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Safety Stories Resulting from Research to Practice: How to Communicate Occupational Safety Data?

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Current methods of presenting data on risks are mainly focused on presenting the objective data such as accident statistics. However, research has shown that risks are not always understood objectively and quantitatively. User involvement showed that RIVM's current fact sheets could be improved. Fact sheets contain data for distinct types of accidents including statistics about the direct and underlying causes. The data is derived from the Dutch national Storybuilder database, which contains information on over 32,000 serious occupational accidents. This paper discusses how scientific insights into effective risk communication are applied to improve the fact sheets: a research to practice approach. Narrative accident descriptions were added to support the quantitative data with a story that is relevant to the target audience. The fact sheets are further extended with possible preventive measures users can undertake and visual support in the form of graphics. Future research will test different versions of the fact sheets with members of the target audience.

1. Introduction

The Dutch National Institute for Public Health and the Environment (RIVM) manages a national database called Storybuilder, which contains data on over 32,000 occupational accidents (Sol et al., 2013). The database contains information about the direct and underlying causes of occupational accidents that occurred in the Netherlands between 1998 until 2014. RIVM transfers this information, consisting of quantitative data, to safety professionals in order to prevent future accidents. The aim is to provide professionals in the field of occupational safety with information to make informed decisions in practice, thus to improve safety for their employees.

Current methods of presenting data on occupational risks mainly focus on presenting objective data such as accident statistics (e.g. Bellamy et al., 2014). For many years, RIVM has been generating fact sheets with data from the Storybuilder database. The 'old style' fact sheets can be composed from different points of view, for example per sector, type of accident or type of work equipment. The information from the database is mostly quantitative and presented likewise. Depending on the users' familiarity with Storybuilder, explanation is added about the underlying model and interpretation of the data. However, feedback showed that the fact sheets are too complex and that presenting solely data is ineffective. Safety professionals commented that they do not fully understand the data, let alone translate it into practical measures (see figure 1 for a graphical representation).To improve safety, understanding possible risks and filling in the gap between the objective and perceived risk is beneficial in several ways. At a personal level, understanding risks and appreciating them correctly contributes to the likelihood that workers adjust their behavior in a desired way. Solely informing employees about objective risks does not guarantee safe(r) behavior as the objective risk can differ strongly from the perception of risk, which is for example also determined by its 'dread' and the extent in which is it 'unknown' (Slovic, 1987). At the organizational level, management's understanding of risks contributes to safety and has financial gains. Better insight in objective risks provides necessary arguments for prioritizing and informed decision-making concerning investing in preventive safety measures. Saracino et al. (2012) consider shared risk perceptions about work activities necessary for a correct management system. This also emphasizes the need for a better understanding of the objective risks, since this common understanding can provide a clear starting point and will contribute to the realization of a correct shared understanding of risks.

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Figure 1: Visual representation of the reason to improve risk communication (see 'old style' fact sheet left)

In addition, the past decades the field of risk communication drastically changed. Gamhewage (2013) described three major changes. First, experts and authorities are trusted less by the public, second, there is an increase in the public's search for (health) advice online, and third, the media play a more dominant role than in the past. The first change leads to a more dominant role for the question whether or not RIVM should be acting as 'the messenger' compared to a decade ago.
This leads to the main research question in this paper. This question concerns the improvement of the fact sheets: How can the presentation of the data in the fact sheets be improved in a way that promotes a better understanding of risks and preventive measures by the users? The main goal for the fact sheets is to inform sectoral organizations, companies and workers on occupational hazards and risks and on prioritized preventive measures. This paper describes the outcome and presents the improved version of the fact sheets.

2. Improving information transfer

2.1 Identifying the problems

User involvement, with the users in this case being professionals in the field of occupational safety, resulted in concluding that improving the fact sheets required adjustments on multiple aspects. The main problem was insufficient accessibility of the fact sheets. The data as presented in the fact sheets, matching the underlying Storybuilder model, was too difficult to comprehend. This applies to the safety professionals, but also the workers, since the safety professionals expressed their interest in fact sheets that can directly contribute to the workers understanding of occupational risks. Ideally, the professionals want to use the fact sheets directly to present the workers with relevant safety information. This shifted the primary target audience of the fact sheets from people with professional knowledge about safety to workers with only practical knowledge about the risks regarding their specific working activities. It also introduced the necessity to raise a feeling of personal relevance to let workers feel engaged and preferably intrinsically motivated to behave safe. Finally, users expressed difficulties in translating the quantitative data to practical safety measures.
Table 1 summarizes the points of focus in improving the fact sheets in the column 'description of the problem'. The column titled 'description of the solution' displays the solutions based on literature from the field of risk perception, research on communicating scientific insights and other disciplines, and will be discussed in the sections below.

Table 1: Identified problems and solutions for improving the fact sheets

No.	Description of the problem	Description of the solution
1	Insufficient appeal to personal relevance	Narratives: add relevant narratives, described from an objective or personal perspective Tailor made: provide possibility to adjust fact sheets to specific wishes
2	Insufficient understanding of the quantitative data and perception of control	Visual support with graphics
3	Insufficient support in translation into practical safety measures	Offer a possible course of action

2.2 Defining solutions

Research has often shown that risks are not always understood objectively and quantitatively (e.g. Slovic, 1987). Other factors such as dread and perceived controllability play an important role. For instance, people tend to underestimate risks that they feel they can control (e.g. falling from height), compared to risks they feel

they can control less (e.g. falling objects), see for example Harris (1996) and Nordgren et al. (2007). In particular, when people are likely to perceive that a particular risk is within their personal control, they may not follow necessary safety precautions or safety rules. This stresses the need for taking the perception of risks into account in the field of safety.

Perceived personal relevance and actions

Flin et al. (1996) showed that there is a difference between how workers perceive safety risks and safety risks resulting from quantitative methods such as QRA or accident analysis. In their studies on oil rigs, it became clear that workers on off shore installations perceive risks for 'getting hit by a falling object' as higher than 'falling to lower level'. However, from quantitative data in the Storybuilder database it is known that the risks for 'falling to a lower level' are twice as high as 'getting hit by a falling object'. This discrepancy can be explained by the difference in perceived personal control in both situations. An object falling from above can be perceived to occur instantaneously without being able to control the situation; whereas falling to a lower level can be perceived as a situation people can influence themselves. Personal control can be regarded in the face of precautionary motivation and action. Research shows that precautionary motivation and action consists out of several factors (Ruiter et al., 2001). Perceived personal relevance is considered crucial to the effectiveness of presenting information about risks. If employees feel that the risks concern them personally, they are likely to experience precautionary motivation. Coping appraisal, consisting of self-efficacy and response efficacy, is a stronger predictor of precautionary action than threat perception (Ruiter et al., 2001). This advocates a more personal approach, preferably one that appeals to a personal level and therefore fosters perceived personal relevance, complemented with information to promote coping appraisal.

Facts: simple and graphics

From the previous it is clear that risk perception does not always follow the quantitative calculation of safety risk. Safety professionals in the field, and scientists as well, have a tendency to try to explain workers that the quantitative calculation of the risks resemble the 'true world'. And if workers do not believe this, safety professionals and scientists tend to explain the data over and over again. This way of communication might not be very effective, especially when considered that people are not that good in understanding data at all. Tversky and Kahneman (1981) conducted an experiment with the threat of an epidemic Asian disease. This experiment showed that people tend to choose a strategy in which the outcome is certain. Furthermore, it showed that people tend to choose a strategy in which lives could be saved. This shows that the presentation of the data greatly influences the way people choose a strategy or act upon these data. Also, people are not good in predicting probabilities from data. Manrai et al. (2014) showed that healthcare professionals are not skilled in statistics; only 23% of the people gave the right answer to a statistical question on the outcome of a test. This means that safety professionals and scientist should be very careful with communicating statistical information. Also, from a research institute perspective, it is not possible to train every workers' statistical skills. Therefore the work of Tufte (2001) has been an inspiration to make choices in the presented data. The advice is to keep the data simple, to explain the data and to give graphic representations. And to interact with the users of the fact sheets to select the relevant information.

Narratives and actions

Narratives support communicating science to non-expert audiences by increasing comprehension and persuasiveness (Dahlstrom, 2014). Evaluating a safety campaign in the agricultural sector indicated that farmers evaluate communication based on narratives or fear appeals more positive than messages based on statistics (Morgan et al., 2002). Witte and Allen (2000) conducted a meta-analysis regarding public health campaigns and concluded that the combination of fear appeals with high-efficacy messages leads to the biggest effect on behavioral change. Only presenting accident statistics and a narrative, mainly focused on what went wrong, cannot be readily translated into preventive safety measures. Also, as mentioned before, the safety professionals themselves reported being unable to translate the quantitative data in specific safety measures. Thus, when using lively narratives, it is important to inform users about the preferred course of action. Lively accident narratives without efficacy-messages can even lead to dreading the risk and have adverse effects, for instance avoidance or rejection of the information (Witte & Allen, 2000). Hence, it is recommended to translate the accident data and narrative into practical safety measures and offer the whole package.

3. Building blocks and fact sheets

The previous insights into effectively presenting accident data resulted in the advice to make several improvements in the fact sheets (see also table 1). The following section elaborates on how RIVM

implemented these improvements. The fact sheet ‘old style’ is presented in figure 1 and the building blocks of the new fact sheets are presented in figure 2. Even though the ‘old style’ fact sheets already contain visuals, they still contain too much data (more than three pages). This type of fact sheet does not appeal to the user and therefore does not address personal relevance or promotes action.

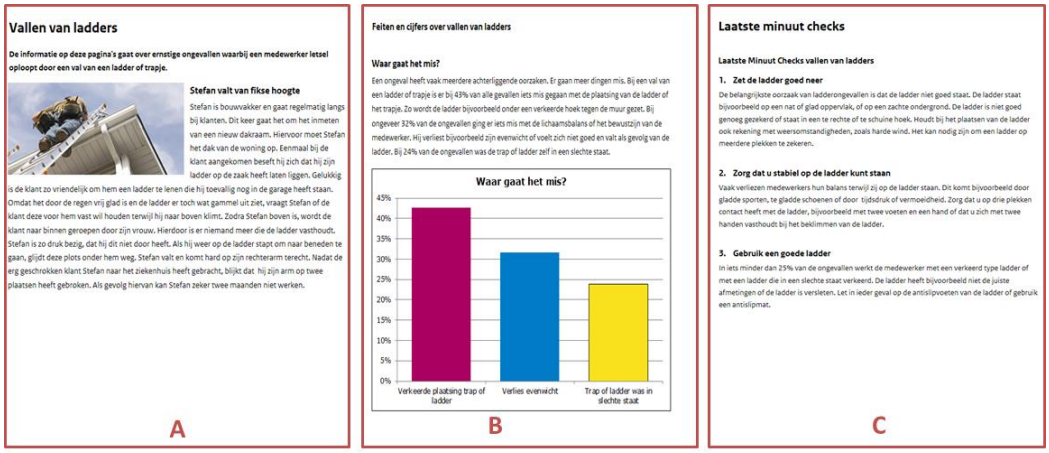

Figure 2: An example of the fact sheet building blocks presenting the narrative of an accident story (A), the facts based on data (B) and preventive measures (C)

3.1 Elements

Narratives

Narrative accident descriptions are developed to support the quantitative data. These narratives are intended to support the data with a story that is relevant to the target audience. A good narrative seems to consist of presenting the risk information in the form of a personal story in addition to the data (Lundgren & McMakin, 2009). The stories are obtained from the Dutch labor inspectorate. The Dutch labor inspectorate electronically stores all accidents reported to them in I-Net (and before in GISAI). These data consist of a short description based on the reporting of the accident. For investigated accidents it consists of a prosecution report including witness statement and inspectors’ conclusions of breaches of the law. From these data sources, RIVM summarizes the accident in so-called accident stories.
Currently, two types of accident stories are developed for each accident type. Storybuilder contains 36 different accident types. The first type of story – the so-called ‘emotional’ story – is a more personalized story, in which fictive names of the victim are used, more contextual information is given around the accident and in which people can relate more to the accident (‘it can happen to us as well’). The other type of story is the so-called ‘rational story’. The rational story is without the names of victims and describes more rationally the events taking place after which the accident occurs. The idea is that for some purposes, e.g. toolbox meetings, companies would rather use the more personalized stories and for other purposes, companies prefer to use the rational stories. Developing both types of stories also allows us in the future to test the different types of stories in respect to information exchange.

Facts supported by graphics

Accident statistics derived from Storybuilder are still presented in a quantitative manner. The improvement lies in that the statistics are accompanied by visual support, mainly consisting out of graphics. Following Tufte (2001) the facts are represented verbally together with data visuals (graphics).
The Storybuilder database is based on the Storybuilder model. The Storybuilder model is a bowtie-based model in which the centre event is the critical event of the accident. For occupational health and safety accidents in total 36 different accident types are identified. From 1998 until now the database contains more than 32,000 serious occupational accidents, which are analyzed within these 36 different accident types. Each Storybuilder bowtie consists of a centre event, which is the release of a hazardous agent, such as ‘falling from a ladder’. The centre event is linked to the direct causes, called safety barriers, and to the root causes, called management delivery systems. The database has a lot more data fields for each accident, which are not described here (for an overview see Bellamy et al., 2014).
A big amount of data sets can be retrieved from the database. For the fact sheets per accident type, which are aimed at use in the workplace, it is decided to give an overview of key data for that accident type. Together

with the sectoral organizations a limited amount of data points are collected to present in the fact sheet building block. For example, for the fact sheet ‘falling from a ladder’, the following data is reported for the ‘facts’ building block:

- Number of accidents reported per year
- Injury type and hospitalisation
- The immediate causes: top three barrier failures involved
- Circumstances: height of the fall

The root causes related to the management processes in an organisation are not included in the fact sheet. As mentioned, the fact sheets are aimed at workers to use in the workplace, and root causes are difficult to explain and primarily intended for management.

Preventive measures

The fact sheets include possible preventive measures for employees. The preventive measures should be formulated as positive actions which employees can carry out themselves. For the selection of preventive measures it is chosen to focus on the safety barriers failures. Safety barriers are most noticeable in the workplace and can be identified easily. Following Jorgensen et al. (2015) three basis questions could be answered for providing the right information towards users:

- What can we observe? This question relates to the safety barriers.
- What can we assess? This question relates to the need to provide, use and maintain the safety barrier.
- What can we do? This relates to the action to be taken, being preventive measures

Together with the sectoral organization, these three questions have been discussed and it is decided to focus on the last question, the immediate action to be taken in the workplace. For the fact sheet falling from a ladder the following three actions are described:

- Place the ladder in a good position
- Make sure you have a stable position on the ladder
- Use a good quality ladder

The actionable sentences are derived from the barrier failures and the loss of control event in the Storybuilder database.

3.2 Finishing touch: personalize

The elements discussed above are constructed and presented separately, somewhat like building blocks. Users can integrate different building blocks into one fact sheet by selecting them (online). This results in a personalized content of choice. Users can select the elements they wish to portray in the fact sheet, thus the fact sheet will only contain information that the individual user deems relevant.

The next step is to create tailor made fact sheets by further personalizing the content. Depending on the user adjustments can be made to further match the specific information. For instance, narratives can be rewritten from the perspective of a specific occupation, sector or type of work equipment. As a result, the wishes of the users can be met to the fullest detail.

4. Future Work

In this paper, the first integrated way of communicating information on occupational safety risks towards workplaces is presented. The fact sheets integrate a safety story, factual data and preventive measures. Furthermore, sectoral organizations and safety professionals can personalize the fact sheets to optimally fit their own working environment. In the near future, RIVM plans to evaluate the building blocks of the first four fact sheets that have been developed. In the evaluation, the main question is whether this way of disseminating safety information (data) is effective regarding the safety perception of employees and prioritizing safety measures within companies. Another point of interest is the so-called ‘messenger’ of the fact sheets. Currently RIVM is the ‘messenger’ of the fact sheets. Sectoral organizations see RIVM as an independent body and a trustworthy organization. This might not be the case for employees in companies, therefore the evaluation will study changing the ‘messenger’ of the fact sheet and evaluate possible differences.

In the future, RIVM would also like to develop building blocks of the same structure for process safety data. RIVM also collects information on process safety incidents with the Storybuilder model. Integrating personal relevance into the story will be interesting since in most process safety incidents there are no victims. Furthermore, as Flin et al. (1996) and Jorgenson (2015) described, the perception of process safety incidents and occupational incidents within major hazard industries can vary depending on the type of hazard. Hence, it is interesting to see whether there is a difference in safety perception for process safety incidents and occupational accidents and whether or not the fact sheets can change this perception.

5. Conclusions

The current paper presents a new way of communicating risk information from a research institute perspective. This new way of communicating has already resulted in positive feedback from sectoral organizations. The main feedback is that these simple fact sheets do not pose entirely new or unknown information, but it delivers useful short and simple information based on real accidents. The underpinning of the three action sentences from a database of more than 32,000 accidents seems to be a crucial point. It further seems to fill a gap between science and practice. Normally, safety professionals think of preventive measures independently from scientific principles and insights. Now there is scientific underpinning on prioritized safety measures based on serious accidents data. To conclude, it is necessary to continue bridging the gap between safety science and practice, in order to help companies make proper decisions on prioritizing safety measures.

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