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Analysis of Factors Related to Work Accident and Occupational Diseases in Mining

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Article Info	ABSTRACT
	Mining is known as a high risk industry with a high accident rate. However, there is a dearth of materials that aim to hide and understand mining accident research trends and current scenarios related to this topic. Therefore, this systematic assessment aims to investigate research trends in mining accidents. By applying the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) method, a systematic literature assessment (SLR) identified 57 cases related to mining accident issues from 2015 to 2019 from the ScienceDirect and Scopus databases. Based on these 57 studies, four main themes were raised, namely the main causes of mining accidents (46%), prevention of mining accidents (20%), and lawsuits (17%) and the impact of post-mining accidents (17%). The four themes produce a total of 35 sub-themes. Engineering failures are identified as a major cause of mining accidents and the application of safety software or models is essential to minimize the number of mining accidents. Mine owners have a responsibility to provide a safe working environment for their miners, and there are major challenges to achieving this. In addition, the impact of post-mining accidents has a negative impact on the environment. This systematic appraisal study aims to assist mine owners by providing a better understanding of the problem of mining accidents. This study is also addressed to miners, government, and policy makers so that all parties can jointly target mining accidents in the future.

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INTRODUCTION

Data mining and analysis of work accident data were invented. Data mining methods have been actively used in data analysis across several disciplines for several years (Chang and Wang, 2006). A cursory literature review reveals, however, that in analyzing occupational safety issues, and in particular, occupational accident data, the utilization of data mining tools has not been very common. Nevertheless, data mining methods can be applied also in analyzing data related to accidents and occupational safety. By definition, data mining lends itself well to, potentially, discover useful new knowledge. (Crossroads et al. 2022)

Defines data mining as "the analysis of observational data sets (often large) to find unexpected relationships and summarize the data in new ways that are understandable and useful to the data owner." It seems that data mining applications are becoming more common because the more recent the year of publication, the more relevant the literature can be.(Darda et al. 2023)

Common data mining techniques are association rules and decision trees. In studies where data mining techniques are used to analyze work accident data, the techniques used are considered applicable and useful

for analyzing work accidents. A key feature of the definition of data mining is seen as a profitable technique in this context. The prospect of generating new knowledge from large amounts of data and many variables, which often occurs in workplace accident data, is seen as one of the benefits of data mining techniques. Data mining is an interdisciplinary field and techniques from other disciplines can be applied. (Sentiment et al. 2013)

Statistics play an important role in data mining. However, larger data sets and secondary data are more commonly used in data mining, as opposed to statistics (Hand et al., 2001). In addition, data mining techniques usually do not require certain assumptions (e.g. variable independence) regarding datasets, which often limits the use of parametric statistical tests. In addition to its benefits, data mining also has limitations. For example, usability of results cannot be guaranteed in advance and domain knowledge of mined data is helpful, as model development may take time (Kumar, Gupta, and Raju 2020)

In addition, data mining techniques may best serve as complementary methods and should not be seen as an attempt to replace other techniques. Further research is still needed to gain more experience about the potential and application of data mining techniques in analyzing work accident data. Important goals to reduce occupational accidents and diseases have been set in EU countries. In many European post-industrial countries, such as Finland, the current challenges in the prevention of occupational accidents and diseases and the promotion of K3 stem from efforts to turn stagnant or even worsening developments in a positive direction again. To achieve the goal and restore the stagnant trend of workplace accidents to ease again, a new perspective for accident prevention may be needed. (Nenonen 2013)

Given the potential of data mining methods to reveal new knowledge from large data sets, they can provide new insights into the data in occupational accident databases and hence accident prevention. To the authors' knowledge, none of the Finnish studies used data mining methods to analyze workplace accident data. Slips, trippings and falls have been recognized internationally as the leading causes of workplace accidents. For example, in the United States, United Kingdom, and Sweden, occupational injuries related to slips, trips, and falls account for between 20 and 40% of occupational injuries. (Allmuttar and Alkhafaji 2023)

Work accident statistics have shown that almost 30% of all workplace accidents are related to slipping or tripping due to a fall, or fall. In addition, an increasing trend of occupational accidents related to slips, trips, and falls has been identified. In the United States alone, the annual direct cost of falling accidents is estimated at $6 billion. (Colbourne et al. 2022) estimates the cost of nearly $10 billion a year to the U.S. economy. In Finland, slips, trips, and fall-related accidents at work, home, and leisure time lead to annual direct national economic costs of 400 million Euros

There is a wealth of literature available on occupational accidents and injuries related to slipping, tripping, and falling, and the factors that contribute to these accidents have been widely discussed in the literature. In general, slips, trips, and falls are caused by a variety of interacting environmental, individual, and task and equipment factors that are affected by the organization/system and extra organizational influences. Slips, trips, and falls occur as a result of accidental or unexpected changes in contact between footwear and the lower surface of the foot Ground surface conditions, footwear, and gait patterns have been identified as major factors affecting the risk of slipping, tripping, and falling.(Kravetz and Schmidt-kastner 2023)

Low friction and easy slipping or poor grip between footwear and the bottom surface of the foot can be considered major risk factors for example, finding that cunning is a contributing factor to 40-50% of injuries from falls. Other risk factors mentioned in the literature include accident-related activity, aging, attention/distraction, fatigue, perceived danger, and urgency. The causes of slips, trips, and falls being complex, multidisciplinary research is needed to support the prevention of related accidents. (Trasierras, Luna, and Ventura 2023)

Research related to slipping, tripping, and falling focuses on topics such as human gait, coefficient of friction, kinetics and kinematics, gait adaptation in anticipation of slippery conditions, and recovery and recovery strategies. Despite extensive research, workplace accidents related to slips, trips, and falls are still common and cause significant occupational safety problems with human suffering and economic losses. Obviously, there is a need for more research to prevent these accidents more efficiently. (Chong and Collie 2022)

Although the factors that contribute to slipping, tripping, and falling are well known, the application of data mining methods can provide new insights into the analysis of work accident data related to slips, trips, and falls. On the other hand, previous bodies of research allowed a good comparison with the results provided by data mining. In addition, other researchers have pointed out that national injury surveillance systems tend to capture only extensive information about work-related slips, trips, and falls and they do not allow detailed injury assessment and development of preventive measures. In recent times, the classification and coding of occupational accidents at the national level has changed in EU countries (Ansari et al. 2019)

Workplace accidents are now classified according to the European Statistical method of Workplace Accidents (ESAW) across Europe. Therefore, it is interesting to analyze accidents associated with slips, trips, and falls in the workplace coded according to the new ESAW methodology. There are several factors associated

with slipping, tripping, and falling accidents in mining. Here are some of the factors found in machinery and equipment, such as the absence of personal protective equipment in the form of gloves. Environmental factors, such as wet or oily floor surfaces. Human factors, such as age, length of service, gender, level of knowledge, and level of education. Unsafe actions or unsafe conditions. Lack of management oversight

To analyze the factors related to occupational accident slips, trips, and falls in mining, it can be done by applying data mining methods to the statistical database of occupational accidents and diseases in mining. With this method, data analysis can be carried out to identify factors related to slipping, tripping, and falling work accidents in mining, so that appropriate precautions can be taken. Prevention can be done by providing training and education on work safety, improving working environment conditions, improving work equipment, and improving management supervision.

RESEARCH METHODOLOGY

This study used the Systematic Literature Review (SLR) method. With the help of the SLR method, it is possible to conduct a systematic review and identification of journals, with each step of the process involving the application of a certain predetermined set of rules. In addition, the SLR method has the ability to distinguish between subjective and objective, with the hope that the results of the latter will be used to expand the literature on the use of the SLR method in international journals. The questions used in this study are made by the needs of the chosen topic. Research questions that will be used include what are the factors that cause work accidents in labor, how the influence of age and experience, work, location, body parts with work accidents on labor, work systems (gas warning systems, ventilation systems, risk assessments, training, procedures and supervision) affect work accidents exposed to toxic gases, and the company's role in the occurrence of work accidents.

The data analyzed were taken from Indonesia's national occupational accident and disease statistics database managed by the Federation of Accident Insurance Institutions (FAII). The FAII database contains information on all occupational accidents and diseases compensated through statutory occupational accident insurance. Official statistics of occupational accidents and diseases are compiled based on the FAII database. In the Work Accident Insurance Law in Indonesia and hence in this data and study, a work accident is defined as any accident that causes injury or illness to an employee on the job, under circumstances arising from work, or when the employee tries to protect or save the employer's property or, in connection with work, human life. "Circumstances arising from employment" include when the employee is at work or in a work-related area, commuting from his home to work or vice versa, and attending business for an employer elsewhere. Here, the terms workplace accident or workplace accident are used to refer to an accident, which occurs when the injured employee is at work or in a work-related area or attending business for an employer elsewhere at the time the accident occurs. The term travel accident is used to refer to accidents that occur during the journey from home to work or vice versa

RESULTS AND DISCUSSION

Distribution of frequency of SSF-related work accidents and other work accidents, based on variables used in data mining analysis. Based on gender, age, and job class, SSF-related workplace accidents appear to be distributed in a similar way to other workplace accidents. Most occupational accidents in both categories involve men, the age group of 25-54 years, and the operation of manufacturing machinery and related occupations. However, when compared to other occupational accidents, the proportion of female and elderly workers is higher and the proportion of manufacturing work accidents is lower for SSF accidents. With other variables, there are more differences between SSF accidents in the workplace and accidents in other workplaces.

Work process in SSF work accidents occur most in movement, sports, and art activities (27%). Specific physical activity is movement (78%); its contact collides with or against a stationary object (77%); the type of injury is dislocation, sprains and strains (51%); The injured body parts were the lower extremities (45%) and the inability to work 30 days (47%). Other accidents in the workplace are most often associated with other categories except impact contact with or against stationary objects. The frequency of other workplace accidents (23%), however, is not as high as the frequency of SSF work accidents in this category (77%).

According to the model, the most important variable included in the analysis is specific physical activity. 56% of workplace accidents, which occur while the injured person is on the move (specific physical activity code 60: movement), are related to SSF. Only 5% of SSF accidents in the workplace are work-related with handheld equipment (specific physical activity code 20). The second most important influencing factor is the duration of inability to work. 74% of workplace accidents that occur while the injured are in motion and result in inability to work for more than 30 days are related to SSF. 61% of them resulted in 30 days of being unable to work.

When the inability to work less than 4 days, SSF accidents in the workplace involving movement are more common in managerial, administrative, and administrative jobs (61%) compared to other deviations. Correspondingly, while the inability to work is 4e30 days, SSF work accidents involving older (67%) are more common compared to other deviations. There are several factors associated with slipping, tripping, and falling accidents in mining. Here are some of the factors found:

- Machine and equipment factors, such as the absence of personal protective equipment in the form of gloves
- Environmental factors, such as wet or oily floor surfaces
- Human factors, such as age, length of service, gender, level of knowledge, and level of education
- Unsafe actions or unsafe conditions
- Lack of management oversight

To analyze the factors related to occupational accident slips, trips, and falls in mining, it can be done by applying data mining methods to the statistical database of occupational accidents and diseases in mining. With this method, data analysis can be carried out to identify factors related to slipping, tripping, and falling work accidents in mining, so that appropriate precautions can be taken. Prevention can be done by providing training and education on work safety, improving working environment conditions, improving work equipment, and improving management supervision. Here are some of the machinery and equipment factors that can cause slip, trip, and fall accidents in mining based on search results:

- Absence of personal protective equipment, such as gloves
- Safety tools or systems that are missing, incomplete, and not functioning properly
- Inadequate environmental conditions, such as wet or oily floor surfaces
- Technical factors, such as inadequate machine safety equipment
- Lack of adequate work equipment

To prevent slipping, tripping, and falling accidents in mining, there needs to be serious attention from management in providing adequate work equipment and personal protective equipment in accordance with work safety standards. In addition, it is necessary to carry out regular maintenance and repair on the tools and machines used in order to function properly and minimize the risk of accidents. Employees also need to be trained and educated about work safety and the use of appropriate work equipment. Here are some personal protective equipment needed in mining to prevent slipping, tripping, and falling accidents:

- Shoes or boots that have anti-slip and waterproof soles
- Knee and elbow guards
- Gloves suitable for the type of work
- Safety helmet equipped with ear protector and safety glasses
- Body safety devices, such as safety vests and seat belts
- Fall safety devices, such as safety ropes and fall safety
- Protective mask to protect the respiratory tract from dust and smoke

Adequate personal protective equipment can help prevent slips, trips, and falls in mining accidents. In addition, it is necessary to carry out regular maintenance and repair of personal protective equipment in order to function properly and minimize the risk of accidents. Employees also need to be trained and educated on the proper use of personal protective equipment and the importance of work safety.

CONCLUSION

Despite extensive research, slips, trips, and falls related to workplace accidents still seem to be topical occupational safety issues. In this study workplace accidents related to slipping, tripping, and falling accounted for 22% of all work accidents Data mining methods have the potential to discover useful new knowledge from large data sets such as occupational accident databases. In this study, decision tree methods and data mining association rules were applied for the first time in the Finnish occupational accident and disease statistics database to analyze SSF accidents in the workplace.

The results of this study support the results of previous studies. The main factors associated with SSF accidents in the workplace include certain physical activity of movement, collision with or against stationary objects, age, and job class. SSF accidents in the workplace are also more common than accidents in other workplaces. The most common injuries are dislocations, sprains and strains, or with more severe accidents, fractures. In the sense that similar precautions as recommended in previous studies still apply. In addition, the application of data mining methods is considered successful because the results are in line with previous research.

Despite its potential, the methods used here do not reveal anything particularly surprising or unexpected Nevertheless, as mentioned in several previous studies on accident data analysis with data mining methods as well, data mining methods are seen as useful complementary methods. The wide range of terminology and focus in research on workplace slip, trip, and fall accidents hinders reliable comparisons between studies. For example in the application of ESAW methodology in Indonesia, 'at level' and 'to a lesser level' SSF accidents in the workplace are not differentiated.

From the point of view of accident prevention it would be useful to be able to distinguish between these accidents because the circumstances, causes and consequences of these accidents are different. Similar problems may exist in other countries depending on the application of the ESAW methodology. In addition, organizational factors (such as the influence of safety culture), recently emphasized in the prevention of slips, trips, and falls, usually cannot be detected directly from national occupational accident databases. The narrative descriptions included in the database may provide some additional information.

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