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Challenges with risk management in safety

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Abstract

Much emphasis has been placed on the adaptation of risk management tools/principles for the safety profession. This article reviews some of the challenges that the safety industry faces in the adoption of risk management tools. Additionally, this article focuses on a few of the most common tools that have been implemented, and highlights some of the deficiencies, as well as offers suggestions for improvement.

1. Introduction

A brief history of risk management and safety

Over 5,000 years ago, one of the earliest documented risk management groups, the Asipu, operated in the Tigris-Euphrates valley (Covello & Mumpower, 1985). The Asipu served as a council of reason for difficult, uncertain, or risky decisions. While their methods differed from the probability that is prevalent in risk management today, the Asipu are among the first recorded practice of risk and decision management.

For much of the next 5,000 years, risk management would remain in the hands of a select few. It was dominated by religious organizations (preparing for the afterlife appears to be the ultimate form of risk management), and practitioners of the divine or supernatural. In the middle of the 1600's Blaise Pascal, the celebrated mathematician, and Pierre de Fermat exchanged a series of letters where they developed some of the elementary laws of probability. Most of the probability laws they were working with were built around the games found in casinos, but the ideas have become integral in the risk management profession (Bernstein, 1996).

These probability laws allowed for the quantification of risk in other settings. Beginning in the 1700's bankers and insurers began to use some of these tools to assess the risks in their fields. For a long time, at least 200 years, the use of these tools was considered a competitive advantage (Hubbard, 2020). In the following years, it would grow from a competitive to an industry necessity.

Following World War II, probability was much better understood, and the tools such as the Monte Carlo Engine were becoming available. These tools allowed experts in probability to port their skills into other trades. In his book "The Failure of Risk Management" Douglas Hubbard explains how the risk management family tree split into four distinct branches (Hubbard, 2020).

Each of these branches had their own specialty, and their own way of managing risks. The least technical group, the management consultants, were the ones who made the broadest impact. They were able to 'sell' their solutions to companies and make large profits. These consultants, having to justify and explain their solutions would often opt for the easiest to explain (Hubbard, 2020). This gave rise to many of the non-technical solutions that are commonly presented in risk management.

A brief history of safety professionals

With the passage of worker's compensation laws, workplace safety began to be of interest to the insurance companies writing their policies. These insurance companies began hiring professionals to help with the reduction of losses. Loss control professionals were originally engineers, and were focused on the inspection of the insured companies property for specific hazards, such as machine dangers and fire hazards (PETTINGER, 2009). Eventually, companies began hiring attorneys and physicians to fill these roles as loss control consultants (Cohen, 1982). The attorneys helped to navigate the legal requirements from interpreting the regulations and avoiding negligence, while the physicians evaluated the injuries to the employees (Buresh, 2000).

In the 1970's with the passage of the OSH Act, and other workplace safety regulations, companies began designating in-house professionals to oversee the compliance with these programs. These employees lacked formal training, or formal education (Buresh, 2000) many were employees simply tasked with understanding the regulations.

As loss control consultants, and safety professionals continued to interact, the safety profession was created as we know it today. It incorporates many different facets, from many different fields. Safety professionals are often tasked with personnel issues, environmental compliance, workplace safety, insurance contracts, and more. This placed safety professionals in contact with many of the management consultants mentioned above. In an effort to improve, along with the business, safety professional began adopting some of the ideas of risk management as taught by the management consultants. This led to a situation where the "flashiest tools" not the most effective, were adopted by safety professionals.

All of this caused one of the major challenges facing the safety profession. It is the concept of risk management. Safety professionals, are generally taught regulations, and methods for complying with said regulations (Rao Chitikela, 2020). Because the safety industry has generally focused on compliance, it has fallen even further behind other fields in terms of risk management.

2. Problems with risk management

The field of risk management itself is rather siloed (Hubbard, 2020). Different industries have evolved different methods of managing risk and many are diverging even further apart. Some of the less rigorous methods, have been introduced as 'best practices' in safety. Notable organizations, such as those in the professional development, or professional networking space for safety professionals, even sell textbooks that further justify, and promote, the use of such tools.

With their widespread use, and being termed 'best practice,' many of the ineffectual methods have been codified and now part of the regulations mentioned above (Taleb, 2016). Utilizing ineffective methods can rarely lead to effective results.

The purpose of this article is to identify some of the major challenges of common risk tools, specifically in the safety industry. It begins with some key challenges facing the industry, and the adoption of proven risk management tools as whole. The article then identifies some prominent tools utilized in the safety industry, and highlights some of the weaknesses inherent in the tools.

3. Challenges of Risk Management in the Safety Profession

Challenges #1, 2 – Definition, and determination of risk

One of the primary drawbacks to risk management being utilized in the safety profession, is the lack of definition of risk. Originally, risk derives from the Italian word *risicarre* meaning "to dare" implying that ultimately, risk is a choice (Bernstein, 1996). Modernly, risk has become associated with some sort of loss/misfortune that befalls the risk taker. To further complicate matters, risk is defined differently, depending on the industry that is using it (Drummond, 2011). It is defined differently by psychologists, economists, actuaries, project managers, and risk management professionals. Generally, in risk management or safety, risk is defined through a non-descriptive equation. Risk is simply defined as:

$$risk = likelihood \times severity \qquad \text{(EQ 1)}$$

Occasionally, it is written slightly differently as:

$$risk = probability \times consequence \qquad \text{(EQ 2)}$$

These "equations" may appear familiar to many of you. These definitions, while technically accurate, provides very little value to the user. This idea, that risk is simply a combination of probability and consequence is an entirely man made definition, and implies that risks are linear (Masuch, 1985). Taleb points out that this method of defining risk, fails to account for the "Black Swans" that may arise (Taleb, 2010). Taleb defines Black Swans as extremely high impact events that are not predictable beforehand (likelihood is believe to be zero).

Additional challenges in the use of this definition arise from a lack of process in determining likelihood/probability, or severity/consequence. Many companies rely on expert intuition for determining likelihood and severity, and have no other method for verifying the results (Hubbard, 2020).

Many articles have been written about the flaws in 'expert judgment' (Kahneman & Klein, 2009; Kruger & Dunning, 1999). Experts simply often "don't know what they don't know" (Dunning, 2011) and have a tendency to overestimate their own skills or knowledge (Kahneman & Klein, 2009). If your process for defining risk, relies solely on the judgement of experts, you are not determining your risks properly. The expert judgement allows for the addition of error into your system as humans tend to underestimate large risks, and overestimate small risks (Slovic et al., 1981).

Expert intuition, while acceptable as a starting point, should not be the sole determining factor of your risk management plan. Many quantitative, and rigorous probabilistic methods are available to help further your risk determinations. Douglas Hubbard suggests a very simple one-to-one substitution for risk matrices in his book "The Failure of Risk management" (Hubbard, 2020). The method entails utilizing Monte Carlo Simulations on the identified risks to quantify your expected losses/gains. It allows the safety professional to quantify some of the risks they face, as well as provide probabilistic models for effectiveness in control strategies.

Challenge #3 – Universal theories/tools

Risk tools are meant to be broadly applicable, but the right tool must still be selected for the right job. In an ASSP publication, several tools are described as "can be used to solve any type of problem, or to improve any system" (Lyon & Popov, 2018). This is clearly an over estimation of the tool's ability. No single tool, however well adapted, can solve any problem.

This challenge is rampant in safety. As one safety professional finds success utilizing a method, such as Behavior Based Safety (BBS), or Human and Organizational Performance (HOP), they begin to share their success. But rather than trying to understand *why* the venture was successful, others immediately look at how they can make this idea successful for themselves. Many of the ideas of "Safety II" or "Safety Differently" worked extremely well in healthcare or aviation settings (Dekker, 2014). However, these ideas struggle to find footholds in 'open systems' such as construction sites, where defining the 'system' becomes more complex. Some of the principles, should be universal, but the practicability of said principles is not. The universality of the principle kills the particulars of the project.

The main rebuttal the authors hear when disputing the ideas of Safety II (or of Behavior Based Safety) is that the tool is simply being misapplied. The tool is being utilized incorrectly, or the system is incorrectly defined, ultimately, the error is in the person utilizing the tool. This flies in face of the concept of HOP. HOP states that the system should be so well designed that the user cannot commit an error (Conklin, 2019). If HOP cannot deliver its central message to its own application that points to a problem with the tool. While HOP is great in specific situations, it is not always the correct tool for the job. This is akin to driving a screw into wood with a hammer, it can be done, but that is clearly not the best tool for the job. Like any well stocked toolbox, a variety of tools is essential to do a complex job correctly.

Safety professionals need to embrace that safety is difficult and messy work. It was never meant to be a simple ‘checklist’ of do’s and don’ts, but rather requires a well thought, customized plan for each operation.

Challenge #4 – The lack of rigor

Safety is considered to be a social science. Social science has a history of non-repeatable studies (Schmidt, 2009) (Klein et al., 2014). Repeatability is one of the essential criteria for proving a hypothesis. However, due to the interconnected nature of social sciences, repeatability is rare. Even among the same group of subjects, over time preferences, beliefs, knowledge, and desires change. Many of the studies done in safety are perception studies which highlight a specific group at a specific time. Perception, one’s view of the world, is constantly changing, and this makes the repeatability of perception surveys a challenge.

Lack of repeatability is a widely accepted flaw in the social sciences. However, because this is accepted, it has led to the support of many theories that only have the scientific support of what appears to be a single case study. The methods, theories, and conclusions drawn from the studies are not reported as case studies, but rather as new methods ‘backed by science.’

The lack of repeatability plagues both academics, as well as consultants. They develop an idea, test the idea in a controlled environment or with a small cohort, and then expand the idea to a general theory. Generalizing from a case study presents many challenges (Sharp, 1998). This problem of lack of rigor, extends to the way in which information is generally disseminated in the safety field as well. It is much easier to write and sell a book, than it is to write peer reviewed articles. Books must be persuasive, not accurate. Articles must be both accurate and precise, though not all articles are equal.

Many different factors play in the number of citations an article will receive (Tahamtan et al., 2016). Furthermore, peer reviewed articles struggle to get published if they are not full of citations from leading authors. This academic self-affirmation doesn’t follow a structured rigor found in experiments, but rather allows a small group of popular speakers/writers to spread their ideas quickly, while systematically keeping their competition from ever getting a seat at the table.

Challenge #5 – Misunderstanding of probability and randomness

Aside from a possible general education course, statistics and probability are not generally taught in safety education, particularly at the undergraduate level. Even at the graduate level, most statistical courses in safety science are methodology, or in the use of a specific statistics program. Students are taught how to test specific hypotheses utilizing specific methods, but they are not taught to understand the methods themselves. They do not gain any understanding of the theory behind the methods, and they are taught very little of the assumptions, and limitations that are built into the methods they are using.

Taleb refers to a phenomenon where people act one way, such as in a classroom, and differently in another situation as “domain specificity” (Taleb, 2010). This challenge arises with the use of statistics as well. In a famous experiment, Kahneman and Tversky gave the following problem to subjects:

> "A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50% of all babies are boys. The exact percentage of baby boys, however, varies from day to day. Sometimes it may be higher than 50%, sometimes lower.
>
> For a period of one year, each hospital recorded the days on which more than 60% of the babies born were boys. Which hospital do you think recorded more such days?
>
> - The larger hospital
> - The smaller hospital
> - About the same (i.e., within 5% of each other)" (Tversky & Kahneman, 1974)

In their results, less than 25% selected the correct answer (smaller hospital). Most (55%) selected "About the Same." This result shows a clear misunderstanding of basic statistical theory. Since the probability of a baby being born a boy is approximately 50%, the larger the sample size, the closer this sample should approach 50%. The smaller hospital, is much more susceptible to outliers (days when 60% are boys). This was referred to as "insensitivity to sample size" (Tversky & Kahneman, 1974). Taleb reports that "many statisticians made the equivalent of the mistake… these statisticians would have flunked their own exams" (Taleb, 2010). Safety professionals must be taught to avoid the same mistakes of domain specificity.

Between the education, the lack of regular/consistent use in their normal job duties, and the pitfalls of domain specificity, most safety professionals lack an understanding of statistics and probability. Additionally, the role of safety professional has become very closely related to that of an outside consultant in many industries. Outside consultants must be able to quickly explain their methods and how they work. All of these have led to a decline in the quantitative methods used in the industry (Hubbard, 2020).

An equally challenging problem is the statistical notion of "noise." Noise, sometimes referred to as variance, is the product of a healthy system. Systems are not static, and small departures from the "average" are normal. This concept, is one of the reasons that The Law of Large Numbers actually holds. Individual measurements may be above, or below the actual average, and by making a lot of measurements over time, we can get an idea of what the average is. In safety, we often take "snapshots" of company safety performance. If there is a week that has more injuries than expected, investigations may be held. Sometimes this is good practice, other times it is simply a move back towards the normal. Safety doesn't stop and investigate a week that performs above average, it just looks at it as a job well done. Taleb addresses ideas of noise and variance in his book "Fooled by Randomness" (Taleb, 2004)

Risk management, fundamentally deals with probabilities and uncertainties. Probability is at the center of nearly all definitions of risk in use in business. A solid grasp of basic statistical theory, and measurement of probabilities is essential for the profession.

There are several challenges facing the safety profession and its adoption of sound risk management principles. A few of these major challenges, that are not often discussed, have been highlighted here.

4. Specific Risk Methods and Tools Used in Safety

To the credit of the profession, safety is always striving for improvement. This has led to the adoption of several methods and tools that are traditionally found in risk management operations. These tools have been hijacked, and are used in the safety profession, leading to both good and bad results. It is important to mention, that no single flaw in a tool should make it "unusable," but the flaws and limitations of tools are seldom discussed. The authors hope that by demonstrating some of the intrinsic weaknesses and flaws in the following methods/tools, safety professionals will better understand the application, use, and limitations of said tools. A better understanding of the limitations of the tools, ideally, will lead to better tool selection for the specific applications, or perhaps, improvements in the tools themselves.

The Bow-Tie Model

The bow-tie model or bow-tie analysis gets its name from its shape. The model generally places hazards, causes on the left side of the model, then draws slanting arrows through controls. These arrows lead to the center knot of the bow-tie, labeled "the event." The right hand side draws arrows slanting up more controls (often labeled 'mitigating controls') and finishes with the consequences on the right hand side (see Figure 1).

Figure 1: Example of Bow Tie Model Analysis with Swiss Cheese Model - adapted from SRMBoK (Talbot & Jakeman, 2009)

This model is widely used to trace a hazard through the controls, to an eventual consequence. More sophisticated versions of this model will utilize James Reason's "Swiss Cheese Model" in the areas with the arrows. The model is widely accepted because of the visual simplicity of it. It allows a complex problem to be graphically communicated very quickly.

Proponents of the bow-tie model will argue that it demonstrates the ability to identify gaps in coverage (as the Swiss Cheese Model often does) as well as illustrate the life of the hazard, all the way through to the consequence.

Generally, the drawbacks of this model far outweigh the benefits. One of the weaknesses of the bow-tie method is the lack of risk scoring. All causes, and all mitigations are given equal weight in this method (Lyon & Popov, 2018). Another drawback of this model is that it forces linear relationships between components in the system. Additionally, this model implies a static state of operation. The model is unable to accommodate changes in the operation.

Often, when detailing the shortcomings of the bow-tie method, the authors are presented with the argument "at least we are doing something." This argument implies that anything, is better than nothing. In the case of a bow-tie analysis, this may not be true. The bow-tie analysis allows the placement of controls/mitigations any where that you would like to place them. If you believe the control will stop the events, your model will reassure you that it will. Predicting the path the event will unfold is nearly impossible. Reasonable guesses can be offered, but the exact path is unknowable (otherwise you could just prevent it as it happens). The other reason that this model may be more harmful than good is the lack of second order events. This model is unable to track (or even identify) what new hazards are introduced by the controls. Every new control placed in the system would necessitate a nested bow-tie analysis. This model leads safety professionals to believe that because the arrow hits a box, the danger has been controlled. This model often leads to an over confidence in the controls that are in place.

The Risk Matrix

Many safety professionals utilize a risk matrix. Often called a heat map, the risk matrix is a table that plots risks based on likelihood and severity. Risk matrices are extremely varied in their use and approach. Companies are able to customize them to their specific tastes and highlight what is most important to them. Generally, they are simplified to use a number system of 1-5 for severity (1 corresponding to negligible/minimal loss, with 5 corresponding to a catastrophic loss) and a 1-5 for probability (1 corresponding to extremely unlikely, and 5 corresponding to extremely likely). These numbers are multiplied together to produce a risk score (from 1-25) and plotted in the appropriate cell of the risk matrix. Furthermore, these matrices are typically color coded with low numbers, say 1-9 plotted in green, medium numbers, 10-16 plotted in orange/yellow, and 17-25 plotted in red. (See Figure 2)

Likelihood					
Very High 5	5	10	15	20	25
High 4	4	8	12	16	20
Medium 3	3	6	9	12	15
Low 2	2	4	6	8	10
Very Low 1	1	2	3	4	5
Severity	Very Low 1	Low 2	Medium 3	High 4	Catastophic 5

Figure 2: Example Risk Matrix

The risk matrix is very useful for visually cataloging your risks, and prioritizing control efforts. Many companies will have a numerical risk score threshold and require that all risks above a risk score of a specific number have mitigations in place. Many companies will even utilize a second risk matrix to plot risks after mitigations are accounted for and the risks are reduced. This allows these companies to gauge the effectiveness, as well as the current priority of mitigations. In some industries, the use of risk matrices is required by regulation.

Risk matrices also vary in their application. Some companies utilize risk matrices on individual projects, and track risks at a very low level. Many companies utilize the risk matrix at the enterprise level tracking large risks affecting the entire company. Both applications have value, and both can be utilized simultaneously.

Risk matrices also suffer from a ‘snapshot effect.’ They become outdated as soon as they are printed. Risks are dynamic and evolving, and once they are relegated to paper, they are often overlooked. For example, with he Covid-19 pandemic, many companies had “pandemic” listed on their risk matrices. But due to the low probability score, pandemic plans were not created in most industries. Once the pandemic hit, and companies had to modify their business plans, it was too late. The value of preparation, provided by a risk matrix, was simply not there. This can work in both directions. In 2014-2015, many companies were bracing for the ‘Ebola outbreak’ that was expected to occur. Many companies varied on the likelihood of an Ebola outbreak, but the severity was almost universally considered to be ‘extreme/catastrophic.’ This led to large expenditures on supplies, preparation, that was never needed.

The biggest challenge to the use of risk matrices is establishing the risk scores. Many companies utilize a verbal score (i.e., extremely likely) while many others use a numerical score. The process should establish a measurable value. Ideally, the likelihood and severity will be reported in intervals (such as a 90% confidence interval). The confidence intervals can be set up based on the company’s experience, or the judgement of a subject matter expert, but they should be formalized. If companies utilized a confidence interval, probabilistic quantification becomes simple, and can be done with a simple spreadsheet program (Hubbard, 2020).

Subjective risk assessments, especially done by experts are a good place to start for risk maps. However, they are not a rigorous place to finish. By utilizing quantifiable methods one can reduce the subjectivity of the matrix and produce a quantifiable result. These results and data are crucial in the decision-making process. For example, a typical risk matrix may show a cyber related risk with a “total expected loss” of $5,000,000. If you created a 90% confidence interval for the losses (such as $3,000,000-$5,000,0000) it would allow simple Monte Carlo simulations to be run. Monte Carlo simulations run thousands of simulations of the event and determine the probabilistic losses and gains from the risks. This type of analysis is common in engineering, where the failure rate of components need to be established. It is also common in financial risk management and utilized in the buying and selling of stocks and options. The mathematical approach of the Monte Carlo method allows the subjectivity of the inputs to become actionable. It demonstrates ‘what could’ happen if the same scenario repeated itself thousands of times. By seeing how the scenario plays out thousands of times, and looking at the average, one can get a stronger idea of what is likely to happen. Hubbard calls this analysis a one-for-one substitution (Hubbard, 2020).

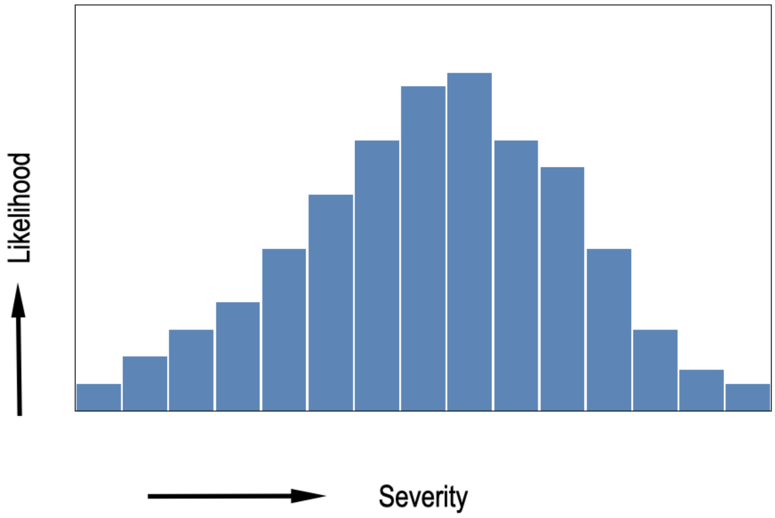

Figure 3: Hypothetical Monte Carlo Distribution

The Risk Register

Risk registers, sometimes referred to as risk logs, are an inventory of risks facing an organization, a project, or any other scale. Risk registers are generally comprised of all the risk assessments that have been completed, and they are summarized, and color coded for viewing ease. Risk registers are required under several laws in the United States.

The benefits of risk registers are simple, all known risks for the operation are cataloged in a single location, along with potential losses, probabilities, and sometimes risk mitigations and mitigated risk scores. Risk registers should be used primarily to share information (Lyon & Popov, 2018).

Risk ID	Category	Owner	Description	Consequence	Probability	Impact	Risk Level	Mitigation	New Risk Level
1	IT	VP -IT	Risk 1	Loss of data	High	High	High	Backups – nightly and redundant	Medium
2	Sales	VP- Sales	Risk 2	Loss of revenue	Medium	High	High	Diversification, new products	Low
3	Operation	Ops Director	Risk 3	Factory Shutdown	Low	High	High	Safety, labor programs	Medium
4	IT	VP - IT	Risk 4	Loss of communication	Low	Medium	Medium	None	Medium

Figure 4: Example of a basic Risk Register adapted from SRMBoK (Talbot & Jakeman, 2009)

The drawbacks to risk registers are more difficult to see. Risk is an abstract concept, and risk registers reduce the abstract to an observed event. Put differently, "harm or risk, lives in the future" (Taleb, 2010) while experience is, by definition, a product of the past. Drummond considers the risk register to be a form of metonymy (Drummond, 2011), substituting something for one of its qualities. Drummond goes on to state "the risk register takes elusive, subtle, dynamic and unpredictable hazards with all their complex social, economic and psychological connotations, and translates them into a system of notation comprising word processed descriptors, numerical probabilities, arrows and the like" (Drummond, 2011). By reducing the risk down to a symbol, an inherent bias is added to view of the risk. One viewpoint is legitimized by the wording on the risk register (Brown, 1990).

Risk registers also give the illusion of understanding (Drummond, 2011). If a risk is listed on the risk register, several questions regarding the risk must be answered, namely:

- What is the risk?
- What is the likelihood/probability of the risk occurring?
- What is the impact should the risk occur?
- What controls are in place for the risk?
- Who 'owns' the risk?
- How effective are the controls in mitigating the risk?

These questions often do not have simple answers, but they are forced to fit into a single cell in a spreadsheet. This creates the illusion that the risk is understood more than it may actually be.

Another challenge with risk registers arises from the concept of ownership (Drummond, 2011). Drummond argues that risk registers lead to a 'missing hero' scenario. The concept of the 'missing hero' comes from a reverse tragedy of the commons, where no one acts to help, because they assume that someone else will do it (Platt, 1973). Because risk registers identify responsible persons/parties for specific risks, people tend to ignore that for which they are not responsible (Drummond, 2011).

Risk registers can lead to the ritual of risk management, rather then the management of risks (Budzier, 2011). The checking of boxes, reviewing the risk register, becomes the activity itself. This can be compounded by the regulations, such as the Sarbanes Oxley Act, that requires risk registers be reviewed. This leads to a compliance ritual of regularly reviewing the risk register as a matter of simply complying with the law, rather than functionally managing the risks. Furthermore, Budzier explains that:

> "institutions can be caught up in contradictions: a contradiction can occur when legitimate practice, such as managing risks by risk registers, undermines functional efficiency. In these cases, institutions ritualistically conform to rationalized myths, for example by repeatedly telling them-selves that risk registers are the best method to successfully manage risks." (Budzier, 2011)

Discussion of the risk register often involves key executives of companies. This can give rise to opinion conformity (Stern & Westphal, 2010). Opinion conformity is a form of bias, where subordinates tend to agree with their superiors even when they do not actually agree. While opinion conformity may be good for your career (Stern & Westphal, 2010) it is not a good practice when discussing risks.

An example of risk registers failing can be seen with the COVID-19 pandemic. Many companies had pandemic listed on their risk registers, but based on historical data, the likelihood of a pandemic was deemed very low, and it was archived on many risk registers. Even the World Health Organization, an organization that is constantly watching for pandemics, failed with their risk register:

> "Like the WHO, the UK Government had learnt from past RNA virus epidemics, was well aware of the pandemic threat and had undertaken risk-register planning as well as exercises leading to valuable recommendations. Yet by the time the pandemic struck 'emergency stockpiles of Personal Protective Equipment (PPE) had severely dwindled in the years of austerity. The training to prepare key workers for a pandemic had been put on hold for two years while contingency planning was diverted to deal with a possible no-deal Brexit'." (Agius, 2020)

Once a risk is placed on the risk register, it should not be forgotten. It should not simply be 'reviewed annually per the regulations.' Drummond suggests the use of "novel metaphors" for the risks on the register, and provides the following examples:

a. Risks as ghosts and shadows – risks often cast shadows before they implode, ask yourself "how can this risk return to haunt me?"
b. Risks as biological mutations – how can the risk change? Will a vaccine (mitigation) today be able to stop a mutation of the risk tomorrow?
c. Risks as an imp – how can this risk cause mischief for me in the future? Drummond specifically states, "If I were a risk, how would I disrupt this plan?" or "If I were a risk, where would I hide?"
d. Risk as irony – how could risk turn my apparent strengths into weaknesses? (Drummond, 2011)

The authors are not suggesting that you create a fantasy world in which you manage your risks, but rather that you constantly change your perception of the risks on your register. Challenge your internal risk committees to review the risk register and ask themselves these questions. Create new "novel metaphors" for your application and use them as you review your risk register. Ask questions about the risks that are not on the script of the risk register.

5. Conclusion

There are many challenges that are facing safety when it comes to the adoption of risk management practices. Several have been listed and considered here, both generally and specifically. Many of these challenges can be eliminated if the tools will be utilized as they were designed. This requires the users of the tool to embrace the quantitative methods, and establish the protocols upfront. Simply opting for the simple path will not produce the necessary results.

These challenges also present an enormous opportunity for improvement. By reviewing and challenging the assigned risks in the risk matrices, management can get a much better idea of where prioritization is most effective.

By understanding the limitations in the tools they are using, making adaptations, and addressing general challenges in the industry, safety professionals can successfully adopt risk management into their practice. The adoption of these tools into the safety profession will help with the overall occupational risk management.

Occupational risk management is the way of the future. More and more companies are opting to hire a "risk manager" who can manage the risks that have previously been assigned to a safety professional, environmental professionals, and insurance professionals. Learning how to utilize these tools can establish credibility in this occupational risk management field. Quantifiable data will drive accurate decisions, and accurate decisions will drive successful companies.

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