A macroergonomic compatibility index for manufacturing systems

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A B S T R A C T

Macroergonomic compatibility (MC) refers to the extent to which macroergonomic factors and elements interact positively with humans. Unfortunately, no research has ever developed an index to measure MC. To address this gap, we propose a macroergonomic compatibility index (*MCI*), validated among manufacturing work systems. *MCI* takes as basis the perceptions of middle and senior managers regarding the implementation of macroergonomic practices (MPs) in their companies. The data were collected through the macroergonomic compatibility questionnaire (MCQ), and such information was supplemented with the opinion of ergonomics experts to obtain the ideal weightings of the MPs analysed in the variables. The *MCI* was developed using dimensional analysis, and it includes an ideal solution. Due to their imprecise nature, macroergonomic variables were analysed through linguistic terms. To demonstrate the capability of our model, we used the *MCI* to measure the macroergonomic compatibility of manufacturing companies located in Chihuahua, Mexico. The results indicate that the *MCI* is an effective tool for measuring MC.

1. Introduction

Research on manufacturing strategies has greatly evolved during the last 40 years (Voss, 2005). In order to improve global competitiveness, manufacturing companies strive to assess and improve those elements that impact on their performance. Such elements include agility (Lin, Chiu, and Chu, 2006; Lin, Chiu, and Tseng, 2006), quality (Zhai et al., 2002), productivity (Moses and Stahelski, 1999), and production processes (Hsu and Shu, 2008). As a result, several mathematical models have been proposed to evaluate corporate performance (Tang et al., 2000; Salameh and Jaber, 2000). These models must represent the reality of companies and should be able to be implemented without being an ergonomics expert (Tang et al., 2000). They also must inform of the current state of every evaluated element, which enables companies to make improvements and detect potential performance risk factors (Deros et al., 2012; Lin, Chiu, and Chu, 2006).

Macroergonomics has steadily become a popular competitive strategy among industries. Also known as organizational ergonomics, macroergonomics is a top-down sociotechnical systems approach concerned with the analysis, design, and evaluation of work systems.[1] In

other words, macroergonomics is concerned with human-system interaction (Hendrick and Kleiner, 2016), and its main goal is to harmonize work systems at the micro- and macroergonomic levels to improve employee productivity, safety, and health (Carrasquero, 2016).

Macroergonomics increases the compatibility between humans and work systems while offering a wide range of advantages. Primarily, macroergonomics improves employee satisfaction and quality of life, thereby reducing production errors and waiting times in processes. Likewise, macroergonomic interventions decrease risks while increasing competitiveness (Realyvásquez, Maldonado-Macías, García-Alcaraz, Cortés-Robles et al., 2016; Realyvásquez et al., 2017).

But what is exactly meant by compatibility? It is claimed that two objects are compatible if they can properly interact while having opposite behaviours (Bordeaux et al., 2004). This definition implies that two objects are compatible when they are complementary in terms of capabilities and limitations, and together, they allow people to achieve goals more easily. It other words, compatible objects fit together to achieve specific goals.

Compatibility is the ability of an object to adapt to the capabilities, limitations, and needs of another object in order to perform a specific