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ANALYSIS OF OCCUPATIONAL RISK FACTORS FOR ERGONOMIC DESIGN OF CONSTRUCTION WORK SYSTEMS

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Abstract - *Construction sector involves more physical tasks to workers compared to other sectors. Using ergonomic principles in construction reduces fatigue experienced by the workers in various tasks. The risk factors are high and more vulnerable in construction workplace. Hence, ergonomic injuries or illness are greater for construction workers. From literature review, the study was carried out and the risk factors have been identified using RII (Relative Importance Index) method. Based on the risk factors identified, a questionnaire was framed and distributed among the workers from various construction sites. The results of this survey indicated major and minor risk factors in the site workplace. In this study, the recommendations for using ergonomics in construction workplace to reduce these risks were also discussed.*

Key Words: *risk factors, construction, results, ergonomics in construction*

1. INTRODUCTION

Working in Construction industry seems challenging because of its diversity, complexity, and dynamic features. Generally, construction workers are exposed to high risk of injuries while working in construction workplace. The work activities in construction site may sometimes completely mechanized or completely based on physical work of the site workers. The environment conditions prevailing in the site such as cold, heat, snow, rain or wind reduces the ability of workers thereby reduces the productivity. Ergonomics is the science which makes the tasks fit to the workers therefore reduces the risk of injuries also. The musculoskeletal injuries develops slowly overtime and occur in nerves, tendons, ligaments and joints. The Musculoskeletal Disorders are caused by physical stresses of the workers which leads to tissue breakdown. By implementing Ergonomics in construction workplace the construction works can be made easier and make the workers to do the work more efficiently. **M.Mohana, et al. (2019)** gave a basic introduction about ergonomics in construction industry and risk controls. It is clear from this study that better management control and communication will increase the application of ergonomics in the construction workplace. It is concluded that there are several control factors were taken into consideration in order to improve the implementation of ergonomics and reduce the ergonomics risk factors on site. **T. Ramya, et al. (2018)** discussed about the ergonomic risk factors, approaches and effective control measures taken to eradicate the ergonomic risk factors. The factors were identified from the questionnaire survey distributed and collected from various construction sites. The ranking of the factors was done by relative important index (RII) using the collected data. The major factors affecting the workers have been identified from the results and suitable suggestions were given to the companies for improving their ergonomic techniques in worksite. Kazys **Algirdas Kaminskas and Jonas Antanaiti (2014)** identifies the ergonomic risks encountered in the small and medium construction companies. A questionnaire was framed about symptoms of musculoskeletal disorders, in neck, shoulders, elbows, wrists, hands, the upper back, hips, thighs, knees and ankles/feet. It is recommended that recruiting contractors and crews to look at specific tasks that placed workers at risk of work-related musculoskeletal disorders and attempt modifications to reduce those risks.

Nabila Huda Adnan and Aziruddin Ressang (2014) identified a method to enhance the ergonomics awareness on construction site. The questionnaire survey was conducted among the professionals working in construction company and the collected data was analysed by frequency analysis method and average index method. It is found from the survey that awareness among workers about ergonomics is satisfactory but still lack on implementation. Therefore, some improvements and recommendations were provided

Satish B Mohan (2018) conducted a study of 1,657 construction injuries and illnesses that occurred at the US Navy Public Works Center (Pearl). This real field data of 589 ergonomic injuries identified the nine ergonomic risk factors: Frequent or heavy lifting, Fixed or awkward body postures, Pushing, pulling, and carrying heavy objects, Work methods, Hand tools and equipment, Repetitive, forced, or prolonged exertions, Noise, Also, the causal relationships between risk factor and musculoskeletal disorder (MSD) have been included. Teena Babu and **Annie Sonia Xavier (2018)** discussed about the various risk factors that leads to ergonomic injuries to the construction workers and it is generally called as Work – Related Musculoskeletal disorders. It is mentioned that Force, Repetition, Posture are the three major ergonomic risk factors and their analyses were done by using the RII method used for ranking the factors and to find their relative importance. It is concluded that from the survey

it's clear that many of the workers have musculoskeletal disorders and some of them were taking medicines also. **Zahra Jabbarani Torghabeha, et al.(2013)** prioritized the Ergonomic Risk Factors (ERFs) in order of risk. To achieve the aim of this study, a questionnaire survey was distributed among respondents randomly selected from construction sites in Malaysia. The results of this study indicated that the most critical ERFs were Extreme hot temperature, leaning forward/side, twisting the back and organizational factors. It is concluded that successful safety performance and management necessitate the investigation of ERFs and hazards regarding risk levels. Hence, Ergonomics improves safety as well as overall productivity of the organization.

1.1 ERGONOMICS

Ergonomics is important because while doing a job, a worker can experience body stress due to continuous physical activities and on overtime the musculoskeletal system gets affected. At the starting stage the body experiences symptoms such as fatigue, discomfort and pain which are the basic signs of musculoskeletal disorders. Ergonomics combines the human abilities with the tool design, equipment and organization.

1.2 OBJECTIVES OF THE STUDY

The objective of the study is to identify the ergonomic risk factors currently facing by the construction workers in building construction. In this paper, the main objectives are

- To study the knowledge of ergonomics among construction workers
- To identify and analyze significant risk factors among the workers
- To suggest and recommend possible measures to minimize the risk in construction work place.

2. SCOPE OF THE STUDY

In the present scenario, the construction sector contributes more than 5% to Nation's GDP. The failure of any construction project is due to many reasons and the major among them is reduction in labour productivity. Globally, it is said that nearly 42% of construction workers have musculoskeletal disorders. So, this study is important to evaluate the main factors affecting the workers in construction projects and providing suggestions and recommendations to improve workers safety and productivity.

3. METHODOLOGY

This represents the methodological framework used for collecting the data and the statistical tools used for analysing the data in order to solve the research problem and answer the research questions from suppliers

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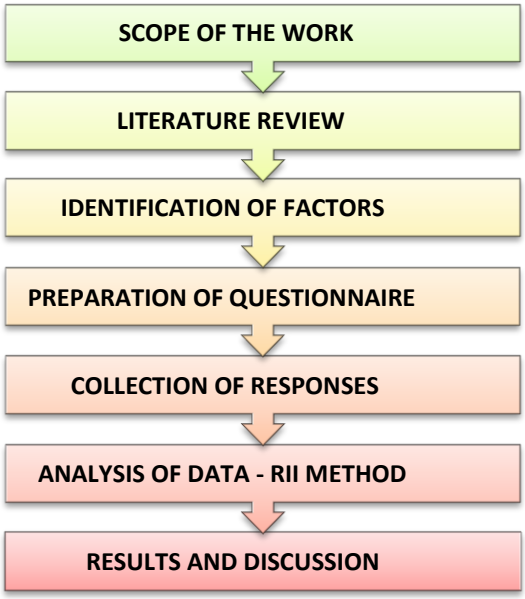

for collecting the data and the statistical tools used for analysing the data in order to solve the research problem and answer the research questions from suppliers

4. DATA COLLECTION

Data were collected directly from different sites by visiting. Personal interview was also conducted to know more about their work- and work-related physical problems that they are facing. Workers were selected randomly from the total population and grouped into a number of occupations (strata) based on the similarities in the nature of the jobs, such as masons, carpenters mason helpers, welders, gas cutters and helpers using stratified sampling technique

5. ISSUES RELATED TO ERGONOMIC

RISK FACTORS

Many of the musculoskeletal disorder for construction workers arise because of highly repetitive and strenuous construction-related activities. In order to assess the impact of these problems on occupational risk, a questionnaire-based status survey of occupational risk factors in construction work system, highlighting a number of research issues are as follows:

- Characteristics of MMH Tasks
- Features of the Working Environment
- Types of MMH Activities
- Characteristics of the general Jobs

- Types of Tools and Equipment used and
- Types of Occupational Health Problem including MSDs

Based on the above issues a set of questionnaires is prepared for each issue and distributed. The ranking of major factors from this issue is done by Relative Importance Index (RII) method

6. RELATIVE IMPORTANCE INDEX

It is used to determine the relative importance of the various causes and effects which leads to Musculoskeletal Disorders (MSDs) for the workers. This method is adopted in this study within various groups (i.e. masons, helpers, painters, plumbers, bar benders etc.). The five point scale ranged from 1(very little effect) to 5 (very high effect) is adopted and transformed to relative importance indices (RII) for each factor as follows.

RII = ΣW / (A*N)

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e. 5 in this case) and N is the total number of respondents. Higher the value of RII, more important was the cause.

6. DEMOGRAPHIC SAMPLE ANALYSIS

Category		Frequency	Percentage
Gender	Male	83	82.2
	Female	18	17.8
Age Group (in years)	Below 25yrs	08	07.9
	25-35yrs	35	34.7
	35-45yrs	48	47.5
	Above 45yrs	10	09.9
Designation	Bar bender	09	08.9
	Crane operator	03	03.0
	Helper	12	11.9
	HVAC technician	10	09.9
	Labour	21	20.8
	Mason	23	22.8
	Painter	09	08.9
	Plumber	14	13.9

7. ANALYSIS OF SAMPLE

7.1 Types of MMH activities

The Relative Importance Index (RII) can be calculated as,

RII = ΣW / (A*N)

Issues	RII	RANK
Repetitive motion	**2.63**	**3**
Awkward postures	**2.88**	**1**
Fixed postures	**2.75**	**2**
Heavy lifting	**2.17**	**4**
Not enough rest breaks	**1.89**	**5**

7.2 Features of working environment

Issues	RII	RANK
Difficult to access materials on site	**2.21**	**3**
Production pressure on workers	**2.05**	**4**
Discomfort due to climate changes in site	**2.41**	**2**
Stress increases with high temperature	**2.71**	**1**
Heavy noise around the site	**2.01**	**5**

7.3 Characteristics of MMH activities

Issues	RII	RANK
Lifting nearly 50kgs without help	**1.37**	**5**
Carrying or pushing without helping tools	**2.70**	**2**
Change of position suddenly	**2.37**	**3**
Discomfort while holding tools	**1.65**	**4**
Stress due to cutting or bending bars	**3.68**	**1**

7.4 Characteristics of tasks

Issues	RII	RANK
Can number of repetitions be reduced by rest breaks ?	**2.23**	**1**
Do you feel you have a healthy work –life balanced ?	**1.21**	**5**
Whether you feel exhausted at the end of the day?	**2.18**	**2**
Whether you are provided with enough safety equipment during work?	**1.44**	**4**
Whether are you often working at holidays?	**2.14**	**3**

7.5 Types of occupational problems and MSDs

Questions	RII	RANK
Whether vibration of seating in heavy equipment cause more body stress?	**2.03**	**3**
Do you feel that frequency and duration of work has more impact on pain?	**1.53**	**4**
Do you have muscle pain, loss of joint movement?	**3.07**	**2**
Whether the pain interferes with your work?	**3.17**	**1**

Questions	RII	RANK
Knees	**2.99**	**2**
Eyes	**2.18**	**6**
Hand/Fingers	**2.92**	**3**
Foot/Ankle	**2.46**	**4**
Back	**3.57**	**1**
Head/Neck	**2.40**	**5**

8. SUGGESTIONS

Rebar tying tool is suggested for ironworkers instead of tying rebar by hands with pliers. This will reduce the pain in hand and wrist. Masons need to stoop to pick the brick, mortar etc. and place them on the wall. Split level adjustable scaffolding may be used since the materials and wok surface are both kept at waist height thus reducing the body stress. Finishing the drywall by hand causes more effort and repetition. Pneumatic drywall system is suggested to reduce the repetitive motion. For carpenters the hand shovel may be replaced by power shovel to reduce the repetitive movements. For low level workers the rest breaks should be sufficiently provided and job rotation will help to overcome the stress.

9. RECOMMENDATIONS

The effective solution recommended is to use materials that are less labour-intensive. It is also recommended to buy or rent material handling devices for heavy works in construction which has more physical activities. Devices such as cushioned grips and round handles cab be used to carry heavy objects. The materials used in construction site is recommended to store at convenient height for easy access. Ergonomics training can also be provided to identify the problems and to find the effective solutions.

10. CONCLUSION

Construction sector involves more physical tasks to workers compared to other sectors. On the construction site, the workers were exposed to physical tasks continuously on regular basis which leads to musculoskeletal disorders, injuries or even death. The risk factors makes the construction sector even more worse due to the work related musculoskeletal disorders. The major and minor factors that causes disorders are found by using RII method. The analysis is done by using SPSS software. From the analysis the major and minor factors causing issues to the workers were found out. The survey also revealed that most of the workers have musculoskeletal disorders and some of them are taking medicines too.

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The research work is undertaken for completing her final year Thesis work. This research is part of the Thesis work. This research is part of the Thesis work being carried out for the final year project submission.