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*Original Article*

# Prediction of behavior towards personal protective equipment use in the Ghanaian construction sector: Application of the extended theory of planned behavior

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## ABSTRACT

**Introduction:** Due to unsafe behavior at job sites, the construction sector has a high accident and injury rate. Personal Protective Equipment (PPE) effectively prevents occupational accidents, but compliance with its use is not always guaranteed due to unsafe behavior. However, the drivers of PPE use behavior, including intention, attitude, and social norms, are poorly understood among Ghanaian construction workers. This study sought to determine the factors influencing Personal Protective Equipment usage behavior among building construction students using the Theory of Planned Behavior (TPB) and the added construct of perceived threat.

**Methods:** Using a cross-sectional study design, information was gathered from 250 building construction students from Ho Technical University using a structured questionnaire in June 2023. A stepwise multiple logistic regression was employed to evaluate the variables affecting Personal Protective Equipment use behavior. The multinomial logistic regression model quantifies the probability of an outcome concerning multiple predictors and predicts the likelihood of a respondent belonging to a specific outcome among various choices.

**Results:** The study revealed that the six constructs explained 94% of the variance in self-reported use behavior. It was found that the best predictor of Personal Protective Equipment usage behavior was the intention construct. Aside from intention, perceived severity was a better predictor of Personal Protective Equipment use behavior among all the other constructs.

**Conclusion:** This finding suggests students are more inclined to utilize Personal Protective Equipment to mitigate the risks of exposure to hazards when the perceived severity of the situation is higher. The findings underlined the importance of emphasizing the degree of harm caused by work-related injuries from construction activities to improve PPE use behavior.

**Keywords:** Behavior intention; Construction industry; Injury; Psychological; Perceived threat

## Introduction

The construction industry is consistently ranked among the riskiest occupations, with a high incidence of fatal and nonfatal injuries.[1-4] Research indicates that many accidents in the construction sector could have been prevented by using the required Personal Protective Equipment (PPE).[5-7] However, some workers still fail to comply with PPE use requirements, possibly due to risky

behavior and deliberate disregard for safety regulations.[7,8] This unsafe behavior, which involves persisting in actions that violate safety regulations, is a significant factor in occupational health and safety.[9,10] It is, therefore, crucial to prevent and control these risky actions to enhance safety on construction sites. Understanding and improving the behavioral component of PPE usage among construction workers is a key step toward enhancing worker safety and reducing accidents. The behavioral aspect has been the focus of recent studies in the construction industry due to its potential to impact health and safety in the sector significantly.[7]

Previous studies in Ghana have shown that many construction workers do not use PPE even when available for the required activity.[4,7,11] The reasons for this behavior have not been fully explored, although it is a critical issue for health and safety in the construction sector. Prior research in Ghana has focused on factors like PPE design, safety climate, and cultural influences among practicing construction workers but has largely overlooked the perspectives of student trainees who are future industry professionals.[7] Building construction graduates are expected to become middle-staff technicians and site supervisors and play crucial roles in safety management on construction sites.[12,13] Therefore, understanding their attitudes and behavior towards PPE is essential for improving occupational safety in the Ghanaian construction sector.

The Theory of Planned Behavior (TPB) was used to assess how the behavioral elements influence the use of PPE among building construction students on construction sites. The TPB model has been widely applied to anticipate various human behaviors.[14] In the construction sector, the TPB model has substantial empirical support, particularly concerning human behavior and the use of PPE.[15-20] The theory posits that behavioral intention (BI) directly and positively influences behavior (B) through constructs such as attitude, subjective norm, and perceived behavioral control.[21,22] Additionally, the sense of threat, a key component of the Health Belief Model (HBM), is a significant driver of safety behaviors, and this concept has been integrated into the TPB due to its relevance to PPE use and occupational health and safety.[9] The specific objectives of the study are (1) to assess the predictive utility of TPB constructs in relation to PPE use behavior, (2) to determine the influence of perceived threats on PPE use behavior, and (3) to evaluate the extended TPB's explanatory power on PPE use behavior.

## Methods

The study respondents were students pursuing a Building Technology program at the Department of Building Technology, Ho Technical University (HTU). Specifically, Higher National Diploma (HND) building construction students were chosen because they are known to have a high prevalence of engagement in live construction projects as part of their study program. A simple random sampling approach was used to administer questions to building construction students at HTU on PPE use behavior from June 1, 2023, to June 29, 2023. The total number of building construction students with experience in live construction was 335, and based on Krejcie and Morgan, it was decided that 181 was a suitable sample size. Cohen argues that a larger sample size lowers the degree of error and raises reliability.[23,24] Based on Cohen's assertion, the study sample size was increased to 250. Permission to administer the questionnaire was obtained from the Head of the Department of Building Technology before approaching the students. In addition, ethical approval for the study was obtained from the Ethics Committee of Ho Technical University (Reference HTU/EC2023-025). Every participant gave their oral informed consent after being advised of their ability to refuse participation in the study at any time. A hard copy of the questionnaire and an explanation of the questions were given to the students who consented to participate in the study during the lecture session. They were then invited to complete it at the end of class and submit their completed response in a drop box without any information leading to their identification to

ensure anonymity.

A structured questionnaire that was primarily based on relevant studies made up the instrument.[15-20,25] Two Lecturers from the Department of Building Technology at HTU who specialize in building construction safety evaluated the questionnaire's face validity. A few minor textual changes were made to better fit the study's objectives, which was about building construction students' PPE use behavior during live construction practical training, without a substantial alteration to the modified study tools. There were two sections to the survey questions. In the first section, demographic information of the respondents relating to gender, and academic level of study. Within the second part of the survey, questions focused on the components of TPB (attitude, subjective norms, and perceived behavioral control) and its extended constructs (perceived susceptibility and perceived severity) on PPE use behavior. A Likert-type scale with five points -1 for strongly disagreeing, 2 for disagreeing, 3 for neutral, 4 for agreeing, and 5 for strongly agreeing - was utilized to gauge the respondent's level of agreement with the questionnaire's statements. A Cronbach alpha coefficient for each of the six constructs was greater than 0.70 after the modified questions were pretested on 19 students studying building construction. This suggests that the questionnaire for the study is sufficiently stable and consistent. The main sample of the research did not include the piloted sample.

An exploratory factor analysis was carried out to assess how well each item or variable perform relative to its loading power and also to facilitate the data reduction process. Subsequently, a multinomial logistic regression was applied to investigate the effect of the predictor variables on PPE use through control factors. The multinomial logistic regression model explains the likelihood of estimating a category with a reference relative to many predictors or explanatory factors or variables. The model provides for the characterization of the chance or likelihood that a respondent will belong to a distinct outcome of the multinomial predictor variables. Therefore, when a multinomial logistic regression model is established, its parameters can be used in predicting the likelihood or probability of an event occurring by juxtaposing it against a reference category. Spearman's correlation coefficient was used to analyze the relationship between the study constructs. R statistical software version R 4.0.4 was used for all statistical analyses. Differences were considered significant at $p < 0.05$.

## Results

The Cronbach's alpha values for intention (0.781), attitude (0.884), perceived behavioral control (0.813), social norm (0.835), perceived susceptibility (0.880), and perceived severity (0.791) were each larger than the threshold of 0.60 (Table 1).

This indicates that the questions employed in the study were consistent with the object being measured. Through the varimax rotation method, Bartlett's sphericity test showed significant results ( $p < 0.01$ ) with a Kaiser-Meiyer-Olkin value (0.631) greater than the reference figure. From the results, the extraction of six components was realized. Its eigenvalue of 3.697 was evidence of the appropriateness of the method deployed in extracting the various components. Moreover, the common variability for these constructs was 45.4%, while the total variance for the complete extraction was 91.7% (Table 1). Each component mostly loaded highly. That is, it recorded factor loadings higher than 0.50. For intention, the highest loading item recorded 0.771, and the lowest loading item was 0.515. Attitude recorded 0.791 and 0.662 as the strongest and the weakest loadings, respectively. For the perceived behavioral control, it loaded 0.803 and 0.688 as the largest and the least, respectively. In the social norm construct, the highest loading recorded was (0.894), and the lowest was (0.698) (Table 1).

**Table 1: Exploratory factor analysis of PPE use constructs and measurement items**

| Construct | Measurement items | Measurement items loading | Cronbach's alpha |
|---|---|---|---|
| **Intention** | I intend to use PPE in the future (INT1) | 0.553 | 0.781 |
| | I will expend attempts to use PPE in the future (INT2) | 0.612 | |
| | I am actually planning to use PPE in the future (INT3) | 0.771 | |
| | I will strongly recommend other BT students to use PPE (INT4) | 0.515 | |
| **Attitude** | For me to use PPE while working is beneficial (ATT1) | 0.662 | 0.884 |
| | For me to use PPE while working is wise (ATT2) | 0.674 | |
| | For me to use PPE while working is good (ATT3) | 0.703 | |
| | For me to use PPE while working is valuable (ATT4) | 0.791 | |
| **Perceived Behavioral Control** | I am confident that I could use PPE while working if I want to (PBC1) | 0.803 | 0.813 |
| | For me to use PPE is easy during working (PBC2) | 0.756 | |
| | I can perform quite well, even when the use of some protective equipment is challenging and complicated (PBC3) | 0.779 | |
| | The decision to use PPE during working is under my control (PBC4) | 0.745 | |
| | I have enough time, and opportunities to use PPE during working (PBC5) | 0.688 | |
| **Social Norm** | My friends who are important to me, think that I should use PPE while working (SN1) | 0.770 | 0.835 |
| | My family/relatives who are important to me think that using PPE is desirable while working (SN2) | 0.698 | |
| | The people in my life, whose opinions are valuable to me, would approve of the use of PPE while working (SN3) | 0.894 | |
| | The construction workers I most respect, wear PPE while working (SN4) | 0.749 | |
| **Perceived Susceptibility** | The chances of getting injured will be high, if I do not use PPE during working (PSU1) | 0.880 | 0.880 |
| | I believe that without PPE, even slight exposure to job hazards will lead me to an illness or injury (PSU2) | 0.842 | |
| | I know some construction workers who become ill from because they did not use PPE (PSU3) | 0.696 | |
| **Perceived Severity** | I am afraid of even thinking about getting an occupational hazard exposure from construction activities (PSER1) | 0.668 | 0.791 |
| | I believe that not using PPE during construction activities can cause serious consequences such as ocular, dermatologic and respiratory problems in the short-term (PSER2) | 0.799 | |
| | I believe that if I do not use PPE, I will be exposed to the long-term consequences of exposure to construction hazards, such as hearing loose, and TB (PSER3) | 0.822 | |
| | I believe that not using PPE during construction | 0.635 | |

| | | |
|---|---|---|
| activities can cause an economic burden (i.e., losing money for curing purposes and reducing involvement in pottery making) (PSER4) | | |
| **Indices** | | |
| Eigen value | 3.697 | 0.834* |
| Common variance (%) | 45.355 | |
| Total variance (%) | 91.738 | |
| Bartlett's sphericity test | 0.000*** | |
| Kaiser Meiyer-Olkin | 0.631 | |

*Cronbach alpha for all items; ***$p < 0.001$

From Table 2, it is worth noting that the correlation between a variable and itself was always perfect. Attitude and intention had a significantly significant (p<0.05) correlation of 0.562.

Perceived behavioral control and intention showed a favorably strong and significant (p<0.01) association of 0.662. The highest correlation was recorded between social norms and perceived behavioral control with a correlation coefficient of 0.810, which was significant ($p < 0.01$). A positive relationship was observed between perceived susceptibility and social norms, which was significant ($p < 0.05$). In contrast, two negative correlation coefficients were observed. These are the relationships between social norms and attitudes and perceived severity and social norms. It was revealed that these negative relationships were not statistically significant ($p > 0.05$).

**Table 2: Correlation analysis of factors**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Intention | 1.000 | | | | | |
| 2. Attitude | 0.562* | 1.000 | | | | |
| 3. Perceived Behavioral Control | 0.662** | 0.627** | 1.000 | | | |
| 4. Social Norm | 0.701** | -0.521 | 0.810** | 1.000 | | |
| 5. Perceived Susceptibility | 0.559 | 0.610 | 0.585 | 0.774* | 1.000 | |
| 6. Perceived Severity | 0.448 | 0.734** | 0.498 | -0.611 | 0.529 | 1.000 |

$n = 250$; *$p < 0.05$; **$p < 0.01$.

The PPE use behavior was modeled as the response variable with control factors and independent variables using multinomial logistic regression (Table 3).

The first model (PPE1) comprised the gender and level of study of the respondents, which were deemed not significant (p > 0.05) in terms of their contribution to PPE use behavior. In the second model (PPE2), only intention was incorporated as a predictor, together with gender and level of study. It was observed that respondents with intention had a three-fold higher likelihood of using PPE than their counterparts without the same. 91% of the variance in PPE use was explained by the intention component of the model, which was significant (p<0.05). The third model (PPE3) had five predictors, including attitude (ATT), perceived behavioral control (PBC), social norm (SN), perceived susceptibility (PSU), and perceived severity (PSER), together with gender and level of study as the control factors. Perceived sustainability and perceived severity influenced very strongly PPE use behavior and were each statistically significant (p<0.001). Attitude and perceived behavioral control also influenced highly PPE use behavior and were each significant (p<0.01). The least influential factor for model PPE3 was the social norm, which was deemed significant (p<0.05). These five predictors accounted for 89.1% of the spread in PPE use among respondents, and the

model is deemed well-fitted ($p<0.01$).

In the last model (PPE4), all six predictors together with the control factors were utilized. Five out of six predictors were statistically significant at either $p<0.05$ or $p<0.01$ in relation to their influence on PPE use among respondents while one was not significant ($p>0.05$) contributing factor. Again, attitude, perceived behavioral control, and perceived severity each had three times higher chances of influencing PPE use as compared to each counterpart without the same classification. Also, social norms and perceived susceptibility each influenced PPE use two times more than their counterparts. The fourth model, seen as the general model, was noted to have fitted well to the data set utilized in the study and all six predictors were responsible for 93.5% of the variability in PPE use behavior among the respondents.

**Table 3: Multinomial regression model for PPE use**

| Dependent variable | Model | Control factors | | Independent variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gender | Level | INT | ATT | PBC | SN | PSU | PSER | $R^2$ | P-value |
| PPE USE | PPE1 | 0.672 | 1.033 | | | | | | | 0.501 | 0.055 |
| | PPE2 | 0.817 | 0.729 | $3.558^{***}$ | | | | | | 0.910 | $0.024^{*}$ |
| | PPE3 | 0.663 | 0.904 | | $2.560^{**}$ | $3.112^{**}$ | $1.884^{*}$ | $2.670^{***}$ | $4.201^{***}$ | 0.891 | $0.001^{**}$ |
| | PPE4 | 0.835 | 0.745 | $4.110^{**}$ | $3.223^{**}$ | $3.148^{*}$ | $2.653^{*}$ | 2.771 | $3.804^{**}$ | 0.935 | $0.000^{***}$ |

$n = 250; {}^{*}p < 0.05; {}^{**}p < 0.01; {}^{***}p < 0.001.$

## Discussion

This study sought to understand the PPE use behavior of building construction students based on the TPB. The TPB was extended by adding perceived threats (perceived susceptibility and severity). Results show TPB utility and its extension in explaining PPE use behavior. The TPB, on average, explains 22% of the variance in behavior intention with self-reported behavior based on the behavioral study meta-analysis by Armitage and Conner. Based on self-reported PPE use behavior, the expanded TPB explains 94% of the variance. The results of this study align positively using the meta-analysis of Armitage and Conner. The predictive power of the extended TPB model was higher, confirming the advantage of using extra variables to explain behavior, which other researchers have mentioned.[26-28]

The intention construct is central to the TPB and serves as the driving force behind a behavior. The level of preparation required to undertake an activity or put in the required effort to carry it out is known as intention.[14] This result supports the TPB's claim that the primary predictor of actual behavior is one's intentions to engage in a behavior. This study's findings that intention was the most important factor influencing employees' safety practices were in line with earlier research conducted in the construction sector and statistically significant to targeted behaviors in other construction industry studies.[10,19,29,30] Norris and Myers also found intentions to be the central predictor of PPE use behavior among motorcyclists.[27] Several studies have indicated the positive influence of motivation in the form of rewards on construction workers' safety conduct.[31,32] In an academic context, students can be motivated intrinsically, extrinsically, or both. The extrinsic aspect, where success is primarily viewed in terms of grades, seems more important in the Ghanaian academic context, particularly at the university level.[33] The reward of marks by technicians and lecturers for compliance with PPE use at project sites served as sources of extrinsic motivation among students.

PBC emerged as the significant predictor of behavior in the original TPB model in the absence of intention. This finding aligns with the meta-

analysis of behavioral research conducted by Armitage and Conner, which discovered PBC to be the primary predictor of observed variance in behavior in the absence of intentions.[26] One significant factor influencing PBC is self-efficacy, which measures how tough or easy a task will be to perform. The students were confident in using PPE while working, which is suitable for safety management. For instance, confidence in using PPE while working if desired, ease of using PPE while working, and maintenance of high performance while working with PPE all recorded high factor loadings. Individuals with higher self-control are typically more likely to perform tasks safely.[20] The PBC significance on behavior observation in this study was consistent with other behavior studies on construction workers.[20,30,34]

Attitude as a significant predictor of PPE use behavior was consistent with the results of other safety behavior studies for the construction industry.[16-18] If someone has a good attitude or an assessment of the conduct, they are more likely to be driven to engage in it. The conviction that PPE use will result in better safety outcomes may account for the significant positive attitude in this study. Social norms proved weak in predicting PPE use behavior among the constructs examined. The weakness of subjective norm as a predictor of safety behavior contradicts findings from other studies that found it to be the strongest predictor.[18,29,34] The contradiction can be attributed to limitations to influences by their colleagues. In a construction social atmosphere, individuals are constantly inundated with other people's safety behaviors, which can affect their perceptions.[35] The supervision by technicians and lecturers might have ensured that individual behavior was not shaped by the people around their immediate colleagues but by those whose opinions they value.

The results of this investigation revealed that the perceived severity of Building Technology students has a significant effect on their PPE use behavior. Indeed, perceived severity was a better predictor of behavior among all the constructs aside from intention. This result implies that the greater the perceived severity, the more likely the students will adhere to PPE use to mitigate the risks of exposure to hazards. Ghana's construction industry is thought to be among the riskiest for worker safety in the country because of the high number of fatalities and chronic injuries.[6,36] According to occupational injury indicators, the frequency, incidence, severity, and average number of days lost were all higher for the construction sector than the national average.[37] Ghana's construction workers are thought to be exposed to occupational injuries at a rate of 57.9%, which ranks high among low- and middle-income countries (LMICs) with documented cases of occupational injury.[3] The respondents' familiarity with occupational injuries associated with the construction industry might have influenced the effect of perceived severity as a strong predictor of PPE use behavior. Individuals frequently underestimate how easily they could get sick.[38] Ghanaians' sociocultural belief that death is predestined impedes occupational safety.[39] Boakye et al. found the sociocultural belief relating to the accidents as predestined to affect the safety record of Ghanaian construction workers.[32] The sociocultural predestined belief in occupational illness may have influenced the underestimation of susceptibility to disease in the absence of intention and accounted for the strong correlation between social norm and perceived susceptibility in this study.

## Conclusions

The current study examined the behavioral influence on undergraduate building construction students' PPE use using an expanded TPB model. This study confirmed the applicability of the original and extended TPB for predicting building construction students' behavior toward PPE use. According to the study findings, the extended theory of planned behavior (TPB), which took into account threat perception variables, was more effective in predicting students' behavior when it came to PPE use. Intention and perceived severity as important predictors of behavior in the use of

PPE was espoused. The study recommends expanding the extended model to include risk factors associated with not using PPE due to its influence on the model's predictive power. Acknowledging and emphasizing the health dangers associated with not wearing PPE can ensure proper use of the required PPE for the necessary task.

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