

Results of survey among SEVESO establishments in the Slovak Republic[☆]

Dynamical development of technologies is a result of man's desire to achieve higher living standard. The modern technologies are becoming still more complicated and may lead to industrial accidents. Slovak republic has its own history of industrial accidents. Risk management activities and spending of funds to prevent major industrial accidents is far from being popular among public and government unless some crisis event occurs. Safety in industrial plants is being improved and modified as a result of growing number of industrial accidents. Implementation of SEVESO II directive in EU member countries is fundamental for serious industrial accidents prevention. The need for risk assessment and management is supported also by the investigations on the European but also on national level. In this paper the selected conclusions which affect the adoption and adaptation of the legal environment in the Slovak Republic are based on a statistical research realized during 2012–2013 in the framework of the MOPORI project.

Based on the results achieved in the framework of the statistical survey, the results were implemented in the Comprehensive Model for the Risk Assessment and Management of the Industrial Processes. The issue was to insert the methods to individual steps of the comprehensive model which were implemented into the model on the basis of the legal requirements and results of the survey. The analysis of the questionnaire yielded some interesting conclusions which have not been included in this paper, not only due to its extent, but also due to the need to bring the results the attention of as wide a group of readers as possible and maintain its consistency and clarity. These unpublished results will be used as the base for achieving further goals of the MOPORI project.

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[☆]This article is result of continuous scientific and research activities of several years of the authors, who are active in the positions of lecturers and research workers at the Department of Crisis Management, Faculty of Security Engineering of the University of Žilina in Žilina, Slovakia. Scientific and research activities of the faculty are focussed on solving the theoretical basis of crisis management. A significant factor of recognition of scientific professionalism of the faculty staff is also their co-operation for many years with the bodies of state administration and self-government in the section of crisis management. The views expressed, however, are solely those of the authors and not necessarily those of the institutions with which they are affiliated or of their funding sources. Also, the authors are solely responsible for any errors or omissions.

INTRODUCTION – IMPORTANCE OF RISK ASSESSMENT AND TREATMENT IN SEVESO ESTABLISHMENTS

Dynamical development of technologies is a result of man's desire to achieve higher living standard. The modern technologies are becoming still more complicated and may lead to industrial accidents. Industrial accidents like the explosions in Flixborough (1974) or Seveso (1976) or Union Carbide's catastrophe in Bhopal (1984), or Chernobyl catastrophe (1986) and many others show that technology failures or operators failures lead to the fatal consequences with many mortal wounded people or seriously injured (subsequently disabled). These failures also lead to enormous material damages and long-term or irreversible environmental damages.

In Europe (Slovak Republic is a part of it), the catastrophic accident in the Italian town of Seveso in 1976 prompted the adoption of legislation on the prevention and control of such accidents. The so-called Seveso-Directive (Directive 82/501/EEC) was later amended in view of the lessons learned from later accidents such as Bhopal, Toulouse or Enschede resulting into Seveso II (Directive 96/82/EC). In 2012 SevesoIII (Directive 2012/18/EU) was adopted taking into account, amongst others, the changes in the Union legislation on the classification of chemicals and increased rights for citizens to access information and justice. It replaces the previous Seveso II directive. The Directive now applies to more than 10,000 industrial establishments in the European Union where dangerous substances are used or stored in large quantities, mainly in the chemical, petrochemical, logistics and metal refining sectors. Considering the very high rate of industrialization in the European Union the Seveso Directive has contributed to achieving a low frequency of major accidents. The Directive is widely considered as a benchmark for industrial accident policy and has been a role model for legislation in many countries world-wide (<http://ec.europa.eu/environment/seveso/>, 2015).

The need to improve of the risk assessment and management is supported

by the investigations on the European but also national level.^{1,2,3} Slovak Republic has its own history of industrial accidents. Risk management activities and spending of funds to prevent major industrial accidents is far from being popular among public and government unless some crisis event occurs. Afterwards, the serious accident like that in VSŽ Košice a.s., Slovak republic on 27th of October 1995 when many lives were lost, shows that many risk management tasks are only formally fulfilled and the complex risk management of organizational, personal, technical and material issues is not sufficient. Dealing with these tasks must be secured/fulfilled on adequate level. Recently, several serious industrial accidents have happened in Slovak Republic. These accidents are available in serious industrial accident information system (<http://charon.sazp.sk/SevesoPublic/Havarie.aspx>, 2015).

University of Žilina ran a project in this field called “Complex Model for Risk Assessment in Industrial processes” which affects the adoption and adaptation of the legal environment in the Slovak Republic in some way. Within this research project began the statistical research in 2011 by developing a questionnaire. Inputs were taken mainly through meetings with stakeholders and by creating questions for the questionnaire and that was used to develop of the research tool. Subsequently our project team accomplished the list of persons in the framework of the companies who were sent the questionnaire – this required involvement of several project team members in this action (81 companies were addressed). The information obtained was often inaccessible and incomplete, but even outdated. The project team as well as the company Risk Consult, Ltd. (which actively participated in this action) had to remind repeatedly the addressed to companies to send the questionnaires.

PURPOSES, METHODOLOGY AND REPRESENTATIVENESS OF THE STATISTICAL RESEARCH

Purposes of the Statistical Research

The University of Zilina the principal investigator for the APVV-0043-10

national project titled “Complex Model for Risk Assessment and Treatment in Industrial Processes” as it was mentioned.

Main objective of project, as is implicated from recent status analysis of issue, is improvement of security in industrial establishments “Seveso establishments” in Slovak Republic, by creating a complex model of industrial enterprise risk assessment using quantitative methods, its synchronization with standards of EU and following application in conditions of Slovak Republic.

The originality and innovative approach (comparing to traditional procedures used in Slovak Republic) of the model is in the synthesis and verification on new scientist approaches usable and applicable in the field of risk management and major industry accidents prevention.

The model of risk assessment and treatment in industrial processes was designed by structured diagrams enabling its transformation into the software tool, which is currently missing and it is wanted by target groups. Its advantage is an easy application of created model based on the flowcharts and it will use quantitative methods for risk defining. The creating of the model of risk assessment and treatment in industrial processes will improve the risk assessment processes as well as the civil security and safety of private or public possession, environment and it will also have a positive impact on sustainable development of Slovak Republic.

The next innovation of the project is the complex analysis of the state-of-art in Slovak Republic and also in EU in the area of major industrial accidents prevention, defining actual problems, solutions and terms definition in this area.

As part of the project a statistical survey aimed at the target group of establishments known as Seveso establishments in the Slovak Republic was undertaken. The need to undertake the survey arose from changes in legislation which are currently being made at European level and will be transposed into the legislative environments of the individual European Union members. They primarily relate to the changes in

the currently effective European Seveso II/III directive and the fundamental alterations they bring. Multiple institutions participated in creating the questions for the survey. These institutions are important in this field and the cooperation yielded a significant contribution to processing of the questionnaire and relating comments.

A similar survey at European level was undertaken in 2008 under the title “Seveso Study of the effectiveness of the Seveso II Directive”. It brought partial results which, if found legitimate, were integrated in the relevant legislation of the individual member countries.

The realization phase of the statistical survey began in 2011 with meetings with the competent bodies and the preparation of the survey questions. Subsequently, a list of contact persons for the establishments to be surveyed was created. This task required cooperation of a number of members of the project team. The required information was often unavailable or incomplete and also out-of-date. Due to the incredulity towards this type of survey on the side of the establishments, a covering letter was sent by the dean of the Faculty of special engineering with formal support from the Ministry of environment. Following the distribution of the questionnaire, the surveyed establishments received a number of reminders from the project team as well as from the representatives of Risk Consult, Ltd., who actively participated in this task. Subsequently, the completed questionnaires were collected and the results statistically evaluated.

Methodology of the Statistical Research

The basis of the statistical project was an investigation of the knowledge and experience of Seveso establishments in Major Industrial Accidents Prevention (MIAP). Project tasks arose from the formulation of hypotheses, questions and problem areas relating to the topic of the project. The project team chose the most intelligible form also known as statistical questions.

The questionnaire contained 29 questions; the types of the questions were as follows – closed, open and combined. The statistical project comprised questions aimed at

- The input data about the Seveso companies and their operation (name, the place of the company's dislocation, economic line of business, the company category according to the law No. 261/2002 Coll.).
- The number of employees and the number of professionally capable persons carrying out the major industrial accident prevention (both internal and external).
- The rate of the company management's collaboration with the professionally capable persons in the framework of the major industrial accident prevention.
- The knowledge about the methods, methodologies and software for assessing the risks of the industrial processes and their usage for the risk assessment in the individual Seveso companies.
- The problems connected with the major industrial accident prevention as well as realizing the law No. 261/2002 Coll., in the Seveso companies.
- The form of working out the necessary documentation (e.g., the Security and Safety Report).
- The costs connected with the major industrial accident prevention.
- The risk companies close to the given Seveso company and collaboration with them in the area of the major industrial accidents, providing information for the public concerned.
- The collaboration with the public administration bodies and the self-government.
- The form of informing the public concerned and the area of major industrial accidents and their prevention.
- The collaboration with academia in the area of solving the problems of the major industrial accidents.

Key statistical attributes were identified in these questions. The statistical attributes were represented by numeric or descriptive values such as the name of the establishment, number of employees, industry, methods of evaluation, types of methodological guides and costs associated with risk assessment. The project team obtained the values (and their variations) of the individual statistical attributes in the

form of a questionnaire, completed by the experts on MIAP from the participating Seveso establishments. Appropriate statistical methods and visualization tools (tables, graphs), suitable for the analysis and results interpretation, were applied to the individual statistical questions. Based on the obtained results, the team analyzed the individual statistical attributes and their mutual relation in the form of dependencies and trends.

In total the authors contacted 81 Seveso establishments from 26 industries based in the Slovak Republic (Figure 1).

Representativeness of the Statistical Research

The level of responses for the individual industries is shown in Figure 2. The representativeness of the survey may have been affected by the following facts

- the questionnaire was completed and returned by establishments from 16 industries, meaning 62% success rate,
- from the 81 Seveso establishments approached, 44 establishments returned a completed questionnaire, meaning 54% success rate,
- 70 approached Seveso establishments were from one of the 16 industries, from which completed questionnaires were returned – from this point of view, the return success rate was 63%.

The following parts of this paper describe selected results from the statistical research of the Seveso companies in the framework of the MOPORI project APVV-0043-10.

RESULTS OF STATISTICAL RESEARCH

The results of the statistical survey have shown several facts which are to be solved in the future especially in connection with the recently adopted directive Seveso III and incorporating the changes for the company in the Slovak Republic in the framework of the legal regulations being prepared. The selected results of the

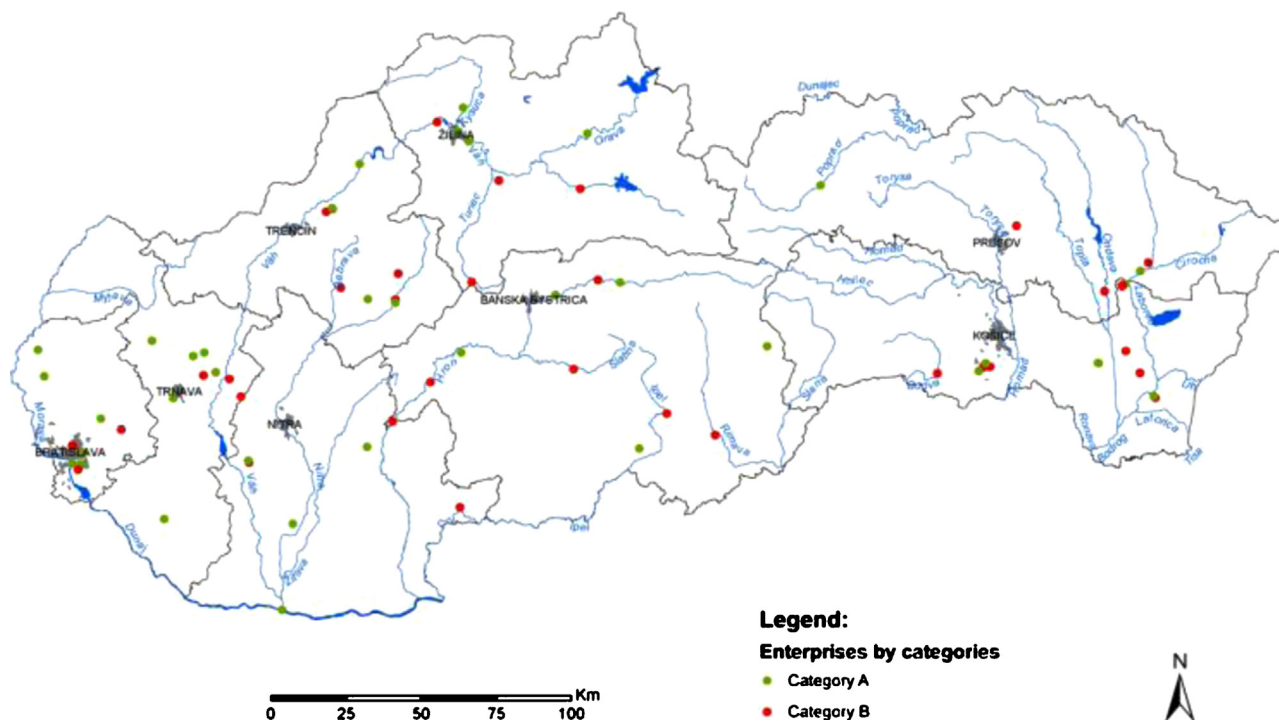


Figure 1. Distribution of establishments falling under the scope of MIAP act in the Slovak Republic.
 Source: <http://charon.sazp.sk/SevesoPublic/Mapa.aspx>, 03.03.2014.

statistical survey are and will be utilized for creating and updating a comprehensive model for assessing and managing the risk especially from the

point of view of involving the methods and techniques to individual steps of the created model. Similarly, the competent bodies of the state administra-

tion will utilize the survey results for justifying the changes in the framework of the law which is just being prepared.

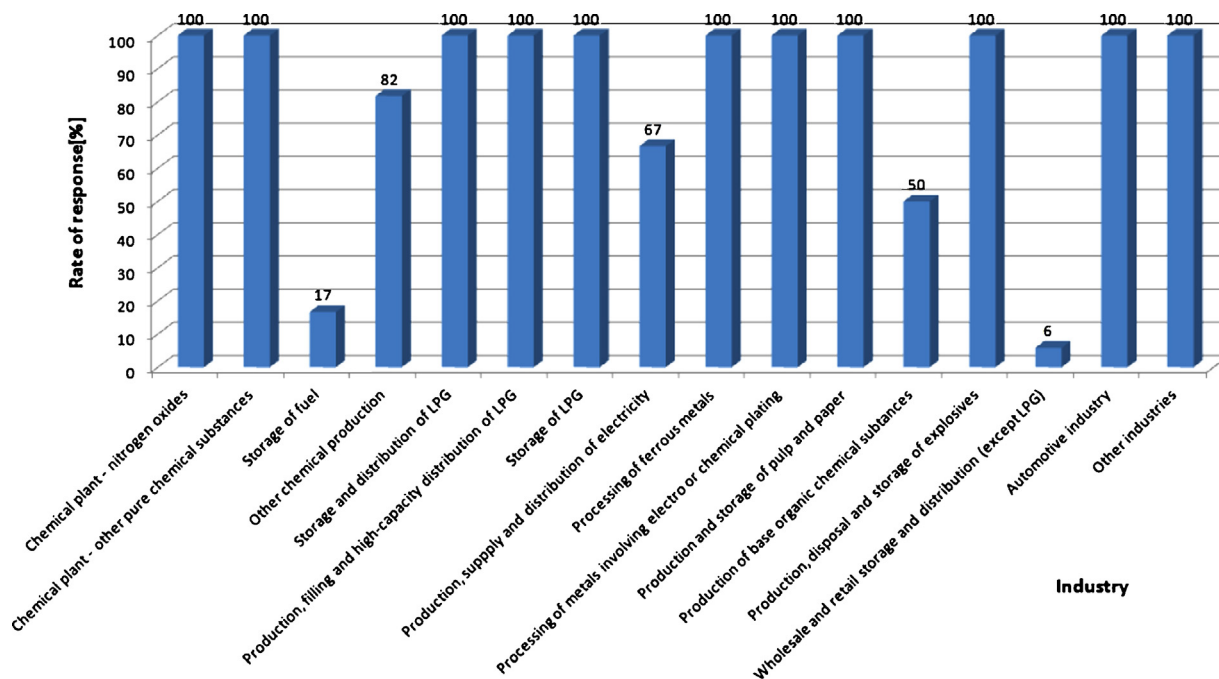


Figure 2. Questionnaire returns success percentage by industry (%).

Ability to Use Methods for Risk by Professionally Qualified and Authorized Persons

Seveso establishments employ persons professionally qualified in the MIAP area or they ensure fulfilling the required tasks and duties by subcontracting to external authorized persons or companies. MIAP specialists and technicians have a license for providing such services and they are responsible for the compilation of the documentation required by the law.

One of the decisive criteria for assessing the qualification level of Seveso establishment MIAP specialists is their knowledge and the ability to use the methods of major industrial accident risk analysis. The individual specialists were presented with 16 well-known methods for major industrial accidents (MIA) risk analysis. The specialists had also the possibility to state another method they knew of and was not included in the list.

The methods most often used by the Seveso establishment specialists were

the ETA – Event Tree Analysis (39 establishments), FTA – Fault Tree Analysis (38 establishments) and safety audit (26 establishments). A detailed overview of the distribution of the MIA risk analysis methods used, based on the knowledge and experience of the MIAP specialists, is given in Figure 3.

The selection of methods and techniques for risk assessment and treatment does not only depend on their availability, but also on the qualification of the person who will be applying them. Currently, the majority of establishments use the PSA (probabilistic safety assessment)/PRA (probabilistic risk assessment) approaches. As part of the Seveso III directive transposition into the legislative systems of the EU member countries, an opportunity to create a unified approach to risk assessment is emerging. This would allow the government institutions to compare the results from the individual establishments to each other and also make the control of required documentation simpler.

Problems with Realization of MIA Prevention Tasks

There are multiple potential problems in the realization of MIAP in Seveso establishments in Slovak Republic. The survey question on the problems with the realization of MIAP in their establishment was answered by 29 Seveso establishments. From the establishments that provided an answer, 23 establishments had specific problems and 6 establishments (14%) stated that they either did not have any problems or they had not been identified. 15 Seveso establishments (34%) did not provide any answer. In the form of free text in the gaps, the professionally qualified and authorized persons described the problems relating to MIAP. The details are given in Table 1.

Use of Software Tools in Major Industrial Accidents Risk Assessment

No particular software package for creating scenarios, modelling consequences and impacts of MIAs is

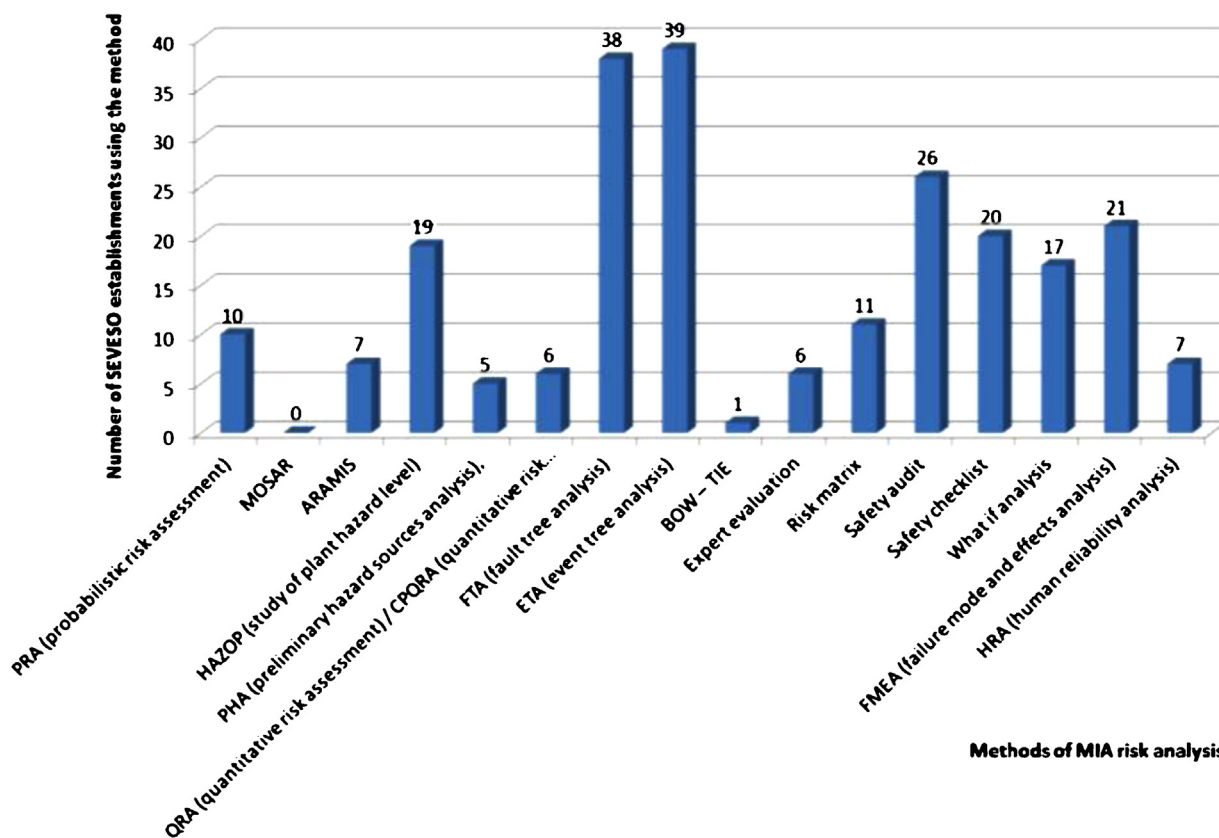


Figure 3. Numbers of Seveso establishments adopting various methods of MIA risk analysis.

Table 1. Overview of Issues Relating to Prevention of Major Industrial Accidents.

| Reference Number | Problems with MIAP | Number of Seveso Establishments | Percentage (%) |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------|
| 1 | Significant costs involved with the storage of even small quantities of toxic gases. | 5 | 13 |
| 2 | Financial requirements in general. | 2 | 5 |
| 3 | Industrial accident prevention is neglected in comparison to health and safety and fire safety. Health and fire safety also increases administrative load and prevents from a broader implementation of performance-based approach. | 2 | 5 |
| 4 | The law does not recognize division of establishments (one large establishment into multiple smaller). | 2 | 5 |
| 5 | Funding allocation for important tasks of greater extent. | 1 | 3 |
| 6 | Employee training. | 1 | 3 |
| 7 | There are other establishments on the same site (e.g., airport) which are not in any contractual relation to the other establishment(s), which causes a problematic summarization of SDS. | 1 | 3 |
| 8 | It is possible that on-site transport of SDS is by train, vehicles or plane and/or that SDS are manipulated with and stored during the transportation. There no guidance on the on-site transportation of SDS within the establishment premises. Current training includes MIAP, ADR, RID, IATA annex. | 18.1 | 3 |
| 9 | A large quantity of raw materials and SDS in the form of mixtures and preparations and constant changes in the transportation requirements (logistics). | 1 | 3 |
| 10 | The categorisation of the establishment is contentious from the appraisal of plating bath point of view. Zinc chloride in water solution (acid zinc plating is over 1 if considered "very poisonous" and/or less than 1 if considered "only poisonous"). | 1 | 3 |
| 11 | No problems identified/or no problems. | 6 | 15 |
| 12 | No answer provided. | 15 | 39 |
| Total | | 38 | 100 |

specified within the EU regulations or the Act on MIAP. The legislation, however, specifies input required for the calculations for the overall expression of consequences. Currently, there are a number of software packages available. These vary mainly in price and input required as well as the user interface.

The survey question on the use of major industrial accidents (MIA) risk assessment software was answered by all of the 44 Seveso establishments. According to their answers, the establishments use primarily the following software packages for MIA risk assessment MS Excel, Aloha, TerEx, Risk-Spectrum and Sapphire. The other software listed in the questionnaire was not selected by any of the establishments. There was also an option to list other MIA risk assessment software which they use. The following softwares were listed ROZEX 2001,

ALOFT-FT 3.10, IAEA-TEDDOC-7, Breze-Hass professional, ATON. These listed software products are used for risk assessment in different fields of industrial processes within EU and especially in Slovak Republic and not all of them should be used for this purpose. So we found out that establishments are using also inappropriate methods here. The majority of the establishments stated that they use MS Excel (38 establishments, 36%) and Aloha (37 establishment, 35%) for risk assessment. The ATON software package was probably included by mistake because it is absolutely out of scope but some establishments used it what was surprising. The overall distribution of the establishments depending on their software of choice for MIA risk assessment is shown in Figure 4.

The results lead to the following conclusions, which may be generalized. The MS Excel software is mainly

used by the establishments for creating FTAs and ETAs, which are included in the legislation as methods for creating scenarios. TerEx should not be included in this list, as it is software intended for operative modelling of scenarios for attending crews. Other software packages are individually selected, mainly by establishments with foreign owners and they often require a significant financial investment (e.g., SAFETI).

Level of Seveso Establishments Cooperation with Government Organizations

State administration in the field of MIAP under Act no. 261/2002 is carried out by the following bodies

- (a) Ministry of Environment of the Slovak Republic,
- (a) Ministry of Interior of the Slovak Republic,

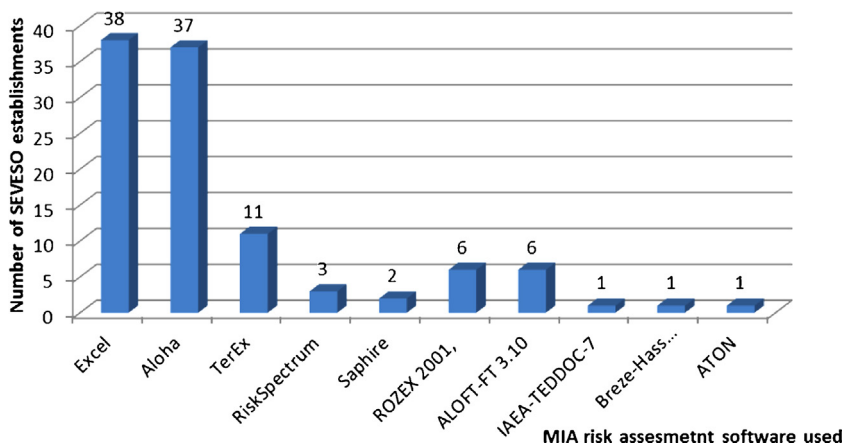


Figure 4. Number of Seveso establishments preferring software products for risk assessment.

- (a) Ministry of Labour, Social Affairs and Family of the Slovak Republic,
- (a) Slovak Environmental Agency, Agency of the Ministry of Environment of the Slovak Republic,
- (a) Government bodies in the section of fire protection,
- (a) Government bodies in the section of civil protection,
- (a) Health protection bodies and state health institutions,
- (a) State mining authority.

From the 44 Seveso establishments, 43 answered this particular question. Based on the obtained results, the majority of Seveso establishments consider their cooperation with government bodies “very good” (23 establishments, 53%) or “good” (12 establishments, 27%). From a government-body point of view, it is positive that only 1 establishment considered the cooperation

to be “acceptable” and none “unsatisfactory”. The overall distribution based on their opinion of the level of cooperation with government bodies is shown in Figure 5.

The establishments cooperate, at various levels and with various aims, with the individual government bodies listed under (a)–(j). The level of this cooperation was part of the questionnaire and its appraisal is provided in the following sections.

DISCUSSION AND RECOMMENDATIONS

It is necessary to point out that the statistical survey has a much larger range of questions and results than it is published here. Due to the extent and the representative character of the paper we have chosen only those

which are connected with the creation of the comprehensive model.

Based on the results, it is possible to make several conclusions (the following conclusions are based on those questions, for which there was at least 50% agreement by the establishments)

- selected results are applicable only to the establishments with a questionnaire return rate greater than 50%; for individual return rates,
- assessment methods used by the establishments were mainly ETA, FTA and Safety Audit,
- MS Excel and Aloha are the most widely used software tools by the establishments,
- Seveso establishments consider the cooperation with government bodies to be very good.

Based on the results, it is also possible to note other remarks and

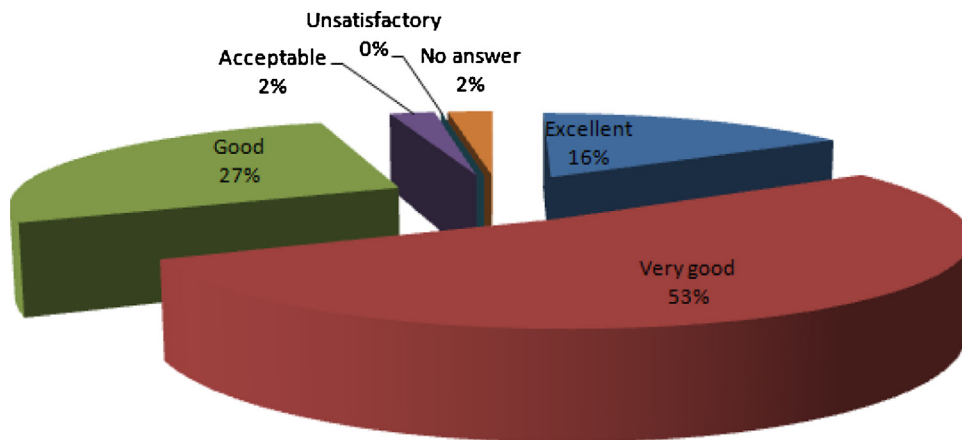


Figure 5. Percentages of Seveso establishments by the level of cooperation with government bodies.

results (based on those questions, which are not part of this paper)

- majority of the establishments employ one professionally qualified or authorized person,
- level of cooperation between the professionally qualified persons, authorized person and company management is considered to be “very good”,
- from the financial point of view, the costs associated with the prevention of major industrial accidents usually lie around the range of 20,000 € per year,
- majority of the Seveso establishments have one hazardous establishment located in their proximity and the cooperation between them is, in general, good.

CONCLUSION

Several facts and important data have been gathered through this survey. These may not only be beneficial in the area of major industrial accident prevention, but, in some cases, they could potentially be incorporated into the upcoming documentation as part of Seveso III guidelines implementation.

Based on the results achieved in the framework of the statistical survey the results were implemented in the Comprehensive Model for the Risk Assessment and Management of the Industrial Processes. The issue was to insert the methods to individual steps of the comprehensive model which were implemented into the model on the basis of the legal requirements and results of the survey. The research did not show any knowledge and utilization of the ARAMIS (Accidental Risk Assessment Methodology for Industries in the framework of SEVESO II directive) methodology in the companies – its individual steps are also part of this methodology what is quite a big challenge for risk assessment in the future. However, based on consultations and expert evaluations of the experts in this area this approach has shown to be more structured and simpler than that one which is utilized for the time being. The utilization of the FTA and ETA methods is directly involved in the law and in this way the alternative of

transposing the bow-tie diagrams into the newly formed software created an appropriate alternative. It will be next project result called iMotýlik which should be used for the same purpose but structured and systematic with generic “trees”. MS Excel as a suitable user-environment result also from the survey results and that is why the given bow-ties were created in this programme.

The analysis of the questionnaire yielded some interesting conclusions which have not been included in this paper, not only due to its extent, but also due to the need to bring the results the attention of as wide a group of readers as possible and maintain its consistency and clarity. These unpublished results will be used as the base for achieving further goals, papers and results of the project.

The results of the survey and this paper may be used by universities in their research and development activities, as well as by government bodies and Seveso establishments.

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