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EVALUATING THE EFFECTIVENESS OF MINING LEGISLATION IN ENHANCING OCCUPATIONAL HEALTH AND SAFETY IN KHYBER PAKHTUNKHWA, PAKISTAN

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Abstract

The mining sector is a critical component of Pakistan's economy and serves as an important source of employment in the province of Khyber Pakhtunkhwa (KP). However, the industry continues to face serious occupational health and safety (OHS) challenges due to inadequate enforcement of mining regulations, outdated mining practices, limited technological adoption, and insufficient regulatory oversight. This study evaluates the effectiveness of mining legislation and its implementation in improving occupational safety and health within the mining sector of KP, Pakistan. A mixed-method research approach was adopted, combining quantitative and qualitative data collection techniques. Information was gathered through structured questionnaires, online surveys, field observations, and interviews involving 340 mine workers and 22 mine inspectors from 30 districts of Khyber Pakhtunkhwa. The collected data were analyzed using the Statistical Package for Social Sciences (SPSS). The results revealed that the mining workforce is predominantly young, with a large proportion of workers possessing limited formal education and belonging to low-income socioeconomic groups. Nearly half of the workers were found to be illiterate, while most were employed in frontline mining activities. These conditions reduce workers' ability to understand safety instructions, regulations, and hazard warnings, thereby increasing their exposure to occupational risks. Furthermore, production-based payment systems encourage workers to prioritize output over safety, often leading to unsafe practices and non-compliance with established regulations. The study found that existing mining legislation, including the Khyber Pakhtunkhwa Mines Safety, Inspection and Regulation

Act, has contributed positively to improving workplace safety and provided a useful framework for regulating mining activities. However, significant deficiencies remain in the practical implementation of these laws. A shortage of inspectors, limited field inspections, inadequate documentation of violations, insufficient training opportunities, and weak enforcement mechanisms continue to hinder effective compliance. Field observations further revealed poor use of personal protective equipment (PPE), reliance on manual mining methods, and inadequate adherence to safety standards despite the existence of regulatory requirements. The quality of legal proceedings and compensation is generally viewed as satisfactory, but the success rate of prosecutions remained relatively low, reducing the deterrent effect of regulatory actions. In addition, a substantial proportion of safety violations were not formally documented, limiting the ability of regulatory authorities to monitor trends and implement corrective measures effectively. Overall, the study concludes that while the legislative framework governing occupational health and safety in KP's mining sector is generally adequate, its effectiveness is constrained by weaknesses in implementation and enforcement. To improve mine safety performance, the study recommends increasing the number of mine inspectors, strengthening inspection and monitoring systems, enhancing training programs for both workers and inspectors, improving accident reporting and violation-recording mechanisms, adopting modern safety technologies, and enforcing stricter legal action against non-compliant operators. Effective implementation of these measures would contribute to safer working conditions, lower accident rates, improved worker welfare, and the sustainable development of Pakistan's mining industry.

1. Introduction

Mining is unsafe, due to both occupational injuries and illnesses (Jamison et al., 2017) and hence considered the most hazardous industry in the world, which exposes workers to dangerous conditions and a higher risk of accidents. Among mining, underground coal mining is the most hazardous as compared to others. The physical and chemical like (flammability, toxicity, and carcinogenicity), risks found in mines cause safety and health problems. Occupational Health and Safety (OH&S) is a multidisciplinary scientific field dedicated to the anticipation, recognition, evaluation, and control of hazards arising in or from the workplace that could impair the routine activities along with the health and well-being of workers (Fanning et al., 2003). According to the World Health Organization (WHO) and International Labor Organization (ILO), occupational health aims to promote and maintain the highest degree of physical, mental, and social well-being of workers in all occupations, prevent health hazards caused by working conditions, and to protect workers from risks resulting

from adverse workplace factors, Ohio Peace Officer Training Academy (OPTA). There are fewer chances of accidents or property damage, as well as fewer instances of employee disability, in a safe and healthy workplace. Occupational health and safety regulations must be more flexible at all workplaces due to the quick changes in life and technology (Leamon et al., 2001). According to current estimates from the International Labor Organization (ILO, 2023), between 160 and 270 million workers experience accidents or occupational disorders annually. Inadequate medical facilities, an ignorant workforce, and other issues contribute to the concerning state of Occupational Health and Safety (OH&S) in developing nations like Pakistan. A motivated and healthy workforce is essential for economic growth and productivity. Pakistan, like many developing countries, is experiencing a transitional phase in its economy. Globalization of world trade is bringing new challenges in the field of OHS. (Pasha et. al., 2003).

The mining and quarrying sector in Pakistan experienced a growth of 4.9% in fiscal year 2024, contributed 13.6% of the overall GDP, according to the Finance Division (Government of Pakistan, 2024). Due to their informal and frequently migratory nature, many mining operations in Pakistan remain poorly regulated with respect to the occupational health and safety. Despite the creation of legislative frameworks like as the Mine Act 1923 and the Khyber Pakhtunkhwa Mines Safety, Inspection and Regulation Act, 2019, implementation of these laws is nevertheless lax, especially in underground sectors. As a result, the mining sector continues to face numerous avoidable events, from silicosis deaths to gas explosions and mine collapses, underscoring the critical need for more inspector capacity and stricter safety oversight. (Human Rights Commission of Pakistan, 2023; Global Union, 2023; ILO Committee observations, 2024). Consequently, the relationship between economic output and health and safety measures has become an issue of international concern (Joy 2004). Pakistan's mining safety situation has been worse than safety standards in countries like China, India, and Turkey. These nations have implemented different initiatives, including increased research and development, technological innovation, and frequent changes to mining regulations (Maiti, J et al, 2009). However, Pakistan continues to be hampered by its antiquated mining practices, which do not adhere to modern safety regulations (Panhwar, 2017).

The mining sector of Pakistan faces numerous challenges, including low socioeconomic status, lack of implementation of laws, unfavorable working conditions, and lack of safety precautions (Jiskani et al., 2018). Workers are the backbone of an industry. A safe and healthy workplace improves employees' performance, eventually impacting an industry's expansion. Small-scale mining operations are dangerous and can result in illness and accidents due to a lack of resources and an unhealthy environment, and small-scale mining is very common in Pakistan. The most frequent mine-related dangers are gases, dust, weak roofs, low heights of underground openings, inadequate ventilation systems, mine fires, water floods, and explosions (Quanlong et al., 2016; Amponsah et al., 2013). In Pakistan, many mining operations remain informal and conventional method, characterized by limited safety equipment, low-skilled labor, and minimal enforcement of occupational health and safety standards. These conditions continue to precipitate frequent, preventable accidents, injuries, and occupational illnesses. Notably, between early 2023 and mid-2024, provinces like Balochistan and Khyber Pakhtunkhwa reported hundreds of fatal mining incidents often associated with insufficient mine inspections and lack of protective infrastructure (ILO Committee 2024; Industrial 2022.

Pakistan has a high rate of mining accidents due to several factors. One major factor is the use of risky and outdated mining methods. Several mines in KP continue to use outdated mining methods that go back hundreds of years. The risks of modern mining are not considered by these methods, which are often dangerous and inefficient. Our research focuses on the impact of Implementation process of legislation on

occupational Safety and Health in Mining Industry of Khyber Pakhtunkhwa (KP), also evaluate the existing implementation of mining legislation in KP, and to assess the impact of reforms incorporated by the inspectorate of mines and minerals KP to improve the state of occupational health and safety in mining sector of the province in particular and of the country in general. The mining industry in Khyber Pakhtunkhwa province is a significant contributor to the country's economy, employing approximately 20,000 workers. However, the mining industry has significant health and safety issues, which contribute to the high rate of workplace fatalities and injuries. This discussion examines the major health and safety concerns faced by Khyber Pakhtunkhwa miners as well as the underlying reasons and potential solutions. For example, a study of KP coal miners found that 36.6% had trouble breathing 31.9% coughed, 59.3% had skin disorders and 57.4% had eye problems. Additionally chronic diseases such as diabetes and hypertension were also prevalent among workers (Thebo et al., 2024). The working condition exposes miners to coal dust, toxic gases like methane, and physical hazards such as mine collapses and landslides. These conditions contribute to frequent accidents and fatalities. In 2023 over 100 mine workers were reported died with many more injured, especially in unregistered mines where safety protocols are grossly inadequate (Shahani et al., 2025).

According to Sherin et al. (2020) the statistics information about workers shows that most of them were under 26 years old and most of them had 1-10 years of relevant work experience. Also, approximately 10 percent of the employees were in supervisory roles, with more than 70 percent being frontline or face workers who were directly involved in the operations and mining of minerals. This distribution shows a large proportion of young workforce with a relatively low level of experience, mostly engaged in direct labor positions, but not in supervisory positions. The literacy level of workers that N. Ambreen et al. (2012) indicated, is 62% and their low-income level, long working hours (12-14 hours a day) and working in harsh weather conditions without shelter are consistent with the general results of labor force literacy and working conditions of our study. Likewise, low literacy skills are likely to be utilized in low-skilled jobs and are more prone to precarious employment terms low pay, and fewer workplace benefits. (Dixon et al., 2010). The relationship between literacy, poverty, and working conditions is well-evidenced. Poor literacy is linked to lower income and higher likelihood of engaging in hazardous or strenuous work, often with extended hours and minimal safety measures. (Toor. 2005). Recent inspection data show that the number of physical visits to mining sites has grown by 84% due to increased regulatory attention and the desire to enhance workplace safety. This observation is consistent with the current literature that has found that poor ventilation systems, lack of personal protective equipment (PPE), and lack of overall safety training of workers are the main causes of hazardous working conditions in mines. As an example, a study by Thebo et al. (2024) revealed that formal safety training was provided to only 3.8% of coal mine workers, which highlights a severe lack of occupational health and safety in the mining industry (ILO 2023). The legislation regulating occupational health and safety (OHS) procedures in Pakistan remains unclear and insufficiently enforced despite Pakistan's ratification of several international labor organization (ILO) conventions aimed at improving worker safety. Implementation of these agreements is still lacking, contributing to ongoing occupational hazards (Singh and Goyal, 2019). Additional studies from other countries highlight similar trends where work demands and family responsibilities increase injury risks. For example research from the U.S. shows that both family and work demand increase the probability of workplace injuries, with energy-related demands such as shift work and the number of children being strongly related to injury risk. Moreover occupational injury rates tend to be higher among male workers and those in precarious employment arrangements such as independent contracting (Nestoriak et al., 2007). The issue is made worse by the lack of a national system for documenting occupational injuries, which results in

underreporting and incomplete information on workplace safety (Muzammil 2020).

Batool et al., 2015, highlights that despite the critical role of OHS standards in boosting productivity and supporting economic growth, improvements in these standards are progressing too slowly. The study emphasizes the urgent need for effective identification and management of OHS issues, advocating for substantial reforms rather than incremental changes. Furthermore, Yaqoob et al., 2024, observed that a considerable number of employees remain untrained in safety procedures and the absence of formal training programs significantly increases this vulnerability to occupational hazards.

Based on the above discussion on mining safety practices and regulatory frameworks Figure 1 shows a conceptual framework of how the Mining Act can enhance Occupational Health and Safety (OHS) in the mining industry. The framework, which is concerned with the implementation of legislation recognizes six interconnected factors that jointly regulate safety performance: worker training, risk assessment and hazard identification, compliance with regulations, mine inspection, enforcement by violation notice, and awareness of mining laws. The initial one is awareness and training that provides the operators and employees with the information they require to understand and adhere to safety regulations. Risk assessment and hazard identification processes are methodical and make proactive reduction of risks in the workplace possible. Compliance with the current regulations ensures operational compliance with the specified safety standards and is verified through regular mine inspections conducted by regulatory agencies. One of the enforcement measures that strengthen accountability and deter non-compliance is the sending of violation notices. These factors combine to form a comprehensive regulatory loop that safeguards the welfare of workers, reduces occupational incidents, and enhances a sustainable safety culture within the mining industry

Figure 1. Role of the Mining Act in improving Occupational Health and Safety (OHS) in the mining industry

2. Problem Statement

Safety is a critical aspect that must be prioritized in any project or industry with the mining sector being especially vulnerable to hazards. The current research aims to analyze how legislation has contributed to enhancing safety measures for miners in the Province of Khyber Pakhtunkhwa Pakistan. Additionally, it focuses on evaluating the effectiveness of current implementation of the existing mining legislation in the province to identify areas for improvement.

3. Methodology

The research is designed for the study combines integrating both quantitative and qualitative approaches to collect and analyze data through field surveys, to assess the impact of mining legislation on occupational safety and health within the mining industry of Khyber Pakhtunkhwa.

Figure 2 represents a flow chart of the steps in which the research is conducted. In the first step, field visits were carried out and data was collected through questionnaires. The data for the study were collected in two distinct phases involving two different respondent groups: (a) Mine Inspectors and (b) Mine Workers. In the first phase, data was gathered from mine inspectors from all thirty districts of Khyber Pakhtunkhwa (KP). Data from mine workers working at both surface and underground mining sites in the same areas was gathered in the second phase. Two data collection techniques were used to guarantee thorough coverage and accessibility. Google Forms were used to conduct interviews and administer an online survey. To help employees better comprehend the questions and provide more accurate answers, the questionnaire was translated to Urdu, the native language. In order to gather data from mine inspectors and mine workers throughout Khyber Pakhtunkhwa, the study used a representative sample technique. An online Google form was used to collect data, and it was sent by email to the Khyber Pakhtunkhwa government's Inspectorate of Mines. Out of thirty inspectors, twenty-two responded to the survey while one response was invalid, resulting in a final valid response count of twenty-one inspectors.

The total registered workforce involved in surface and underground mining operations in KP is estimated by the Inspectorate of Mines, Government of KP, to be between 15,000 and 20,000. However, the Inspectorate of Mines and Minerals KP reports that during data collection and field visits, the number of registered mine workers falls below this estimate. Depending on the kind of mining operation these workers are mostly concentrated in particular districts. The Buner district, which has a greater number of surface mine workers is home to the majority of surface mining activities, especially those involve the extraction of dimension stone. On the other hand, majority of the underground mine workers are engaged in the districts of Kohat and Dara Adam Khel where underground mining operations mostly coal mining is concentrated.

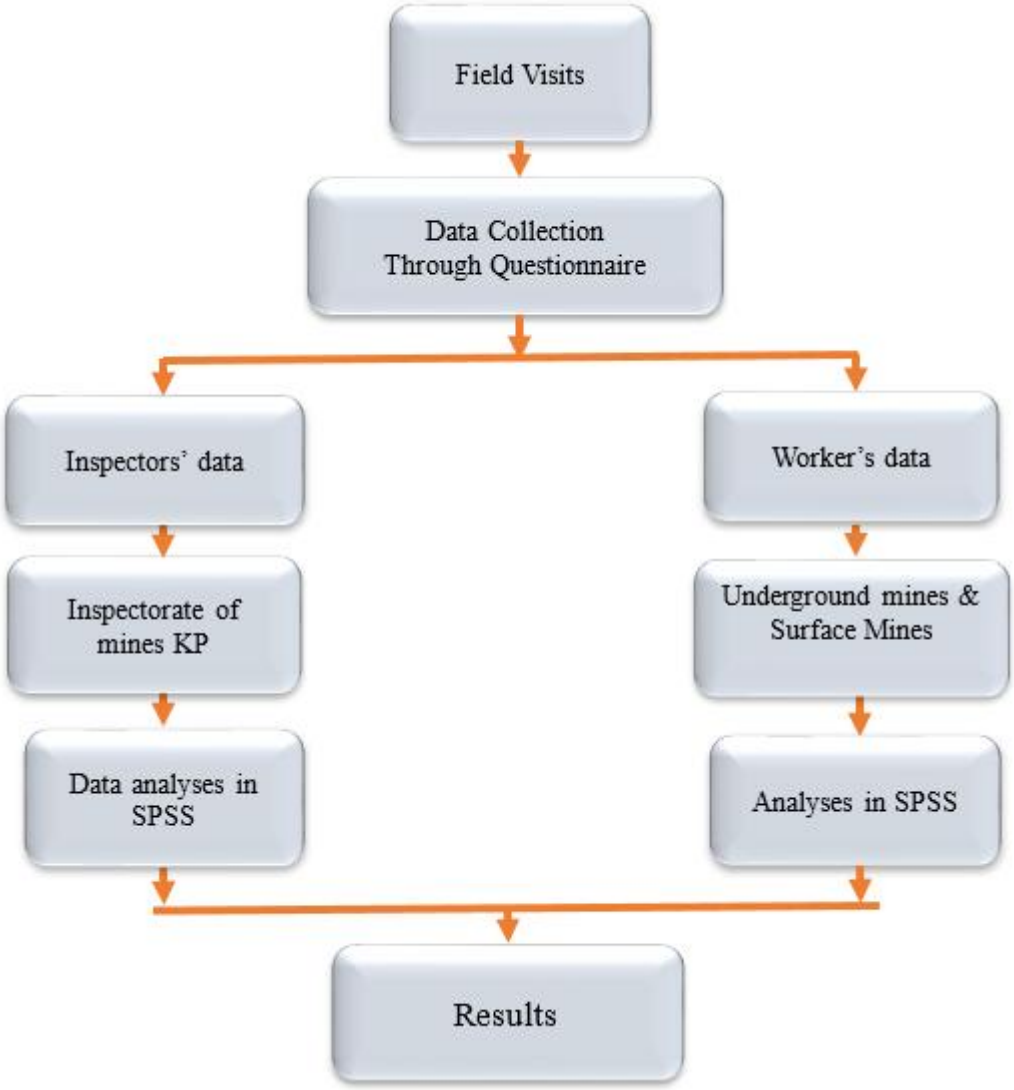

Figure 2 Flow Chart of the Study

Samples were chosen randomly from surface and underground mines spread over 30 districts of KP where mining operations are in progress. The purpose of this sample technique was to represent the variety of mining operations and the dispersion of workers throughout the province. The spatial and operational disparities in the KP mining industry are also brought out by the varying distribution of workers in the surface and underground mines with Buner serving as a center of surface mining and Kohat and Dara Adam Khel serving as key centers of underground coal mining. The sampling framework and demographic data of the mining workforce provides a solid foundation of future research on occupational health, safety, and regulatory compliance in the KP mining industry. The information gathered using this representative samples provides suggestion for specific interventions and policy development for enhancing the working conditions and supervision of mining activities in the areas.

In the next stage, the data is analyzed in SPSS (Statistical Package for the Social Sciences), and the results are presented in the form of tables and figures in the following section. Since the data was collected

from two categories of mining staff, i.e., Mine Inspectors and Mine Workers, the data was analyzed separately for inspectors and mine workers. At the end, the results are discussed thoroughly, and conclusions are drawn from the results.

4. Results and Discussion

The data collected through questionnaires and personal observations are thoroughly analyzed in the following sections. As discussed earlier that the data is categorized into two fragments, i.e., data collected from Inspectors of Mines and laborers. The data is analyzed accordingly.

4.1 Analysis of the Data Collected from the Mine Inspectors of Mines

As mentioned earlier that mines in 30 districts were visited and data was collected from the inspector mines of these districts. The data was further analysed accordingly and the results are presented in the following sections.

4.1.1 Biographic Data Collected from the Inspectors of Mines and Minerals

Figure 3 shows the biographic data collected from the Inspectors of Mines and Minerals, Inspectorate of Mines and Minerals, Government of Khyber Pakhtunkhwa. The percentage of different variables, including age, education, working experience, nature of job, and socio-economic conditions are presented in the figure. The data reveals that the number of senior inspector officers (Basic Pay Scale (BPS) 18) was 86% whereas the rest of them are junior inspectors (BPS 17). The data further reveals that all the inspectors are basically B.Sc. Mining Engineering degree holders, whereas only 22.7% of them have got M.Sc. degrees in Mining Engineering. It can be observed from the figure that about 41% of the inspectors had more than 5 years of working experience, while among the others 27.3% have less than one year experience. Hence, it can be concluded that all inspectors are well qualified however their experiences on these positions are mixed. Majority of them (around 73%) having 5 years or more experience but there are around 27% inspectors recently graduated with experience less than 1 year. It is obvious that due to lake of experience, there will be more chances for them to skip some important laws and rules to be followed or thorough inspection of mines. One the other important aspect that the Figure 3 shows, that only 59.1% of the inspectors physically visit the mines and inspect them for health and safety measures, whereas the rest (40.9%) of the inspectors are involve in official assignments such as attending court cases, arranging awareness and training seminars. Moreover, some of the inspectors do not visit their assigned mines and involved in the official activities; which is alarming. They must be provided assistance to spare time for inspection of their allocated mines. It is expected that with consistent field visits and regular inspections, the number of mine accidents will be decreased and the work will be conducted according to the rules. During field visits it was observed that the number of inspector mines are less as compared to the mining areas allocated to them and this is also one of the reasons that they could not get enough time to visit a mine consistently and conduct follow up visit, to see that whether the instructions of the previous visits are followed or not. So, the number of inspectors should be increased for smooth and safe mining operations in the province.

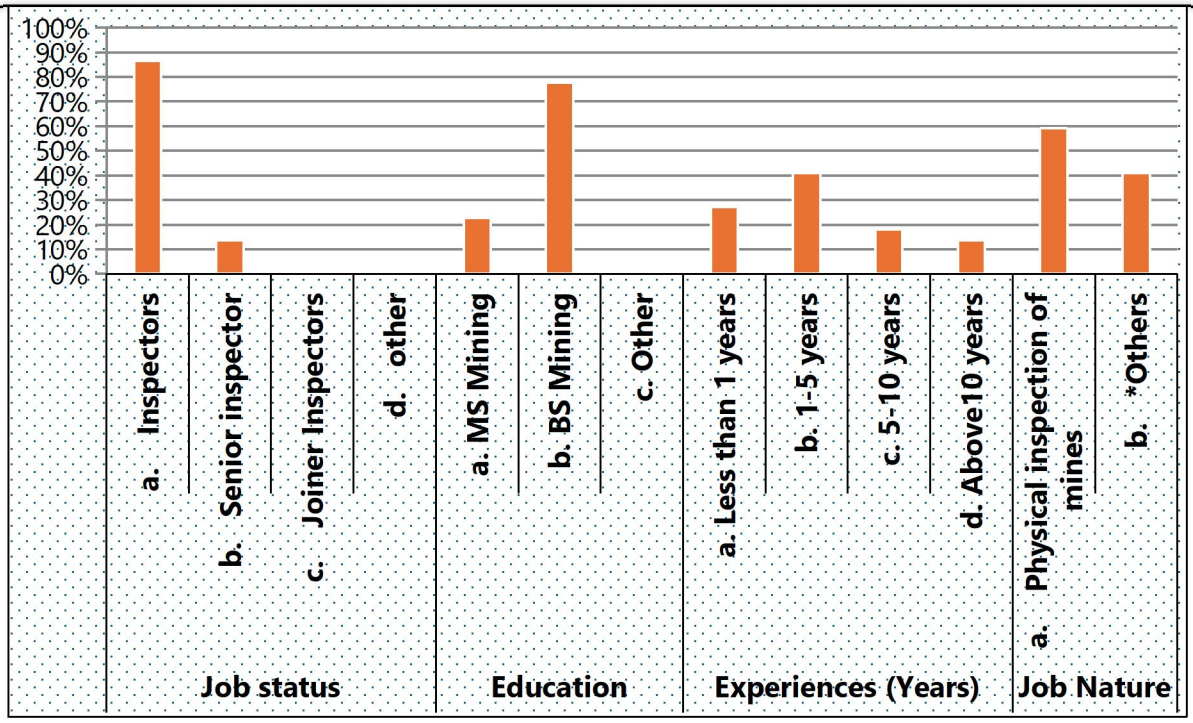

Figure 3. Analysis of biographic data collected from Inspector Mines

4.1.2 Perspective facts collected from the Inspectors

The inspectors were asked about their time they spend in the mine's inspection and some question about the laws. Table 1 shows the data collected from them and their analysis. It can be observed from the table that 40.9% of the inspectors spend more than 50% of their time on the examination of mines. It means that half of the available inspectors visit mines and among these halves, only 50% inspectors spend their times in mines. Hence, the actual visit time of the inspectors are reduced by about 75% which is extremely shocking. As per current worse situations of the mine workings, it is needed that all the inspectors should visit their sites on regular basis and also spent all of their times at the mine sites.

The table further reveals that mining-related laws have improved greatly (90.9%) for the health and safety of workers; however, there is further room for improvement. Moreover, existing mining legislation is not fully effective, as observed by 59.1% of the inspectors, which also needs further development, and as per 60% of the inspectors meaningful amendments are needed in the legislation related to mining engineering although according to 63.6% of the inspectors, positive amendments in mining legislation have already been made over the past decades, whereas 36.4% inspectors viewed that the changes made in the legislation are up to some extent. This shows that the legislation should be thoroughly reviewed by experts and more changes should be carried out for the improvement of health and safety conditions of the mine workers and mining environments.

Table 1 Perspective knowledge of inspectors

Variables	Options	Frequency	Percentage
Time dedication	Above 50%	9	40.9%
	41-50%	5	22.7%
	31-40%	3	13.6%
	21-30%	5	22.7%
Laws to improve safety	To some extent	2	9.1%
	To a greater extent	20	90.9%
	To no extent	0	0.0%
	To have no answer	0	0.0%
Existing mining legislation is ineffective.	To some extent	3	13.6%
	To a greater extent	4	18.2%
	To no extent	13	59.1%
	No answer	2	9.1%
Meaningful amendments in legislation	To some extent	8	36.4%
	To a greater extent	14	63.6%
	To no extent	0	0.0%
	No answer	0	0.0%

4.1.3 Legislation Implementation in the mines of KP

Table 2 shows the details of data collected from the inspector that as per your observations, to what extent the mining legislation in KP is implemented. Around half of the inspectors revealed the laws are implemented up to greater extent, whereas about 41% expressed that the laws implementation is up to some extent. It can be concluded from these statements that if the inspectors says that the laws are fully not implemented that what will be actual situation, which should be carefully analysed, the sites should be regularly visited and the implementation of laws should be confirmed. The reason for not implementing the rules fully is the lake of regular visits of inspectors. According to the data collected which is stated already that only 63% of the inspectors visit the mines regularly and the main reasons are already mentioned which are lake of number of inspectors as compared to the area allocated to them. The frequent visits of inspectors are important because they give on the spot instructions to the worker/management (about 91%) which are very useful. With that, other parameters such as mine's record, and the on-site assessment training/educating of inspectors' workers about hazards. The lake of implementation of the rules is further supported by another question that was about the record of violations. Although 60% of the inspectors did their routine visits in which they found that only 68.2% of violations are recorded in the mentioned whereas about 32% of the violations are not recorded, which is a greater figure and it should be reduced. Because the record keeping of violations will give an overall trend, which can be calculated monthly or yearly and hence the improvement in the implementation of rules can be monitored.

Table 2 Details about the implementation of the legislation

Variables	Options	Frequency	Percentages
The extent of mining laws implemented	No answer	1	4.5%
	To no extent	1	4.5%
	To some extent	9	40.9%
	To a greater extent	11	50%
On-the-spot instruction to the management	No answer	1	4.5%
	To no extent	1	4.5%
	To some extent	0	0%
	To a greater extent	20	90.9%
how many violations were recorded in 2024	<50	7	31.8%
	>50	15	68.2%

4.1.4 Impact of Trainings, Implementation of New Technology and Prosecution Procedure

During survey, the inspectors were asked about the trainings (of workers and inspectors), incorporation of new technology and prosecution in case of rules violations (Figure 4). The data is presented in Table 4. 81.8% of the inspectors revealed that the regular training sessions of the workers are conducted whereas about 42% confirmed that the inspector's trainings are conducted to greater extent whereas 42% stated that no regular trainings for the inspectors are conducted. Regular trainings both for workers and inspectors are crucial, because with the passage of time innovations come in every field which are mostly efficient and safer.

The compensation for serious and fatal accidents has been enhanced to a greater extent (54.5%), but still this is enough figure, it can be improved further. Similarly, 50% of latest hazard assessment and measurement technology has been made mandatory to be available on mine site. More than 80% respondent showed their satisfaction over the quality of prosecution, but the number of successful prosecutions is not satisfactory. About 20% of the inspectors stated that above 50% of the prosecutions are successful, whereas the rest of the inspectors showed less than 50% success ratio of the prosecutions. Among these about 30% of the inspectors expressed that the success ratio is from 10 – 25% where about 22% inspectors showed that success percentage of prosecution is less than 10%. These are alarming figures; i.e., the prosecution success should be 100%, then the rules will be implemented otherwise the mine operators will not care of the implementation of rules at their mine sites. All the concerned organizations should support the success of prosecutions; hence the overall safety and economy will be increased. Comparing the decades old data, with the partial increase in the number of inspector's visits, regular trainings of workers and inspectors, incorporation of new technology and success in the prosecutions, have greatly improved in the implementation of rules, which will further improve with the passage of time and increasing the efforts in future.

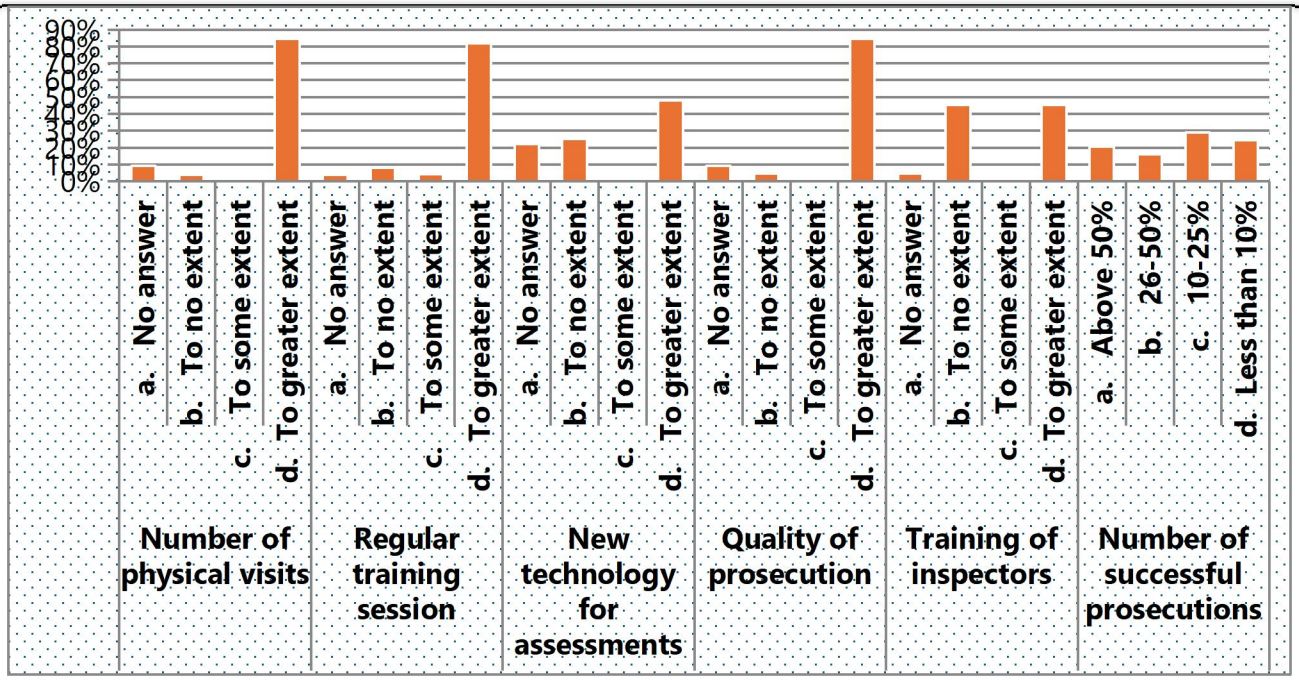

Figure 4. Impact of Trainings, Implementation of New Technology and Prosecution Procedures on the Implementation of legislation

4.2 Analysis of the Data Collected from Workers

Besides the mine inspectors, the data was also collected from about 100 mine workers both from underground and surface mining sites. This data collected from the workers is composed of worker's biographic information, awareness about the legislations and its implementation at their respective mine sites. The overall safety conditions were also observed during field visits for data collection, from which the implementation of rules could also be noticed. The data is discussed in the following sections.

4.2.1 Biographical information of mine workers

Biographical data of the workers is presented in Figure 5. It can be observed from the figure that majority of the mine workers (48.8%) are illiterate. It is a huge number. It means that about half of them cannot either read the mining rules or write their concerns to the respective authorities. They will not be able to understand the messages/symbols/notices or training materials during their jobs and there are chances that they might skip some important information necessary for implementation of rules. Similarly, the data revealed that about 34% of the workers are in the age range of 18-25 years (34.2%) whereas ages of the rest of the workers (65.8%) are in the range of 26-33 years. It shows that majority of the workers are younger and there are very a smaller number of workers above 33 years old. Since the mining jobs are extremely hard for the old people, but on the other hand the experience of young workers is less as compared to the old workers, and we know that the experience matters a lot in terms of judging a hazardous situation. Based on the workers ages, the data reveals that 72% of workers have 5-10 years of job experience, while 25.8% have 11-20 years of experience, which shows that keeping in view of their ages, majority of the workers are well-experienced in their jobs and know the overall environment of the mines. The monthly income of the workers shows that 67.5% make less than 25 thousand per month, while 32.5% of the worker's monthly income is above 25 thousand, which is not an encouraging figure and needs a thorough insight to fulfill the requirements of the workers; otherwise, they will try shortcut routes to earn more money. The nature of job's data shows that most of them are face

workers (exposed directly to mine's harsh environment and problems), while 15.8% are doing their supervisor's duties. It can be concluded that majority of the workers are illiterate and need regular training to improve the overall environment of safety at their workplaces. They are experienced and young and have the capabilities to be improved. Moreover, their income is extremely low which should be increased. Mostly the income is based on their production, hence the workers follow short routes to get more production without keeping care of the rules to follow or safety. And that is one of the biggest reasons that the accidents are more than it should be. Moreover, during field visits it was found that workers for installing supports in underground mines get less money as compared to producing the commodity, hence they try focus on production and ignore installing supports and taking preventive measures. The mine workers should be paid equally for production and installing supports or taking preventive measures, then they will try to make their working environment safe and then work.

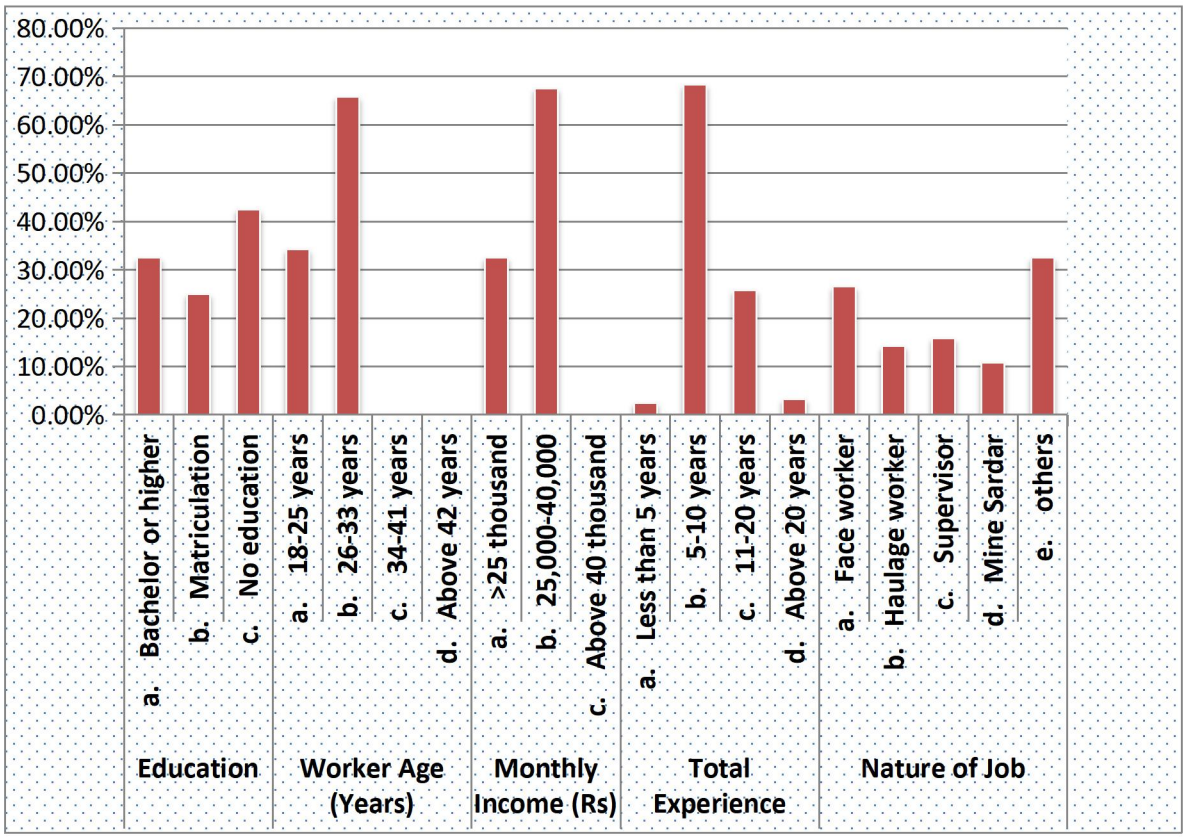

Figure 5 Biographic information of mine workers

4.2.2 Awareness and Implementation of the Mining Legislation in KP

Figure 6 shows awareness of the workers about the Mine Safety and Inspection Act 2019 and its implementation conditions. 89% of the workers revealed that the Mines Act, regulations, and rules are employed in their workplaces in Khyber Pakhtunkhwa, and 91.7% expressed that the mining laws are satisfactory for working conditions in mines. They further stated that up to a greater extent (93.3%) the mining laws help in improving the safety and health conditions of the workers. However, up to some extent (30.8%) of the existing mining-related legislation is ineffective. Workers agreed that meaningful

amendments to mining legislation have been made over the past decade (65.0%). Based on the above facts that the workers are aware of laws and rules of their workplaces, however it should be investigated that whether they follow the rules or not. For this purpose, regular and consistent visits of mine inspectors are must. The government should facilitate their visits.

Similarly, Figure 7 shows the data where implementation of the legislation is related to the greater extent (77.5%) of the existing laws as mentioned earlier as well. However, 38.3% mentioned that the inspectors' visit to their mine sites have been conducted more than a month ago, which they think will improve the overall mining and physical conditions, if their visits are more frequent and consistent. Because the inspector's on-spot instruction for corrective measures is very helpful up to a greater extent. By the way, the workers mentioned that the routine visits of the inspectors are up to a greater extent (92.5%). This figure does not consistent to the data acquired from the inspectors, which shows that workers mentioned su3h high number to get sympathy of the mine inspectors. During the last years, not a single notice violation has been issued by the area inspector, although 28 sections of the Mines Act are violated. They further revealed that up to a greater extent (61.7%) of the existing legislation is sufficient and needs no further amendments. In comparison, 70.8% of the workers are satisfied with the existing state of implementation as mentioned in the last section as well. But actually, it is not practicing as mentioned. For example, Figure 8 (a and b) indicates that field observation during the data collection stage of this study at Dara Adam Khel, Khyber Pakhtunkhwa, Pakistan, that the coal mining activities are mainly reliant on manual labor, where miners are using hand chisels and picks without the use of proper Personal Protective Equipment (PPE) and dress. Despite the Inspectorate of Mines Khyber Pakhtunkhwa having a legislative framework on safe mining practices, field data showed that compliance was generally poor.

Further the workers mentioned that most of the rules are outdated and do not meet the industry's current demand, which should be improved on priority basis.

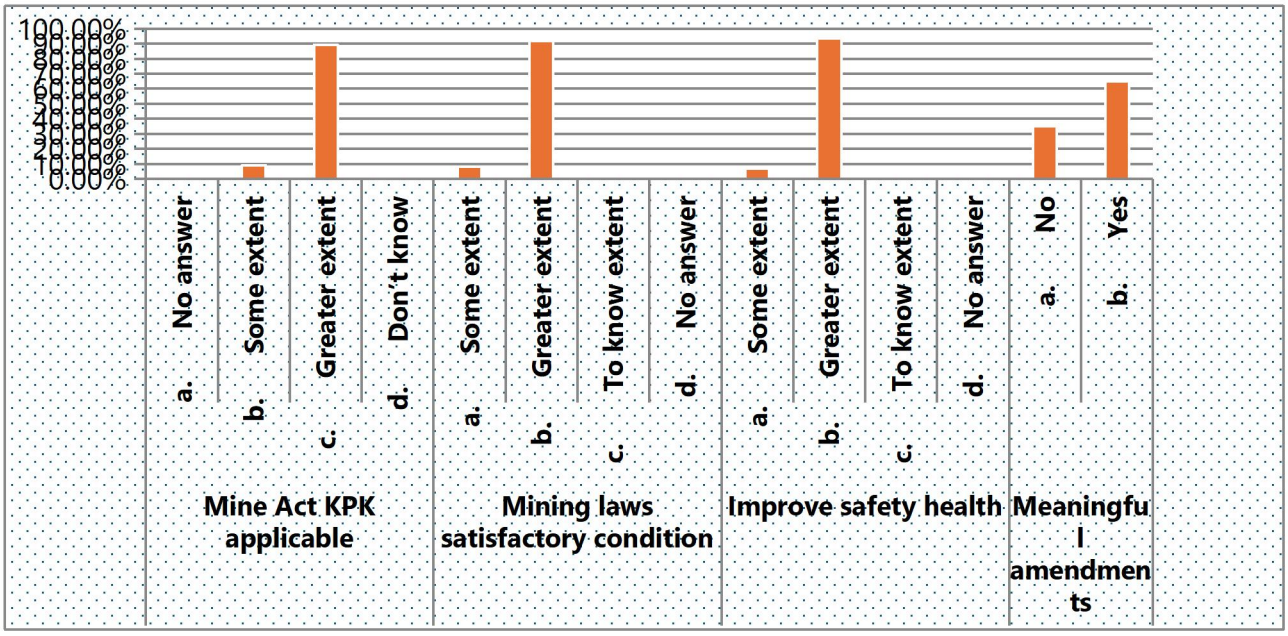

Figure 6 Awareness about legislation

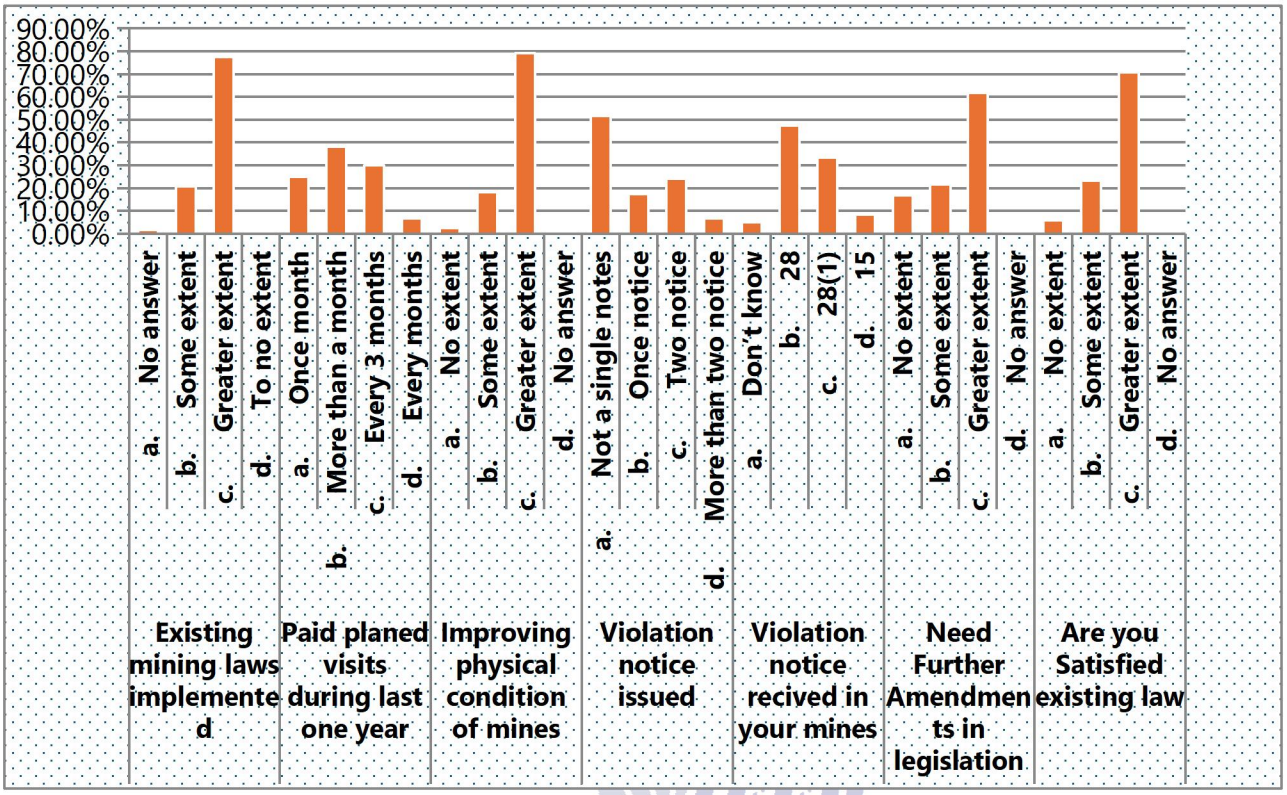

Figure 7 Implementation of legislation

Figure 8 (a & b) Workers working with no PPE pictures was taking during data collection

5. Conclusions

The mining industry remains a vital component of Pakistan's economy, contributing significantly to national development and providing employment opportunities to a large workforce. Despite its economic importance, the sector continues to face considerable occupational health and safety challenges, including workplace accidents, fatalities, permanent disabilities, and occupational diseases. This study evaluated the effectiveness of mining legislation and its implementation through surveys conducted among mine inspectors and mine workers, supported by field observations and secondary data analysis. The findings indicate that mining legislation has played a positive role in improving safety conditions at mine sites, with most inspectors acknowledging the benefits of recent legislative reforms. However, the effectiveness of these laws is constrained by inadequate enforcement mechanisms, a shortage of qualified inspectors, limited field inspections, insufficient documentation of violations, and gaps in professional training. The relatively low experience level of many inspectors further emphasizes the need for continuous capacity-building programs to enhance regulatory oversight and enforcement effectiveness. The study also highlights several workforce-related factors that contribute to unsafe mining practices. High levels of illiteracy among workers, limited work experience, production-based payment systems, and low wages encourage risk-taking behaviors and non-compliance with safety regulations. Although workers generally possess a satisfactory awareness of existing safety rules, compliance remains a challenge due to economic pressures and insufficient monitoring. Furthermore, the study revealed deficiencies in accident reporting, violation recording, compensation mechanisms, and prosecution procedures. While the quality of legal proceedings was considered satisfactory, the relatively low success rate of prosecutions limits their deterrent effect. Strengthening enforcement actions and ensuring accountability for safety violations are therefore essential for reducing accident rates and improving workplace conditions. Based on these findings, it is concluded that the existing mining laws and regulations in Pakistan provide an adequate

framework for promoting occupational health and safety; however, their effectiveness depends largely on proper implementation and enforcement. To achieve sustainable improvements in mine safety, it is recommended that the number of mine inspectors be increased, regular training programs be provided for both inspectors and workers, inspection frequencies be enhanced, violation reporting systems be strengthened, compensation packages be improved, and strict legal action be taken against non-compliant operators. The adoption of these measures will contribute to a safer working environment, reduce occupational accidents and diseases, and support the long-term sustainability and productivity of Pakistan's mining industry.

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