

Ergonomic Risk Manipulations in Construction Sphere- A Literature Review

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Abstract: This paper overview the ergonomics risk control in the field of construction industry. The objective of this paper is to give a basic introduction of ergonomic in construction industry and risk controls in affiliation risk controls. Management control and Better communication will increase ergonomics application in the workplace. It is pursued by the convenient ergonomics design, education and organization training. Written ergonomics program statement which summarize the goals and plans for the organization ergonomic program are also necessary in order to reduce the ergonomics risk factors.

Keywords: ergonomics, risk control, construction industry

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I. Introduction

The Board of Certification for Professional Ergonomists (BCPE), defined Ergonomics "is a knowledge about human limitations, human abilities, and human characteristics that are suitable to design. Ergonomic design is the application of the knowledge in design of machines, systems, tools, , jobs, tasks and environments for safe, comfortable and effective human use" (BCPE, 1993). Ergonomics is the science of designing the job that fits for worker, fairly than physically forcing the worker's body to fit the job. It helps in reducing ergonomic stress and eliminate many potential ergonomic disorder (e.g. 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. Construction is a labour intensive as well as craft based activity and thus behavior of people has an enormous influence upon the organization and performance of firms. A Variety of injuries can occurs on a person's body because of demanding in construction jobs nowadays. The purpose of this work is to focus on obstacles faced by older workers in the workplace and provide main ergonomic solutions designed to mitigate and prevent work-related injuries.

1. Ergonomic Risk Controls

The construction industry is a vigorous and hazardous industry, making it both challenging and unique for ergonomic aspects to be carry out on site., There are slathers of controlling factors that can be taken into consideration in resolving ergonomics and controlling ergonomics risk factors in the construction site. Ergonomic controls are mainly used to help fit the workplace to the worker. They follow to place the body in a neutral position and reduce the other ergonomic risk factors. These controls must accommodate the extensive range of personnel. There are a few steps and approaches that can be taken to enhance ergonomics implementation in the workplace to reduce the risk factors that can be done by few control channels such as management control, communication, ergonomic design factors, education and training as well as written ergonomics programs.

2. Communications

Many problems in safety and health arise due to poor communication. This is not just a problem between workplace and management; it is generally a problem the other way or indeed at same level within an organization. It arises from uncertainty or even, accidental distortion of a message [14]. Therefore it is important for supervisors and team leaders to engage in actions which determine support for workers to help positive exchange relationships, encouraging the employees to raise safety concerns. Mittal [16] believes in ergonomics problem usually occurred due to lack of Better communication , management control , appropriate ergonomics design, organization training and education. will enhance ergonomics implementation in workplace

and He clearly explains that Proper communication between management and workplace needs to improved.

Brooks [4] believes that understanding the requirements of the workplace and communications network can be the key to getting the internal structure and layout right. There are a few common medium of communication such as reporting structures, meetings, and clear link between departments may be well understood, but spontaneous communications network within an organization which makes the difference between the success and failure. Therefore it is necessary to understand the basic informal communication such as how things get done, who needs regular access to whom, and which departments need to be sited close to each another. According to and Karwowski and Marras [11], in order to enhance communication the following points should be considered:

- Interest to give a message that the program is important and to install energy and quality of work in employees.
- Express the objectives of the program clearly.
- Verbally communicate the priority of ergonomics as the means to a healthy, safe and efficient workplace.

Cooper [5] stated that better communications and closer contact between all organizational levels is a indicative of good safety culture. It also be supported by Agarwal [2] said that communication is the effectiveness of management in communicating the safety goals to employees in the similar field. In order to intensify communication in ergonomics implementation in the workplace, there are few types of communication that can be carried out by top management. Manikandan [1] in his book stated that, verbal communication is the most essential and common. It is communication by a word or speech of mouth.

Ahankoo [3] identifies the risk factors Risk factors include Awkward posture, Repetition, Static posture, Vibration Force, Contact stress and Extreme temperature and it can be control ergonomic risk factors in construction operation and also monitor access the process of program implementation to prevent or cutout ergonomic risk factors in construction.

Verbal communication should only be used for relatively simple pieces of instruction or information. It is most commonly used in the workplace, during meetings or training sessions. The advantages of verbal communication is that, it is very less formal, implement an exchange of information to take place very quickly and message that to be conveyed as near to the workplace as possible. Training or instructions that are conveyed in this way are called as toolbox talks and that can be very effective.

Written communication takes many forms and represent from the simple memo to the detailed report. A memo should contain a simple message and be written in clear language and straightforward. The title should exactly describe the contents of the memo. The advantage of emails and memos is that there is a record of the message even after it has been delivered. Reports are more considerable documents and cover a topic in greater detail [15]. The report should contain a precise account of the topic and any recommendations or conclusions. The most common way the written communication is used in the workplace is the notice board. It must be positioned flourishingly within the workplace. Graphic communication is nothing but the communication by the use of photographs, drawings, or videos. The most frequent forms are the poster and videos. Both can be used very effectively since they can retain interest and convey a simple message.

Roper [22] stated that high amounts of muscular force such as lifting, lowering, or carrying of heavy loads, which cause injury and developing CTDs among aged workers. The main problem is that lack of communication. Solutions like Providing adjustable equipment, providing close, convenient storage for frequently used materials, parts and tools, providing lifting aids and mechanical aids for transporting materials and products, all help reduce force, repetition and awkward positions in everyday.

Manikandan [14] also found that, supervisors and managers should plan to have routine discussions to learn about the problems faced by employees and discuss feasible solutions. Some meetings, like the safety committee, are clearly planned for safety matters, but this should be strengthened by discussing safety and health issues at all regular management meetings. Regular one to one talks should also take place in the workplace to get exact messages across and get feedback from employees in order to enhance the ergonomic implementation by means of communication channel.

3. Ergonomic Designs

The ergonomic approach to work place design must be identified at the earlier stage and be considered as one of the most fundamental factors in designing a workplace as suitable design will be the most impressive and it is the first choice for controlling sources of workplace stress. Application of ergonomics principles to the design of man machine articulation, including displays of control devices, process information, and panel layout needs to be considered seriously in designing the best ergonomic design for the construction workers. He also believes that, design and presentation of procedures and workers operating instructions in the simplest

terms as possible by organization and control of the working environment, including the workspace, approach for maintenance, noise, lighting and heating conditions.[14]

On the other point of view, Agarwal et al [6] stated that, –conventional treatment of these disorders, especially in the early symptom stages, using the workplace evaluation for risk factors followed by alternation and rest to reduce aggravating positions and movements. While Piligan

[19] claims that, the goals of mediation are to reduce the awkward positions, minimize the use of excess force, reduce highly repetitive movement, reduce the period of time spend in same position and ensure sufficient recovery period. It was hypothesized by Torghabeh [30] that compared to workers who received an ergonomic evaluation and modifications of existing workstation, workers who received both the ergonomic and job stress management would have greater improvement in outcomes. It is important to emphasize that the focus of the prevention was modifying the existing workstations, rather than providing new furniture or equipment. For the space requirement in designing, Brooks [4] described space requirement as the amount of space each individual member needs to do their job, meeting rooms, storage space, communal areas and equipment space. A wish list may be relevant to stakeholders in order to help to understand what the needs of each department or individual. Apart from that, it may also very helpful to ask people to priorities their lists so that it can be differentiate between needs and nice. Considering what people’s needs can make a honest difference of the staff productivity and new surroundings. Muhammed [17] provide solutions like provide gloves and dust mask, Use gloves while steel work, proper training and proper surveillance is provided. listed below are the few design guidelines that should be taken into consideration in designing the most ergonomic design for workers in the construction field: Following are the Design Guidelines recommended by the authors, Woodside [31] recommended that,

- Avoid design that incur static (isometric) muscle tension If static muscle tension cannot be
- Avoided, ensure that the muscular load remains less than 15% of the maximal muscle force.
- Use postures for the limbs and body that provide the best lever arms for muscle used.
- Use footrests, wrist rests, proper backrests, and other ergonomic features to prevent fatigue, Design for allowing changes in posture

The worksystem should be designed in order to prevent overloading.

Adum [1] recommended that,

- Work with both hands. Do not use one hand as a biological holding device.
- Hands should move in symmetrical and opposite directions, and use the feet as well as the hands
- Design knowing the capacity of the fingers, and do not overload the fingers.
- Counter balance tools when possible to reduce the weight and forces.
- Train the individual to use the workplace facility and equipment properly.
- Avoid overloading of muscular system.
- Work surface heights should depend on the size (anthropometry) of the worker and the type of task.
- In general work within 30% of one’s maximum voluntary contraction (strength).
- Aim at dynamic work; avoid static work.
- Primary controls, devices and workplaces should be placed within the normal working area.

Woodside & Kocurek [31] Recommended that,

- Eliminate the hazard instead of treating the symptom.
- Design for the tallest workers where working height of the hands cannot be adjusted.
- Limit the amount of reaching and twisting required in handling materials.
- Design the bend in the tool to prevent twisting and bending of the wrist and use of excessive force.
- Avoid sharp or hard edges where hands contact tools.
- Incorporate changes in position or short breaks into the job or workstation to avoid static work situations.
- Use controls and displays that respond in the way most people expect them to, such as a knob that turns clockwise to increase volume.
- Design to accommodate more than just the average user. Make tools and the work environment adjustable or designed to fit a majority of the users.

4. Safety Management

Management must understand the part of safety that can play in company strategy. There are a few opinion regarding to organizational management in establishing safety in workplace and to workers, the first and oldest view proposed by Simard [27] is that accidents are caused by employee behaviour (the one injured) This view supported by Haddon [9] who believes that the working environment acts on the employee to cause the

accident (example: missing machinery guards, poor design or scaffolding collapsing). The Haddon method of reducing accident rates is by the design solution. Smallwood [28] believes that Source of ergonomics knowledge, Degree of awareness of the Occupational Health and Safety Act (OH&S Act) needed to consider in major level. Whereas Kulkarni [13] considers a safe working environment a hygiene factor finds that the management results in lack of a safety program which is the regulatory compliance issues, influence company morale, make engaging difficult and impact the bottom line. Therefore continuous management support which is very critical part in every successful safety program. Rechten [21] mention that a successful safety program is defined as a program that not only just meet regulatory compliance, but a program that stands out from the competition.

The program will identify the value of people, and the people create value among the client. Shoubi [26] identified most of Strains caused by Lifting items , Carrying load , Forceful grip, Long term holding one position , Poorly designed tools , Poorly maintained tools , equipment Joint & disks, High load weight & Fast movement . To overcome this problems Mechanization of Job rotation, Job enlargement, Team work ,Work place design and Equipment design are followed properly.

Kratzenstein [12] aim to investigate the neuromuscular response of shoulder muscles at different attachment heights of a carrying system during arm movement. To overcome muscle injury, use a hip belt, height adjustments should relief the shoulder muscles. While the hip belt remains stationary on the pelvis in most technical developments, a loading or unloading of the shoulders can be achieved by a stepwise adjustment of the attachment height of the shoulder belt. Result shows that an increase of the attachment height tends to relief the muscles.

According to Sharma & Gupta [25] management must be fully supportive; otherwise the program will not results in successful. The ergonomics programs should be given as much priority to production, quality and safety. Commitment by management provides the organizational resources and motivating effort that is necessary to deal dramatically with hazards related to ergonomics (Occupational Safety and Health Administration (OSHA) 1990).

Sharma & Gupta [25] believes that management's support must be entrenched at all organizational levels for the program to get reliability. In order to get support from employee, it is necessary to educate them about the advantages of an ergonomics program such as by conducting a brief seminar about ergonomics implementation. The above ideas also supported by Brooks [4] who believes that shareholders (the top management) should play an important part in heighten the ergonomic. This can be done through shareholder analysis which is a technique used to gather the requirements, feelings and views of all the people. Shabin [24] list out all the major ergonomic factors and prioritize them based on its severity and consequences. Likert scale questionnaire is prepared for the survey work and FMEA (Failure Mode and Effect Analysis) methodology is chosen. a step-by step approach for identifying various potential failure modes and estimating their corresponding failure effects were done using Failure mode and effect analysis (FMEA). Followed by FMEA, Risk Priority Number (RPN) is computed for prioritizing the factors. Risk Priority Number (RPN), which is the product of occurrence (O), severity (S) and detection (D).

Godwin [8] use lifting equation was for the calculation of the Recommended Weight Limits (RWL), and Lifting Index (LI). The Lifting Index (LI) is used to estimate the risk of specific lifting tasks in developing low-back disorders. For enhancing the well and good health for workers and to improve productivity we needs to maintain optimum lifting index. Rodriguez [23] Specific strategies that may be considered to overcome work related problems include alternating tasks, job enlargement, the use of active and passive pauses, changes in the work place, shift scheduling, and changes in the overall organization.

These may include managers, office staff, maintenance person and the union. This analysis can lead to extra benefits such as gaining a good understanding of these shareholders' views ~~that~~ they will finally feel involved in the process of change which leads to greater impression of commitment and ownership to any changes which could promote a smoother move from one layout to another. There are two types in gathering information, which is by conducting interview or through paper or modern electronically circulated questionnaires. Interview is the most adequate method in gaining information but is clearly time consuming compared to the questionnaire analysis. In order to increase the effectiveness of organizational management in strengthening ergonomics in workplace and reduce the risk factors, there are a few management controls can be done by Sharma & Gupta [25] as the following:

The first management controls can be done by engineering control, which required a designing or redesigning workplace, tools and method in order to wipe out the occupational risk factors in terms of:

- Workplace design: should be designed to accommodate the population. This design should fit for all size of worker.
- Work method design: static, awkward postures, extreme postures, repetitive movements, and excessive forces should minimize.
- Tool and handle design: ergonomically designed tools can reduce the risk of cumulative trauma disorders

(CTDs). Various sizes of tools should be provided for a proper fit comparatively than one size fits all. Special tools should be used where in needed for certain job.

The second management controls according to Brooks [4] is by the administrative controls. Administrative controls are applied to reduce the frequency, duration or severity of exposures to work stress. The following are some of the example of administrative controls by Brooks [4]:

- Providing rest breaks to recover from work fatigue.
- Increase the number of employees assigned to a task to distribute the overall work load over a larger number of individuals.
- Using job rotation. Job rotation should be used with caution to insure that the same muscle tendon groups are not used.
- Job enlargement. Various tasks may be added to the employee's work.
- Implementing an effective mechanism to that facilities, equipment are well maintained.

Surveillance is an initial step to enhancing workplace by identifying the areas with problems for improvement. Data can be obtained through information on injuries and accidents, production and quality measures and personnel records [3]. There are some surveillance method that can be conducted by Karwowski & Marras [3], such as the medical information at which injuries or illness have been reported in to determine the problem areas, discomfort surveys, open ended interviews, focus groups and employee suggestions. Pransky explains in a work place the workers get affected due to discomfortness and some other factors such as forceful exertion, repetition of work, awkward and static postures, tools and materials. The factors are identified by the questionnaire survey among the workers in various construction projects.

According to Mittal et al [16] error reduction is an important for good ergonomic management because minimizing the error that reduce injury, lowering the accident rates, improve quality and increase reliability and productivity. ergonomic management is a complex and ongoing process which should be an integral part of both corporate strategy and culture. Mittal [16] also believe that ergonomics management needs the involvement of each and every department and all level of employee. Awareness of ergonomic principles needs to establish in entire organization.

5. Training and Education

According to Sharma & Gupta [25], education and training are an effective way of increasing awareness of ergonomics issues (i.e. CTDs and back injuries) and resolving problems before injuries occur. Sumarningsih [29] believes productivity falls mainly because of the labor. Labor is the most important factor, since labor needs to know how the work is done and problems can be reduced by Taking regular breaks, avoid multitasking, Minimize interruptions during work. Muhammad [17] identified the ergonomic problem by a survey involving the use of questionnaires, on-the spot assessment, participatory approaches are the tools for investigation. By conducting survey the Major problems identified are MSD, bending or twisting the back action, staying same position for longer period and handling heavy materials. People reports that 66% worker needs helmet, 60% of the workers demand for eye protectors and 55% of people think dust mask is needed. The solutions are attained by providing gloves and dust mask, Use gloves while steel work, proper training and proper surveillance is provided. Ozkaya [18] explains about Improper workplace design is one of the significant reasons for occupational accidents and also injuries in labor-intensive production sites. After analyzing unloading and loading operations of workers, posture frequencies and operation times are determined. The workloads and risk of work-related musculoskeletal disorders is founded using Ovako Working Posture Analysis System (OWAS). Pransky [20] explains in a work station the workers get affected due to the discomfort of workers and several other factors such as forceful exertion, repetition, static postures, awkward and tools and materials. Proper safety management needs to be followed up and postures needs to be followed properly by the workers.

Ergonomics education allows managers, supervisors and employees to understand work related hazards in a job. There are a few training that can be done to educate workers in order to reduced the workplace risk factors and enhance the ergonomic educations among the workers because training and education will strengthen the efforts of first line supervisors in getting the employees to follow with proper work practices. A well educated workforce will lead to healthier workforce. Karwowski & Marras [3] stated three training that needs to be done to increase workers awareness which are the awareness training, in depth training, and refresher training. In depth training is recommended for a person or team that are responsible with ergonomics. The objectives of these training are to:

- Understand the objectives, goals and process of the overall program.
- Understand the illness and injury system for treatment work and job modifications
- Knowledge about conducting basic problem solving job analysis for ergonomics issues

- Distinguish risk factors for injury and illness in workplace design
- Capable to develop, implement effective solutions to the basic problems
- Understand basic ergonomics principles to apply to solution and new designs
- Be familiar with outside resources and methods for finding resources

The awareness training needs to be implemented for all employees. New employees should be properly trained to maintain the knowledge of the workforce. Commercial training programs can be used to conduct basic training. The objective of awareness training are,

- Recognize the medical management system of the company
- Recognize the physical problems in early.
- Appreciate their role and responsibilities of employees in the program

Davies [6] conduct experiment by comparison between movement times of left and right hands by both the standing and sitting postures, the factors of sex and age fell naturally into the programme by conducting 24 trials and those findings confirms that hand movement time differences caused due to the age and sex of the employee . Helander [10] also supported this idea and investigates the most of the accidents occurs due to falls of persons during work on roofs, scaffolds and ladders and These accidents can be avoided by the formulation of procedures and regulations to enhance safety. Everett [7] finds that generic risk factors includes the Repetitive exertions, Static postures, Forceful exertion, Localized mechanical stresses, Posture stresses, Low temperature and vibration which can be reduced by the techniques of automation and robotics which will be most cost effective in tasks that require speed, repetitive motions, large forces, and operation in hostile environments.

Refresher training sessions help employees to maintain interest in ergonomics and can be part of other processes such as continuous improvement on safety and health. Induction training should be provided to new employees, trainees, it must also include health and safety that would include the following topics:

- The safety and health policy of the organization.
- A brief summary of the health and safety management system including the name of the safety representative, employee's direct supervisor, and source of health and safety information.
- The employee responsibility for health and safety also includes general health and safety rules (example : smoking prohibitions)
- A summary of any relevant risk assessments and safe systems of work.

Apart from the above essential training, there are other types of training that can be done to increase workers knowledge on ergonomics such as job specific training confirms that employees undertake their jobs in a safe manner. Such training is a form of skill training sometimes known as toolbox training. Specialist training is normally needed for certain activities that are not related to a specific job but more to an activity. Example includes first aid, scaffold inspection, statutory health, safety inspections, fire prevention, fork lift truck driving, overhead crane operation,. These training courses are also provided by specialist organizations and participants who are all successful gets awarded certificates.

6. Written Programs

Sharma & Gupta [25], stated that once management has allowed an ergonomics program, the next step is to establish a written ergonomics program statement which outlines the goals and plans for the program. It should also illustrate management's concern about employee benefits and their productivity. This written program statement serves as a medium for popularizing new employees, managers and supervisors with the ergonomics philosophy of the organization. The above point of view supported by Karwowski & Marras [3], who also believes that written program is needed to support and improve ergonomic as well as to reduce the risk factors. A written program basic helps to:

- start the program more efficiently
- Apparently communicate the process
- Easy to introduce the process to a newcomer in the organisation
- Organize our thoughts and select best course of action.
- Create the goals and achievements by which the program can be judged for success and improvement.

The written program should be in clear statement instead of a lengthy to convey the objectives, goals and processes to establish and continue ergonomics within the company. The written program of ergonomics needs to be consider including the following in the document:

- An overall illustrative of the components and the process.
- Objectives of the program

- A list of those who are involved and their individual responsibilities
- Process of the program

II. Conclusion

Based on the literature review study it can be concluded that there are several control factors that significant to be taken into consideration in order to improved the implementation of ergonomics and reduced the ergonomics risk factors on site such as through enhancing communications and improving ergonomics workplace design. Followed by the management control, training and education for the employees and last but not least a proper written ergonomic programs.

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