Improvement of the audit process of health and safety management system with an application of FMEA method

Grzegorz Ostasz
Head of Department of Humanities
Vice-Rector for International Relations, Rzeszów University of Technology, Poland

Andrzej Pacana
Head of Department of Finance,Banking and Accounting
Faculty of Management, Rzeszów University of Technology, Poland

Tadeusz Olejarz
Vice-Dean for Development of Faculty of Management
Rzeszów University of Technology, Poland

Abstract

In the article the issues of problems prevention in the internal audits of the occupational health and safety management system have been discussed. For this purpose an application of the failure mode and effects analysis (FMEA) method known from the quality management has been proposed. On the basis of the tables adopted and adapted to the specifics of the audit process, the FMEA sheet for potential failures, their causes and effects has been completed. A conducted a pilot study in one of the companies from the Podkarpackie Province has shown that the major causes of poor health and safety management system audits is a lack of preparation for the audit and the difficulties of auditing caused by current affairs and too many auditors' duties. Removing these causes can contribute significantly to increasing the effectiveness of audits, which in turn will translate into a higher level of occupational health and safety.

1. Introduction

Production orientation, which was used by the companies in the first half of the twentieth century, assumed that the most important is to produce the maximum quantity of the product at the lowest possible price, without paying special attention to the quality of manufactured products. The situation began to change almost twenty years after the Second World War. It turned out that in some sectors of the economy quality and reliability of the product was more important than quantity and price. This phenomenon dominated the market in the seventies of the last century and today it is operating under the name "customer market" since it is the customer who decides what to buy. As studies show, but also the prose of everyday, currently customers, while purchasing a product, prefer to choose the one characterized by high quality, reliability, safety, which provides satisfaction, even at the cost of slightly higher prices compared to competitors' offer. To provide such high-quality products, a variety of methods and tools of quality management are used in the production process. Their implementation makes the replacement of the imperfections detection at the stage of use of the product to prevent their occurrence. Recently, it has been a great need for methods which allow relatively early detection of failures in a product or a process.

The response to this demand was, among others, FMEA analysis developed in the US in the sixties of the twentieth century for the needs of the "Apollo" project implemented by NASA. After achieving success, the method became more widespread in other industrial fields such as nuclear technology, aerospace and automotive industry, and now it is a regular part of the quality system. Currently, it is adapted to other areas of management.

From the beginning of civilization people have suffered from accidents at work, but the issues related to working conditions have become more important with the development of the

industry. Nowadays, in order to avoid work accidents or minimize their effects, an analysis is performed, followed by an assessment of occupational risk at the workplace. Risk assessment has led to the prevention (like FMEA in quality) of the potential negative effects of occupational hazards.
At the same time when the FMEA method was developed, in countries with a market economy producers, who wanted to make sure of the solidity of its suppliers and subcontractors, began to conduct research and evaluate the possibility of maintaining a stabilized level of quality of supply in accordance with the technical requirements contained in the agreement. In this way, the so-called audits were developed.

An audit of management system and occupational health and safety of PN-N-18001standard defines a systematic and independent examination whose aim is to determine whether the actions undertaken under the safety management system and occupational health and the results achieved, correspond to the planned arrangements, and whether these arrangements are implemented effectively and if they are suitable for the implementation of the policy of health and safety, and to achieve the objectives of the organization in this regard.

Also, along with the spread of a standardized system solutions in the field of quality, environment, but also safety, the practice of auditing developed. Then the need to harmonize the methodology of conducting audits was observed. It was particularly important in relation to audits, the result of which was the certification of the company, or so-called recording in the register of qualified suppliers. Audits of system management of occupational safety and health were adopted for use in the final years of the last century, when the importance of safety management system started growing and the new standards and regulations, which were associated with increasing legal liability and economic, were developed. As a result of measures taken by the committee TC 207 ISO, the international standards for conducting environmental audits were developed. In 2002 and then in 2012, these standards were replaced by ISO 19011 "The guidelines for auditing management systems," which can also be used to audit occupational health and safety. In Poland the standard of PN-N-18011 "Safety management systems and occupational health. Guidelines for auditing" is still working and it is compatible and complemented by ISO 19011. This standard provides guidance on the principles of auditing, managing audit programs, conducting audits of the management system, as well as guidance on auditors' competence about management system. It applies to all organizations that need to conduct internal or external audits of management system or management audit program. However, the standard does not specify how to improve audits. A tool that can be used to streamline audits may be FMEA. Therefore, an attempt to identify the causes and consequences of ill-conducted audits of safety management systems and occupational health has been made. The results, which have been presented in the article, can be used to improve the audit process of safety management system in organizations which already have the health and safety management system or in those which plan to implement it.

2. Failure Mode and Effect Analysis

The method of Failure Mode and Effect Analysis (FMEA) is mainly used for the prevention and elimination of the effects of failures that can occur in the design and manufacturing processes. But this method can be used to improve the internal audit process. When one decides to carry out an analysis of FMEA, the purpose and the scope it cover should be clarified. The greatest benefit is achieved when the FMEA will be done before starting the process. In this case it will be before the start of a program or a schedule of audits in the organization, but after the training of auditors. However, due to the nature of the internal audit, it is necessary to gain experience during audits. Hence, particularly in the case of the internal audit, the conducting of FMEA seems to be significant when the auditors carry out at least two internal audits.
The essence of FMEA method is connected with the following steps:
1. Identification of all the elements of the process.
2. Making a list of possible failures.

3. Making a list of the probable results of these failures
4. Making a list of possible causes of failures.
5. Assignment of possible failures to the LPW risk value (a number of priority incidence - indicates the probability of failures occurrence), LPZ (a priority number of significance - indicates how painful this failure may be to the customer), LPO (a priority number of detection - informs what about the probability whether the process failure is going to be detected during the process. These numbers are selected from the tables available in the literature or developed for the needs of a specific organization.
6. Calculation of the priority number of risk according to the following formula:

LPR = LPW*LPZ*LPO (1)

7. Systematization of possible failures according to their rank.
8. Indication of corrective actions.

The risk priority number may vary in the range (1, 1000). If it is significantly greater than 1 a recommendation (proposal) to take preventive action, e.g. by modernizing the structure or process changes is issued.

3. Analysis

FMEA analysis to improve the process of internal audits has been carried out in one of the manufacturing companies of the Podkarpackie Province. The company has implemented an integrated y management system of quality, environmental safety and occupational health. It has its own internal auditors, but occasionally it also uses the services of external auditors from outside the company. The company has tried to improve the process of internal audits due to significant differences in the conduct and reporting of audits by the company's employees in comparison with the external auditors. The course of the audit are presented in fig. 1.

Audit initiation	
↓	↓
Preparation of audit operations	
↓	↓
Conducting audit operations	
↓	↓
Preparation and distribution of audit report	
↓	↓
1.4 Audit termination	

Fig. 1. Block diagram of the audit process of health and safety management system

In the later part of the study health and safety guidelines for the estimation of the priority numbers matched in the FMEA, agreed for the process for auditing management systems, have been presented. In the task three internal auditors, in addition to the authors, have taken part. As already mentioned, the first step was to prepare tables for the selection of priority numbers as they are characteristic depending on whether they serve of a product FMEA (design) or a process, and if the process, then what kind it is. The audit process is such a characteristic one. In another action a form to assess audits by the FMEA has been prepared. In tables 1, 2, 3 the results of the valuation of priority numbers: LPZ, LPO for FMEA internal audit process of health and safety management system have been presented.

LPW	DESCRIPTION	PREDICTED FREQUENCY
1	**Unprobable** The occurrence of the audit imperfections is almost impossible.	below average in every tenth audit per year
2	**Very rarely** Audit imperfection audit occurs sporadically.	on average in every ninth audit per year

3	Audit imperfection audit occurs sporadically.	on average in every eighth audit per year
4	**On average rarely** Audit imperfection occurs on average sporadically	on average in every seventh audit per year
5	**Average** In comparison with similar activities audit imperfections do not occur more frequently.	on average in every sixth audit per year
6	**Big** Audit imperfection creates problems; as it occurs more frequently than in similar activities.	on average in every fifth audit per year
7	**Medium high** Audit imperfection creates problems; as it occurs more frequently than in similar activities.	on average in every fourth audit per year
8	**High** Audit imperfection creates problems; as it appears much more frequently than in similar activities.	on average in every third audit per year
9	**Very high** It is almost certain that audit imperfections will appear.	on average in every second audit per year
10	**Very high** It is certain that audit imperfections will appear.	during each audit

Tab. 1. Determination of the LPW number (occurrence)

LPW	DESCRIPTION
1	**No** One should expect that audit imperfection will have any impact on the level of health and safety procedures. Imperfection will not affect the functioning of the system.
2	**Very low** Audit imperfection will cause minor repercussions in the system, and perhaps a minimal decrease in health and safety procedures.
3	**Low** Audit imperfection will cause minor repercussions in the system, and perhaps a small decrease in health and safety procedures.
4	**Medium** Audit imperfection will result in a noticeable reduction of the system's functionality and its consequence could be a decline in the minimum level of health and safety procedures.
5	**Medium high** Audit imperfection will result in a noticeable reduction of the system's functionality and its consequence could be a minimum decline in level of health and safety procedures.
6	**Big** Audit imperfection will result in a noticeable reduction of the system's functionality and its consequence may be a small decrease in health and safety procedures.
7	**Very big** Audit imperfection will result in a noticeable reduction of the system's functionality and its consequence can have a clear decrease in the level of health and safety procedures.

8	**Considerable** Audit imperfection will result in a noticeable reduction of the system's functionality and its consequence may be a severe decline in health and safety procedures.
9	**More than considerable** Audit imperfection will cause a significant impairment of the system's functionality and can lead to a major accident, a clear drop in the level of health and safety procedures. There is no safety risk for a customer.
10	**Extremely significant** Audit imperfection will cause a significant impairment of the system and can lead to a major accident, a clear drop in the level of health and safety procedures. It can lead to a safety breach for a customer.

Tab. 2. Determination of the LPZ number (significance)

LPW	DESCRPTION
1	**Considerably big** The measures used will detect the potential audit imperfection.
2	**Very big** The measures used will almost certainly detect a potential audit imperfection.
3	**Big** The measures used have a very high chance of detection of potential audit imperfection.
4	**Medium big** The measures used have a high chance of detection of potential audit imperfection.
5	**Medium** The measures used have a high chance of detection of potential audit imperfection.
6	**Low** It is likely that the measures will detect potential audit imperfection.
7	**Medium low** It is likely that the measures will detect potential audit imperfection.
8	**Very low** The measures used probably will not detect the potential audit imperfection.
9	**Minimum** The measures used may not detect the potential audit imperfection.
10	**No** The measures used will not detect the potential audit imperfection, or no measures are applied.
The measures used - records, subsequent audits, reviews of documentation, preventive measures and possibly other actions arising from the specifics of the situation.	

Tab. 3. Determination of the LPO number (detection)

The next step was to complete an already prepared form in tab. 4.

No	Failure	Failure results	Failure causes	LPW	LPZ	LPO	LPR	Corrective actions
1.	Unfinished audit	No conclusions, no summary, the lack of all the evidence, the employee's and auditor's frustration	Mismatched audit time	4	6	1	24	Auditors training
2.	Confusion	Repeatition	Inadequate numer	3	1	2	6	Analysis of the

	during the audit	of questions, asking a few questions at the same time, cross-question, multiple simultaneous requests towards the auditee	of auditors					situation, talk with auditors and auditees before the audit
3.			Making excused of auditees	3	3	5	45	Auditors training
4.	Audits conducted carelessly	Bad opinion of audits, auditors and QMS, the lack of constructive observations from the audit	Lack of motivation of auditors	5	3	4	60	Consider the introduction of financial incentives
5.	Audits conducted carelessly	Bad opinion of audits, auditors and QMS, the lack of constructive observations from the audit	Too many duties of auditors	5	5	6	**150**	Analysis and possible changes of auditors' responsibilities
6.	Audits conducted carelessly	Bad opinion of audits, auditors and QMS, the lack of constructive observations from the audit	No after-audit consequences	5	6	4	120	Introduce the formal assessment of auditors
7.	Wrong audit questions	Misunderstanding from an auditee, wrong observations	No auditors' skills	3	4	5	60	Perform interviews with auditors and possibly resign from conducting audits by some of them. Train new auditors
8.	Wrong audit questions	Misunderstanding from an auditee, wrong observations	Improper auditors	2	3	5	30	Develop a plan of staffing
9.	Wrong audit questions	Misunderstanding from an auditee, wrong observations	No trainings for auditors	6	3	3	54	Reserve an amount for trainings. Introduce the auditors who are training and the self-training.
10.	The lack of coordination during the audit		Improper audit time	4	2	3	24	Training of auditors regarding the conduct of the audit
11.	The lack of coordination during the audit	Intermittent audit	No preparation for audit	7	6	5	**210**	Introduction of financial motivation. Changing procedure. The need to prepare records of the review of documentation and checklists.

12.	The lack of coordination during the audit	Intermittent audit	Difficulties in auditing caused by current affairs.	5	6	6	**180**	Trainings for all employees
13.	Unrepeatable audits	Excessive details, or excessive generality, different forms	Bad system documentation in the area of audits.	3	2	2	12	Realize additional documentation review
14.	Inadequate atmosphere in the organization in relation to the audit.	Low audits rank	Lack of executives' involvement	2	2	5	20	Prepare and give a presentation about the benefits of the system.
15.	Inadequate atmosphere in the organization in relation to the audit.	Low audits rank	Indulgence of plenipotentiary	2	6	5	60	Explain to the plenipotentiaries of their important role in the audits.
16.	Inadequate atmosphere in the organization in relation to the audit.	Low audits rank	Lack of team awareness	3	3	5	45	Plan short trainings

Tab.4. Fundamental part of the FMEA sheet for the internal audit process of health and safety management system

4. Conclusions

The preliminary failure mode and effects analysis (FMEA) has shown that the FMEA can be used to improve the process, internal audit management system of occupational health and safety. In order to do that, the tables of priority numbers selection should be prepared. Such prototype tables were prepared prior to the pilot use of FMEA in the context of improving the audit process in one of the plants of the Podkarpackie Province. These tables can be improved in the future based on data from the FMEA course. The analysis of the causes and consequences of failures in the audit process has revealed that the biggest problem may be the lack of preparation of auditors to audit health and safety management system. For this the corrective actions in the form of, among others, financial motivation, have been introduced. Also some corrections to the procedure have been introduced. According to them it would be necessary to prepare records from the review of the documentation before the audit and checklists. Other major causes of problems with the audits were difficulties of auditing caused by current affairs, too many responsibilities of auditors and the lack of after-audit consequences in case of bad audits of safety and occupational health management system. For these and other reasons of the audit problems the corrective actions have been proposed. After some time the FMEA method should be repeated for further improvements of the audit process of occupational health and safety management system. One needs to keep in mind that internal audits are an important component of the system, and their improvement is a part of the improvement of the safety system.

References

ISO 9001:2015, access: http://www.bsigroup.com/, on 8.09.2016.

Jodkowski, L., 2015. Possibilities and Methods of Risk Assessment under ISO 9001: 2015, International Journal of Managerial Studies and Research (IJMSR), Volume 3, Issue 10, pp. 14-23, October 2015.

Kleniewski, A., 2011. Zarządzanie ryzykiem w systemach zarządzania jakością, środowiskiem, bezpieczeństwem i higieną pracy - praktyczne rozwiązania, Problemy Jakości, pp. 23-27, R. 43, nr 11, 2011.

PN-EN ISO 9000:2015-10 – Polish version, PKN, Warszawa, 2016.

PN-EN ISO 9001:2015-10 – Polish version, PKN, Warszawa, 2016.

PN-ISO 31000:2012 Zarządzanie ryzykiem – Zasady i wytyczne, PKN, Warszawa 2012.

Sęp, J., ,Pacana A., 2001. Metody i Zarządzania Jakością, Rzeszów: Rzeszów University of Technology Publisher.

Sęp, J., Perłowski, R., Pacana, A., 2016. Techniki wspomagania zarządzania jakością, Rzeszów: Rzeszów University of Technology Publisher.

Stamatis, D.H., 2003. Failure mode and effect analysis: FMEA from theory to execution, Quality Press, Milwaukee.

Zapłata, S., Methods of Risk Assessment for the Purpose of Normalized Management Systems Implementation, Współczesne Zarządzanie, pp. 9-19, 1/2012.

Znaczenie ryzyka w zarządzaniu jakością. Jak podchodzić do zmian?, access: http://www.bsigroup.com/ISO-9001-2015, on 8.09.2016.