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Assessing Work System Processes Using Macroergonomic Analysis and Design Approach: A Literature Review

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Abstract. This study's goal is to provide an overview of the macroergonomics approach, which is used to evaluate work systems and make improvements to working conditions and efficiency. A process for the system evaluation was developed using the pertinent framework, Macroergonomic Analysis and Design (MEAD). Using the MEAD framework, the system may be assessed more completely overall, and any conflicts can be resolved to fully harmonize the system. A thematic analysis of papers addressing macroergonomic analysis and design (MEAD) is the methodology used in this study. To successfully complete a research project using this methodology, ten steps must be followed. The ten steps are as follows: examining the subsystem of organizational and environmental design; identifying the type of manufacturing system and establishing performance benchmarks; outlining work procedures and unit operations; detecting variances; generating the matrix of variances; establishing the role network and key variance control table; allocating functions and designing jointly; recognizing the views of roles and responsibilities; creating and modifying interfaces and supporting subsystems; putting into practice, refining, and upgrading.

Keyword: Ergonomics, Macroergonomic Analysis and Design, Macroergonomics, Management and Organizational Design, Work System

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1. Introduction

It has been suggested that, in order to strengthen the impact of ergonomics in organizations, systemic measures should be used. There has been a steady increase in the use of macroergonomic concepts in work system design and redesign. Macroergonomics contributions to work systems is fundamental analysis and design of system elements with which human factors interact [1]. Given that sociotechnical systems are frequently referred to as "systems," it should come as no surprise that sociotechnical systems theory serves as the foundation for macroergonomics [2]. The goal of evaluating a work system using the macroergonomics approach is to determine a well-coordinated work system by maximizing the work system's design in terms of its sociotechnical system, organizational structure, and work system with

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regard to people, technology, and environment [3]. The goal of ergonomic interventions is to improve the entire work system. Human intervention is used to improve system modifications [4].

A work system is made up of two or more individuals collaborating and interacting with technology within an organizational system that is defined by a physical and cultural internal environment [5]. By meticulously considering each of the crucial aspects of the sociotechnical system elements, researchers may construct a work system structure that produces successful outcomes [6].

The personnel subsystem, the technology subsystem, the organizational subsystem, the internal environment subsystem, the external environment subsystem, and the interactions between all components make up the system elements [7]. The efficiency of the work system is determined by the technological and human subsystems' exquisite designs, which are created with mutual respect. Three design dimensions that the organization concentrated on were centralization, formalization, and complexity. Differentiation and integration comprise the two components of complexity. Segmenting the organization was the main goal of differentiation. The goal of integration is to connect the segments through coordinating systems. The degree of standardization is defined by formalization. Centralization is associated with decision-making [5]. The reason organizational analysis is noteworthy is that it may be thought of as a collection of research studies pertaining to the overall revamping of the organization with the goal of improving quality of life, safety, comfort, and system efficiency [8]. The level of training and professionalism, as well as demographic and psychosocial characteristics, make up the personal subsystem. The ability to adapt to one's surroundings shapes the external environment, which is influenced by political structures, legal frameworks, and public policies, among other things. These factors contribute to the internal environment's uncertainty [9].

Reviewing numerous studies on MEAD literature is the goal of this research in order to increase work system productivity, efficiency, and effectiveness, ultimately leading to a fully functionally harmonized work system.

The purpose of writing this literature review is to obtain a grasp of macroergonomics analysis and design applications and to convey the process in the form of a written report. Additionally, it makes the relationship between each piece of work under consideration and the others clear. Furthermore, a literature review can be used to evaluate certain studies that cover macroergonomics analysis and design frameworks. This makes it easier to identify the gaps in the studies that are now available for possible future research.

2. Theoretical Basis

2.1. Macroergonomics Analysis and Design

Identifying the needs of system users is the first stage in the work system assessment process in the field of engineering. After that, such demands are interpreted as system needs. These

requirements eventually become engineering specifications that serve as the foundation of ergonomic procedures [1]. Practitioners and researchers frequently do systems assessments in organizations, but they rarely provide extensive explanations of the process. One often used framework to define a process for the systems analysis of the workplace is the Macroergonomic Analysis and Design (MEAD) framework [5]. The MEAD framework is useful because it creates a thorough evaluation system by combining current methods from several disciplines. The use of the MEAD framework provides the option of using conventional methods such as laboratory tests, field research, questionnaires, survey organizations, survey interviews, and focus groups [10]. Macroergonomic Analysis and Design (MEAD) enables researchers to integrate tools and methodologies from various fields. Figure 1 illustrates Macroergonomic Analysis and Design (MEAD) procedure [2].

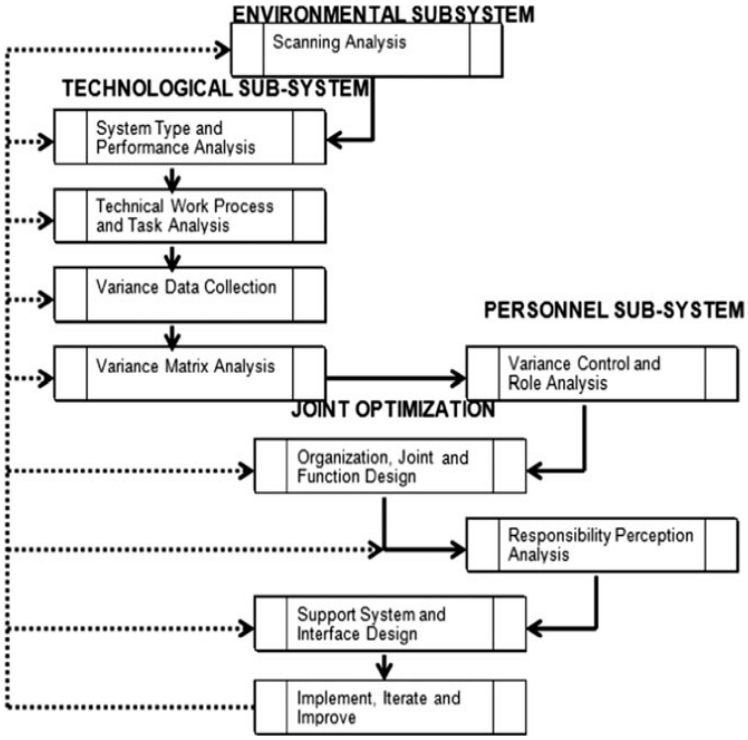

Figure 1 MEAD Process

2.2. Macroergonomics Analysis and Design Process

There are ten steps in this distinctive methodology, as follows [11]:

1. Examining the subsystem of organizational and environmental design
2. Identifying the type of manufacturing system and establishing performance benchmarks
3. Outlining work procedures and unit operations
4. Detecting variances
5. Generating the matrix of variances
6. Establishing the role network and key variance control table
7. Allocating functions and designing jointly
8. Recognizing the views of roles and responsibilities
9. Creating and modifying interfaces and supporting subsystems

10.Putting into practice, refining, and upgrading.

3. Research Methodology

The present investigation adheres to the thematic analysis principle, which involves the review of both domestic and international publications sourced from reputable online journals including Google Scholar, Science Direct, Springer, and Sage publications. The paper's review of the literature covers the years 2015 through 2022. One technique for assessing qualitative data is thematic analysis, which entails looking for recurrent themes in the data set [12]. Looking through published works on journal websites is the first step in conducting this study [13]. The researcher then chooses the appropriate literature to be reviewed [14]. The selected literature is then reviewed by the researcher through thematic analysis [15]. Ultimately, the researcher extrapolated the findings gleaned from the literature [16].

4. Result and Discussion

The result and discussion part are divided into a general result and a thematic analysis. The general result discusses the application of macroergonomic analysis and design (MEAD) framework in manufacturing and service industries, as well as the frequency of work system elements being discussed in the literature reviewed.

4.1. General Result

The macroergonomics approach to work system assessment seeks to maximize the work system's design in terms of its organizational, sociotechnical, and work system with consideration for people, technology, environment, and the way they interact in order to establish a well-coordinated work system [3]. The framework is extensively used in the manufacturing and service sectors since it is helpful in resolving work system issues.

The novelty of this study is that it covers a wider range of variables than previous research, resulting in a more general discussion. Several literatures that discussed the use of macroergonomic analysis and design in manufactures and service industries are presented in Table 1.

Table 1 Frequently MEAD Framework Applied in Industries

Type of Industry	Publication
Manufacture	Perez, et al [17], Kleiener, et al [2], Muslim, et al [3], Kleiner [6], Wahyuni, et al [18], Pradini, et al [19], Sesariningrum, et al [20], Sukendar, et al [21], Ristyowati [22]
Service Industry	Murphy, et al [7], Silva [8], Derenevich [9], Nugroho, et al [10], Putra, et al [18], Suzianti, et al [23], Padhil [24], Sumarmi [25]

Based on Table 1, it can be concluded that Macroergonomic Analysis and Design (MEAD) framework is widely used both in the manufacturing and service industries. The articles that discuss its application in the manufacturing industry are 53%, while those in the service industry

are 47%. The infographic of macroergonomic implementations in the manufacturing and service industries is illustrated in Figure 2.

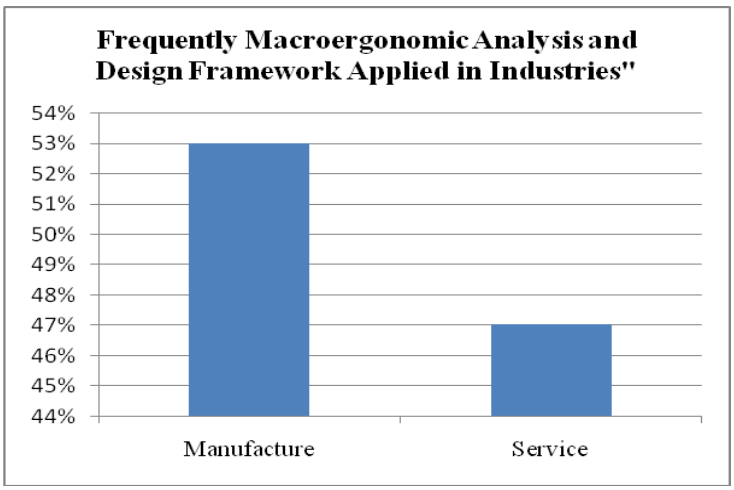

Figure 2 MEAD Framework Application in Industries Graphic

A work system is made up of a variety of components, including personnel, technology, organization, environment, and method. Every literature that uses macroergonomics analysis and design framework application must focus on work system elements, with each literature discussing a distinct work system aspect [9]. The frequency of work system elements discussed in literatures is shown in Table 2.

Table 2 Frequently Work System Elements on Macroergonomics Analysis and Design Literature Application

Type of Industry	Publication
Organizational	Kleiner, et al [2], Muslim, et al [3], Kleiner [6], Murphy, et al [7], Silva [8], Derenevich [9], Nugroho, et al [10], Perez, et al [17], Putra, et al [18], Pradini, et al [19], Sesariningrum, et al [20], Sukendar, et al [21], Ristyowati [22], Suzianti, et al [23], Padhil [24], Sumarmi [25], Wahyuni, et al [26],
Personnel	Kleiner, et al [2], Muslim, et al [3], Kleiner [6], Murphy, et al [7], Silva [8], Derenevich [9], Nugroho, et al [10], Perez, et al [17], Putra, et al [18], Pradin, et al [19], Sesariningrum, et al [20], Sukendar, et al [21], Ristyowati [22], Suzianti, et al [23], Padhil [24], Sumarmi [25], Wahyuni, et al [26]
Technology	Kleiner, et al [2], Murphy, et al [7], Silva [8], Derenevich [9], Nugroho, et al [10], Ristyowati [22], Suzianti, et al [23], Padhil [24], Sumarmi [25]
Environment	Kleiner, et al [2], Muslim, et al [3], Kleiner [6], Murphy, et al [7], Pradini [19], Ristyowati [22], Padhil [24], Sumarmi [25]
Method	Muslim, et al [3], Kleiner [6], Sukendar, et al [21], Ristyowati [22], Sumarmi [25]

It can be concluded that all of the literatures discussed about organizational and personnel elements. The literatures percentage that discussed about technology is 53%. While the percentation of literatures that discussed about environment is 47%. Whereas the litertures percentation that discussed about method is 30 %. The infographic of work system elements discussed in Macroergonomics Analysis and Design Literature illustrated in Figure 3.

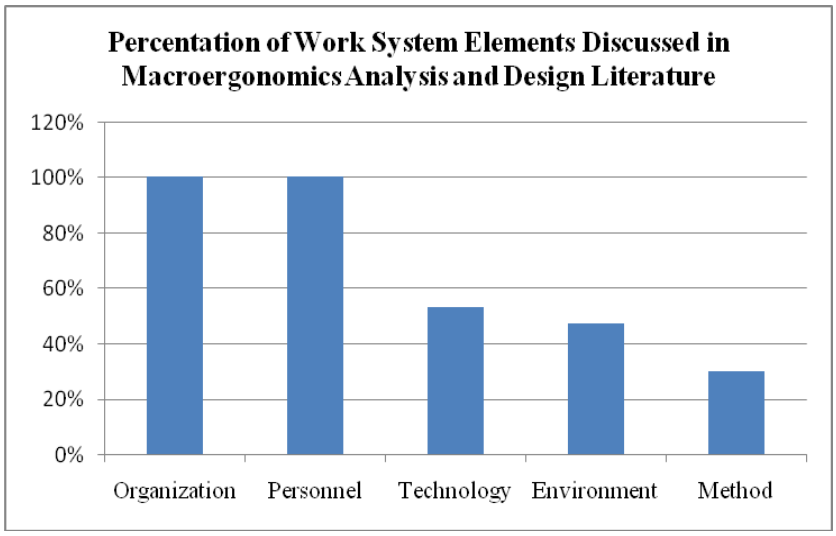

Figure 3 Percentation of Work System Elements Discussed in Macroergonomic Analysis and Design Literature

4.2. Thematic Analysis

Since macroergonomics contributions to work systems is vital for analyzing and designing a work system to enhance effectiveness and efficiency, there are plentiful literatures describing the application of this methodology, as follows.

Putra, et al [18] established a research that shows that work system affects the performance of employees of the Department of General Affairs and Civil Service at the Office of Community and Village Empowerment. The head of the Village and Community Empowerment Service anticipates that staff members will meet their goals. Work systems with structured and methodical procedures are evaluated using the Macroergonomics Analysis and Design (MEAD) technique. This approach was selected because it can more precisely assess the problem's source within a work system. The study's findings demonstrate that goals can be met and staff productivity is increased when using the macroergonomics analysis and design (MEAD) technique.

Pradini, et al [19] carried a research out using the macroergonomics method in the purse seine type shipbuilding industry. Selecting the sort of wood, calculating the ship's dimensions, assembling, coating, and launching are the steps necessary for making a ship. Shipbuilding is a time-consuming process; therefore, meeting output targets is not acceptable. Machines and equipment are frequently damaged owing to poor maintenance. Workers also lament their fatigue as a result of the monotonous, lengthy hours spent manufacturing ships. The production work area's room temperature is 340 °C, which makes it uncomfortable for the employees to do their jobs. When there is insufficient supervision, employees perform tasks that are not related to their assigned tasks. The lack of appropriate work standards led to these issues, which prevented targets from being met.

Sesariningrum A [20] conducted a research about work system problems that occurred in the production area of the slip house department of a household ceramics company. The demand for

household ceramics increased significantly, increasing the workload of employees at these enterprises. The repetitive pattern of work in the slip house department causes workers to complain of sore muscles. The slip house department's work system is examined using the MEAD approach. The macroergonomic MEAD approach helps in identifying the work system design, problem risks, and cause variables. The purpose of Standard Operating Procedures (SOP) is to enhance the manufacturing department work system in household ceramics companies.

Sukendar [21] making a research at the Indonesian Football Robot Contest (KRSBI). Wire winding is an entirely manual process. The working posture while performing the activity does not adhere to ergonomic guidelines. As the convolution process is taking longer than expected to complete, fatigue and low back pain have also been reported. To overcome the issue, the MEAD approach is applied. As a result, semi-automatic coil rolling devices based on the Arduino Microcontroller were designed in accordance with ergonomic principles. It has been proven that this reduces muscle pain and fatigue.

Ristyowati [22] established a research at Ayu Arimbi Batik Center in Sleman Regency, Yogyakarta. Workers expressed their fatigue at having to spend so much time creating batik patterns. This resulted from the lack of necessary tool assistance for this task. The issue is solved using the MEAD framework. After analyzing the key variance, a solution is developed based on the key variance. A batik pattern table aid was created when it was discovered that the most important aspects were technology and workspace. The intended batik pattern table could lessen workers' fatigue, according to the results.

Suzianti [23] organizing the research towards the citizen of Jakarta’s habit on waste management system. Due to the absence of a waste management system, citizens failed to dispose of their waste in the appropriate locations. The research used the MEAD framework. It is advised that garbage cans be created with a few more characteristics when the method is put into practice to reduce the likelihood of human error when using them. The results show that implementing MEAD can help solve the waste management system.

Padhil [24] arranged a research at tourist villages among the tourist attractions. The presence of tourist communities may cause changes in land use for tourism, damage to cultural assets, and land conversion. This study implements the MEAD framework to improve the system. The goal of the suggested work system design is to create work instructions, standard operating procedures, visions, and missions in order to integrate the current components.

Sumarmi [25] conducted a research at the Wono Ayu Sidoarja Health Center. The limited availability of outpatient rooms, inpatient rooms, laboratory rooms, and pharmacy rooms created inadequate services in the health center. In order to improve service facilities, this study aims to offer recommendations for using the MEAD framework. The results indicate that job descriptions need to be regulated, the number of health professionals—such as doctors, nurses,

pharmacists, and midwives—has to be increased, and inpatient room air ventilation needs to be fixed.

The literature presented above shows that the MEAD framework is proven to enhance work system productivity, efficiency, and effectiveness through ergonomic interventions to create a fully harmonized working system that works well. Since it's proven to solve the problems occurred in work system, it's widely used on manufacturing and service industries.

5. Conclusion and Recommendation/Policy Implication

The study of work system evaluation and design is known as macroergonomics. A more thorough approach to assessing a work system is provided by the MEAD framework, especially in situations that are generally industrial. Researchers can create an effective work system structure by examining the key aspects of the sociotechnical system components. By putting the approach that has been demonstrated by the many studies mentioned above into practice, a completely synchronized work system can be created.

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