

Ergonomics in Mining: An Investigation on Occupational Safety in Indonesian Tin Mining

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ABSTRACT

Thousands of employees in small and medium enterprises (SMEs) in the tin mining industry work in hazardous environments without adequate safety and health protection programs. Occupational safety (OS) is the main focus in terms of preventing dangerous incidents that can cause serious injury and death, given that mining involves hazardous and high-risk activities. This article presents the results of a series of studies on participatory ergonomics (PE) in Indonesian tin mining. It describes an investigation into occupational safety and on how PE can be implemented. The purpose of this study is to see occupational safety conditions in Indonesian tin mining in a certain period to see the phenomenon of work safety, especially in small-medium enterprises under tin company work contracts. This study was conducted by requesting data by post, interviews with participants including representatives of local governments, tin companies, and small and medium enterprises (SMEs). This study shows that support from OS authorities is needed to strengthen workers' knowledge of ergonomics and good safety practices and to enable them to apply ergonomics through training and participatory approaches. The results of this study can contribute to the implementation of PE. As a consequence of better implementation, tin mining accidents can be reduced.

Keywords: participatory ergonomics, SMEs, tin mining.

1. Introduction

In Indonesia, tin mining has been operating for more than 300 years. Located in Bangka Belitung islands, tin mining is continue to produce around 90% of Indonesia's tin and fulfills 30% of the world's tin requirements [6], [11]. In fact, Indonesia is the world's second-largest tin exporter after China [2]. Since 2000, Bangka and Belitung Island became new province and through the regional autonomy, illegal miners have emerged developed as local government has the ability to issue permission where central government has not [1]. Tin mining activity can be done by small scale miners and even by individuals who do not have experience and knowledge of mining best practices. Consequences to illegal mining practice with unsafe devices, lack of knowledge about the tin mining exploitation process and limited funds result in dangerous incidents, accidents and even fatalities. This could be the reason why the number of occupational accidents in the mining industry sector is relatively high when compared to other industry sectors [9].

One of the approaches to support ergonomics intervention is participatory ergonomics (PE). Wilson et.al [15] defined participatory ergonomics as 'the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes in order to achieve desirable goal'. The implementation of PE has been applying in many fields and industries such as in military, manufacturing, production and processing plants, service industries, construction and transportation [5], [7].

In review of ergonomics applications in industrially developing countries (IDCs), Hermawati et al. [4] posited the view that a participatory approach is needed as a bottom-up approach in implementing ergonomics at workplace. They also suggested that by 'having an appropriate adaptation and modification of ergonomics tools will definitely

be beneficial in the future'. Hermawati et al [4] found that there are few studies addressing the health and safety domain in Indonesia, and the mining sector, which was shown to have the least number of ergonomics application.

So far there has been little research on PE in Indonesia; the research work that has been done has tended to focus on the physical ergonomics rather than organizational ergonomics [4]. To the best of authors knowledge, there are no other scientific publications that discuss the implementation of participatory ergonomics (PE) in occupational safety in Indonesian tin mining.

The aim of this research was to investigate the current status of occupational safety in Indonesian Tin Mining. This paper's main contribution is on the identification by the actual condition of PE issues, new approach to measure participation, and future research recommendation in addressing identified problems. Although this paper is focus on Indonesian tin mining companies, it is expected that this findings will also be useful for other IDCs where tin mining SMEs is one source of employment.

2. Methods

This research was conducted to investigate into the current status of occupational safety (OS) in Indonesian tin mining. Although there are illegal tin mining activities done by individuals or groups these activities are uncontrolled, and therefore the opportunity for influence or change would be minimal; thus, the research for this study has been conducted only in legal tin mining under the small medium enterprises (SMEs), the state-owned tin company, P.T. Timah (Persero) Tbk referred to from here as PT. Timah, and local government i.e. Manpower and Transmigration Office (MTO).

The study used postal data request and semi-structured interviews to the employees of tin companies and to local representative government. Each will be described in detail in the following.

1. Postal data request was conducted to gather data related to the number of working accident/fatality during 10 years from 2004 to 2013 and the training subjects for employees that implemented in 2014. The author was approached PT. Timah by sending letters to the Head of Safety, Health and Environmental Department (SHED) and the Head of Human Resource Department (HRD) to request the required data. SHED and HRD were given the required data by email to the author in Microsoft Excel format. Meanwhile, the number of PT. Timah employee's data was collected from PT. Timah's Annual Review that available online from 2008 to 2013.
2. Interviews were carried on investigation into the existing OS in Indonesian tin mining. The semi-structured interview was prepared for each party to identify the OS program and injuries experiences in the work places. Eighteen participants within four parties: local government i.e. MTO ($n = 2$), PT Timah's OSH Department ($n = 5$), Training Department ($n = 2$), and employees in SMEs under PT Timah's cooperation ($n = 9$). They were all male, ranging in age from 27 to 69 years ($M = 38$ years; $SD = 10.8$ years) and had an average of 7.1 years' experience in their roles ($SD = 4.9$). The interviews were conducted in two cities i.e. Sungailiat and Pangkalpinang. The main questions for them were incorporated into three research question categories: kinds of injuries occur in Indonesian tin mining, how is the OS standard performing, and is there any safety training in the Indonesian tin mining? How is it conducted? The expected information gathered from interviewees were specific injuries in tin mining, occupational safety, and OS training and research.

3. Results

3.1 Postal Data Request

The Figure 1 shows the number of injuries with three classifications i.e. fatality, major injuries and minor injuries for 10 years period from 2004 until 2013. These numbers applied to register mine workers included workers in the SMEs under PT. Timah's supervision. The most prominent from this data is the number of fatalities in 2004 and this striking number was the peak of fatalities along the time. Aside from this, the numbers of fatalities were relatively similar through the years. Major and minor injuries fluctuated along the ten years period.

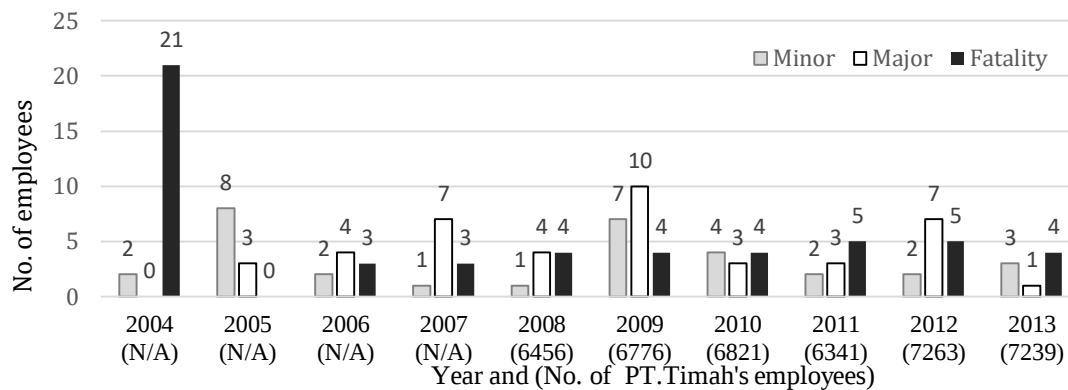


Figure 1. Number of injuries in Indonesian tin mining

PT. Timah's data related to training implementation was gathered and according to the data, there were 180 training events with 3,283 employees participants throughout the year in 2014. As the company's standard operating procedure stated, there are five training categories, i.e. technical, managerial, certification, leadership and basic training. Figure 2 shows the percentage of training types conducted in 2014. In terms of safety and health issues, there were some training related to OSH, i.e. company hygiene, health and safety for paramedic ($n = 6$), safety certification for chemists ($n = 3$), OSH management system-OHSAS 18001 ($n = 1$), firefighting ($n = 78$), safety in tank maintenance ($n = 10$), onshore mining safety and health supervision ($n = 80$), and health and safety training ($n = 28$).

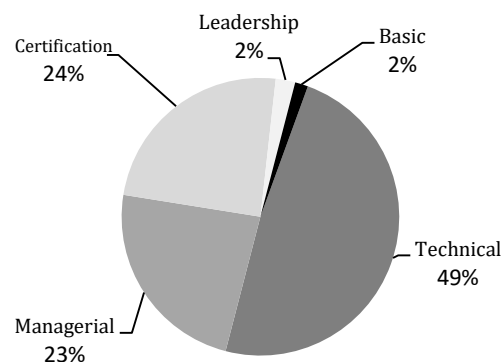


Figure 2. Training types

3.2. Interviews

The interview participants were from local government i.e. Manpower and Transmigration Office and five tin companies, i.e. in state-owned companies, private SMEs and private SMEs under state-owned supervision. It is noted that some participants were act as double roles, for example, managers of SMEs often act as OSH and training staff as well. This situation in SMEs is common where SMEs are characterized as managed by the owner in a non-formal way [8].

3.2.1 Local Representative Government

Local representative government has a responsibility in supervising mining companies. MTO was one of local government offices that managing and supervising employment issues in enterprises. During the interview, they admitted that the office has a problem related to lacking the number of qualified staff to conduct those roles. To overcome this deficiency, third parties or consultants were used especially in certifying standards of specific equipment.

MTO stated that one of the possibilities of working accident was lack of dissemination of mining practices and mining safety. In fact, in terms of supporting OSH, some acts and rules are still in debated inter organizations involved in, i.e. tin companies, MTO, District Mining Office, District Health Office in the perception of implementing acts and rules.

In OS issue, there was a tendency that the numbers of accident reported to MTO has been in decline due to them promoting zero accident programs to get a company's good impression in their product market demand. One of the MTO staffs was said:

"I think its trend is declining sir, but its declining is not because of their awareness doing OSH programs but because of corporate image. They have to sell their products but they have to fulfil the requirement in safety aspects in their companies, such as standards like ISO, OSHAS, SMK3 or other safety or management standards".

"..It relates to SR FR or safety rate and frequency rate and concern about fatality. They reach this thing to get a zero accident. It is booming".

Due to technology develop rapidly, MTO suggested to central government to revise the law umbrella of employment in Act No. 1/1970 and Ministry Act No.19 /2012 as the rules are not covered in the new technological aspects.

3.2.2 PT Timah and SMEs' OSH Department

In the OSH staff point of view, the law umbrella for general OSH in Indonesia is Act No. 1 / 1970 which is under responsibility of Ministry of Employment and Transmigration. There were some derivatives that used by other Ministry, such as Act No. 555 / 2012 about general mining used by Ministry of Energy and Mineral Resources. They seem confused and overlapping.

OSH standards used are ISO 9000, ISO 14000 and company-owned standard. Only PT. Timah use ISO as its standard for their operations and some of them refer to other international standards. The standards are good in writing but lacking in practice with regards to workers' awareness, worker behaviours, and good corporate governance. The lacks of supervising, safety climate, unskilled and changeable employees, and lack of management commitment were claimed as the basic reasons for accident occurrence. Moreover, SMEs under PT. Timah were said to be the cause of a high numbers of injuries.

Informal training was conducted by SME's in the form of safety talk at least fortnightly and everyday basis as in their break time or before working by supervisors. Meanwhile, local government provides technical meetings in yearly basis or paid-training which are non-compulsory for SMEs. One of problems in SMEs in conducting training was a budget issue. Instead of send the employees to get paid-training; SMEs were willing to have internal training by means of technical meetings and safety talk. However, OSH training was needed as a form of sharing OSH experience from other companies practice facilitated by local government.

SMEs, through the Advisory Team on Occupational Health and Safety (*Panitia Pembina Keselamatan dan Kesehatan Kerja - P2K3*), should reported OSH evaluation every 3 months to MTO and it was always asked if they were not submitted it. However, there was no specific response or feedback on their reports. This lack of communication leads to an ineffective running of OSH programs.

3.2.3 PT Timah's Training Department

PT. Timah has training centre as part of their human resources development program including OS. OSH Department also conducting training for specific purposes. The training are modular, and on the job training (OJT) system. Training centre also manage school and university students in managing OJT and or data collections. The OS training conducted by PT. Timah is only for PT. Timah's employee and for SMEs heavy-duty vehicle operators, as they have to have certification as mining operators.

3.2.4 Tin Mining Employees

All interviewed participants, from SMEs, had an experienced or witnessed a work accident in onshore exploitation and in smelters plant. Some accident cases were not reported to management due to fear of punishment. Most of the health cases in SMEs were 'just tired' and they need a rest after getting permission from the owners. Sadly, in

SMEs under PT. Timah, employees are not covered by health insurance except who work at 'the front' i.e. the place where a process of muddy-material sucked by pumping system which is hot, wet, muddy and danger area. This is a SMEs owner initiative to pay for their health expenditures. However, the 'front' employees are unskilled and changeable. Most of them were decided not actively working anymore due to their health condition.

The use of personal protective equipment (PPE), its quality and its inventory are common problems in SMEs. Moreover, employee status, result-based remuneration system triggers employees to ignore work safety. On the other hand, employees suggested that companies' management must have commitment to OS programs. The P2K3 were formed as a government initiative to support the improvement of OSH in SMEs, but it seems it was not effective in an employee point of view.

4. Discussion

The main law on OS is the Work Safety Act (Law No. 1, 1970). This law covers all workplaces and emphasis primary prevention. Nevertheless, there is a debate whether this act is satisfy to protect workers [9]. She explained that The International Labor Organization (ILO) recommends that the main Law No. 1 of 1970 on Work Safety be upgraded to a stronger occupational safety and health (OSH) Act reflecting more clearly the provisions of the ILO's Occupational Safety and Health Convention (No. 155, 1980). However, Topobroto [13] highlighted that current laws are sufficient for implementing the necessary OSH measures. It was pointed out that 'the weakness rests on the enforcement of the laws as well as on low awareness, behaviour, and conduct to instil safety and health culture at enterprises'. In addition to this, Indonesia has problems with enforcement of OSH i.e. limited competent inspectors, resources to conduct adequate number of inspections [3]. Topobroto [13] persuades to formulate a realistic and concrete action OSH programs to enable all parties concerned to participate and contribute. Due the fact that there were lacking of practicing OSH standards, implementing of PE could improve workers' awareness and management commitment. Employee involvement can motivate the successful of ergonomics intervention in the work place. To support this, management must provide resources available for the intervention i.e. training and tools for implementing improvements.

In terms of injuries/accident data, SMEs tend to not keep it properly as they do not have a specific OSH structure in the organization. OSH is a part of human resources manager or operation manager. It is not focused since SMEs employees is not much and OSH programs still assumed as need unnecessary cost. SMEs management are tending to make report on their productivity by calculating production efficiency. Meanwhile, larger company, PT.Timah, has standards and procedures for their specific operations, so the accuracy of data related to safety and health is cleared and provided. PT.Timah has implemented good practices in their safety and health aspects, even though a fatality had occurred in this company. In private SMEs of smelter, there is no evidence of fatalities but it was found that they had no good recording for accidental data.

As the characteristic of SMEs, they generally have a lack formal documentation since they are in informally managed by the owners and work under pressure of financial and tight margin, high potential of failures and more reliant on trusted relationship [8]. It could be some reasons why OSH in SMEs is not the same with larger enterprises in practicing OSH. Legg, et al. [8] studied that policies and legislation on OSH still based on larger enterprises (usually defined as companies with more than 250 employees). He observed that 'some characteristics of SMEs make it more difficult for them to create and maintain a safe and healthy work environment and to manage safety'. Moreover, he exploited the view that SMEs' characteristics compare to larger enterprise are: low level of management and training skills, lack of resources, burden of compliance with regulations, difficulties in implementing and understanding safety practices.

MTO argued that there is a tendency that the numbers of accident reported to MTO has been decreasing due to targeting zero accident programs to get a company's image in their product market demand. Organizational and personal factors could affect the accident report for many reasons i.e. organizational processes and incentive programs [12]. Injury-free bonus, safety incentives could make employees may not report an injury, which would mean they get reward [10]. For example, there was one tin company applied a zero accident program that allowed employees in a group could get a bonus if no one of them get an injury in a certain period of time. This top-down approach program would create employee to remind each other about safety at workplace but the other side, employees tend to not report the accident even though there is no injury. In addition, some accident cases were not reported to management due to fear of punishment (Interview with one of SMEs). Moreover, McKinnon [10] discussed that prize or awards as an injury-free bonus are a 'behaviour modification' way so-called positive reinforcement that is as bad as negative reinforcement.

One of central government initiatives to improve the enforcement of OSH at workplace for SMEs is the establishment of Advisory Team on Occupational Health and Safety (*Panitia Pembina Keselamatan dan kesehatan Kerja* or P2K3) in every SME. This P2K3 acting as an extension of local government responsibility. However, many employees are not familiar with this team role and due to insufficient staffs; supervision from MTO seems not effective. Moreover, the P2K3 are not focus on application OSH but rather it is an administrative work.

There was evidence that management is lack in giving OSH coaching or training in the fields/workplace. One of problems in SMEs in conducting training is budget issue. Instead of sending the employees to get paid-training; SMEs are willing to have internal training by means of technical meetings and safety talks. Sadly, not all employees get training. Training provided was only for certain workers and it is rare, so employees need OSH training. However, in larger company, there are programs that focus on improvement of safety and health in workplace such as safety training in training centre, applications of risk assessment such as job safety analysis (JSA) and regular safety and health meeting in OSH Department that support the top management in establishing the planned annual target. Moreover, local government provides technical meetings and/or paid-training which are non-compulsory to tin mining SMEs.

Furthermore, during this study, it was not clear that ergonomics intervention had been applied in tin mining SMEs. Even though the questions of interviews were not directly mentioned to an ergonomics issues, but from direct observations and a few questions regarding ergonomics in workplace, i.e. quality circles application were not considered as an important issues. In Indonesia, there is evident of ergonomics application. However, it is limited and participatory ergonomics (PE) is not the most common approach and 'PE application is still focused on the physical ergonomics domain' [4]. Moreover, they stated that 'all of the reviewed studies were geared towards resolving existing and particular issues in SMEs. As a result, the contribution of the studies towards the wider knowledge of ergonomics was limited'.

Through discussion above, there are some points can be highlighted and essential information:

- 1) Larger tin mining company, PT.Timah, has been operating for more than 50 years and has a considerable experience in practicing tin mining operations including OSH issues in its company. However, since a decade, this company had to give their tin mining operational focus to approximately 16 private onshore SMEs in around 400 locations under of PT.Timah cooperation scheme. Unfortunately, OSH issues were not fully included in the scheme. Thousands of SMEs employees are working in dangerous environment without sufficient safety and health protection program.
- 2) Private smelters SMEs are relatively new establishment plants. Although the organizational structure is relatively better than private onshore SMEs, OSH issues are still need to be considered in order to better and safer workplace.
- 3) It is proved that ergonomics was not seen an important issue, especially in private onshore SMEs and during interview with employees, it is a need to have information by means of sharing knowledge about OS and the desire to give valuable practice as a sign of participatory approach in solving workplace problems.

Above it all, ergonomics cannot be ignored by any industries. In fact, industries need ergonomics to improve productivity, safety, and health. OSH-related problems that emerge, including work accidents, are mostly because of ergonomics deficiency [14].

Conclusions

It is found that many problems occurred especially in occupational safety issues in SMEs. Local government, tin mining companies, and employees have their own OS issues that need to be addressed. Furthermore, the investigation on acceptability and suitability of PE intervention within Indonesian tin mining SMEs has revealed some important issues. Despite the floor workers are accept the PE approach to improve occupational safety, the study distinctly prove that support from OSH authorities are needed in order to strengthen workers' knowledge in ergonomics, good safety practices and allow them implemented ergonomics through training and participatory approach. The findings of this study offered new information on specific barriers to implementation of participatory ergonomics intervention.

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