



Study of Different Factors Influencing Risk Tolerance of Individuals in Safety Critical Industries with Special Reference to the Indian Mining Industry

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Abstract

Despite mechanization, improved working condition, and stringent and exhaustive safety laws, mining is still one of the most hazardous occupations on the earth and the toll of accidents in Indian mining industries is one of the highest in the world. Previous studies affirmed that an individual's risk tolerance is one of the primary reasons for their unsafe acts at the workplace. In order to improve the safety performance of an organization, it is essential to reduce individual employees' risk tolerance. Even under identical work conditions and environments, two different people behave differently and may have different risk tolerance. The present study focuses on identifying all the factors influencing an individual's risk tolerance level at mine workings in the Indian mining industry. The factors have been identified comprehensively and categorized into four major categories: (1) Organizational factors, (2) Human factors, (3) Task environment and task condition factors, (4) Social factors. It is proposed in the study that the effect of each factor on an individual's risk tolerance at the workplace may be assessed through computational intelligence techniques for developing a prediction model to predict an individual's risk tolerance level. Based on that, effective recommendations may be made for reducing the risk tolerance of individuals to prevent accidents in the mining industry.

Keywords: Decision Making, Human Behaviour, Risk Profiling, Risk Tolerance, Safety Performance, Unsafe Act

1.0 Introduction

The Indian mining industry is well known for its hazardous and high-risk working environment^{1,2}. With the quantum jump in the production of coal and other mineral, persons working in this sector are greatly exposed to inherent hazards. Apart from exhaustive safety laws, machinery equipped with advanced safety features and improved working conditions, many previous studies identified the safe behaviour of an individual by improving their risk perception and lowering risk tolerance as an effective tool for reducing accidents in many industries.

In the mining industry, Lehmann, *et al.*,³ claimed that risk tolerance significantly influences the risky behaviours of male miners. In the aviation industry, Hunter⁴ found that pilots' decision-making while flying is substantially influenced by their risk tolerance level. Similar conclusions are drawn by Bhandari and Hallowell⁵ for the construction sector.

The risk tolerance of an individual is a key component in determining whether to take a high risk or low risk or no risk at all. To reduce the individual's risk tolerance level, it is to be understood, why two different individuals under identical workplace conditions behave differently.

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Researchers say that many factors ranging from human to organizational factors influence the risk tolerance of the individual.

This study is aimed to identify all the factors influencing an individual's risk tolerance level by reviewing the work of previous studies of safety-critical industries. Based on the study, an exhaustive list of all identified factors has been prepared and categorized into four different groups. This study will help to identify the critical factors influencing an individual's risk tolerance and also assess of individual's risk tolerance level through computational intelligence. Accordingly, measures can be implemented to reduce the level of risk tolerance of such critical groups and thereby preventing them from taking risky decisions.

2.0 Risk Tolerance

Risk tolerance is the individual capacity or willingness to accept a certain amount of risk in pursuit of some goal^{4,6}. The term 'risk tolerance' was first derived from financial risk decision making which is about the individual's confidence in their capacity to make correct decisions and defined risk tolerance as the level of risk an individual is willing to take⁷.

Tolerating a risk means a willingness to live with it either for a moment or for a longer period in order to gain any goal, rather than to eliminate the risk, treat the risk or transfer the risk to another party. While taking the risk, the benefits associated with it are judged on the criteria of the amount of risk. With more beneficial tasks, individuals or groups or organizations are more likely to take a higher level of risk. On the contrary individual or groups or organizations tend to avoid risk or take a lower risk if the benefit associated with it is less.

Safety professionals consider risk tolerance as an important factor in the workplace because employees are frequently confronted with various types of workplace hazards⁸. According to Rae⁹, risk tolerance is at the core of all safety decision-making. So, safety professionals associated with inherently hazardous industries like mining, aviation, construction, chemical, nuclear plant etc. are more concerned with an individual's risk tolerance level as the consequence of a risky decision may be catastrophic. Workers with higher risk tolerance are most likely to be exposed themselves to hazard and thereby increasing the likelihood of accidents. Hence, wherever high risk is involved, a person with lower risk tolerance is desirable and reducing the degree of risk tolerance of

workers would help in improving the safety standards at work.

3.0 Factors Influencing Risk Tolerance

Risk tolerance is the function of nature and nurtures many other personality traits. An individual's risk tolerance is the result of many variables or factors like demographic, socio-economic, organizational, personal factors and working environment. It is evident that an individual's risk tolerance doesn't change instantly, it is moreover a semi-permanent personality trait. However, an individual is subjected to different factors like organizational factors, socio-economic along with many other factors over a longer period of time. An individual's risk tolerance may change in any direction depending on the influence of factors. Some factors are positively associated with risk tolerance whereas other are negatively associated with it. Yin, *et al.*,¹⁰ confirmed that demographic variables like age, working experience and accident exposure have correlations with coal miners' safety attitudes. Mirzaei Aliabadi, *et al.*,¹¹ analyzed the factors that influence accidents in the mining sector based on the Bayesian network and revealed that personal, environmental and other factors have a high influence on the unsafe acts of miners.

Several researchers emphasized the importance of many factors that affect the risk tolerance or risk-taking behaviour of construction workers. Wang, *et al.*,¹² workers' risk tolerance can be affected by four groups of factors and they are as follow: working experiences and knowledge, work characteristics, personal subjective perception and safety management. According to Man, *et al.*,¹³ behavioural and environmental factors influence the risk-taking behaviour of construction workers whereas according to Manjula and De Silva,¹⁴ personal and organizational factors also affect the safety behaviour of construction workers apart from behavioural factors. The upcoming sections describe different factors influencing an individual's or team's risk tolerance with particular reference to the mining industry under major groups: (1) Organizational factors, (2) Human factors, (3) Task environment and task condition factors, (4) Social factors.

3.1 Organisational Factors

The prominence of organizational factors in mitigating accidents and improving individual safety performances

has been acknowledged earlier by many researchers. For example, Hsu, *et al.*,¹⁵ analyzed the data of Taiwanese high-risk industries through structural equation modelling and revealed that organizational factors, such as leadership style and organizational harmony, influence individual awareness about safety and similar is the observation of Rollenhagen, *et al.*,¹⁶ for those who are engaged in nuclear power plants. Low, *et al.*,¹⁷ concluded that organizational factors such as supervision, inspection and safety culture influence the risk-taking propensity of construction workers.

The authors have studied in detail various factors influencing the risk tolerance of individuals in the Indian mining industry and found that an individual's risk tolerance at the workplace is greatly influenced by many organizational factors such as: (1) Management commitment, (2) Structure and responsibility within organization, (3) Communication and information management, (4) Safety culture, (5) supervision, (6) Safety regulations, (7) Training assessment and feedback system, (8) Welfare services, (9) Contract management, (10) Outcome of non-compliance, (11) Allocation of resources and resource management, (12) Acceptance of wrong practices, (13) Acceptance of less than adequate design, (14) Availability of PPE, (15) Culture of denial and (16) Decision motivation. The factors are described in the upcoming paragraphs:

3.1.1 Management Commitment

When the top management is committed to ensuring safety at the workplace, the employee will also behave more safely. However, if top management wants to get the work done at any cost then, safe behaviour from an employee cannot be expected. The top management through their actions and initiatives can exhibit their commitment towards safety and stimulate the organization as a whole to make safety a top priority. Different researchers like^{18,19} supported similar views. Weyman, *et al.*,²⁰ analyzed the factors influencing the risk-taking behaviour of miners working in coal mines in the UK and observed that management commitment is one of the critical factors that decide the disposition of miners to be engaged in the risky workplace. A study of the Indian mining industry reveals that in the mining companies where the top management is committed to safety and shows zero tolerance towards safety violations. Then, risk tolerance among employees of such organizations is comparatively less and the safety performances of such organizations as

a whole are also much better than others. However, if the top management gives priority to production over safety, then the employee also ignores safety at the workplace aligning with the priority of management.

3.1.2 Structure and Responsibility within Organization

Structure and responsibility within the organization are established to define the responsibility, accountability and authority of each employee so that they can identify, evaluate or control hazards. Poor organizational structure, lack of defined roles and the lack of a defined reporting mechanism create a sense of carelessness among employees which will ultimately increase their risk tolerance. Many researchers like^{21,22} have similar views that the structure and responsibility of the organization influence the safety behaviour of construction workers.

3.1.3 Communication and Information Management within the Organization

Effective communication and information management within the organization are vital for assuring safety in any organization. Burton¹⁸, also concluded that good communication within the organization is key to assuring safety at work. Turner²³, mentioned that communication barriers and complications contribute to injury causation at the workplace. Wagenaar and Groeneweg²⁴, analyzed one hundred injury situations at sea for determining the types of human error and confirmed that the information process is a significant factor affecting human behaviour.

A review of the literature reveals that two-way communication systems, effective feedback mechanisms, and minimal communication barriers are significant for developing a sense of higher involvement and responsibility towards safety at the workplace which eventually decreases the risk tolerance of employees. Effective communication within the organization will bring awareness among the workforce. An informed employee is less risk tolerant than others.

3.1.4 Safety Culture

According to UK Health and Safety Commission, (1993) safety culture is a "set of individual and group values, beliefs, attitudes, competencies and behaviour patterns determining the health and workplace safety policy and programme of an organization". The safety culture

is a subset of an organizational culture characterized as the common understanding of individual employees in relation to workplace safety in an organization. Inouye²⁵, argued that an individual's risk tolerance is significantly influenced by organizational safety culture. According to Fleming and Buchan²⁶, workers are less likely to take risks in an organization where positive safety culture prevailed and due emphasis is given to employee health and safety.

A study of accident causation in the Indian mining industry also reveals that positive safety culture within an organization with having top priority on safety over all other organizational goals results in improved organizational health and safety. However, poor safety culture would result in a great negative influence on employee perception and attitude towards safety and thereby increases the risk tolerance among employees in an organization.

3.1.5 Supervision

Effective supervision enhances the culture of safe behaviour among employees at the workplace whereas casual supervision would increase the violations at the workplace thus supervision has a great influence on the level of risk tolerance among employees in an organization. In the mining sector, Dash, *et al.*,²⁷ after analyzing many accidents that occurred in Indian mines found that inadequate supervision is one of the causes of numerous accidents. In the manufacturing industry, Simard and Marchand²⁸, claimed that workers' safety performances are substantially influenced by the supervisor's safety participation. Experience in the Indian mining industry also corroborates the fact that effective supervision is an important tool for reducing workplace safety violations and accidents which eventually reduces risk tolerance among employees.

3.1.6 Safety Regulations and Safe Operating Procedure (SOP)

Readily available and easy-to-understand regulations, SOP for all activities will significantly influence workers' attitude towards safety and thereby eventually decreases the risk tolerance level among employees in an organization. According to Wang, *et al.*,¹² clear and specific safety regulations help workers to easily understand its significance and they also got aware of the consequences of non-compliance which ultimately decreases their risk tolerance level.

Experience in the Indian mining industry also shows that the absence of suitable safety regulation based on risk assessment for particular activities or mining operations gives scope to perform as per the preference and convenience of individuals. Provisions of safety regulations and SOP based on risk assessment for each mining activity or operation will help an individual to identify the hazard associated with such activities or operations which also outlines the risk control process and decreases the risk tolerance among employees.

3.1.7 Training, Assessment and Competency

Organization provides basic training (for each employee), need-based training (required for a particular task), specialised training (for the abnormal and emergency), etc. in order to make their employee competent and rational in their decision and action while dealing with unsafe condition at the workplace. It also brings safety awareness and objectivity among employees. Thereby, safety training programmes eventually may decrease the risk tolerance among employees and subsequently enhance the safety performances of the organization.

Safety training enhances the hazard recognition abilities of individuals at the workplace and thereby develops a positive attitude towards safety because of enhanced safety awareness among workers^{29,30}. According to Wang, *et al.*,¹² employee risk perception increases with comprehensive safety-specific training and thereby decreases the risk tolerance level of employees. A study from the Indian mining industry also shows that lack of proper need-based training and re-training, and absence of regular and unbiased assessment of competency results in less than adequate hazard perception amongst workers leading to higher risk tolerance and increases involvement in workplace accidents.

3.1.8 Welfare Service

Welfare service includes anything that is done for the comfort and improvement of the living standard of the employee and is provided over and above wages. Welfare services like adequate sanitation facilities and canteen services at the workplace, good housing, and access to health care, educational, sports and recreational facilities are essential for keeping the moral of workers high. Choudhry and Fang³¹ and Khosravi, *et al.*,³² asserted that management's focus should not only be

on the implementation of safety rules or norms at the workplace but also workers' welfare activities as better welfare services provide better physical and mental health to workers and thus promote healthy work environment which encourages them to become more attentive towards discharging of duties and thus behaving in a safer manner at the workplace. Experience from the Indian mining industry also shows that the mining companies providing better welfare amenities are having better safety culture and workers tend to take less risk at the workplace because of better risk perception and which eventually reduces the risk tolerance of individuals.

3.1.9 Contract Management

Contract management manages both pre- and post-contractual matters which includes the drafting, reviewing and negotiation of contracts and thorough monitoring of the performances of that particular signed contract until its close-out. Comprehensive contract management will likely give less scope to escape from the responsibility of assuring safety by the contractors and thus eventually lowering the risk tolerance level of the contractor's workers engaged and the organization as a whole. On the contrary, if the primary criteria of awarding a contract are least price or cost, contractors are indirectly compelled to compromise with a budget on health, safety and welfare and thereby weakening the safety management system inherently. Researchers³²⁻³⁴ also reiterated similar views. Many recent accidents in the Indian mining industry revealed that a lack of comprehensive contract management, clearly defining the safety obligations of contractors and the least cost criteria for awarding contracts results in higher risk tolerance by the operators, supervisors and managers because operational goal supersedes safety goal to achieve the overall goal of maximizing profit.

3.1.10 Outcome of Non-compliance

If statutory non-compliance leads to a heavy penalty like suspension from a job or a huge monetary penalty, the employee may decide to conduct themselves in a less risky manner. In the contrary to that lenient management induces higher risk tolerance levels among employees. According to Inouye²⁵, Jones³⁵ and Wang, *et al.*,¹² if the outcome of statutory non-compliance is not significantly adverse it will increase the risk tolerance level among employees and employees take higher risks in the workplace when there is no system of severe punishment against the same. It has also been observed in the Indian

mining industry that violations of safety norms are very common and repetitive as the provisions of penalty in the Mines Act are quite insignificant.

3.1.11 Allocation of Resource and Resource Management

Due to inadequate resources in terms of men, materials, money or machinery, sometimes workers are left with no choice but to finish the assigned job with available resources. Hence, inadequate allocation of resources in an organization would eventually increase the risk tolerance level among employee and thereby causes unsafe behaviour in the workplace. According to Mirzaei Aliabadi, *et al.*,¹¹ inadequate resource allocation may result in undue stress or work pressure which has direct and indirect effects on the safety behaviour of employees. For example, in the Indian mining industry, with large-scale deployment of contractors in outsourcing activities like removal of overburden in opencast mines, operators of the dump trucks are having high-risk tolerance levels and they operate the trucks in an unsafe manner like driving at higher speed mainly due to lack of resources in terms of a number of truck operators in each shift, which result in many accidents in surface mines.

3.1.12 Acceptance of Wrong Practices

Repetition of a particular type of unsafe act at the workplace over a longer period may lead to acceptance of such acts as usual and safe practice in general. Sometimes it becomes the most accepted way of performing any job which ultimately increases the level of risk tolerance among employees. According to Verplanken³⁶, workers knowingly perform some dangerous activities out of their habit, not due to conscious deliberation of associated benefits and side effects. Ajzen³⁷, has examined the impact of the past on individual behaviour and claimed that frequently performed behaviours turned into habits or routines and were subsequently enacted without substantial deliberate attention. This negative culture of accepting wrong practices either out of habit or due to its routine nature results in an increase in risk tolerance among employees. Hence acceptance of wrong practices at the workplace is positively associated with risk tolerance among employees in an organization.

3.1.13 Acceptance of Less-than-Adequate Safety Design

Accepting less than adequate safety design of equipment or process will eventually lead to high-risk

tolerance levels which in turn creates unsafe conditions at the workplace. For example, the deployment of continuous miners without provision of interlocking with Automatic Methane Detector (AMD), which is highly required to work in mine atmosphere likely to have a higher concentration of inflammable gas like methane in coal mines, will eventually reduce the risk perception of the operators regarding hazards of methane and thereby their risk tolerance will be increased over a period of time.

3.1.14 Availability of PPE and Other Safety Equipment

Availability of sufficient and suitable Personal Protective Equipment (PPE), and other safety equipment and their easy access will ensure the maximum usage of the same and thereby enhance workers' confidence in dealing with workplace hazards. On the other hand, the non-availability of sufficient and suitable PPE compels the work persons to take more risk sometimes and over a period of time they start ignoring the importance of PPE due to an increase in their risk tolerance. However, over-emphasis on PPE or other safety equipment may also result in a culture of general ignorance of the principle of the hierarchy of controls and people will tend to avoid higher controls like elimination, substitution, engineering control or administrative controls and apply the easiest but least effective control of using PPE. Under such circumstances, the risk tolerance level of individuals will tend to take more risks at the workplace due to over-dependence on PPE.

3.1.15 Culture of Denial

A culture of denial is about beliefs or misconceptions that "everything is fine and nothing will happen here" which prevents many times a proper investigation into the reported abnormalities. The dominance of organizational hierarchy in decision-making often leads to a culture of denial in an organization. Higher officials tend to ignore the valuable or critical suggestions of the ground-level supervisors or sub-ordinate without proper investigation which increases exposure to higher risk and thereby, increases the risk tolerance of an organization as a whole. This culture of denial percolates down the line of managers and supervisors and eventually increases the risk tolerance level of the individuals and organization as a whole. Analysis of many inundation disasters in Indian mines by Dash, *et al.*,³⁸ concluded that a Culture of Denial or normalization of pre-warning signals is a very

common cause of a number of major mine inundation disasters in Indian mines.

3.1.16 Decision Motivation

Every step in life is a decision and decisions are guided by the motivation behind them. There are many motivational factors individuals come across in their daily life like professional ethics, organizational recognitions in terms of cash rewards, performance appraisal etc. and those motivational factors influence decisions and actions. Ford and Tetrick³⁹, concluded that organizational recognition of employees encourages their colleagues towards safe behaviour and avoiding safety violations. Some researchers like Choudhry and Fang³¹, affirmed that incentives given for safety compliance influence the safety behaviour of workers. Motivational measures like safety incentives such as cash rewards enhance a positive attitude towards safety which eventually lower the risk tolerance level among employee and thereby enhances the safety performances of individual or group or organization as a whole. In contrast, if production incentives are more frequently adopted for improving production, employees will gradually develop a sense of ignorance towards safety which eventually will increase their risk tolerance among them.

3.2 Human Factors

Human factors are those which relate to a particular employee and have a profound influence on how they act and behave in the workplace. Any organization's manpower is comprised individuals from different demography and each employee possesses a different perception towards safety at the workplace. Many researchers like^{14,40} have acknowledged various human factors which influence the safety behaviour of workmen in the workplace. A study of the influence of human factors on mine safety in Indian mines reveals that an individual's risk tolerance is greatly influenced by human factors like: (1) Age, (2) Gender, (3) Physical health condition, (4) Educational background, (5) Marital status and a number of dependents, (6) Professional knowledge and working experience, (7) Alcoholism, (8) Previous exposure to accidents, (9) Overconfidence of individual, (10) Job dissatisfaction, (11) Personality traits, (12) Risk perception, (13) Judgment ability, (14) Familiarity with the task, (15) Over trust in the equipment etc. The factors are detailed in the following paragraphs:

3.2.1 Age

In general, the knowledge, experience and job skill of an individual vary directly with age whereas physical strength, reflex action or response etc. varies inversely with the age of individuals. Several studies identified a significant influence of age on an individual's safety behaviour like^{31,41}. Many researchers in the past assessed the impact of miners' age on accident or injury rates and have made different observations. According to Paul and Maiti⁴², injury frequency is higher among older workers due to increased fatigue, and reduced reflex action. On the contrary, Root⁴³, analyses the data collected from more than a million employees across all major industries and confirmed that the injury rate is lower among older workers mainly due to their experience and skill.

3.2.2 Gender

It is evident that great biological differences exist between males and females, and there is a great variation in their attitudes and behaviour due to social and biological differences. Many researchers^{44,45}, examined the decision-making ability of males and females under risky situations and found great variation in risk tolerance due to gender differences and men exhibit a higher tendency to take risks than women. Byrnes, *et al.*,⁴⁶ and Steger & Witt⁴⁷, concluded that women are more concerned about health and safety than men, as they give birth and nurture human life.

3.2.3 Physical Health Condition

Miners require a certain level of physical capability for performing their tasks as the working environment in mines is generally very tough and harsh. In general, physically weak individual doesn't like to venture into high-risk activities as they normally possess a lower risk tolerance level. However, some physically weak person, who is mentally very strong, may likely get involved in high-risk activities. Physically fit individual possesses high-risk tolerance level due to their confidence in their physical capability. According to Wang, *et al.*,¹² physical condition and health of individual influences their quality of work and safety performances. Health problems like high blood pressure, lack of sleep and other health problems or diseases severely affect an individual's working quality and safety performance⁴⁸.

3.2.4 Educational Background

Education helps the employee in developing a better understanding of the safety and occupational health

requirement at the workplace which leads to better implementation of a safety management system and thereby further enhancing the safety performance of an organization. Generally, educated employees of any organization possess a positive outlook towards safety and health programme. Hence, most educated employees have a low-risk tolerance. Manjula and De Silva¹⁴, found that employees with sound educational backgrounds understand the significance of following safe work procedures and also appreciate the consequences of non-compliance. Similarly, according to Wang, *et al.*,¹² educated workers are more rational and cautious whereas less educated workers tend to be impulsive and fearless. In contrary to that, Weyman, *et al.*,²⁰ claimed that educational level has nothing to do with the safety attitudes of coal miners.

3.2.5 Marital Status and Number of Dependents

Family responsibility of a married person motivates him to take less risk at the workplace and hence married persons have a lower risk tolerance level than an unmarried person with comparatively less responsibility. Researchers^{13,31,49} observed that married workers with more dependents are more concerned and committed towards safety than others.

3.2.6 Professional Knowledge and Working Experiences

Employees with more professional knowledge and work experience are likely to be more aware of workplace hazards, understand better the task-related complexity and are also able to deal with it. According to Wang, *et al.*,¹² knowledgeable professionals are more rational in their actions and have lower risk tolerance levels in the workplace. Analyzing the case history of 119 accidents, Verma and Chaudhari⁵⁰, concluded that working experiences have a significant correlation with unsafe acts of miners. Experience in Indian mining reveals that experienced workers are comparatively less risk tolerant compared mainly due to a better understanding of hazards and its consequence. However, the higher risk tolerance of experienced miners, particularly supervisors or managers, has caused serious accidents in the past, mainly due to overconfidence or complacency out of the experience.

3.2.7 Alcoholism

Alcoholism or drinking habits not only have an adverse effect on health and well-being, but it also causes

deterioration in the overall performance of the individual. Alcohol influences an individual's moods, emotions, actions, reactions, decision-making ability etc. In the mining industry, Zhang, *et al.*, (2014), found that working under the effect of alcohol or any drug may put himself and others at great risk and cause a number of accidents. Similarly, Masood, R. And Choudhry⁵¹, investigated the construction sector and found that drinking habits have a serious negative influence on the safety behaviour of workers.

3.2.8 Previous Exposure to Accidents, Near Misses or Any Incident

If any individual personally is involved in any near miss or incident or accident, one becomes more cautious as they could perceive very well the consequences. Employees having previous exposure to accidents or near misses or any incident have lower risk tolerance. Moreover, they also try to encourage others at the workplace to behave safely by sharing their experience. According to Gucer, *et al.*,⁵² workers with previous experience of any accident or near-misses are more aware and concerned about workplace hazards. It is an established fact that employee with previous exposure to accidents or near misses or any incidents results in low morale of the individual and they become less risk tolerant.

3.2.9 Overconfidence of Individual

It is observed that many times individuals become more risk tolerant due to their overconfidence as they believe that they can manage or handle any situation or uncertainties arising out of the job at the workplace. Overconfident individuals may take higher risks without proper assessment of the situation or identification of hazards and make irrational decisions. Weyman, *et al.*,²⁰ found that coal miners' likelihood of engaging in risky behaviour is increased by their confidence level and over a period of time they become more complacent towards safety due to increased risk tolerance resulting from overconfidence.

3.2.10 Job Satisfaction

If employees in an organization are satisfied with their job, then it will make them highly focused on the task. Such employee makes fewer mistakes at the workplace and they will perceive the risk associated with the task. Thus, job satisfaction would eventually lower the risk

tolerance level. However dissatisfied employees tend to finish the task anyway without proper attention towards safety. They tend to ignore safety talks, safety guidelines etc and these all seem to be rubbish for them as they fill themselves ignored in the organization. Hence dissatisfied workers become more risk tolerant in the workplace.

In the mining industry, Paul and Maiti⁴², concluded that miners dissatisfied with their job tend to take more risks and behave unsafely. Similarly in the construction industry, Wang, *et al.*,¹² found that an individual's interest in the assigned work influences the level of risk tolerance over a period of time which ultimately affects their motivation towards safety behaviour at the workplace.

3.2.11 Personality Traits

In general, there are five personality traits which are extraversion, agreeableness, conscientiousness, neuroticism and openness to experience. These traits primarily influence an individual's attitude, behaviour and decisions. Individuals with different personality traits have different attitudes and behaviour in regard to safety, some personality traits positively influence risk tolerance levels whereas some influence negatively. Several researchers^{53,54}, claimed that personality traits significantly influence behaviour and risk-taking attitude. Rundmo and Iversen⁵⁵, investigated the number of road accidents in two Norwegian countries and observed that personality traits had an intense secondary effect on risk behaviour.

3.2.12 Risk Perception

Individuals may perceive workplace risk correctly or incorrectly. Inaccurate perception of risk i.e. either overrating or underestimation of risk, could influence the risk tolerance level. In general, inaccurate risk perception leads to ignorance or misinterpretation of the clues for a quick and effective decision to avoid a hazard. Many researchers^{55,56} argued that an individual's risk perception is an important parameter that has a profound effect on their risk-taking attitude. According to Wang, *et al.*,¹² if workers perceive the risk correctly then they become alert and tend to take less risk. Studies of the Indian mining industry also reveals that individuals having higher risk perception may likely become more conscious about risk and subsequently develop lower risk tolerance level and risk tolerance is negatively associated with risk perception.

3.2.13 Judgment Ability

Judgment ability is the process by which individuals consider and evaluate evidence and assess the likelihood of the occurrence of different outcomes. At the workplace, judgment ability helps individual to analyze and comprehends problems or situations according to their knowledge and experience. According to Wang, *et al.*,¹² judgment ability plays an important parameter of risk tolerance.

3.2.14 Familiarity with the Task

Familiarity with the task grows through the successful execution of a particular task several times. However, such unconscious competence sometimes leads to growing complacency resulting in the blind spot to potential hazards which eventually increases the risk tolerance level of individuals or the organization as a whole. When performing a routine task, like maintenance and repair, an employee takes procedural shortcuts ignoring inherent hazards of doing so due to excessive familiarity or repetition of the job and resulting higher risk tolerance level³⁵.

3.2.15 Over-Trust in the Equipment

Over trust on any equipment or system grows over a period of time if the frequency of failure is too less. However, such over-trust sometimes influences the risk tolerance level of the operator or supervisor as they start to believe the equipment or system will never fail and become too much complacent to ignore the safe operating procedure resulting in some undesirable outcome. These acts of over-trusting equipment or machinery or any tool create a sense of carelessness which eventually leads to an increase in risk tolerance among individuals. For example, it has been observed that a number of accidents on roads occurred because of the carelessness of the drivers resulting from the high-risk tolerant attitude of the individuals due to growing trust in the reliability and safety features of the car. In mining, operators of winding engines nowadays are less careful while operating winding engines provided with a PLC control system due to over-trusting the system.

3.3 Task Environment and Task Condition Factors

The mining industry is known to have the most arduous working environment and conditions, in which occupational health and safety of the employee are always

a foremost concern and especially underground mining is one of the most physically challenging professions in the world. Exposure to a such difficult and arduous working environment and conditions affects the miners, both physically and mentally and thereby affecting their risk-taking behaviour at the workplace. Various task environment and task condition factors like (1) Site layout and housekeeping of site, (2) Workload and time constraints, (3) Lack of adequate safety provisions and effective safety features in equipment design or lack of ergonomically designed equipment, etc. can influence individual's risk tolerance level in an organization. Various influencing factors of risk tolerance of individual workers due to task environment and task condition are discussed in the following paragraphs.

3.3.1 Site Layout and Housekeeping

Workers of the mines where the working sites are well planned and designed considering the safety and health of the workers become less risk tolerant over a period of time, as they are used to working in such a safe task environment with adequate space and layout. Whereas on the other hand, if work persons are working under a constrained site layout with a lack of safety provisions over a long period of time will develop some kind of acceptability in working under such an unsafe work site layout and their risk tolerance will increase accordingly. Similarly, working at workplaces over a long period of time, which are not kept in tidy conditions like clear and obstacle-free walkways and working areas, having slippery floors, haphazard stacking of materials, stacks of materials not properly secured, multiple activities in close proximity, etc., will also develop a sense of acceptability amongst the workers to such untidy workplace and thereby increasing their risk tolerance. They will tend to ignore the risk of working in such a task environment as they do not have much control over the task environment. Researchers like Choudhry and Fang³¹, claimed that cleanliness and tidiness at the workplace ensure an accident-free environment. Several authors^{57, 58}, concluded that a site with a planned layout also influences the safety behaviour of workers and helps in mitigating the risk.

3.3.2 Work Load and Time Constraints

A higher production target or too much workload may indirectly pressurize employees to ignore safety standards

in most cases for meeting the set target. However, an appropriate workload may give sufficient time for an employee for complying with all the safety provisions. Hence, a person working continuously under a regime of a very high workload will be used to working under such conditions not giving enough attention to safety to complete the task and thereby over a period of time may eventually develop high-risk tolerance in contrast to those having a lesser workload.

According to Wang, *et al.*,¹² workers sometimes feel frustrated due to excessive workload, thus want to finish the job in hurry and thus taking a higher level of risk whereas Li⁵⁹, concluded that workers have no time to think about safety if they are under pressure to complete the work early. In the mining industry,²⁰ asserted that time pressure is one of the factors influencing miners' disposition to engage in risk-taking at the workplace. Similarly, in the construction industry, Wang, *et al.*,¹² asserted that time constraints while making a decision influence worker's risk tolerance level.

3.3.3 Lack of Adequate Safety Provisions and Effective Safety Features in Equipment Design or Lack of Ergonomic Design

Mining machineries are particularly tailor-made to achieve optimum mineral production but in many cases lack the application of ergonomics concepts in the design of such machines or sometimes the machines are not provided with adequate safety provisions or features. It affects an individual's physical mental comfort, and job satisfaction level which influences their overall productivity and safety performance. It may influence their level of risk tolerance over a period of time. Shikdar and Sawaqed⁶⁰, investigated the oil industries of a developed country and believed that lack of ergonomic design is a root cause of health hazards and poor safety standards in the industry. After analyzing factors affecting the safe behaviour of miners, Lv, *et al.*,⁴⁸ found that possibility of errors and accidents increases in mines due to flawed design or machinery defects. Due to defective design or lack of ergonomics design, the workers, particularly the operators over a period of time will be used to working under such defective or poorly designed machines and will induce some wrong practices in their procedure. Adapting such wrong practices without any negative outcome will create a false sense of security or

belief amongst them and will eventually increase their risk tolerance and motivate them to ignore safety as a whole.

3.4 Social Factors

Many researchers^{25,61,62}, highlighted the role of social factors on individuals' unsafe behaviour and their involvement in workplace accidents. According to Low, *et al.*,¹⁷ social factor affects the risk-taking tendency of workers and a similar observation was made by Zohar and Luria⁶³. Social factors and their effect vary according to society. Researchers identified many social factors that have a tremendous influence on employee behaviours. Social factors, such as (1) Peer pressure and (2) Socio-economic are two factors which significantly influence an individual's risk tolerance level at the workplace. The following paragraph details the characteristics of these factors and their influence on an individual's risk tolerance.

3.4.1 Peer Pressure

Peer pressure is the direct influence on people by peers, or the effect on an individual who gets encouraged to follow their peers by changing their attitudes, values or behaviours to conform to those of the influencing group or individual. A person's decisions and actions are significantly influenced by the people around them. Peer pressure can affect individuals in both directions either positively or negatively towards safety. It influences newcomers at the workplace more as they are more vulnerable. As workers in general are fundamentally social beings, they strive to behave like others around them whom they recognize as members of their social group, and in turn, they teach others what behaviours work well, and what is expected of them⁶⁴. According to Wang, *et al.*,¹² immediate supervisors' safety attitudes influence workers' risk tolerance levels greatly. According to Inouye²⁵, sometimes, individuals, in order to maintain the image of being a tough or competent person among their colleagues, take a greater risk in the workplace.

3.4.2 Socio-Economic Factor

It is well-established fact that the overall attitude of society influences individuals towards every aspect of life. In some regions, safety is given the top priority at every phase of life and society, in general, is safety-minded. This attitude towards "Safety First" is reflected in every

sphere of life including all workplaces and workers' risk tolerance is very low. Safety is never compromised due to less risk tolerance of society as a whole. Similarly, an individual's risk tolerance is significantly influenced by the Socioeconomic condition to which they belong. Socio economic factors may influence an individual's risk tolerance in both ways. It may either increase risk-taking attitude or may reduce risk-taking behaviour. For example, Illegal mining in some parts of India involves a great level of risk and a direct threat to human life. However, a group of persons who are involved in illegal mining use to take high risks despite knowing the danger associated with it. People belonging to such groups are highly risk-tolerant due to poor socio-economic conditions and lack of alternative scope of livelihood. According to Slovic and Fishhoff⁶⁵, decision-makers of a company take a higher level of risk when a company's financial status is strong. Similarly, Wang and Yuan⁶⁶, indicated that contractors' risk attitudes are strongly influenced by the economic environment.

4.0 Discussion and Conclusion

In conclusion, this review confirmed that when an individual worker or group decide to take on any risk at the workplace, risk tolerance definitely influences their decision making and also there are many factors which influence individual employees' risk tolerance in an organization. The review supported the importance of many factors and they are broadly categorized into four groups: (1) Organizational factors, (2) Human factors, (3) Task environment and task condition factors (4) Social factors.

It is evident that some factors are positively associated with risk tolerance whereas others are negatively associated with it. It is also obvious that each factor has a different weightage on an individual's risk tolerance. A finding of those critical factors having a higher influence on the risk tolerance of employees in an organization will be useful for recommending measures to improve the safety performances of an organization. Hence, further research is necessary to assess the influence of each factor on an individual's risk tolerance and also the development of a prediction model can be quite useful in order to conduct an objective assessment of an individual's risk tolerance.

5.0 References

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