# Ergonomics Risk Factors in Construction Sector

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***Abstract- Construction industry is one of the highly risky industries with more number of accident and injuries. Many construction companies have difficulty in providing a safe working environment for their employees. The purpose of this research is to identify the ergonomics risk factors on the construction site. This was done by site visit and asking questionnaire from the employees of the construction industry. This study will include ergonomics risk factors in relation of human and their nature of work. One of the most significant ergonomics risk factors are awkward posture in handling of job task, repetition and force of specific movement including vibration. Other ergonomics risk factor includes static position, contact stress of tendon and muscles and also extreme temperature condition. The study will enhance the awareness of the ergonomics risk factors which may occur in the construction sector.***

***Keywords- Construction, Ergonomics, Risk Factors***

## I. INTRODUCTION

Ergonomics is known to be related to human and their job. In larger scope ergonomics examines human behavioral, psychological, and physiological capabilities and limitations. Professionals in the field of ergonomics normally will design new work environments or modify established work environments based on the studies on the human capabilities and limitation. The basic premise of ergonomics is that job demands should not exceed workers' capabilities and limitations to ensure that they would not be exposed to work stresses that can adversely affect safety and health as well as the company's productivity. Therefore, the objective of an ergonomics program is to provide a safe and productive workplace to the worker's comfort to fulfil the goals and objectives of the organization.

The focus of ergonomics implementation should removes barriers to quality, productivity and safe human performance by fitting products, tasks, and environments to people instead of forcing the person to adapt to the work. In order to assess the fit between a person and their work, ergonomists will consider the worker, the workplace and the job design. Ergonomics is a broad science with wide variety of working conditions that can affect worker's comfort and health, including factors such as lighting, noise, temperature, vibration, heavy lifting, repetitive motion, workstation design, tool design, machine design, chair design and footwear and others. Job design also gives a great impact with such factors such as shift work, breaks, and meal schedules.

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## II. ERGONOMICS RISK FACTORS

Ergonomic risk factors are characteristics of a job that facilitate ergonomics stress/strain on the body. We need to know about ergonomics to help employers if they work at maritime, manufacturing, agriculture and construction. Risk factors can happen at different jobs and tasks. The greater exposed to these risk factors the greater is the probability of ergonomics injuries and that is what is called work related musculoskeletal disorders (WMSDs). It is not only affecting the people immediately but also they take time to commence the feeling on the person's health. Therefore, there is sufficient time to prevention of occurring injury and cleaning the work environment from all the risks by utilizing the suitable risk assessment process.

Workplaces traditionally have been designed to move products or support machines efficiently. So long people have always seemed to be adaptable, how they fit into the workplace has received less concentration. The increasing number of injuries that is caused by repetitive motion, excessive force and awkward postures, ergonomics has become a very important factor in workplace safety. Ergonomics and human factors are often used interchangeably in workplaces. These both terms describe the interrelation between the workers and their job demands. The difference between these two is that the ergonomics keeps attention on how work affects workers, and human factors highlight designs that reduce the potential for human error.

Risk and risk factors are the common concepts that used in the safety and applied ergonomics literature. Risk includes the component of how likely or what is the probability of an event is and the seriousness of the consequences or what is the severity if something occur. Risk is frequently defined on how many accidents or injuries resulted for a given exposure. At the extreme level , injury risk could be viewed as a very low probability but at extremely high consequence (e.g.: multiple fatalities) or higher probability but less severe consequence (e.g.: a worker slipping and tripping. Risk is also intuitively relative within and across work settings. It implies a probability for injury, and the odds of an injury are the function of the level of the risk and the worker exposure time. It is possible for the workers at a site not to have an injuries for a long period of time. The absence of injuries does not imply that there is absence of risk.

Ergonomics Risk Factors (ERF) is a situation that exists or created intentionally or unintentionally that could or might contribute to results that violates or are against the principles or philosophies of ergonomics that could or might harmful to the health and well-being of workers or users at work or after work. Understanding and aware on the negative aspects of ERF are critical and essential

for countermeasures to take correct solutions to the problems could be found. Risk factor exposure is an early warning of increasing more serious problems - physical signs and symptoms that can lead to serious injury. Long-term exposure to risk factors will reduce the quality of life. Every job carries risk. The key issue is relative risk.

Organizations and professionals can be better informed to reduce MSD injury risk by being aware of risk factors, becoming skilled in identifying and classifying these factors, and examining options to reduce the frequency or duration of exposure to the ergonomic risk factors. Reducing exposure to the ergonomic risk factors should make the task smoother and more predictable in its outcomes. Reducing the risk factor exposure should make task performance less variable.

Some work activities can cause strain in the worker's bodies. These acticities may lead to injuries to their joints, tendons, muscles and ligaments. This type of injuries are called as musculoskeletal injury or MSI. Parts of their job that may strain their bodies or increase the risk of injury (MSI) are called ergonomic risk factors. Risk factors are experienced by the affected individual during non-professional activities. In addressing to any ergonomic issue, it is a mistake to focus only on the workplace. The major ergonomic risk factors are exerting a force, repetitive work, awkward and static postures, pressure or contact stress. The factors that may lead to the to the risk of musculoskeletal injury are called ergonomic risk factors. A risk factor is everything that may lead or contribute to the injury. Two or more risk factors could be present at one time, may lead to increase the risk of injury. Workers are not always able to identify all the ergonomic risk factors in a task. However, it is most important for the workers to recognize the situations when they are at higher risk.

The main ergonomic risk factors in construction industry are as follows:

(1) Awkward posture
(2) Repetition
(3) Static posture
(4) Vibration
(5) Force
(6) Contact stress
(7) Extreme temperature

These ERFs are discussed in detail in below paragraph.

### *2.1 AWKWARD POSTURE*

Posture refers to the position of different parts of the body. Awkward posture is the position of the body that deviates from neutral that is the best location of each joint that can provide the control and strength. In the construction industry, there is prolonged reaching, bending, kneeling, twisting, squatting, working overhead with hands or arms, or holding fixed positions are the awkward posture . Working methods or workplace dimensions could contribute to create awkward posture. Therefore, an awkward posture can relate to raising the rate of injury in the shoulder, wrist, low back and neck.

Muscles, ligaments, and tendons must work hard and can be stressed when the worker are in an awkward posture. Awkward posture occurs when any joint of their body twists or bends excessively, outside the comfortable range of motion.

Various work activities can cause awkward postures:

(i) Leaning sideways, i.e. when reaching to a low drawer to one side (awkward back posture)
(ii) Reaching overhead (awkward shoulder posture)
(iii) Bending down to the work at low level (awkward back posture)
(iv) "Flaring" the elbows out to the side (awkward shoulder posture)
(v) Bending of the wrist when moving the objects or keyboarding (awkward wrist posture)
(vi) Bending the neck down, i.e. looking at small components in the poor lighting conditions (awkward neck posture)
(vii) Twisting part of the body, i.e. twisting the neck to view documents while keyboarding for a long time (awkward neck posture)

If the position of the body is held long enough to them, it will feel aches and pains, then their muscles have been held in one position for too long. A posture held for the long time is called as static posture. Posture is the position of the part of the body relative to the adjacent part as measured by an angle of the joint connecting them. Postural stress is assumed to be an extreme posture at or near the normal range of motion. Posture is one of the most frequently known occupational risk factors. There is a neutral zone of movement for each articulating joint in the body. For every joint the range of motion is defined by movements that does not require high muscular force or cause discomfort. Injury risks increases whenever the work requires a person to perform his tasks with body segments outside to their neutral range in a deviated posture. Awkward posture include repeated or prolonged twisting, reaching, bending, squatting, kneeling, working overhead with the hands or arms, or holding fixed positions. For the shoulder and upper arm area neutral position is relaxed with the shoulders down and on the same plane, with arms at the side. Working with the arms drawn away from the body, overextended and shoulders hunched places, these joints at the end of their normal range of motion, requires high muscular force and greatly increases the risk for the injury. Strained sitting positions, i.e. tilting sideways, bending forward, twisting the vertebral column or slumping begin in response to compensate for specific work relationship but it can become habit after sometime. Posture and positioning profile factors such as, tipped shoulders, torso twist, raised elbows (dominant, non-dominant, or both), head tilt/rotation and operating with hands closer to the face are associated with the increased risk of musculoskeletal symptoms.

### *2.2 REPETITION*

Performing the similar motion of the work in every few seconds for more than two or hours without any break time and rest and is called as a repetition work. Repetition of work can increase the rate of injury in the local tissue of the body. As well as interaction of other ergonomic risk factors such as force, awkward posture can extend the rate of injuries.

Repetition rate is defined as an average number of exertions or movements performed by a body link or joint within a unit time and performing similar motions with the same part of the body with a little rest or recovery.

Repetition can also be defined as performing the same task or group of motions repeatedly. It involves doing the task that uses the same muscles again and again with little chance of rest and recovery. This applies to both small muscles and large muscles. Repetition of work put workers at a higher risk of injury when other risk factors are also present (such as heavy force or an awkward posture). Repeated identical or same motions performed over a long period of time can cause overuse and over-extension of certain muscle groups, which leads to muscular fatigue. Interestingly, symptoms often relate not to the muscle and tendon groups involved in repetitive motions, but to the antagonistic or stabilizing tendon and muscle groups used to stabilize and position the extremity in the space. Sometimes, by changing tasks, muscle groups have a periods of activities alternated with the periods of rest, which may be beneficial in reducing the possibility of injuries.

Repetition also is the time quantification of a same exertion performed during the tasks. An assembly worker may produce 25 units per hour; a warehouse worker may lift and place on the floor two boxes per minute. Repeated motion has been closely associated with an injury and worker discomfort. Generally, the greater the number of repeated motions, the greater would be the degree of risk. However, the relationship between repetition and the degree of injury risk is modified by some other risk factors such as posture, force, recovery time and duration,. No specific repetition threshold value (movements/unit of time, cycles/unit of time) is associated with an injury.

### *2.3 STATIC POSTURE*

The human body requires to move over a period of time that remains fixed and that is not comfortable to keep the position of the body without change over a long period time. On the other hand, performing a task in one outside from the neutral position is called static posture. Our body is built to move around, not to remain still. It is tiresome and uncomfortable having to maintain the body position without changing over extended periods. We experience these discomfort when driving a motor vehicle where the location of the trunk on the seat, of the head in order to see and of the feet and hands on controls constrains us to the nearly immobile posture.

Although defined in many ways, static posture generally means the performance of tasks from one postural position to an extended duration. This condition is a combination of posture, force and duration. The degree of risk is in proportion to the combination of the magnitude of the awkwardness of the posture, external resistance and duration.

### *2.4 VIBRATION*

Vibration is defined as any movement of the body in one fix point while using some power tools or equipments when driving them which can put stress on the hand, tissues of the fingers and arms.

Vibrations occurs when an object oscillates or rapidly moves back and forth from its stationary point, like a swinging pendulum. Vibrations may be defined by the frequency also (how fast the object is moving), amplitude (the distance of the movement) and magnitude.

Vibration is defined simply as any movement in a body about a fixed point. These movement may be regular, like the motion of the weight on the end of the spring, or it may be random. Vibration is found to be an important factor in the working environments utilizing the tools that are vibrating in the frequency band from 20 to 80 Hz. For example, use of powered wood working tools or a chain saw for the long period of time.

Vibration gives much effects such as damage caused to the organs of the body as a result of their being buffeted by high vibration levels at relatively low frequencies and breakdown of the body tissues due either to their absorption of high energy vibration or to continued resonance. Vibration applied to the hand can cause a vascular insufficiency to the fingers/hands (vibration white finger or Raynaud's disease). Also, it can be interfere with sensory receptor feedback leading to the increased hand grip force while holding the tool. Furthermore, a strong alliance has been reported between segmental vibration and carpal tunnel syndrome. Hand-arm vibration (HAV) is mainly associated with the operating power tools. Exposure to them occurs only when the vibration of the tool is transmitted to the hand and arm.

Whole-body vibration (WBV) is mainly associated with sitting or standing on a vibrating surface. WBV exposure occurs when vibrations are transmitted mainly through the feet if the legs and hips are seated or, if standing. WBV can affect the whole body, including internal organs too. Exposure of the entire body to the vibration (usually through the buttocks/feet while riding a vehicle) has some support as the risk for injury.

### *2.5 FORCE*

The amount of physical effort that is required by the workers to do their task or to control and maintain the equipment and tools is termed as force. Utilization of the muscles much harder than the normal by applying an extreme force can cause stress on the tendons, muscles, and joints.

Force is the physical or mechanical to accomplish a certain movement or exertion. Force is defined as the amount of physical effort that is required to perform a given task (such as lifting) or to maintain a control on equipment or tools. Exerting a force to the person or objects may overload our tendons and muscles. The force may come from lifting, gripping, pulling or pushing. The force that the worker exerts on an object is the primary risk factor. Tendons and muscles can be overloaded while applying a strong force against an object. Holding a light object (such as a mouse) for long period of time can also expose workers to the risk of MSI. There are mainly three types of activities that require force i.e. (i) force involved in lowering, lifting, or carrying, (ii) force involved in pushing or pulling and (iii) grip force. In other word, force is the amount of physical effort that is required by a person to do the task or to maintain control on equipment and tools. A pinch grip produces 3 to 5 times more force to the tendons in the wrist than a grip with the whole hand. With excessive force, the muscles are contracting more harder than normal, this may lead to stress on the tendons, muscles, and joints.

The amount of force depends on the weight of an object, the type of grip body posture, the type of activities and the duration of the tasks.

Using hands instead of a clamp to hold an object while doing a task shows that force occurs. The amount of force that is required by an activity could sometimes be magnified causing more muscular fatigue. Task forces can be observed as the effect of an exertion on internal body tissues (e.g. tension within a muscle/tendon unit from a pinch grasp and compression on a spinal disc from lifting), or the physical characteristics associated with an objects external to the body (e.g. pressure required to activate a tool, weight of a box, pressure necessary to snap two pieces together). The greater the force, the greater would be degree of risk. Higher force has been associated with the risk of injury at the neck, shoulder, forearm, low back, wrist and hand. It is very important to note the relationship between force and degree of injury risk. It is modified by other work risk factors such as repetition, duration, posture and acceleration/velocity

### *2.6 CONTACT STRESS*

Contact stress is caused by exposure to any hard or sharp object putting localized pressure on the parts of the body. Contact stress could affect the local tissue and results in interruption in circulation of nerve function.

Contact stresses are defined injury or impingement by hard or sharp objects, equipment or instruments while grasping, manipulating or balancing. Contact stresses are encountered when working with wrists or forearms against the edge of the desk or work counter. The tendons and muscles are impinged when pressed to the sharp edge. Using the hand as a hammer to close the lid securely also creates mechanical stress, especially when the lid has elevated surfaces or sharp edges. Local contact stress occurs when a sharp and hard object comes in contact with the skin. The tissues and nerves beneath the skin could be injured by the applying pressure.

Here are some of the examples of the activities that may result in local contact stress:

(i) Hard edges and ridges on tool handles digging into the hand.

(ii) Edges of the work surfaces digging into the wrist or forearm.

(iii) Striking objects sharply with the hand, knee or foot (i.e. striking the carpet stretcher with the area above the knee while laying carpet)

### *2.7 EXTREME TEMPERATURE*

Extreme temperatures are one of the environmental features that can be divided into the extreme heat and extreme cold temperature. Extreme heat temperaturecan cause fatigue and heat stress. On the other hand, extreme cold temperature can narrow the blood vessels and decrease sensitivity and leads to harmonization of body part.

Cold temperature can be defined as a low temperature that reduces manual dexterity and prominent the symptoms of nerve-end impairment. It is the exposure of the body to the cold i.e. there is a lowering of the body deep core temperature. Systemic symptoms that the worker can present when exposed to the cold include clouded consciousness, shivering, extremity pain, ventricular fibrillation and, dilated pupils.

Heat stress temperature is the total load of the body must accommodate. It is generated externally from the environmental temperature and internally from the human metabolism. More heat could leads to heat stroke, a condition that could be life threatening or results in irreversible damage. Less serious conditions that are associated with the excessive heat include, heat cramps, heat exhaustion and heat-related disorders (e.g electrolyte imbalance, loss of physical/mental work capacity and dehydration,).

## III. CONCLUSION

This study was focused on the ergonomics and risk factors in the construction sector. Ergonomics mainly can beis defined as the relationship between humans, machine systems, job design and the work environment. The aim of ergonomics is to fit the task to the individual.

The study also found the ergonomics risk factors or conditions that may increase the chances of injury to musculoskeletal system. The risk factors include working in awkward posture, force and vibration which may come from lifting, gripping, pushing or pulling. Repetition involves in doing a task that uses the same muscles again and again with little chance for recovery or working in extreme temperature condition either extremely cold and extremely hot also are the main risk factors. Working in uncomfortable static position or contact stress of tendon and muscles also will increase the likelihood of injury.

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