

Implementation of Macroergonomics in Human Safety

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Abstract: This paper is an overview of the implementation of macro ergonomics in human safety on work accident incidents. The aim is to determine the relationship between the level of knowledge of K3 with the incidence of work accidents. The method used is a literature study on literature articles and books obtained through a search engine, namely, 12 from Google Scholar. This review shows that the implementation of macro ergonomics in human safety has proven to have a positive impact. For this reason, improving security in organizational systems or workplaces with the risk of accidents, especially in sensitive locations with unsafe behavior, and improving integrated resilience engineering and macro ergonomics concepts are very essential things to do.

Keywords: Macroergonomics, Human Safety, Macroergonomics Implementation

1. Introduction

Macroergonomics is a top-down sociotechnical systems approach to work systems design and the application of overall work systems design from human-work, human-machine, and human-software interfaces. Macroergonomics aims to optimize the design of work systems in terms of the characteristics of sociotechnical systems and then take them as a whole so that individual job designs and human-machine and human-software are ensured to have a fully harmonious work system (Hendrick and Kleiner, 2001).

The macro ergonomic approach can be applied in various industries with organizational design and management factors that vary from industry to industry, especially in safety solutions. The capabilities of occupational safety and health solutions in this regard include the requirements and performance of safety regulations. It is further suggested that the Macroergonomics approach will provide a comprehensive process for selecting and implementing a system security analysis that includes an understanding of technology, personnel, external environment, internal environment, organizational structure and management, and interactions some of which are aimed at improving worker safety in the environment. work.

Safety issues are one of the most prominent ones faced by most organizations. Many factors affect system security due to increasing industrial growth and more complex systems. Despite advances in processes in industry and the replacement of operators with machines, the human factor is still the main reason for accidents (Aju Kumar and Gandhi 2011).

The application of macro ergonomics, especially the interaction between workers and organizations in safety culture seeks to optimize the work system so that it is mutually beneficial where individual and organizational success can be obtained (Hendrick & Kleiner 2001). From one point of view, safety is important for everyone.

However, safety as an attribute in the design and performance of work systems will vary in importance and concern as work systems are designed to ensure organizational success. In a dynamic business or service environment, organizations need a high level of integration to provide flexible and versatile change. Occupational safety is an organizational judgment based on how the workforce perceives their role and expectations for doing the job. Studying perceptions between organizational groups can provide an opportunity to identify differences in work systems perspectives due to miscommunication and lack of interaction.

2. Method

The method used in this study is a literature study on literature articles and books obtained through search engines, namely, 12 from Google Scholar. The criteria for international journals used are Scopus accreditation. This research was conducted by identifying the results of previous studies related to the title, namely the implementation of macro ergonomics in human safety. The journals obtained were from industrial engineering macro ergonomics journals and public health journals.

3. Findings and Discussion

Safety culture is part of the organizational culture in dealing with errors and risk management. There is some consensus that safety culture forms a framework within an organization that defines employee behavior where various definitions of safety culture emphasize organizational, systemic, and individual aspects. All of these definitions are similar but are presented in a way that offers different levels of thought or action to ensure their safety (Choudhry, Fang, & Mohamed, 2007a; Petitta, Probst, Barbaranelli, & Ghezzi, 2017). Hale (2000) suggests that safety culture refers to the attitudes, beliefs, and perceptions shared by groups and individuals within an organization that defines its norms and values.

The risk of accidents in the workplace, especially in sensitive locations with unsafe behavior, has increased substantially and requires more accurate management. To improve security in such systems, improving integrated resilience engineering and macro ergonomics concepts are important steps to consider. This is as stated by Hendrick & Kleiner (2001) regarding the application of macro ergonomics in organizations, especially the interaction between workers and organizations where a safety culture is very necessary and beneficial.

Todd William Loushine (2012) research entitled *Macroergonomic Approach to Safety Culture/Climate: A Healthcare Facility Case Study* stated that when workers are “just trying to do a good job”, they may inadvertently expose themselves to hazards or risks that are underestimated or considered to interfere with work performance. A comprehensive work system assessment eliminates “errors” for safety issues and identifies discrepancies in perceptions/expectations that will inadvertently lead to negative work outcomes. In his study, injury history was also analyzed to better understand the types and causes of nurses' injuries which provided a basis for focusing on organizational and social contributions to safety issues.

In a study by Yeung et al. (2005), a comprehensive approach to work stress and tension was used to assess the risk factors contributing to the nursing population. Similar to the current study, the size of the study used by Yeung goes beyond environmental and hardware factors which also considers the interaction of social and organizational factors of the work system. Based on the results of this study, safety should be considered as a work attribute, not a single work characteristic. The study methodology needs further attention and improvement to increase knowledge and application of worker systems to define safety culture (Todd W.L. 2012).

Current standard practice in occupational safety and health has reached its potential in terms of reducing the risk of injury or disease through such efforts as written programs, hazard identification and control, and employee safety training (Nagamachi and Imada 1992).

Human factors professionals can make significant improvements in occupational safety and health by extending interventions from the physical and cognitive level to the macro ergonomic level. The nature of the systems we design and the human interactions within these systems demand a multidisciplinary systems approach to addressing safety enhancements. The human factor is well suited to meet the challenge of making

improvements in this area. However, intervention strategies should be based on a broad conception of people working in organizational, social, political, and psychological contexts (Nagamachi and Imada, 1992).

Imada & Feiglstock (1990) reported the results of interventions to improve safety and health in companies that produce and distribute petroleum products. Key components for this intervention include organizational assessments that produce strategic plans to improve safety, equipment changes to improve safe working conditions and improve safety, and three macro ergonomic classes of action items. These actions include increasing employee engagement, communication, and integrating safety into the broader organizational culture.

In particular, the method called "Macroergonomic Structure Analysis" or MAS provides a framework and factor and context analysis for the analysis of organizational design and management processes through the Ergonomic Macro Analysis and Design (MEAD) method. Together, MAS and MEAD represent a formalization of fundamental methods in macro ergonomics that can be used to regulate existing tools and methods such as those in system security and help differentiate macro ergonomics from other approaches (Elizabeth Haro & Brian M. Kleiner, 2008).

The macro ergonomics and MAS frameworks provide an excellent foundation for methods such as MEAD, merging and integrating existing tools and techniques as available in the system security arena. Through additional applications, additional enhancements can be made and knowledge contributed as to what works and why. A partial validation of the general approach, the Rapid Universal Safety and Health (RUSH) system was designed, developed, and used to incorporate process safety for rapid construction projects (Kleiner et al., 2006).

The paper of Ali Taghi-Molla et al. (2020) which is a case study at a gas refinery in Ilam, Iran, revealed a new method based on Bayesian networks and artificial neural network models to improve the safety of macro ergonomics systems in the workplace, especially in sensitive locations with unsafe behavior. Utilizing the Bayesian network, the effect of the indicator on the security efficiency of the system was evaluated according to expert opinion. The neural network examines this effect based on operator opinion. Furthermore, to reduce the uncertainty and bias of the results and also increase their robustness and accuracy, the combination of the results of these models was considered as the final criterion. The results obtained were found to corroborate the validity and efficacy of the proposed method and draw extraordinary managerial insights.

Forty years of safety culture research show that a proper assessment in a safety-critical context would include items that are general safety factors as well as items that are specific to particular industries and societies. In developing a new survey tool suitable for use in the gas refinery industry, a socio-technical work systems approach was used to capture all aspects of the context of the work system (Haji Omid Kalteha et al., 2020).

The study which is part of a comprehensive research program to understand and improve safety culture in the substantial gas refining industry in the Persian Gulf was conducted by Haji Omid Kalteha et al. (2020). Common factors in his research pertain to management or supervisor commitment, resources, and training. The main contribution of this study is the development of a scale that includes general factors from the industry that are critical to safety, in addition to relevant items for factors that vary in detail according to the specific characteristics of the gas refinery industry. A new approach to extending the theoretical concepts of safety culture and safety climate has revealed the fact that there is a lack of application of general factors, such as management commitment or employee participation in safety culture assessments, without considering industry-specific characteristics.

The socio-technical work system approach program was carried out by Haji Omid Kalteha et al. (2020) in three parts at a gas refinery complex in the Persian Gulf. First, 18 semi-directed interviews with experienced employees were conducted. Using the confirmation framework, the rich qualitative data were condensed into a structural code and 12 themes. Second, 15 safety specialists served as the expert panel on the items proposed in the qualitative interview. Their comments and content validity assessment resulted in a 59-item questionnaire, in which 12 themes aligned with 12 safety culture factors and 5 macro ergonomic subsystems of the socio-technical work systems approach were used. In the third section, the psychometric properties of the questionnaire were examined using a sample of 276 employees, supervisors, and managers. The CFA results show that the 56-item assessment tool is declared valid and reliable. The fit index had acceptable values and the measurement model was confirmed (CMIN/DF = 1.55; GFI = 0.94; AGFI = 0.91; CFI = 0.89;

RMSEA = 0.05). The sociotechnical work systems approach provides a suitable route for developing safety assessment tools that recognize aspects of the gas refinery industry, such as type of work schedule, cultural environment, and distance from family support.

Based on the information that has been collected and described above, it is concluded that the implementation or application of macro ergonomic in the industry is one of the important efforts in improving human safety. If this is implemented properly, macro ergonomics can produce benefits for the system, one of which is in the manufacturing system, ranging from process optimization and job risk reduction to improving the quality of life in the workplace. Workers who in this case have a high work commitment will also have increased productivity followed by effective and efficient work processes.

The consistent support of all elements of the organization in implementing macro ergonomics will automatically improve risk management and be able to solve problems related to K3 or human safety comprehensively and improve the quality of K3 in the workplace. Several studies related to the title of this paper have similar results, namely, the implementation of macro ergonomics for human safety has proven to have a positive impact on the industrial, construction, health, and mining sectors. The author recommends expanding macro ergonomic research to other fields, such as education and trade, more specifically in supermarkets. The aim is not only to determine whether macro ergonomic practices have been applied in this area but further to apply them and carry out a comparative analysis of the possible results.

4. Conclusion

The safety issue is one of the most prominent and facing most organizations. Many factors affect system security as a result of increasing industrial growth and more complex systems. The implementation or application of macro ergonomics in the industry is one of the important efforts in improving human safety. The implementation of macro ergonomics for human safety has proven to have a positive impact on the industrial, construction, health, and mining sectors. To improve security in organizational systems or workplaces with the risk of accidents, especially in sensitive locations with unsafe behavior, it becomes very important and crucial to improve integrated resilience engineering and macro ergonomic concepts.

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