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**DEVELOPMENT OF CONCEPTUAL MODEL AS A
MEANS OF FORMING EFFECTIVE QUALITY
MANAGEMENT SYSTEMS FOR ENGINEERING
SERVICES ENTERPRISES**

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Introduction. Integration of Ukraine into the European Economic Area, membership in the World Trade Organization put forward strict requirements on the quality of goods (services, jobs) to the activities of domestic enterprises, in particular in the field of engineering. The formation of quality management systems (QMS) at engineering services enterprises in the context of the requirements of the international standard ISO 9001: 2015 can become an effective mechanism for ensuring their competitiveness as a decisive factor for commercial success. Along with the obvious advantages of designing and implementing quality management systems according to the requirements of the international standard ISO 9001: 2015 at enterprises, today there are a lot of problems, in particular in the field of engineering, to resolve which companies require methodological developments, practical tools and quality specialists.

Aim and tasks. The aim of the study is to develop a conceptual model for the formation of the quality management system of an engineering enterprise according to the requirements of international standard ISO 9001: 2015 as a tool to improve its performance and ensure integration with the overall management of the company.

Research results. The article substantiates the relevance of the formation of quality management systems at the enterprises of engineering services in the context of the requirements of international standard ISO 9001: 2015 and proves that they are an effective mechanism for ensuring their competitiveness as a decisive factor of commercial success. The existing models of quality management as a basis for the development of quality management systems in the leading countries of the world been analyzed. The model of processes of quality management system of the engineering enterprise according to requirements of standard ISO 9001: 2015 has been investigated and the essence of all its components has been revealed. The conceptual model of quality management system formation of an engineering enterprise in the context of the requirements of international standard ISO 9001: 2015 has been developed.

Conclusions. The developed conceptual model of quality management system formation of the engineering enterprise is an effective methodological tool of quality management that will allow providing its integration into the general management of the company. Further developments are aimed at expert assessment of quality management system processes of engineering services companies in the context of the requirements of international standard ISO 9001: 2015.

Keywords: quality management systems, international standard, ISO 9001: 2015, sphere of engineering services conceptual model.

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РОЗРОБКА КОНЦЕПТУАЛЬНОЇ МОДЕЛІ ЯК ЗАСОБУ ФОРМУВАННЯ ЕФЕКТИВНИХ СИСТЕМ УПРАВЛІННЯ ЯКІСТЮ ПІДПРИЄМСТВ СФЕРИ ІНЖИНІРИНГОВИХ ПОСЛУГ

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Вступ. Інтеграція України в європейський економічний простір, членство у Світовій організації торгівлі висувають до діяльності вітчизняних підприємств, зокрема у сфері інжинірингу, жорсткі вимоги щодо якості товарів (послуг, робіт). Формування систем управління якістю (СУЯ) на підприємствах сфери інжинірингових послуг у контексті вимог міжнародного стандарту ISO 9001:2015 може стати ефективним механізмом забезпечення їхньої конкурентоспроможності як вирішального фактору комерційного успіху. Поряд з очевидними перевагами формування та впровадження СУЯ в контексті вимог ISO 9001:2015 на підприємствах, сьогодні існує велика кількість проблем, зокрема у сфері інжинірингу, для вирішення яких компанії потребують методологічних розробок, практичного інструментарію та спеціалістів з якості.

Мета та завдання. Метою дослідження є розробка концептуальної моделі формування СУЯ інжинірингового підприємства в контексті вимог міжнародного стандарту ISO 9001:2015 як інструменту поліпшення його діяльності та забезпечення інтеграції із загальним менеджментом компанії.

Результати. У статті наведено обґрунтування актуальності формування систем управління якістю на підприємствах сфери інжинірингових послуг у контексті вимог міжнародного стандарту ISO 9001:2015 та доведено, що вони є ефективним механізмом забезпечення їхньої конкурентоспроможності як вирішального фактору комерційного успіху. Проаналізовано існуючі моделі управління якістю як основи для розробки систем управління якістю в провідних країнах світу. Досліджено модель процесів системи управління якістю інжинірингового підприємства згідно до вимог стандарту ISO 9001:2015 та розкрито сутність всіх її складових. Розроблено концептуальну модель формування системи управління якістю інжинірингового підприємства у контексті вимог міжнародного стандарту ISO 9001:2015.

Висновки. Розроблена концептуальна модель формування СУЯ інжинірингового підприємства є ефективним методологічним інструментом управління якістю, що дозволить забезпечувати її інтеграцію в загальний менеджмент компанії. Подальші розробки будуть спрямовані на експертне оцінювання процесів СУЯ підприємств сфери інжинірингових послуг у контексті вимог міжнародного стандарту ISO 9001:2015.

Ключові слова: система управління якістю, міжнародний стандарт, ISO 9001:2015, сфера інжинірингових послуг, концептуальна модель.

Introduction. Integration of Ukraine into the European Economic Area, membership in the World Trade Organization put forward strict requirements on the quality of goods (services, works) to the activities of domestic enterprises, in particular in the field of engineering. Competitive advantages are given those entities whose activity is based on the introduction of effective mechanisms and modern tools aimed at ensuring the proper quality of services (works), innovative development, achievement of key business goals.

The complexity, technical direction, the need to comply with a number of regulatory requirements for the quality of engineering services (performance of works), participation in tenders - all these require the use of effective means for achieving the goals of enterprises.

The formation of quality management systems (QMS) at engineering enterprises according to the requirements of the international standard ISO 9001: 2015 (DSTU ISO 9001: 2015) can become an effective mechanism for ensuring their competitiveness as a decisive factor for commercial success. The application of international standards, in particular, the ISO 9000 series sets up equal conditions to enter the foreign market and the foundation to build effective quality management systems at enterprises [1]. Shnytko [2] proves that the level of efficiency of the quality management system is directly proportional to the level of product competitiveness and the enterprise.

Along with the obvious advantages of designing and implementing quality management system according to the international standard requirements ISO 9001: 2015 at enterprises, today there are a lot of problems, in particular in the field of engineering, to resolve which companies need methodological developments, practical tools and quality specialists.

Actual scientific researches and issues analysis. Recent studies on models of quality management systems formation in enterprises of various scopes of activity indicate urgency and a number of unresolved issues. Quality management system should be defined as a set of interrelated and interdependent processes that enable to define enterprise's quality policy, set

goals and define objectives. It is a management tool, the application of which ensures the improvement of the activity of enterprises, in particular the field of engineering, quality of products, services (works). Quality management systems can be seen as an organizational structure coupled with the planning system, enterprise operational processes, resources and documented information needed to achieve quality goals. Quality management systems of the enterprise are a complex of interconnected subsystems aimed at ensuring the appropriate level of quality of products (services).

Increasing the competitiveness of enterprises is possible if only the focus is on the formation of effective quality management systems, as well as on the methodology for its implementation in accordance with the requirements of international standards ISO 9000 series. The advantage of the formation and implementation of quality management systems at enterprises is the possibility to intensify internal and external investments in certified companies and production processes [3].

It should also be noted that the formation of effective quality management systems is influenced by a number of internal factors such as: lack of financial and material resources, low skills and competence of staff, weak innovation policy of the enterprise and the external environment: imperfect legal regulation, integration and transformation processes in the economy, NTP level, competitive state, political instability, etc. [4].

The reasons for establishing and implementing formal quality management system at enterprises, according to V.H. Versan, are the following [5]: the implementation of the quality management systems is seen as a one-off action that does not require constant efforts to ensure its functioning; lack of the staff motivation to perform the work on the formation and implementation of quality management systems; decision making by senior management on the implementation of quality management systems is not consistent with other decisions of the enterprise performance; the existence of contradictions between the current enterprise management system and the requirements of ISO 9000 series of standards.

Considering that the quality management system in the context of the requirements of ISO 9001: 2015 should integrate into the enterprise management system and ensure their improvement, sources [6; 7] have been analyzed, in which scientists focus on the impact of general economic laws on improving the performance of enterprises by improving the management of production and economic activity through the use of a transfer system. The authors of the articles argue soundly that the implementation of this approach requires the implementation of the principles of systematic, adaptive, development, flexibility, cost-effectiveness by top management of the companies.

In spite of the large number of studies on the quality management systems in the enterprises of different spheres of activity, the problem of forming quality management systems of the companies in the field of engineering services, in particular methodological direction, is required to develop models of their formation according to the requirements of the international standard ISO 9001: 2015.

Aim and tasks. The aim of the study is to develop a conceptual model for the formation of quality management systems of an engineering enterprise in the context of the requirements of the international standard ISO 9001: 2015 as a tool to improve its operations and ensure integration with the overall management of the company.

Results. The formation of quality management system of an engineering enterprise takes place under the influence of factors of its activity development, which should be considered from the point of view of the system approach, is described, in particular, in the works [8; 9]. The system approach as a principle of quality management systems formation in accordance with the requirements of ISO 9001: 2015, today is absent. The basis for the establishment of quality management systems of the enterprise is the process approach, which provides for the interaction of related elements (actions), which turn the inputs into outputs. The output of the preliminary process can be an input for the following. This approach allows to identify the elements of engineering activity of the enterprise as an open system, the components of which are the leading and controlled

subsystem, direct and feedback relationship between them, the relationship "input-output", information flows, as well as engineering activity as such.

In order to achieve the goal of the article, we studied the largest enterprises of the engineering services sector of Ukraine, whose activities are focused on the implementation of works (services) in the energy sector for the period of 2013-2018. The results of the researches allowed to justify that their engineering activity and development are closely connected with quality management system efficiency and to reveal the problems on establishing and functioning of the latter (Fig.1).

It is obvious that the problems of low quality of methodological support for the formation of quality management system and for the integration of quality management system of the enterprise into its business processes are priority. First of all, it is advisable to focus on models of quality management as a tool for methodological support for the formation of effective quality management system in order to improve the quality of products, services (works), increase the competitiveness of enterprises.

Models of quality management system of the enterprises have specific features which are expedient to consider as the organizational models of the special purpose aimed at achievement of the goals of the company and improvement of their activity. The developed models of quality management system should be practically valuable for activity of the enterprises, concentrated on its development, improvement of quality of services (works), to provide achievement of key goals of business in the competitive environment. An important task of effective modeling is the application of correct approaches, methods and means to achieve set goals. Let us consider the existing general models, which are based on the concepts of outstanding scientists on quality management. They are classical and characterize certain stages of development of the system approach to quality management. According to A. Feigenbaum's model, it is worth noting that its concept contains two provisions: the consumer should receive only quality products; the main efforts should be directed to quality control.

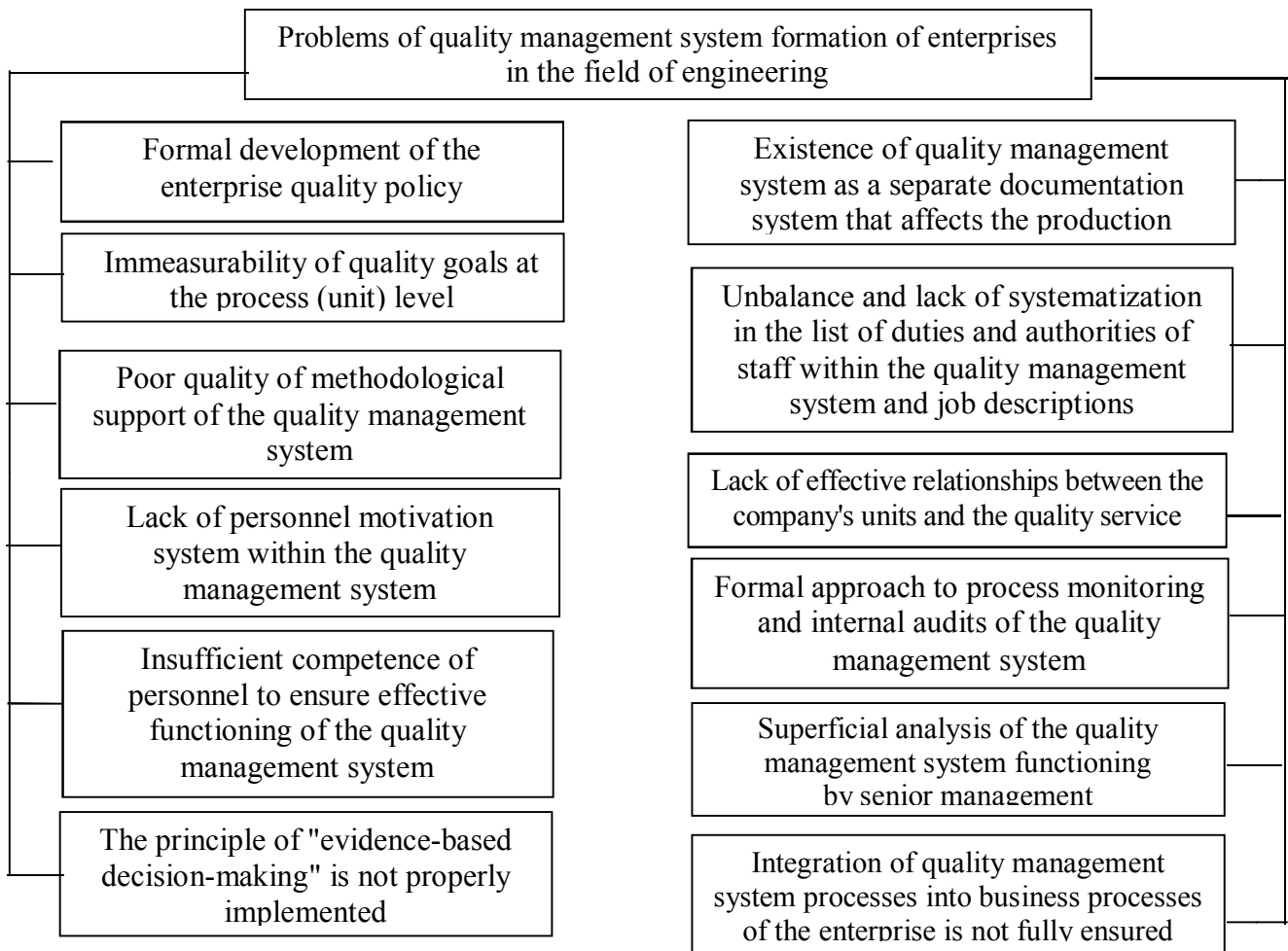


Fig. 1. Problems of formation and implementation of quality management systems for enterprises in the field of engineering

Source: author's own development

A. Feigenbaum introduced the concept of "cost of quality" for the first time and created the model of total quality control (TQC). This is undoubtedly a major contribution to quality management, but the implementation of this concept has led to a sharp increase in the cost of quality control. The system has been fully implemented in Japan. The Ettinger-Sittig model is based on a concept that takes into account the need for functional quality management and the impact of demand on product quality and its markets. Graphically, this model looks like a circle, divided into sectors, each of which corresponds to its respective functions.

E. Juran's model provides for continuous research of the market demand, continuous provision and improvement of the quality of products. This determines the orientation of production to the requirements of consumers and the market for products.

It is advisable to emphasize that the ideas underlying the Juran's model are applied in the international standards of the ISO 9000 series.

The "Quality loop" can be considered as an improved E. Juran's model, taking into account the requirements of environmental protection. It is a closed circle of quality, including 11 stages of product life cycle marketing, market research; design and/or development of product specifications; logistics; preparation and development of production processes; product manufacturing; inspection, testing; packaging and storage; sales of products; installation and operation: technical assistance in maintenance; recycling. The "Quality loop" does not reflect the quality improvement process. These models became the basis for the development of quality management systems in the leading countries of the world.

Models aimed at determining the level of quality of enterprises include models reflected in the international standards ISO 9000 series, as well as management models based on quality / business excellence (including models of quality awards). It is advisable to focus on the models reflected in ISO 9001: 2015. According to the requirements of ISO 9001: 2015, the quality management systems in the leading countries of the world. Models aimed at determining the level of quality of enterprises should contain mutually agreed processes that are integrated into the overall management of

the enterprise. Obviously, this fact is important for positioning quality management systems as an important tool for successful business. The model is based on the process approach, using the Deming cycle, which contains four main functions: planning, execution, monitoring, evaluation and corrective actions (improvement). The model of quality management system processes in the context of the requirements of the international standard ISO 9001: 2015 for the use at the enterprises of the engineering services (hereinafter - the model) is shown in Fig. 2.

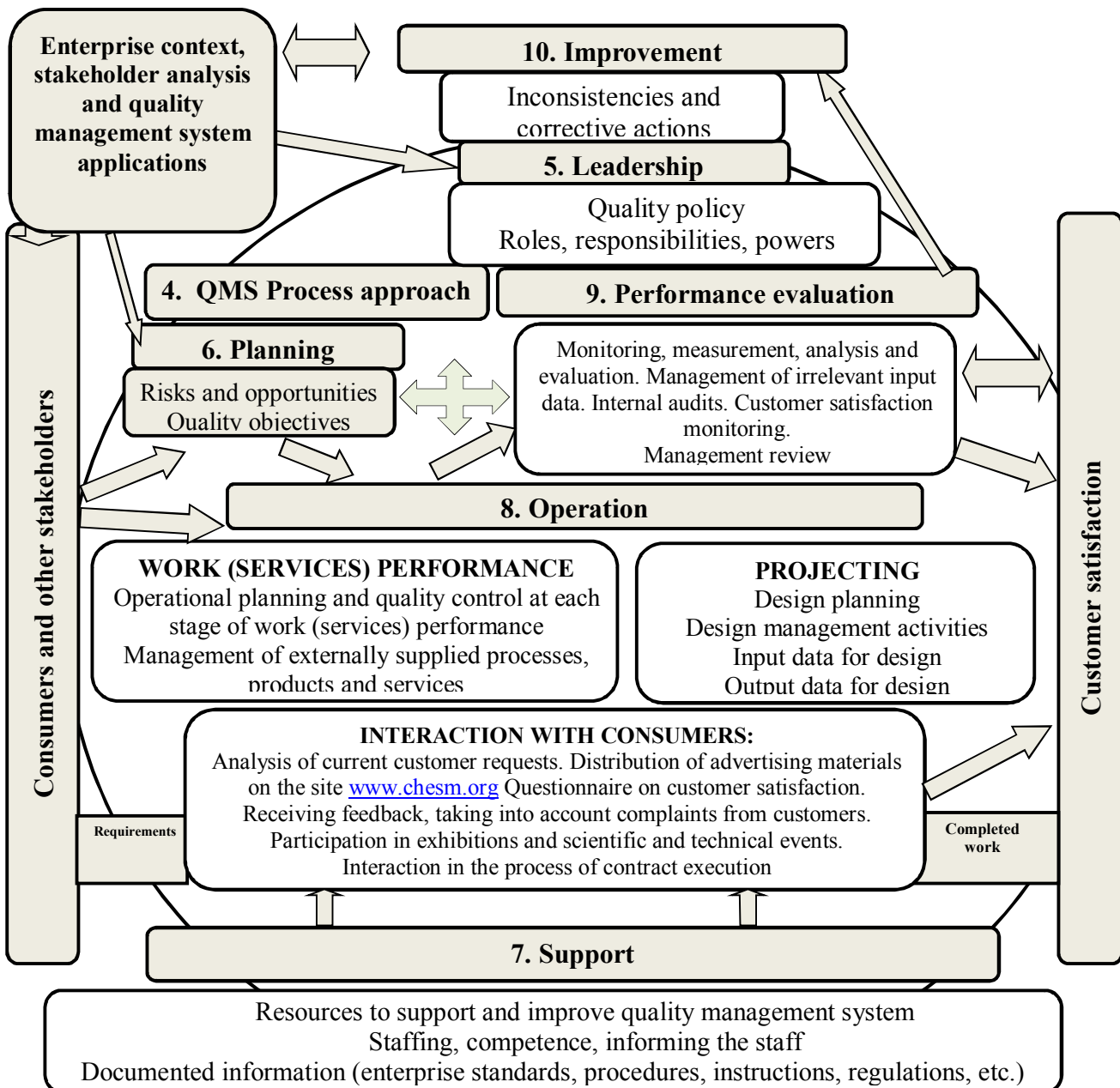


Fig.2. Process model of quality management systems of the engineering enterprise in the context of the requirements of the international standard ISO 9001: 2015

Source: developed by the author on the basis of [10]

The main processes of the quality management system model of the engineering enterprise reflected in Fig. 2 are the requirements of ISO 9001: 2015 standard for its formation. According to the requirements of this standard, first of all, it is necessary to determine the "context of the enterprise" – internal and external factors affecting its ability to achieve the planned results of the quality management system and to analyze the needs and expectations of stakeholders that have an impact on the ability of the company to provide services (works) in accordance with the requirements of consumers (customers), legislative and regulatory documents. The context of the enterprise has a significant impact on the definition of its risks and opportunities, which should be taken into account in order to enhance the desired impact or prevention / reduction of undesirable or to improve both the quality management system and the company's activities as a whole.

As it was mentioned earlier, the process approach is one of the basic principles of formation and introduction of quality management systems of the enterprise. The model contains a component "4. Quality management Systems. Process approach", which indicates that the engineering company should determine processes required for quality management systems (input and output data), resources for their implementation, criteria and methods to ensure their effectiveness, as well as responsibility and authority of officials to implement them.

"Leadership" as a component of the quality management system process model of an engineering company plays an extremely important role, since the requirements of ISO 9001: 2015 focus on the responsibilities of the company's top management including the responsibility for the quality management system performance, facilitating its integration into the business processes of the company, providing the necessary resources to improve processes, etc. The top management of the company has to position the quality management system as an effective means of ensuring the proper quality of services (works), achieving key business objectives and increasing competitiveness.

The model contains the process "6. Planning. Risks and Opportunities. Quality Goals", which identifies risks and opportunities and plans for managing them; setting measurable quality goals for relevant functions, levels and processes and planning a program to achieve them.

The component of the model "7. Support" aims to identify and provide the resources needed to form, implement, support and continually improve the quality management system of an enterprise in the field of engineering services. The company must ensure that the requirements for the number of personnel and competence of the personnel, necessary for the implementation of infrastructure processes, to establish and maintain conditions for the implementation of processes aimed at achieving the proper quality of services (works). In addition, it is advisable to focus on personnel management as a process aimed at enhancing the role of the employee's personality, the ability to determine their motivational attitudes in the context of the needs and goals of the enterprise and the formation of its management quality system [11]. Enterprise quality management systems should contain documented information (enterprise standards, procedures, regulations, guidelines) that requires the ISO 9001: 2015 standard and which should be managed in terms of its availability, usability, adequacy, adequate protection against loss of confidentiality, proper use etc.

Particular attention should be paid to the component of the model "8: Functioning", which is aimed at ensuring the proper performance of works (services) in the field of engineering, quality design of services as one of the main business processes of the enterprise, effective interaction with consumers (customers of works / services) in order to meet their needs and expectations regarding the quality of works (services). To fulfill these requirements on the example of the engineering company 'Chornomorenerhospetsmontazh' LLC (Odesa), within the framework of the research work on the theme "Adaptation of the integrated enterprise management system to the requirements of the international standards ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018" provided the transition, including the

enterprise's quality management system in accordance with the requirements of ISO 9001: 2008 to the new version of 2015, and developed enterprise standards for design to determine the stages of designing services (works) and operational procedures to determine functions at each stage, the criteria of quality and responsibility of officials for their performance. Expert assessment of the quality of performance of works on the design of services (works) using simple statistical methods has allowed to identify the most important parameters that affect the quality of the performance of these works and to develop recommendations for improving the design process. All the R&D and practical projects were implemented in the quality management system of 'Chornomorenerhospetsmontazh' LLC. Monitoring customer's satisfaction (customers of works / services) should be carried out systematically by the company using effective methods, including questionnaires, surveys, etc.

An important process, which refers to the "8. Operation" component is the management of externally supplied processes, products and services. Companies that comply with these requirements must establish and apply criteria for evaluating, selecting and monitoring the performance of external suppliers on the basis of their ability to carry out processes and deliver services in accordance with the requirements. Assessments and acceptance of priority suppliers should be carried out once a year.

One of the principles of quality management system is continuous improvement. Component of the model "9. Performance Evaluation in Quality Management System" involves monitoring and measuring quality management system processes, the results of which should be used to analyze and evaluate the performance and efficiency of quality management system of the enterprise for the compliance of services (works) with the requirements to their implementation, the degree of satisfaction of consumers (customers), actions to manage risks and opportunities to improve quality management system. An

important process in the assessment of quality management system functioning of the enterprise is the internal audit, which should be conducted at certain intervals, using effective methods, with the formation of reports on the effectiveness of quality management system functioning. In addition, the senior management of the enterprise shall conduct the quality management system analysis with the periodicity of once a year to ensure its suitability, adequacy, efficiency and consistency with the strategic directions of the engineering company.

The model under study contains the component "10. Improvement", the requirements of which are aimed at continuous improvement of suitability, adequacy and efficiency of quality management system of an engineering enterprise.

The analysis of the process model of quality management systems of an engineering enterprise according to the requirements of the international standard ISO 9001: 2015 allowed to justify that it is an important tool for the formation of the quality management system. However, such a model only defines the requirements of ISO 9001: 2015 standard, but does not fully provide integration into the overall management of the enterprise. For this reason, it is not enough to understand the importance of quality management system formation and what is the integration with the engineering enterprise management system and, as a consequence, the formal approach to its creation. In order to provide methodological support for the formation of the quality management system and eliminate the problems of its inefficient creation, in our opinion, it is essential to identify and coordinate the subsystems of the quality management system of the engineering enterprise. We have developed a conceptual model of forming a quality management system of an engineering enterprise, which defines the managing and managed subsystems and provides an assessment of its efficiency with the aim of continuous improvement (Fig. 3).

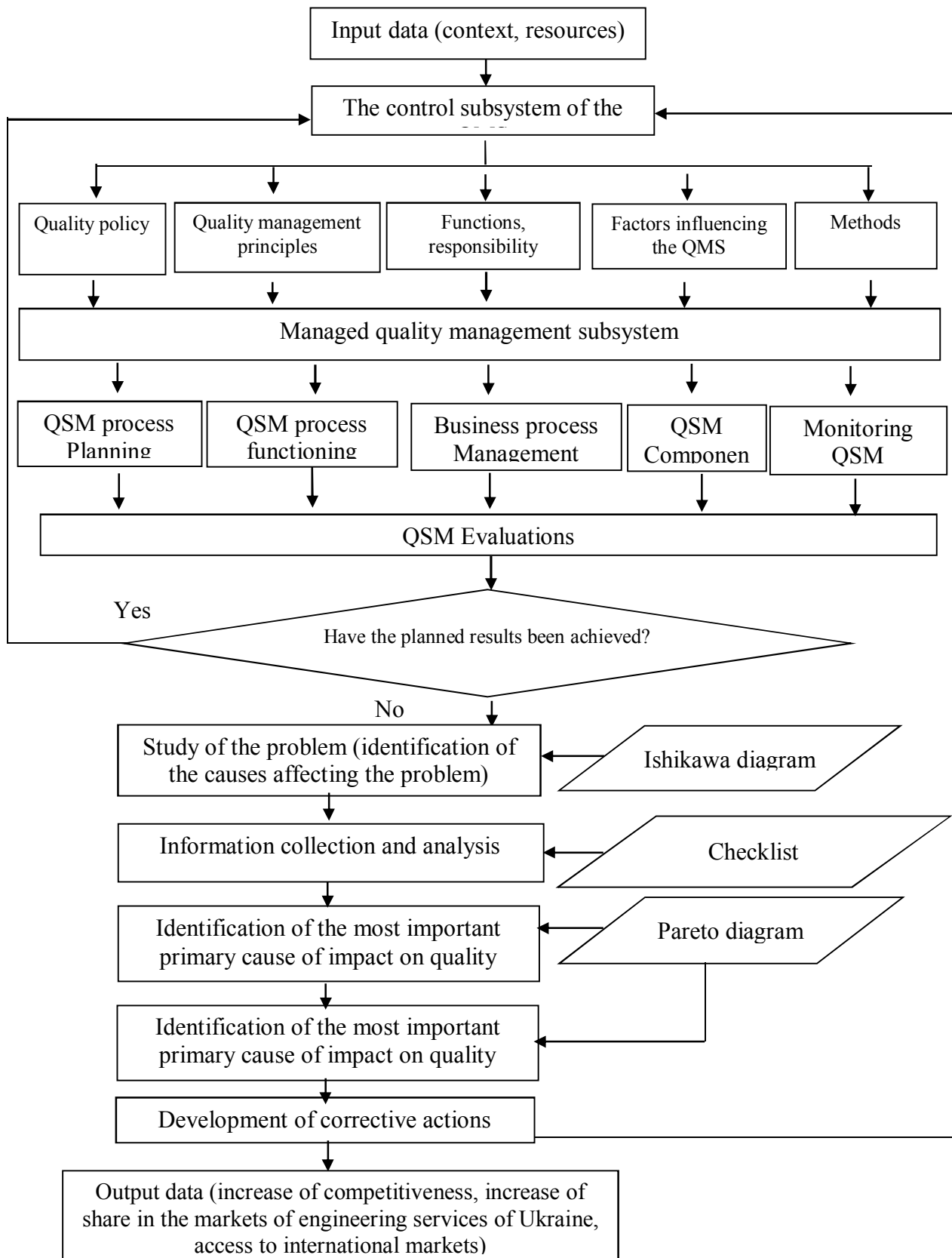


Fig. 3. Conceptual model of quality management system formation of an engineering enterprise

Source: author's own development

The context of the enterprise, as mentioned earlier, is an important input to the formation of the quality management system of the engineering enterprise, as it determines the internal and external factors affecting this process and the company as a whole. In our opinion, it is expedient to apply SWOT-analysis to determine the context of the enterprise. It is necessary to provide a special attention to the analysis of needs and expectations of stakeholders of the company, as they affect its ability to provide services (works) that meet the needs of consumers (customers) and the current legislative and regulatory requirements. We propose to apply the method of stakeholder analysis as an effective tool to determine the influence of stakeholders on the quality management system of an engineering enterprise. A weighted approach to the definition of these input data will ensure the establishment of an effective quality policy, planning of quality management system processes and measurable objectives, risk identification and effective risk management.

Under resources, the company should consider the internal and external means necessary to perform the work on the formation of quality management system, implementation of business processes, as well as qualified personnel for the effective implementation of quality management system and management of its processes, modern infrastructure to perform processes in order to achieve the proper quality of services (works) provided by the engineering company, favorable working environment (social, psychological, physical), resources for monitoring and measuring the processes required to obtain reliable results (measuring devices), knowledge of the company - to perform processes and compliance services (works), which provides the company with legislation and regulations.

The developed model contains two levels: the managing subsystem of quality management system and the managed one. In our opinion, this approach allows to outline the subordination and the concept of interaction of key areas of formation and functioning of the quality management system of an engineering enterprise. The managing subsystem contains: quality policy; principles of quality management; functions, responsibility; factors affecting quality

management system; methods. Quality policy is one of the fundamental documents of quality management system, declaration by the top management of the engineering enterprise of the basic concept and directions of formation, functioning and improvement of quality management system, is a reference point for planning measurable goals in the field of quality and continuous improvement of both quality management system of the enterprise and the company as a whole.

The following principles of quality management are based on the formation of the enterprise quality management system according to the requirements of the international standard ISO 9001: 2015: customer orientation; leadership; staff involvement; process approach; improvement; making decisions based on evidence; relationship management. Unlike previous versions of the standard, in particular ISO 9001: 2008, the "system approach" principle is excluded in the 2015 version. And there is an explanation for this, as a set of interrelated, mutually agreed processes, the implementation of which are aimed at achieving compliance with the requirements of services (works), we consider as a system.

The roles and responsibilities for the implementation of the quality management system processes shall ensure their effectiveness, efficiency and improvement. It is no coincidence that the leadership of top management has supplemented the requirements of ISO 9001: 2015 significantly. It is no secret that the positioning of quality management systems activities by the top management of enterprises as a secondary business is one of the root causes of its formalities and inefficiency. Fuzzy distribution of functions and responsibility, lack of control over their implementation significantly complicate planning and functioning of quality management system processes, including risk management [12], business process management, monitoring and evaluation of processes. For this reason, the top management of the engineering enterprise has to focus attention, first, on definition and distribution of functions, powers and responsibility, which should be reflected in the documented information of quality management system, in particular in job descriptions.

Factors influencing the efficiency of the quality management system of an engineering enterprise are certainly elements of the management subsystem. This is especially true of environmental factors (macro environment) that can affect significantly the main activities of an engineering enterprise, while the company is in no way able to counteract (for example, the country's tax policy).

As for methods as an element of the management subsystem, it is advisable to select those that are acceptable, understandable and accessible to both management and company personnel. Practical experience in the field of quality management systems indicates the feasibility of applying simple statistical methods of quality management such as: Ishikawa diagram (cause and effect), checklist, Pareto diagram. However, it is also appropriate to emphasize sociological methods and questionnaires to provide feedback to customers and analyze their needs and expectations for performance of works in the field of engineering.

The managed subsystem consists primarily of the planning and operation of the quality management systems processes, monitoring to improve them. In addition, the managed subsystem contains a component of "business process management". Worth noting is that the international standard ISO 9001: 2015 does not pay enough attention to the requirements of business processes of the enterprise, which, in our opinion, is not a convincing basis for effective establishment of quality management systems. In our opinion, "business process management" is an essential element of the managed subsystem, since it indicates the integration of quality management systems into the business processes of an engineering enterprise and enables the company management to ensure the formation of effective quality management system, which is the basis for running a successful business.

Analyzing and evaluating quality management system is a mandatory requirement for its effective functioning. The expected results of functioning of quality management system of the enterprise are not always achieved – there are problems (inconsistencies), so it is

necessary to determine in due time causes of their emergence and to formulate corrective measures. The model proposes the use of a cause-and-effect diagram (Ishikawa), a checklist, and a Pareto diagram (Pareto curve) as effective methods for analyzing problems and causes of their emergence.

In our opinion, the developed conceptual model of establishing quality management systems of an engineering enterprise is an essential tool that enables senior management to prioritize correctly effective quality management, to ensure the integration of quality management system with the overall management of the company.

Conclusions and prospects for further developments in this area. It has been proved that the formation of the quality management systems at the enterprises of engineering services according to the requirements of the international standard ISO 9001: 2015 (DSTU ISO 9001: 2015) is an effective mechanism to ensure their competitiveness, profitability and stability of the development. The main problems of quality management system formation have been defined and attention has been focused on methodological support for the purpose of its integration into the general management of the enterprise. An analysis of the process model of the quality management system of the engineering enterprise according to the requirements of the international standard ISO 9001: 2015 has been conducted and the essence of its components has been revealed. The conceptual model of forming the quality management system of the engineering enterprise has been developed as an effective methodological tool of quality management that will allow ensuring its integration into the general management of the company. It contains clearly structured management and control subsystems, key aspects for the formation of a quality management system, outlines the subordination of its processes and the concept of their interaction, and provides an assessment of its effectiveness with a view to continuous improvement. Further developments will be aimed at expert assessment of QMS processes of engineering services companies according to the requirements of international.

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