International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 08, August 2016
www.ijates.com
ijates
ISSN 2348 - 7550

AN APPROACH FOR EFFICIENT ERGONOMIC INTERVENTION IN MATERIAL HANDLING ACTIVITIES IN AN INDUSTRY

Ebin Mathew[1], Dr. R. Rajesh[2]

[1] P.G. Scholar, [2]Associate Professor, Department of Mechanical Engineering, RIT Kottayam (India)

ABSTRACT

In today's competitive world each organization aims to increase their productivity by one or other means. Sometimes the ergonomic factor related to the production is ignored. But Ergonomics is a vital factor in achieving the expected outcome with maximum employee satisfaction and minimum strain for them. Ergonomics focus on human factors and make the work environment suitable for the persons doing the work. Ergonomics ensures minimum human energy consumption and maximum productivity. There are various intervention strategies that should be followed while designing a work environment. But there are many hindrances in implementing the desired intervention. This may be due to several administrative or engineering factors. Through this paper some of the important factors that are to be considered in a work system design and propose a strategy that would enable the organizations in achieving the target. The first phase of the paper contains an introduction about ergonomic concepts and the work related disorders caused to workers. In second phase different intervention strategies and the factors that affect the ergonomic system design is explained. Then a model is proposed that would help in successful implementation of intervention strategies.

Keywords: Ergonomics, ergonomic intervention, manual material handling, work related disorders.

I.INTRODUCTION

Musculoskeletal disorders (MSD) are injuries or pain in the body' joints, ligaments, muscles, nerves, tendons and structures that support limbs, neck and back that cause pain and impair normal activities. MSDs can arise from a sudden exertion (e.g., lifting a heavy object), or they can arise from making the same motions repeatedly repetitive strain, or from repeated exposure to force, vibration, or awkward posture. Overexertion injuries are first among the ten leading causes of disabling injury and cost the US business $ 14.2 billion in direct costs. Workplace risk factors results in strain on musculoskeletal, cardiovascular and neurological system. Manual material handling (MMH) is the most common cause of occupational fatigue and low back pain. Such back injuries account for about one third of all lost work and even more than one third of all compensation costs. More important than financial cost is human suffering. Immediate and short-term effects include accidental injuries and fatigue. More serious problems related to MMH are the long-term health effects -- chronic back pain.

Another adverse effect of MMH tasks are fatigue. Fatigue is a common and expected effect of MMH. The effort required to perform MMH tasks uses up muscular energy. Where the pace of work is not too high, workers can find enough time between individual tasks to recover their energy, and work can be resumed and continued safely throughout the whole shift. On the other hand, a fast pace of work shortens the time between tasks and does not allow the workers to restore their energy. As a result, workers who try to maintain such a fast pace may become increasingly tired as the shift progresses. Recent development in research on the causes of back injury shows that even a moderate pace of lifting, not necessarily at the maximum lifting limit, if maintained for a prolonged time without breaks rapidly decreases workers' lifting ability by speeding up their fatigue. Fatigue not only causes instant and obvious discomfort but its effects add up over time. For that reason, fatigue can also contribute to serious injuries to the musculoskeletal system. These injuries can later develop into chronic conditions that can become difficult to treat effectively. Additionally, fatigue decreases workers' alertness, making them more likely to act without due caution. This, in turn, increases their risk for accidents.

There are various work related factors that contribute to MSDs. Work-related factors include the weight of the load lifted, the range of the lift, the location of the load in relation to the body, the size and shape of the load, distance and duration the load is carried, and the number and frequency of lifts performed. Excessive bending and twisting also increase the risk for back injury.

When a person is engaged in physical work, such as MMH activities, several physiological responses are affected. These include metabolic energy cost, heart rate, blood pressure, blood lactate, and ventilation volume. Of all these responses, metabolic energy expenditure has been the widely accepted physiological response to repetitive handling as it is directly proportional to the workload at steady-state conditions.

II. LITERATURE REVIEW

Musculoskeletal disorders (MSD) include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels. MSDs are very much common in every workers irrespective of the task they do but the effects may vary. There are number of studies that highlights the magnitude and types of MSDs. These studies shows that the nature of work has a significant influence in developing musculoskeletal disorders.

Worksystem characteristics has a significant influence in developing MSDs. The worksystem characteristics may be categorised into

- Worker characteristics
- Material characteristics
- Task/workplace characteristics
- Environmental characteristics
- Organizational characteristics

Ergonomic evaluation of work system, responses on human musculoskeletal and physiological system are evaluated by biomechanical, physiological, psychophysical, and epidemiological approaches. Biomechanical and physiological measurements provide an objective scale based on strain and fatigue accumulated from

different types of industrial jobs. Biomechanical approach assumes infrequent application of external forces and, therefore, the effects of fatigue are ignored. In physiological approach the focus is primarily on whole-body. Psychophysical approach uses a subjective scale, and the primary goal is to design tasks that are acceptable to the majority of workers performing a task.

III. ERGONOMIC PROBLEM AND SUITABLE INTERVENTION

Manual material handling involves human body for handling of loads. Very high human effort is required for this. This may cause extra strain and effort for workers if they do not follow safety rules for handling the tasks. These will contribute to work related musculoskeletal disorders. Ergonomic interventions are the best method to reduce work related problems to the workers. Ergonomic interventions are those activities that could reduce the human discomfort. Ergonomic interventions may be of engineering, administrative and behavioural interventions.

Engineering interventions are engineered or physical manipulations of hazards or routes of exposure to physical hazards. Typical examples may be the provision of lift tables to prevent lifting from ground level, or adjustable office equipment. Administrative interventions concentrate on changing the duties or the design of the job such as the introduction of job rotation, enlargement, work cells, or policies, for example requiring at least two persons to lift patients in a hospital.

Behavioural interventions focus on the individual worker's behaviours or capacity. A behavioural (or personal) intervention may focus on increasing fitness or strength, on stress reduction workshops, on improving work methods. Requiring the use of personal protective equipment is a further option and is commonly used in safety and industrial hygiene.

We now discuss a case study in which an experimental setup aimed to transfer blocks of different weights from one rack to another. The weights we considered are 5Kg, 10Kg and 15Kg. One of the task is now discussed. Out of the many tasks the most difficult task identified is described below. The task is to:

- pickup a box of weight of 15Kg weight from a rack at a height of 75cm
- carry it to another rack at a height of 75cm placed at a distance of 4.25cm
- at the rate of six boxes per minute
- and it is done by a single person.

The following graph shows how the heart rate of the persons increases as the task progress.

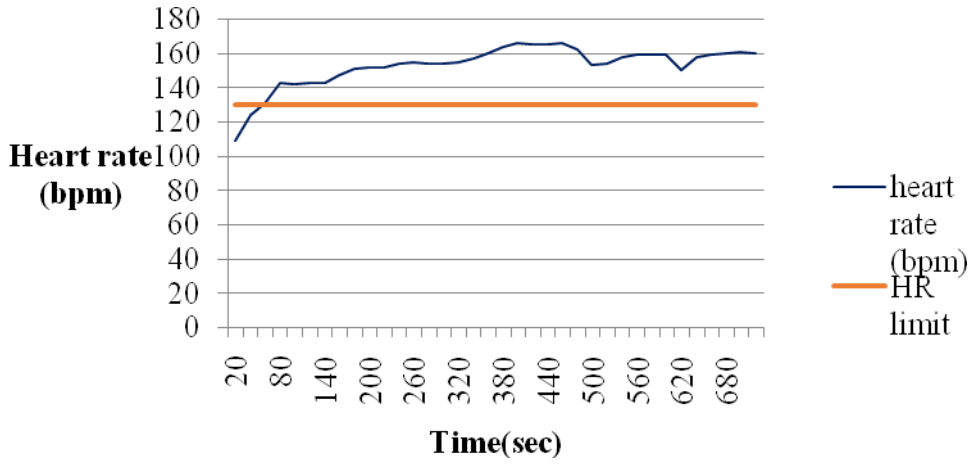


Fig 1: Average heart rate Vs Time

From the graph it is clear that the heart rate increases above 130bpm within a short time. This may be because the task may be very strenuous to the worker and required very high effort for completion. This causes very difficulty for the worker to complete the task. Now we see the posture the worker uses for the work.

Fig 2: Extreme awkward posture

The posture is analyzed using catia software and the RULA score is found out.

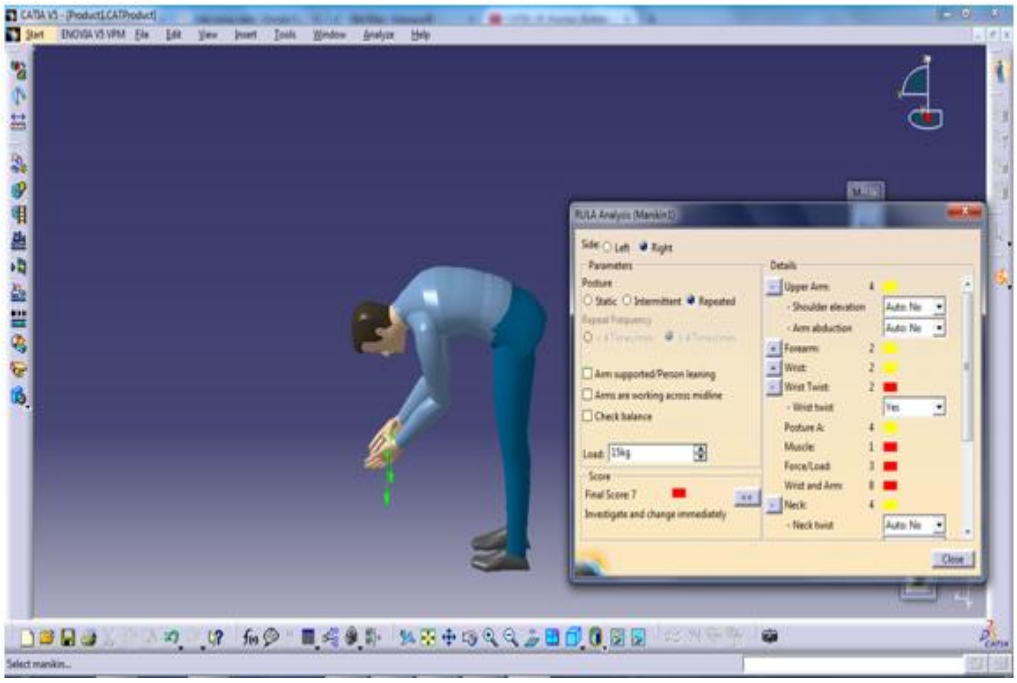


Fig 3: RULA analysis

RULA score of 7 shows that the posture is not acceptable and modifications are needed urgently. So there is a for improving the work posture and minimize the human effort. The various possible interventions are discussed below.

The behavioural interventions possible here are:

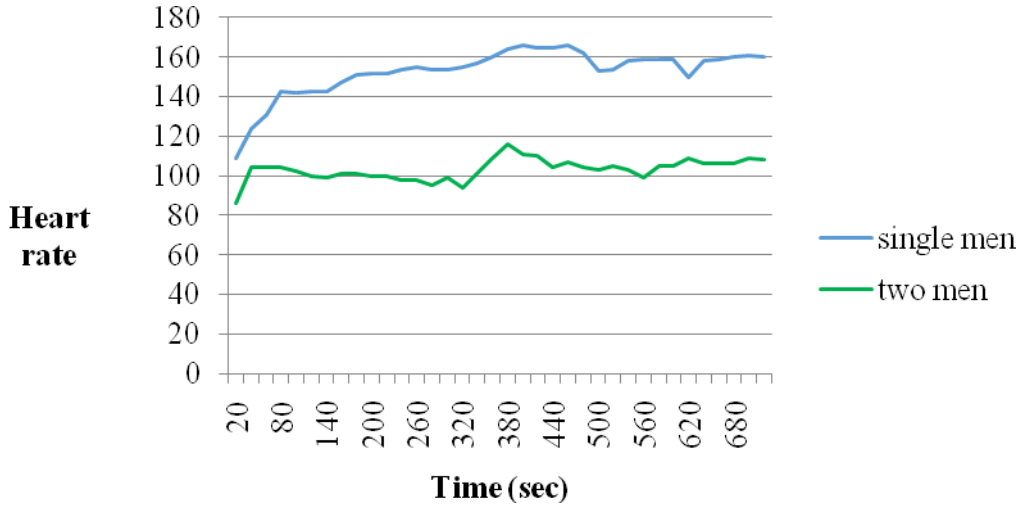
a)Proper lifting technique should be used.

b)For proper lifting employees should be given adequate training on how they could do it.

There are various rules that could be followed while lifting an object(ergonomic plus). They are

- Get as close to the object as possible.
- Use a wide stance with one foot forward and to the side of the object for good balance.
- Keep your back straight, push your buttocks out, and use your legs and hips to lower yourself down to the object.
- Slide the object as close to you as possible.
- Put the hand (same side of your body as the forward foot) on the side of the object furthest from you.
- Use this basic lifting technique for small objects when you can straddle the load and use a wide stance.
- Put the other hand on the side of the object closest to you. Your hands should be on opposite corners.
- Grasp the object firmly with both hands.
- Prepare for the lift, tighten your core muscles, look forward and upward, keep a straight and strong back.
- Lift slowly and follow your head and shoulders. Hold the load close to your body. Lift by extending your legs with your back straight, and breathe out as you lift.

The administrative intervention that could reduce worker effort is to make the task to be done as a team task. the following graph shows variation in heart rate when the task is done as single and team.



.Fig 4: Average heart rate Vs Time

The above graph makes it clear that if the task is done as a team then the effort of the worker could be considerably reduced.

The various engineering interventions possible are:

- Use of powered or non powered equipments
- Provide height adjustable rack
- Use sliding rack

We have seen many possible interventions that could be applied to make the work easier. But there are many hindrances in achieving this.

IV. APPROACH FOR PROPER ERGONOMIC INTERVENTION

The above discussed interventions other than the engineering interventions does not require much cost. The only thing needed is the support from the management side and the active participation of the workers towards modification. Training is a good method to improve the working condition of the worker. In achieving the desired there should be a proper link between the workers and management. Ergonomic evaluation team may serve this purpose.

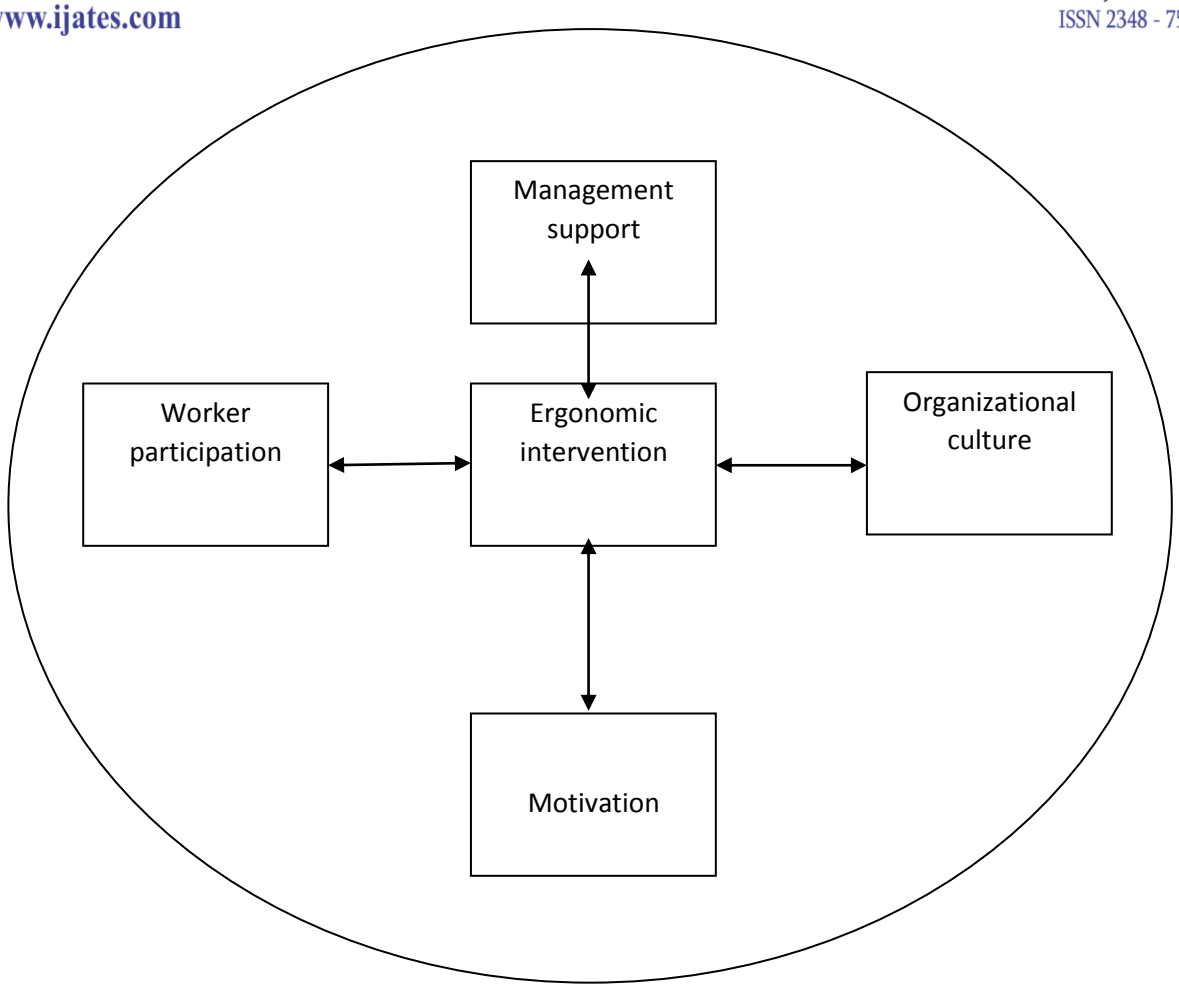


Fig 5: Ergonomic approach

The above approach is formulated by the motivation from the paper by Abarghouei, Nasab, 2012 and Maria,Cirjaliu 2015. The approach focuss on four parameters: Worker participation, management support, motivation and organizational culture for better implementation of ergonomic interventions. These parameters are very much essential for proper implementation of he ergonomic interventions. First of all, the management must be willing to provide safer working environment to the workers. They should make an effort to study and analyze the working condition of the workers and the job must be designed to fit for the worker. Regular evaluation and investigation is required for this.

The next aspect is regarding the attitude of workers towards accepting the change. Actually workers are affected but they does not know about it in the right manner. So they may be reluctant to the change suggested by the management. The motivation from the management and the proper knowledge of the situation can influence them. The organization culture towards the ergonomic problems is another concern. The organizations willingness towards these problems should be positive. The organization and management is concerned about productivity improvement. But along with it proper and adequate concern for worker comfort should also be considered by the management.

V. CONCLUSION

Material handling tasks are inevitable in any sector of business. There are lot of health issues for workers related with it. These issues were discussed in many literatures. Through this paper we made an attempt to study a manual material handling task using an experimental analysis. We found out some difficult task based on the average heart rate of the worker doing that work. Some intervention strategies to reduce human effort is proposed. For implementing those interventions an approach is proposed that consists of worker participation, management support, motivation and organizational culture. These have influence over the ergonomic intervention required. So these factors should be well organized and coordinated for better implementation of ergonomic interventions.

REFERENCES

[1] Putz-Anderson, Vern, Bruce P. Bernard, Susan E. Burt, Libby L. Cole, Cheryl Fairfield-Estill, Lawrence J. Fine, Katharyn A. Grant et al. "Musculoskeletal disorders and workplace factors." National Institute for Occupational Safety and Health (NIOSH) (1997).

[2] D'Souza, Jennifer C., Alfred Franzblau, and Robert A. Werner. "Review of epidemiologic studies on occupational factors and lower extremity musculoskeletal and vascular disorders and symptoms." Journal of occupational rehabilitation 15.2 (2005): 129-165.

[3] Maria – Elena Boatca, Bianca Cirjaliu "A Proposed Approach for an Efficient Ergonomics Intervention in Organizations" 2nd GLOBAL CONFERENCE on Business, Economics, Management And Tourism, 30-31 October 2014, Prague, Czech Republic

[4] Abarghouei, N. S., Nasab, H. H., (2012). An Ergonomic Evaluation and Intervention Model: Macro ergonomic approach. International Journal of Scientific & Engineering Research, 3(2), pp 1 - 7

[5] Parent-Thirion, A., G. Vermeylen, and G. van Houten. "Eurofound (2012), Fifth European Working Conditions Survey." Publications Office of the European Union, Luxembourg, S 158 (2012)

[6] Gerr, Fredric, Nathan B. Fethke, Dan Anton, Linda Merlino, John Rosecrance, Michele Marcus, and Michael P. Jones. "A Prospective Study of Musculoskeletal Outcomes Among Manufacturing Workers II. Effects of Psychosocial Stress and Work Organization Factors." Human Factors: The Journal of the Human Factors and Ergonomics Society 56, no. 1 (2014): 178-190

[7] Malchaire, Jacques, N. Cock, and S. Vergracht. "Review of the factors associated with musculoskeletal problems in epidemiological studies."International archives of occupational and environmental health 74.2 (2001): 79-90

[8] Genaidy, A. M., S. M. Waly, T. M. Khalil, and J. Hidalgo. "Spinal compression tolerance limits for the design of manual material handling operations in the workplace." Ergonomics 36, no. 4 (1993): 415-434.

[9] Seay, Joseph F., Shane G. Sauer, Tejash Patel, and Tanja C. Roy. "A history of low back pain affects pelvis and trunk coordination during a sustained manual materials handling task." Journal of Sport and Health Science (2016)

[10] Hogan, Dervla AM, Birgit A. Greiner, and Leonard O'Sullivan. "The effect of manual handling training on achieving training transfer, employee's behaviour change and subsequent reduction of work-related musculoskeletal disorders: a systematic review." Ergonomics 57.1 (2014): 93-107.