

Enhancing Workplace Safety and Efficiency via Ergonomics and Office Management Systems

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Abstract: Ergonomics, rooted in the Greek words "ergon" (work) and "nomoi" (natural laws), optimizes product design for enhanced human usability. This paper explores ergonomics' pivotal role in office and workplace productivity and innovation. Examining human dynamics and factors like vision and temperature, it addresses digital age stress points, particularly in computer-dominated workspaces. Emphasizing Human-Computer Interaction (HCI), the study underscores the historical evolution of ergonomics and its profound impact on productivity. Recognizing productivity's global economic importance, the study highlights human resources as a key determinant. It establishes a link between ergonomics availability and improved productivity, urging a comprehensive approach to enhance workplace conditions. The paper further explores workplace innovation's often-overlooked influence on safety, health, human resources, management changes, worker participation, policy, and training. It posits that such innovation fosters radical changes, contributing to enhanced profitability. In conclusion, the study advocates a holistic understanding of ergonomics for workplace productivity and innovation. Empowering employees with control over their surroundings and embracing innovation creates environments conducive to sustainable development and economic growth.

Keywords: Ergonomics, Productivity, Office Buildings, Workplaces, Musculoskeletal Disorders, Safety

1. INTRODUCTION

Global workplaces and service centres are currently grappling with significant occupational safety and health challenges [1]. Addressing these issues involves the implementation of ergonomic studies [1] and workplace innovation as potential solutions [2]. Ergonomics, which entails redesigning jobs to enhance safety and productivity, is a key component of this approach [2]. Workplace innovation, encompassing new interventions in work organization, human resource management, and supportive technologies, is also integral to creating safer and more efficient work environments [1].

The positive correlation between productivity and the proper implementation of ergonomics in the workplace is well-established [1]–[4]. Achieving ergonomic value occurs when organizations make efforts to create comfortable workspaces, allowing employees to maximize productivity with minimal fatigue when using both computerized and non-computerized equipment [3]. Productivity, defined as the optimal utilization of various resources to produce goods and enhance overall well-being, underscores the crucial role of human resources in organizational productivity [4]. Researchers have identified environmental, physical, and psychosocial factors as key elements influencing human resource productivity [4]. Recognizing the essential nature of ergonomics, its significance becomes apparent when considering the adverse effects on the musculoskeletal system caused by awkward postures, intolerable temperatures, or repetitive movements during tasks [2]. Musculoskeletal disorders (MSDs), affecting muscles, joints, tendons, ligaments, and nerves, can develop

gradually over time or occur suddenly due to overload [1], [2], [5].

The link between MSDs and Work-Related Musculoskeletal Disorders (WMSDs) is evident in research that highlights how applying ergonomic principles enhances workers' productivity and reduces the incidence of WMSDs [5], [6]. WMSDs, associated with body aches, physical disability, and high treatment costs, necessitate compensation for affected employees [5]. Recognizing employee comfort, values, and personality is crucial for job satisfaction and productivity, with successful companies implementing ergonomic strategies to bridge these gaps [2].

Examining workplace safety in the context of workplace innovation reveals its positive contribution to overall workplace enhancements [1]. In the current technological era, increased computer use has raised concerns about health-related productivity loss among office workers. The extended hours spent at the workplace contribute to a higher prevalence of musculoskeletal disorders. Therefore, creating an ergonomic workplace is imperative for safeguarding workers' safety and health while simultaneously increasing productivity [4].

2.0 Literature review

2.1 Ergonomics

The term "ergonomics," derived from the Greek words "ergon" (meaning work) and "nomos" (meaning law), refers to the study of work carried out by humans. [2], [3]. It involves

restructuring a job to accommodate the worker, ensuring that the work is both safer and more productive.[2], [4]. Organizations depend on their employees to operate and achieve established goals. They allocate resources to support and uphold an effective workforce. Insufficient workplace safety measures can impede the productivity of employees. [2], [4], [5].

Productivity is achieved when due attention is given to ergonomics in the workplace [2], [6], [7]. Ergonomic value is achieved when an organization ensures that the workplace is comfortable for employees, enabling the optimal use of both computerized and non-computerized equipment to enhance productivity while minimizing fatigue [6]. Productivity is commonly described as the ratio of output quantity to the amount of input [8]. Productivity is a comprehensive concept that has consistently been a focal point for politicians, economists, and government officials, leading to substantial investments due to its critical role in enhancing the quality of life, welfare, and comfort. It involves the efficient utilization of diverse resources to produce goods and contribute to all aspects of life. In this definition, human resources stand out as the paramount factor influencing the increase or decrease of an organization's productivity. Consequently, numerous researchers have elucidated the factors impacting human resource productivity, including environmental factors (such as workstations, noise, lighting, and temperature), physical factors (like posture), and psychosocial factors (including motivation, anxiety, and job satisfaction), all playing essential roles in employee productivity [7].

Ergonomic elements such as fixed and neutral body positions, lack of support, rotation, and tilting to one side, as well as leaning forward [3] significantly influence the comfort of work, particularly in the design and amenities utilized by workers [9]. The application of ergonomic solutions in research can offer employees an improved and comfortable work environment, ultimately leading to increased productivity [4].

Advantages of ergonomics

Research has proved many advantages of the study of Ergonomics,

- Reduced injuries can be achieved through scientifically designed equipment, preventing harm to employees [3], [4].
- Improved physical comfort enhances employee productivity [2], [4], [7].
- Fewer job-related injuries lead to reduced workers' compensation claims [4][2].
- The study of ergonomics contributes to employees' well-being and contentment, decreasing discomfort [2], [4], [10], [11].
- Ergonomic enhancements mitigate risk factors associated with discomfort [4], [11], [12].
- Ergonomic improvements reduce primary risk factors for Musculoskeletal Disorders (MSDs), fostering efficiency and

job satisfaction [4], [7].

- Attention to ergonomics instils value among employees, enhancing morale [2], [4], [6].
- Ergonomics promotes healthy, engaged, and productive workers, reducing absenteeism [4], [6], [7]].
- Creating a health-focused workplace enhances productivity through ergonomic design [4], [6], [8], [12], [13].
- Ergonomics ensures employees work comfortably and efficiently, reducing quality issues [4], [6].
- A commitment to health and safety through ergonomics fosters employee engagement and reduces absenteeism [2], [4], [6].
- Ergonomics reflects a company's commitment to a safety and health culture [4].
- Proper implementation of ergonomic practices reduces accident risks, leading to increased productivity and cost savings [4].

In its historical development, ergonomics has been organized around the principles of human actors and activity-factor ergonomics. According to the Human Factors and Ergonomics Society, human factors is a scientific field focused on comprehending human interactions with their surroundings. This discipline also represents a profession that utilizes theoretical knowledge, principles, gathered information, and various methodologies in the design process to improve both human well-being and the overall performance of the system [2].

2.2 History of Ergonomics

Although the use of the word 'ergonomics' is relatively new, the concept itself is not. One of the first noted interests in ergonomics was in the 16th century, from Italian physician Bernardino Ramazzini, who wrote a medical journal ('De Morbis Artificum' - translated as 'Diseases of Workers') about complaints from his patients. The journal details a variety of injuries and how these related to the working environments and occupations of his patients. The use of the term 'ergonomics' was eventually coined by Wojciech Jastrzebowski and came into use around 1857.

The concept of ergonomics in the 19th century was introduced by Frederick Winslow Taylor. A 'scientific management' was implemented as a method for increasing Productivity & efficiency in workers shovelling coal. Taylor found that by reducing the size and weight of the shovels used, the amount of coal being shovelled was tripled. The changes in the shovel design also lead to reductions in work-related injuries and increases in productivity.

In the 1900 the concept of ergonomics was further explored in the 'Time and Motion Studies' by Frank and Lilian Gilbreth, which examined techniques for decreasing the number of motions required to perform a given task successfully. In one example brick layers were able to increase their productivity

from 120 to 350 bricks laid in one hour, due to a reduction in the number of motions involved per brick lay.

Ergonomics was further used during World War II to enhance cockpit design as a means to reduce pilot errors and increase safety [4].

2.3 Ergonomics and Productivity

Ergonomics are affected by many factors including the environmental, physical, and many more.

2.3.1 Productivity and Environmental Ergonomics

Environmental ergonomics deals with how individuals engage with their surroundings from an ergonomic standpoint [7]. The quality of the workplace environment, where employees continually interact, plays a pivotal role in determining their motivation, subsequent performance, and overall productivity [2], [6], [8].

Unfavourable work environment conditions can impact employees' health and safety, error rates, innovation, collaboration, absenteeism, and productivity [2], [5], [7]. Researchers assert that a substantial 86% of productivity challenges stem from the physical conditions of the workplace [7]. Examining the environmental conditions of any workspace, encompassing aspects like indoor air quality, noise, lighting, and temperature, reveals that these environmental factors influence employees' attitudes, behaviours, satisfaction, performance, and productivity by diminishing their comfort [7].

2.3.2 Productivity and Physical Ergonomics

Physical ergonomics focuses on human anatomy, encompassing anthropometric, physiological, and biomechanical characteristics related to physical activity [7]. A crucial aspect within this branch of ergonomics involves selecting appropriate equipment and adapting workstations to mitigate musculoskeletal disorders [7]. Musculoskeletal disorders are identified as among the most costly health conditions, potentially diminishing employee efficiency and productivity [4], [7], [9]. Research indicates that suboptimal ergonomic conditions and workstations can contribute to increased instances of musculoskeletal disorders, fatigue, and reduced productivity [2], [4], [7].

In recent times, Ergonomic Equipment Guidelines have been employed to guide the selection of office equipment and computer workstations. Enhancing computer workstations, such as incorporating the ability to switch between standing and sitting postures and utilizing adjustable tables and equipment, has the potential to enhance the physical and cognitive performance of human resources, thereby increasing overall productivity [7].

2.4 Ergonomics and musculoskeletal disorders

Ergonomics is crucial because engaging in tasks with tense and unscientific postures, intolerable temperatures, or repetitive movements adversely affects the musculoskeletal system. Symptoms such as numbness [3] fatigue [4] discomfort and pain [3], [4] and even vision problems may manifest, serving as initial signs of potential musculoskeletal disorders [3], [4].

Numerous studies highlight that the application of ergonomic principles leads to a reduction in working musculoskeletal disorders (WMSDs), which can result in body aches, physical disability, substance abuse, and significant treatment costs. As a consequence, employers may be required to compensate employees suffering from WMSDs [2].

Musculoskeletal disorders (MSDs) encompass conditions affecting various body parts, including joints, muscles, nerves, bones, tendons, ligaments, and the circulatory system [1], [3] influenced by both individual tasks and immediate working conditions [2], [4]. Manual Material Handling (MMH) tasks involving heavy labour, such as climbing, lifting, pushing, and pivoting, also pose a high risk of occupational hazards, particularly MSDs [2]. MSDs are prevalent in MMH and other professions like teaching and banking, which, although previously neglected, have garnered increased attention in recent years [2].

Workers experiencing MSDs often require extended rest periods to manage pain, impacting their working hours. The duration of rest varies among workers, with some needing brief breaks and others requiring more extended periods [9].

Work-related MSDs are linked to factors such as highly repetitive work, rapid hand movements, contact stress, compression of soft tissues, nerve and blood flow issues, sustained stressful postures, force application, heavy lifting, individual factors, and poor work organization [3].

Affected body parts due to poor ergonomics include the upper back, lower back, shoulders, hips, knees, wrists, hands, elbows, forearms, and neck [2], [3]. Research indicates that man/machine interaction involving Manual Material Handling (MMH) often requires the use of various body parts, such as hands, legs, knees, back, elbows, etc [2].

Affected body parts

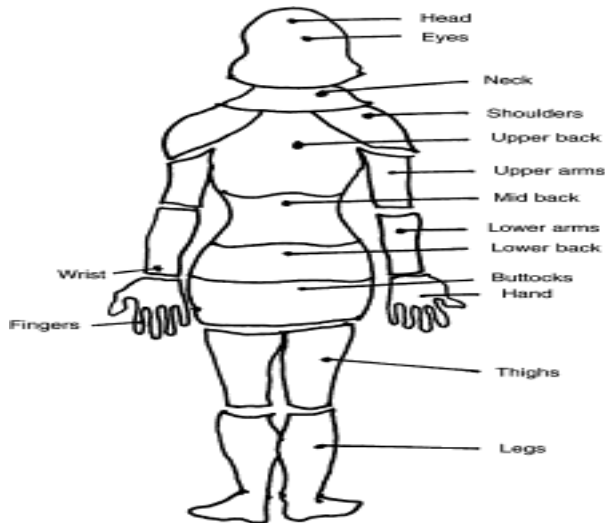


Figure 1 shows body parts affected when ergonomics is not properly implemented [3]

Potential Risk Factors for MSDs

Musculoskeletal disorders (MSDs) present compounded risk factors influenced by working conditions, individual characteristics, lifestyle, and psychological factors. Prolonged periods of standing, sitting, squatting, kneeling, bending, and stretching below knee level are significant contributors to risk assessments for MSDs. These disorders are among the most prevalent ailments globally, particularly Work-Related MSDs (WRMSDs), which entail physical, mental, time, productivity, health, and financial losses [2].



Figure 2 Body Postures during Manual Handling Tasks[2]

These manual tasks can be carried out by utilizing one or multiple body parts, and, if necessary, the approach can vary

based on the specific task at hand. For instance, lifting an object involves primarily using the hands (fingers, palm, wrist, forearm, and upper limb), with additional support provided by other parts of the body, including the toes, feet, legs, lower limbs, and spine [2].

3.0 Methodology

In this paper, data collection was precisely conducted through an extensive literature review. A comprehensive approach was employed, primarily relying on a systematic examination of scholarly articles, journals, and other credible sources related to ergonomics at workplaces, workplace safety and office environments. The goal of this data collection method was to gather relevant information and insights, employing a thorough review process.

The literature review involved a systematic analysis of existing knowledge, including key concepts, theories, empirical studies, and best practices within the realm of ergonomics in a work environment. The critical examination of the gathered literature aimed to extract key insights, identify trends, and uncover findings that contribute to the understanding of integrating office management systems about ergonomics

By utilizing a literature review as the primary data collection method, this research ensures a comprehensive exploration of existing knowledge, laying a robust theoretical foundation for the paper. This approach aligns with best practices in academic research, allowing the study to make meaningful contributions to the ongoing discourse on ergonomics in work environments.

4.0 Workplace Safety and Office Management Systems

4.1 Workplace safety

Globalization, legal mandates, and technological advancements significantly impact organizational management, altering the nature of work, the workforce, workplaces, and safety concerns. Work environments have become more intricate and safety-sensitive[5]. Inadequate workplace safety ergonomics expose employees to injuries and swift fatigue, potentially resulting in productivity losses [1]. Every organization encounters safety challenges, but employees need optimal safety measures to ensure productivity. Hence, organizations should implement comprehensive programs that address all potential contingencies without disrupting regular work operations [5]. Workplace safety ergonomics are anticipated to

enhance the comfort of work activities, reduce safety injuries and fatigue, and allow employees to fulfil their tasks effectively [1].

Various international guidelines provide frameworks for ensuring effective workplace safety. These include the National Occupational Safety Association (NOSA) system, the International Safety Rating System (2016), the International Labour Organization's (ILO) guidelines on Occupational Safety, ISO:31000:2009 safety risk management standard, and the three Es of safety (engineering, education, enforcement) recommended by these guidelines. All emphasize that robust safety management should encompass ergonomics, emergency management, safety training, and safety transfer. Addressing these four areas is deemed essential to creating a safe workplace, ultimately enhancing employee productivity [5]. However, commonly adopted workplace safety programs may not suffice to protect employees from the modern hazards of the workplace [5]. Workplace safety ergonomics play a crucial role in enhancing workplace safety by identifying and eliminating hazards. They mitigate risk factors leading to injuries, ensuring optimal employee productivity is maintained. Occupational safety and health challenges have become a global concern in industrial and service centres, and workplace innovation is suggested as a method to address these issues [1].

The significant aspects not covered adequately in workplace improvement include workplace innovation and its contemporary relevance. Previously, innovation was perceived primarily in terms of creating new ideas or developing new products, as discussed in the literature review [1].

4.2 Office management systems

Organizational ergonomics and culture play a pivotal role in influencing employees' choice of workplace [6]. An office, defined as any location used for administrative, clerical work, money handling, or communication, serves as a workspace primarily for management and administrative staff [8]. Ergonomics, also known as human engineering, has become increasingly essential with the surge in computer usage and exposure to various harmful factors [7].

Office workers, spending prolonged hours at work, often face a higher prevalence of musculoskeletal disorders compared to many other occupations, emphasizing the importance of an ergonomic workplace for both productivity and the health of workers [7], [8].

A poor workplace environment has diverse effects on employees, impacting health and safety, error rates, innovation, collaboration, absenteeism, and overall job satisfaction. Work systems not only influence commitment, competence, and cost-effectiveness but also have lasting

effects on the physical and mental health and life longevity of employees [4].

Recognizing these factors, modern offices are designed and furnished with the well-being of employees in mind, aiming to provide an environment that supports high performance. The philosophy driving the development of ergonomics is centred on equipping employees with a suitable workplace, including furniture, equipment, tools, and techniques, to discharge their duties efficiently and effectively. Employee performance, measured by individual output, is directly linked to productivity. At the corporate level, productivity is influenced by various factors, including employees, technology, organizational objectives, and the physical environment's impact on health and employee performance [4].

Additional challenging work hazards involve prolonged periods of sitting on uncomfortable and inflexible chairs, limiting the ability to adjust sitting postures. As work increasingly becomes standard practice for employees, it is crucial to identify sustainable solutions that allow employees to use ergonomic office equipment and adhere to guidelines [11].

Table 1. Work ergonomics issues and solutions.[11]

WFH ergonomics issues/problems	Proposed solutions
Improper chair height	Choose a chair with a height adjustment feature
Key object distance	Keep key objects, such as your telephone, stapler, or printed materials, close to your body to <u>minimise</u> reaching
No footrest/armrest	Keep feet flat on the floor or footrest and use a table or chair with armrest
Poor laptop/desk positioning causes neckstiffness, neck sprain and back sprain	Place the monitor directly in front of you, about an arm's length away. Adjust the desk position to chest level upon sitting down
Poor lighting, glare from the screen or vision complications	Adjust the position to the brighter light source or next to the window. Use blinds if too much glare
Noise and distortion	Use earphones or find a quiet place for work
Too much screen time	Move away from the screen every 30-45 minutes or use the 20-20-20 rule
Mouse task/keyboarding (awkward hand and wrist postures) increase pressure in carpal tunnel	While typing or using a mouse, keep wrists straight, upper arms close to the body, and hands at or slightly below the elbow level
Fatigue, sedentary, and lack of muscular activities	Occasionally go outside for fresh air and sunlight for improved circulation
High mental workload, stress, and burnout	Take a rest and time off, meditate or seek help from friends and family
Poor work layout or design of equipment and poor working conditions	A room with proper lighting, a large flat table surface/desk that allows room for computer equipment
Dehydrated or no proper meal break	Keep reminders for meal breaks and drink water frequently

Pop-up windows can cause an employee to repeatedly make data entries, which will decrease his efficiency and productivity [6].

Workstation Design

The design of equipment and working environments, guided by ergonomic principles, relies on operator characteristics and the functionality of the equipment to limit errors, and enhance safety, comfort, and work efficiency [2]. Desks and chairs, both in offices and homes, must adhere to anthropometric standards to prevent musculoskeletal disorders [9].

Desks, tables, stands [3]

- 24-28 inches adjustable if possible
- Different heights to reading versus computer work
- Room for chair and keyboard tray
- Room for equipment and tools
- Leg room under the table
- Equipment and files used must be within reach if the keyboard and mouse are on the table, adjust the chair so arms are neutral

monitor [3]

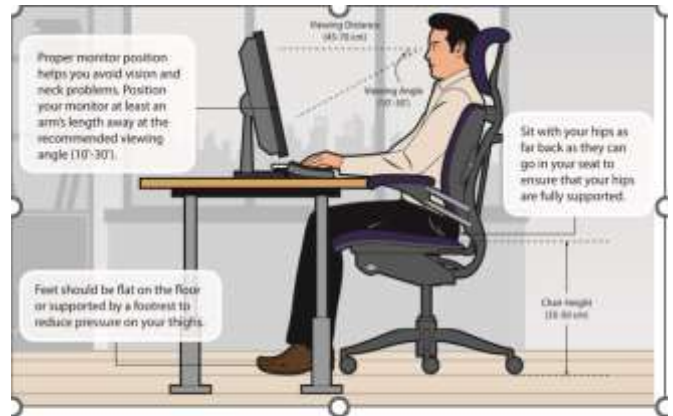
- between light fixtures, height adjustable monitor, viewing area (top line of the monitor screen in line with eyes or slightly below, a distance of 22 to 38 inches, viewing and distance depends upon the vision and corrective lenses, corrective lenses anti-glare or anti-reflective coating



A stable and supportive chair, a table with a suitable height, a space with good lighting [3]

- Face the keyboard and monitor

- Neck, upper back and shoulders supported and relaxed
- Mid and low back supported
- Arms near sides and open to more than 90°
- Forearms can be supported
- Feet supported as if flat on the ground



<https://www.tal.sg/wshc/-/media/tal/wshc/topics/images/office.ashx?h=356&w=602&hash=EB412FD9711AE97AB44FF50B758>

5.0 Conclusion and Recommendations

5.1 Recommendations

It has been well noticed that most organizations have no or poor ergonomics in place and therefore have recommended the following

- Integrated Ergonomic Training, Propose the implementation of ongoing ergonomic training programs for employees at all levels.
- Regular Ergonomic Assessments, Suggest the establishment of a routine ergonomic assessment process to identify and address issues promptly.
- Flexible Workstations, recommend the introduction of flexible workstations that allow employees to adapt their workspace according to their ergonomic needs.

- Technology Integration, advocates for the integration of technology solutions that support ergonomics, such as software that prompts employees to take breaks, ergonomic apps for posture correction, or tools that monitor workstation ergonomics.
- Employee Involvement, encourages organizations to involve employees in the decision-making process regarding ergonomic changes.
- Wellness Programs,
- Propose the development of wellness programs that encompass ergonomic considerations. These programs can include initiatives like yoga or stretching sessions, health seminars, and resources for maintaining a healthy work-life balance.
- **5.2 Conclusion**
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- The significance of ergonomics on productivity cannot be overstated, as research indicates a substantial influence on workers' satisfaction and efficiency in office buildings. Workplace ergonomics play a crucial role in determining occupants' productivity levels, with the potential to either enhance or hinder performance.
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- The paper primarily focused on white-collar workers, particularly regarding non-ergonomic furniture that contributes to discomfort, muscular strain, and musculoskeletal issues. Additionally, complaints extended to factors such as background noise, office layout, and circulation space.
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- In light of these findings, it is evident that ergonomics significantly impacts productivity in office buildings and in many workplaces. Therefore, it is essential to integrate ergonomic considerations into the design of office spaces to create environments conducive to optimal performance.
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- It is noteworthy that many organizations currently lack proper ergonomic structures, reflecting a need for greater attention to be given to incorporating ergonomic principles in the design and layout of office buildings.
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