



**THE FRAMEWORK OF AN EXPERT SYSTEM
SUPPORTING QUALITY MANAGEMENT**

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Abstract:

The current market conditions have led to the situation in which the companies operate in an environment in which having a certificate of quality management system is insufficient to ensure and guarantee customers' satisfaction on one hand, and effectiveness and efficiency of the implemented pro-quality system on the other. Activities related to the identification and assessment of non-compliance are extremely important and critical in terms of achieving the desired objectives of quality management. Due to the numerous difficulties associated with these activities and the limited use of traditional methods and support tools in this regard, the authors developed the concept of the expert system in the following article. The aim of the system is to ensure effective supervision of all non-compliances arising in the operation of any organization that intends to improve the quality management systems.

Key words: quality management system, improvement, expert system

INTRODUCTION

The increased interest in issues of quality is conditioned by many factors, which may include the need to improve the quality of work, as well as of processes and products. This need stems from a growing awareness in this field and aims to improve the effectiveness of management [9, 19].

Economic conditions have led to the situation in which the quality orientation won great importance over recent decades, manifested in such activities as the implementation of quality management systems and the use of methods of TQM – Total Quality Management, or management by quality [19]. It is also advised to take actions based on the philosophy of "Kaizen" [5]. In any organization qualitative effects intended can be achieved when quality is treated as an overarching goal which all members will seek to. Hence, the main task turns out to design and implement a quality management system, which will be effective [19].

The question to be asked is the reason why entrepreneurs decide to implement pro-quality system. Well, the environment associated with competition and meeting customers' demand that organizations currently exist in make taking measures to make efficient and economical operation of guaranteeing the survival of the market necessary. Essential in this respect is to strive for customer satisfaction, which is directly determined by the quality of products or services [23]. Therefore, more and more companies in addition to the development of marketing activities, decide to implement solutions ensuring the achievement of the desired results in the area of quality through the implementation of appropriate quality management system [33]. It appears that the quality management and take appropriate action in this regard is very important in companies fulfill a strategy of sustainable development [12].

Because of the above mentioned, a need for methodology in the field of quality management emerged, methodology that would be applicable in different types of organizations [19]. Therefore, ISO 9000 standards were developed and published, including terminology, requirements and guidelines for implementing, improving and controlling the quality management system. The significant interest in these standards is the fact that all organizations, regardless of business profile or size, can build their quality system on its basis.

Currently, a large number of companies certified their quality management systems according to ISO 9001 standard. Standards have played an extremely important role in business. In fact, they contributed to the dissemination and development of quality systems in enterprises around the world [8]. For the first time the ISO 9000 series was established in 1987. The following years of amendment introduction are 1994, 2000 and last in 2008. Each subsequent edition been introducing changes aimed at improving the requirements and specify approach to quality management in organizations [13, 14, 32].

Since 2007, however, pace of growth of number of certificates of conformity to ISO 9001 has been slowing. Results of a study conducted by Maciej Urbaniak in 2008 indicate the reasons for the cancellation of a certificate, among which he mentions, lack of customer interest and excessive bureaucracy [31]. There is the assumption that organizations that have implemented quality management system should strive for continuous improvement. Unfortunately, these objectives are not achieved particularly in the small and medium-sized enterprises [11].

Hence, there are many aspects emphasizing that the maintenance of the system is an extremely difficult project.

The universality of ISO 9001 is therefore not adequate to the benefits that organization should achieve thanks to implementation of the standard. The desire to stand out from the competition thanks to the certificate possessed is an aspect that unfortunately – because of the universality – is no longer sufficient. What is more, formal certificate confirming compliance with the requirements of quality management is insufficient to ensure customers' satisfaction on the one hand (both external and internal), and on the other the effectiveness and efficiency of the implemented quality system [22, 23]. And yet it is precisely meeting the requirements and expectations of customers that is the primary goal of quality management systems implemented in enterprises. In order to meet that goal, organizations need to take action in the field of continuous improvement and efforts to properly maintain the system. As a consequence, in addition to the design and implementation phases, phases of maintenance and improvement should be applied. According to the logic of Deming, implementation of the system and obtaining a certificate are really just the beginning of a process towards building effective and efficient quality management system. It is appropriate to maintain the current system [24, 27]. In practice, the implementation of quality management systems and getting a certificate, is much easier comparing to maintenance and improvement [15]. Often appearing difficulties in maintaining quality management systems are connected with wrong or unavailable information. Very important is transmission of relevant information about appearing nonconformities. Every observed mistakes should be reported by all members of the organization [7].

Introduction of a specific surveillance system over incompatibilities, both those that have already occurred and potential proves to be necessary for the proper maintenance and improvement of the quality management system. Non-compliance is defined as "failure to comply with the requirements" [26] means deviation of the actual state from the state desired by the standard or customer [24]. Hence, declaration of non-compliance does not have to concern only the same product or service and related processes, but also the entire area of the organization and all the processes implemented, both major and minor.

The literature repeatedly points out that non-compliance is an integral part of every organization. A challenging task for entrepreneurs appears to be the desire to prevent their formation or striving for early detection and elimination. Unfortunately, it is not fully achieved and the more common problems include, among others belief that it is enough to establish a procedure and describe how it should fulfill the formal requirement of ISO 9001 with the 8.5. "Improvement" and the lack of preventive measures to document what is intended to continuously improve of the system [18, 32]. Often, corrective or preventive actions shall be determined only on the basis of current records, no additional analyzes deepening aimed at finding actual sources of confusion. In such organizations, unfortunately, the supervision of these activities is not different compared to what was done before the implementation of the system and result primarily from an intuitive prediction [25].

METHODS AND TOOLS SUPPORTING QUALITY MANAGEMENT

Quality management is a source of improvement of enterprises [20]. In accordance to the directions of improvement of the quality management system use of addi-

tional instruments to ensure effective and efficient fulfillment of the requirements of ISO 9001 proves to be necessary [28]. Wide range of different kinds of tools and methods that are proving to be invaluable to support the quality management system.

FMEA method, that is, analysis of the causes and effects of defects (called Failure Mode and Effect Analysis), is of great importance for the identification and assessment of non-compliances. It allows to detect existing or potential defects, determine its causes and effects and to identify actions that will allow for improvement. By design, FMEA applies to potential errors that may arise in various stages of the product life-cycle or its manufacturing process (FMEA can be applied for product, process, system, equipment or environment). FMEA of the product shall be carried out for example at the time of the introduction of new projects, components, or materials, the use of new technologies, expanding the scope of the product, etc. [10, 22]. Similarly, in the case of other FMEA analyzes, they shall be conducted at the time of the specific situation. In fact, continuous supervision of all non-conformances using this method is not assumed.

Analysis of secondary research, however, shows little interest in using this method and the rare cases of its regular use. In addition to the FMEA, a method relevant to the improvement and maintenance of quality management systems is also a method of SPC-Statistical Process Control – a method involving the use of Shewart cards (Control Chart) for the graphical presentation of information, whether in the course of process, there were no changes requiring corrective action or preventive measures. In addition, the significant improvement in the way is the use of the following tools:

- FTA – (Fault Tree Analysis) – used to search for the actual and potential damage to the system, process or product, and indicate ways to prevent their occurrence,
- Ishikawa diagram (Fishbone Diagram) – used in the analysis of causes of the problems in the process,
- Decision Matrix – used to setting priorities in the field of corrective and/or preventive actions,
- Contingency Diagram – used when identifying potential causes of failure of the plan,
- „why?-why?“ diagram – used when identifying potential causes of failure of the plan, [29].

It turns out, however, that Polish managers have unfortunately little knowledge and practical skills on them. The reasons for the lack of use of methods and support tools can be traced to the fact that the publications lack of specific information referring to their practical application [3].

Methods and tools to support quality management have a positive impact on the functioning of the organization. The advantage gained are additionally increased by using computer technology. From the analysis of the impact of computerization methods and tools of quality management on the effectiveness of the company, carried out by Krzemień E., and R. Wolniak in their study of 2001 on computer-aided methods of quality management in enterprises, it follows that there is a relationship between the company's financial condition and use of computerization. Organizations not implementing computer systems are mostly (70% of respondents) in a very bad condition, and a significant proportion of companies (43%) implementing such a solution achieves very good condition within a short time. In addition, it was observed that with the increased

number of computerized methods and tools financial condition is improving [16]. Undoubtedly, the use computerized version of FMEA method can contribute to a more accurate calculation, accelerate action, ease of analysis of the results, focusing on substantive matters by automating repetitive tasks, the possibility of using pre-made templates and create a detailed knowledge base [17]. Unfortunately, the use of these solutions has its drawbacks as well. A major limitation is the use of only a simple analysis, a maximum of twenty steps. A significant problem is beyond the possibility of being too interfering user [34].

It is reasonable, therefore, to develop a comprehensive tool support for the maintenance and improvement of quality management systems, with particular emphasis on the supervision of non-compliances. The purpose of this article is to present an original framework of the expert system.

THE FRAMEWORK OF AN EXPERT SYSTEM

The concept of expert system does not have a single definition. There are many formulations trying to define its essence [4, 35]. More often it is emphasized that it is a complex computer program that has been designed and constructed to be able to imitate human behavior- as an expert in a narrow field of expertise in solving various problems [1, 2, 4, 6].

Functions that are executed by an expert systems include the following:

- diagnosis (analysis and interpretation of the input data and to formulate proposals),
- advice (consultation in the selection of methods for dealing with the search for solutions to the problems of users),
- control,
- forecasting,
- planning,
- classification and selection,
- pattern recognition, etc. [30, 35].

Each expert system has a specific structure. Its architecture consists of a knowledge base and requesting subsystem, that interact with the accumulation of knowledge and explanatory subsystems. Creation of an expert system requires a specific expert knowledge implemented to the knowledge base by a knowledge engineer. Knowledge engineer is a person whose job is to gather knowledge from experts and other available sources, transform it into the required form, and then place it in the knowledge base. For this purpose, knowledge engineer communicates with the knowledge base via interface and subsystem for acquisition of knowledge. Knowledge base stores the original knowledge (basic facts), while the concluding subsystem seeks for relevant knowledge and creates a new knowledge, necessary for the operation of the expert system from it. Explanatory subsystem notes the user's query, looking for answers, and editing it [4, 35].

An example configuration of an expert system architecture is presented in Figure 1.

In view of the fact that supervision over non-compliance is important for the proper functioning of the quality management systems, the intention of the expert system was to support this stage. The main components of the system is presented in Figure 2.

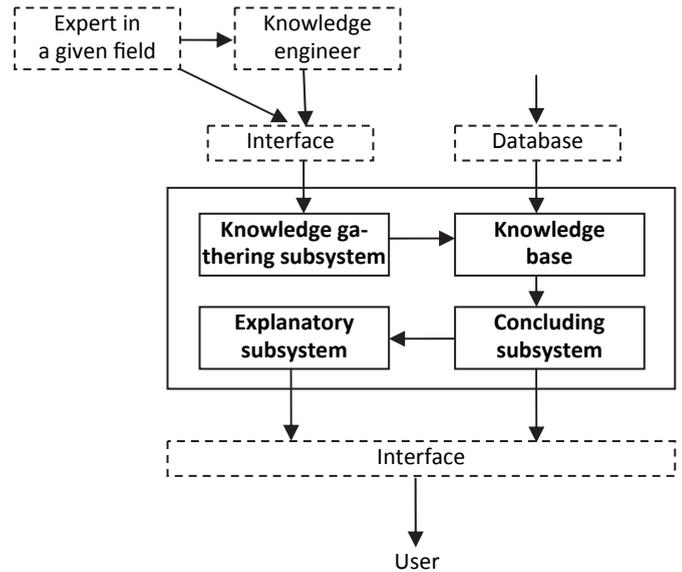


Fig. 1 Experts system structure
Source: [4, 35]

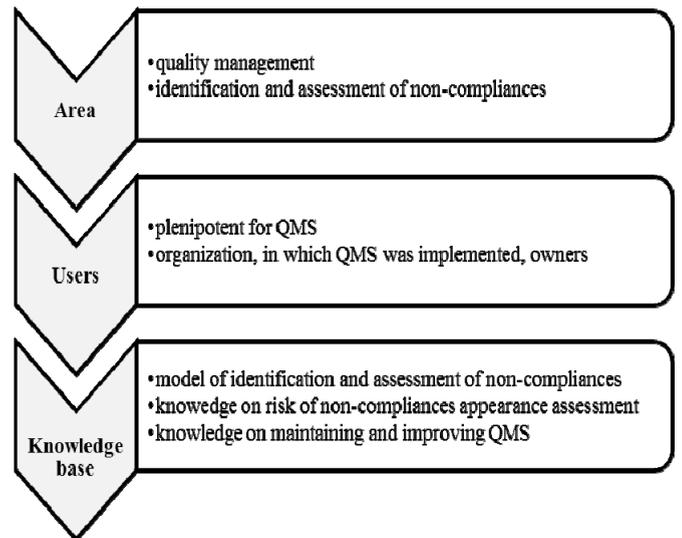


Fig. 2 Main elements of an expert system supporting quality management

Expert system is aimed to provide support in the analysis of any discrepancies that may occur within the organization. Due to the universal nature of the system, it will be able to provide support in any enterprise that takes actions striving for maintenance and improvement of quality management systems. Knowledge base will be built primarily based on the model developed.

The general idea of the algorithm showing the expert system is presented in Table 1.

The first stage of the interaction between the system and the user will be based on the need to provide information on defects identified by a user and assigning it to the appropriate area/process identified the company (dialog box 1). Then, on the basis of information contained in the knowledge base, system would direct a series of questions regarding the significance of the defect from the point of view of the customer, the probability of the defect detection capabilities to the user, to assess the risk. In the next stage, the expert system will direct to the user ques-

¹Discussion on the model is presented in the following works: [4, 21].

tions that will allow it to determine the possibility of eliminating non-compliance, which will be necessary to determine the final grade for the defect (dialog box no. 2-5). For non-compliance with the highest risk number, the system will automatically propose preventive measures based on the knowledge accumulated in the database, the introduction of which the user will be prompted (dialog box 6). At this stage, in order to ensure the supervision of non-compliances, it will be necessary also to identify those responsible for ensuring that appropriate action will be taken. Eventually the ranking of individual areas/processes due to the possibility of occurring a specific defect within them will be defined, so that people involved knew which aspects in particular they should pay attention to, where to take priority action to prevent the occurrence of non-compliance that are critical to the functioning of the company.

The example of a dialog box is presented in the Figure 3.

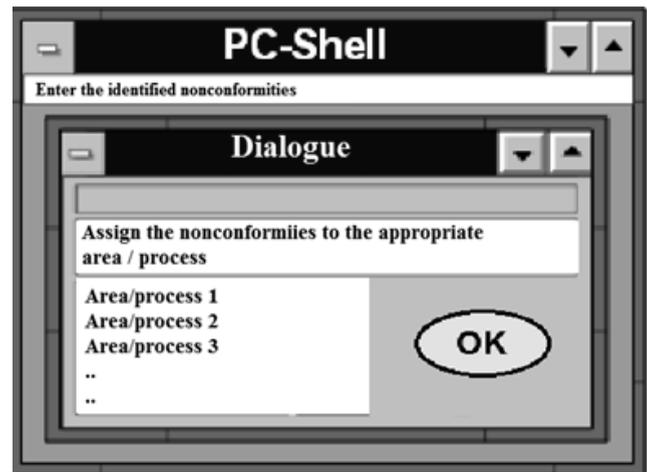
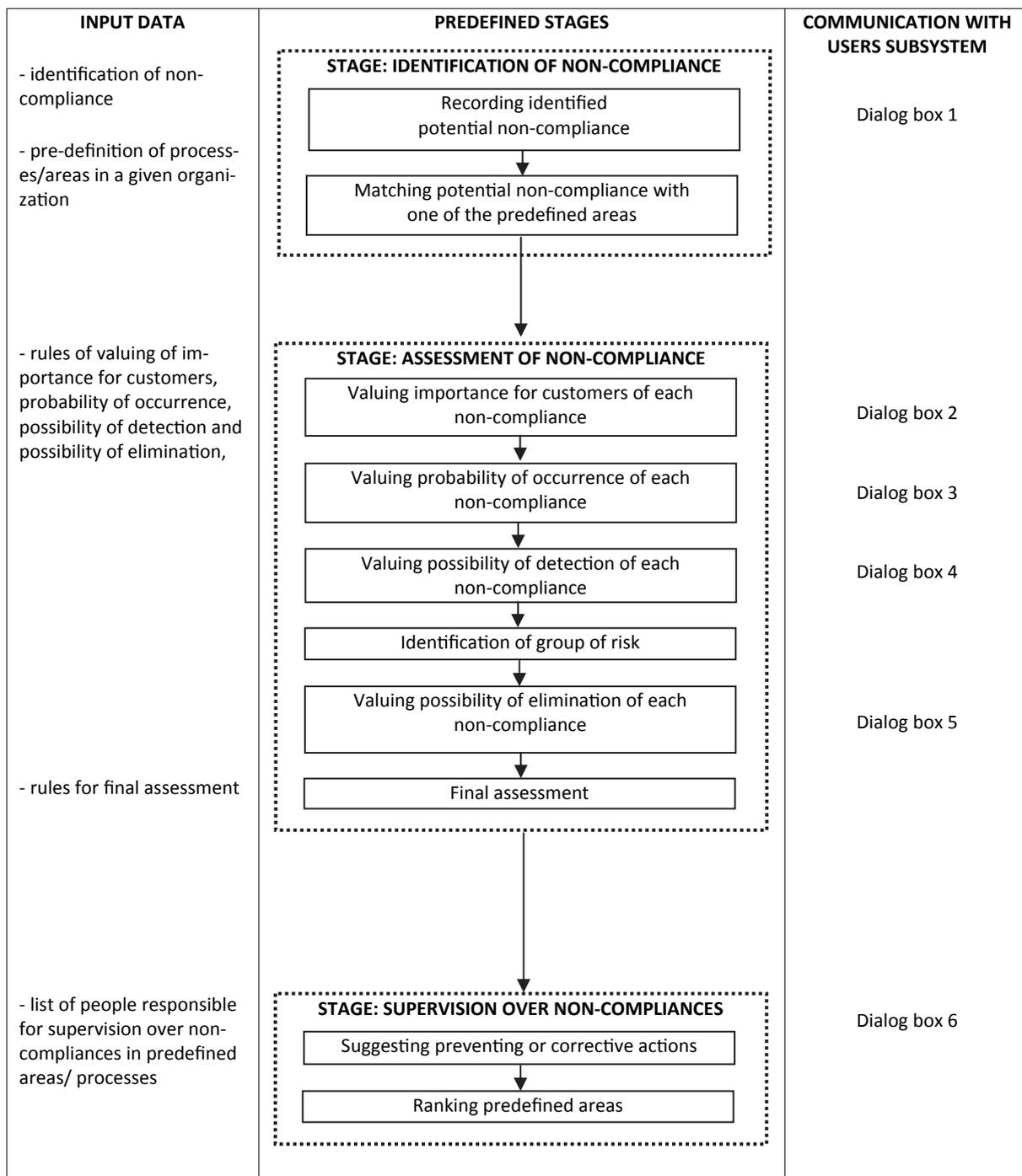


Fig. 3 Dialog box no. 1.

Table 1
General scheme of an expert system performance



SUMMARY

Representatives of any organization that has implemented a quality management system should realize that an important element that determines the effectiveness of and efficiency of the implemented system, is the identification and assessment of non-compliance that may occur. This problem must be examined by all those who actually seek to ensure that goods produced or services provided are of high quality. The mere implementation of a system or obtaining a certificate is not enough to be able to guarantee to customers that the product or service actually are of sufficient quality. Important, it also appears that customer dissatisfaction is not only his loss. Now his opinion communicated to others may adversely affect the company's operations.

The proposed expert system can contribute significantly to facilitate and increase the efficiency of the identification and assessment of non-compliance. Among the advantages of the development, and then the use of the system the following should be emphasized:

- significantly shortening the time needed to identify and assess non-compliance,
- providing for the full and ongoing control of all non-conformances that may occur in different areas of the organization,
- the possibility of an immediate response to critical threats
- increasing the effectiveness of the implemented quality management system [4].

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