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Evaluation of Correct Usage, Comfort and Fit of Personal Protective Equipment in Construction Work

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Abstract : There are several reasons behind the use, non-use, or inadequate use of personal protective equipment (PPE) in the construction industry. Comfort and accurate size support proper use, while discomfort, misfit, and difficulties to understand how the PPEs should be handled inhibit correct usage. The need for several protective equipments simultaneously might also create problems. The purpose of this study was to analyse the correct usage, comfort, and fit of different types of PPEs used for construction work. Correct usage was analysed as guessability, i.e., human perceptions of how to don, adjust, use, and doff the equipment, and if used as intended. The PPEs tested individually or in combinations were a helmet, ear protectors, goggles, respiratory masks, gloves, protective cloths, and safety harnesses. First, an analytical evaluation was performed with ECW (enhanced cognitive walkthrough) and PUEA (predictive use error analysis) to search for usability problems and use errors during handling and use. Then usability tests were conducted to evaluate guessability, comfort, and fit with 10 test subjects of different heights and body constitutions. The tests included observations during donning, five different outdoor work tasks, and doffing. The think-aloud method, short interviews, and subjective estimations were performed. The analytical evaluation showed that some usability problems and use errors arise during donning and doffing, but with minor severity, mostly causing discomfort. A few use errors and usability problems arose for the safety harness, especially for novices, where some could lead to a high risk of severe incidents. The usability tests showed that discomfort arose for all test subjects when using a combination of PPEs, increasing over time. For instance, goggles, together with the face mask, caused pressure, chafing at the nose, and heat rash on the face. This combination also limited sight of vision. The helmet, in combination with the goggles and ear protectors, did not fit well and caused uncomfortable pressure at the temples. No major problems were found with the individual fit of the PPEs. The ear protectors, goggles, and face masks could be adjusted for different head sizes. The guessability for how to don and wear the combination of PPE was moderate, but it took some time to adjust them for a good fit. The guessability was poor for the safety harness; few clues in the design showed how it should be donned, adjusted, or worn on the skeletal bones. Discomfort occurred when the straps were tightened too much. All straps could not be adjusted for somebody's constitutions leading to non-optimal safety. To conclude, if several types of PPEs are used together, discomfort leading to pain is likely to occur over time, which can lead to misuse, non-use, or reduced performance. If people who are not regular users should wear a safety harness correctly, the design needs to be improved for easier interpretation, correct position of the straps, and increased possibilities for individual adjustments. The results from this study can be a base for re-design ideas for PPE, especially when they should be used in combinations.

Keywords : construction work, PPE, personal protective equipment, misuse, guessability, usability
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