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# DEVELOPMENT OF A HUMAN RELIABILITY ANALYSIS (HRA) MODEL FOR BREAK SCHEDULING MANAGEMENT IN HUMAN-INTENSIVE WORKING ACTIVITIES


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# Abstract

Human factors play an inevitable role in working contexts and the occurrence of human errors impacts on system reliability and safety, equipment performance and economic results. If human fallibility contributes to majority of incidents and accidents in high-risk systems, it mainly affects the quality and productivity in low-risk systems. Due to the prevalence of human error and the huge and often costly consequences, a considerable effort has been made in the field of Human Reliability Analysis (HRA), thus arriving to develop methods with the common purpose to predict the human error probability (HEP) and to enable safer and more productive designs. The purpose of each HRA method should be the HEP quantification to reduce and prevent possible conditions of error in a working context. However, existing HRA methods do not always pursue this aim in an efficient way, focusing on the qualitative error evaluation and on high-risk contexts. Moreover, several working aspects have been considered to prevent accidents and improve human performance in human-intensive working contexts, as for example the selection of adequate work-rest policies. It is well-known that introducing breaks is a key intervention to provide recovery after fatiguing physical work, prevent the growth of accident risks, and improve human reliability and productivity for individuals engaged in either mental or physical tasks. This is a very efficient approach even if it is not widely applied.

Starting from these research gaps, the thesis focuses on the development of a HRA model for the break scheduling management in human-intensive working activities. The Simulator for Human Error Probability Analysis (SHERPA) model provides for a theoretical framework that exploits the advantages of the simulation tools and the traditional HRA methods to model human behaviour, to predict the error probability for a given scenario in every kind of working system and to manage the work-rest policies. Human reliability is estimated as function of the performed task, the Performance Shaping Factors (PSF) and the time worked, with the purpose of considering how reliability depends on the time that a worker has already spent on his work. Knowing the HEP distribution allows to understand the nature of the factors that influence human performance and to intervene, from the

perspective of reducing the errors and their huge monetary costs, with re-design tasks or other interventions, such as the management of the worker's psycho-physical recovery through appropriate work-rest policies. SHERPA is not limited to the reliability assessment, as many existing HRA methods, but uses it in the operator recovery modelling and breaks scheduling management. The main focuses of SHERPA are the HEP quantification, the assessment of the impact of context via PSFs, the management of break scheduling through an economic model that identifies the best configuration among those possible to reduce errors and increase productivity and efficiencies. As shown in the case studies, SHERPA is able to predict the HEP, to assess the impacts of individual features and working environments on human reliability for every kind of working context. Furthermore, the model is useful in assessing the impact of different work- break policies, with different placement and duration of breaks, on human performance (HEP and recovery after the break) and on the overall system performance in terms of percentage of compliant performed tasks and economic results.