



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : Mrs. Susmita Nath

Roll Number : 156105008

Programme of Study : Ph.D.

Thesis Title: **Ergonomic redesign of hand-held floor-polishing device for reducing the occupational exposure to vibration improvement of usability**

Name of Thesis Supervisor(s) : Dr. Sougata Karmakar

Thesis Submitted to the Department/ Center : Design

Date of completion of Thesis Viva-Voce Exam : 20-6-2020

Key words for description of Thesis Work : Ergonomics; Occupational vibration; Electromyography, Usability; Unorganized sector

SHORT ABSTRACT

The use of hand-held vibrating device like drill machines, polishing machines etc. are very common in unorganized sectors where users recurrently encounter occupational vibration. Vibration energy is transmitted from the vibrating device to human body primarily through hand-arm and affects from early fatigue to irreversible hand injuries. From the literature review, in the Indian context, it was evident that the impact of HAV on the health of workers involved in various occupational set up (specifically in construction sectors) lacks attention among researchers. Moreover, applied research targeted about design interventions to reduce vibration content in machines/ tools has been rarely carried out. Based on the literature survey and initial field visits, mainly four research questions were raised. Following the pilot study, various problems have been noticed. Therefore, the present research aimed to study the occupational exposure to HAV during the use of hand-held floor polishing device and come up with ergonomic design intervention to curtail vibration content while maintaining the usability. To achieve the aim and based on problem statements, objectives were framed. Three hypotheses were conceived for ensuring a proper direction to the research work. They are as follows:

H1: Design Interventions of the polishing device by modifying the gear train mechanism and using vibration dampening material would significantly reduce vibration generation and transmission and thereby exposure to vibration.

H2: Supportive/weight-bearing mechanism for avoiding sustained load holding during use of hand-held floor polishing device can significantly reduce muscular effort.

H3: Proper anthropometric and biomechanical compatibility of hand-held floor polishing device can significantly improve the usability of the device.

Data pertaining to demographic characteristics, body parts discomforts and other occupational health related issues was collected from the users (n = 45, localized in and around Guwahati city,

India) of hand-held floor polishing device after administering the standard questionnaire. Working postures was evaluated using REBA (rapid entire body assessment) technique. During use of polishing device, quantification of the exposure to vibration was performed for 15 workers in three different working conditions (polishing on floor, stairs and vertical walls). Electromyography was performed for 15 floor polishing device to study the muscular effort required while performing polishing activity. Following brain storming, CAD model and thereafter mock-up and prototype were developed from the final concept. Field trail of the redesigned floor polishing device was carried out involving real users. The Usability of the both the existing and redesigned device was evaluated using System Usability scale (SUS).

Following analysis and interpretation of the responses against the questionnaire, it was found that workers had been exposed to a high level of hand-arm vibration, adopting awkward postures, performing strenuous repetitive activities for prolonged duration which ultimately imposed adverse impact on occupational health. The hand-held floor polishing device was redesigned considering anthropometric and biomechanical compatibility to reduce biomechanical stress associated with hand and arm of the operators. A supportive mechanism was provided to avoid sustained load holding during floor polishing. Handle grip was coated with rubber as vibration dampening material to reduce the vibration transmission to arm. The measurement of vibration transmission (in terms of intensity) to the wrist of the user before and after design intervention showed significant reduction. There was significant difference in requirement of muscular effort during the operation of the existing and redesigned device. The redesigned device with better usability and aesthetic look was liked by the users. It was evident from their higher comparative ratings against the existing design. The hypotheses formulated at the commencement of the research work have been tested by fulfilling various objectives. The key features of the redesigned floor polishing device in comparison to the exiting one were mentioned. The key contribution of the thesis along with limitations and future scope were also mentioned in the thesis.

The research work notably imparted to the existing knowledge base of occupational health evaluation in the context of the industrially developing countries like India in the field of occupational vibrations in construction sectors. Current research also demonstrated innovative design intervention as mitigation strategy to adverse impact of ergonomic stressors on workers' health. Research outcome of the thesis could be able to ameliorate the vibration exposure of the workers during the use of vibrating device (hand held floor polishing device) and this would also facilitate the improvement in quality and efficiency of the system as well as life of the polishing workers in the unorganised construction sector.