Understanding Construction Employee Responses to and Interactions with Wearable Technologies to Facilitate Their Integration in the Construction Industry

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2023

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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Introduction

Construction is an inherently dangerous industry. The industry was responsible for the largest number of worker deaths of any industry in the US in 2015 (*The Construction Chart Book*, 2018, Figure 38a.) and, according to the Occupational Safety and Health Administration (OSHA), deaths on construction sites are most likely to be due to incidents involving falls, an individual being struck-by something, electrocutions, and an individual being caught in or between something (*OSHA Quick Card: Top Four Construction Hazards*, n.d.). These data show that the industry is fundamentally broken and in need of repair. This need becomes even more pressing when one considers the expected future growth of the industry. According to a Marsh & GuyCarpenter and Oxford Economics report published in 2021, it is thought the construction industry will be worth $15.2 trillion by 2030 (p. 5), while the U.S. Bureau of Labor Statistics suggests that, between 2021 and 2030, a growth of 4% is expected in the construction and extraction industry workforces (*Construction and Extraction Occupations*, 2022). Based on this data, it is clear that there are significant issues related to worker safety in the construction industry and multiple research teams argue wearable technology has the opportunity to improve worker safety (Lee et al., 2017; Awolusi et al., 2018). However, the question of what is the best way to implement wearable technology remains.

Steven Jackson's framework of repair provides a basis for understanding how the technology implementation process can function within an industry. In his work "Rethinking Repair" (2014), Jackson suggests that the creation of new technology can and perhaps should be motivated by an intent to repair existing technologies and systems, as opposed to exclusively focusing on creating something new. Jackson (2014) then provides a specific definition of repair describing it as "the subtle acts of care by which order and meaning in complex sociotechnical

systems are maintained and transformed, human value is preserved and extended, and the complicated work of fitting to the varied circumstances of organizations, systems, and lives is accomplished" (p. 222). This definition of repair shifts the focus of technology development from viewing humans and human behavior as a problem in need of solving, to an asset crucial to the development of effective industry systems.

Jackson's conceptualization of repair provides a framework for the implementation of wearable technologies in the construction industry that addresses existing safety issues, while empowering individual employees. First, I introduce the current state of wearable technologies in the construction industry: what they can do, how they need to be used, and the factors that shape their use. Then, I conduct a historical analysis of the trucking and Amazon warehouse industries through the lens of repair, as these industries share important similarities with the construction industry and represent interesting case studies. I use Jackson's framework of repair to show that technologies cannot be ethically introduced when their implementation focuses on "fixing" workers themselves, as opposed to repairing the systems designed to support both workers and entire industries. Finally, I conclude that the implementation of wearable technologies in the construction industry should be designed to support safety goals, while utilizing the expertise of workers and construction managers.

Literature Review

Some researchers argue that wearable technology should be introduced into the construction industry because it can be used to improve worker safety, health, and well-being. Lee et al. (2017) note, "By leveraging wearable sensors and regularly obtaining data at the individual level, we could eventually explain how effectively and positively a worker's physiological reactions can change [their] job demands as well as safety and productivity

performances" (p. 351). This argument has even been demonstrated quantitatively through the work of Okpala et al. (2021) who developed a success model which showed wearable devices have the potential to provide benefits to construction workers related to improved safety and health. Awolusi et al. (2018) emphasize the importance of the integration of wearable technology, specifically stating, "it is time construction stakeholders and professionals strongly embrace these emerging trends in technological development to drastically enhance safety performance" (p. 104). This evidence shows that wearable technologies can provide tangible benefits to the construction industry and that there are strong motivations to implement these technologies.

The implementation of these technologies however is not a simple task and for the benefits of wearable technologies to be realized by all stakeholders, technology must be used properly. In their 2017 paper, Choi et al. describe that individual workers must effectively use and value wearable technology for the impact of those technologies to be completely realized (p. 32). This presents a complex problem for construction managers given the challenges presented by both the technologies themselves and challenging conditions and work tasks that are present on a construction site every day.

Additionally, the cultural features of an industry deeply shape worker responses to and opinions of various technologies. Choi et al. (2017) note that assumptions related to whether a technology would help the worker complete tasks, potential impacts to an individual's privacy, and how an individual's peers react to a technology all impact how an individual reacts to a piece of technology (p. 40). Writing specifically about trucking, Levy (2016) notes that due to the masculine culture of the industry, there is a particular resistance to the introduction of

surveillance technology, because it directly impacts and limits that masculine culture. Levy's work shows how a specific industry's culture can directly impact technology acceptance.

Given the relative newness of wearable technology within the construction industry and that the technology is yet to be widely implemented, it is useful to look other industries that have already implemented similar technologies to understand those industries' successes and failures. In this paper, I will analyze technology implementation in the trucking industry and at Amazon warehouses. The construction and trucking industries shared similar cultures as shown by Levy's description of the trucking industry above and researchers' identification of construction work as an "occupation [that] is socially marked as masculine" (Duke et al., 2013, p. 293). The construction and Amazon warehouse industries share a similar intense focus on satisfying customer demands. A 2021 *Washington Post* article quotes a previous Amazon vice president quoting former CEO Jeff Bezos saying "'we have always wanted to be Earth's most customer-centric company'" (Greene), while major US-based general contractors like Clark Construction and Whiting-Turner note on their websites "we build with the intention of exceeding our clients' expectations for safety, quality, functionality, and aesthetics…" ("A Tradition of Excellence", 2023) and "we constantly strive to exceed each client's expectations through innovation, collaboration, and best practices" ("About Us", 2023) respectively. Developing an understanding of what has occurred in these industries can be used to better understand how the implementation of wearable technologies could occur in the construction industry.

Methods

To analyze this question, I will use secondary sources like journal articles, news articles, and industry publications to understand the processes of technology implementation in the trucking industry and the Amazon warehouse industry. Specifically, I will research the history of

the development of tracking systems, the evolving opinions of drivers related to tracking systems, and the industry motivations behind introducing tracking systems in the trucking industry. Related to the Amazon warehouse industry, I will research the implementation of wearable technologies, motivations for their introduction, and worker opinions of these technologies. This data will be considered using a historical analysis to find examples of repair as defined by Jackson being implemented in these industries and to understand what impact the integration of repair into technology implementation has on the success of technology implementation from the perspective of all involved.

Analysis

The motivations behind the development of the technologies that support industry systems profoundly shape both the success of the industry itself and the experience and value of the individuals who work within that industry. When considering what is "broken" within an industry system, it is easy to focus on the failures of human actors and consider how technology can be used to curtail and control the actions of people. However, a focus on control can lead to system that disregards the importance and value of human experience and skill, ultimately harming both individual employees and entire industries. Jackson's (2014) definition of repair provides a different framework for issue-motivated technology development, arguing that when repair is conducted "human value is preserved and extended" and "the complicated work of fitting to the varied circumstances of organizations, systems, and lives is accomplished" (p. 222). A focus on "fixing" people as opposed to systems does nothing to extended human value and does not allow systems to account for the nuanced challenges present in many industries.

Recent reporting detailing the use of surveillance technologies at Amazon warehouses demonstrates the harm caused by designing a technology meant to improve a worker as opposed

to enhance their capabilities within a system. In a 2022 *Vice* article, reporter Laura Gurley notes "Amazon tracks and records every minute of "time off task" (which it calls TOT) with radio-frequency handheld scanners that warehouse associates use to track customer packages". Given that many warehouse positions require constant use of the hand-held scanner (Gurley, 2022), it functions as a wearable device designed to constantly track employee performance. Gurley also describes an Amazon rule that required managers in an Amazon warehouse to use data collected by the scanners to determine which of their employees spent the most amount of time off task and ask that employee about every instance they were "off task" (2022). "[Internal Amazon documents] also indicate that Amazon uses surveillance footage to corroborate employees' claims about their whereabouts" (Gurley, 2022). This system is example of a company using a wearable-like technology to attempt to control workers. According to a former Amazon vice president paraphrased by a *New York Times* reporter: "Company data showed that most employees became less eager over time, he said, and Mr. Bezos believed people were inherently lazy… That conviction was embedded throughout the business, from the ease of instant ordering to the pervasive use of data to get the most out of employees" (Kantor et al., 2021). This statement suggests a company culture of assuming that the worker is doing something wrong and that it is the worker themselves who are in need of fixing, as opposed the system designed to support the work of employees being the focus of repair as Jackson's framework would encourage.

The introduction of electric logging devices (ELDs) into the trucking industry is another example of the introduction of a technology intentionally shifting an industry system towards an emphasis on control of workers. Prior to the introduction of ELDs, truck drivers were required to keep paper logs of their hours driven, and these logs were supposed to be kept to ensure that

drivers were not violating federal regulations related to how long they were allowed to drive (Levy, 2015, p. 163). However, paper logs could be relatively easily falsified, allowing drivers to drive for longer time periods than they are supposed to (Levy, 2015, p. 163). ELDs are "monitoring devices… integrated into the trucks themselves… that create a record of the hours the truck is driven … and largely automate the functions served by paper logs in efforts to curtail unsafe practices" (Levy, 2015, p. 163). Levy questions the industry decision (a combination of companies and regulators) to use on-board surveillance technology to ensure truck drivers are adhering to rules related to how long they are allowed to drive and how long they must rest given drivers' primary motivation for staying on the road longer than they should is the industry pay structure. (Levy, 2023, p. 42-43) This rigid control of drivers using ELDs prevents them from using their expertise to effectively work within the industry system, while also not repairing what is broken in the industry (Levy, 2023, p. 48), creating an application of technology that directly conflicts with Jackson's concept of repair

The use of technology to create systems that focus on the control of human actors, instead of creating systems to support employees has negatively impacted both the Amazon warehouse and trucking industries. According to reporting by Kantor (2021), there is worry among leaders at Amazon that their existing systems of managing workers will cause them to not be able to staff their warehouses in the near future. After ELDs began to be required in long-haul trucks, instances of crashes involving these vehicles increased, because drivers felt increased pressure to adhere exactly to rules related to driving hours and drove less safely to ensure time requirements were met (Levy, 2023, p. 50-51). These examples show the dangers of "human value [not being] preserved and extended" and not "fitting to the varied circumstances of… systems" (Jackson, 2014, p. 222) as Jackson describes is necessary for repair. In the case of the Amazon warehouse

industry, Greene (2021) quotes "'the system doesn't recognize the human part of people, like, 'I'm having a bad day,' or 'I'm having a tough time at home,'' said Hamilton, who has worked at Amazon's Shakopee, Minn., warehouse for four years," showing the negative impact on both individuals and an industry a company's disregard of human value can have. In the case of the trucking industry, ELDs specifically limit the opportunity for truckers to adapt to changes in variables that appear in their work. Jackson's concept of repair provides a framework for considering technology implementation that could prevent the missteps that appeared in the trucking and Amazon warehouse industries.

Examples can also be found in the trucking industry of stakeholders considering how technology can be implemented in a manner that, instead of exclusively enforcing rigid rules, allows workers to utilize their expertise to improve industry function. While the initial implementation of electric logging devices (ELDs) was questionable as discussed in previous paragraphs, recent research on the regulations that govern the use of ELDs concluded that both drivers and the industry as a whole (due to increased efficiency) would benefit from greater flexibility in the regulations that govern drive time and rest time, because drivers could rely on their expertise to avoid congested areas. (Short, 2018, p. 30) This type of approach to problem solving within the trucking industry is much more in line with Jackson's concept of repair, because the solution focuses on developing a system that better supports workers and allows workers to utilize their expertise.

It might appear that this difference in how an industry might implement technologies is too minor to be impactful, but, in reality, the above examples show the prominent impact this nuance can have. In fact, I expect the impact of implementing wearable technologies within the construction industry using Jackson's framework of repair might be even more impactful

because of the value of experience within the industry. Even in my limited experience working on construction sites as an intern and visiting sites as a student, it has been clear that the success of construction projects is absolutely dependent on individuals on-site using their personal experiences and expertise to solve unexpected problems. What is written on the plan sheets rarely, if ever, exactly matches the conditions present in the field, meaning it is often up to the employees who find the problem to find a solution, or to find the person on-site who has seen this problem before and knows how to fix it. Similar observations appear in literature, with Chan (2016) noting "the successful delivery of construction projects depends on the ability of different specialists to collectively put their respective expertise to work" (p. 472). While maintaining a safe environment on a construction site is of the utmost importance, the construction industry will not be able to function as efficiently if wearable technologies designed to improve safety performance function on a fundamental distrust of employees and do not allow them to use their experience. Jackson's framework of repair provides a method for creating a technology system that could increase construction industry success, both by improving safety and maximizing employee contributions to work.

Conclusion

Luckily, the Amazon warehouse and trucking industries can provide guidance on how technology can be implemented in a manner that adheres to Jackson's definition of repair. According to Gurley (2022), "Amazon warehouse workers… say they don't have insight into how much TOT (time off task) they've accumulated, and have said they skip water and bathroom breaks because they fear being disciplined and terminated", showing that a major issue in Amazon warehouses was data transparency. This suggests that any wearable technology implementation strategy should include clear explanations of the purpose of the devices and

employee access to data. In the 2007 edition of a yearly report published by the American Transportation Research Institute called “Critical Issues in the Trucking Industry”, on-board truck technology was ranked as the tenth most critical industry issue and the report noted, “many respondents remain concerned that on-board technology systems have not been adequately tested to evaluate real-world economic and safety benefits” (p. 11). This suggests that a technology should not be implemented on a large scale till it is well-tested and its benefits and risks can be clearly shared with employees. Both of these suggestions adhere to Jackson’s definition of repair, because they emphasize the importance of individual employees and their value and allow for the integration of nuance into the implementation of wearable technologies.

The recent histories of the trucking and warehouse industries show that success can be found in the implementing of new technologies by using those technologies to solve problems in a manner that adheres to Jackson’s definition of repair. As was shared in the introduction, construction is a dangerous, but constantly evolving industry and opportunities are quickly becoming available for construction managers to address safety issues using wearable technologies. While the potential positive impact of these technologies is exciting, the potential for these technologies to have a negative impact on the lives and work of construction workers cannot be understated. This work provides construction managers with a path forward for the implementation of wearable technologies that asks they view the implementation of these technologies as a method of repair within the construction system.

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