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MINIMISING CATASTROPHIC RISK IN THE CHEMICAL INDUSTRY: ROLE OF MINDFULNESS

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Abstract

The chemical industry is a high-risk working environment with the potential to cause catastrophic accidents. The use of hazardous chemicals and complex equipment requires a constant state of alertness from workers to prevent accidents that have low probability of occuring but have can cause great harm to people, the environment, and the company's reputation. Mindfulness practices have been shown to reduce the risk of accidents by helping workers develop a heightened sense of awareness, focus, and attention to detail. A mindfulness culture in the workplace can reduce the risk of accidents by helping workers to be more present and focused on their tasks. This means they are more likely to recognise potential hazards before they become accidents. Additionally, mindfulness can help workers develop better stress management skills, which can help them remain calm and focused when unexpected situations arise. This can be especially beneficial in high-pressure situations when the risk of accidents is higher.

Keywords: Business, Risk, Chemical Industry, Mindfulness

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1. Introduction

The chemical industry came into being three centuries ago with a view to cater to the demands of other industries (Aftalion, 1991). Now, the chemical industry is central to the modern world economy. It converts raw materials like natural gas, oil, minerals and metals into more than seventy thousand different products. It has a turnover of around five trillion dollars globally (American Chemistry Council, 2013). For a long time the chemical industry was commonly assumed to be a forerunner of prosperity. Then, Rachel Carson (2002) in her

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well recognized book "Silent Spring" wrote about how it was scattering poison as also disinformation. Carson also incriminated public officials of collaboration with the chemical industry, setting in process what would eventually get transformed into the environmental crusade (Lytle, 2007). At that time the dispute was restricted to non- disclosure of the harmful effects of substances and no catastrophic occurrence was forecast (Setterberg and Shavelson, 1993). In December 1984 the world's worst industrial accident took place in aUnion Carbide3 pesticide plant which killed at least 3,800 people and injured tens of thousands by a poisonous gas in Bhopal, India. Since then the fear of "dark chemical cloud" hangs over the public mind (Kellow, 1999).

The impact of this accident went well beyond the end of Union Carbide. It led to changes in views and practices about toxicology in the entire U.S. chemical industry. It provided a push towards enactment of federal laws which required the companies to alert the government and the public about manufacture or use of poisonous materials. The United States Environmental Protection Agency developed a grid of local "emergency planning councils" in which corporate experts work with their local communities to prevent such catastrophes.

2. Inherently unsafe

An explosion at a chemical plant in Flixborough, England in 1974 gave a push to research in inherently safer design which had begun in the mid seventies. However, it slowly went to the back burner as most inherently safer designs were difficult to backfit on an existing plant. At the beginning of the twentieth century synthetic chemicals started becoming components of various consumer products. With the growth of the chemical industry, the use of toxic materials also grew in large quantities. Methyl Isocynate, the poisonous material which killed thousands in Bhopal, is an intermediate which was convenient to store in large tanks. At that time the attitude of the chemical industry was that there was no need to worry about storage of large stocks of a poisonous substances as long it was stored carefully. The Bhopal accident destroyed this complacency. It became crucial that safety measures should not just be supplements but should form an integral part of the original project. The Bhopal accident gave a huge impetus to this research. Ways to significantly reduce or eliminate hazards became the focus rather than development of add-on protective systems and operating procedures (Hendershot, 2006, 2012). The principal methods of accomplishing inherently safer design relate to minimisation of the batch size, substitution of hazardous materials,

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moderation (using dangerous materials in diluted form) and simplification (eliminating problems instead of adding designs for extra constituents (Khan and Amyotte, 2003.

Evaluation of an inherently safer design is difficult as it does not always reveal which of the alternatives appraised are the most appropriate. It may be the case that an option which is intrinsically safer with respect to one or more hazards may lead to the introduction of new dangers or even enhance the scale of some other deathtraps. For example, flammability may increase with the use of a less lethal solvent. As of now industries using toxic materials lack common understanding and tools for inherently safer process choices as scientists of different streams talk at cross purposes. Decision theory tools may be able to suggest some assistance in this matter.

The Bhopal accident led to the rapid development of an application of the inherent safety principle which seeks to minimize the number of deaths to a number "As Low As Reasonably Practicable" in the event of a poisonous release (Shariff and Zaini, 2010). The first stage is to generate a credible incident which may be a sudden release of poisonous gas which diffuses into the atmosphere. Concentration will depend on the total mass of the toxic gas released, height above the ground at which the toxic gas is released, dispersion and distances coefficients in the downwind, upward and crosswind directions. The stability class of the pisonous material will in turn decide the dispersion coefficients (Center for Chemical Process Safety, 2000). The data relating to the source and dispersion model goes into the toxic release model to estimate loss of life due to contact with the gas concentration by criteria set by toxicologists. A probit model can indicate probability of death and percentage of deaths can be estimated by using error function (Crowl and Louvar, 2011). The objective of inherently safe design will be to bring down the probit to "As Low As Reasonably Practicable" level. However, even after decades of research, there is no consensus on the details of the toxic release (Havens et al., 2012).

The placement of various units inside a plant handling dangerous material has typically been determined using heuristic methods. Heuristic methods do not always result in a secure layout (Center for Chemical Process Safety, 2003; Penteado and Ciric, 1996). The "Layer of Protection Analysis" methodology, which integrates techniques to describe repercussions and predict frequencies, has recently been used by researchers (Center for Chemical Process Safety, 2001). In a situation involving a harmful release, optimal arrangements can minimise fatalities (Jung et al., 2010). By employing probability distributions of risk rather than

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expected values, the traditional "Layer of Protection Analysis" methodology can be expanded (Ramírez-Marengo, 2013). Since most of the research is sponsored by the chemical industry itself, peop;e have no faith in it. The problem is exacerbated by lack of transparency in the chemical industry. In one case of storage of Methyl Isocynate, Bayer CropScience admitted: “There were, of course, some business reasons that also motivated our desire for confidentiality. These included a desire to limit negative publicity about the company and to avoid public pressure to reduce the volume of Methyl Isocynate that is produced and stored by changing to alternative technologies”. In a poll in 1990 to measure public approval of the chemical industry, it was found that in comparison to other industries, the chemical industry was rated ahead of only the tobacco industry by the general public.

3. Making sense

The events of the Bhopal accident which do not make sense are still being analyzed and assessed by scholars. It is human nature to accept the unexplained but not the inexplicable (Goffman, 1974). The Bhopal accident brought a seminal research article by Karl Weick (1988) on Sensemaking in crisis situations. Human errors cannot be designed away even in the case of inherently safe designs because these errors are caused by human variability (Ayers and Rohatgi, 1987). Not much understanding is available regarding such triggered events that can lead to an industrial crisis (Srivastava, 1987). Sensemaking, in this context, could be viewed as a course of social construction that happens when an ongoing activity is interrupted by discordant cues and involves the retrospective development of rationalizing what people are doing (Weick et al., 2005).

A poisonous gas release is a low probability but high consequences event. It tends to challenge explanations and therefore foist severe strains on sensemaking. The structures that have been developed before the chaos arrives determine our ability to deal with the chaos (Lagadec, 1993). The operating manual of the Bhopal plant stated in respect of the leakage in storage tank of Methyl Isocynate that cannot be stopped or isolated “The situation will determine appropriate action. We will learn more and more as we gain actual experience”. This method was tolerated when the consequences of the cosequences were small but not when these were the magnitude of the Bhopal accident (Kletz, 1993).

Union Carbide was a corporation had a management with a keen sense of public responsibility and had kept a sophisticated “environmental monitoring system” backed by top management (Browning, 2003). Whereas management scientists analyse the structures and

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functioning of organisations, theoretical literature in Sociology points out that the organization may not provide the meaningful level of analysis (Wiley, 1988). It can alternatively be argued that in the instant case, "organisation" was not the corporation but the maintenance crew of the Bhopal plant. Their perception that their unit did not matter was as dangerous as the decreased maintenance of the unit in raising the susceptibility to a crisis. A production facility which is deteriorating masks sensemaking tools which in turn gloss over accumulating problems. According to Karl Weick (2010), the lesson which the Bhopal accident teaches the chemical industry is that each decision taken in the course of action in this chain can tragically raise the low probability of an event of high consequence.

Looking from an engineering viewpoint, reliability which is defined and affected by stochastic parameters, is described as the ability of a system to function under stated conditions. However, there is a growing realization in the engineering profession that because of the range of uncertainty involved, it may not be possible to achieve reliability and safety through the use of mathematical models as the uncertainty involved largely invalidate the quantitative methods used (O'Conner and Kleyner, 2012). Also, it should be borne in mind that when the unexpected events happen, "encapsulated learning" set into routines could fail. To address this mindlessness, reliability may be achieved through the process of cognition which is presently being largely overlooked by most organisational learning and adaption theorists.

4. Mindfulness

In early Eastern contemplative traditions, a unified mental experience is made up of numerous factors of which one important factor is mindfulness. Mindfulness enhances attentional stability and clarity. It is inherently a state of consciousness which involves consciously attending to one's moment-to-moment experience (Asthana, 2004,2021; Brown & Ryan, 2003). Mindfulness describes a present-oriented state of conscious awareness, in which the individual is aware of multiple perspectives. The concept of mindfulness was brought to the West by venerable Buddhist scholar Thích Nhât Hạnh in the 1960's. The person credited most in popularising mindfulness in the west is Jon Kabat-Zinn who had been a student of Nobel laureate microbiologist Salvador Edward Luria as also of Thích Nhât Hạnh. He introduced mindfulness as a flexible vehicle for the seamless integration of eastern meditative practices and perspectives within a western paradigm of behavioural intervention. As pointed out by Grossman & Van Dam (2011), "mindfulness within Western psychology is

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generally assumed to reflect the Buddhist construct. However, definitions of the term vary greatly from that of a simple therapeutic or experiential technique to a multi-faceted activity, which requires practice and refinement" (p. 220).

Mindfulness can play a significant role in reducing the risk of catastrophic accidents in the chemical industry. There are several ways in which mindfulness practices can avoid catastrophic accidents:

1. Increased awareness and attention: Mindfulness practices cultivate heightened awareness and attention to the present moment. This helps chemical industry workers to be fully present and focused on their tasks, reducing the likelihood of making errors or overlooking critical details that could lead to accidents.
2. Improved decision-making: Mindfulness enhances cognitive flexibility and clarity. By practicing mindfulness, workers develop the ability to respond rather than react impulsively to situations. This allows for more thoughtful and informed decision-making, reducing the risk of hasty actions that could result in accidents.
3. Stress reduction: High-stress levels can impair judgment and concentration, increasing the likelihood of errors and accidents. Mindfulness practices help individuals manage stress more effectively by promoting relaxation and emotional regulation. By reducing stress levels, workers are better able to maintain composure and make sound decisions, even in high-pressure situations (Asthana, 2004, 2021).
4. Enhanced situational awareness: Mindfulness encourages individuals to be fully attuned to their surroundings, both internally and externally. This heightened sense of situational awareness enables chemical industry workers to detect potential hazards, identify deviations from normal conditions, and respond promptly to prevent accidents or mitigate their impact.
5. Improved communication and teamwork: Mindfulness fosters empathy, active listening, and effective communication skills. These qualities contribute to better teamwork and collaboration within the chemical industry, as workers are more likely to share concerns, observations, and safety-related information. Improved communication can help identify potential risks, implement preventive measures, and coordinate responses to minimize accidents.

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6. Attention to standard operating procedures (SOPs): Mindfulness encourages individuals to approach tasks with a sense of precision and detail-oriented focus. By being mindful of standard operating procedures, workers are more likely to follow established safety protocols, reducing the likelihood of accidents resulting from deviations or oversights.
7. Early detection of abnormal conditions: Mindfulness practices promote self-reflection and self-monitoring, allowing individuals to recognize signs of fatigue, distraction, or impairment in themselves and others. Identifying these conditions early on enables proactive measures, such as taking breaks, seeking support, or reporting concerns, before they escalate into safety hazards.

"When the allocation of attention is done with discipline and mindfulness, a wealth of issues do not create poverty of attention, but can instead be plentiful and enable decision makers to intelligently coordinate and attend to more issues" (Rerup, 2009, p.888). Organisations can enhance their action options for spotting emerging issues and exceptional events, as well as their available repertoire of categories for categorising environmental challenges, through discipline and mindfulness (Ocasio 1997). When "employees interrelate and voice their concerns with mindfulness, data for detecting threats and learning from them is produced because the facilitation process helps such raw data to travel unfiltered to the top of the hierarchy" (Rerup, 2009, p.889).

5. Creating High Reliability Organisations

High Reliability Organisations (HROs) use a variety of cognitive techniques to counteract system overstructuring temptations, operational sensitivity, tendency to oversimplify, and failure proxies. When combined, these processes bring about a condition of collective consciousness that develops a deep awareness of discriminatory detail and makes it easier to find and fix mistakes that could potentially lead to catastrophes. Since they are a dormant framework for process improvement in all organisations, these procedures are not special. Planning does not naturally foster stagnation, routines work well because of change, and awareness may result in learning (Weick et al., 1999).

The mindfulness that keeps HROs functioning efficiently when confronted with unforeseen circumstances has been linked to five properties of HROs. HROs "are preoccupied with their failure,large and mostly small. They treat every lapse of system" (Weick and Sutcliffe, 2001, p. 10). These organisations "manage for the unexpected by being recluctant to accept

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simplifications and create more complete and nuanced pictures" (Weick and Sutcliffe, 2001, p. 11). HROs are always sensitive to conditions that alter unexpectedly. They keep an eye on the safety and security safeguards and controls of the systems to make sure they are still in place and working properly. For HROs, situational awareness is crucial. HROs learn how to recognise, stop, and recover from errors. Although mistakes will occur, HROs are not seriously affected by them. Finally, in stressful situations, HROs defer to the expert who has the knowledge to fix the issue. Decisions are taken on the front lines during a crisis, and authority shifts to the individual who can fix the issue, regardless of their position in the hierarchy.

Proponents of mindfulness argue that when organisational members concentrate with vividness on a group of concerns, the capacity to proactively distinguish daily warning indicators and transform them into issues that can drive preventive action develops (Weick and Sutcliffe 2006, 2007; Vogus and Sutcliffe 2007). Focusing on multiple topics at once and taking into account more nuanced and occasionally conflicting interpretations of the facts results in vivid attention. It activates an extensive yet comparatively broad awareness of what occurs in a given setting. According to Weick (2007), attentional vividness corresponds to the depth and specificity of organisational scanning and interpretation. "If the periphery gets less attention than the center, then it is not at all clear thatthe center holds. To loose the periphery is to lose the context for the center, which means the center vanishes" (Weick 1995, p. 104). Mindfulness can generate all round vigilence toavoid catastrophic accidents in the chemical industry.

6. Conclusion

All over the world people are now more aware of dangers of toxic chemicals. Factories or establishments using or storing toxic materials in their neighbourhood is a totally unacceptable idea to most people. The "not in my backyard" attitude is referred to as NIMBY in the trade. There is a strong case for impeding nimbyism. However, attempts of the chemical industry in this direction are frustrated by misinformation. It is becoming clearer that engineering solutions, e3ven if honestly implemented can only scratch the sutface of the problem.

The chemical industry is a high-risk working environment with the potential to cause catastrophic accidents. The use of hazardous chemicals and complex equipment requires a constant state of alertness from workers to prevent accidents that have low probability of occuring but have can cause great harm to people, the environment, and the company's reputation. Mindfulness practices have been shown to reduce the risk of accidents by helping workers develop a heightened sense of awareness, focus, and attention to detail.

A mindfulness culture in the workplace can reduce the risk of accidents by helping workers to be more present and focused on their tasks. This means they are more likely to recognize potential hazards before they become accidents. Additionally, mindfulness can help workers develop better stress management skills, which can help them remain calm and focused when unexpected situations arise. This can be especially beneficial in high-pressure situations when the risk of accidents is higher.

Implementing mindfulness practices in the workplace requires commitment and investment in training and resources. However, the potential benefits to workplace safety and employee well-being make it a worthwhile endeavor. Companies that adopt mindfulness practices can expect to see improvements in safety, productivity, and overall employee well-being and minimise the risk of catastrophic accidents.

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