost of manufacturing the product (service) and increasing its quality at relatively low costs.

In fact, Design of Experiments requires development of a mathematical formula which describes the behaviour of the tested object while its parameters are being changed. This allows for the verification of input and output values which have a significant impact on the monitored process and the optimisation of the manufacturing process parameters which are able to guarantee an optimal result, i.e. the highest possible product quality and minimal process variability (elimination of irrelevant factors). The implementation of the so-called simplified experiment starts with a relatively full spectrum of product factors (attributes) or factors of the method of process implementation, which are subsequently downsized to several main factors (attributes) in the next stages. This allows for the so-called full experiment and analysis of interaction between factors (Hamrol, 2010, p. 391-392). Various methods of designing and evaluating parameters may be applied here (TQMsoft, 2013), including the parameter design method according to G. Taguchi, which reduces the effort and workload of studies by using appropriate procedures allowing for selection of desired process implementation parameters. However, this requires a detailed identification of the object, goal, scope and plan of studies (sets of input data values). In the method developed by Taguchi, the focus is shifted from demonstrating benefits to highlighting the level of losses occurring in the design system, which strongly corresponds to the TQM method (Wawak, 2006, p. 11-47). This method may be applied both to optimise new products or processes and improve the existing ones, however, if this method is applied in the initial stages of product development, this may ensure higher efficiency of design and implementation operations, as well as production activities (Karaszewski, 2006, p. 255).

4. Strategies for comprehensive quality management

Each project organisation must take into account certain expenditure related to quality assurance which should be regularly estimated and verified. The process of quality evaluation and management may entail significant costs. Due to the diversity of operations and quality evaluation models and their relationship to the manufacturing process, it is important to ensure adequate resources in the design process.

As mentioned before, modern concepts of quality management in design projects should be able to demonstrate information resources and the use of information technologies, as well as access to various types of own and external (environmental) resources in cloud computing (Figure 3). The use of the following systems: CAQ (Computer Aided Quality), CRM (Customer Relationship Management) and Integrated Information Management Systems, such as ERP (Entity Resources Planning), (Zaskórski, 2012, p. 221-228) requires organisation of information (information ordering). Hence, quality evaluation models allow for mapping quality attributes in the measurable world, clear determination of quality levels and mutual provision of information on the risk of poor quality and its prevention.

The use of quality evaluation and validation models contributes, in the long run, to reduction of overall costs and increased efficiency and quality of project activities, and as a result, increased quality of project outcomes (products/results). Thus, quality, understood as a general systemic criterion, requires special care and the choice of management concepts (strategies) which are adequate to the needs and possibilities. It seems that those strategies which demonstrate a comprehensive approach to quality, combined with the desire to constantly monitor and evaluate quality levels, are particularly useful. This class of strategies includes the following concepts:

a) TQM,
b) Hoshin kanri,
c) Six Sigma.

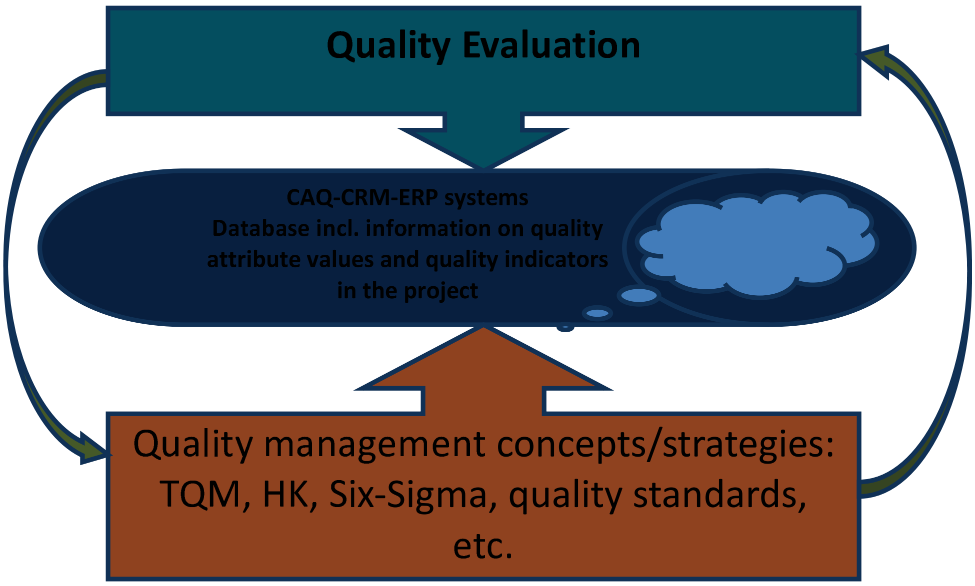

Figure 3. Quality evaluation and quality management concepts

Author's own elaboration

TQM (Total Quality Management, i.e. comprehensive management through quality) takes into account constant commitment of performers to quality assurance, not only in terms of product quality, but also in terms of quality of the entire organisation. In the comprehensive quality management, all the basic components of the design system are subordinated to the concept of quality – this allows the organisation, as a whole, to operate more effectively (each resource and process plays a role in the creation of quality). The involvement of the top executives of the organisation is a crucial aspect of this concept. The executives should demonstrate initiative in the implementation of the quality policy. At the same time, their involvement should be accompanied by effective communication among employees of different levels (Zaskórski, Zaskórski, Lipner, 2015, p. 103-126) and their common understanding of quality – in which different perspectives of quality evaluation models seem to be a prerequisite. Therefore, the concept of TQM (Łunarski, 2008, p. 57) forces focus on the customer, in process terms, and a systemic approach to management, as well as the need for continuous improvement.

TQM emphasises the importance of teamwork skills for the achievement of common objectives, while taking into account adopted values and standards, which has a significant impact on the employees as well as their actions and mode of thinking. This leads to the creation of desired internal working conditions and relationships with the environment necessary for the development and utilisation of techniques for building global quality (awareness of pro-quality factors). It is a significant approach in the management of a project organisation, in which quality is determined by the whole design system and processes occurring in it.

The concept of hoshin kanri is a certain type of management system in which "a fixed annual policy of the company (project organisation) passes, in a sequential manner, through the individual structures of the company, and afterwards, is implemented in all departments and functional areas across the organisation" (Karaszewski, 2006, p. 188). The quality policy should be accepted at all levels of the operational system in the long term.

This concept may be defined as a method of strategic management and a tool for managing complex projects, with a fixed quality system (including fixed quality evaluation model), taking into account the feedback of the user of the project outcome (e.g. the QFD model) or a system ensuring adequate efficiency (evaluation of resources and project outcomes in ERP systems). In this method, strategic management is closely related to the ongoing operation of the design system. This forms a good basis for managing changes and maintaining quality levels in critical business processes (including project processes), (Ćwiklicki, Obora, 2011, p. 14). The human factor is usually a critical component of the design system and requires creative interaction. The annual quality policy for the organisation is determined after comparison of the developed guidelines with feedback from the line managers and leaders of individual task teams. The so-called catchball process takes place in a cascade-like manner between various executive levels (of the project) for the purpose of approval of the assumptions of such process. This requires a clear identification of quality attributes in order to ensure that any fixed plans demonstrate clear objectives for the project team. Catchball is a method for aligning objectives, resources and common values.

The hoshin kanri technique shows that the process of developing an annual plan should be systemic in its nature. This in turn, requires interaction between the policy draft defined by the top executives and the main objectives determined on the basis of experience and forecasts and consultations with line managers, as well as 'downward' transfer thereof to the individual performers. Implementation teams seek to achieve the goals defined in the strategy (including adopted quality indicators) based on a schedule.

It is worth noting that hoshin kanri is based on the synergy between strategic objectives (e.g. quality of products and project processes) and operational plans, thus, creating a single coherent body within the organisation in which objectives and their implementation control (e.g. their quality) are the same at each level of management of the project and the management of the entire portfolio of projects as well as implementation and manufacturing projects.

The concept of Six Sigma is defined as "the buyer's and supplier's right to value in every aspect of economic exchange" (Harry, Schroeder, 2011, p. 19). The assumption of this concept is that improvement of quality is possible if customers and the organisation itself are able to benefit from it. Thus, each design and manufacturing organisation expects manufactured products to be of high quality provided that efficiency criteria have been met. This method is aimed at effective fulfilment of requirements (see QFD, quality triangle) which have been defined in the plans, specifications or technical documentation. Another feature of Six Sigma is its focus on the reduction of errors and product defects (see FMEA) with the simultaneous improvement of financial performance, in accordance with the approved quality level. The application of Six Sigma in the context of quality criterion does not only entail cost reduction, but most importantly, improvement of processes and reduction of defects through experience and experiments (e.g. DOE models).

Six Sigma can be deployed at three levels of the organisation at the same time, i.e. organisation-wide, operational and process levels, with different but complementary results obtained at each level. This requires successive reference to a defined level of quality as a common value for all levels. This strategy emphasises the level of process improvement (DMAIC: Define-Measure-Analyze-Improve-Control). In this sense, quality evaluation (measurement) is of essence in design and manufacturing processes (Hamrol, 2008, p. 82). The concept of Six Sigma uses the measure of quality level referred to as the sigma level (parameter), which designates the statistical standard deviation (with normal distribution, where the range of variation of this measurable feature is determined by tolerance limits). Product quality is assessed by the value of the sigma level, which means that any company which deploys the concept of Six Sigma should aim at the practical elimination of defects in the manufacturing process. Ensuring and maintaining an almost zero probability of defects in the manufactured product results in the redundancy of maintenance (or implementation) of the systems for detecting, analysing and repairing defects, which may entail reduction of quality assurance costs in the project organisation.

The different concepts of effective quality management should be used in conjunction with adequate quality evaluation models. Adoption of uniform quality norms and standards may be a good reference to the quality assessment system. Standardisation leads to formalisation and documentation of typical and repetitive action. The market environment is very significant for any design system, i.e. it may determine the position of the organisation in the environment based on a certificate confirming the operation of a quality management system held by the organisation.

For example, in the European Union, mandatory certification is required for certain products which may pose a threat to life or hazard to people or the environment. Such certificates may also condition the statutory design and manufacturing activities in a given field. The currently existing ISO standards comprise separate test standards, including specification of certain test methods and product or service standards which define requirements for specific products. The existing standards also apply to the design and manufacturing process and its functionalities, as well as data, including lists of features and properties which should be parameterised in order to identify a product or a service.

The processes of continuous quality monitoring and quality assurance in a design and manufacturing organisation may lead to a reduction in quality expenses. Quality expenses should be recognised not only in terms of product quality but also – and perhaps primarily – in terms of quality of the design process in the context of ex-ante quality. This means that a properly dimensioned level of quality of project processes can have a significant influence on the level of quality of project products/outcomes.

Summary

Acceptance criteria for product quality should be determined together with the definition of the product description. Each defined pro-quality attribute of the product should be measured (quantified) in order to disambiguate (standardise) the level quality and affect the quality of the entire product. In the case of non-compliance with quality criteria, the company implementing the project on behalf of the customer will incur additional costs related to the improvement of product quality, or in the worst scenario, the project may end in failure (the risk of impairment of the entire project).

The customer/user of the product pays attention to the utility (ex-post) quality, i.e. the quality of use/operation of the product. Thus, the user has to accept the functionality and reliability of the product. Both these quality features influence the so-called global product quality.

Ensuring the required level of quality is a key issue in every project. Therefore, both the quality of the design process and available project resources, and the quality of project outcomes are complementary perceptions, and quality evaluation and validation should be an ongoing process implemented at each stage of project development.

EWALUACJA JAKOŚCI W ZARZĄDZANIU PROJEKTAMI

Streszczenie: W artykule podjęto problem ewaluacji jakości. Ewaluacja jest odpowiedzią na dążenie do jednoznaczności ocen i porównań oraz ostatecznie obiektywizacji wartości i jakości projektów. Przechodzenie do świata mierzalnego wymusza na wykonawcy co najmniej potrzebę uświadomienia czynników warunkujących wartość i jakość procesów oraz produktów realizowanych w projekcie, a także kompleksową i spójną ich walidację.
Słowa kluczowe: system, projekt, jakość, ewaluacja, kryteria jakości.

REFERENCES

[1] Barańska R., Kamiński Ł. et al., ed. P. Zaskórski, 2015, *Selected Issues of Project Evaluation and Validation* [Wybrane zagadnienia ewaluacji i walidacji projektów], WWSI, Warsaw.

[2] Ćwiklicki M., Obora H., 2011, *Hoshin Kanri, Japanese Method of Strategic Quality Management in Poland* [Hoshin kanri. Japońska metoda strategicznego zarządzania jakością w Polsce], Polskie Wydawnictwo Ekonomiczne, Warsaw.

[3] Hamrol A., 2008, *Quality Management With Examples* [Zarządzanie jakością z przykładami], Wydawnictwo Naukowe PWN, Warsaw.

[4] Harry M., Schroeder R., 2001, *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations* [Six Sigma. Wykorzystanie programu jakości do poprawy wyników finansowych], Publishing House: Dom Wydawniczy ABC, Kraków.

[5] Karaszewski R., 2006, *Modern Concepts Of Quality Management* [Nowoczesne koncepcje zarządzania jakością], Towarzystwo Naukowe Organizacji i Kierownictwa „Dom Organizatora", Toruń.

[6] Lock D., 2009, *Project Management* [Podstawy zarządzania projektami], PWE, Warsaw.

[7] Łunarski J., 2008, *Quality Management. Standards and Rules* [Zarządzanie jakością. Standardy i zasady], Publishing House: Wydawnictwa Naukowo-Techniczne, Warsaw.

[8] Szczepańska-Woszczyna K., 2009a, *TQM Methods and Techniques* [Metody i techniki TQM], Oficyna Wydawnicza Politechniki Warszawskiej, Warsaw.

[9] Szczepańska-Woszczyna K., 2009a, *Quality Costs for Engineers* [Koszty jakości dla inżynierów], Wydawnictwo Placet, Warsaw.

[10] Trocki M., Grucza B., Ogonek K., 2009, *Project Management* [Zarządzanie projektami], PWE, Warsaw.

[11] TQMsoft, www.szkolenia.tqmsoft.com/node/1122, 21.05.2013.

[12] Wawak S., 2006, *Quality Management: Theory and Practice* [Zarządzanie jakością: teoria i praktyka], Wydawnictwo Helion, Gliwice.

[13] Wolniak R., Skotnicka-Zasadzeń B., 2010, *Quality Management for Engineers* [Zarządzanie jakością dla inżynierów], Wydawnictwo Politechniki Śląskiej, Gliwice.

[14] Zaskórski P., Woźniak J., Szwarc K., Tomaszewski Ł., 2013, *Project Management in a Systemic Perspective* [Zarządzanie projektami w ujęciu systemowym], WAT, Warsaw.

[15] Zaskórski P., 2012, *Information Asymmetry in Process Management* [Asymetria informacyjna w zarządzaniu procesami], WAT, Warsaw.

[16] Zaskórski P., Zaskórski W., Lipner K., 2015, *Communication Management in Projects*, [in:] „Nowoczesne Systemy Zarządzania" ["Modern Management Systems"], vol. 9, WAT, Warsaw.