

## **The Potential of Implementing Smart Personal Protective Equipment (PPE) To Minimize Work Related Injuries in Construction Sites**

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### **Abstract**

Construction accidents has earned a bad reputation along the years even with personal protective equipment (PPE) provided on site. Wearable technology has become more common nowadays for preventing workplace injuries, ensuring level of safety in the workplace. Smart personal protective equipment (PPE) refers to PPE that connects to the internet and other devices like software or tablets to deliver real-time safety information. Hence, the aim for this research is to study the possibility of implementing smart personal protective equipment (PPE) in Malaysian construction industry. The findings show that majority of respondents are aware of construction accident, smart PPE are better in reducing injuries than conventional PPE and respondents are willing to implement in their company if Smart PPE is available in the market and the cost is reasonable.

### **Keywords**

Smart PPE, workplace injuries, construction industry, implementation of Smart PPE

### **Introduction**

Hoffman and Novak (2015) define smart products as “those which are able to communicate with humans by sending and collecting data through internet connectivity that are stored and monitor in a database server”. Smart products are combination of mobile and wireless technologies to expand opportunity from traditional product boundaries to advance functionality, higher utilisation and better reliability for users. These smart products consist a combination of sensors, hardware, microprocessors, data storage, software, and variety connectivity (Porter and Heppelmann, 2014). They are reshaping industry boundaries and creating entirely new industries.

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Wearable technology has become more common in many industries for preventing job site injuries and ensuring level of safety in the job sites (Adjiski et al, 2018). Smart personal protective equipment (PPE) refers to PPE that connects to the internet and other devices like software or tablets to deliver real-time safety information. Smart PPE not only minimizes exposure to hazards, but also collects data, sends notifications, and automatically adjusts to internal and external conditions (Ca0,2013).

Most Smart PPE connect to other devices via Bluetooth. Through this connection, Smart PPE are able to detect risk in real time (Barro-Torres et al, 2012). Other than its original usage of protecting labour from physical hazards, it also collects data on surrounding workplace condition, worker body movements, notifies worker of possible prevention or improvement regarding the surrounding condition or positioning.

Benefits of Smart PPE include the following ; real-time detection and monitoring of hazardous and strenuous factors (such as noise, exposure to toxic chemical substances, optical radiation and high or low temperature), monitoring worker's health condition and stress level (e.g. breathing rate, heart rate, galvanic skin response, body temperature, etc), geographical localisation of workers with regard to potentially dangerous machinery, objects or high-risk zones, providing safety warnings and instructions to workers in case of any hazardous situation, environmental sensors embedded in clothing can monitor gas, chemical, heat, sound, ultraviolet radiation, impact, etc. and alert supervisors if workers are in trouble. (Podgórski, 2017).

On the other hand , there are also challenges in implementation of Smart PPE; contractors in are indifferent towards the performance between Conventional and Smart PPE, resistance to change, lack of user knowledge, performance and financial risk, and high purchasing / maintenance cost (Guo et al,2017).

The aim for this research is to study the possibility of implementing Smart PPE in Malaysian construction industry. Three objectives are set as a guideline for this report; to assess the benefits of implementing Smart personal protective equipment (PPE) in construction, to analyse the potential of Smart personal protective equipment (PPE) able to minimize work related injuries, and to evaluate the challenges of implementing Smart personal protective equipment (PPE).

## **Methodology**

The target respondents for this survey are the construction Safety Officers in the state of Selangor. The questionnaire was designed via online survey approach with close ended questions which was the Google form and results collected saved in Google Drive Data Storage. The results are displayed in simple pie charts, bar charts and histograms for discussion.

## Results and Discussion

A total of 250 sets of questionnaires were distributed to Safety Officers working in construction industry in Selangor and 60 respondents replied to this survey. The survey utilized Likert Scale in ascending order from 1 to 5, where 5 being the highest weightage and 1 is the lowest.

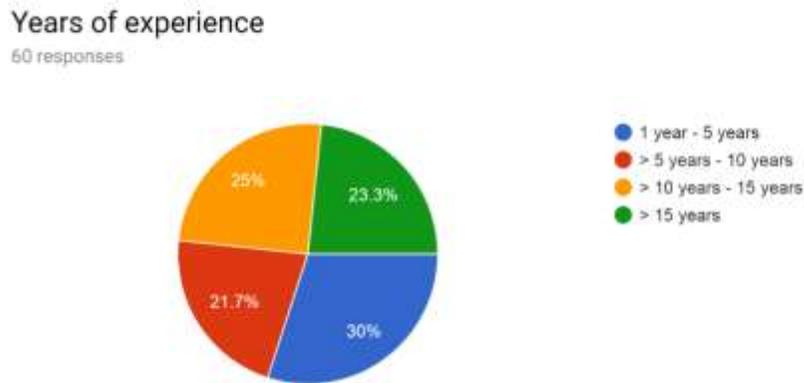


Figure 1. Working Experience

Figure 1 indicates that 23.3 % of respondents have more than 15 years of working experience whilst those with more than 10 years and less than 15 years' experience comprises 25%. This totals up to 48.3% of the respondents having more than 10 years of experience which implies that overall the respondents are fairly experience.

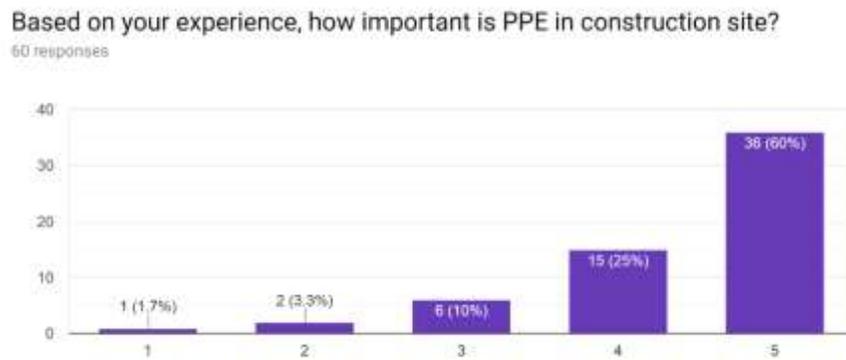


Figure 2. Importance of PPE

Figure 2 shows that majority of respondents (85%) rated PPE as “important” and “very important” in construction site. This indicates that safety in construction site and PPE are essential to avoid accidents from occurring because workers are exposed to high accident risk in material handling, working at heights, housekeeping, etc.

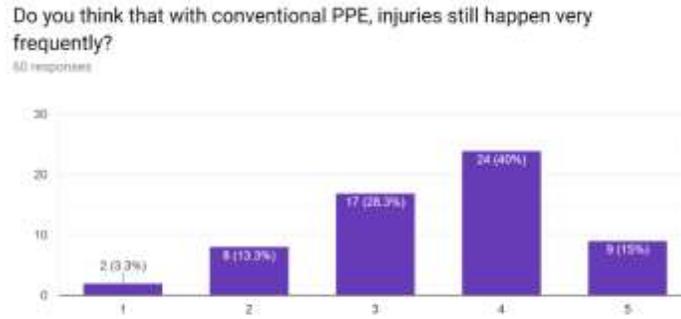


Figure 3. Frequentness of Injuries with Conventional PPE

Figure 3 shows that 83.3% of the respondents believe that even with conventional PPE provided in construction site, injuries still occur “quite frequently”. This means that conventional PPE may not be as effective as desired by Safety Officers after all.

Analysis of Relative Important Index (RII) identifies the four major causes of injuries at the construction sites are unsafe method (0.82), poor communication and management (0.82), act of god (0.81) and negligence of contractors (0.78).

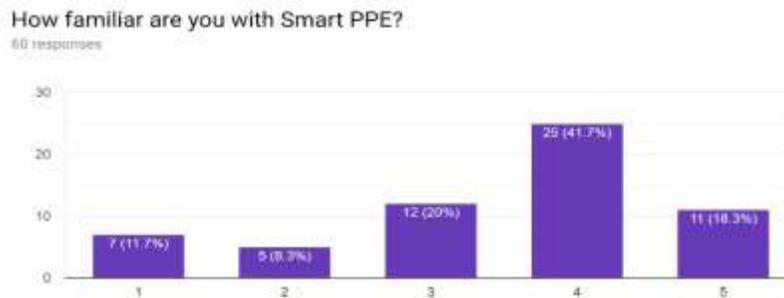


Figure 4. Level of familiarity towards Smart PPE

From Figure 4 above, 18.3 % of respondents are “very familiar” with Smart PPE products, 41.7% of respondents are “familiar” and 20% “ moderately familiar” whereas 20% of the respondents are “not familiar” and “totally not familiar”. This indicates that majority of respondents are aware of Smart PPE technology.

On the benefits of Smart PPE, the respondents ranked real time risk detection (0.87), enhance safety warning (0.86) and detection of changing surrounding conditions (0.81) in descending order of significance. The results are based on the RII values.

From their experiences, 45% of the respondents “agree” that Smart PPE are more effective than conventional PPE, 16.7% “strongly agree” with the statement, 21.7% “moderately agree” and 16.6% “disagree” and “strongly disagree”.

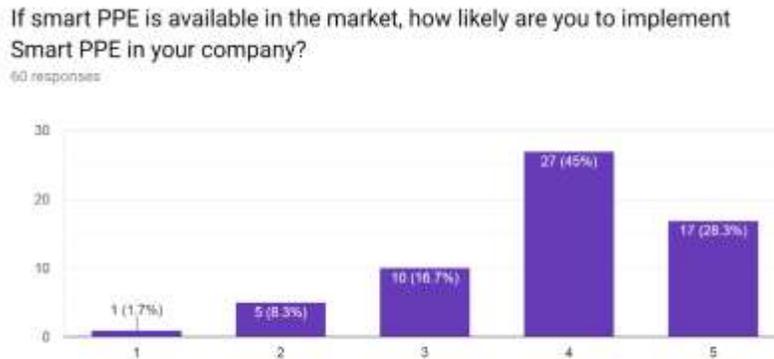


Figure 5. Implementation of Smart PPE chart

Figure 5 above shows that 28.3% of the respondents are “very likely” to implement Smart PPE in construction sites, 45% “likely” to implement, 16.7% “moderately likely” to implement, 8.3% “not likely” to implement and 1.7% “very unlikely” to implement if these equipment are available to them.

On challenges to the implementation of Smart PPE, the respondents rated “strongly agree” on the high cost of implementation, “agree” on the resistance to change and also “agree” on lack of user’s knowledge on technology trend.

## Conclusions

This survey concludes that although conventional PPE is mandatory in construction sites, it may not be as effective in reducing accidents at sites as the desired by stakeholders of projects. Smart PPE, which provides function not found in conventional PPE, has real time warning of risks and ability to track the whereabouts of workers at sites can mitigate accident rates causing injuries and death. In view of these useful functions, most Contractors favor the adoption of Smart PPE due to these proactive approach of avoiding accidents and improved performance of workers as they become more vigilant in performing their works since they can be located easily. However, there are also challenges in implementing Smart PPE such as high purchasing, installation and maintenance costs. Similar to other high technology products, the unfamiliarity of product usage and the cumbersome of wearing and operating the Smart PPE create resistance to its adoption.

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