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Ergonomic Risk Controls in Construction Industry- A Literature Review

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Abstract:-

This paper overview the ergonomics risk control in construction industry. The objective is to give a basic introduction of ergonomic in construction industry and risk controls in relation to minimize the ergonomics risk factors. The study will highlight five (5) significant ergonomics risk controls. Better communication and management control will enhance ergonomics implementation in the workplace. It is followed by the appropriate ergonomics design, organization training and education. Written ergonomics program statement which outlines the goals and plans for the organization ergonomic program are also essential in order to reduce the ergonomics risk factors.

Keywords: - ergonomics, risk control, construction industry

I. Introduction:-

Ergonomics, as defined by the Board of Certification for Professional Ergonomists (BCPE), "is a body of knowledge about human abilities, human limitations and human characteristics that are relevant to design. Ergonomic design is the application of this body of knowledge to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable and effective human use" (BCPE, 1993). The term ergonomics is derived from the Greek word ergos meaning "work" and nomos meaning "natural laws of" or "study of." The profession has two major branches with considerable overlap. One discipline, sometimes referred to as "industrial ergonomics," or "occupational biomechanics," concentrates on the physical aspects of work and human capabilities such as force, posture, and repetition. A second branch, sometimes referred to as "human factors," is oriented to the psychological aspects of work such as mental loading and decision making.

II. Ergonomic Risk Control

The building and construction industry is a dynamic and hazardous industry, making it both unique and challenging for ergonomic aspects to be implemented on site. Therefore, there are lots of controlling factors that can be taken into consideration in implementing ergonomics and controlling ergonomics risk factors in the construction site. Ergonomic controls are used to help fit the workplace to the worker. They seek to place the body in a neutral position and reduce the other ergonomic risk factors. These controls must accommodate the widest range of personnel. There are a few approaches and steps can be taken to improve ergonomics implementation in the workplace and to reduce the risk factors that can be done through a few control channels such as communication, management control, ergonomic design factors, training and education as well as written ergonomics programs.

III. Communications

Many problems in health and safety arise due to poor communication. It is not just a problem between management and workplace; it is often a problem the other way or indeed at the same level within an organization. It arises from ambiguities or even, accidental distortion of a message [1]. Therefore it is important for team leaders and supervisors to engage in actions which demonstrate support for workers to facilitate positive exchange relationships, encouraging employees to raise safety concerns. Brooks [2] believes that understanding the communications network and requirements of the workplace can be the key to getting the layout and internal structure right. There are a few common channel of communication such as meetings, reporting structures, and clear link between departments may be quite well understood, but, informal communications network within an organization which makes the difference between success and failure. Therefore it is essential to understand the basic informal communication such as who needs regular access to whom, how things get done and which departments need to be sited close to one another. According to Marras and Karwowski [3], to enhance communication the following points should be considered:

- Verbally communicate the importance of ergonomics as the means to a safe, healthy and efficient workplace.

- Express interest to give a message that the program is important and to instil energy and quality of work in employees.
- State the program objectives clearly.

Cooper [4] stated that closer contact and better communications between all organizational levels is a characteristic of good safety culture. It also be supported by Keith Molenaar [5] said that communication is the effectiveness of management in communicating safety goals to employees in the field. In order to enhance communication in ergonomics implementation in the workplace, there are few types of communication that can be implemented by top management. Dias & Coble [1] in his book stated that, verbal communication is the most common. It is communication by speech or word of mouth. Verbal communication should only be used for relatively simple pieces of information or instruction. It is most commonly used in the workplace, during training sessions or at meetings. The merits of verbal communication is that, it is less formal, enables an exchange of information to take place quickly and the message to be conveyed as near to the workplace as possible. Training or instructions that are delivered in this way are called toolbox talks and can be very effective.

Written communication takes many forms from the simple memo to the detailed report. A memo should contain one simple message and be written in straightforward and clear language. The title should accurately describe the contents of the memo. The advantage of memos and emails is that there is a record of the message after it has been delivered. Reports are more substantial documents and cover a topic in greater detail. The report should contain a detailed account of the topic and any conclusions or recommendations. The most common way in which written communication is used in the workplace is the notice board. It must be well positioned within the workplace. Graphic communication is communication by the use of drawings, photographs or videos. The most common forms are the poster and videos. Both can be used very effectively as training aids since they can retain interest and impart a simple message.

Dias & Coble [1] also found that, managers and supervisors should plan to have regular discussions to learn about the problems faced by employees and discuss possible solutions. Some meetings, like the safety committee, are specifically planned for safety matters, but this should be reinforced by discussing health and safety issues at all routine management meetings. Regular one to one talks should also take place in the workplace to get specific messages across and get feedback from employees in order to enhance ergonomic implementation through communication channel.

IV. Ergonomic Designs

The ergonomic approach to work place design must be recognized at the earlier stage and be considered as one of the most essential factors in designing a workplace as suitable design will be the most effective and it is the first choice for controlling sources of workplace stress. According to Dias & Coble [1], application of ergonomics principles to the design of man machine interfaces, including displays of plant and process information, control devices and panel layout need to be considered seriously in designing the best ergonomic design for the workers. He also believes that, design and presentation of procedures and operating instructions in the simplest terms possible such as by organization and control of the working environment, including the workspace, access for maintenance, lighting, noise and heating conditions.

On the other point of view, Michael et al [6] stated that, "conservative" treatment of these disorders, especially in the early symptomatic stages, using workplace evaluation for risk factors followed by modifications and rest to reduce inciting or aggravating positions and or movements. While Piligan [7] claims that, the goals of intervention are to reduce awkward positions, minimize the need to use excess force, reduce highly repetitive movement, reduce the period of time spend in one position and ensure sufficient rest/recovery period. It was hypothesized by Byrne [8] that compared to workers who received an ergonomic evaluation and tailored modifications of existing workstation, symptomatic workers who received both the ergonomic and job stress management intervention would have greater improvement in outcomes. It is important to emphasize that the focus of the prevention intervention was modifying the existing workstations, instead of providing new furniture or equipment. As for the space requirement in designing, Brooks [2] described space requirement as the amount of space each individual staff member needs to do their job, storage space, meeting rooms, communal areas and equipment space. A wish list may be relevant to stakeholders in order to help to understand what the needs of each individual or department. Apart from that, it may also helpful to ask people to priorities their lists so that it can be differentiate between needs and nice to haves. Understanding what people's needs can make a real difference of the new surroundings and staff productivity. As listed below, there are few design guidelines that should be taken into consideration in designing the most ergonomic design for workers:

Table 1:- Design Guidelines

Authors	Design Guideline
Woodside [9]	• 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 • Design the work system to prevent overloading of the muscular system • Forces necessary for dynamic activities should be kept less than **30%**^ of the maximal forces that the muscles are capable of generating, forces over 50% are

	acceptable only when kept to short duration. • 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
Jeffrey [17]	• Work surface heights should depend on the size (anthropometry) of the worker and the type of task performed (precision, light assembly or heavy manual) • In general work within 30% of one's maximum voluntary contraction (strength). Avoid overloading of muscular system. • Aim at dynamic work; avoid static work (work where there is no movement). Static work or static loading of the muscles is inefficient and accelerates fatigue. Static work can occur when holding a weight in one's arms for an extended period, or constant bending of the back to perform some task. • Primary controls, devices and workplaces should be placed within the normal working area. • Work with both hands. Do not use one hand (non preferred 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.
Woodside & Kocurek [9]	• Eliminate the hazard instead of treating the symptom • 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. • 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.

V. Safety Management

Management must understand the part safety can play in company strategy. There are a few historically opinion regarding to organizational management in ensuring safety in workplace and to workers, the first and oldest view proposed by Heinrich [10] is that accidents are caused by employee behavior (the one injured). In Heinrich"s view, the method to lower accident rates is to change employee behavior. This view supported by Haddon [11] who believes that the working environment acts on the employee to cause the accident (example: poor design, missing machinery guards or scaffolding collapsing). The Haddon method of lowering accident rates is with design solution. The third historical view on management is by Cohen 1977 which stated that "*Management commitment to safety, that is its overt concern and support for safety activities, represents a dominant factor in safety experience*".

Whereas Herzberg [13] considers a safe working environment a hygiene factor, thus it does not motivate if it is in place and is only an issue if missing which leads to situation that employee may see safety as only a maintenance factor if in place, but for management the lack of a safety program can have regulatory compliance issues, influence company morale, make recruiting difficult and impact the bottom line. Therefore continuous management support is a critical part of a successful safety program. Rechentin [14] mention that a successful safety program is defined as a program that doesn"t just meet regulatory compliance, but a program that stands out from the competition. It must be an exemplary program with results that add value for the client and the company. The program will recognize the value of people, and the people create value for the client. According to Tayyari & Smith [15] management must be fully supportive; otherwise the program will not be successful. The ergonomics programs should be given as much priority as production, quality and safety. Commitment by management provides the organizational resources and motivating force necessary to deal effectively with ergonomics related hazards (Occupational Safety and Health Administration (OSHA) 1990).

Tayyari & Smith [15] also believes that management's support must be demonstrated at all organizational levels for the program to get credibility and corporate wide cooperation. In order to obtain support from employee, it may be necessary

to educate them about the benefits of an ergonomics program such as by conducting a brief seminar or successful ergonomics implementation and high visibility of a plant manager at the ergonomics meetings and educational programs effectively demonstrates commitment by top management for sustaining the program. The above ideas also supported by Brooks [2] who believes that stakeholders (the top management) should play an important part in enhancing ergonomic. This can be done through stakeholder analysis which is a technique used to gather the requirements, views and feelings of all the people. These may include managers, office staff, unions and maintenance person. This analysis can lead to additional benefits such as gaining a good understanding of these stakeholders‟ views that they will subsequently feel involved in the process of change which leads to greater sense of ownership and commitment to any changes which could facilitate a smoother move from one layout to another. There are two types in gathering information, which is via interview or through paper or electronically circulated questionnaires. Interview is the most effective method in gathering information but is clearly time consuming compare to questionnaire analysis. In order to increase the effectiveness of organizational management in enhancing ergonomics in workplace and reduce the risk factors, there are a few management controls can be done according to Tayyari & Smith [15] as the following:

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

- Workstation design: should be designed to accommodate the population that will assign to the workstation. The design should fit all size of worker.
- Work method design: static, awkward and extreme postures, repetitive movements, and excessive forces should minimize. The strength and endurance requirements of the jobs should be within the workers abilities.
- Tool and handle design: ergonomically designed tools and handles can reduce the risk of cumulative trauma disorders (CTDs). Various sizes of tools should be provided for a proper fit rather than one size fits all. Special purpose tools should be used where needed for certain job.

The second management controls according to Brooks [2] is through the administrative controls. Administrative controls are applied to reduce the duration, frequency or severity of exposures to work stressors. The following are the example of administrative controls stated by Brooks [2]:

- Providing rest breaks to recover from work induced fatigue.
- Increase the number of employees assigned to a task to distribute the overall 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 job.
- Establishing an effective mechanism to ensure that facilities, equipment and tools are well maintained.

Surveillance is an initial step to improving workplace by identifying the areas with problems or the potential for improvement. Data can be obtained thru information on injuries and accidents, production and quality measures and personnel records [3]. There are a few surveillance method that can be conducted as suggested by Marras & Karwowski [3],such as the medical information at which injuries or illness have been reported in order to determine the problem areas, discomfort surveys, absenteeism and turnover that can be indicators of difficult or stressful jobs that may warrant redesign, production and quality data as the indicators of a mismatch of the workplace to the employee, accident investigation can be a powerful tool to identify ergonomics based problems, audit to determine problem areas or areas of potential improvement and the last but not least, open ended interviews, focus groups and employee suggestions.

According to Rowan & Wright [16], error reduction is an important benefit of good ergonomic management due to the reason that minimizing the error can reduce injury, lowering the rates of accidents, improve quality and increase productivity and reliability. Contributing factors of error are known to be routine, fatigue and distraction. Therefore the goal of ergonomic management are to reduce or eliminate factors which contributes to error and minimize the consequences of error because ergonomic management is a complex and ongoing process which should be an integral part of both corporate strategy and culture.

Rowan & Wright [16] also believe that ergonomics management requires the involvement of every department and every level of employee. Awareness of ergonomic principles must permeate the entire organization. Identifying ergonomic problems is not the big picture to ergonomic management because finding the solution is more challenging. Good solution often requires inputs from numerous department and employees who are most directly involved with the work being studied are the best inputs. Financial commitment is another essential component of an ergonomics process as many ergonomic problems can be resolved with minimal cost, some organizations, because of budget restrictions, may have to limit initial ergonomic endeavours to a particular department or section rather than simultaneously implementing ergonomic changes across the whole organization.

VI. Training and Education

According to Tayyari & Smith [15], training and education are an effective way of increasing awareness of ergonomics issues (i.e. CTDs and back injuries) and resolving problems before injuries occur. Ergonomics education allows managers, supervisors and employees to understand work related hazards with a job. By reducing medical claims, training lowers insurance premiums and increases the organization’s profitability and helps prevent liability suits. There

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

- Understand the overall program objectives, goals and process
- Understand the injury and illness system for treatment, return to work and job modifications
- Be able to correctly record and interpret medical records and OSHA logs for surveillance purposes
- Know how to conduct basic problem solving job analysis for ergonomics issues
- Recognize risk factors for injury and illness in workplace design
- Be able to develop, implement and affirm effectiveness of solutions to 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 level training should be implemented for all employees. New employees should be trained to maintain the knowledge base in the workforce. Commercial videos and training programs can be used to conduct a training program for basic training. Nevertheless, it is not unusual to give separate programs for supervisors, management and production workers as there may be differences in educational level and perspective of each group. Awareness training prepares employees to participate in ergonomics process with the objectives to:

- Appreciate their role and responsibilities in the program
- Recognize the early indicators of physical problems
- Understand the medical management system of the company
- Understand basic risk factors for injuries and illness
- Know basic ergonomics principles
- Understand their participation in job analysis

Refresher training sessions help to maintain the employees‟ interest in ergonomics and can be part of other processes in the company such as continuous improvement or safety and health. Some companies have set up self assessment approaches and found that when the employees receive training and are empowered to contribute, the employees address many problems themselves. Induction training should be provided to new employees, trainees and possibly contractor's covers items such as pay, conditions and quality; it must also include health and safety that would include the following topics:

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

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 -ensures that employees undertake their jobs in a safe manner. Such training therefore is a form of skill training and is often best done "on the job" sometimes known as „toolbox training". Detailed of the safe system of work or in more hazardous jobs, a permit to work system should be covered. It is common for this type of training to follow an operational procedure in the form of a checklist which the employee can sign on completion of the training. Supervisory and management training follows similar topics to those contained in an induction training course but will be covered in more depth. There will also be a more detailed treatment of health and safety law. Specialist training is normally needed for activities that are not related to a specific job but more to an activity. Example includes first aid, fire prevention, fork lift truck driving, overhead crane operation, scaffold inspection and statutory health and safety inspections. These training courses are often provided by specialist organizations and successful participants are awarded certificates.

VII. Written Programs

Tayyari & Smith [15] stated that once management has approved an ergonomics program, the next step is to develop a written ergonomics program statement which outlines the goals and plans for the program and its support. The program statement should insure that employee well being and productivity have been addressed. It should also demonstrate management's concern about employee benefits. This written program statement can serve as a medium for familiarizing new employees, supervisors and managers with the ergonomics philosophy of the organization. The above point of view supported by Marras & Karwowski [3], who also believes that written program is essential to support and enhance

ergonomic as well as to reduce the risk factors. A written program is often emphasized as essential for a successful program. A written program basic helps to:

- Get the program started more efficiently
- Organize thoughts and the best plan of action
- Clearly communicate the process
- Make it easier to introduce the process to a newcomer
- Establish the goals and achievements by which the program can be assessed for success and improvement.

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

- An overall schematic of the components and the process.
- Program objectives
- A list of those involved and their responsibilities
- The program process
- Program action list, analyses and changes records and their effectiveness.

VIII. 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 least but not least proper written ergonomic programs.

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