

Wearable Technologies in the Workplace

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ABSTRACT

Wearable technology, once predominantly associated with step counters and fitness trackers, represents a new frontier in workplace innovation. From the Apple Watch to Google Glass, wearable technology is big in the consumer market and holds even bigger promises for boosting workplace productivity and employee health. In the workplace, wearable technology uses smart devices to monitor worker health, safety, and performance by tracking vital signs, fatigue, proximity to hazards, and location. Its benefits include increased safety, productivity, and improved worker well-being. They present an exciting opportunity for workplaces. They can streamline workflows, improve time management, boost overall productivity, provide stress management tools, improve communication and workplace safety, and increase job satisfaction. This paper aims to examine the impact of wearable technologies in the workplace.

KEYWORDS: *wearables, wearable devices, wearable technologies, immersive technologies, workplace.*

INTRODUCTION

According to the latest research of the International Labor Organization (ILO), 2.78 million workers die annually due to work and occupational accidents. Thus, the most critical priority for employers is to ensure high job security and safety for employees. Because working in an industrial environment is dangerous, accidents regularly occur in workplaces, and workers are injured. Mining, construction, agriculture, textile, manufacturing, and chemistry sectors are the places where the working conditions are the most difficult and the workers are exposed to the most dangers during the work process [1].

In an era where technology has seamlessly integrated into our daily lives, wearable devices have emerged as a powerful tool for enhancing productivity and managing stress in the workplace. These technologies, including smartwatches, fitness trackers, augmented reality glasses, and biometric monitoring devices, are increasingly being used by employers to enhance productivity, improve workplace safety, and monitor employee health and performance. Integrating wearables into the workplace equips individuals with tools to optimize

time management and task organization. Workplace wearable technology includes smart devices worn by employees, including glasses, hearables, helmets, sensor-embedded vests, exoskeletons, and wristbands that monitor movement, environmental conditions, biometric data, posture, and exposure to harmful substances through Wi-Fi, Bluetooth, and GPS [2].

WHAT IS WEARABLE TECHNOLOGY?

A wearable device is any device that is worn comfortably on the body and enables user interaction. It is typically integrated into the clothing or attached to the body of a person to enhance human performance. It often includes smart devices that can be worn on the body or attached to clothes. Wearable devices have been around for centuries. The first one was introduced in the 1660s by the Qing Dynasty. Since then the popularity of wearables has shifted from royalty to the healthcare industry. Wearable computing is a natural evolution of the smartphone technology that has become so ubiquitous and indispensable in education, business, and medicine. We wear wrist watches to know the time. Perhaps the most crucial bit of wearable tech accessible today is

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Google Glass. There has been a proliferation of wearables from consumer gadgets to medical devices that are approved by the Food and Drug Administration (FDA).

Wearable devices or systems are usually lightweight, miniature electronic or digital devices that are worn by a user, including clothing, watches, glasses, shoes, and similar items. A wearable computer is computer-powered device that is never-sleeping ever-present network-connected electronic system that can be used at anytime and anywhere and does not in any way disturb the user's interaction with the real world. It should be worn, much as eyeglasses or clothing are worn, and interact with the user [3]. It includes all manner of technology that is on or in the body such as fitness trackers, smartwatches, smart clothing, smart rings, smart glasses, wearable mobile sensors, smart jewelry, and smart ECG (electrocardiogram) monitors.

Wearables are always ready, unrestrictive, not monopolizing of user attention, observable and controllable by the user, attentive to the environment, useful as a communication tool, and personal devices [4]. Wearables are being used across healthcare, insurance, interactive systems, safety critical settings, wearable cameras, baby and pregnancy monitors, entertainment, fitness and sports, emergency responders, and military. Typical wearable devices are shown in Figure 1 [5]. Due to its wide range of applications, international corporations such as Google, Apple, and Intel are investing heavily on wearable technology research and development [6]. As with any new technology, one must exercise caution when using a wearable device.

A wearable device essentially consists of two different components: wearable and body sensors. It incorporates sensors, memory, solar cells, and batteries. It stays in contact with the body for extended periods of time. Traditional materials for wearables are mostly metals and semiconductors with relatively poor mechanical flexibility. Modern wearable technologies are characterized by body-worn devices, as smart clothing, e-textiles, and accessories [7]. Wearable devices can be used to collect various data to support a series of innovative applications. Today, wearable devices have numerous applications due to their integration with artificial intelligence. Wearable devices can be attached to shoes, eyeglasses, earrings, clothing, gloves, and wrist watches [8].

WEARABLE TECHNOLOGY IN THE WORKPLACE

The US Equal Employment Opportunity Commission (EEOC) has released new guidance addressing the

use of wearable technologies in the workplace. The issuance of the EEOC fact sheet was triggered by the growing use of wearable technologies in workplaces and concerns about potential discrimination stemming from the data these devices collect. By targeting a wide spectrum of industries in their guidance, the EEOC aimed to ensure that employers across different sectors understand the potential pitfalls and legal obligations associated with wearable technology. Employers and insurers must act now to align their practices with the EEOC's guidance, ensuring compliance and fostering trust with employees [9].

The workplace influences the safety, health, and productivity of workers at multiple levels. The multitude of workplaces come with their inherent distractions, risks, and dangers. Wearable devices enable constant monitoring of individual workers and the environment, whereas connected worker solutions provide contextual information and decision support. It is becoming increasingly common for employers, especially in the construction, manufacturing, and warehousing sectors, to outfit workers with wearable technologies worn on the body to improve worker safety and productivity. To enhance worker safety and monitor employee productivity, employers are increasingly relying on wearable technologies. Figure 2 shows some workers [10], while Figure 3 shows a worker with a immersive device [11].

APPLICATIONS OF WEARABLE TECHNOLOGY IN THE WORKPLACE

There are a broad range of employers across many industries that commonly use or are exploring wearable technology. Use cases for wearable technology in the workplace are being developed to monitor productivity, intervene on safety risks, provide instruction to improve task management, and facilitate health and wellness. The applications are seemingly endless, as few industries are without risk in the workplace. Common areas of application include the following [12,13]:

- *Workplace Safety:* Wearable technology represents a pivotal shift in workplace safety, providing real-time insights, enhancing communication, and preventing accidents. Safety wearables are incredibly beneficial to both employers and workers when appropriately used. Innovation in the workplace technology space has led to enhanced employee safety solutions designed to mitigate the risk of injury at work. Devices track heart rate, body temperature, and fatigue, sending alerts to workers and supervisors to prevent heatstroke, overexertion, and fatigue-related incidents. Wearables can monitor

employee movements and alert co-workers of danger, as well as monitor fatigue, body temperature and repetitive motion. In occupational health and safety, it is important to use personal protective equipment that reduces or prevents injury to employees during an accident. Figure 4 shows a user with wearables [14].

- *Worker Ergonomics:* Ergonomics is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. The role of wearable technology in ergonomics is to keep the human body as safe as possible from an ergonomic standpoint during work activities. This can be related to body posture, body position, weights and sizes of objects or parts being lifted, awkward work positions, and other various ergonomic aspects. An exoskeleton is a wearable device that supports and protects the wearer. Exoskeletons are one form of ergonomic safety technology. Devices enhance and support workers while other devices may simply just be implemented to help a worker maintain proper posture. Figure 5 shows a typical exoskeleton user [15].
- *Productivity Monitoring:* Protecting and improving the safety, health, and productivity of workers is paramount. Wearables contribute to increased productivity by automating tasks, streamlining processes, and granting workers immediate access to critical information. Employers use wearable tech to track productivity, health metrics, or stress levels to optimize workplace performance. Examples of wearable devices to monitor the productivity of workers include asset tracking and social behavior monitoring, augmented reality and virtual reality, gesture and motion control, and mental acuity, brain-wave sensing, and occupational stress management.
- *Health Monitoring:* Wearable technology plays a crucial role in enhancing worker safety by providing real-time data and insights that help prevent accidents and injuries. For example, a smart wristwear can issue alerts at signs of heat stress, while smart helmets are utilized to detect driver fatigue, thereby mitigating potential safety risks in mining companies.
- *Asset Tracking:* Rugged and lightweight wearables are indispensable for tracking assets and the workforce in warehouses, grocery stores, manufacturing sites, factory floors, field stations, and even the battlefield.

BENEFITS

Wearable technologies in the workplace have undeniable benefits. Wearables in the workplace can streamline workflows, improve time management and boost overall productivity. They now cater to time management, task prioritization, stress monitoring, sleep behavior and relaxation techniques, thus becoming indispensable tools in enhancing workplace efficiency. Other benefits include the following [12]:

- *Stress Reduction:* Stress is a pervasive factor that can hinder productivity. Wearable technology such as biofeedback sensors equipped with stress-monitoring capabilities and stress-relief tools offers users insights into their stress levels and guides stress-reduction techniques. Wearables analyze sleep patterns and real-time data to provide fatigue scores and identify peak strain times, enabling proactive interventions.
- *Efficiency:* Wearable technology will allow workers to process their tasks more efficiently. Wearables provide real-time feedback and statistics – thereby helping everyone in the workplace to identify areas where they can become more efficient. Data-driven insights into workflow and performance can lead to more efficient processes and optimized output.
- *Worker Well-being:* Monitoring health metrics and preventing fatigue leads to a healthier, happier, and more resilient workforce. Employees report that the smart glasses make their jobs easier and more intuitive, leading to higher job satisfaction. Healthier, happier employees mean greater productivity, fewer accidents, and a more resilient team.
- *Improved Communication:* Wearables have also changed how employees and customers communicate. Improved communication, safety, and productivity and tools that help to manage stress lead to increased job satisfaction.
- *Safety:* In companies all over the world, keeping workers safe involves always staying alert, adapting to changes, paying close attention, finding new solutions, and getting better all the time. The more a company understands the risks its employees face and comes up with ways to make those risks smaller, the better it is for everyone.

CHALLENGES

The usage of wearables raises critical questions about privacy, data accuracy, and potential bias. Some other challenges include costs, integration complexities, ethical concerns related to data privacy, potential discrimination, and the need for transparent policies,

especially regarding data use and consent. What is a sophisticated gadget that increases productivity for some is an invasion of privacy for others. Other challenges include the following [10,12,16]:

- *Privacy Concerns:* Privacy concerns pose a potential obstacle to the widespread use of wearables for workers. Monitoring devices can store data on employee physiology and movements, which may create privacy concerns. There are critical questions about what data is collected, who sees it, and how it is used, requiring transparent policies and consent. Consent alone does not absolve an employer from complying with laws. Wearable tech often collects sensitive data, such as health metrics or location information, which could lead to violations of laws like the Americans with Disabilities Act (ADA). The integration of wearables can also create employee morale issues if workers feel their privacy/confidentiality is compromised. Employees may perceive mandatory wearable programs as invasive or discriminatory, especially if the programs are not implemented transparently or equitably. Employers must not use wearable data in ways that adversely impact employees based on protected characteristics such as race, gender, religion, age (40 or older), or disability. For example, using health metrics to infer pregnancy or chronic illness and taking adverse employment actions is strictly prohibited.
- *Cost:* Financial considerations may impede widespread wearable deployment. The initial investment in wearable technology can be a significant barrier for some companies. Concerns with the costs of smart wearables in the workplace include initial investment and ongoing expenses for maintenance, training, and integration with existing systems.
- *Training:* Providing comprehensive training to ensure employees are familiar with smart wearables, minimizing the risk of improper use due to lack of understanding, and promoting positive behavior in their usage. Coaching, education, and training programs can help workers learn to appropriately use wearables and enhance the potential safety benefits.
- *Resistance to Change:* A key concern with adopting wearable technology in the workplace is employee acceptance and adherence to its use. Employee acceptance of wearable technology differs across use cases and is predicted by factors related to the organizational setting as well as employee characteristics and beliefs. Employees may have concerns about monitoring and data privacy, requiring clear communication and trust-building. Technology that is quickly adopted by some is met with resistance by others. Some employees would be willing to use wearable technology if it helped them do their job better.
- *Pressure to Participate:* Even when participation is technically voluntary, employees might feel pressured to consent due to workplace culture or fear of retaliation, such as being seen as uncooperative or missing out on incentives. Before companies can adopt the latest technology, they must have employee buy-in and be invested in its return.
- *Bias and Misuse:* Work with vendors to ensure wearable devices provide accurate data across all demographics and are free from bias. Training is needed on the risks of wearable technology misuse and how to handle sensitive information appropriately. The EEOC also warned of the risks of improperly using information from wearables.
- *Regulatory Compliance:* Companies must ensure their wearable programs comply with labor laws and data protection regulations to avoid penalties. Employers using information collected by wearable technologies must also comply with the nondiscrimination requirements of federal laws, which prohibits employment discrimination based on a protected characteristic, such as race, religion, sex, age, and disability.
- *Workplace Injuries:* Workplace injuries can have a major impact on businesses, causing a drop in productivity and often resulting in members of the workforce requiring long-term support for an injury sustained at work. Data-driven solutions allow for a more advanced level of protection for workers at high risk of workplace injury. Exoskeleton suits are increasingly being utilized in workplaces to help keep workers safe when carrying out high impact repetitive activities. These devices are particularly valuable in industries like manufacturing, logistics, and construction, where physical labor poses significant injury risks. Exoskeletons reduce physical strain, detect temperature extremes, and increase safety and efficiency, though initial costs and adaptability limitations may pose challenges.

FUTURE OF WEARABLE TECHNOLOGY IN THE WORKPLACE

Wearable technology products are advanced sensor and computing technologies that a person can wear on their body during daily activity to generate, store, and transmit data. Wearable devices have been around for

the past 50 years. They have come a long way from step trackers and smartwatches. Today, wearables are changing the game in industries from logistics to agriculture. They are becoming a normal practice in everyday life. They are actively enhancing workplace safety by addressing hazards and reducing the risk of injuries.

In today's modern world, more individuals are using wearable devices to help them stay connected, keep better track of their daily activities, and achieve their health, fitness, and overall wellness goals. With the latest developments in technology, wearable devices may emerge as a promising solution in the management of occupational health and safety in real working conditions.

The impact of wearables will touch every industry. Not long from now, wearables will be as ubiquitous as tablets in the workplace. As the costs of devices like smart helmets, biometric sensors, and augmented reality glasses continue to decrease, adoption rates are climbing. Wearable sensors will continue to evolve as technology advances and computing power increases. The future of wearable technology is astonishingly bright for both manufacturers/producers of this technology as well as for the actual users.

CONCLUSION

In today's technology-driven environment, the market for connecting everything to the local network or the cloud often focuses on wearable electronic devices that can report environmental and biometric data and detect security trends. While wearable technology promises to transform the workplace, its use can pose significant legal and operational risks if not managed properly. Productivity aside, many companies introduce wearable devices for health and wellness benefits. As workplace safety evolves, wearable technology is emerging as a tool that may help some employers improve workplace safety and return-to-work outcomes. More information about wearable technology in the workplace can be found in the books in [16,17] and in a related journal: *Applied Ergonomics*.

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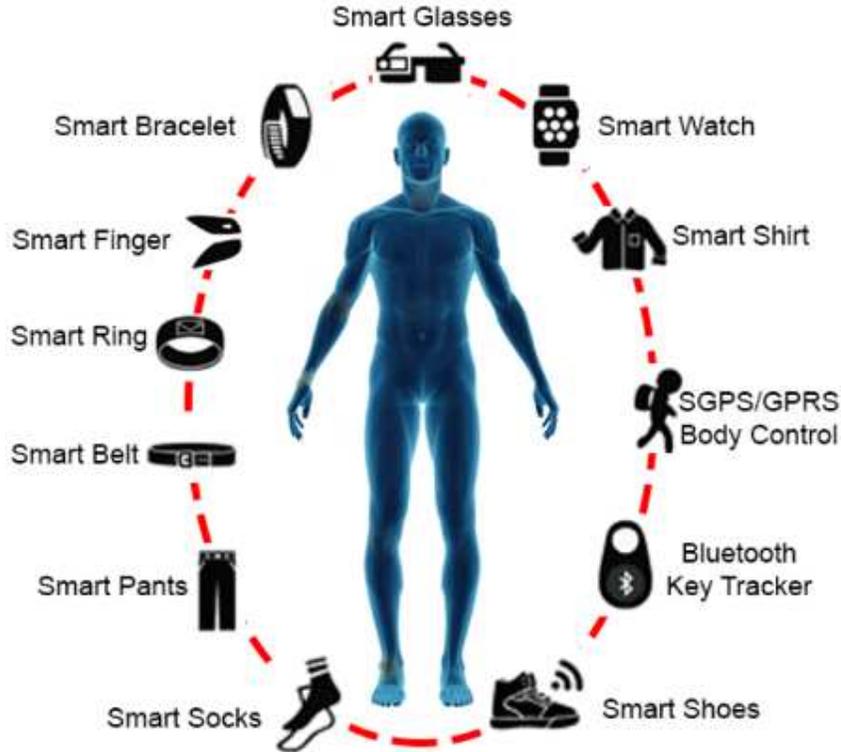


Figure 1 Different types of wearables on human body [5].



Figure 2 Some workers [10].



Figure 3 Worker with an immersive device [11].

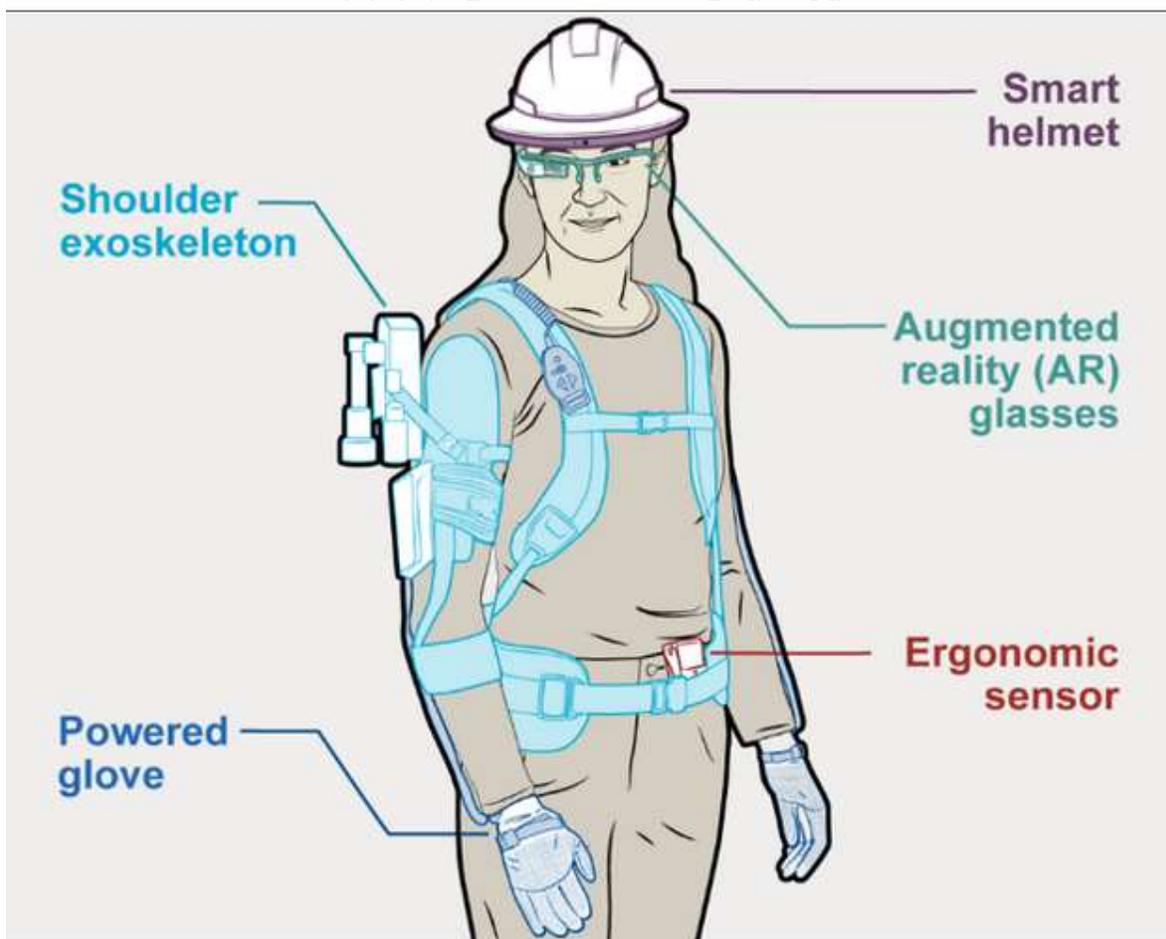


Figure 3 A user with wearables [14].



Figure 4 A typical exoskeleton user [15].