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Applications of Ergonomic Analysis Tools in an Industry : AReview

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Abstract - *Productivity is today one of the most important aspects of a business, the productivity concept not only implies higher profits, but use their resources efficiently, based on the purpose or goal of the organization. One of the most important resources is the human resource., it is vital to consider the environment or workspace in which the operators perform. The aim of this review is to provide a observational postural analysis ergonomic assessment to reduce ergonomic risk. This paper gives brief idea about different work related awkward postures, their causes and solutions for the different discomfortable conditions. Working postures and specific ergonomic tools for every activity can be identified and used to find out Risk levels. Cornell Musculoskeletal Disorder Questionnaires are used to find out % of different parts are caused due to Musculoskeletal Disorders. Ergonomic risk factors are identified and their Analysis tools are discussed to clarify which tool can be used to reduce this risk and prepare a safety workspace which will improve productivity.*

Key Words: **Ergonomic Assessment Tools, REBA, Cornell Musculoskeletal Disorder Questionnaires, Risk levels.**

1. INTRODUCTION

Ergonomics talk is talk of a tool for increasing productivity, as this, to bring the physical conditions of the work area, allows workers feel more comfortable and the risk is diminished by poor posture, resulting an increase in production since the worker gets healthier and safer working conditions. Manual material handling (MMH) is the most common cause of musculoskeletal disorders (MSDs) and low back pain (LBP). It involves manual lifting, lowering, carrying, pushing and pulling loads.

The Ergonomics Risk Factors (ERF) are listed below:
i) Awkward Posture ii) Force iii) Repetition iv) Vibration v) Static Loading

The common ergonomic analysis tools are:

a) RULA: RULA (rapid upper limb assessment) is a survey method developed for use in ergonomics investigations of workplaces where work-related upper limb disorders are reported.

b) REBA: REBA (Rapid Entire Body Assessment) Provide a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures.

c) Strain –Index: It is a semi-quantitative job analysis method yielding a numerical score, which is intended to correlate with the risk of developing distal upper-extremity disorders.

d) Jack: The main impetus for the development of Jack was to support the design and development of workspaces, with the emphasis on optimising the human machine interface.

e) Push-pull analysis: Push-pull analysis is carried out to assess the awkward postures which occur during the push-pull activities in various sectors. Such activities are observed in aeroplane industries. The objective of analysis is to measure the maximum acceptable initial force and sustained force for push-pull activity while workers perform their tasks.

f) OWAS (Ovako Working Posture Analysis System) : The posture classification system, which includes the upper arms, lower arms, wrist, trunk, neck, and legs, is based on body part diagrams. The method reflects the extent of external load/forces exerted, muscle activity caused by static, dynamic, rapid changing or unstable postures, and the coupling effect.

g) NIOSH Survey: NIOSH Survey is a self-report method allows the ergonomist to easily assess measures of musculoskeletal discomfort in numerous body regions, such as the intensity, frequency, and duration of discomfort.

h) Muscle Fatigue Assessment: The MFA method can define which jobs might be appropriate for people to work on for a short term during initial return-to-work after an injury or illness. By rating all body parts on a task, those tasks that might exacerbate a muscle or joint problem can be separated from those tasks that should be acceptable for the injury or illness of concern during a short term rehabilitation period. This reduces the need for general work restrictions and minimizes the chance of re injury.

i) Plibel: A method assigned for the identification of ergonomic hazards. A checklist is presented for the identification of ergonomic hazards, with relevance to different body regions.

2. LITERATURE REVIEW

A literature review of the recently published research work on Ergonomic Analysis in industry is carried out to understand the research issues involved and is presented here,

P.N.Kale et al (2016) presented the review on the studies carried out so far to analyze the various tools used for ergonomic analysis. Review shows that the many of the researchers are focused on study of a single tool and its use in particular industry for analyzing the problem. Some researchers focused on comparison between two or more tools and determined the suitability of tools in particular field. Some researchers carried out the same study using various tools and discussed the strength and weakness of ergonomic analysis tool. While selecting a particular tool for ergonomic analysis it is necessary to know about the various options available and selecting one is quite difficult. This paper made it easiest to select an appropriate tool for particular ergonomic analysis.[1]

N. Jaffar et al (2015) focused on the overview of ergonomics risk factors in construction industry. The objective was to give a basic introduction and clear definition of ergonomic. The study included the ergonomics risk factors in relation of human and their nature of work. Based on the literature, the most significant ergonomics risk factors are awkward posture in handling job task, force and repetition of specific movement including vibration. Other ergonomics risk factor includes uncomfortable static position, contact stress of muscles and tendon and also extreme temperature condition. This study enhanced the awareness of the risk factors which may occur in the construction industry.[2]

Er. Girish Joshi et al (2015) explained the common occupational problem of the workers. The present study was aimed to evaluate the musculoskeletal disorder (MSD) of workers engaged in Small scale casting industries. Study was conducted on 55 workers of a casting industry using the posture analysis tool REBA Method. A video showing the different activities of the workers was shot and the snapshots were taken from it for the analysis. The results of REBA showed that about 28 % of the workers were under very high risk levels and required immediate change. About 51.5 % of the workers were at high risk levels which required changes soon and 20.5 % of the workers were at medium risk levels. The present Study recommended the awareness and proper ergonomics training to the workers.[3]

Dima Al Madani et al (2016) focused on provide a summary of one of the observational postural analysis ergonomic assessment tools; Rapid Entire Body Assessment (REBA) in terms of its development, applications, validity and limitations. Research showed REBA's convenience for postural assessment of jobs in numerous professional settings, including industrial and health care jobs, construction, sawmill tasks, supermarket industry, food industry, computer based jobs, packaging, school workshop, nod ontological services and for firefighters and emergency medical technicians. Face validity is established in two stages. In terms of concurrent validity, several studies used REBA to compare the results with other observational and direct methods so that the level of conformity between the two was determined. [4]

Baba Md Derosa et al (2011) explained about Manual material handling (MMH) was the most common cause of musculoskeletal disorders (MSDs) and low back pain (LBP). It involved manual lifting, lowering, carrying, pushing and pulling loads. This study has three main objectives, first: to identify ergonomics awareness towards MMH activities amongst the workers; second, to identify the body discomfort or body pain of the workers using Body Parts Symptom Survey (BPSS); and third to study the LBP and MSDs risk exposure in reference to MMH practiced by the workers using RULA. The respondents for the study were selected from the production area.[5]

Juan Luis Hernandez-Arellano et al (2015) presented to design a proposal for extremes where men and women perform similar tasks in the same workstations. Within assembly lines hydraulic presses that allowed to be adjusted to different heights are used. However, at the initial workstation of the cell production, a high fixed workstation is used. In addition, workers have to handle axis of different dimensions. For example, the shortest is 50 centimeters while the longest is 90 centimeters. Medical service department has received constant complaints from workers assigned to this workstation, which reported mostly musculoskeletal discomfort in shoulders, neck and back. The objective of this research is to develop a new workstation design that allows adjusting its dimensions according to the worker´s statures and part´s sizes used in the assembly lines.[6]

Rajesh R (2016) studied on (MMH) which has largely been based on task analysis approach where the job are broken down into simpler tasks and studied. But there is lack of clarity in the use of terms defining various MMH activities. The challenge in classifying MMH arises because of the dependence of man-machine interaction on multiple work system characteristics. This paper presents a classification scheme for MMH tasks. Towards making a classification scheme the work system characteristics are examined and the important dimensions from those are identified that are able to differentiate the nature of MMH exposure. Suitable examples for each class are presented. The methods for collecting biomechanical and physiological responses, and nature of ergonomic analysis required are discussed. A qualitative judgment on exposure magnitude and measurement cost is made. Finally, critical issues and scope for research is presented.[7]

Raemy Md. Zeina et al (2015) explained that Industrial workers were frequently exposed to injury at work due to an

incorrect working posture. Improper working posture such as bending, twisting, overreaching, repetitive task and uncomfortable posture contribute to musculoskeletal disorder (MSD). This paper deals with the survey of the posture practices by Malaysian industrial workers. The questionnaire was distributed among 282 industrial workers. The survey was concerned with demographic detail, job specialization, industrial sectors, work and rest duration and the physical and mental condition during working time. This survey provided a preliminary data for further research to ensure the correct working posture for worker.[8]

Kailash Subramanian et al (2017) analyzes that Ergonomics has been a key concern which hinders both health & productivity of the industrial workers. This study has been an initiated to identify such ergonomic risks of an Aluminium casting industry. The industrial workers of this industry has been facing issues of having joint & muscular pains at lower back, arms & Necks due the nature of work that is performed by them at their work places. This study aims at assessing the ergonomic risk factors at various workplaces of the Industry. Various causative factors which shall in long run result in Musculo Skeletal Disorders or Cumulative Trauma Disorders for the employees has been assessed. In order to assess the Ergonomic Risks for the above operations, various Ergonomic tools like Rapid Upper Limb Assessment Checklist (RULA) and Rapid Entire Body Assessment Checklist (REBA) are being used.[9]

Sareh Moosavi et al (2015) studied about world background literature reviews have shown a high prevalence of musculoskeletal disorders (MSDs) among dental practitioners. Prevalence of MSDs among dental practitioners in India is not well documented. Aim of this study is to determine the prevalence and distribution of MSDs among dental practitioners in Pune city in the state of Maharashtra, India. A cross sectional descriptive study in which a self-administered questionnaire (Body part discomfort survey) was used to assess the musculoskeletal symptoms among dental practitioners. In this study (n=57) in total, 47% of the respondents were males and 52% were females. The recorded data was analyzed. This questionnaire results (for all body parts), showed neck trouble to be the most predominant MSDs (69%), followed by shoulder (51%), upper back (51%), and lower back problem (39%).This results suggest that there is a need for change of body posture. This mean can be achieved by using a proper body support or change in prototype has reduced the RULA scoring and proved by t-test calculation. Results were verified by using the p-chart. The fraction of defects for all 12 areas and each respondent were calculated for further study.[10]

Maura Mengoni et al. (2017) studied Risk Management has become a taken-for-granted form of practice for manufacturing companies and in most cases a strategic for their success. The research goal is to define a multipath methodology that drives the analysts to find the proper ergonomics factors impacting on specific safety elements, how they relate to the workspace, the adopted tools, the overall production environment and to the workers' job, how to quantitatively and qualitatively measure these factors and which VP tools and experimental set-ups could be used to conduct simulations. A case study is used to illustrate the methodology.[11]

Mustafa Khan et al. (2015) explained that Manual assembly tasks are widespread in many production facilities. However, the manual tasks were often linked to workstations that are not ergonomically designed, which can lead to work-related musculoskeletal disorders (WRMDs). These may result in low productivity, deterioration of worker performance, and issues affecting quality. The first aim of this research project was to analyze the various work postures associated with manual assembly work, within a plastics manufacturing company. The analysis of these work postures will help in understanding the ergonomic conditions of different workstations within the company. The second aim of this project was to study the OSHA incident reports and determine whether correlation exists between a specific workstation and specific body parts. The ultimate objective of this research was to find solutions and to recommend changes that improve the workstations. [12]

Lidilia Cruz Rivero et al. (2015) studied that in the northern state of Veracruz, Mexico, was located a company Ironmonger industry and construction, which has about 376 people. It had been found that operators do not have the area right job, so a study was done through the RULA (Rapid Upper Limb Assessment) method for the assessment of risk by maintaining inadequate by the poor design of workspace views. The Rula method provided a useful tool for evaluating working postures that may create a risk tool, however when you had a large number of workers, this process becomes tedious.[13]

L P Singh (2010) studied and analyzed that Musculoskeletal disorders (MSDs) are common health problem throughout the world. Assessment of exposure levels to MSD risk factors could be an appropriate base for planning and implementing interventional ergonomics programs in the workplace. The present study was focused on posture analysis of the workers working in forging industry. The study was conducted on 130 workers engaged in various process of small scale forging firms of northern India. Video recording on different activities of the workers was done and then images were cropped from it for the analysis. Posture analysis tools RULA, REBA and OWAS were used.[14]

N. A. Ansari et al. (2014) analyzed that Postural analysis tool using Rapid upper limb assessment (RULA) and Rapid entire body assessment (REBA) were applied for assessment which indicates that the workers are working above the secure limit. This ergonomic study sheds light on posture analysis of the workers in small scale industry. The study was conducted on 15 workers engaged in small scale industry situated at MIDC Wardha (Maharashtra, India). Video tape on different

activities of the workers was prepared and then images were cropped from it for the analysis. This study presents assessment of work posture of workers engaged in different activities of small scale industry. Evaluation of posture was carried out using RULA and REBA. Assessment is carried out using worksheet.[15]

S. C. Mali et al.(2015) studied and analyze that for most of the small scale industries in India the ergonomics principles were not considered at the time of designing industrial workstation. So there was a necessity to consider ergonomic principals at the time of designing industrial workstation to reduce musculoskeletal disorders (MSDs) and prevented injuries to the industrial operators. The objective of this paper was to give an overall literature review on the work done related to ergonomic evaluation of industrial workstations and suggested ergonomic improvements. Ergonomic problems are major issues faced by the foundry industry. The ergonomics principals play very vital role in operators' productivity. The two factors, namely workstation layout and work design were important for operators' or workers' efficiency. [16]

Mohd Nasrull Abdol Rahman et al. (2016) provided aims to give an overview of current techniques available for pen and paper based observational methods in assessing work-related upper limb disorders. Searched from an electronic database for materials from 1993 until 2015, the methods discovered were based on upper limb disorders, observational method, risk factors and musculoskeletal disorders. The evaluation process for selected publication has been conducted by two ergonomic researchers. Seven observational methods used to assess exposure to work-related Upper Limb Disorders (ULDs)were identified. The risk factors involved in current techniques of pen and paper based observational tools were postures, force, repetition, vibration, movement, frequency of action and duration. From the seven methods, only three methods were proven to be reliable and rated as moderate to good. For the three methods reviewed, the validity test showed moderate results. Many observational tools exist, but no single tool appears to cover all of the risk factors which is related to upper limb. Although the most important factor in developing tool is proper validation of exposure assessment techniques, the existing observational method did not test reliability and validity.[17]

S. C. Mali et al. (2015) analyzed that Ergonomic troubles are major issues faced by the metalwork manufacture. The ergonomics principles played very life-sustaining role in operators' productivity. The two factors such as workstation layout and work design were important for operators' or workers' efficiency. Work-Related Musculoskeletal disorder (WMSD) is the common health problems of the industrial workers. This health problem could lead to long term effect on the output performance. The objective of this work was to study the postures of industrial worker in foundry industry using the RULA assessment using CATIA V5R19 software. The working postures were modelled in the CATIA V5 R19 software and then RULA assessment was conducted. From the RULA analysis, several awkward postures were detected with high in risk ingredients. This paper presented an ergonomic evaluation of workstation in a one foundry industry at sangali in Maharashtra state. The Various key postures of the workers were evaluated . Also study includes suggestions for the improvement. Tools like Rapid Upper Limb Assessment (RULA) and digital human manikin (DHM) were used in this study.[18]

A. H. Abdul-Tharim et al. (2011) provide overview of the ergonomics risk control in construction industry. The objective was to give a basic introduction of ergonomic in construction industry and risk controls in relation to minimize the ergonomics risk factors. The study highlighted five (5) significant ergonomics risk controls. Better communication and management control enhanced ergonomics implementation in the workplace. It was 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 were also essential in order to reduce the ergonomics risk factors.[19]

Enrico Del Fabbro et al. (2016) analyzed that An important approach to correctly investigate in this direction was the human interaction with the workplace and the assigned activities or, in other words, the ergonomic aspects. The target is to identified and prevent, using standard methods (NIOSH) and index (OCRA), eventual ergonomic hazards in pre-assigned movements (picking, handling, loading, etc….) also comparing alternative solutions. Operating in advance in a "fully virtual world" using only 3D drawings, it would be possible to simulate in few minutes any working operation and to get the relevant ergonomic evaluation. It also possible to get real time analyses of already existing activities, simply using standard cameras and without any impact on the workers privacy. Such an innovative way of analysis will allow an immediate understanding of any work-related physical disease and selecting a better solution for both random and mass working operations.[20]

Edmo da Cunha Rodovalho et al. (2019) This research proposed a new ergonomic device for blast hole drills to reduce the ergonomic risk of the operators without affecting the performance. The methods included simulation tools and ergonomic analysis based on the NIOSH Lifting Equation (NLE). The results of the application of the new ergonomic device in all bit replacement tasks have shown risk indexes below the critical limits established by NIOSH. The results have also indicated a performance improvement, with a 60% reduction in bit replacement time.[21]

Rafaela Q. Barros et al. (2015) This article described an ergonomic assessment of the production of traffic lights in an electronics company, located in Recife -PE. The workstation studied was assembly and maintenance in which we sought to identify potential ergonomic problems. Then such problems

were ranked in order to determine their seriousness and the urgency of solving them using the technique of value analysis and Kepner Trego. Video recordings and photographs were taken to support the ergonomic assessment and scientifically validated questionnaires were used to survey the profile of the workers, the characteristics of the job, health indicators and the physical and social conditions and the human labor costs. This paper also presents ergonomic recommendations for improvements in the physical, organizational and cognitive conditions in the work environment.[22]

3. RESEARCH ISSUES

- There is great potential for research on Ergonomic analysis tools and its linkages with other initiative such as productivity improvement and safety of workers. Less work reported considering the effect of awkward postures and MSDs in small scale industries.
- Work carried out using the Ergonomic analysis tools and to find out the MSDs intensity and their causes not explored with full potential.
- There is a need to have more case studies clearly presenting the application of Ergonomic Analysis tools within each domain in a proposed framework.

4. Conclusion

The objective of this review paper was to understand the Status of application of Ergonomic Analysis tools. Instead of discussing much about the basics, we should more focus on how to improve productivity and reduce risk by Ergonomic point of view. It was found that not sufficient work carried out using Ergonomic analysis tools for productivity improvement in small scale industry. The implementation of Ergonomic analysis tools will reduce risk of operations ,save the time which results in higher profit of organization. This study gives new approach on improving process by Ergonomically safe workstations and working Environment.

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