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Seveso Accident: An Analysis Of Human And Organizational Factors

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Summary

This article is the result of work developed by some undergraduate students in the discipline of Work Psychology. By adopting the case study methodology, this article analyzed the industrial accident in Seveso. The objective was to understand how human and organizational factors were crucial points for such an event. The aim is to highlight the context of the way in which the accident occurred and its technical failures, as a contribution to a better understanding in relation to prevention and the adoption of measures in emergency situations in order to minimize the consequences and prevent future accidents from happening. It is concluded that human error does not occur as a result of a single person's error, but rather is the combination of several problems that accumulate until the accident culminates. In this sense, it is not possible to blame the worker who may have actually made a mistake, needing to go beyond that and look for the organizational failures that can be considered the root causes of the accident.

Keywords: Industrial Accident; Seveso Directive; Seveso Industry; Operational Security.

1. Introduction

The Seveso accident is considered one of the biggest industrial accidents in the history of the entire European territory. It occurred on July 10, 1976 at the Roche factory in Seveso, Italy, following an overheating of the dioxin reactor, which is widely considered to be one of the most toxic chemicals produced by man (MOCARELLI et al.

MAN, 1991), released into the environment through a defective valve. The incident directly killed around 3,000 animals and caused another 70,000 to be euthanized to prevent dioxins from entering the food chain, and could be considered one of the largest expanded chemical accidents. According to Freitas, Porto and Gomez (1995), expanded chemical accidents produce multiple damages in a single event and have the potential to cause effects that go beyond the place and time of their occurrence. These types of accidents can affect long distances, and even other cities or countries, and are also complex from a risk management point of view (FREITAS et al., 2000). Considering the size, the various consequences of accidents are difficult to assess and highly complex, making it a huge challenge to develop prevention and control strategies, since the majority of these accidents have very different characteristics.

The impact on society is also worth highlighting, as the chemical industry is considered an industry with the potential for serious consequences, as when an accident occurs, the resulting impacts are enormous (PERROW, 1984). Dioxin can cause chronic effects that can manifest themselves after years of exposure (AXELSON, 1993; LANDI, et al., 1997). Although no immediate deaths were reported, the release of around three tons of chemicals containing, among them, TCDD, forced the evacuation of around 600 people and more than 2000 received immediate treatment for dioxin toxicity. In the short term, severe health problems arose in exposed people (EC, 2009). In this way, Seveso experienced a dramatic increase in the number of victims of heart and vascular diseases, a doubling of deaths from leukemia, and a tripling of the incidence of brain tumors. Cases of liver and gallbladder cancer have increased tenfold, as have deaths from skin diseases. Two days after the accident, the factory closed and Swiss multinational Roche paid US$240 million in compensation to the victims.

According to Gomez (2000), the investigation of accidents shows the simultaneous presence of environmental problems internal and external to the manufacturing facilities involving similar technical matrices and which, from then on, begin to require preventive policies integrated both in the issue of worker health and in the issue environmental. However, Roche was aware of the risks of producing trichlorophenol, as there were previous cases of industrial accidents. These risks are due to dioxin, a substance produced as waste during the conversion of trichlorophenol.

Despite authorities' efforts, the physical, psychological and environmental effects of a Seveso-scale environmental disaster may never be remedied.

The accident represented, in any case, the beginning of the configuration of an international policy for the prevention and treatment of large-scale accidents, with the definition, by Community Europe, of the “Seveso Directive”, which prioritizes, in several passages, the right public access to information about the risks associated with certain types of industrial activity and the use of certain types of substances (BARBOSA, 2009).

Work-related accidents and illnesses are predictable and preventable injuries. However, despite being avoidable, they continue to occur and have a strong impact on productivity, the economy and society. Therefore, the proposed article aims to investigate the causes of the accident that occurred, in addition to analyzing the risks of accidents among workers in the chemical industries and their consequences. Because, according to Lustosa (2002), the chemical industrial genre is among the biggest causes of damage to the environment, due to the production and manufacturing processes, storage and transportation of polluting products.

This article is justified by showing the application of theoretical concepts discussed in the discipline of Work Psychology, including ergonomics, by undergraduate students in a real case. The relevance of the article is to make the results of this teaching work evident to motivate other students to apply ergonomics concepts to real accidents with a high impact on society.

1.1. Materials and methods

This study is characterized by being a case study, with a qualitative research approach, focusing on data analysis and interpretation procedures. Therefore, for Gil, (2008, p.57) the case study is characterized by the exhaustive study of one or a few objects, in order to allow broad and detailed knowledge. Furthermore, according to Silveira (2009, p.31), qualitative research “is not concerned with numerical representation, but rather with deepening the understanding of a social group, an organization, etc”.

The research was carried out on websites, texts, scientific articles, various materials, and government data available electronically, in order to obtain results that portray the reality available in the study sources. As a reference framework, the theory of organizational accident brought by the authors Llory and Montmayel (2014) was used. For these authors, analyzing and understanding complex events, such as those discussed here, means interpreting them beyond recent technical factors. Indirect, latent, or not immediately visible causes should be considered a product of the security organization.

2. Development

2.1 The accident

The Seveso accident happened due to organizational issues at the company ICMESA. As the Parliamentary Commission of Inquiry into the disaster demonstrated, the accident was directly related to the lack of investment in the safety of the factory facilities (CENTEMERI, 2010).

Before analyzing the reasons for the disaster in Seveso, it is essential to observe the entire chronology up to the moment of the accident.

• In 1963: Roche becomes owner of the fragrance and flavors company Givaudan SA, Geneva. According to Centemeri (2012, p.3) “the small chemical factory responsible for the disaster had been installed in the city of Meda since 1945, but belonged, through the company Givaudan, to the pharmaceutical multinational Hofmann-LaRoche (hereinafter Roche), with headquarters in Switzerland”;

• In 1969: Givaudan acquires the remainder of the capital of ICMESA, which manufactures intermediaries for subsequent processing in the Group (fragrances, flavorings, cosmetics and pharmaceuticals);

• 1969-1970 ICMESA begins production of trichlorophenol (TCP). Givaudan needs high-quality TCP to produce hexachlorophene, a disinfectant used in medical soaps;

• 1970 to July 1976 Increased TCP production, all delivered to Givaudan;

• 1976 Friday, July 9th 2:30 pm Seveso/ICMESA. Dr. Paolo Paoletti, production director at ICMESA, discusses the production program with the various managers, including the person responsible for Building B. As usual in Building B, trichlorophenol

(TCP) was to be produced. Trichlorophenol is an intermediate used in the production of the disinfectant hexachlorophene. 16:00 The TCP reaction vessel is filled with the various starting materials.

• 1976 Saturday, July 10th 02:30 am ICMESA According to the temperature diagram, the reaction is complete. 04:45 the responsible foreman gives the order to stop a distillation that is not completed. The heating is turned off and the contents of the container mixed for another 15 minutes. The last temperature measured is 158°C. 06:00 hours the night shift ended. Workers leave the factory, and only the cleaning and maintenance staff are left behind. 12:37 the rupture disc in the safety valve bursts as a result of excessive pressure, caused by an exothermic reaction in the TCP vessel. A chemical mixture in the form of an aerosol cloud escapes into the air in a southeasterly direction. It was later discovered that the mixture falls mainly in the communes of Seveso, Meda, Cesano Maderno and Desio.

It should be noted that there was a lack of communication between the company and the authorities, as it took a long time for the population to be informed of what had happened. When the accident began, the threat did not appear clearly, neither to the authorities nor to the population, especially because by then the workers had become accustomed to the gases and bad smells that escaped from the factory from time to time CENTEMERI (2012, p3). At first, Givaudan engineers did their best to hide the seriousness of the accident to avoid intervention by the authorities.

This timeline, especially on the two days that caused the accident, shows how there were people who were directly involved in some decisions that were one of the primary causes of the event. What would it have been like if these people had acted differently? It is possible that the accident did not happen. In fact, the presence of "human errors" in this accident can be identified. In other words, human factors in production were also the cause of the accident. However, it would be a mistake to focus only on these "human errors" and point to workers in the specific area where the accident occurred as those mainly responsible.

It needs to be pointed out that the accident resulted directly from serious negligence on the part of ICMESA (understood as an organization) in terms of safety. It can also be said that these neglects were caused by pressure from Roche to reduce production costs (CENTEMERI, 2012). At the time, Roche was not only aware of

ICMESA's precarious safety conditions, but the company also knew that the production of trichlorophenol generated a particularly toxic category of dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Some security conditions at the organizational level were discussed below.

2.2. Safety conditions

According to Daniellou et a. (2010) “Human error is often invoked to explain accidents, but the error is not the basic cause, it is a consequence of other defects in the organization”. In this context, the lack of safety and low investment on the part of ICMESA was fundamental to the large-scale accident. According to the HSE (Health and Safety Executive) website, there were several technical failures such as:

- Operational procedures. The production cycle was interrupted, without any agitation or cooling, prolonging the reaction mass. Furthermore, the conduct of the final batch involved a series of failures to adhere to operational procedures. The original patent method of distillation specified that the charge be acidified before distillation. However, in the plant procedures, the order of these steps was reversed;
- Relief systems / ventilation systems: failures in ventilation of excessive pressures and in the sizing of openings for exothermic reactions. The burst disk was set at 3.5 bar to guard against excessive pressure in the compressed air used to transfer the materials to the reactor. If a burst disc with a lower set pressure had been installed, venting would have occurred at a lower, less dangerous temperature;
- Control Systems: sensor/trip/interlock alarm failures: loss of cooling, agitator failure. The reactor control systems were inadequate, both in terms of measuring equipment for a number of fundamental parameters and the absence of any automatic control system;
- Reaction/product test: calorimetry methods, thermal stability. The company was aware of the dangerous characteristics of the main exotherm. However, studies showed that weaker exotherms existed that could lead to a runaway reaction;
- Design Codes - Plant: in the nature of the hazardous releases there was no device to collect or destroy the toxic materials as they vented;

• Secondary Containment and catchpots: The burst disc manufacturer recommended the use of a second receiver to recover toxic materials, but this was not assembled;

• Emergency response / Spill control: there were failures in the safety management system and the site emergency plan. Information about the released chemicals and their associated hazards was not available from the company. Communication was poor and failed both between the company and local authorities and within regulatory authorities.

Excessive cost cuts can result in the purchase of equipment that is inappropriate for the organization's activities and a lack of maintenance of equipment and work environments (SHAPPELL; WIEGMANN, 2000). If there is no communication between management and staff, or if it is not known who is in charge, the organization's safety is at risk and accidents will occur (MUCHINSKY, 1997 apud SHAPPELL; WIEGMANN, 2000). The great challenge is to provide conditions to eliminate conditions that increase errors, increasing the chances of detection and recovery from human errors that will inevitably occur (REASON, 2002).

It is important to point out that failures in safety conditions should lead to improvements in technical control systems to prevent accidents. As a result of this accident, a directive was instituted that will be discussed below. If this directive had been implemented earlier, the accident would most likely not have happened.

2.3. Seveso Directive

The Seveso accident contributed dramatically to the growth of public concern about the industrial risks associated with the production of chemical substances. This event is considered an important milestone for the regulation on prevention and control of these accidents within the scope of the European Community (EC) (EC 2007). This experience showed that there was major damage, both to public health and the environment, accelerating the need for a regulatory response to the safety of chemical installations. According to Benite (2004), an occupational health and safety management system is a set of initiatives, embodied through policies, programs, procedures and processes. These must integrate the organization's activity with the aim of facilitating compliance with legal requirements and, at the same time, connote coherence to the organization's own philosophical and cultural conception, in order to conduct its activities with ethics and social responsibility. According to Puiatti (2000), the first international experience for the prevention of expanded accidents took place in June 1982, with the publication in the European Community (now European Union) of Directive 82/501/ECC, better known as the “Seveso Directive ”, which was changed by two amendments (1987/1988). Conceived as a conceptual tool, the project aimed to be a guiding element for industries, competent authorities and local authorities. The objective was to prevent each of these actors from approaching the risk management process unilaterally, harmonizing risk assessment methodologies, considering the consequences of scenarios and the efficiency of enterprise security management and also estimating environmental vulnerability. (SALVI 2006, KONTIÉ, 2006). Crowl and Louvar (2001) indicate that risk assessment methods (Risk Assessment) must include not only the Identification of Incidents (Incident Identification), but also the Analysis of their Consequences (Consequence Analysis). While the first describes “how” events can happen, the second must identify the expected damage expected as a result, including possible injuries and loss of life, damage to the environment, material damage and damage resulting from the interruption of activity. From this concept, mathematical techniques began to be used that allow the comparison between measurable results and acceptability standards for them, as currently addressed in risk management processes (DANESHKHAN, 2004). According to Amendola (1998), the first Seveso Directive was strongly concerned with the generation of adequate and sufficient information about installations from which risks of major accidents could arise, due to toxic emissions, fires or explosions, and with their respective consequences. means of control. This information should flow through all sectors that could perform some type of management over these risks, including the entrepreneur himself, the established public control bodies and the community that could be affected by such events. According to De Marchi (1988), the new Directive gave more emphasis to socio-organizational issues and prevention policies than to issues of a technical nature, considering that the analyzes of serious events recorded since the implementation of Directive 82/501 /EC referred, for the most part, to deficiencies in the organizations' management system. The Seveso II Directive gives more rights to access to information, as it establishes that companies and authorities have obligations to provide the population with the necessary information. Instead of a reactive process, we adopt a proactive attitude with practical information for society on how to proceed in the event of an accident (ROCHA JR., et.al. 2006, p.04). In this sense, the most innovative part of the directive is that contained in its article 8, in terms of information to the public, establishing an obligation that will weaken industrial secrecy within the scope of the activities covered. At the same time, the directive designs a kind of information network between public authorities and industry and between industry and parties potentially at risk (OTWAY, 1990; OTWAY AND AMENDOLA, 1989). The Seveso Directive has undergone some changes over time, with several revisions having been made in which the last one was published in Directive 2012/18/EU of the European Parliament and of the Council, also called the Seveso III Directive, on the prevention of serious accidents involving dangerous substances that amends and subsequently repeals Directive 96/82/EC of the Council of the European Union (DIRECTIVE 2012/18/EU).

2.4. Human factors and ergonomics

As pointed out so far, the accident had different causes, and the improvement of technical control systems (later promoted by the Seveso Directive) would most likely have eliminated the occurrence of this catastrophic event. However, it is possible to point out that companies could ensure better levels of security by introducing these technical systems together with greater consideration of human and organizational factors (DANIELLOU et al., 2010). Putting in place rules and procedures is not enough if "human costs" are created resulting from some organizational decisions. In the case of the Seveso accident, we pointed out that there was a failure in the technical control systems. Even so, it is possible to point out that the accident might not have happened if the company had understood the consequences of its own organizational decisions. For example, pressure from the company Roche to reduce production costs may have impacted the lack of introduction of technical control systems to prevent the accident. But this pressure probably also impacted the decisions made and the activities of its workers. At the operational level, workers can act by taking additional risks in order to cope with hierarchical impositions in relation to the need to reduce production costs. This connects to the distinction between task and activity present in the ergonomics literature (ABRAHÃO et al., 2009; FALZON, 2007). For reasons of care, or for some reason related to the presence of human costs (as in this case), the worker may act differently from what is prescribed by the organization. Work is a coordinated activity developed by workers to face what in a task cannot be obtained by strict execution of the prescribed organization (DEJOURS, 2005). Therefore, the organization needs to get closer to workers to better understand their work and transform it, with organizational benefits in relation to performance and health and safety (GUÉRIN et al., 2001).

In this context, the authors Kanki et al. (2010) argue that human error is not the cause of problems in an otherwise safe system. In fact, it is a symptom. It is the byproduct of individuals working as a team trying to succeed in an imperfect, constrained, resource-limited system. According to Areosa (2020), “accidents only occur because there are risks that precede them and that at some point materialize or materialize (occupational risks are essentially the product of the internal functioning of organizations)”. Thus, the proposal is to go beyond the judgment that human error was the essential cause of the accident, looking for human and organizational factors that were, in fact, the fundamental causes of what happened (DANIELLOU et al., 2010).

3. Conclusions

When analyzing major industrial accidents, there must be a tendency to overcome what they call the “blame game” (MARTINS et al., 2012), seeking to understand the true origin of these tragedies of alarming proportions. Such events cannot be attributed solely to human errors, but rather to the inherent failure of poorly planned management. Therefore, there are no ways of understanding work relationships and organizational factors in the generation of accidents if traditional approaches are still motivated by a reductionist view of the simple causes of accidents. It is necessary to move away from the vision of the causes associated with inappropriate behavior by workers due to non-compliance with safety standards (VILELA et al., 2012). Therefore, the organization of work needs to take into account the entire human cost of its decisions so that there is a regular functioning of work in all instances.

In addition to the organizational scope, such large-scale destruction events are a direct result of mistaken planning choices, which allow the location of dangerous technological activities in inappropriate locations, where the ability to control unexpected catastrophic events is deficient or even non-existent (SMITH and PETLEY, 2009). In this way, the urgency of involving all relevant actors in decisions is highlighted, so that choices can be made that consider the different needs and perspectives involved (FALZON, 2013).

In short, through integrated approaches, such as the introduction of ergonomic work analyses, systematic audits, ongoing training and training of employees, open engagement with the local community and a careful assessment of the location of industrial activities, the aim is to effectively minimize of risks and promoting transparency in the management of these issues. On the one hand, it is important to improve the technical control system, but on the other hand, it is also important to involve the main actors in the situations to be improved (in particular, the workers).

The implementation of periodic ergonomic work analyzes (GUÉRIN et al., 2001) will allow an in-depth analysis of operational processes, identifying vulnerable points and enabling corrective actions to be taken proactively. By understanding the real activities of workers, it is possible to transform work and the causes of possible accidents. Furthermore, the presence of audits and adequate education and training of employees constitute fundamental foundations for strengthening the safety culture, enabling them to act in a conscious and responsible manner in the face of risk situations.

Active engagement with the local community plays a crucial role in identifying and mitigating potential hazards, as well as promoting a relationship of mutual trust between industry and society. This collaborative approach will allow the sharing of relevant information and the consideration of interested parties' perspectives in the decision-making process.

Another essential element is carrying out a careful assessment of the location of industrial activities. It is imperative to thoroughly consider aspects such as proximity to inhabited areas, the sensitivity of surrounding ecosystems and the ability to control unexpected events. This detailed analysis will help reduce the risk of accidents occurring in inappropriate locations.

Furthermore, offering tax incentives to companies committed to safe and sustainable practices will act as an additional stimulus for the adoption of preventive measures and continuous improvement of security strategies. Sharing good practices among companies in the sector will allow the dissemination of valuable knowledge and the construction of a collaborative network that works together to raise industrial safety standards.

By adopting a broader and more collaborative approach, we will be better prepared to prevent future accidents, honoring the value of safety, human well-being and environmental protection in all industrial spheres. Only in this way can we build a safer and more resilient future for everyone involved.

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