# Supporting Work Place Risk Assessments by Means of Natural Language Processing

Martin WESTHOVEN, Adnane JADID

*Bundesanstalt für Arbeitsschutz und Arbeitsmedizin,*
*Friedrich-Henkel-Weg 1-25, D-44149 Dortmund*

**Abstract:** Work place risk assessments are mandatory in Germany. Despite this, up to 50% of work places are estimated to never have been assessed. We propose to empower occupational safety practitioners by employing artificial intelligence techniques. From previous work, we gathered that most of the available risk assessment data is more or less digitalized and more or less structured text. Therefore, we focus the algorithm family of natural language processing to boost the capabilities of analyzing large amounts of documents. More specifically, we show the feasibility of retraining an algorithm for handling accident data and hazard identification and risk assessment checklists, as well as the transferability to a German text corpus.

**Keywords:** Hazard Identification, Risk Assessment, Natural Language Processing

## 1. Introduction

A cornerstone of occupational safety in Germany is the work place risk assessment (German: Gefährdungsbeurteilung). Although law mandates employers to perform a risk assessment, it is estimated that for up to 50% of work places, no risk assessment has been done (Arbeitsschutzkonferenz 2014).

At the same time, the growing influx of innovative technologies into work spaces increases the complexity of work environments (Barth, Eickholt, Hamacher & Schmauder 2017) and an overall lack of specialized personnel further aggravates the problem (IFA, 2021). In light of recent advances of AI to handle complex and also unstructured data, the idea of empowering occupational safety risk analysis by employing artificial intelligence becomes more viable than ever before.

For a successful introduction of such technologies, though, there is a need for a comprehensive understanding of the system's target context (Rosson & Carroll 2002). In a first step, Westhoven (2022) investigated the requirements to introduce AI support for occupational safety risk analysis by performing expert interviews with occupational safety practitioners at the German Federal Institute for Occupational Safety and Health. One insight gained by Westhoven (2022) is, that currently much of the risk assessment data is only available in some more or less structured and more or less digitalized text format. Although further data collection is possible, objective measurements of environmental factors are typically coupled with large effort and thus reserved for high-risk contexts.

Taken together, further investigation into the feasibility to apply artificial intelligence approaches to the problem should consequently focus on the algorithm family of

natural language processing (NLP). Natural language processing is a research area at the intersection of Artificial Intelligence and Mathematical Linguistics, which focuses on computer-powered analysis, synthesis, and representation of human language. It covers a wide range of particular problems such as machine translation, speech recognition, information retrieval, language modelling and information summarization (Chowdhary 2020). The great advantage of the AI factor is of course the speed with which the data can be processed. With the use of NLP methods, one can analyze massive amounts of data (documents, letters, newspapers, books etc.) extracting the most useful features as required by the task at hand. Risk assessment tasks, which are the main focus of this work, include or can benefit from including such classic NLP techniques as information condensation, sentiment analysis, anomaly detection and many others. Recently, the whole research field of NLP including Natural Language Generation made quick advances by using deep learning techniques (Otter, Medina, & Kalita 2020). The speed of computations together with the theoretical and empirical background of the NLP methods can significantly boost task performance in risk assessments.

In this work, we show the feasibility of using NLP techniques for work place risk assessment by applying a deep-learning NLP method to a corpus of fatal work accident descriptions and hazard identification and risk assessment checklists obtained from the US Occupational Safety and Health Administration (OSHA). We highlight how the results are easily transferable to German data and discuss further opportunities for using NLP techniques to support work place risk assessment.

## 2. Data

The availability of large amounts of data is central to recent advances in Natural Language Processing. Sometimes, the need for such large amounts of data for a specific application field can be circumvented by using transfer learning from an adjacent field, but success is not guaranteed. The following subsections describe the data base of our work as well as possible shortcuts.

### *2.1 Work Place Descriptions*

As already mentioned, in theory a risk assessment should have been performed for every work place in Germany at some point in time. While this is not the case in practice, our initial thought was to use work place descriptions which should exist at least for already assessed work places. Albeit, it turned out that work place descriptions often do not exist, especially for standard work places like offices. So while such descriptions entail information about hazards and risk of work places, only small numbers exist, which is insufficient for most machine learning approaches. We thus turned to accident data (see subsection 2.3 Accident Data) for showing the general feasibility of our proposed method.

### *2.2 Hazard Identification and Risk Assessment Checklists*

As one of the most common tools in occupational safety practice, checklists for hazard identification and risk assessment exist for nearly every imaginable work place. Furthermore, these checklists are often freely available. Coming from potentially many

sources, we decided to break down checklists to their contained items, while simultaneously keeping the information on probable dependencies to other items on the source checklist. Since we used English language accident data in the end (see subsection 2.3 Accident Data), we also compiled English language checklist items. More specifically, we compiled the checklists from the US OSHA Small Business Safety and Health Handbook (OSHA 2022), covering electrical safety, exit routes and emergency planning, fire protection, hazard communication and chemicals, lockout/ tagout procedures, machinery & machine guarding, materials handling and storage, personal protective equipment, respiratory protection, and walking-working surfaces.

### *2.3 Accident Data*

As work place descriptions proved to be unobtainable in the short run, we resorted to using accident data for showing the feasibility of analyzing unstructured text regarding hazard and risk information. Since US government data is public domain, we gathered data from roughly 25.000 fatal work accidents provided by the US OSHA accident search (https://www.osha.gov/ords/imis/accidentsearch.search). For each accident, we extracted the title, the accident description, and a set of keywords. The setup of this dataset is thus a perfect fit for training keyword extraction methods, as for each description the ground truth for keywords provided by occupational safety inspectors is available.

Similar databases exist in Germany, both compiled by the Federal Institute for Occupational Safety and Health and by the accident insurances. These databases, however, are not public domain, requiring more effort to access. We thus postponed using these German databases until after showing the general feasibility of our approach.

## 3. Natural Language Processing Method

Natural Language Processing (see e.g. Chowdhary (2020)) classically requires a large effort of gathering and preprocessing data, and especially to engineer the features to be extracted. The performance of classical NLP approaches often hinges on these early steps, which sometimes take months or even years to perfect.

With the advances of deep learning also affecting the field of NLP (Otter et al. 2020), this has changed significantly. Especially transfer learning, that is roughly speaking transferring a learned algorithm to another application, enables to use machine learning for domains were a lack of data previously made such approaches unfeasible.

Martinc, Škrlj, and Pollak (2022) provide a transformer-based approach (tnt-kid) for keyword extraction as a basis for transfer learning, which is pre-trained on hundreds of millions of samples of scientific or news texts. Such amounts of data are necessary for powering deep learning approaches, but are also simply not accessible in the domain of occupational safety and health. For transfer learning, however, the available data may just suffice.

We retrained the tnt-kid transformer with the US OSHA data on fatal accidents, namely the accidents descriptions and keyword sets, thus making the safety relevant vocabulary accessible to the algorithm. This in turn allows to also extract keywords from non-trained, but similar datasets, such as the checklist items from the safety and health handbook. Having both keywords from accident descriptions and also from

checklist items, a simple text matching between keyword sets now allows for finding fitting checklist items to use for preventing specific accidents in the future.

## 4. Discussion and Conclusion

We motivated our work by highlighting the current status quo in the practice of (missing) risk assessments in Germany. We further provided an insight into data availability in the occupational safety and health domain, which necessitates some of the methodological choices. Finally, we sketch our approach of retraining a keyword extraction method with the limited data available and thus allowing for the use of NLP for matching accident descriptions with related risk assessment checklist items.

Due to unforeseen difficulties with the initially targeted data sets, we had to resort to accident data instead of work place descriptions, and English language texts instead of German ones.

While the general feasibility of the approach can be shown like this and being able to provide specific items to check in the future after a fatal accident is a desirable thing in itself, the next step has to be to access similar German data and to replicate the retraining accordingly. Some optimism is justified here, as several NLP approaches are able to handle textual data independent of language.

Building on the approach we presented here, the ability to identify fitting checklist items can be further refined to yield truly dynamic checklists with only the necessary items for the work place at hand. Since some error will remain, though, this entails to also consider the human-AI interaction with the users.

## 5. Literatur

Arbeitsschutzkonferenz (2014). Grundauswertung der Beschäftigtenbefragung 2015 und 2011 – beschäftigtenproportional gewichtet. Retrieved from Berlin.

Barth C, Eickholt C, Hamacher W, Schmauder M (2017). Bedarf an Fachkräften für Arbeitssicherheit in Deutschland. Retrieved from Dortmund.

Chowdhary K (2020). Natural language processing. Fundamentals of artificial intelligence, 603–649.

IFA (2021). Arbeitswelten. Menschenwelten. Prioritäten für den Arbeitsschutz von morgen. Retrieved from Berlin.

Martinc M, Škrlj B, Pollak S (2022). TNT-KID: Transformer-based neural tagger for keyword identification. Natural Language Engineering, 28 (4), 409–448.

OSHA (2022). Small Business Safety and Health Handbook. 86.

Otter DW, Medina JR, Kalita JK (2020). A survey of the usages of deep learning for natural language processing. IEEE transactions on neural networks and learning systems, 32 (2), 604–624.

Rosson M B, Carroll JM (2002). Usability engineering: scenario-based development of human-computer interaction: Morgan Kaufmann.

Westhoven M (2022). Requirements for AI Support in Occupational Safety Risk Analysis. In Proceedings of Mensch und Computer 2022 (pp. 561–565).

Gesellschaft für Arbeitswissenschaft e.V.

# Nachhaltig Arbeiten und Lernen

## Analyse und Gestaltung lernförderlicher und nachhaltiger Arbeitssysteme und Arbeits- und Lernprozesse

69. Kongress der
Gesellschaft für Arbeitswissenschaft e.V.

Gottfried Wilhelm Leibniz Universität Hannover

01. – 03. März 2023

GfA-Press

**Bericht zum 69. Arbeitswissenschaftlichen Kongress vom 01. – 03. März 2023**

**Fakultät Maschinenbau, Institut für Berufswissenschaften der Metalltechnik (IBM) und Institut für Fabrikanlagen und Logistik (IFA), Leibniz Universität Hannover**

Herausgegeben von der Gesellschaft für Arbeitswissenschaft e.V.
Sankt Augustin: GfA-Press, 2023
ISBN 978-3-936804-32-4

NE: Gesellschaft für Arbeitswissenschaft: Jahresdokumentation

Als Manuskript zusammengestellt. Diese Jahresdokumentation ist nur in der Geschäftsstelle (s. u.) erhältlich.



**Schriftleitung: Prof. Dr. Rolf Ellegast**
im Auftrag der Gesellschaft für Arbeitswissenschaft e.V.



**Geschäftsstelle der GfA**
Simone John, Tel.: +49 (0)30 1300-13003
Alte Heerstraße 111, D-53757 Sankt Augustin
**info@gesellschaft-fuer-arbeitswissenschaft.de · www.gesellschaft-fuer-arbeitswissenschaft.de**

**Screen design und Umsetzung**
© 2023 fröse multimedia, Frank Fröse
**office@internetkundenservice.de · www.internetkundenservice.de**