

**ERGONOMIC EVALUATIONS OF WORK
RELATED MUSCULOSKELETAL DISORDERS
AMONG WORKERS IN PUMP
MANUFACTURING INDUSTRIES**

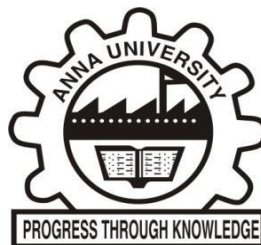
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BONAFIDE CERTIFICATE

The research work embodied in the present Thesis entitled “**ERGONOMIC EVALUATIONS OF WORK RELATED MUSCULOSKELETAL DISORDERS AMONG WORKERS IN PUMP MANUFACTURING INDUSTRIES**” has been carried out in the Department of Production Engineering, PSG College of Technology, Coimbatore. The work reported herein is original and does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion or to any other scholar.

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ABSTRACT

Workers in pump manufacturing industries face various risks in their work environment, including work-related musculoskeletal disorders (WMSDs) and ergonomic hazards. One important risk factor is poor posture, contributing to multiple health issues. Ensuring a safe and productive work environment requires prioritizing measures that mitigate these risks. This research work focuses on improving occupational health and safety among workers in pump manufacturing industries, explicitly addressing WMSDs and manual material handling (MMH) practices.

The research work comprises preliminary investigations and three modules of research work. The preliminary studies aim to understand the characteristics of the study population and quantify the level of discomfort experienced by workers in different workstations. The methodology involves data collection, ergonomic evaluations using tools such as Rapid Upper Limb Assessment (RULA), and the development of lifting aids for MMH.

The preliminary investigation collects data on the study population's general, health and work characteristics to identify potential risk factors associated with WMSDs. In addition, another investigation focuses on assessing the level of discomfort experienced by workers at different workstations using the RULA tool.

The research comprises three modules: investigations on repetitive motion tasks, investigations on MMH, and the evolution of the tray lift trolley design. In the repetitive motion investigation module, the impact of repetitive motions on WMSDs is examined specifically at the winding workstation. Ergonomic evaluations are conducted to identify potential risks associated with repetitive motions, and interventions are proposed to mitigate these risks. Another module studies MMH tasks performed at a workstation. Critical

postures are identified through task observation, and the RULA tool is employed to assess these postures in a digital environment. A lifting aid prototype is designed to aid the loading and unloading of heavy objects. To assess the effectiveness of the ergonomic intervention, a comparison is conducted between tasks executed with and without a lifting aid. The third module aims to enhance MMH between workstations by analyzing the existing conditions related to MMH. A tray lift trolley is designed and prototyped using product development principles. Ergonomic evaluations are then conducted to assess the safety and effectiveness of the trolley in reducing the risk of WMSDs.

These modules collectively contribute to improving occupational health and safety in pump manufacturing industries by addressing the risks associated with repetitive motions, MMH, and the design of ergonomic solutions. The findings from these modules provide valuable insights for implementing measures that reduce the prevalence of WMSDs and create a safer work environment.

The preliminary investigations revealed an association between WMSDs and potential risk factors. A preliminary investigation was carried out to understand the general, health and work characteristics of the study population. Inferential univariate statistical analysis indicated that awkward work postures and excessive load handling significantly contribute to the prevalence of WMSDs. Logistic regression analysis quantified the significance of the prevalence. Results showed that awkward posture has a higher odds ratio of 9.5, and excessive load handling has an odds ratio of 3.8, indicating a stronger association with WMSDs. In another preliminary study, a virtual ergonomic assessment was conducted to measure the discomfort levels of work postures at four distinct workstations: lathe, winding machine, drilling machine, and vertical machining center (VMC). The study employed RULA scores to evaluate ergonomic conditions and subsequently introduced modifications to

the workstations. However, the preliminary nature of the study emphasizes the necessity for a more comprehensive examination of tasks at workstations.

An investigation into occupational risks at the winding station focuses on repetitive tasks. Workers in the winding section perform repetitive motions during the winding process, prompting a method study to analyze static work postures. The study unveiled low-risk RULA scores (2 or 3) for circular winding, thread tying, and pouring. To assess the impact of repetitive motions, hand grip strength was measured before and after tasks, revealing a 25.05% reduction after circular winding, 18.22% for thread tying, and 11.26% for pouring in the winding section.

The development of lifting aids and the introduction of the tray lift trolley demonstrated positive outcomes in reducing the risks associated with MMH tasks. Biomechanical analysis revealed a significant reduction in force by 161 N and joint shear limits on the L4/L5 lumbar disc by 22 N when using lifting aids compared to MMH without assistance. The trolley's implementation in the workstation significantly decreased the L4/L5 compression load from 2450 N to 1366 N. Additionally, the RULA score reduced from 7 to 3 after the ergonomic intervention. Following this, an economic analysis revealed estimated profits of Rs. 760 in the first year and Rs. 9600 annually from the second year onwards.

The research study emphasizes the importance of creating a comfortable and safe work environment for workers in pump manufacturing industries. By identifying and addressing potential risk factors associated with WMSDs and MMH, the study provides insights into preventing injuries and promoting better occupational health and safety practices. The findings support the implementation of ergonomic guidelines and interventions to mitigate risks and improve the overall well-being of workers in pump manufacturing industries.