Worker Well-Being, Safety, and Productivity on Construction Sites

Protecting Data Privacy in Response to Data Breaches

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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The Four Problems in The Construction Industry

Currently, there are four significant problems within the construction industry which involve: productivity, safety, environment effects, and worker-wellbeing.

Over the past few decades, even with the widespread use of computer technology, productivity in the construction industry has not improved at the same rate as in other industries. Specifically, the global annual average labor-productivity growth for construction has been 1 percent over the last twenty years. Meanwhile, the productivity growth of the world economy has been 2.8 percent. This problem is more apparent in the United States as construction productivity is at the same level as 80 years ago (Barbosa et al., 2017). Additionally, the construction industry continues to be one of the most unsafe industries in the United States. In 2020, there were 1008 fatal occupational injuries in the construction industry which was approximately 21 percent of total worker fatalities that year (United States Bureau of Labor Statistics, 2021). While there was a decrease in construction-related worker deaths compared to 2019, construction is still the industry with the most deaths by a significant margin. Even with vast advancements in technology, the slow evolution of the construction industry has resulted in little to no improvement in both productivity and safety.

Two other significant problems within the construction industry are associated with worker well-being and the environmental impacts caused by construction. Construction can affect noise and air pollution in areas surrounding the site (Environmental Pollution Centers, 2022). Air consists of particulate matter and/or volatile organic compounds (VOC) becoming airborne caused by construction activities, such as demolitions. Construction activities that use heavy machinery, such as excavation, cause noise pollution. Both types of pollution affect both workers' health and the environment. Exposure to on-site air pollution can increase workers' risk

of respiratory infections, heart disease, and lung cancer (World Health Organization, 2019). Meanwhile, noise pollution can lead to hearing loss, lost productivity, and stress-related illnesses (United States Environmental Protection Agency, 2015).

Workers have viewed their well-being as being neglected within the construction industry for a long time. Their viewpoint is one of the factors that has led to significant rates of alcohol and substance misuse (ASM) among construction workers (Flannery & Oyegoke, 2019). In the construction industry, 16.5 percent of workers reported past month heavy alcohol use and 14.3 percent reported past year substance abuse disorder, both almost double the overall industry averages (Bush & Lipari, 2015). Additionally, males in construction have the second highest suicide rate for industry data at 45.3 per 100,000, considerably higher than the average for males in all industries at 27.4 (Peterson et al., 2020). Factors that have influenced these rates include worker perception of not being valued, site conditions being hazardous, and mental strain (Flannery & Oyegoke, 2019). These high rates show that there is a worker well-being problem within construction that needs to be addressed.

An on-site monitoring system can address the four problems concerning worker productivity, safety, well-being, and the environment using different devices. This paper will continue describing the technical aspects of an employee monitoring system and then investigate employee privacy concerns arising from the collection of their data within the monitoring system, specifically the security of health data.

On-Site Construction Monitoring

With the advancement in smartwatch technology, smartphone apps, and other sensor-based technology, employee monitoring systems are becoming more widespread to improve productivity in the workplace. However, there are other factors besides productivity that a monitoring system for construction should track, such as safety, worker health, and environmental quality. Our team will design components of the system architecture for Hourigan, a construction company, that will monitor the Contemplative Commons project site across Central Grounds Garage. The architecture of the system, called a Connected Worker Solution is depicted in Figure 1, collects data from sensors and other wearable devices, communicates the data to the edge gateway where it is processed, sends it to the cloud hub for storage, and then has a central dashboard to view data (Patel et al., 2022).

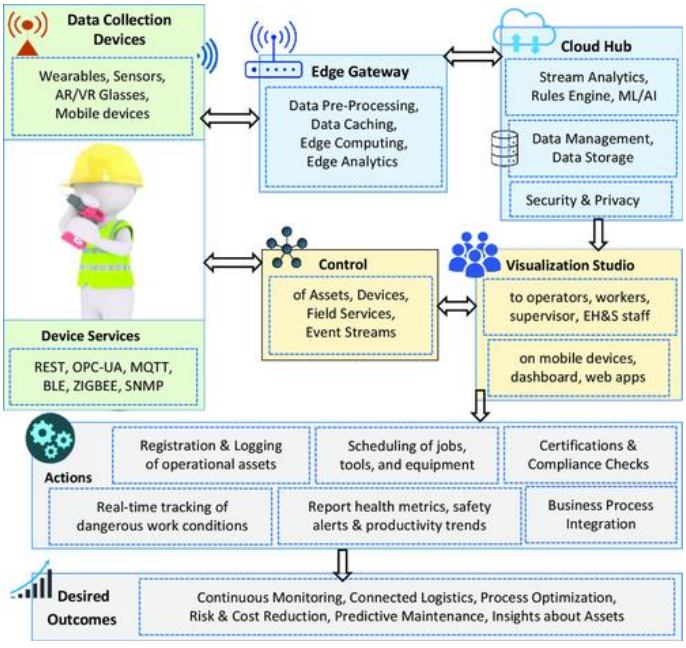

Figure 1. Architecture of Connected Worker Solution (Patel et al., 2022)

The designed components our team will deliver are a list of the data collection devices, their locations on site, and the user interface design for the visualization studio. Once our team chooses the devices, we will deploy the network of sensors, and our team will collect and analyze data to validate the system. Once validated, Hourigan can address the four problems previously discussed.

First, the monitoring system will aid in tracking the construction site's environmental effects. The sensors will track particulate matter less than 10 micrometers and less than 2.5 micrometers (PM10 and PM2.5), VOCs, and noise identifying the environmental impacts. The sensors will provide continuous real-time information on air and noise pollution in indoor and outdoor areas of the project site. Second, cameras and wearable devices, such as smartwatches, will monitor safety. Cameras enable project supervisors to ensure safety measures are followed at all times via surveillance footage. Additionally, cameras will help identify any unauthorized personnel that has entered the site, enhancing the security of the site. Smartwatches can track changes in the user's body temperature, in this case, the workers. This will increase on-site safety by lowering the risk of temperature-dependent injuries. Smartwatches may also help identify accidents through heart rate monitoring since a worker's injury will cause a spike in heart rate due to the activation of the fight or flight system (La Rosa, 2020). The monitoring system will improve response times to safety incidents as well as identify potential safety hazards more efficiently.

Third, monitoring using cameras and location tracking equipment and machinery will improve productivity. Tracking equipment will decrease the time spent by workers searching for equipment or materials, thus increasing productivity. Cameras will help track project progress

continuously and identify construction activities that are not being done efficiently. From this identification, project executives can make changes to increase productivity. Lastly, smartwatches will monitor worker well-being. This will directly address the workers' viewpoints of not being valued while also identifying instances of alcohol misuse. Both resting heart rate (RHR) and heart rate variability (HRV), which is the measure of the fluctuation of time between heartbeats, can be monitored using smartwatches. Typically, lower RHR and higher HRV are signals of better health, performance, and recovery. A study found that for every subject, their highest RHR and lowest HRV value in a week occurred after alcohol intake, with that value being an outlier for most subjects (Koskimäki, 2019). Additionally, some smartwatches can detect signals associated with stress. Thus, health monitoring can identify workers that have potentially abused alcohol or have mental health issues. Employers can then get these workers the help they need. Ultimately, If the monitoring system is successful in addressing the four problems, then the client, Hourigan, may decide to deploy similar systems on future sites and projects.

Privacy Concerns and Pervasive Monitoring Technologies

The primary human dimension of this project involves the relationship between the employer, Hourigan, and their employees and hired subcontractors. With a worker monitoring system, there will be employee privacy concerns about the data that is collected and how it is used. While there are protections in place for workers' privacy rights, privacy is primarily covered by case law which tends to favor employers, especially when involving monitoring devices owned by the employer (Nwosu, 2022). This may lead to the employer abusing this power and monitoring their workers extensively, invading their privacy. Additionally, health data

monitoring, such as heart rate monitoring, may reveal greater detail about the overall health of the employees (Ajunwa, 2018). Employees may not know this when they first consent to have a device like a smartwatch track their heart rate. Monitoring may also lead to discrimination based on how the employer uses the data. For example, an employer may monitor a specific group of employees more than others (Turner, 2016).

Multiple studies have investigated how specific employee privacy concerns affect their attitude toward monitoring systems. For example, Carpenter et al. (2018) looked into how the three concerns of perceived employee accountability (PEA), perceived employee vulnerability (PEV), and employee distrust (EDT) affect employee attitudes toward biometric data being collected for authentication technology. PEA is the employees' view that they will be held to more stringent standards when monitored using biometrics. PEV encompasses how much the employees believe their biometric data is at risk. Lastly, EDT entails the concern that employers will use biometric data for unintended reasons. The study found that concerns about PEA and PEV were associated with a negative attitude toward the biometric system while EDT did not have a significant effect (Carpenter et al., 2018).

The second study is based on Communication Privacy Management (CPM) theory which argues there is a private information boundary created when individuals pick and choose what information of theirs, they disclose and to whom (Petronio, 1991). Boundary turbulence occurs when there is disagreement on what information should be disclosed in a relationship which often affects the trust in the relationship. With employee monitoring, boundary turbulence may occur when employers and employees disagree on what employee data should be collected. They investigated how information boundary concerns affect trust in employee monitoring. They found that concern about the organizational infringement (COI) and perceived amount of

monitoring (PAM) significantly reduced trust in employee monitoring policy (TEMP), and only COI significantly reduced trust in employee monitoring members (TEMM) (Chang et al., 2015). COI can consist of privacy infringements which is why it reduces trust. PAM affects TEMP because employees may get uncomfortable when they perceive the policy as excessive.

Privacy concerns have led to the development of new methods to secure collected data. Yang et al. (2020) presented an enhanced differential privacy system for student health monitoring using smart wearable devices. Differential privacy is a process where information about a dataset is shared by describing patterns within the data and not individual data points. The proposed method adds extra shielding to the data to ensure no important information is leaked. This protection occurs during the transmission of data from the app connected to the smartwatch to a database for storage. This new method supports Pinch and Bijker's social construction of technology (SCOT) by showing how students, the social group, affect the technology of a socio-technical system.

Pinch and Bijker (1984) theorized SCOT by looking at the evolution of bicycle design and how it was affected by the needs of different groups, such as women and race cyclists. SCOT states that technology evolves from social groups rather than scientific advancements. This is due to interpretive flexibility, which means that different groups may have different meaning or interpretations of technological artifacts (Pinch & Bijker, 1984). Resulting in diverse user groups having different needs and problems with the technology, which ultimately leads to distinct technical solutions. For example, women had a dressing problem with the high-wheeled Ordinary bicycle resulting in a new bicycle design with pedals on the same side (Pinch & Bijker, 1984). Thus, a specific problem arises for a social group with the existing design technology, which results in modifications of that design to solve the problem. Closure in technology arises

when interpretive flexibility diminishes creating stability in the technological artifact. Two closure mechanisms Pinch and Bijker (1984) describe are rhetorical closure, which results when social groups view their problems being solved by the new design, and closure by problem redefinition, in which a design that has its conflicts can be stabilized by solving a different or new problem.

SCOT can be applied to describe the sociotechnical relationships of a monitoring system, specifically the student health monitoring system discussed in the Yang et al. (2020) study. For that system, the students are the social group, and the problem is that current smart wearable devices do not have secure enough data collection and transmission due to limitations in size and wireless communication being susceptible to data interception. Thus, there was concern about the vulnerability of students' data, so the proposed method addresses this problem and increases their data security.

Employee concerns with monitoring systems primarily involve the security of their data that is collected, as previously mentioned. Thus, SCOT can also be applied to these concerns about data collection and storage, that may have led to other improvements in data security. For example, data breaches show there is a problem with the current methods of data storage. Therefore, those methods must be improved in order to ensure employee data security.

Research Question and Methods

With the monitoring system collecting health data of employees, there must be careful consideration by the employer on how to ensure the security of the data, which is already a significant concern of employees. As digital data storage became more popular around the turn

of the century, external data breaches became more prevalent and more significant. For example, 79 percent of breached records between 2010-2017 were from network servers, and in this same timeframe, the number of breach reports increased every year except in 2015 (Mccoy & Perlis, 2018). Thus, data security has risen in importance. Ultimately, this arises to the question: How have data breaches affected the way in which companies collect & store health data? To answer this question, I will perform a historical analysis of how companies responded to health data breaches

Specifically, I will look at four different health data breaches since 2010 and assess them using Wairimu & Fritsch's (2022) modified PRIAM assessment method. This method describes the harms and effects of data breaches by considering the scale of victims, the irreversibility of the harm caused, and the type of harm done. The method provides a severity score for physical, financial, psychological, societal, and dignity harm contributing to the total severity of the privacy harm done. Once I have described the event, I will analyze the response to data security by the company that was involved with the breach. I will compare these responses and see how they have changed over time.

Conclusion

The construction industry has long had four problems concerning stagnate productivity, low safety, negative environmental impacts, and poor worker well-being. The components of the monitoring system architecture that our team will design will address these problems by identifying potential instances of them arising. This will give project supervisors insights about what is occurring on-site, allowing them to make decisions that can improve productivity, safety,

environmental effects, and worker well-being on-site. Ultimately, this system has the potential of saving thousands of lives and millions of dollars.

With the monitoring system collecting different data on employees, such as their health data, privacy concerns will arise. By researching how companies have responded to health data breaches, potential methods to protect health data can be found. These methods can then be applied to the monitoring system to increase data security, preventing future data breaches.

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