IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Optimizing Ergonomic Postures In Foundry Operations: A REBA RULA Approach

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Abstract: This research paper presents a comprehensive analysis of ergonomic risk factors among workers in a foundry environment using the Rapid Upper Limb Assessment (RULA) method. Foundry work often involves repetitive tasks, awkward postures, and heavy lifting, which can contribute to musculoskeletal disorders (MSDs) among workers. The RULA method, a widely used ergonomic assessment tool, was employed to evaluate the ergonomic risks associated with various job tasks in the foundry. Data was collected through direct observation and video recordings, and RULA scores were calculated to assess the ergonomic risk levels. The findings highlight specific tasks and workstations with high ergonomic risks, providing valuable insights for implementing targeted interventions to improve workplace ergonomics and mitigate the risk of MSDs among foundry workers.

***Index Terms* -** RULA analysis, Ergonomic risk assessment, Musculoskeletal disorders (MSDs), Workplace ergonomics

I. INTRODUCTION

The foundry industry, vital in the manufacturing sector, relies heavily on sand casting, an age-old method esteemed for its versatility and cost-effectiveness. However, this traditional approach often imposes significant ergonomic challenges and hazards on workers. Manual tasks such as mold preparation, molten metal pouring, and finishing operations demand awkward postures, heavy lifting, and repetitive motions, predisposing workers to musculoskeletal disorders (MSDs) and other occupational health issues. Historically, many foundries have prioritized production efficiency over worker ergonomics, resulting in work practices that exacerbate ergonomic risks and compromise worker well-being. Recognizing the pressing need to address these concerns, this research focuses on assessing ergonomic risk factors among foundry workers engaged in sand casting processes. To achieve this, the study employs the Rapid Upper Limb Assessment (RULA) method, a renowned ergonomic assessment tool, to comprehensively evaluate and quantify ergonomic risks associated with various job tasks within the foundry environment. By leveraging RULA, the research aims to pinpoint specific tasks and workstations presenting elevated ergonomic risks, shedding light on critical areas for intervention and improvement. Through this endeavor, the research endeavors to contribute to the burgeoning understanding of ergonomics in the foundry industry, advocating for proactive measures to enhance workplace safety, productivity, and worker well-being. By prioritizing ergonomic considerations and implementing targeted interventions, foundries can foster a safer and more conducive working environment, ensuring the sustainable growth and prosperity of the industry while safeguarding the health and safety of its workforce.

II. Objectives

1. Utilize RULA assessment to identify and characterize ergonomic risk like WMSD's factors prevalent in various tasks within the foundry environment, particularly those associated with sand casting processes.
2. Employ RULA assessment as a proactive tool to enhance worker safety, health, and overall well-being by systematically addressing ergonomic concerns and creating a safer work environment.
3. To suggest changes to be made in the workplace for reducing the discomfort experienced by workers.

III. Methodology

Awk-ward working postures were recorded. The study uses RULA analysis to assess the risk of WMSDs in small- and medium-scale foundry. The foundry activities from four major departments, namely fettling department, melting and pouring department, molding department and pattern making department, were selected for data collection. The RULA analysis is carried out manually by observing movements of workers in person and also RULA assessment is done using CATIA-V5 software. Further, to identify the risk levels and to compare results of REBA and RULA statis-tical analysis was carried out using Minitab · -16 software. The results of these two methods were compared statistically to check the agreement between them. Based on risk levels, the activities prone to WMSDs were identified and ergonomic interventions are suggested. RULA analysis both with software and manual were done before and after inculcating suggestions.

IV. RULA Assessment Worksheet

The Rapid Upper Limb Assessment (RULA) is a widely used ergonomic assessment tool designed to evaluate the ergonomic risks associated with repetitive tasks and awkward postures in the workplace, particularly those involving the upper limbs The assessment utilizes a structured observation method to systematically analyze various job tasks and identify ergonomic stressors may contribute to musculoskeletal disorders (MSDs) among workers. The RULA assessment worksheet consists of a series of ergonomic criteria, including posture, force exertion, repetition, and duration of exposure, which are scored based on observed characteristics of each task. By assigning scores to these criteria and combining them using predetermined algorithms, RULA generates an overall ergonomic risk score, indicating the level of risk associated with the task ,This score serves as a tool for prioritizing intervention areas, guiding ergonomic improvements, and promoting worker safety and well-being in the workplace.

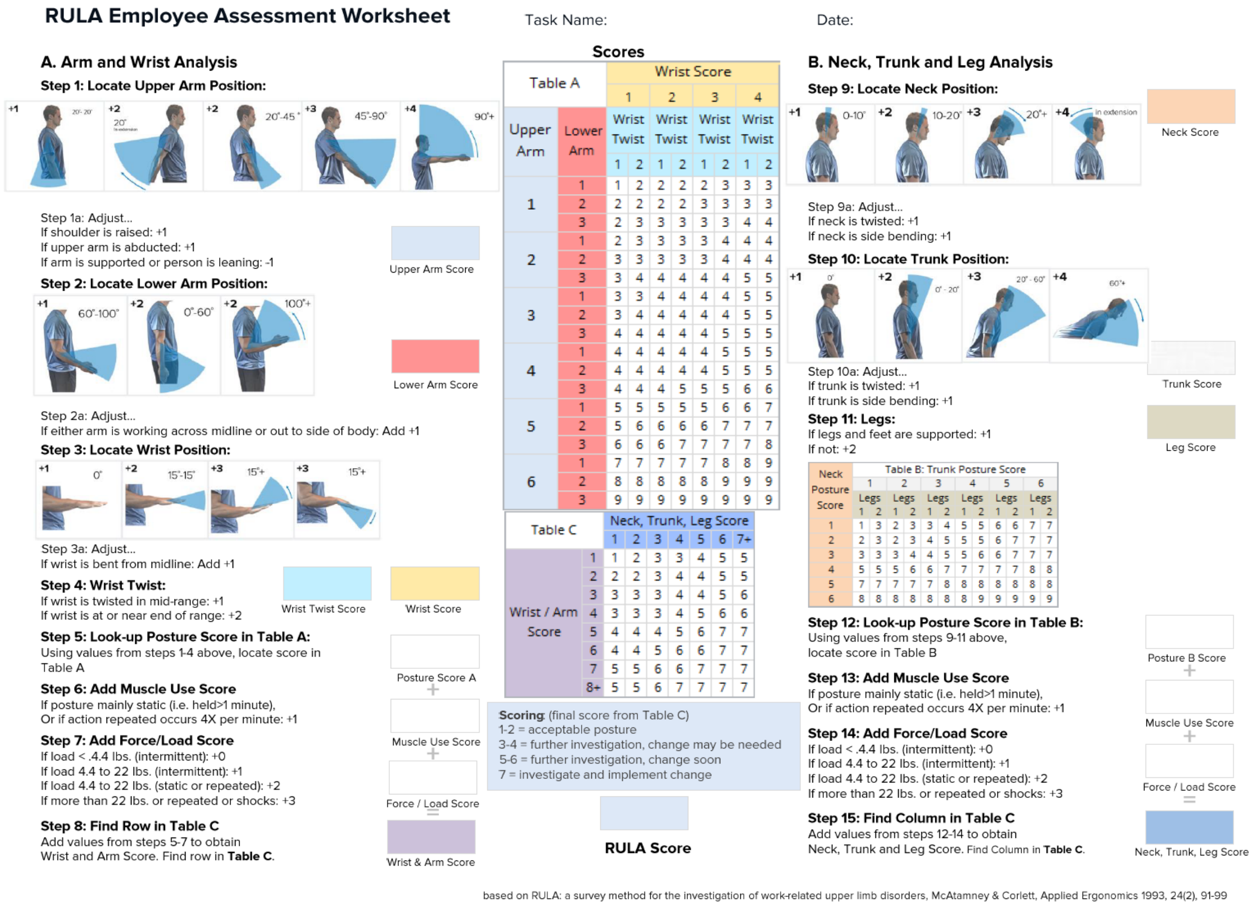

Figure 1Worksheet

V. RULA ANALYSIS (CATIA -V5)

RULA assessment in CATIA V5 first, utilized the Human Builder tool to add a digital representation of a worker to the workspace.

Position the worker in accordance with the task being assessed, ensuring that the posture accurately reflects the real-world scenario

of worker working in the foundry. Next, applied the load to the worker's arms and hands using CATIA V5's simulation capabilities

to simulate the task's weight-bearing requirements. Then, paused the simulation at key points during the task to analyze the

worker's posture, joint angles, and movements. Use CATIA V5's measurement tools to quantify joint angles and distances,

focusing on upper limb and trunk posture. Applied the RULA scoring system to assign the score based on observed postures,

movements, and force exertions. The score came out to be 7 which was hazardous for the workers to work in such environment

Combine the scores to determine the overall ergonomic risk level associated with the task.

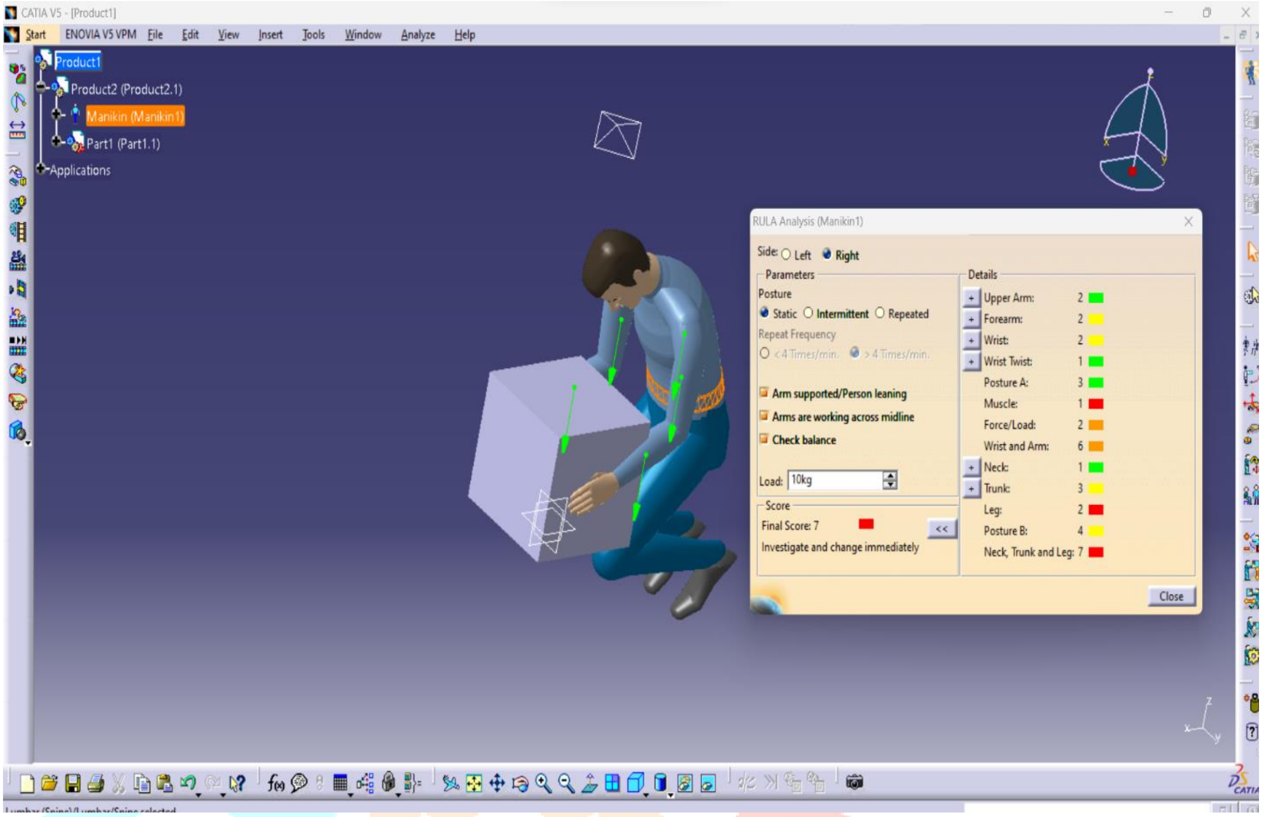

Figure 2 Catia Analysis (Before Suggestion)

VI. RULA Analysis (Manual)

After conducting manual RULA analysis on the movements of workers within the foundry environment, a RULA score of 7 was obtained, indicating a high level of ergonomic risk associated with the observed tasks. The analysis focused on evaluating various job tasks commonly performed in the foundry, particularly those related to sand casting processes, to assess the ergonomic stressors experienced by workers. Findings revealed frequent instances of awkward postures, repetitive movements, force exertion, and limited rest opportunities among workers. These ergonomic risk factors pose significant hazards to worker health and safety, increasing the risk of musculoskeletal disorders (MSDs) such as back pain, shoulder injuries, and repetitive strain injuries. Failure to address these hazards can lead to reduced worker morale and satisfaction, potential legal and financial ramifications for the company, and decreased productivity. Therefore, it is imperative to implement targeted interventions aim at mitigating ergonomic risks, improving workplace ergonomics, and safeguarding the health and well-being of foundry workers.

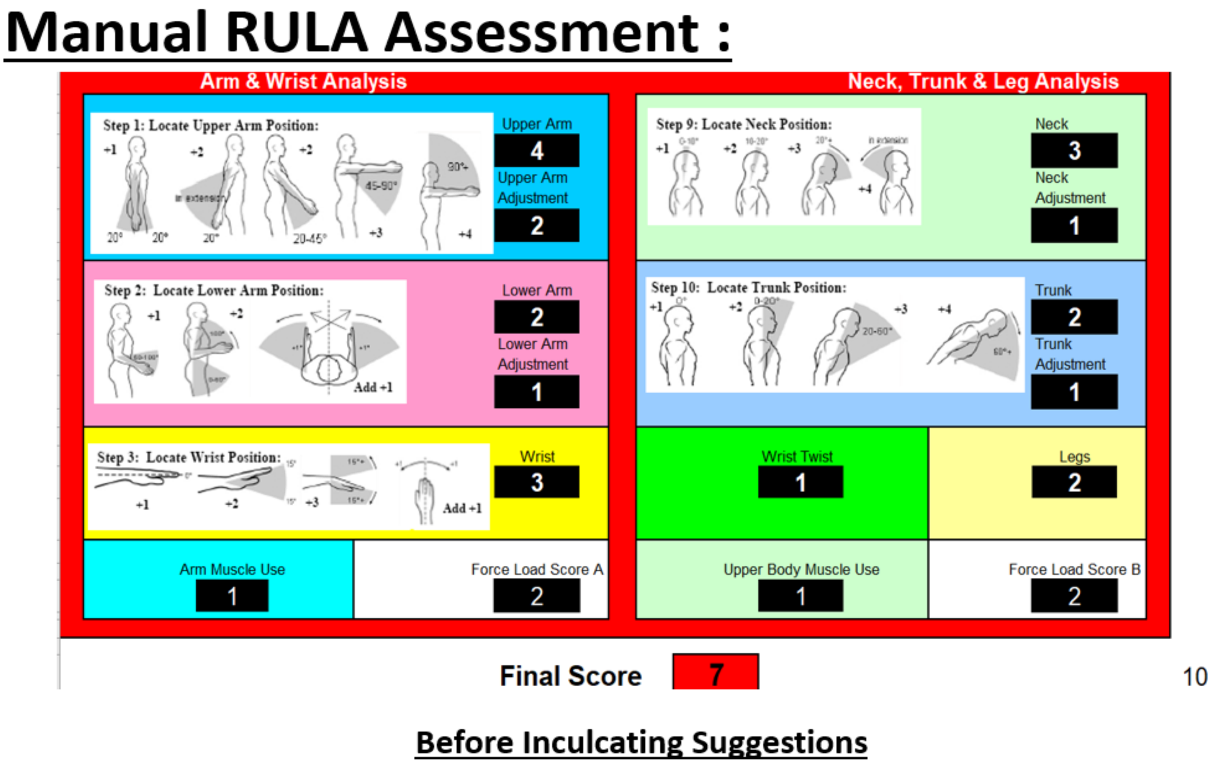

Figure 3 Manual Assessment (Before Suggestion)

VII. Suggestion

[1]. Integrating Multi head centrifugal die casting, CNC, Lathe, and Shot blasting machines streamlines production, reducing manual labor and minimizing ergonomic strain. These automated processes enhance precision, efficiency, and worker safety by eliminating repetitive motions and heavy lifting, thus significantly improving RULA scores in the foundry environment.

[2]. Provide comprehensive training on proper lifting techniques, ergonomic principles, and the importance of taking regular breaks to prevent overexertion and fatigue.

[3]. Provide ergonomic training and education to workers to raise awareness of ergonomic principles and safe work practices. Emphasize proper lifting techniques, posture awareness, and the importance of taking breaks to prevent overexertion.

VIII. Analysis Following Suggestions (CATIA – V5)

Following the integration of Multi head centrifugal die casting, CNC, Lathe, and Shot blasting machines in the foundry, CATIA analysis revealed a score of 5, indicative of further refinement in ergonomic conditions. This reduction underscores the sustained benefits of automation in mitigating ergonomic risks associated with manual labor-intensive tasks. CATIA's comprehensive evaluation of ergonomic factors, including posture, force exertion, and repetitive motions, provides valuable insights into the effectiveness of implemented measures. The score of 5 reflects continued improvements in workstation ergonomics, task efficiency, and overall worker well-being. Leveraging CATIA analysis enables organizations to identify remaining ergonomic challenges and implement targeted interventions to optimize ergonomic conditions further. This outcome reaffirms the efficacy of automation in fostering a safer, healthier, and more efficient work environment within the foundry, emphasizing the importance of continued investment in technological solutions to uphold worker safety and productivity.

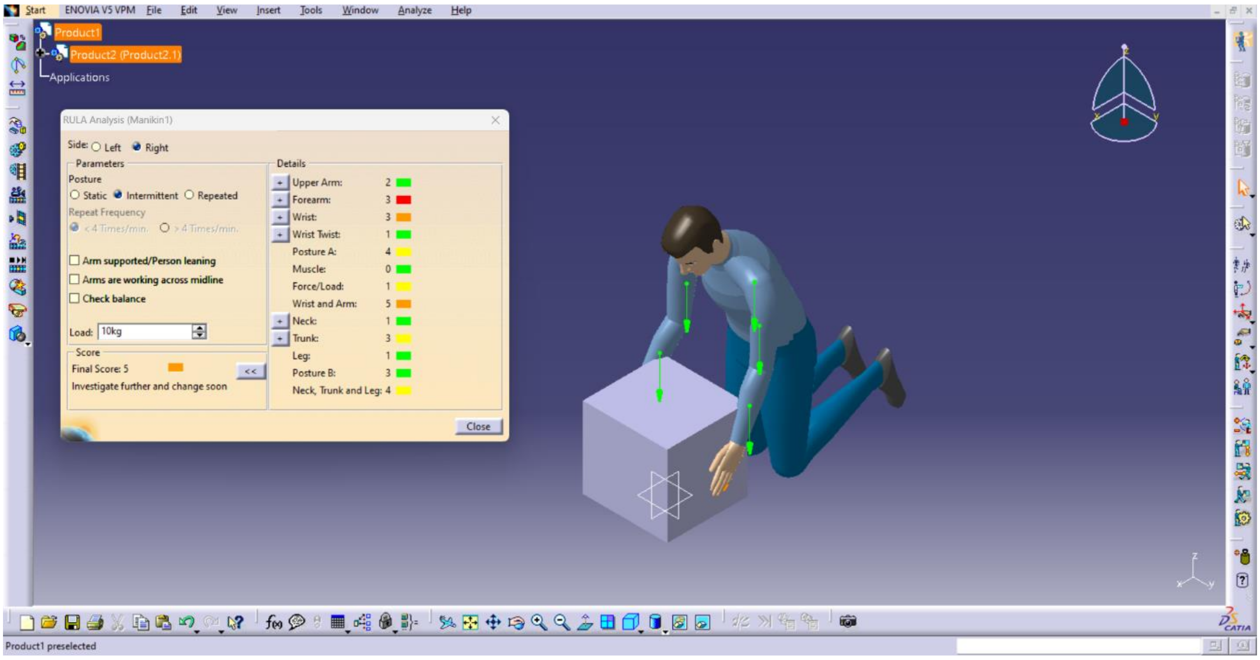

Figure 4 CATIA Analysis(After Suggestions)

IX. Analysis Following Suggestions (Manual Assessment)

Following the integration of Multi head centrifugal die casting, CNC, Lathe, and Shot blasting machines to streamline production processes in the foundry environment, a notable improvement in the manual RULA score has been achieved, reducing it to 4. This significant reduction indicates a marked decrease in ergonomic risks associated with manual labor tasks, highlighting the effectiveness of technological interventions in enhancing workplace ergonomics and safeguarding worker health. The utilization of automated machinery has led to a substantial reduction in the need for manual handling of heavy materials and repetitive motions, thereby minimizing musculoskeletal strain and fatigue among workers. Additionally, the precision and efficiency offered by these machines have contributed to a more streamlined production process, further reducing the overall physical demands on workers. By addressing key ergonomic concerns and optimizing task performance through automation, the foundry has successfully created a safer and more conducive working environment, ensuring the well-being and productivity of its workforce.

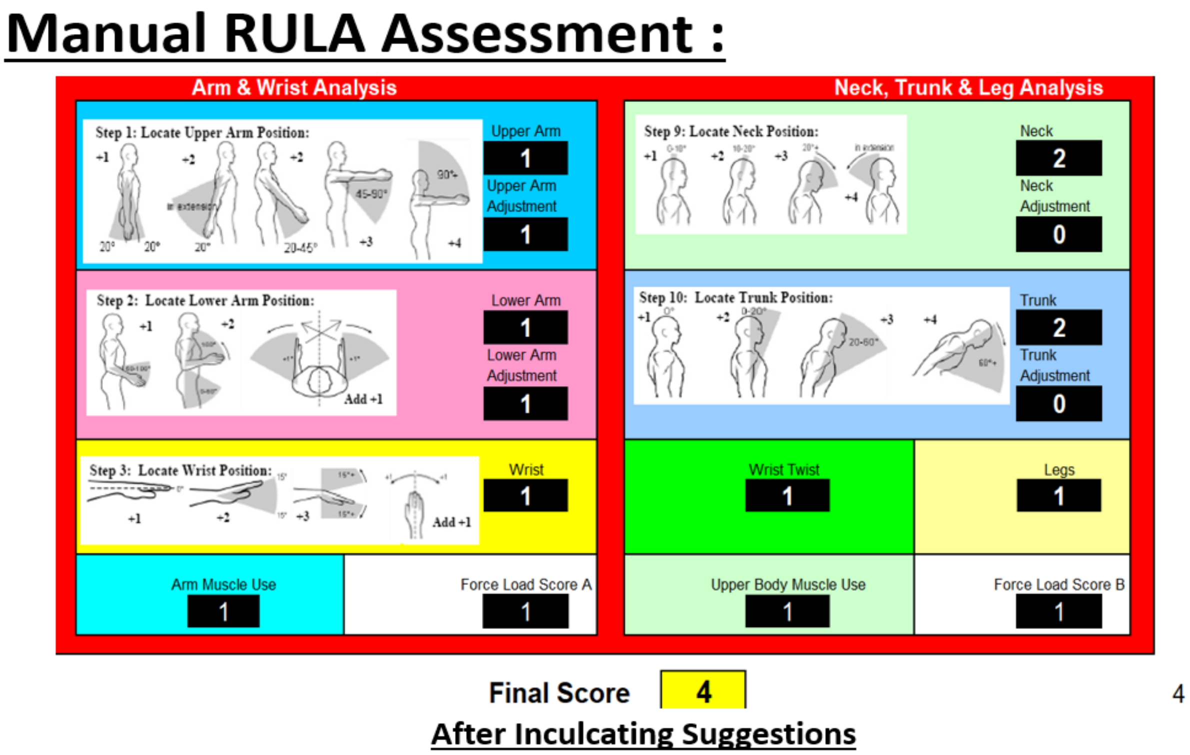

Figure 5 Manual Assessment

X. Result & Discussions:

[1]. Prior to intervention the Rapid Upper Limb Assessment (RULA) score stood at 7 in CATIA software and also in doing manual assessment indicating potential ergonomic risks for workers. Following the implementation of suggested improvements, we successfully lowered the RULA score to 4, resulting in approximate 42.9% reduction.

[2]. This signifies a notable enhancement in ergonomic conditions, ensuring the well-being and comfort of the workforce.

[3]. This significant reduction indicates a marked decrease in ergonomic risks associated with manual labor tasks, highlighting the effectiveness of technological interventions in enhancing workplace ergonomics and safeguarding worker health

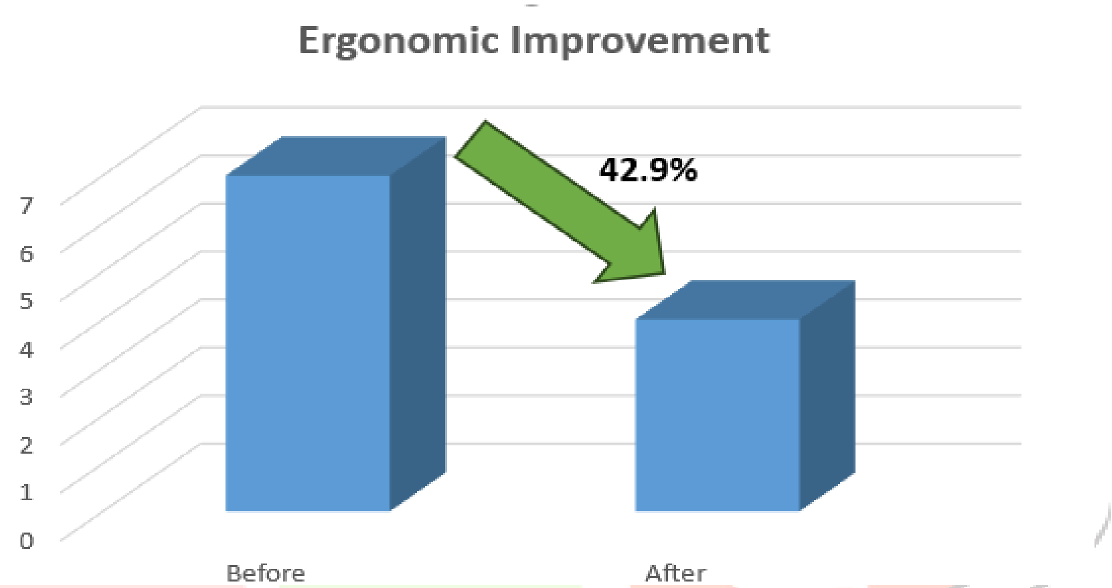

Figure 6 Ergonomic Optimization Graph

XI. *Conclusion*

There are limited studies available related to analysis of risk of WMSD using postural analysis methods, particularly in foundry context. This investigation shows that workers from small and medium foundry units are subjected to high-risk WMSDs and immediate ergonomic interventions are necessary. The workers from melting, pouring, casting & fettling department are under highest risk than other departments. The utilization of automated machinery has led to a substantial reduction in the need for manual handling of heavy materials and repetitive motions, thereby minimizing musculoskeletal strain and fatigue among workers The outcomes of the study can be used to design participative program and train the workers to follow the principles of the safety and ergonomics at workplace.

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