The New Normal in the Post-pandemic Workplace? A Meta-Analysis on the Use Cases and Implementation Challenges of Internet-of-Things Technology in Office Settings

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Abstract

While governmental tracing apps received special attention by research and the media during the Covid-19 pandemic, the surge in new work surveil-lance technologies went almost unnoticed. New organizational infrastruc-tures based on Internet-of-things (IoT) technology have emerged at both, public and private sector organizations, promising a safe return to the workplace but equally threatening the privacy of employees. The goal of this paper is to take a closer look at a technology with ambivalent use by conducting a meta-synthesis of extant IoT studies. We classify the literature into four use cases with their implementation options: physical health monitoring, mental health monitoring, environmental health monitoring, and connected workplace. We also discuss main challenges emerging from privacy concerns along the IoT data lifecycle for occupational health initia-tives in the office context. Based on that, we propose normative guidelines to assist employers interested in implementing privacy preserving IoT solu-tions for health and safety at work.

Keywords

Internet-of-Things, Workplace Surveillance, Future of Work, Meta-Synthesis

1. Introduction

Employees' productivity and efficiency are of central consideration in the public administration. Creating an adequate working environment for employees, or providing "digital ergonomics" is, therefore, the aim of employers wanting to be attractive for skilled workers and to improve the cognitive and emotional aspects of work [1]. As the public administration primarily unfolds in an office setting, the lack of physical activity caused by desk-based sedentary work contributes to an increased risk of obesity, diabetes, cancer, and cardiovascular diseases [2]. Also, excessive stress at work has been proven to lower work efficiency and, in some cases, lead to negative emotions and illnesses [3]. The exposure to an unhealthy indoor environment at work equally affects the employee's working performance, comfort, and health [4]. Consequently, employers have been continuously investing in digital solutions and interventions, such as, wearables or sensor networks for measuring movement, body temperature, heart rate, and other parameters for quantifying employees' well-being or detecting health and safety risks [5, 6].

The COVID-19 pandemic brought additional health challenges and required changes to the workplace. With increased number of cases worldwide, public and private organizations were obliged to shift work from office buildings to the home office and social distancing became the new norm to avoid the transmission of the virus. With the pandemic seemingly coming to an end, the demands of getting back to "normal" got louder and employers were required to take necessary measures and deploy tools to allow a safe return to work [7]. In addition to context-aware services that can ensure the respect of social distancing, the use of IoT is key for achieving such a cause. Chamola et al. [8] explain the role of wearables in COVID-19 impact management through detecting temperature, vital signals, and

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abnormal respiratory behavior. Also, Fitbit Care Ready for Work is one solution proposed to help employees make an informed decision about their return to the workplace through measuring key health metrics and temperature logging. This wearable aims at supporting their emotional and physical well-being through this global pandemic. Similarly, Mumtaz, et al. [9] have proposed an indoor air quality monitoring solution based on a sensor network to measure indoor contaminants to protect the health of employees from possible COVID-19 infection once they are back in the workplace.

Although the objective of IoT solutions is maintaining occupational health and safety, they are accompanied by privacy reservations from users, particularly employees [10, 11]. Employees fear that personal data from wearables is processed by the employer for other purposes, such as, performance appraisals or lay-off decisions [12]. Hence, employers are often faced with resistance and the lack of employee engagement. IoT initiatives require high investments in terms of technology and integration, and possibly a change of workplace design, which could result in negative return on investment if not accepted by employees [13]. A major obstacle is the knowledge gap among employers and employees about their essential rights and obligations concerning data collection and use [14]. Insufficient or unclear awareness about what is allowed or not allowed in data collection and processing often creates misunderstandings and ethical problems which can even lead to court disputes between employees and their employers.

With the number of IoT-enabled workplace health and safety initiatives raising, there is an urgent call for better understanding how such connected workplaces function. We, therefore, investigate the following questions: What are use cases of IoT technology implementation for occupational health and safety in office settings? and What are the challenges from a health data lifecycle perspective that these connected workplaces need to overcome? In answering these questions, we aim to provide an overview and propose guidelines for the implementation of IoT for occupational health that address main challenges discussed in the management of employee health data in the workplace. Through reviewing IoT initiatives aiming at improving office workplaces, we contribute to research in the IS field through theoretical knowledge on the meta-requirements for privacy preserving IoT design in occupational settings. For practice, we assist employers by providing an account of existing technologies and realization options as well as guidelines that respect the privacy of employees for successful implementations.

2. Background

2.1. Health Risks in the Workplace

The World Health Organization (WHO) emphasizes that the health of employees and workers are essential prerequisites for economic development [16]. Health risks at the workplace can cause occupational diseases that lead to reduced productivity and increased absenteeism, which negatively affect the business performance. To address the different possible health issues in today’s workplace, WHO urges companies to develop workplace health initiatives that allow them to monitor employees’ health and provide the necessary services [16].

In the specific case of office workers, previous research has highlighted several risks associated with the working behavior and environmental conditions for facility management that can affect the employees’ productivity. Office workers spend a prolonged period sitting at their desks, which is the main cause of occupational health problems [17]. Sedentary behavior and physical inactivity can increase mortality as well as the risk of certain diseases including diabetes, obesity, high blood pressure, and cardiovascular diseases [18]. Moreover, wrong seating postures lead to musculoskeletal disorders such as neck and lower back pains that can affect an employee’s health [19, 20]. While employees spend 90% of their time indoors, the environmental conditions in the workplace critically affect the employees’ well-being and productivity [21]. Sun et al. [4] explain that indoor air quality has a significant impact on the person’s health, comfort, and performance. Also, environmental conditions such as thermal comfort and noise can impact the individual’s blood pressure and stress levels, which affects concentration and productivity [21, 22].

Work stress and mental health are also important topics when it comes to occupational health. Not only because of the work arrangements but also with the increased pressure due to the fast-paced business environment [23]. Schneider and Kokshagina [24] explain that the digital workplace creates a pressure of constant connectivity and availability, which can result in technostress. Tamers et al. [25] illustrate that the blurred boundaries between work and personal life and constant preoccupation with work has become a major factor for work-family conflicts leading to stress and poor sleep practices. Moreover, Han et al. [3] emphasize that heavy stress might lead to depression and other health problems, such as cardiovascular diseases and musculoskeletal disorders.

2.2. IoT for Occupational Health

The technology landscape, to address the above-mentioned risks, is evolving rapidly. IoT technology provides solutions for monitoring behavior and environmental settings to improve occupational health and safety. Among the different IoT implementation options, wearables frequently represent the favored option of organizations [26]. These devices, including accessories (e.g., smart watch and sociometric badges) and smart clothing can record physiological and environmental parameters in real-time, perform analysis to the data, provide insights to the users and allow for immediate interventions as preventive measures for the targeted health issues such as physical inactivity [27]. Moreover, sensor networks are commonly used to detect and monitor ambient conditions for achieving quality of the working environment and allowing remedial actions [22, 28].

Yassaee et al. [29] identify opportunities for IoT technology in the workplace through the affordance lens, they explain that such initiatives can help in detecting and preventing root causes for certain health issues, and in mitigating health risks. They also mention that introducing IoT into the workplace can help employees be more conscious about their health and proactive in terms of actions. However, the implementation of health initiatives in the workplace remains challenging. First, integrating IoT solutions requires considerable investments in technology and personnel [13], which increases its criticality. Second, the use of IoT technology is always accompanied by privacy concerns as it often trespasses the boundary between monitoring online and offline behavior during work time but also outside working hours (e.g., while commuting or at home). The use of wearable devices and sensor networks for continuously tracking and monitoring employees is considered to be a major privacy concern [11, 30]. Due to the sensitive nature of health data, many employees have serious doubts about participating in company-sponsored (or mandated) health and well-being initiatives.

3. Methodology

Meta-synthesis is a novel method that is becoming more popular in research areas outside medicine [31]. It allows the combination of results from qualitative studies to synthesize theoretical knowledge on a specific domain of research. Based on Siau and Long [32], the general procedure of the meta-synthesis involves: First, selecting a group of studies related to a defined research problem. This includes the definition of the research question(s) and the relevant literature to be synthesized. Second, synthesizing translations of the studies. This includes reviewing the literature, identifying relationships and patterns within the collection of studies. Finally, expressing the overarching synthesis through classifications or categorization to postulate or advance theoretical knowledge for further development in a research domain. Accordingly, we perform a meta-synthesis of the existing studies on IoT initiatives for occupational health in office settings. This approach allows us to have an overview of the domain to understand the existing implementation scenarios and associated challenges. Based on that, it enables us to build reference knowledge on the topic from a design perspective and support successful future implementations in practice. More specifically, we aim to summarize the existing knowledge on IoT initiatives for occupational health and safety by formulating a set of use cases, which explain different implementation scenarios. We then identify associated challenges in the data management process generated with IoT solutions and suggest relevant guidelines for privacy-preserving future implementations.

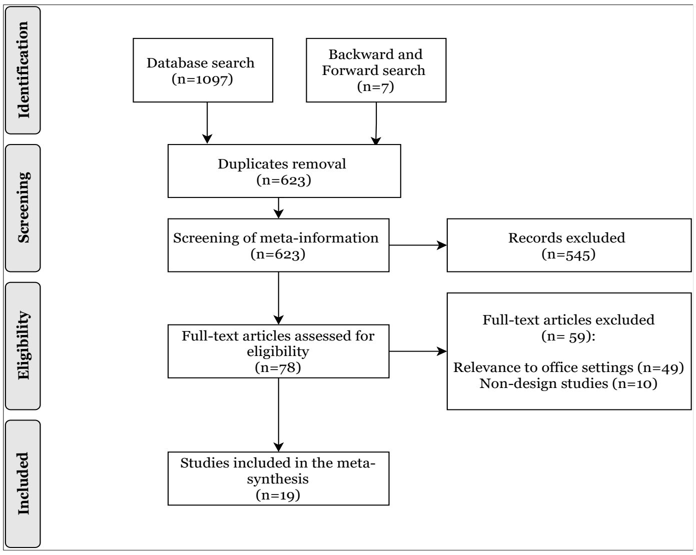

Figure 1: Systematic approach for studying the extant literature.

To identify and select relevant studies, we performed an electronic search in the AIS Electronic Library, EBSCOHost, ScienceDirect, and SpringerLink. We then performed a search in Google Scholar to identify missing papers from different fields. The search criteria were based on the following keywords: ("IoT" OR "Internet-of-Things") AND "occupational health" AND "workplace" AND "privacy" AND "design". The literature search, using backward and forward search, resulted in 1104 articles (Fig 1). After removing duplicates and screening the meta-information including title, abstract, and keywords, 78 publications remained. After reading the full text, we eliminated 46 publications that were not concerned with office environments but with the general workplace context including factories and construction sites. We also eliminated publications that do not demonstrate the design of an IoT solution, but rather discuss the user perceptions on such initiatives in the workplace as a predictor for intentions to use. The final list includes 19 articles on the different IoT initiatives for occupational health and safety in office environments.

In the second stage, we reviewed the literature to identify relationships and synthesize findings. For that, we performed qualitative content analysis [33]. To classify the use cases on IoT technology in office settings, we followed an inductive approach. We coded the literature based on the following elements: the purpose of IoT initiative, devices used, and data types collected. This allowed us to categorize a study in a defined use case or to develop a new use case if new coding schemes were detected. We followed a deductive approach to analyze the existing challenges associated with the implementation of IoT initiatives. Our main focus here was the data management process of employee data. As IoT data is considered to be part of the big data realm, we opted for an analysis framework that targets big data management to detect challenges related to the four stages of the data lifecycle, that is, data collection phase, data storage phase, data processing and analysis, and knowledge creation [34]. Our analysis provides information on the challenges specific to the IoT context in an organizational setting. These challenges are the basis for developing recommendations for the successful implementation of the IoT solution. We, thus, used the synthesis of existing studies for formulating guidelines that should assist organizations interested in implementing IoT for health and safety reasons in doing it in a reasonable, efficient, and ethical manner.

4. Use Cases of IoT in the Context of Occupational Health and Safety

4.1. Physical Health Monitoring

Physical health and well-being are important for improved office worker productivity. The majority of the studies (10) focus on physical health monitoring of the employees, either through addressing physical inactivity/sedentary behavior or wrong postures that cause musculoskeletal disorders. For these types of studies, most implementation scenarios rely on wearables attached to the employee's body.

In the sub-category of physical inactivity and sedentary behavior, the aim is to measure employee's activity in the workplace to detect prolonged sitting times on the desk, which is a major cause for chronic diseases. For that purpose, pedometers [2] or accelerometers [13] are typically used to count steps or measure speed of motion to assess activity data and suggest corrective actions. Gorm and Shklovski [2] and Glance et al. [35] suggest a workplace physical activity intervention through the use of activity trackers for well-being. In a similar manner, Nair et al. [18], Gomez-Carmona and Casado-Mansilla [36] as well as Huang et al. [13] propose to use activity trackers to reduce sitting time. Synnott et al. [37] suggest an alternative solution for detecting physical inactivity by means of using sensor networks (e.g., a thermal sensor above the employee's workstation to sense presence or absence) instead of activity trackers.

The second sub-category aims at assessing posture for protection against musculoskeletal disorders that affect the employee's productivity. For that, wearable correction sensors are used to detect wrong postures for neck, head and back movements [19, 20, 38]. Another implementation scenario involves the use of smart furniture for detecting posture discomfort [17]. Such devices allow a tactile feedback signal (e.g., vibration) as an intervention mechanism for correcting posture.

4.2. Emotional Health Monitoring

Besides physical well-being, mental and emotional health are an important area of concern for occupational health initiative using IoT. Emotional health monitoring is crucial for detecting occupational stress or burnouts that can affect the health of employees and compromise the quality of work in the long run. For that purpose, wearable devices are distributed among employees that enable the measurement of biomedical data including heart rate and body temperature for estimation of emotional levels. Han et al. [3], Zenonos et al. [39] and Stepanovic et al. [40] illustrate how wearable wrist bands can help in supporting emotional health by measuring physiological indicators for mood recognition or for detecting stress.

Another sub-category for this use case is the monitoring of the emotional and psychological state of employees for a healthier lifestyle. For this purpose, Fugini et al. [41] illustrate a scenario of a sensor network linked with a video camera for capturing facial expressions and processing posture and hand gestures as well as audio sensors for speech recognition to assess the employee's state and provide suggestions for healthier habits based on the analyzed data.

4.3. Environmental Health Monitoring

Another use case of IoT technology in the workplace is environmental health monitoring. Providing optimal environmental conditions in an office setting is important to achieve thermal comfort. This is necessary to have a well-suited ambient environment that allows focusing and productive work. Rabbani and Keshav [42], van der Valk et al. [43], and Nižetić et al. [44] all focus on measuring ambient conditions including temperature and humidity sensors for detecting abnormalities and optimal settings. There is also a possibility in such implementations to use wearables [43, 44] to obtain a metabolic reaction to detected discomfort and provide insights on corrective measures as supporting evidence. However, the focus here remains the monitoring of the work environment.

4.4. Connected Workplace

The previous use cases target specific purposes and employ defined technologies for measuring certain data points to achieve their goal. The "connected workplace" use case is a combination of all the different use cases that enable monitoring of physical, emotional, and environmental health at work. This use case relies on a combination of technology options including wearables and sensor networks for this purpose. Bhatia and Sood [45] and Benhamida et al. [46] envision the connected workplace as a smart office with hybrid technology involving wearables and an inclusive sensor network to combine multiple information on the physical, emotional and environmental conditions to promote a holistic approach to well-being and safety at work. Thus, addressing physical activity and sedentary behavior, avoiding wrong postures, stress detection and environmental comfort based on the type of data to be processed.

Table 1: Overview of Use Cases of IoT for Occupational Health and Safety in Office Settings.

Use Case	Purpose	Study	Device	Data collected
Physical Health Monitoring	Physical Inactivity/ Sedentary Behavior	[36]	Wearables	Pedometer (Steps count) Distance
		[2]	Wearables	Pedometer (Steps count)
		[35]	Wearables	Pedometer (Steps count)
		[13]	Wearables	Accelerometer
		[18]	Wearables	Accelerometer
		[37]	Sensor network	Thermal sensor
	Posture/ Musculoskeletal disorders	[20]	Wearables	Neck movement
		[38]	Wearables	Low-back movement
		[19]	Wearables	Head movement Neck movement
		[17]	Smart chair	Seat surface sensor, backrest sensors
Emotional Health Monitoring	Stress detection	[39]	Wearables	Heart rat, skin temperature, acceleration
		[3]	Wearables	ECG sensor: impedance pneumography, accelerometer, body temperature sensor, photoplethysmography sensor
		[40]	Wearables	Heart rate, blood oxygenation, skin temperature, skin blood perfusion, respiration rate, heart rate variability, blood pulse wave
	Emotional and psychological state	[41]	Sensor network	Frontal face camera, profile face camera, speech and voice body pose (images), hand gestures (images)
Environmental Health Monitoring	Thermal comfort	[42]	Sensor network	Temperature, occupancy
		[44]	Sensor network + Wearables	Metabolic rate, air temperature, relative humidity, level of carbon dioxide
		[43]	Sensor network + Wearables	Metabolic rate, air temperature, mean radiant temperature air speed, humidity
Connected workplace	Multiple	[46]	Sensor network + Wearables	Ambient light intensity, background noise, amount of phone calls, computer built-in camera (e.g., eye gaze), smart devices
		[45]	Sensor network + Wearables	Data about health (temperature, blood pressure, heart rate, vital signs), data about environment (cleanliness, room temperature, noise, oxygen level, toxic waste), data about meals (nutritional value, quantity), data about movement (pedometer, accelerometer)

5. Implementation of IoT Technology in Occupational Settings

Through our analysis of the different IoT solutions in office settings, we were able to determine a set of challenges that employers face in their implementation. These challenges stem from the employees' privacy concerns related to "big brother" work surveillance practices that aim to collect, store, and process their data [47]. This data-based management ideology can result in excessive data collection and an illusionary sense of control, which ultimately leads to a climate of distrust, fear, and cynical employee attitudes [26]. As shown in Fig. 2, we will now proceed to analyze each phase of the data lifecycle: data collection, data storage, data analytics, and knowledge creation. This will be our basis for proposing guidelines (derived from our synthesis of the different use cases) in response to each data-related challenge identified.

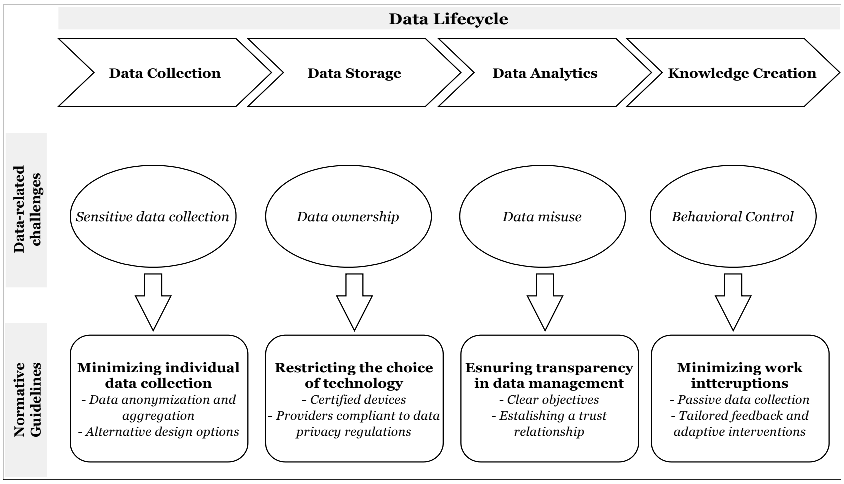

Figure 2: Data-related challenges and corresponding normative guidelines.

5.1. Data Collection

The use of IoT technology in the workplace involves the collection of data from different sources. IoT devices allow companies to collect data about online behavior (e.g., screen time) and offline behavior (e.g., location). Sensitive data collection is of major concern when implementing IoT initiatives at work. In fact, IoT generates a large volume of data and allows collecting personal data, which is frequently not work-related. Solutions for physical and emotional health monitoring involving data collection from wearable devices, where the individual can be identified, are considered the most critical. Data collected indicate health information that might be problematic in certain situations and are considered private. Gorm and Shklovski [2] explicitly explain that activity tracking and collection of health information has been a matter of concern for privacy advocates. In their study, they highlight that employees chose not to participate in health initiatives involving the use of wearable devices since they understood this information to be private and feared that organizations scrutinized the behavior and outcomes of their work activity in ways they do not want to. Moreover, emotional health data on stress levels and mood are strictly sensitive information. Therefore, employers should pay attention to the privacy management of all the data collected from sensors used for emotional health purposes [3, 40]. On the other hand, data about environmental conditions collected from temperature or thermal sensors could be considered less problematic [42, 43].

As a response to the data collection concerns, we suggest solutions that minimize individual data collection. While the type of data and its sensitivity are critical aspects, the most convenient option involves data anonymization and aggregation as observed in most studies. This guarantees that the data collected is not identifiable of the individual employees and is used in anonymous matter. Due to its importance to users, Stepanovic et al. [40] derive meta-requirements for data visualizations of wearable solutions to add a new level of granularity that captures group levels in the specific case of stress detection. They illustrate how new indicators could be derived at an aggregated level to communicate generic information that can be useful in devising corrective instructions for the workforce. In addition, certain studies promote alternative design options for specific design objectives that require less interactions and collection of sensitive data. These studies suggest using IoT solutions that can be considered less intrusive and are specific to the workplace context only. For example, Synnott et al. [37] suggest the use of thermal sensors for detecting movement and detecting physical inactivity in contrast to the common use of wearable devices that entail the collection of sensitive and personal information for the same purpose [2, 35]. Also, Lo Presti et al. [20] and Zaltieri et al. [38] promote the use of novel wearable devices in the workplace that embed fiber grating sensors for posture correction and could be also used for measuring vital signs to detect physical activity or potentially stress levels. In addition, Roossien et al. [17] provide a comprehensive solution that is relevant to the workplace context using connected but fixed sensor devices instead of wearable sensors, in that case a connected chair that enables the detection of sedentary behavior and wrong posture. These studies demonstrate alternative objective design options that could be safely used to meet the desired objectives of health initiatives and address the different concerns associated.

5.2. Data Storage

Once the data is collected, it is stored for further preparation and processing. A major topic when we discuss this phase in an IoT initiative is data ownership. Who owns the data collected? Is it the employee (as the data object and owner)? Is it the employer? Or is it also the manufacturer or service provider of the technology used? Does an informed consent from an employee qualify for exploiting the data in all possible ways? These are important questions that the enterprise should be able to answer. This is especially the case when we have scenarios with off-the-shelf wearable devices [2]. While some companies would provide the devices to their employees, other companies might ask their employees to use their own private devices (e.g., smartwatches or Fitbits). Once the owner is identified, the data treatment and management practices are identified. That is, the data transfer protocols use, storage and access. In fact, the regulations that will be applied greatly rely on this piece of information. In addition, with the blurred lines between the use of wearable devices in private and professional lives, the ownership of this data remains a dilemma. Stepanovic et al. [40] raise an important issue with the use of wearable devices, where there exist measurements done outside of working days. In their study on work-related stress, the elimination of these data points sounds logical. While the type of data collected from wearables (including activity data, physiolytics and location) can be considered sensitive, entities in possession of this data have an advantage and can eventually process it in combination with other personal data to create user profiles for different purposes – whether occupational or commercial.

Once data is collected by the IoT device, the employer should plan for an appropriate technical architecture that is trustworthy and that guarantees the safety and integrity of data. It is critical then to aim for a sound choice of technology. Previous studies emphasize the importance of using validated (certified) sensor technologies and wearables (e.g.[38], [42]). The devices should be tested for security and privacy, and the algorithms used should be compared against benchmark algorithms that ensure privacy management of the collected data [3]. Whether these devices are owned by the company or the employees, the employer should only allow devices from providers that function in compliance with the data privacy regulations to ensure proper data management and treatment [41]. This means, they should provide secure options for data transfer and storage, as well as guaranteed encryption as a rule for individual privacy. A promising technology choice was suggested by Bhatia and Sood [45] and Benhamida et al. [46] for the connected workplace, the Fog-Cloud. It is described as a “highly virtualized platform that provides compute, storage, and networking services between end devices and traditional Cloud” [45]. It is specifically relevant to the IoT scenario as it relies on edge decision mechanism, that is, the data is processed at the edge of the network where it is collected. Thus, the user has the option to filter and transform the data before sending it to the Cloud, which ensures privacy of user data and eliminates ownership concerns.

5.3. Data Analytics

Following the collection and storage of IoT data, analytics are applied to generate insights. While the main purpose of IoT initiatives is supposed to improve the health and well-being of employees, the possibility of the data misuse or being used for other purposes than initially agreed upon is a matter of concern for both, employees (e.g., worried by possible measures their employer can introduce against them) and employers (e.g., fearing improper re-use and data breaches of device manufacturers). As a result, data misuse is often perceived to be a major concern in this phase. The large volume of data generated by IoT devices entails different types including sensitive data that is not necessarily related to the use case. Fugini et al. [41] explain that the use of IoT technology in the workplace has the potential to capture the employee’s behavior. As mentioned earlier, activity tracking data could infer certain work behavior not only for health purposes, including absence/presence and working time at desk. Sensor networks can additionally be used for facial expression detection, voice recognition, and vital signals, which can be indicators of actual and mental workloads. As shown by Synnott et al. [37], collecting data about occupancy can be considered problematic as it can also infer absence/presence at work. In short, there exist legitimate concerns that these technologies are extended and used for surveillance purposes rather than for improving health and well-being only.

The most important aspect when we discuss IoT initiatives is transparency in managing the data and analytics generated from it due to potential risks. The objectives for using the IoT technology in the workplace should be clearly stated and communicated by the employers. Therefore, the scenario or the purpose of using IoT for occupational health should be transparent. We have discussed earlier a list of use cases and their IoT implementation options, which can be helpful in designing the future workplace. It is critical to note here that the technology put in place should aim to provide insights and improve the work life of the employees rather than monitoring and preventing unwanted behavior. Through achieving that, employers can ensure the employees' compliance and use of the system invested in. Transparency is also a method for establishing a trust relationship among employers and employees, to minimize concerns of data misuse. Based on that, we have observed in the literature that involving stakeholders in the design of the IoT initiative or system can be beneficial in achieving this trust. For instance, Huang et al. [13] derive meta-requirements for a suggested IoT solution to avoid sedentary behavior. Their results are based on participatory design through involving different stakeholders. Also, having group challenges is one way to promote health initiatives as suggested by Glance et al. [35]. These types of initiatives require the participation of a large group of people to achieve desired goals, which are identified at the beginning of the challenge. The use of such approach can mitigate the privacy concerns of individual users as they are voluntarily signed-up and the objectives are clearly communicated to participants.

5.4. Knowledge Creation

Analytics applied on IoT data generate knowledge that is important in taking precautions and counteractions for protecting the health of employees on different levels. However, the exposure of health information and work behavior are facilitators for employers and third-party discrimination acts. As mentioned above, data can be potentially misused for performance monitoring to justify dismissals, salary negotiations and promotions [11]. Accordingly, behavioral control becomes a critical topic in this last phase of the data lifecycle. Although these initiatives can be useful in improving health and safety [18, 35, 36], it can be seen as a pathway to behavioral control through nudging and interventions imposed on the employees who somehow lose their freedom and do not have the choice anymore to decide on their reactions to certain events. All these considerations become more and more critical with the discussion of the connected workplace where data is collected in an integrated manner and for the different purposes [45, 46], as discussed previously.

Finally, a critical aspect in the implementation of IoT initiatives is the feedback mechanism provided to employees as a result to the knowledge created from the data analytics. Our analysis of the studies resulted in a final guideline which suggests minimizing work interruptions as much as possible. This proposition is closely related to the previous two when it comes to data collection. Benhamida et al. [46] promote the use of non-intrusive designs that do not affect the employee's routine. These designs combine passive data collection using technologies surrounding the employee such as sensor networks or connected digital devices. This is an important point in determining how users interact with the system and how their concerns are formed based on this interaction. In terms of feedback, studies have focused on the necessity for automated tailored feedback through adaptive interventions that are also non-intrusive to the work routine. These interventions should provide information to the employee regarding his state and recommend improvements and deliver useful feedback without controlling the employee's behavior. The employee is then left with the choice to react without pressure from the employer or fear of discrimination. Stepanovic et al. [40] demonstrate the role of individual data visualizations in providing informative feedback that can be used for corrective behavior. Other studies, such as Huang et al. [13], derive meta-requirements for the feedback process and illustrate the importance of visual feedback that is non-intrusive and that provides flexibility for reaction. Gomez-Carmona and Casado-Mansilla [36], and in accordance with Huang et al.'s requirement for social comparison, demonstrate how social recognition and gamification can play a role in user acceptance and participation. Their initiative comprised a feedback mechanism that is accessible to all employees in the form of a smart mirror, which proved to be an effective solution for engagement.

6. Conclusion

Our meta-synthesis provides an overview of the implementation options as use cases of IoT technology in office settings. Based on the analysis of major concerns along the data lifecycle, we derive guidelines that can support the implementation of future scenarios. Our guidelines aim at addressing these challenges through normative knowledge. They target the data practices and use concerning the implementation of IoT initiatives. Companies need to take a responsible and active role in reflecting about what is reasonable and ethical when implementing IoT-enabled occupational health initiatives. Instead of reacting in case of problems, proactive behavior and reducing unnecessary risks would lead to less resistance. While we highlight different implementation options for the same purpose, we conclude that there exist alternative designs that minimize the collection of individual data for each use case. These options should be considered and further tested to assess their reliability. We also emphasize that technology choice is a critical aspect as it controls the consequent data treatment process and can mitigate data ownership concerns. In fact, there exists a triarchy of roles with respect to data management for the discussed use cases involving employees, employers, and service providers. The responsibility and rights of each role should be clearly specified and further discussed for future implementations. Moreover, we highlight the importance of transparency through clear objectives and data management practices in establishing a trust relationship in the workplace among employees and employers.

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