# ABSTRACT

This research is directed towards development of a comprehensive macroergonomic methodology for evaluation and design of electric overhead transmission (EOT) crane operator's job in an integrated steel plant in India. The thesis addresses several important objectives as: (i) to assess and model the risk of musculoskeletal disorders among EOT crane operators, (ii) to assess and model job stress among EOT crane operators, and (iii) to design macroergonomic interventions for EOT crane operators' job. A cross sectional study among 76 EOT crane operators, operating 33 cranes in the cold rolling mill (CRM) under flat product rolling of the integrated steel plant is undertaken. Data is collected with predesigned questionnaires, which included demographic information, Nordic MSD questionnaire, and occupational stress index (OSI) tool. Analysis of variance (ANOVA), factor analysis, and classification and regression tree (CART) are used to model the impact of the work system characteristics on MSD risk and job stress. Finally, axiomatic design concept is used to identify interventions for reduction of MSDs and job stress on the EOT crane operators. In fulfilling the research objectives, the thesis has made several contributions as: (i) a methodology is developed to assess MSD risk and to model the effect of worker, task and workplace characteristics on the occurrences and severity of MSD using relative risk concept, and classification and regression tree (CART), (ii) a methodology is developed to assess job stress using factor analysis and to model job stress among EOT crane operators using CART, and (iii) a design framework is developed for providing interventions related to reduction of MSDs and job stress for EOT crane operations using axiomatic design concepts. The application of the developed methodology shows that EOT crane operators suffer from MSDs related to neck, shoulder, and low back and the worksystem characteristic, crane height contributes the maximum. From job stress point of view, employee empowerment, role overload, and job hazard cause job stress more and while comparing job stress across different worksystem characteristics, crane height, cabin feature, and exposure hour appear to be the major contributors. Several interventions in the primary, secondary and tertiary levels are identified and the immediate interventions needed are: (i) CCTV cameras in the cabin to bring the image of the job in front of the operator, (ii) reduction of operators' involvement through mechanisation of movements of the crane whenever applicable so as to reduce job load and posture load on the operators, (iii) rescue mechanism to effectively address post incident management, and (iv) providing movable cabin and reduction of exposure hours to the operators of 30 feet crane height.



**Keywords: Risk of MSD, job stress, EOT crane, questionnaire survey, ANOVA, factor analysis, CART, axiomatic design, intervention design.**