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A CONCEPTUAL OVERVIEW OF ERGONOMICS IN CONSTRUCTION INDUSTRY

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Abstract
The purpose of this paper is to give a conceptual overview of ergonomics in construction industry. The objective is to give a preliminary introduction and definition of ergonomics as applied in the construction industry. The study will include a brief introduction to the Malaysian construction industry, the history of ergonomics as well as the trades that are related to ergonomics in the construction process. The paper will also cover the result of ergonomics application in managing the effects of Musculoskeletal Disorders amongst construction workers. Ultimately, it is hoped that this research paper will be able to contribute towards a better understanding of an ergonomics overview in the construction industry.

Keywords: Ergonomics, Construction Industry.

1. Introduction

Ergonomics refers to the integration of worker, task, tool and workstation to achieve a safe and comfortable working environment. The focus of ergonomics should be to fit the task to the worker, not the other way around.In their jobs, workers can be exposed to heavy lifting, repetitive motion, vibration, noise and eyestrain which can result injuries or related problems involving the tendons, muscles or nerves. Many of these problems develop from light-duty or seemingly harmless activities whose ill effects accumulate over time because of continuous or repetitive exposure.

Ergonomics is a broad science with wide variety of working conditions that can affect worker's comfort and health, including factors such as lighting, noise, temperature, vibration, heavy lifting, repetitive motion, workstation design, tool design, machine design, chair design and footwear and others. Job design also gives a great impact with such factors such as shift work, breaks, and meal schedules. These factors can result in injuries or related problems involving the tendons, muscles, or nerves which most of the problems may develop to musculosketal disorders (MSDs). MSDs, or musculoskeletal disorders, are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system. They can affect nearly all tissues, including the nerves and tendon sheaths and most frequently involve the arms and back.

According to Yelin et al. (1999), 90% of disabled older workers had MSDs. Furthermore (Lawrence et al.,1998) reported that it is estimated around 18.4% of the U.S population (nearly 60 million individuals) will suffer from one or more chronic MSDs by the year of 2020. The treatment of the MSDs problems will cost tens of billions of dollars as stated by Praemer et al. (1999).These statements shows that studies on ergonomics is really important to develop the best prevention method of the MSDs which can benefits the employer and also their workers.

2. History of Ergonomics

Historically, the study of ergonomics evolved from the study of human performance, in particular from human factors. Human factors are the science of designing the interface between operator and machine. As mentioned in a study by Shaver & Braun (2008), Frederick W. Taylor was a pioneer of this approach and evaluated jobs to determine the "One Best Way" they could be performed. At Bethlehem Steel, Taylor dramatically increased worker

production and wages in a shoveling task by matching the shovel with the type of material that was being moved (ashes, coal or ore).

The study also mentioned that Frank and Lillian Gilbreth made jobs more efficient and less fatigue through time motion analysis and standardizing tools, materials and the job process. By applying this approach, the number of motions in bricklaying was reduced from 18 to 4.5 allowing bricklayers to increase their pace of laying bricks from 120 to 350 bricks per hour.

World War II prompted greater interest in human-machine interaction as the efficiency of sophisticated military equipment (i.e., airplanes) could be compromised by bad or confusing design. Design concepts of fitting the machine to the size of the soldier and logical/understandable control buttons evolved. After World War II, the focus of concern expanded to include worker safety as well as productivity. Research began in a variety of areas such as:

i) Muscle force required to perform manual tasks
ii) Compressive low back disk force when lifting
iii) Cardiovascular response when performing heavy labor
iv) Perceived maximum load that can be carried, pushed or pulled

Areas of knowledge that involved human behavior and attributes (i.e., decision making process, organization design, human perception relative to design) became known as cognitive ergonomics or human factors. Areas of knowledge that involved physical aspects of the workplace and human abilities such as force required to lift, vibration and reaches became known as industrial ergonomics or ergonomics.

The broad group focuses and name duality continues at this time. Contributors to ergonomics/human factors concepts include industrial engineers, industrial psychologists, occupational medicine physicians, industrial hygienists, and safety engineers. Professions that use ergonomics/human factors information include architects, occupational therapists, physical therapists, occupational medicine nurses, and insurance loss control specialists and many others.

3. Definition of Ergonomics

Ergonomics is concerned with promoting compatibility between humans and systems. Ergonomics normally will focuses on humans and their interaction with products, equipments, facilities, procedures and environments used in work. However there are a few others definition of ergonomics as the followings:

Table 1: Definition of Ergonomics

Authors	Definition of Ergonomics
Te-Hsin & Kleiner (2001)	An applied science that co-ordinates the design of devices, systems and physical working conditions with the capacities and requirements of the workers
Wilson (1995)	The practice of learning about human characteristic and then using that understanding to improve people's interaction with the things they use and with the environments in which they do so
Fernandez (1995)	Ergonomics is defined as the design of the workplace, equipment, machine, tool, product, environment and system, taking inti consideration the human's physical, physiological, biomechanical and psychological capabilities and optimizing the effectiveness and productivity of work systems while assuring the safety, health and wellbeing of the workers
Woodside & Kocurek (1997)	Ergonomics refers to the integration of worker, task, tool, and workstation to achieve a safe and comfortable working environment.
Tayyari & Smith (1997)	A branch of science that is concerned with the achievement of optimal relationships between workers and their work environment

The ergonomic approach to design may be summarized as a user centred design which comprises the product, the user as well as the task as stipulated in the following figure. In other words, ergonomics is best defined as the science of fitting the job to the workers and the product to the user.

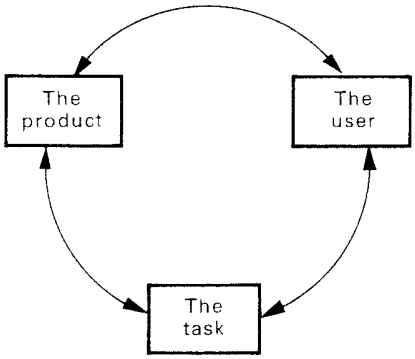

Figure 1.1 Principle of User-Centred Design

4. Introduction To Costruction Industry

Ergonomic changes on construction sites need not be difficult or time consuming but regardless of the expense they are worthwhile and necessary investments. Musculoskeletal disorders are going to be the major health and safety issue of the future. In fact unless these risks are reduced now, construction workers will be at even greater risk of injury leading to chronic pain and dysfunction. This is due to the facts that construction requires inter alia, bending and twisting, working awkward or cramped positions, reaching away from the body and overhead, repetitive movements, handling heavy materials and equipment, use of body force, exposure to vibration and noise, and climbing and descending which can leads to musculosketal disorders (MSDs) symptom.

The Malaysian construction industry is going through a phase of stabilization following a period of regional recession. In 2006, the industry reported growth of 3% year-on-year (y-o-y), (BMI, 2006). The industry is extremely competitive and the local players operating in the industry have the ability to handle large projects. In the newly released Malaysia Infrastructure Report Q207, BMI (2006) forecasts that the Malaysian construction industry will grow at an average 5.35% over 2007-2011.

In order to fit in with Malaysia's 2020 vision of becoming a fully developed country, the Malaysian Construction Industry Masterplan (CIMP) 2006-2015 was developed by the industry for the industry. The CIMP was developed to overcome some of the weaknesses that were inherent in the construction industry. Through the seven trust outlined by the CIMP, Malaysian construction industry is expected to be a world class, innovative and knowledgeable global solution provider. Enhancement of project success is vital in the future construction projects.

5. Trades Involved in Constructions Industry and Their Relations to MSDs Symptom

Trade is a person who carries out a job that involves training and special skills. There are several trades involves in a construction project that related to the MSDs symptom as stipulated in the following table:

Table 2: Trades Involved In Constructions Industry and Their Relations to MSDs Symptom

TRADE	NATURE OF WORK	PROBLEMATIC WORK-RELATED ACTIVITIES	ACTIVITIES	RISK FACTOR	MSDs
Bricklayer	The nature bricklaying (at the floor level) often involved the bricklayers kneeling when placing the bricks	Bending of the body and twisting the body (bend down, straighten up and turn to lay the brick	To scoop up mortar and working below knee level (material at feet level).	Awkward posture and repetition	Lower back disorder, knee disorder
Plasterer	Plastering was normally commenced at the upper level and continued downwards.	Bending and twisting of the body, lifting heavy material	Working above shoulder height and reaching overhead, working below knee level, reaching away from the body and	Repetition , force	Shoulder disorder, upper arm disorder, neck disorder

			working when kneeling.		
Painter	Painter is a trade person who responsible for the application of decorative and protective coloured coatings to building surfaces. Painting was done while standing at ground or floor level as well as in elevated positions.	Bending of the body and twisting of the body	Working below knee level, working above shoulder height, reaching overhead.	Awkward positions, force	Lower back disorder, shoulder disorder, upper arm disorder
Concretor	Concretor is a labour that works with concrete works such as floor concreting	Bend their back and twisting the right side when concreting floor in awkward position.	Straight leg, Work in static position and moving/twisting.	Awkward posture	Back pain, shoulder, wrist region and neck
Carpenter	Carpenter is a skilled craftsman who performs carpentry works with a wide range of woodworking. Carpenters can perform several tasks including ceiling, drywall, and concrete form.	Back bending and twisting the body	Lifting heavy materials and work below shoulder	Force, awkward posture	Back and Knee disorders
Roofer	Roofer is a tradesperson responsible in applying final roof coverings such as shingles, built up roofing and other waterproof covering.	Back bending	Lifting heavy materials	Awkward posture	Shoulder disorders, knee, upper arm and wrist region.
Masonry	Masonry is a tradesperson responsible involving stone work for wall or other structures.	Bending or twisting the back, working in the same position or in pain, and heavy lifting.	Lifting heavy material below knee level and work above shoulder height.	Awkward posture and repetition.	Low back pain, wrist, and shoulder.

6. Results of Ergonomics Applications

Ergonomics means finding ways to make the work easier so workers can work smarter not harder. It means asking experienced workers for their ideas on how to do the work. Usually, it ends up making the job more productive since workers are less often fatigued or hurt. Ergonomic changes, generally, are not expensive and can be very simple. Types of ergonomic changes include:

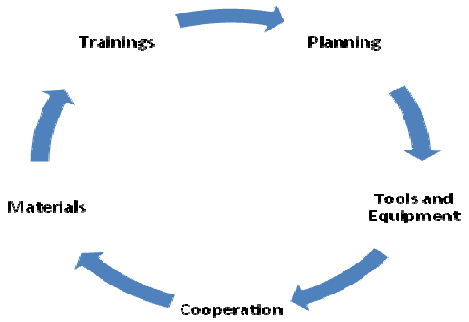

Figure 2: Ergonomics Changes

Nowadays, companies are observing several benefits when implementing an ergonomics program . According to Kohn (1997), benefits most frequently cited included improved worker morale, improved productivity, better ergonomic hazard control, fewer complaints, fewer injuries reported, and improved health awareness. Brown has reported an 85 percent increase in productivity with a cost-benefit ratio of 1 to 10 with the implementation of ergonomic programs (Brown et. al., 1991). Brown pointed out that the combination of increased production along with the reduction of worker compensation expenses reaped significant rewards when compared to the minimal costs incurred during the redesign of the workplace equipment and facility. Numerous benefits have been demonstrated with the implementation of ergonomic programs (Refer to Table 2 for a list of these benefits of ergonomic programs as pointed by Tayyari & Smith 1997, Fernandez 1995 & Kohn 1997 . These benefits can positively impact both employees and employers.

Table 2: Results of Ergonomic Applications

Results of Ergonomic Applications
Increase productivity
Improved health and safety of workers
Lower workers'compensation claims
Compliance with government regulations(e.g OSHA standards)
Job satisfaction
Understanding the effects of a particular type of work on workers' bodies and their job performance;
Establishment of a knowledge base support for designers improving the productivity and well-being of individuals
Improved morale of workers
Increased work quality
Decreased errors and product defects
Improved morale
Reduced fatigue related costs
Improved hazard identification and control
Improved organizational performance
Improved company efficiency resulting from smaller workforce
Reduced management and supervision costs
Decreased ergonomically related litigation
Reduced disruption of work teams
Reduced productivity fluctuations resulting from late-shift or late-week operations

7. Conclusion

This paper have highlighted on the basic introduction, definition and history of ergonomics and the relation of it to the construction industry. The principle of ergonomics is that job demands should not exceed workers' capabilities and limitations to ensure that they would not be exposed to work stresses that can affect safety and health as well as lower the worker's productivity. This explains that the focus of ergonomics implementation in the construction industry should concentrate on fitting the products, tasks, and environments to workers instead of forcing them to adapt to the work in order to achieve maximum benefits.

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