

Smart Sensor System in Enhancing Construction Site Safety Management

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Abstract

The Smart Sensor System is a derivative product that executes in the concept of the Internet of Things (IoT). It is anticipated as an effective way to collect, identify, and process information, sensor-based technology is deemed to provide a new generation of methods for advancing construction safety management. Since Malaysia's construction industry has faced a vital issue due to the high frequency of construction accidents over the years, the smart sensor system is recommended to be implemented in improving the construction site safety management. It makes the real-time construction safety management with high efficiency and accuracy a reality and provides a solid foundation for facilitating its modernization, and informatization. This paper aims to analyze the potential of the Smart Sensor System in enhancing the construction site safety. This research utilized the qualitative method by interviewing experienced professionals, as safety officers and an Information Technology (IT) engineer. The result shows that the smart sensor has high potential to be implemented in the construction industry for site safety management while minor improvement and enhancement need to be carried out in minimizing error risk, coverage, and cost performance.

Keywords

Internet of things (IOT), smart sensor system, site safety, construction management

Introduction

In the 21st century was a blooming era for every sector of industries, not to mention the construction industry that developed a lot in the past 100 years. One of the most significant changes in this industry is construction sectors were no more a site full of cement, sand, and bare hands, whereas in the present days, construction is all about computers, machinery, and including the Internet of Things (IOT). Internet of Things (IOT) is referring to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines (GSMA Association, 2014).

The construction job site is now a ripe fruit and complex to accepting any fundamental changes (“Official Website Department of Occupational Safety and Health - Introduction,” n.d.).

International Conference on Innovation and Technopreneurship 2020
Submission: 4 September 2020; Acceptance: 17 September 2020



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Construction technology is no more a strange word among this industry, more and more technology was introduced and invented not just for construction productivity whereas covers almost every aspect throughout the construction stages, like 3D design modeling, safety management, smart monitoring site, etc. (Nichols, 2020).

Sensor-based technology or system in construction can be widely defined as the Smart Sensor System, which is the concept of combining both hardware and software to achieve and carrying out their task given. In practice, these two factors of Smart Sensor system are connecting and interlinking to each other to function, however, with deeper researches and developing, after nearly two decades of development, sensor-based technologies have facilitated the transformation from experimental exploration to practical applications (Zhang et al., 2017).

The development of sensor-based technologies carries high potential and possibilities in the industry. Do not underestimate what a sensor system can do. In many circumstances, sensor-based technology can serve as data collection, transmission, and processing tools, this is a foundation and basic concept of IOT in construction technology. The application of sensor-based technologies can benefits construction in many ways, starting from site controlling to safety management, this technology can do much more works than a normal site inspector did (Bremer et al., 2017).

With the rapidly growing rate of construction activities, more and more workers, labor becomes the key to production and essentials for such a fast rate of development in this industry. According to reliable data from the Occupational Safety and Health Administration (OSHA), nearly 6.5 million people work at approximately 252,000 construction sites across the nation on any given day (OSHA, 2019).

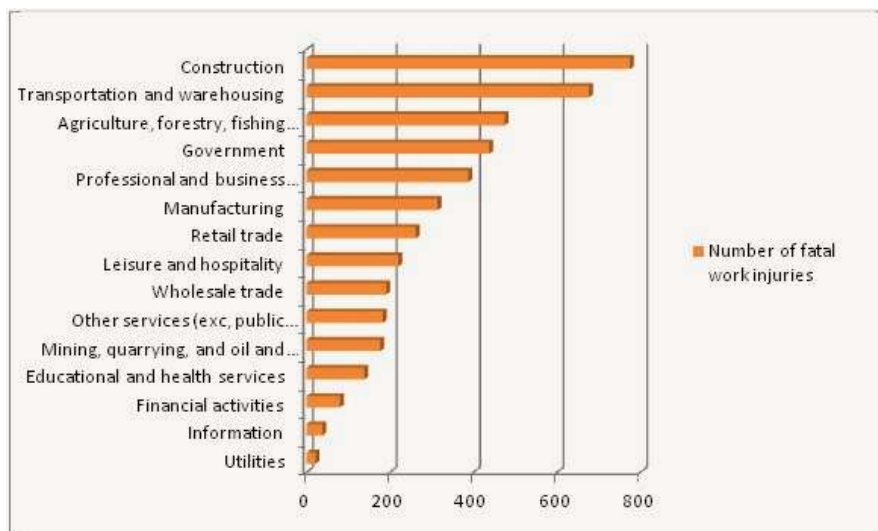


Figure 1. Number of fatal injuries in different sectors (Ayob et al., 2018)

Despite the high worker's quantity in the construction industry, the average fatal accident rate of this industry are relatively higher than in other industry else. This is an unhealthy scenario and malady to be found out in the industry. The construction industry is now facing a huge problem with the high frequency of site accidents. All site-involved workers are deemed to be exposed to a

hazardous working environment. From a simple road construction site to a complex few hectares construction site, every site carries a high risk of site accidents to have occurred. Fatal accidents may happen in the corner of each site, falls from height, collapse, electric shock, failure to use proper personal protective equipment, etc. are some of the highest rates of death among fatal accidents. In Malaysia, hectic construction sites like Selangor and Johor Bahru becoming the most common hot spot with almost 45% percent of the total fatal accident rate in the peninsula Malaysia (OSHA, 2019).

Fatal site accidents similar to this occurs in the construction site at a worrying rate in this sector. This clearly shows us a good scenario of the absence of an effective way of securing a site accident. A way to prevent is there, by manual calculation of joint strength and pressure test from time to time. However, it was still far away from an effective method. A manual calculation has its shortages and logically, pressure tests are sure cannot be run 24 hours a day (Ayob et al., 2018). Hence, the main question for all site workers is how to take care of and secure the safety of a working construction site effectively and perfectly.

With the problem that is yet to be resolved above, this research is focused on the application of an IOT based Smart Sensor System during the safety and accident precautions management on the construction site. The success of this Smart Sensor System can be defined as a relevant and effective way in which a secure fatal accident occurs in a construction site.

Methodology

To achieve the aim and objectives of the study, a qualitative research approach has been adopted. The respondents of this study are the professionals in the construction industry, such as engineer, contractor, site safety officer, and also the expertise in sensor-based technology. The interviews were conducted to define the overview from expertise on the application and implementation of the smart sensor system in the construction site safety management. The results are analyzed by comparing the responses from respondents. The discussion is made according to the feedbacks that appeared to be similar among the interviewees, yet for the conflict and discrepancy in opinions, those will be considered and becomes issues encountered related to Smart Sensor System or safety management system that will be further discussed and analyzed.

Results and Discussion

The results collected from the interviews are analyzed and interpreted accordingly to achieve the research's objectives. The interviews were conducted to three (3) respondents who had been selected due to their expertise and also relevant to the construction site safety management. The background profile of respondents is listed in Table 1.

Table 1. Background Profile of Respondents

Description	Respondent A	Respondent B	Respondent C
Designation	Engineer (JKR)	Safety Consultant (CIDB)	Electrical Engineer (Malaysia Internet of Things Association)

The Function of Smart Sensor System in Creating a Safety Construction Site

The application of a smart sensor system for safety management is always one of the parts that being neglect in the Malaysia construction industry. The interviewee A and B responded that the safety degree and awareness across sites of the construction industry in Malaysia are still poor. The safety awareness across the site is still weak among this industry, which proves why the accident rate is the highest among all the industry (OSHA, 2019). Table 2 shows the responses from the respondents towards the application of a smart sensor system in the construction site safety management.

Table 2. The Responses of Smart Sensor System in Construction Safety Management

Description	Respondent A	Respondent B	Respondent C
Degree of Safety	Weak	Weak	-
Causes of the low safety degree	The small project does not hire safety officer, Limited fund allocation at safety part of a project	Less awareness among construction worker, The untrained worker on site	-
Degree of Familiarity (toward safety management)	Limited	Yes	Expertise
The functionality of the smart sensor system	Not necessary	Yes	Yes
Potential of the smart sensor system (to be implied on)	Pressure sensing, underground water detection	Accident forewarning, hazard identification	Radiofrequency detection, data transition system, the precise positioning technique

The respondent A identifies that the majority government project tends to neglect or not emphasize the safety part of the project. Usually, small projects with a total contract sum not exceeding 5 million will not involve the hiring of safety officers as the hiring cost could be a form of extra burden for the contractor. This scenario is mainly caused by a limited fund allocation of a project that becomes the key to why safety management cannot be armed effectively in a project (Ayob et al., 2018). The respondent B mentioned that despite there are countless courses and training sessions held by respective authorities like CIDB every year, there are still many unauthorized workers that tend to be permitted by a contractor to enter the site without any safety

knowledge and training. This causes why this much of safety education being imposed, the awareness on the practical side is still weak.

The Workability of Smart Sensor System for Site Safety Management

The respondents agree on the statement of there are tons of tendencies and opportunities available in Malaysia for the implementation of the smart sensor system in practical uses. Whereas, respondent B specified that the tendency of application of smartphones and further exploited their features to build interactive platforms for construction safety management.

There are quite a several ways to promote, which includes the support from government and relative authorities, hire smart system expertise consultant, or even financial support infrastructure project that may require startup funds for implementing this system, organizing safety training and education; and through the continuous testing and design phase.

Table 3. The Workability of Smart Sensor System for Site Safety Management

Description	Respondent A	Respondent B	Respondent C
Tendency to implement	Yes	Yes	Yes
Barrier and improvement	Lack of knowledge, Lack of financial support, Lack of expertise consultant	Reliability	Wearable size, Cost-performance ratio, Minimize error
Ways to promote	Government implementation and support	Compulsory education and training session	Continuous improvement and development in technique

Conclusion

In conclusion, different parties in the construction industry stand a different point of view on the topic of safety management smart sensor systems. Actively seeking the exploitation and exploration in various fields of sensor-based technology application is one of the current development trends in construction safety management to meet with what is needed in the industry by every party involved. In another way of speaking, the smart sensor system is just like all the IoT products, their tendency is not just limited in this industry, whereas even manufacture sectors, financial sectors, etc. standing a chance to implement this system

Acknowledgments

The authors would like to express gratitude to INTI International University for giving full support and encouragement towards this research.

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