

Ergonomic Analysis of Building Construction Workers Using RII Method

Teena Babu¹, Annie Sonia Xavier²

¹PG Student, Civil Department, Toc H Institute of Science and Technology, Kerala, India

²Asst.Professor, Civil Department, Toc H Institute of Science and Technology, Kerala, India

Abstract - Ergonomics deals with the study of internal and external stresses acting on human body. Using ergonomic principles in construction reduces fatigue experienced by the workers in various tasks. Risk factors are present at varying levels for different construction jobs. The greater exposure to a single or combination of risk factor leads to greater ergonomic injury or illness, to the construction workers also termed as Work – Related Musculoskeletal Disorders (WMD). Force, Repetition, Posture are the three major ergonomic risk factors. RII (Relative Importance Index) is based on the degree of severity and degree of frequency. The RII method helps for ranking the factors and make easy to find their relative importance.

Keywords: Musculoskeletal Disorders, RII

1. INTRODUCTION

Construction industry is an important area of development and it creates wide opportunities across various sectors. Thus it's a labour intensive sector, including direct jobs and indirect jobs, provides employments to more than 35 million people. Construction industry has more accident prone working environments and many risk factors are involved. Building workers are exposed to excessive construction site dangers that can result in injuries or even death. They face different kinds of safety and health hazards while working in site. Workers are often exposed to extreme environmental conditions such as thermal stress, loud noise, vibrations, etc. Musculoskeletal disorder is the main problem that caused by the construction workers. Providing good working environment is very important as it will affect the overall productivity of the construction.

2. ERGONOMICS

Ergonomics is a branch of science that aims to learn about human abilities and limitations and then apply this learning to improve people's interaction with products, systems and environment. Ergonomics aims to improve workspace and environment to minimize risk of injury or harm. Employees in construction industry perform their job tasks that expose them to serious injuries and illness. This is mainly due to the poor workstation or tools that they are using for each task. Ergonomics involves the assessment of job tasks to identify ergonomic risk factors and appropriate engineering or works practice controls to reduce or eliminate the risk factors. Ergonomic risks in construction filed are mainly strains, sprains, and work related musculoskeletal disorder

(WMSD) that caused by carrying heavy loads, repetitive movements, awkward postures and contact stress vibrations.

Increase in construction works leads to constant exposure of unfavourable ergonomic challenges. The worker injury and fatality rate is increasing in construction industry mainly due to Work – Related Musculoskeletal Disorder. In work related health problems, Musculoskeletal Disorder is the most common one.

3. MUSCULOSKELETAL DISORDER

Musculoskeletal disorders are the pain or injuries that affect the bones, muscles, ligaments, tendons, and nerves. It can be acute or chronic. Musculoskeletal pain can be localized in one area, or all over the body. Common pains include bone pain, muscle pain, tendon and ligament pain, fibromyalgia, joint pain, tunnel syndromes etc. due to repetition of work, force, vibration, environmental factors, awkward posters etc. musculoskeletal disorder can occur to workers and it leads to fatigue and thus reducing the productivity in long run.

4. OBJECTIVE OF THE STUDY

The objective of the study is to identify the ergonomic risk factors that are facing by the construction workers in building construction.

- To identify the ergonomic risk factors
- To analyse the risk factors
- To adopt appropriate measures to reduce the risk factors

5. SCOPE OF THE STUDY

The scope of the research was mainly focused on literature review and a questionnaire survey and adopting proper measures to reduce the risk factors.

- To find out the ergonomic risk factors that present in building construction works.
- To find out the measures that want to be taken for reducing the risk factors and providing better working environment for each worker in building construction.

6. LITERATURE REVIEW

Luenda and Claudia *et al* (2017), investigated about the vibration and economic exposures associated with musculoskeletal disorders of shoulder and neck. Among full time workers 32 % of all nonfatal injuries and illness are caused by musculoskeletal disorders (MSDs). They conducted literature review about musculoskeletal disorders, vibrations and awkward postures. And the results obtained are the awkward postures during working leads to musculoskeletal disorders and exposure to whole - body vibrations resulted in MSDs.

Ratri Parida, Pradip Kumar Ray (2015), says about factors influencing construction ergonomic performance in India. Poor management of labours, bad working conditions, tools and improper working methods are the main problems experiencing by the construction industry. Based on the collected data questionnaire survey was conducted and critical issues related to workers at construction site are studied. Based on Relative Importance Index method, rank of each factors are identified and these factors are classified into 3 groups, they are; human/labour related factors, tasks-related factor and equipment/tools-related factors. They concluded that based on the task - specific MMH studies, identification, application of preventive measures, tools and proper working conditions can be done.

Pradip Kumar Ray, *et al* (2015), they conducted a biomechanical evaluation of manual material handling tasks that are carried out by construction companies in India. A two dimensional dynamic biomechanical evaluation approach was developed for construction tasks like carrying and lifting of normal and RCC bricks and heavy jack pipes. As a result of this study they concluded that there was a need of ergonomic performance improvement in manual material handling based on the preventive and corrective measures obtained.

Vikram S. Kulkarni, R.V. Devalkar (2017), studied about various tasks in building construction and found out various ergonomic principles for reducing the fatigue that developed in human body. Over erection and repetitive action of works are the major reason for most of the injuries, strains and stresses in body. The study was conducted using RII and PATH method. The result of this study was the risk of developing Cumulative Trauma Disorder (CTD) and musculoskeletal disorder. The preventive measures taken after conducting this study were; redesigning the activity, for eliminating unnecessary movements platforms are provided, material was kept at reach and trolleys and conveyor belts are used.

Kazys Algirdas Kaminskas, Jonas Antanaitis, (2010), they conducted a cross sectional survey to identify the ergonomic risk factors. Based on the investigation they concluded that most of the workers are affected with lower back pain and the main reason for this was awkward posture, high use of force and repetitive bending during work. Training for

workers should be provided such that, they will get adequate knowledge about how to work without fatigue.

Manikandan R, Sathyanathan M, (2014), says about the ergonomic hazards of workers in an educational institution building construction. For improving efficiency of workers eliminate the ergonomic hazards by providing workers, proper awareness and training about the work. Carpal tunnel syndrome, Tenosynovitis, Trigger finger, Disc injuries and Tension neck syndrome are the main Work Related Musculoskeletal disorder. From this study they concluded that solution for control the WMSD are engineering control, administrative control, and proper usage of personal protective equipment's, creating awareness about ergonomic diseases, provide training about safe lifting techniques and provide training about ergonomic principles.

Rabia Anwar, *et al* (2015), they conducted study to determine the significant association between posture risk level and work related musculoskeletal disorder. For the study they collected data by Nordic questionnaire and RULA assessment sheet. Data collected from 195 workers and chi square test was conducted to find the significance level. From the study they concluded that most of the workers are affected with lower back pain and there was significance between posture risk level and WMSD.

In-Ju Kim, (2017), they says about the increased exposure of construction workers to ergonomic environment and injury and fatality rate was increasing. Work Related Musculoskeletal Disorder was the major problem in construction sector. Adopting awkward postures, lifting heavy loads, frequent bending, manual handling of heavy load, working below the knee level, working above shoulder height, staying in one position for long time etc. involved in construction works. Workplace modification should be done to reduce the injuries at workplace and increase the productivity. Occupational ergonomics is very much important in construction field.

7. METHODOLOGY

7.1 Need For The Study

The aim of this study is to find out the ergonomic risk factors that are faced by building construction workers and for taking appropriate safety measures for reducing the effect of risks as well as to increase the productivity with minimum cost. As ergonomic risk factors increases and it will affect the workers working conditions, as time passes this will affect the cost of the project. Identifying the risk factors that facing by workers and taking necessary steps to minimize these factors will improve the productivity and hence the chance of getting musculoskeletal disorder will be less.

7.2 Research Methodology

Questionnaire was prepared based on literature review and survey was conducted. Three site are selected based which

having G+10 floor in Ernakulum. Total numbers of 31 respondents were participated in this survey among these, 20 are helpers and 11 are masons. Questionnaire are mainly based on three factors; level of discomfort in body, level of discomfort in various body movement and discomfort with work related factors. And also personal interview also was conducted with the workers for knowing about the personal information, nature and type of work and total time which the worker will remains in same position during working. The flowchart given below indicates the step by step procedure of finding out the risk factors of ergonomics.

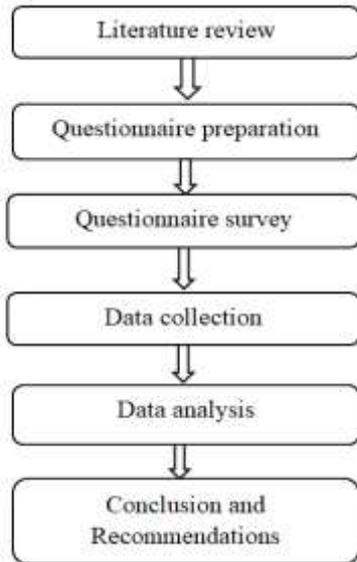


Fig-1: Methodology flow chart

8. RISK FACTORS OF ERGONOMICS

There are many risk factors that affect workers in construction. Main factors are force, repetition and posture. Identifying and reducing these factors play an important role in this study. Here for this study 28 numbers of factors are considered as shown in table 3.1.

Table 1: Risk factors

	Risk Factors	
Level of discomfort in body	1	Tiredness
	2	Redness
	3	Back pain
	4	Lower back pain
	5	Joint Pain
	6	Muscle Pain
	7	Swelling in any part of body
	8	Rise in temperature
	9	Loss of functions

Level of Discomfort in various body movements	10	Repeated exposure of force
	11	Repeated vibrations
	12	Improper work positioning
	13	Bending
	14	Standing
	15	Squatting
	16	Stretching
	17	Suddenly Changing position
Level of Discomfort with work related factors	18	Twisting
	19	Kneeling
	20	Stooping
	21	Methods of work
	22	Work load
	23	Repetitive work
	24	Lack of rest
	25	Climate/ environment
	26	Awkward posture
	27	Static posture
	28	Difficult task

9. QUESTIONNAIRE DESIGN

Questionnaire preparation was based on the literature review and for analysis Relative Important Index (RII). The main causes of musculoskeletal disorder and symptoms are included in the questionnaire. The discomfort level due to pains in body, temperature changes, swelling, redness, tiredness etc., discomfort due to body movements, such as bending, kneeling, squatting etc., and discomfort due to work related factors such as, climate, difficult task, lack of rest etc. are included in the survey.

Questionnaire has three parts; one is the personal details, second is the survey and third is general interview questions to workers. In first part, the respondents were requested to give correct data related to their personal details such as, name, age, experience, qualification, nature of job and type of job.

In second part, survey questions were included. Risk factors for the analysis of ergonomics are listed. The data collected based on Likert 5 point scale as shown in table 2

Table - 2: Likert Scale

Never	Mild	Moderate	Severe	Very severe
1	2	3	4	5

10. DATA COLLECTION

Data collected directly from three sites by visiting. Personal interview was also conducted to know more about their work and work related physical problems that they are facing. From three sites, with the help of site in charge, workers are selected and questionnaire survey was conducted.

10.1 Data Analysis

For improving the construction ergonomic performance analysing the risk factors involved in the construction sites want to be studied. It has been observed that masons and helpers are most affected by musculoskeletal disorder in construction site than other workers. For analysing ergonomic factors 31 respondent's data were collected. Data were analysed using RII method and rank was calculated.

10.2 Relative Importance Index

For ranking the risk factors of ergonomic analysis, relative importance index method was used.

Relative important index is given as, $RII = \frac{\sum W}{A \times N}$

Where,

- RII = Relative Important Index
- W = Weighting given to each factor by the respondents (ranging from 1 to 5)
- A = Highest weight (here 5)
- N = Total number of respondents

11. RESULT AND DISCUSSION

Questionnaires are done from five types of workers such as, masons, helper and plasterers from three sites. 28 factors were selected and 31 respondents were participated. From each type of workers the factors are analyzed and rank was given to each factors. The result obtained by using relative important index. The results obtained are given below.

Table -2: Data collection

	Factors	Mason		Helpers	
		RII	Rank	RII	Rank
Level of discomfort in body	Tiredness	0.382	14	0.4	10
	Redness	0.2	27	0.21	25
	Back pain	0.545	5	0.55	6
	Lower back pain	0.545	5	0.48	1
	Joint Pain	0.4	13	0.47	17
	Muscle Pain	0.381	15	0.4	13
	Swelling in any part of body	0.218	24	0.2	25

	Rise in temperature	0.2	27	0.2	25
	Loss of functions	0.218	24	0.23	25
	Repeated exposure of force	0.309	20	0.38	16
	Repeated vibrations	0.327	19	0.38	20
	Improper work positioning	0.509	8	0.45	17
Level of Discomfort in various body movements	Bending	0.6	4	0.54	6
	Standing	0.381	15	0.55	6
	Squatting	0.472	12	0.52	10
	Stretching	0.345	18	0.48	13
	Suddenly Changing position	0.363	17	0.4	24
	Twisting	0.236	23	0.3	21
	Kneeling	0.709	1	0.68	2
	Stooping	0.672	2	0.72	3
Level of Discomfort with work related factors	Methods of work	0.527	7	0.48	6
	Work load	0.49	11	0.46	10
	Repetitive work	0.636	3	0.48	3
	Lack of rest	0.254	22	0.25	21
	Climate/ environment	0.509	8	0.54	3
	Awkward posture	0.509	8	0.43	13
	Static posture	0.290	21	0.31	17
	Difficult task	0.218	24	0.26	21

12. CONCLUSION

Based on the literature review factors effecting workers are identified and the effect of musculoskeletal disorder was studied. Symptoms of musculoskeletal disorders were identified and questionnaire was prepared. Three construction sites were selected and survey was conducted. From 55 respondents from five areas of work; mason, helper, painter, bar bender and plasterer, data's are sorted and rank of each factor was determined by using relative important index (RII). The three factors that causing musculoskeletal disorder were force, repetition and posture. In every site visited the workers don't have any idea about ergonomics and proper posture for each work. From the survey it's clear that many of the workers have musculoskeletal disorder and some of them are taking medicines also.

12.1 RECOMMENDATIONS

Based on the questionnaire survey and personal interviews, the risk factors are identified and the following recommendations are made.

- a. Platforms should be given for avoiding unnecessary bending.
- b. Material should keep as near as possible
- c. Reduce the body movements by using appropriate tools
- d. Lifting of heavy material should be done by two or more people.
- e. Use trolleys and wheel barrow for transporting materials.
- f. Correct posture should be maintained throughout the work.
- g. Take rest in between works.
- h. Reduce the amount of repetitive works.
- i. Inhale and exhale properly while working
- j. Drink sufficient amount of water

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