

PROCESS SAFETY TRENDS IN A TRANSITION ECONOMY– A CASE STUDY

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This paper is dedicated to the loving memory of my mother

INTRODUCTION

Till 1989 Romania was a centralized economy. The process industry, especially regarding the manufacturing of chemical products was in full development. Massive investments were performed to assure the technical and safety level of these facilities at the 1980 international standards.

With the change of government in 1989 and the progress towards a market economy the whole concept has changed.

The paper presents a research towards the build-up of a global safety image of the Romanian process industry, on the basis of statistic data.

Starting with this analysis a range of scenarios was developed. The worst case-best case scenarios are presented also in the paper.

ROMANIAN PROCESS INDUSTRY DEVELOPMENT VS. OCCUPATIONAL ACCIDENTS

Our analysis follows two significant periods of time- 1980–1989 and 1997–2005. Between 1980–1989 there was a relatively constant growth of the process industry in Romania.

A very harsh transition period between 1990–1996 materialised in the closing of process units, especially those which had no export potential.

Between 1997–2005 the remaining facilities were upgraded and improved on the basis of foreign investitions.

A) THE 1980–1989 PERIOD

Generally, process industry was an essential objective in the industrial development of Romania between 1965–1989. Taking into account the existing resources (oil, natural gases, salt, etc.) there were developed many process facilities, generally at a big scale. Some of these facilities were built in cooperation with well known Western companies. These units had decent safety facilities for this period. Other units were built on own Romanian experience. For some of these units, safety was pushed on a secondary plan.

The primary goal of these units was to fulfill the production plans. Every other aspect was secondary. A number of accidents occured just because safety was exluded in the interest of obtaining more and more process products.

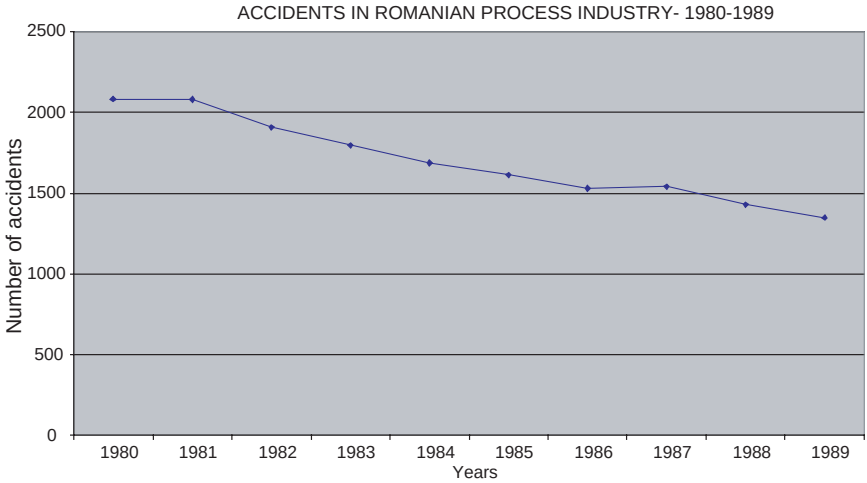

Figure 1. Total number of accidents in Romanian process industry between 1980–1989

The Figure 1 shows the general accident trend in Romanian process industry between 1980 and 1989[1].

There is a slow decrease in the number of accidents towards 1989. This decrease could be explained mainly by the energy resources policy of this period (as these resources were generally imported). A lot of secondary faciltities were closed. Some of the other facilities were used at half of their capacity.

From a number of 2085 total accidents in the process industry in 1980, there was a decrease to 1351 accidents in 1989.

The situation of deceased persons in these accidents is presented in the Figure 2.

With an average of 850 deceased/year, process industry was one of the most dangerous inside Romanian economy.

Generally accidents were so severe for the following reasons:

- there were no efficient risk assessment procedures inside process facilities; generally used risk assessment methods were unknown in Romania;
- there were no efficient emergency action plans; the existing plans were not optimally implemented; there were a number of serious accidents when the deceased persons were simply caught by the spill because they didn't know where to exit in an emergency situation;
- the intervention equipment did not match the specific chemical risks. In many situations the action of the fire fighters worsened the situation because they used the wrong fire fighting substances. There was no efficient resuscitation equipment; the medical personnel was not properly instructed.

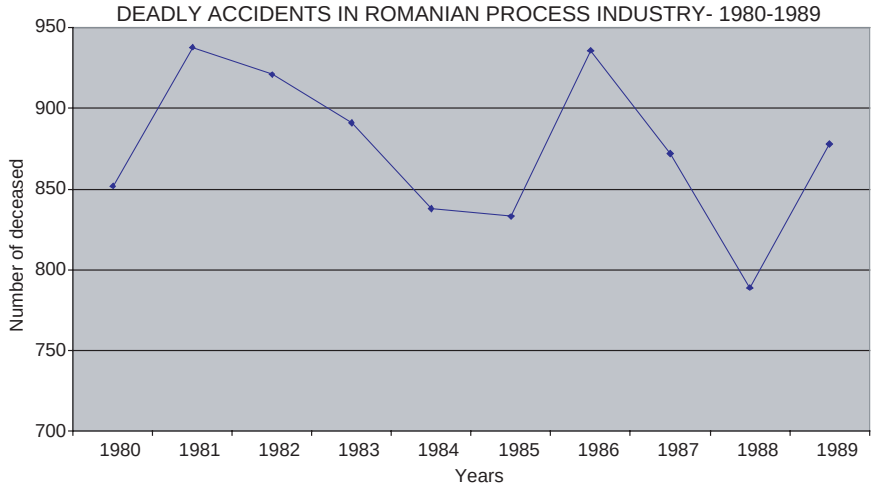

Figure 2. Victims in process accidents between 1980–1989

- Fire fighters and other external intervention teams were not prepared for specific situations as many of the necessary data (for example the substances or products used in the process reactions) was secret.

B) THE 1997–2005 PERIOD

After a period of harsh recession between 1990 and 1996, the period of 1997–2005 was a period of progressive development for the process industry. The process units that were not closed were mostly taken in private ownership. A number of new process units were developed with foreign capital.

Better products were designed and developed, based mostly on foreign know-how. Better and safer technologies were used.

To understand the development of process industry in this period there is interesting to see some specific data.

For example, the growth of the productivity index gives an accurate image of the development of the process facilities in the period.

Figure 3 shows this growth of the productivity index.

The dynamic of the growth of process facilities between 1992 and 2002 in Romania is also an image of the developments registered in the process domain.

Figure 4 shows these aspects.

The majority of these units are Small and Medium Enterprises(SME). Some data in this respect is presented in the Figures 5 and 6.

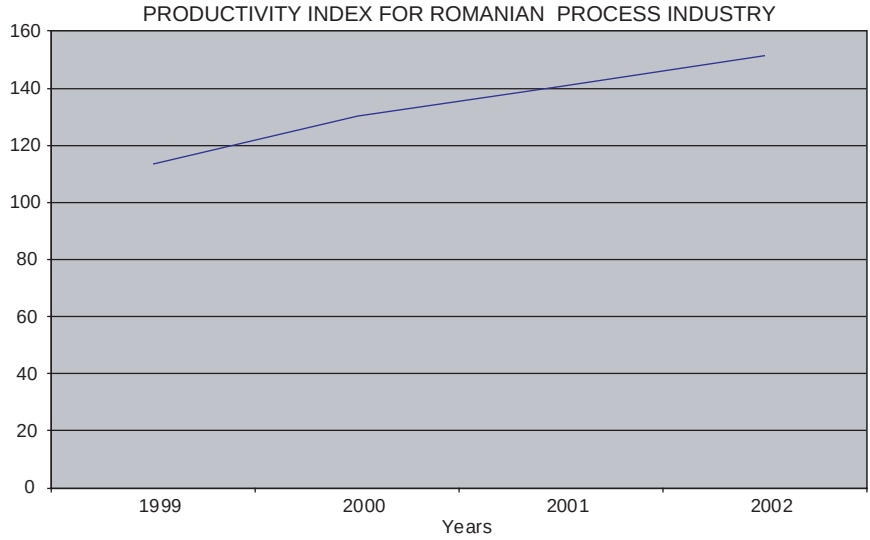

Figure 3. Trend of the productivity index for the Romanian process industry

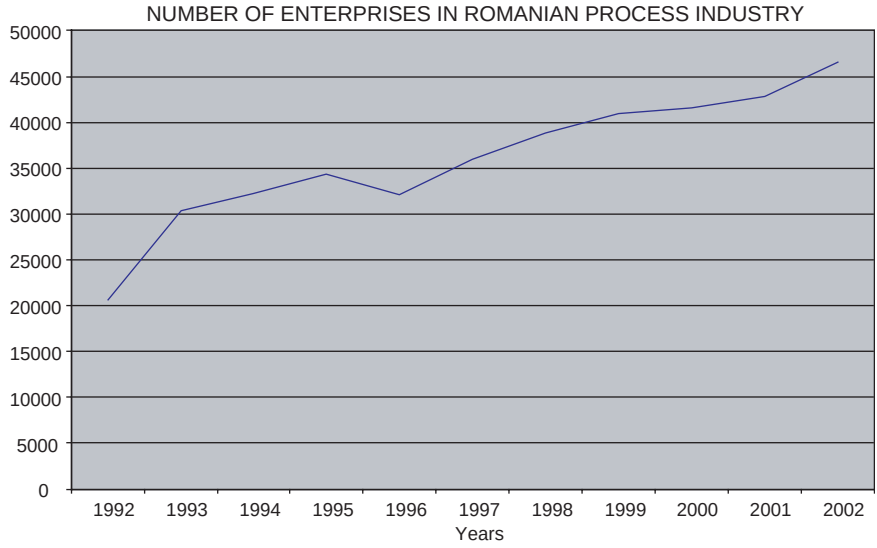

Figure 4. Development of process facilities between 1992–2002

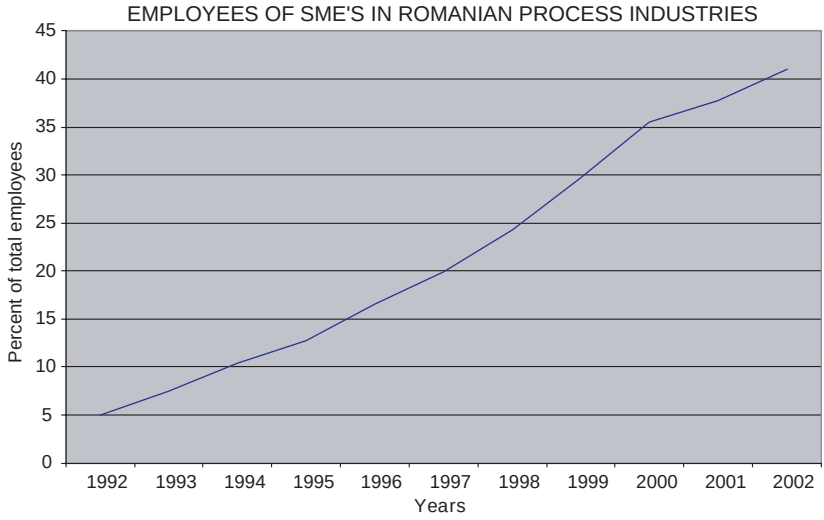

Figure 5. SME employees in process industries (percent of total employees in Romanian industry)

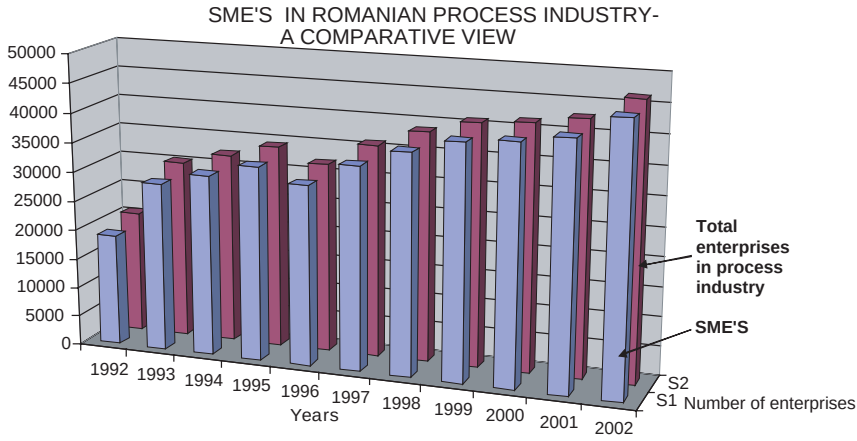

Figure 6. SME in Romanian process industry

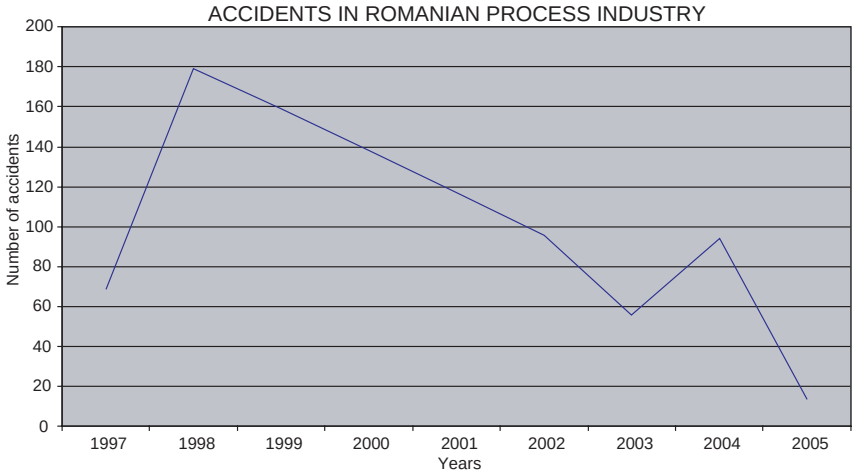

Figure 7. Accidents in Romanian process industry between 1997 and 2005

The situation of the registered accidents in the 1997–2005 period is presented in the Figure 7.

The decrease compared with the 1980–1989 period could be explained by:

- The closure of a significant number of obsolete process facilities (about 35% of the existing 1989 facilities were closed);
- Improved risk assessment procedures and methods (however, a lot more are to be implemented till reaching the EU level);
- Better safety facilities;
- Better safety training;
- Better in-plant safety management;

The problem of training and adequately protecting the intervention teams with equipment remains however unsolved yet. Mostly of the 20 deceased following the fire of a truck and the explosion of chemical fertilizer were untrained fire fighters[2].

We hope that the implementation of Seveso II provisions will lead towards a better safety management in process plants.

The situation of deceased in these accidents is shown in the Figure 8.

Most of these accidents had as primary cause the lack of proper training in the contact with specific chemical substances and products (about 65%). About 20% of these accidents had as main cause the absence of PPE (Personnel Protective Equipment). The other 15% accidents had various main causes, connected however with the obsolete process facilities yet in use.

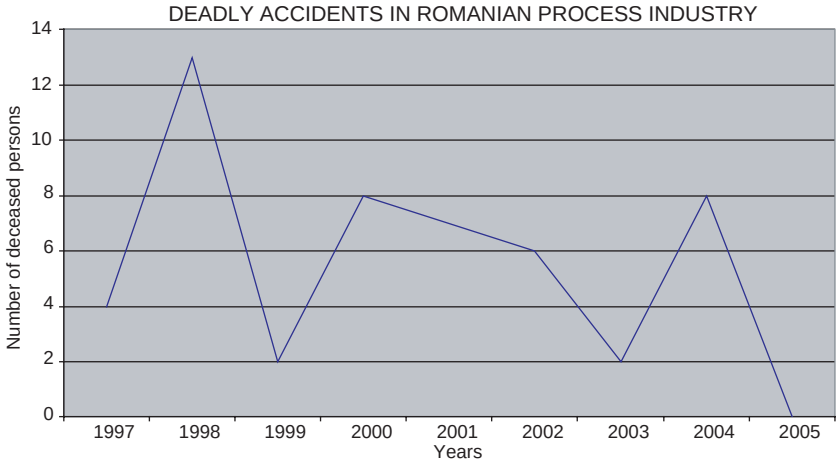

Figure 8. Victims in the Romanian process industry between 1997 and 2005

The situation of collective accidents (more than 1 injured person in accident) in the process industry is presented in Figure 9.

SCENARIO DEVELOPMENT

Scenarios are useful mainly to have a global image about the possible consequences of different developing trends connected with process industry and also as an instrument in order to be able to plan and develop risk prevention measures[3].

On the basis of statistical data and also on the basis of extensive interviews with specialists from the Romanian process industry we have developed a methodology for generating scenarios[4].

We have started with a best case-worst case scenario and have gradually improved it and developed about 50 more.

Our scenario builder mechanism is based on the following schema

Three main elements are considered in this mechanism:

***Workforce*:** includes mainly attitudes, training and physical fit with the job.

***Existing facilities*:** include the technical and safety facilities.

***Safety management*:** includes organizational prevention options. As inner plant safety is decaying in the absence of an external safety input (mostly as cash flow) this input was also considered.

The developed scenarios were designed starting with a number of main features.

The features are further developing the three main elements taking also into account the need for process products (without this need the plants would be closed). Also, safety

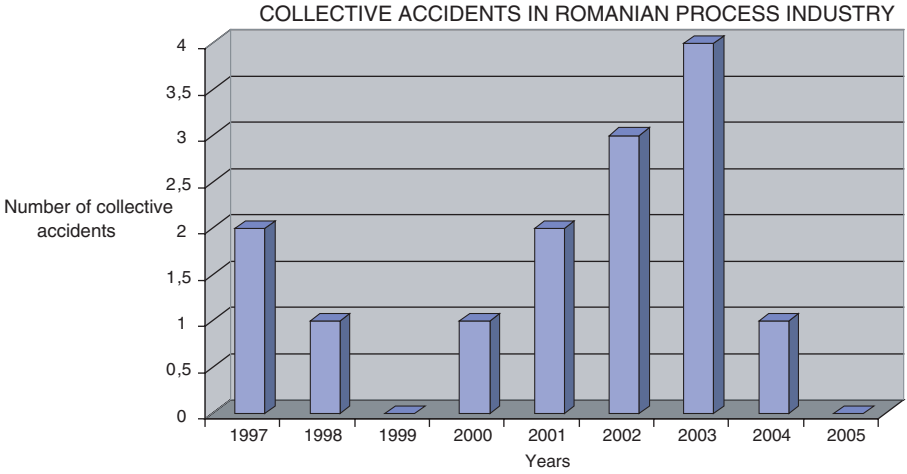

Figure 9. Collective accidents in Romanian process industry between 1997–2005

aspects like inner plant safety, safety management and prevention and containment plans are considered separately.

A distinct feature was considered the public openness. The dissemination towards public opinion of data regarding plant risks, especially major risks will help the better understanding of the nature of these risks and also will contribute to the prevention aspects.

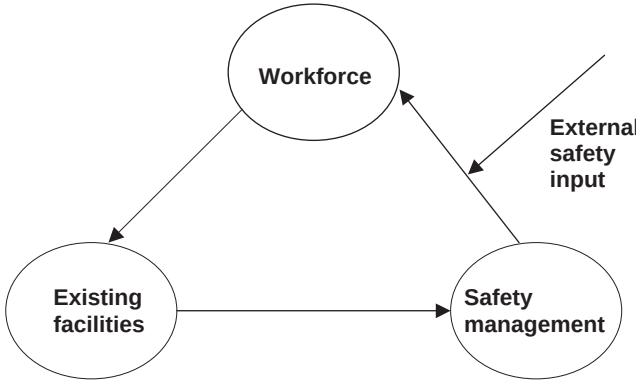

Figure 10. Scenario builder mechanism

These features were grouped in the following groups:

- Need for process products;
- Existing facilities;
- Existing workforce;
- Existing (inner) safety;
- Safety management;
- Emergency and containment plans;
- Public openness;

Figure 11 shows the connexion between these groups.

For every feature were considered values between 0 (worst case) and 5 (best case). Some of these features are explained in the Table 1.

The worst case and best case scenarios are presented in order to exemplify these concepts.

A) WORST CASE SCENARIO

In this scenario, the need for the products of process industry leads towards the abrupt break of the minimum safety rules and principles. The safety investments are nil. The workforce is generally low paid and untrained. Inner safety is quickly decaying in the absence of cash flow. Risk management is just a theoretical issue. Competent Authorities are lied by false reports. Considering the need for the process products extensive inspections inside the facilities (which could disrupt the process) are not performed.

A number of incidents are developing inside process facilities. These incidents, minor in appearance are ignored by plant management and not reported towards Competent Authorities. The incidents are not disseminated towards public knowledge so, a false state of safety prevails. No lessons are derived and no viable emergency and containment plans exists.

Then, a major accident occurs. The emergency personnel (mostly fire fighters) are not trained to act in a specific dangerous environment. They have not the needed protection equipment; they could not contain the existing spill and could not put down the fires. As there are not emergency and containment plans that could function, the spill/fire is spreading quickly towards the surrounding environment. The population in the neighbourhood is not announced about the spill/fire in order not to induce panic. No evacuation actions are taking place, waiting for an order from the upper level. As the most process facilities are built in Romania inside big cities the worst case scenario could lead to minimum 10000 dead and twice this number injured.

The typical values for this scenario are presented below.

Analysing these values is possible to see that many of them are dangerously close to the default values presented.

B) BEST CASE SCENARIO

In the eve of Romania membership to the European Union there is a sustained investment process, especially in the process industry. Efficient risk assessments are taking

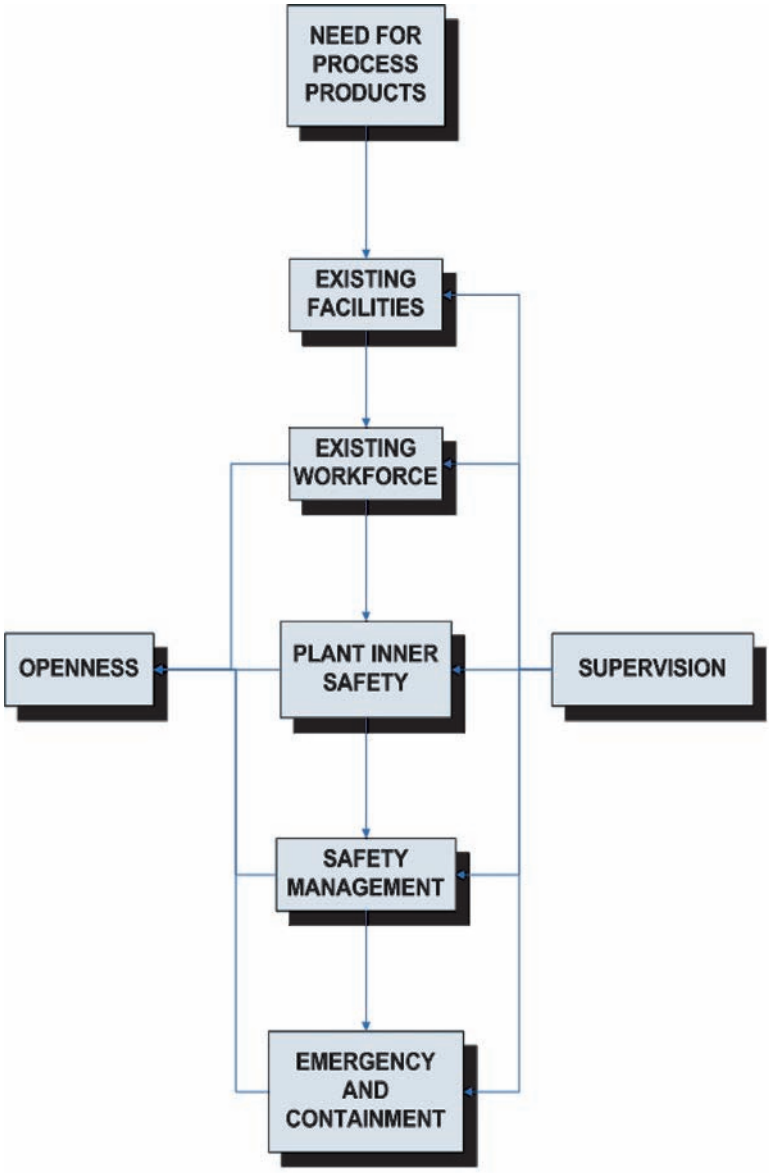

Figure 11. Feature groups

Table 1. Feature explanation

No.	Feature	Default value	Observation
1	Need for the products of process industry	3.5	0-no need internally or externally for such products; 5-maximum need;
2	Existing facilities (quality of these facilities)-mainly:		0-lowest quality; 5-highest quality;
	-process facilities;	3	
	-transport facilities;	4	
	-storage facilities;	2.5	
3	Existing workforce	3.5	0-very low quality of training and experience; 5-highest quality training and experience[5];
4	Plant inner safety(quality of)	2.5	0-no safety 5-excellent safety; the scenarios are following the trends for inner safety, trends like: -quickly decaying; -slowly decaying; -quickly improving; -slowly improving;
5	Safety management Includes: -risk assessment; -risk prevention; -risk prevision;	2.5	0-no safety management; 5-excellent safety management
6	Emergency and containment plans[6] Includes: -plans design; -plans development; -plans implementation; -drills;	2	0-no emergency and containment plans; 5-excellent emergency and containment plans;
7	External supervision. Includes controls and inspections performed by the Competent Authorities	3.5	0-no external control; 5-most efficient control;
8	Public openness – includes the dissemination of data regarding major risks, incidents/accidents, etc.	1.5	0-no openness 5-maximum openness

Table 2. Worst case scenario values

No.	Feature	Worst case scenario value
1	Need for the products of process industry	4
2	Existing facilities (quality of these facilities)-mainly:	
	-process facilities;	2.5
	-transport facilities;	2
	-storage facilities;	2.5
3	Existing workforce	2
4	Plant inner safety	2
5	Safety management	1.5
6	Emergency and containment plans	2
7	External supervision.	3.5
8	Public openness	1.5

Table 3. Best case scenario values

No.	Feature	Best case scenario value
1	Need for the products of process industry	4–5
2	Existing facilities (quality of these facilities)-mainly:	
	-process facilities;	4
	-transport facilities;	4.5
	-storage facilities;	4.5
3	Existing workforce	4
4	Plant inner safety	4
5	Safety management	4.5
6	Emergency and containment plans	4.5
7	External supervision.	4
8	Public openness	4

place for every major process facility; the viable facilities are preserved, the others are closed.

The investment process covers the upgrade of the obsolete inner safety devices. Parallel processes are taking place in order to upgrade the training of the workforce at the European level and also the improvement of safety management at European standards.

Emergency and containment plans are designed, implemented and drilled, not just with the inner personnel of the facilities or with the intervention teams but also with the population in the neighbourhood. Everyone knows what to do in an emergency case; also everyone knows how to act as a team.

Minor incidents that happened are analysed. Immediate prevention measures are taken. Also, these incidents are serving as case studies for the training and managerial processes.

Every major event is contained at the source efficiently. No casualties.

The typical values for this scenario are presented below:

As it is possible to see from the above table all the values of the analysed features must be in the 4 . . . 5 range in order to have such a scenario.

CONCLUSIONS

Our research was directed towards the goal of having a global past-present-future image regarding process safety in Romania.

We have started with finding and analysing significant statistical data regarding Romanian process industry in the 1980–2005 period. As this data is not extremely rich (the same situation as for other former socialist countries) we could just built a partial image of the best and worst regarding the process industry in Romania in the past and in the present.

However, it appears distinctly that, when the only goal of this industry is to produce and produce more, regardless of other aspects like work conditions and existing risks, the worst can happen. Examples from the 1980–1989 period and analysis of recent process industry accidents have shown this aspect.

Process safety must be significantly improved in the following directions:

- Better safety knowledge, mostly regarding major risks
- Implementation and current usage of modern risk assessment methods, especially for major risks;
- Better safety training;
- Better safety equipments, especially for intervention and salvage actions;
- Better safety management;

An important part of our research was dedicated to the development of possible scenarios. We have found that the default (actual) scenario lies at the half way between the worst case and the best case. There are many possibilities of improvement, especially considering the full implementation of Seveso II Directive and its mechanisms into Romanian economy.

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