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### Study and analysis of occupational risk factors for ergonomic design of construction work systems

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#### ABSTRACT

Occupational risk has been defined as any condition of a job that can result in illness, injury, disability and death. Although technology has advanced and new methods of work have been introduced, occupational risk factors are prevalent in every work system as workers perform diverse activities associating themselves with specific risk factors. The main objective of this study is to analyze these risk factors that cause losses to the workers productivity. This paper deals with the performance analysis of the data is using SPSS to find the important factor influencing labour productivity. With the main important factors another set of questionnaire is prepared and comparative results were drawn using the SPSS and fuzzy logic optimization. The model can handle both uncertain demand and availability of supply using fuzzy logic control system. These findings mainly reflect the occupational risk factors that affect the labour productivity in the construction industry which create losses to the particular concerns.

**Keywords:** Occupational risk, Labour productivity.

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#### INTRODUCTION

Construction industry is an ancient human activity. It is a significant part of industrial culture, a manifestation of its diversity and complexity which can produce a widely varied built environment to serve the diverse needs of society. Construction industry is an important indicator of the development of any country it creates investment opportunities and also employment across various related sectors. It is a complex process and is considered to be dangerous and risky job. Despite advances in technology, it remains a physically strenuous occupation. Construction is not possible to workers involvement. Construction is a labour intensive as well as craft-based activity and thus behaviour of people has an enormous influence upon the organization and performance of firms.

Construction jobs are so challenging physically on workers, a various injury can occur. Accidents in the construction field are very high with nearly 17,500 nonfatal injuries and 1,121 deaths in 2002. The ratio of injuries on workers for non-fatal and serious injuries is 7.1:2.8 per 100 full time workers. These injuries affect the workers productivity in construction sector. Work is still straining, work organization and working methods are traditional. The worker performs job tasks that expose them to potential injuries and illnesses due to the poor design of a workstation or tool they are using. Ergonomics involves the assessment of job tasks to identify ergonomic risk factors and appropriate engineering or work practice controls to reduce or eliminate the identified risk factors. The purpose of this work is to focus on complications faced by elder workers in the

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workplace and provide key ergonomic solutions designed to mitigate and prevent work-related injuries. [1-3]

## Ergonomics

Ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. Adapting the job to fit the worker can help reduce ergonomic stress and eliminate many potential ergonomic disorders (e.g. carpal tunnel syndrome, trigger finger, tendonitis). Ergonomic focuses on the work environment and items such as design and function of workstations, controls, displays, safety devices, tools and lighting to fit the employee's physical requirements, capabilities and limitation to ensure his/her health and wellbeing. It may include restructuring or changing workplace conditions to reduce stressor that cause musculoskeletal disorders. It also useful to increase the productivity in construction. [4-8]

## LITERATURE REVIEW

**Tutisumarningsih et al (2016)** describes the productivity is an important issue in the construction industry. The result of this research proves that labor productivity achieved by the application of ergonomic work method increased significantly, especially for job that rely on skill and physical capability of labor. [9-10]

**Er.Saurabh et al (2016)** states that Construction jobs are so demanding physically on a person's body, a variety of injuries can occur. Therefore, during construction works it is important to provide safe environment for their employees. Ergonomics plays a major role in attaining high productivity and efficiency of the worker.

**Naman et al (2015)** focuses on the study of the ergonomics aspects and various field areas on which ergonomics studies are carried out using different techniques and analysis. The various aspects of ergonomics contribution and influence in the industry and also various measurement techniques are described by this study. The evaluation of same. From the research reported by different researchers it can be concluded that ergonomics is an important criterion that must be

included in any industry for achieve human comfort and satisfaction. [11-15]

**Janagan et al (2014)** studied to identifies the major problems that each worker faces and finding the appropriate actions to overcome those problems. In this study to compare the characteristics of local and migrant labours. The comparison between local and migrant labours are based on different parameters such as resource utilization, work quality, job knowledge etc...

**Manikandan et al (2014)** evaluated the ergonomic hazards which was not aware among the construction workers. The best solution is creating awareness to the workers and provides proper training to work in a safe way.

## NEED FOR THE STUDY

Ergonomic program is considered as one of the viable plans considered by numerous businesses to bring wellbeing and health factors for the workplace to expand work exhibitions. Stress on the workers or employees' body due to inappropriate posture and extremely high or low temperature impacts the overall system is the vital principle. Musculoskeletal system, cardiovascular system and mental system are the three various systems on the human body which cause injuries due to poor design of working environment. Ergonomic injuries affect the cost of project which occurs due to loss of time, treatment and compensation claims.

## RESEARCH METHODOLOGY

The methodology is carried as per the objectives of study. This study started by reviewing the literatures and interviews from various sites of workers. The various factors that contribute to the occupational risks are identified from literature reviews and interviews. Based on these factors questionnaire is prepared and survey is conducted to find the top factors that contribute to occupational risks from various construction industries. In this study, questionnaires were used as tool for collecting data for quantitative analysis. The cause for using a questionnaire is that the options of responses can be acquired in a structured manner, according to questionnaires are

the most common method used to identify the practice of companies. Although designing a questionnaire appears to be relatively simple, it is a complex process. The questions must be formulated and selected carefully and the aim of the project must continuously be borne in mind.

## FACTORS IDENTIFICATION

### Awkward and static posture

Various position of the body defines posture. Awkward postures may cause stress to muscles, tendons, ligaments. Awkward posture occurs when any joint of your body bends or twists excessively, outside a comfortable range of motion. A task is performed for a long period of time in a single position is the static loading it is due to the force, posture and duration.

- Maintaining same position while performing task
- Standing up for too long at work in site

### Duration

When the task is repeated without any break duration factor plays an important role. The longer duration of the task, the greater the cumulative load on the tissues. Without considering any break for extended amount, the useful potential of these affected tissue is reduced and also the chance of injury is exaggerated. Some remedies such as changing footrest, rest breaks etc, it can be effective in mitigating damages caused by this kind of ergonomic risk factor.

- Working more than 8 hours
- Working at holidays

### Repetition

Repetition work may be defined as Performing the similar motion of the work in every few second for more than two hours without any rest and break time. Ergonomic risk factor such as force and repetition of work increase the injury rate in local tissue of the body, awkward posture can extend the rate of injuries.

- Repetitive movements
- Boredom felt because of repetition

### Temperature

Temperature also comes under the ergonomic risk factor. Working in extreme surroundings, makes workers to be fatigue much faster due to increasing the aerobic demand. Both extreme cold and hot temperature can impose injuries to the workers. Blood flow decreases due to cold temperature cause weakening of muscle strength and agility. Gripping action is tougher in cold temperature injury will increase in the cold temperature as more muscles need to be applied. Fatigue and a variety of heat related illness to the workers will occur in the situation of hot temperature

- Stress level during work in extreme temperature
- Climatic conditions affect the performance

### Tools and materials

Manual handling of loads may cause cumulative disorders due to gradual and cumulative deterioration of the musculoskeletal system through continuous lifting/ handling activities, e.g. low back pain. Manual handling causes musculoskeletal disorders such as low back pain and injuries.

- Handling heavy materials
- Using advanced equipment in site

### Vibration

When the object moves to and from a stationary point vibration occurs ex. Swinging pendulum. Movement of a body about a fixed point is defined as vibration. The movement may be regular or random. Hand vibration is typically associated with operating power tools such as road breakers, rock drills vibratory rammers, grinders, demolition hammers and etc which can place stress on the tissues of the fingers. When the total vibrations are transmitted to the hand and arm exposure occurs. Whole-body vibration is typically associated with standing or sitting on a vibrating surface such as wheel loader, grader, scraper, excavator, dozer, compactor single drum and etc which can impose stress on the spinal tissues.

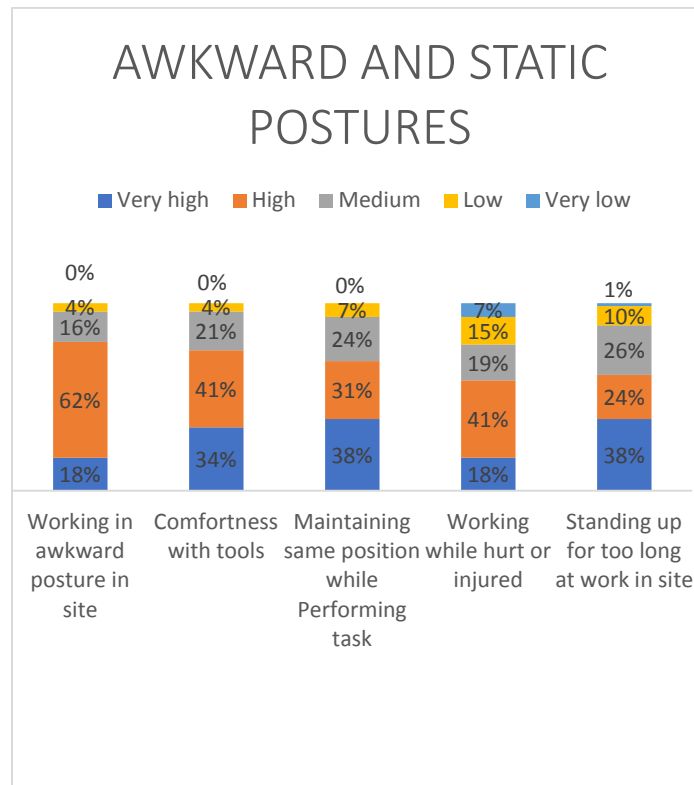
- Using vibrating tools
- Vibration due to movement of equipment

**RESULTS AND DISCUSSION**

The questionnaires were distributed through Google forms. 68 responses were received from site engineers, project managers, owners, contractors to assess the risk factors that occurs during construction to evaluate their effects and severity.

**Awkward and static postures**

From the responses it is observed that 62% feels working in awkward posture in site, 41% feels comfort with tools, 38% feels more comfort in maintaining in the same position while performing the same task, 41% got hurt or injured while working and 38% feels standing up for too long at work in site.



**Figure 1 Awkward and static postures**

Hence, we can infer that most of the respondents feel that the working in site is an awkward posture.

**Duration**

From the responses it is observed that 44% feels working more than 8 hours, 37% workers

feels discomfort in working in holidays and also agree changes in scheduling during execution, 29% people feels that there was a longer duration of work without break and finally 28% feels working in night shift.

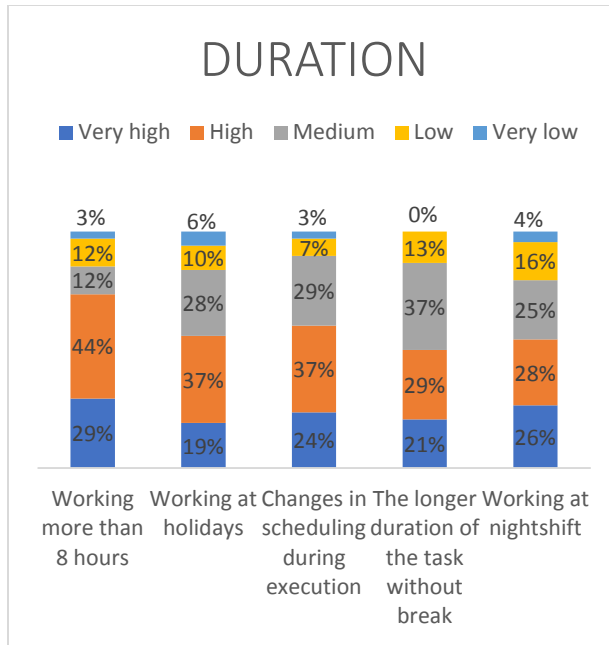


Figure 2 Duration

Hence, we conclude that the most of the workers feels that the working hours was more than 8 hours duration.

**Repetition**

From the responses 37% feels repetitive movements in works, 28% felt boredom of

repetition, 29% feels performing the task without any break, 32% feels physical stress developed during repetition and 22% workers negotiate the work due to repetition.

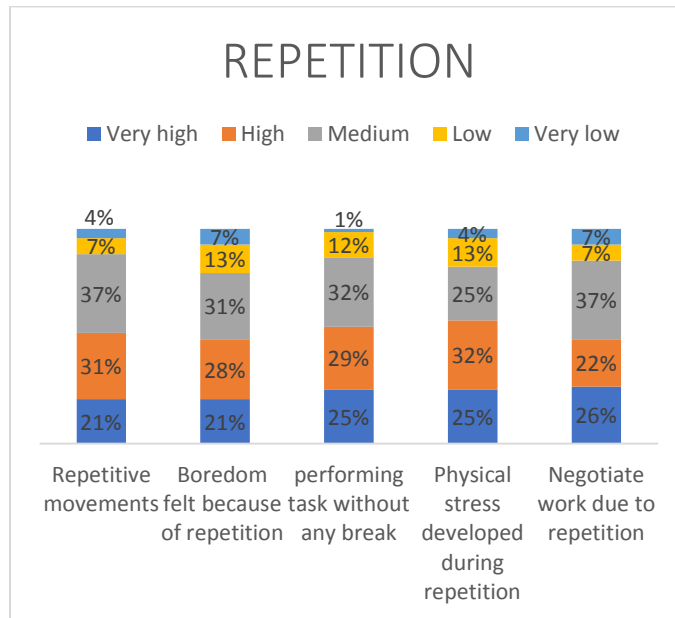


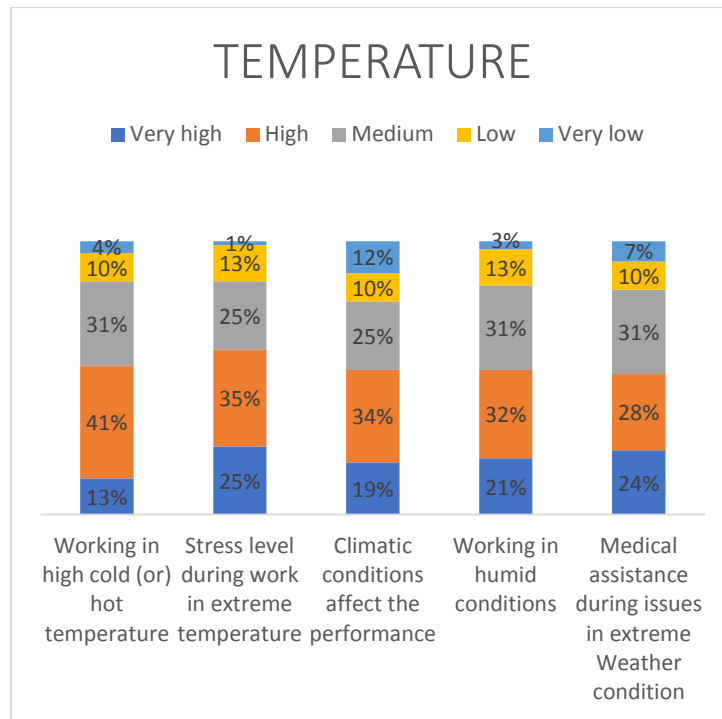
Figure 3 Repetition

Hence, we conclude that most people are intended to prevent the repetitive movements in work.

**Temperature**

From the responses it is observed that 41% accept that working in high cold or hot

temperature, 35% feels high stress during work in extreme temperature, 34% feels that the climatic conditions affect the performance of work, 32% feels working in humid conditions and 28% people accept that there was an medical assistance during issues in extreme weather condition.



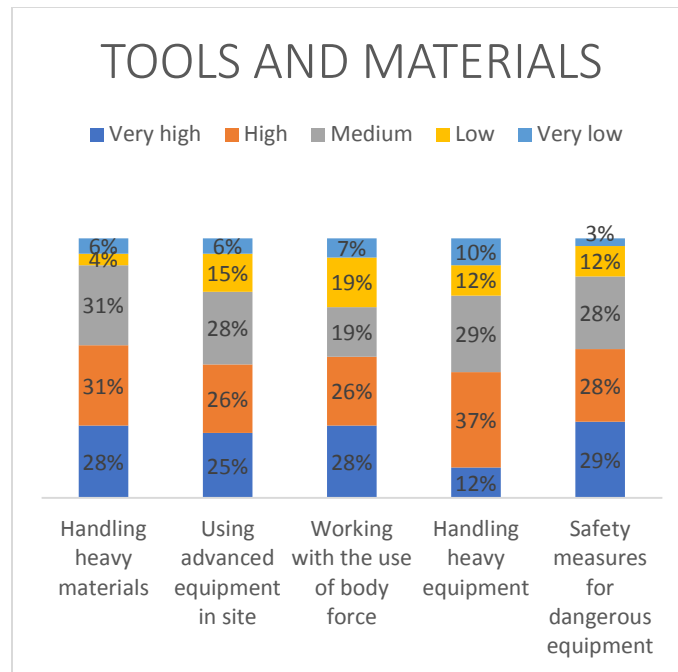
**Figure 4 Temperature**

Hence, we conclude that the most of the people avoid working in extreme temperature.

**Tools and materials**

From the responses it is observed that 31% feels handling heavy materials in site, 26% uses

advanced equipment in site and working with the use of body force, 37% feels handling heavy equipment and 28% using safety measures for dangerous equipment.



**Figure 5 Tools and materials**

Hence, we conclude that daily variations of solar and static solar system affect people to adopt towards sustainable development.

## CONCLUSION

Ergonomic of the construction industry and the losses of governing agencies are influenced by the workers productivity. Ergonomics is drastically reducing the occupational risks in construction projects. In a work station the labour productivity gets affected due to discomforts and several other factors such as forceful strain, awkward and static postures, duration, repetition, contact stress, tools and materials, extreme temperature. In phase various factors affecting construction productivity are identified from literature review. Based on

literature study a detailed questionnaire was prepared and survey was conducted from workers from various companies. The methodological approach used in this study is a quantitative descriptive design using a Google forms and questions in persons of questionnaire survey. Finding from the survey of Google forms, the result indicates the most of the factors that is about to cause occupational stress in construction industry. 125 questionnaires are distributed to site engineers etc. through Google forms. Among these 68 responses was received during the short period. The response rate was 54.4%. The online survey results show that occupational stress is caused due to 58.3% of handling heavy tools and materials, 66.7% of repetitive work and 66.7% of changes in scheduling affects duration.

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