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Framework to Improve the Attitudes of Construction Workers towards Safety Helmets

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Abstract: Construction workers in various studies across the globe have indicated that there is some discomfort with the use of safety helmets, and that some workers do not use safety helmets as required, resulting in a compromise to their health and safety protection. This study investigates the processes involved in the selection and procurement of safety helmets for construction workers and assesses these efforts by interrogating the discomforts experienced by users in spite of these selection considerations. The study focuses on safety helmets used by construction workers, as this is a common form of personal protective equipment (PPE) usually given out on construction sites to prevent head injuries, which are among the severest forms of occupational accidents in the industry. Primary data were obtained through a questionnaire survey conducted with construction firms operating in Ghana and semi-structured interviews with construction workers. The findings from the study indicate that in spite of the purported considerations by construction firms in the selection and procurement of PPE, construction workers continually experience several discomforts with the use of safety helmets. The study proposes a Behaviour-Based Safety Intervention Framework to guide the selection and procurement of user-friendly PPE that improves the user experience of safety helmets.

Keywords: Behaviour modification, Construction workers, Discomfort, PPE selection and procurement, User-friendliness

INTRODUCTION

Safety helmets are essential equipment on the construction site to protect against head injury caused by falling objects or the impact of a lateral collision. However, construction workers complain that safety helmets are uncomfortable (especially in hot temperatures), do not fit well and get in the way of work (Adade-Boateng, Fugar and Adinyira, 2018; Davis et al., 2001; Hsu, Tai and Chen, 2000). Research indicates that wearing safety helmets under hot working conditions may result in an increased risk of heat disorders, as the head is one of the regions that are most susceptible to heat stress (Ueno and Sawada, 2019). According to Ueno and Sawada (2019), construction workers are at a high risk of heat-related discomforts due to the safety attire they must usually wear and suggest that it is imperative that the head maintains an adequate temperature in order to prevent damage to the brain as a result of heat.

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Users of personal protective equipment (PPE) are susceptible to experiencing physiological strain (Holmér, 2006); however, a study conducted on the effects of using safety helmets on construction sites in hot environments indicated that indigenous construction workers experience little or no physiological strain as a result of its use (Adade-Boateng, Fugar and Adinyira, 2018). In as much as it is relieving to know that workers' lives are not physiologically compromised with PPE use, it is worrying to observe global incidences of non-compliance with PPE protocols due to the physical discomforts that are experienced.

Research suggests that workers are likely to take additional risks when they have been provided with sufficient safety interventions. In a study of the latent effects of safety interventions by Hasanzadeh, de la Garza and Geller (2020), participants increased their risk-taking behaviour by up to 55% when they were provided with higher levels of fall protection. It is thus necessary to ensure that workers maintain good safety behaviour. The success rates of behaviour-based interventions in improving safety behaviour in several industries indicate that it is possible to improve the attitudes of construction workers and their safety behaviours regarding safety helmet use through a behaviour-based safety intervention.

This study investigates the considerations made by procurement officers in the selection and procurement of safety helmets for construction workers. Construction workers are interviewed to understand their experience with using procured safety helmets. Finally, a Behaviour-Based Safety (BBS) Intervention Framework that could aid the selection and procurement of user-friendly helmets and concurrently improve the attitudes of construction workers toward their use is proposed for adoption by the construction industry.

LITERATURE REVIEW

Improving Safety Helmet Use through the Selection and Procurement Process

The discomforts experienced by construction workers with regard to safety helmet use despite the absence of physiological strain is an indication that the selection and procurement process of helmets should be extensively examined in order to improve physical and psychological comfort (Adade-Boateng, Fugar and Adinyira, 2018).

The foremost procedure in selecting PPE usually involves conducting a thorough analysis of the hazards present in the work environment that are directly related to the practical demands of the work task to prevent over-protection or under-protection of the worker (McPherson, 2008). Proponents of clothing comfort suggest that people are more likely to wear clothing in which they are comfortable (Li, 2001). Thus, while it is essential that helmets ensure adequate protection for users, the helmets should also satisfy the comfort requirements of users to maintain their continual use.

Some research into improving helmet comfort has advocated the use of white helmets in hot temperatures (e.g., Abeysekera and Shahnavaz, 1988) because they have been shown to retain comparably less heat than their coloured counterparts in the presence of radiant heat in a laboratory experiment.

Another study conducted by the Missoula Technology and Development Center (United States) to investigate the effect of colour on temperatures within hard hats discovered measurable differences in the temperatures within the different helmets, with lighter coloured hard hats being dramatically cooler than darker coloured ones (Smith and Throop, 2006). This study also identified that white industrial safety helmets absorbed the least amount of heat amongst all the colours, supporting the principle that lighter colours absorb less solar radiation, thereby generating less heat inside a helmet than darker colours. Heat stress has been linked to reduced work capacity and performance (Gotshall, Dahl and Marcus, 2001; Kjellstrom, Holmer and Lemke, 2009). The maximal adaptability model (Hancock and Warm, 1989) also indicates that physiological and psychological attentional resources are depleted with continual exertion of stress on a person. To reduce the effects of heat discomfort with safety helmet use and maintain physiological and psychological comfort, white coloured helmets that are adequately ventilated are recommended, especially for use with workers susceptible to heat stress (Abeysekera and Shahnavaz, 1988; Smith and Throop, 2006), such as those in the tropics.

In addition to ensuring adequate ventilation, helmets should provide a good fit for the user to enhance physical comfort. Gupta (2014) recommends that designers of clothing items take into consideration the characteristics of the fabric, the peculiar needs of the user and the kind of mobility and flexibility required to undertake tasks while wearing the clothing item. Abeysekera and Shahnavaz (1988) attribute the discomforts associated with transplanted PPE to the variabilities in physical, cultural and sociological environments as well as technological and anthropometric differences between people in the manufacturing country and those in the user country. To ensure adequate fit of clothing items and enhance physical comfort, it is necessary to consider the anthropometric features (i.e., a scientific analysis of shapes and sizes) of the target users (McPherson, 2008; Gupta, 2014) before manufacturing or procuring them. The considerations being advocated for could be summed up by McPherson's (2008) assertion that users of PPE are more likely to comply with PPE protocols when comfort, fit and style are considered in the procurement process, hence her statement that "When PPE is 'connected to' the wearer, compliance becomes more automatic".

Safety helmets are often purchased from external suppliers by construction firms. The research rationalises that the physical discomforts associated with safety helmet use on construction sites are a function of selection considerations made before the purchase. In the researchers' opinions, if the appropriate considerations/comfort requirements and anthropometric characteristics are considered in the selection and procurement stage, as suggested by Gupta (2014) and McPherson (2008), construction workers would be more likely to wear given safety helmets on site.

Improving the Safety Behaviour of Workers towards Safety Helmets

Unsafe acts have been identified as the leading cause of workplace accidents (Choudry, 2014), and researchers advise that the reduction of accidents and improvement of safety performance can only be achieved by systematically focusing upon unsafe behaviours at the construction sites (Choudhry and Fang,

2008; Choudhry, 2012). The Multiple Causation Theory of accidents indicates that unsafe acts and unsafe conditions create a conducive environment for accidents on the site. Based on the accident root cause tracing model (ARCTM), discomforts associated with safety helmets can be described as the root causes of the refusal to use safety helmets (unsafe acts), and unsafe conditions are created as a result of non-helmet use.

BBS interventions have gained popularity among attempts to improve the safety behaviour of operatives (Lees and Austin, 2011), and their application has proved to be successful in improving safety behaviour across different industries and cultures (Choudry, 2014). For example, in a case study involving construction sites, safety performance at one project improved from 86% (at the end of the third week) to 92.9% in the ninth week when a behaviour-based intervention programme was applied to construction workers. Significant performance improvements were observed with PPE use, housekeeping, scaffolding, access to heights and plant and equipment (Choudry, 2014).

A BBS methodology aims at improving safety through the integration of behavioural science, quality and organisational development principles with safety management in order to reduce industrial injuries. The BBS approach becomes especially important in tackling safety issues since it focuses on the psychology of the human at work and employee behaviour as critical elements in achieving better safety standards (Salem et al., 2007).

According to Tuncel et al. (2006), the BBS approach originated from operant conditioning, which is a method of learning that occurs through rewards and punishments for behaviour. However, Manu et al. (2017) opine that insight into the significant drivers of workers' safety behaviour, some of which could be intrinsic, is critical to the success of a BBS programme. Hence, in order to improve safety behaviour with regards to helmet use, it is imperative to clearly identify the discomforts experienced with their use, to make the requisite changes that would address the discomforts and improve the user experience of safety helmet users to stifle any intrinsic or extrinsic motivators of bad safety behaviour.

Studies on improving helmet use among workers often focus on improving physical characteristics such as ergonomics and enhanced safety. However, not much literature focuses on the total comfort experience (which Slater (1985) describes as consisting of physical, physiological and psychological comfort) of workers while they use these helmets. After ensuring that workers have been provided with user-friendly safety helmets, it is also important to ensure that construction workers have the right attitudes or behaviours towards helmet use.

METHOD

Questionnaire Survey

A questionnaire survey administered among construction companies in Ghana was used to ascertain the considerations made in the selection and procurement of PPE and how these considerations were informed by employers' perceptions of the discomforts experienced by workers with PPE use. Participants in the survey were large construction firms operating in the country. Clients for these classes of contractors are usually government agencies and large private organisations and usually demand that the requisite PPE be used on site. One hundred

self-administered questionnaires were hand delivered to the offices of these construction firms and 74 responses were received at the end of a three-month data collection period.

Respondents to the survey were presented with a list of factors identified from the literature and from interactions with construction personnel that are usually considered in the procurement of safety equipment. These consideration factors were grouped under five different themes, namely: (1) Nature of the project, (2) Characteristics of PPE users, (3) Comfort and fit considerations, (4) Socio-cultural considerations and (5) Compliance considerations. Respondents were also presented with a list of discomforts associated with PPE use that were obtained from interactions with construction workers. The respondents were asked to rate the level of importance attached to these discomfort complaints. Descriptive analysis consisting of frequency analysis, mean scores and standard deviations was carried out on the data obtained.

Semi-Structured Interviews

The study conducted semi-structured interviews with 16 construction workers who volunteered to offer information regarding the discomforts they felt while using safety helmets, how they managed the discomforts felt and their opinions on measures that could improve user experience. The study required volunteers to have the general characteristics of a healthy body mass index (BMI), normal blood pressure (i.e., non-hypertensive/hypotensive) and no chronic medical condition. Volunteers underwent a pre-testing exercise where they had their blood pressure readings taken over a one-week period to ensure they were eligible for the study. Sixteen volunteers were finally selected to take part in the study, with ages ranging between 20 years old to 49 years old and construction work experience ranging from 5 years to above 15 years. Selected candidates signed consent forms after they had indicated their complete understanding of the study requirements. A content analysis was performed on the data collected to identify the relevant issues arising from the interviews.

Validity

To ensure the validity and reliability of the survey, the questions were discussed several times with research supervisors to judge the appropriateness of the questions and review them to ensure their relevance to the study objective. Pre-testing was necessary to ensure that the questions fully conveyed their intended meaning (Bowden et al., 2002). Research assistants employed in the distribution and collection of the questionnaires had a minimum educational level of a Bachelor of Science degree in Building Technology. Their educational level coupled with orientation processes ensured they completely understood the intent of the data collection.

The semi-structured interviews were mostly conducted in the Akan language, as many construction workers cannot communicate effectively in the English language. To ensure the linguistic validity of the interview process, the answers provided by interviewees were repeated to them for confirmation and written out in English on the answer sheets provided for this purpose. The primary language (mother tongue) of the interviewer being Akan coupled with the

fact that all of her formal education (basic to post-graduate level) was done in English ensured that the context of the questionnaire was not lost, and cultural validation of the interview process was achieved.

RESEARCH FINDINGS

Survey

Demographic data of survey respondents

All respondents had tertiary levels of education; however, their years of experience in procuring PPE varied, as described in Table 1.

Table 1. Demographic data of survey respondents

Socio-Economic Characteristics		Frequency	%
Educational level	Tertiary	74	100.00
Experience in procuring PPE	Less than 5 years	33	44.59
	6 to10 years	18	24.32
	11 to15 years	3	4.05
	Above 15 years	20	27.03

Considerations in the selection and procurement of PPE

Respondents were presented with a list of factors grouped under five different themes, namely: (1) Nature of the project, (2) Characteristics of PPE users, (3) Comfort and fit considerations, (4) Socio-cultural considerations and (5) Compliance considerations. Results indicating the level of importance attached to the considerations are listed in Table 2.

Table 2. Means and standard deviation analysis of safety helmet selection considerations

Selection Considerations in the Procurement of PPE	*N*	Minimum	Maximum	Mean	Std. Deviation
Nature of the Job					
Job hazard analysis	74	–	2	1.65	0.559
Experience from previous work done	74	–	2	1.51	0.614
Foreman's request	74	–	2	1.10	0.820
Worker feedback	74	–	2	1.27	0.833

(*Continued on next page*)

Table 2. *Continued*

Selection Considerations in the Procurement of PPE	*N*	Minimum	Maximum	Mean	Std. Deviation
Characteristics of PPE Users					
Gender	74	–	2	0.74	0.698
Age of worker	74	–	2	0.74	0.755
Body sizes of workers	74	–	2	1.16	0.714
Medical condition	74	–	2	1.12	0.830
Comfort and Fit Considerations					
PPE weight	74	–	2	0.88	0.598
PPE style	74	–	2	0.71	0.675
PPE breathability	74	–	2	1.43	0.733
Least restriction to movement	74	–	2	1.35	0.721
PPE wearability	74	–	2	1.47	0.708
Least obstruction of vision	74	–	2	1.35	0.749
Colour preference	74	–	2	0.39	0.569
General wearer comfort	74	–	2	1.04	0.703
Socio-Cultural Considerations					
Indigenous cultural practices	74	–	2	1.20	0.863
Religious practices	74	–	2	0.22	0.558
Environmental factors	74	–	2	1.40	0.702
Compliance Considerations					
Compliance with international standards	74	0	2	1.31	0.793
Compliance with national standards	74	0	2	1.27	0.858
User involvement	74	0	2	1.00	0.761

Nature of job considerations

All the listed indicators of "Nature of the job" as a selection consideration emerged as significant, as their means were above the theoretical mean. "Job hazard analysis" recorded the highest mean (1.65) and was most important, followed by "Experience from previous work" with a mean score of 1.51. This was followed by a mean score of 1.27 for "Worker feedback". "Foreman's request" for PPE was also an important consideration, with a mean score of 1.10.

Characteristics of PPE users

Under this category of considerations, only the body sizes of workers and medical conditions of PPE users had significant mean scores of 1.16 and 1.12, respectively. The remaining variables under this consideration, i.e., "Gender" and "Age of worker" had mean scores below the group mean.

Comfort and fit considerations

Respondents indicated strongly that considerations such as "PPE wearability" (with a mean score of 1.47), "Breathability" (1.43), "Least restriction to movement" (1.35) and "Least obstruction of work" (1.35) were important considerations. "General wearer comfort" had a mean score of 1.04. The remaining variables in this category, such as "PPE weight", "PPE style" and "Colour preference", did not have significant mean scores as considerations for selecting PPE.

Socio-cultural considerations

For socio-cultural factors, environmental conditions such as air temperature and atmospheric humidity were considered important (1.4) in the selection and procurement of PPE. "Indigenous cultural beliefs" had a mean score of 1.2; however, "Religious beliefs" was not considered an important consideration in PPE procurement.

Compliance considerations

All variables under compliance considerations had significant mean scores and were considered by respondents as important in the selection and procurement of PPE.

Interviews

For this study, the demographic data of the 16 respondents are as shown in Table 3.

Table 3. Demographic data of respondents

Socio-economic characteristics		Frequency	%
Gender	Male	16	100.00
	Female	–	–
Marital status	Married	9	56.25
	Unmarried	7	43.75
Educational level	None	2	12.50
	Basic school	2	12.50
	Junior high school	2	12.50
	Secondary/vocational	9	56.25
	Higher national diploma/ bachelor's degree	1	6.25
Years of experience in the construction industry	< 5 years	3	18.75
	6 to 10 years	6	37.50
	11 to 15 years	4	25.00
	> 15 years	3	18.75

(*Continued on next page*)

Table 3. *Continued*

Socio-economic characteristics		Frequency	%
Job description	Carpentry	6	37.50
	Electricals	1	6.250
	Masonry	2	12.50
	Machine operators	2	12.50
	Unskilled labourers	3	18.75
	Steel bending	2	12.50

Semi-structured interviews

Discomfort felt while using safety helmet

Construction workers were asked to describe the discomforts they felt while using the safety helmets. The interviewees complained of feeling intense heat inside the helmet, especially during very hot weather. According to them, coloured helmets accumulated more heat than their white counterparts, and plastic harnesses were very uncomfortable in hot weather. One respondent, who indicated that it was hot inside the helmet, lamented, "Some helmets have no ventilation holes…" while another also remarked, "I sweat more when I use it". Almost all the interviewees felt that ventilation holes on the helmets were not enough to allow for sufficient aeration of the micro-environments within them. According to the interviewees, the discomforts with safety helmets described here, often lead to other discomforts such as headaches, dizziness and excessive sweating, which indicate possible physiological strain.

Workers also complained that helmets usually did not fit their heads well. In addition, workers experienced discomforts such as itching upon contact with the harness within the helmet. According to one worker, "My head is very small and so even though I adjust it; it keeps dropping down my face". Another lamented that "My scalp itches when in contact with the harness". It was observed that almost all the construction workers were clean shaven, as is typical amongst Ghanaian men. This makes the harness within the helmet come into direct contact with the skin. One worker mentioned that helmets with fabric harnesses were usually more comfortable than those with plastic ones.

The safety helmet was also considered quite heavy when worn by the respondents. One worker reported that he felt like he was being punished whenever he had to carry the weight of the helmet about. Workers complained that the helmets began to smell badly sometimes. This may be a result of constant use and the accumulation of sweat in the helmets and the lack of a proper maintenance routine. Workers complained that using helmets with all these discomforts often resulted in the early onset of fatigue and headaches before the end of each day. Again, workers can undergo psychological strain as they continually battle with discomforts such as those described previously.

From Table 4, the top four discomforts described by the interviewees were the helmets being hot inside (33%), helmets not fitting properly (22%), helmets being heavy (11%), contending with badly smelling helmets (11%) and headaches (11%) as a result of using them.

Table 4. Discomforts with safety helmet use described by interviewees

Discomfort	%
Helmet is hot inside	33
Helmets does not fit properly	22
Helmets are heavy	11
Helmets smell badly	11
Headaches	11
Early onset of fatigue	6
Obstructs vision	3
Too old	3

Source: Fieldwork (2017)

Management of PPE discomfort

The study further probed the interviewees to find out how they managed their discomforts with helmets and requested their recommendations for a more comfortable PPE use experience.

Management of discomforts with helmets

Workers intimated that the discomforts felt with using the helmets were sometimes quite unbearable and described several ways they dealt with these discomforts. For most workers, they took off the helmets at regular intervals while they worked, especially when no one was watching. Interestingly, one machine operator said, "I take it off, immerse it in water to cool it and put it back on". Another worker remarked, "I tie my head with a head scarf before wearing the helmet so it does not scratch me and leave marks on my skin".

DISCUSSION OF FINDINGS

The complaints of discomfort by the construction workers reported here are indeed similar to those in the literature (Abeysekera et al., 1996; Davis et al., 2001; Vigneswaran and Arulmurugan, 2014; Ueno and Sawada, 2019). The use of a hot or ill-fitting safety helmet can be a source of stress for the construction worker, which may result in the impairment of their physical, physiological and psychological abilities, leading to an increased likelihood of accidents or an adverse impact on productivity. To improve safety helmet use among construction workers, it is essential that the helmets provided satisfy their physical, physiological and psychological needs.

It is interesting to note that even though procurement officers purportedly assign importance to selection considerations that should improve the PPE user experience, construction workers do not experience the needed comfort to maintain the continual effective use of the safety helmets provided. Perhaps an important reason lies in the significance assigned to user involvement as a selection consideration (with a mean score of 1.0). The mean score of this

consideration suggests that significant importance is not attached to the active involvement of construction workers during the selection and procurement of PPE. According to McPherson (2008), PPE procured in consultation with users is more likely to be used. McPherson further suggests that wearability/fit/compatibility and style factors should be considered as well in the selection of PPE, as this makes compliance more automatic, allows workers to express their individuality and gives workers some control over how they look without compromising safety. In McPherson's view, people are less likely to make modifications to their PPE attire when they are content with how they look, as this would satisfy their psychological comfort needs.

Procurement officers indicated in the survey that the decision to procure PPE is largely dependent on the price. It is also possible that other considerations (e.g., comfort and fit considerations and compliance of PPE with international standards), which would ensure that helmets are comfortable, are sacrificed at the point of purchase for a price suitable for the firms.

The provision of physically, physiologically and psychologically comfortable safety helmets for construction workers in and of itself is not a sufficient guarantee of an improvement in compliance with the PPE protocols, as has been shown by Hasanzadeh, de la Garza and Geller's (2020) study on the latent effect of safety interventions. It is necessary to safeguard against complacency and increased risk-taking on the part of construction workers using comfortable safety helmets. Based on the information obtained, this study indicates that an improved PPE selection process and a modification of behaviour in a hands-on approach by both management and employees are required to improve the user experience of safety helmets. Thus, a BBS Intervention Framework was designed as a remedy to resolve the identified factors that may be impeding the effective use of safety helmets on construction sites.

RECOMMENDATION: THE PROPOSED BBS INTERVENTION FRAMEWORK

Overview of the Framework

The framework was developed in two stages. The first stage illustrated the relationship between the discomforts experienced from using safety helmets as indicated by construction workers and incidents on construction sites within the ARCTM. The ARCTM basically identifies and classifies the causes of accidents into causal factors and root causes. Causal factors are the group of factors that contribute to an accident. Root causes are, however, the underlying factors that give rise to the causal factors, thereby resulting in accidents. It is still possible to reduce the severity or frequency of accidents when causal factors are identified and dealt with. However, dealing with the root causes results in total elimination of the accident.

Discomforts associated with safety helmet and goggle use on construction sites are a potential root cause of accidents on construction sites. This is because construction workers engage in unsafe acts when they do not use safety helmets or adapt them for their use on the construction site. An unsafe condition is subsequently created with these unsafe acts because workers are then more highly exposed to the risk of direct contact with hazards that exist and could result in avoidable accidents resulting from impact to the head and eyes.

Workers who maintain the use of uncomfortable PPE are not exempt from danger. According to the maximal adaptability model, a person subjected to continuous increasing stress goes through the phases of psychological and physiological adaptation to keep the body comfortable in such a persistent condition. However, beyond the stage of maximal adaptability, this person will suffer psychological and physiological instability, which may also result in an accident. It is important that any attempt to improve PPE use on construction sites focus on improving both the physical and psychological user experience to achieve good results.

The following Figure 1 is based on the ARCTM and illustrates how discomforts associated with safety helmet use may lead to accidents on a construction site.

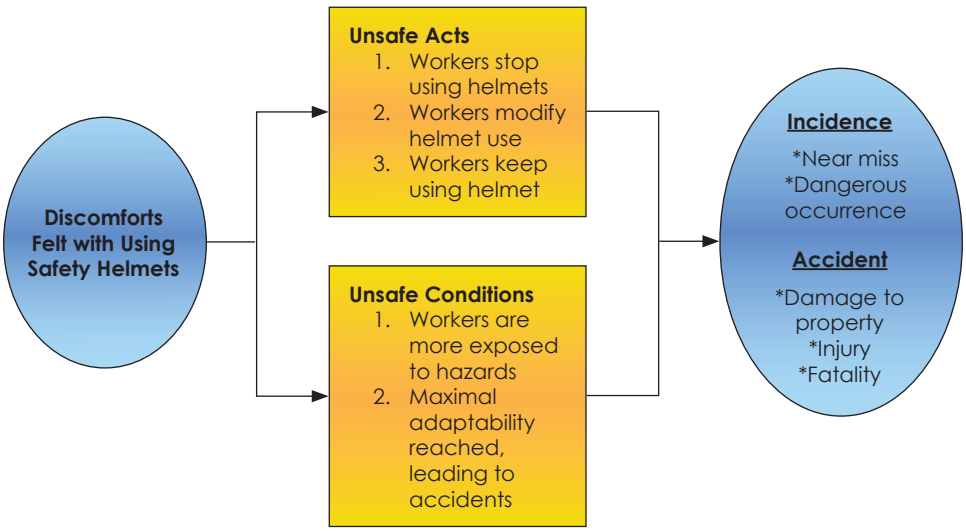

Figure 1. Flow process of incidents that may arise as a result of using uncomfortable safety helmets

The next stage of the framework development addressed the discomforts expressed by construction workers with a two-tier intervention process illustrated in Figure 2. This process aimed at removing the physical discomforts and enhancing the psychological acceptance of safety helmets by construction workers.

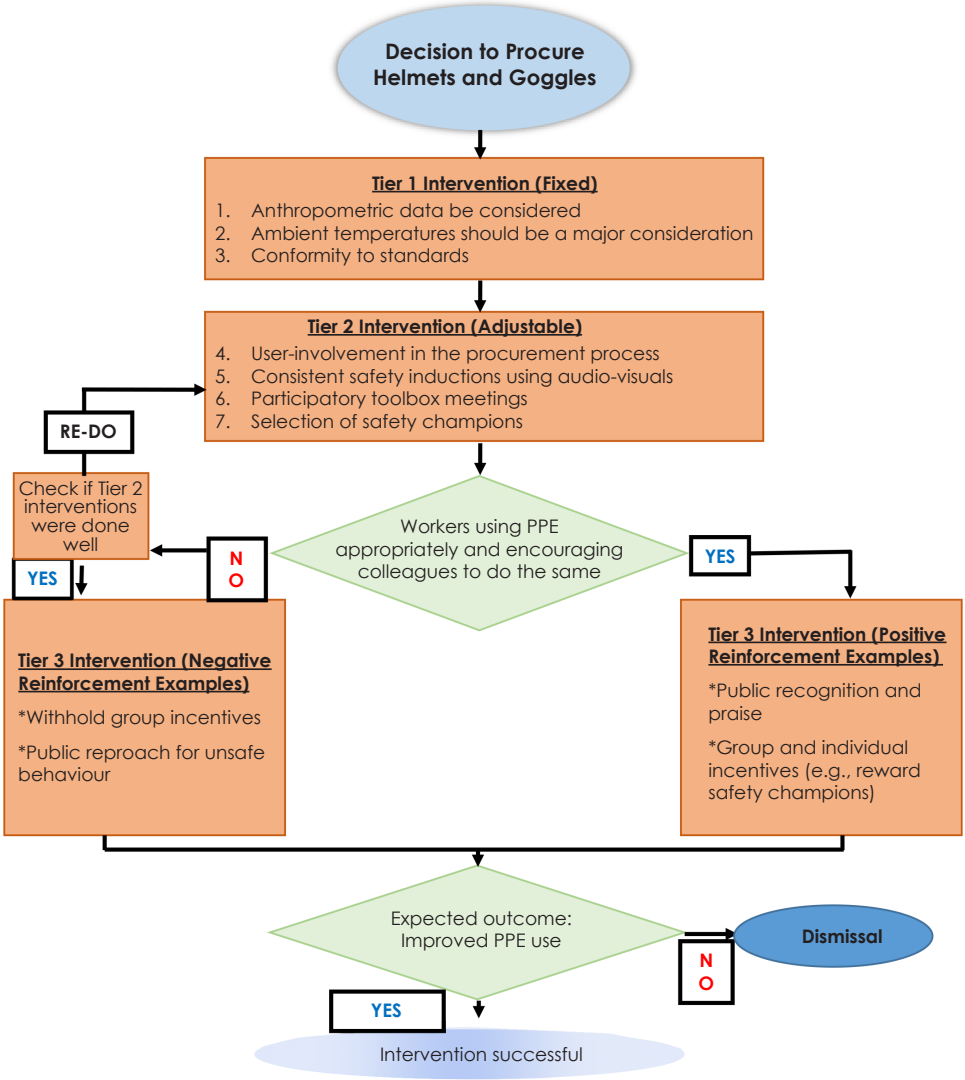

Figure 2. Framework to improve the attitude of construction workers towards safety helmets

Sections of the Framework: Intervention Stage

Tier 1: Fixed interventions

1. This study discovered a significant variance between workers' head measurements taken across three construction sites and the safety helmets that were in use on these sites. It is therefore recommended that the importation and/or procurement of safety helmets into the country should be done with consideration of the anthropometric (physical) measurements of users to remedy discomfort complaints of poor fit.

2. From the interviews, several safety helmet users complained of heat build-up within the PPE while they used them. The study recommends that safety helmets imported into the country should be tested to be certain they are suitable for the ambient temperatures that exist in the country.

3. The study proposes adherence to international standards during the procurement period. These standards will ensure that helmets are safe and satisfy the ergonomic conditions necessary to maintain comfort. However, the country may consider the development of a set of standards for safety helmets, taking into consideration the anthropometric features of the users and the existing environmental conditions.

Adjustable interventions

1. To encourage improved compliance with PPE use, construction firms should involve construction employees (e.g., supervisors and operatives) in the helmet selection and procurement process (by seeking their opinions on the characteristics of PPE that should be bought for them). Workers should be given the opportunity for fitting and trial uses before bulk procurement.

2. Safety helmet use can be improved when construction workers undergo regular periodic safety inductions using audio visuals. Audio visuals showing the effects of non-PPE use and near misses are preferred, as they will enable workers to see human beings who have been impacted by site incidences as a result of the non-use or improper use of PPE.

3. Daily toolbox meetings (i.e., short morning meetings that discuss work packages planned for the day) should be carried out in a manner that is participatory and allows the workers to contribute personal and observed experiences. This meeting should also aim to discuss the risks and hazards that are likely to be encountered in every work area for the day.

4. The selection of Safety Champions from amongst the workers to champion safety initiatives in their work areas by leading health and safety meetings and ensuring that colleague workers adhere to PPE protocols and that they are duly rewarded for safe behaviour.

Observation stage

It is expected that the interventions proposed, when executed diligently, will result in a gradual change/modification of behaviour among some employees that sets the stage for the next phase of improving the behaviour of a wider group of employees. Within the context of the Social Cognitive Theory, it is expected that a few employees will initially embrace change and start exhibiting safe behaviour, thus serving as models for the rest of the team. The remaining employees, by observing the models exhibiting good behaviour, being rewarded (motivation) for such behaviour and finding it to be a good thing (cognitive processes), may then try to alter their own behaviours by consistently observing the proper use of PPE. It is also expected that some workers at this stage may still refuse to comply with the required safety behaviour of using PPE the right way.

Tier 3: Reinforcement stage

This stage is very important to the process because reinforced behaviour tends to be repeated. Thus, when an employee observes consistent reinforcement of a model's good behaviour by the superiors, he/she will be encouraged to exhibit the same. Even though positive reinforcement is preferred, negative reinforcement and punishment for consistent unacceptable behaviour is necessary to eliminate such behaviour.

Positive reinforcement processes prescribed to improve the use of construction helmets include:

1. Public recognition and praise for safe behaviour. Workers who consistently adhere to PPE protocols should be identified and commended for good behaviour in the presence of others (e.g., at toolbox meetings). The site could also post the names or pictures of fully compliant personnel on notice boards to motivate others to aspire to be recognised in such a manner.

2. Company or site management developing an incentive scheme that would be utilised periodically to award consistent compliance with PPE protocols by individuals. A group incentive scheme (in the form of a quarterly, half-yearly or annual bonus) to reward the whole team for good safety performance will also encourage the effective use of PPE.

3. The team consistently being persuaded and encouraged to engage in safe behaviour by prioritising safety over work schedules because it is the right thing to do.

Negative reinforcement can be executed through:

1. Warning notices at the initial stages.
2. Public acknowledgement and reproach of unsafe behaviour.
3. Withholding of group incentives from offending personnel.

Outcome Stage

According to Operant Theory, behaviour that is reinforced is likely to be repeated; however, Social Cognitive Theory asserts that as people observe models being rewarded for "good" behaviour, they will likely engage in the same (McLeod, 2018). It is expected that as safe behaviours regarding helmets are reinforced, this behaviour will be diffused among the workers, resulting in an improved group safety culture. At this stage, it is important to document and present feedback on safety performance to workers to further boost their morale and increase PPE use. If feedback is negative or not encouraging enough, modifications should be made to the variable interventions to improve subsequent results. A recalcitrant worker who refuses to comply with the PPE protocols after being repeatedly taken through the intervention process should be punished by dismissal.

When feedback obtained is acceptable, then the implication is that the intervention has been successful. Management thus has the duty of maintaining the acquired safe behaviour of the personnel.

Validation of the Framework

The following section expounds on the purpose, objectives and process used in validating the proposed framework. The respondents and results from the validation are also presented in this section.

Objectives of the validation process

The objectives of the validation process were to:

1. Obtain the opinions of PPE users on whether the listed interventions could affect their user experience.

2. Find out from procurement officers how well the listed interventions could affect the PPE user experience.

3. Draw additional comments from PPE purchasers and users, which can aid in improving the user experience.

Respondents

The validation process was undertaken by three groups of respondents made up of construction operatives (consisting of various tradesmen, some of whom took part in the field experiment described previously), construction managers and academics. Construction operatives were required for the validation process as they are primary users of safety helmets and as such would be at the receiving end of the proposed intervention. Some of the operatives were also participants in the data collection stage of the study. The proposed interventions require commitment from construction managers to ensure success; hence, their practical perspective and input were needed in the validation process. Academics in the built environment contributed to the process by providing an objective analysis of the framework with respect to both theory and practice. Table 5 outlines the three groups of respondents in the validation process.

Table 5. Details of respondents to the validation questionnaire

Item	Description of Respondent Group	Frequency	%	Relevance to the Validation Process
A	Construction operatives	9	45	Primary users of PPE and beneficiaries of the intervention
B	Construction managers	5	25	Implementers of the intervention
C	Built environment academics/researchers	6	30	Providers of a practical-cum-theoretical assessment of the intervention
	Total	20	100	

Validation process

The validation process was completed in two stages. It began with an introduction of the various teams present. A short PowerPoint presentation was delivered to the participants outlining the problem statement, data collection process and results from the research that culminated in the design of the proposed framework.

In the second stage of the process, the framework was presented to the participants to analyse the various components within it. Participants in the validation process were subsequently presented with a two-page questionnaire that would aid in assessing the components of the framework. The questionnaire required respondents to rate the listed components of the framework, on a scale of 1 to 5, on their effectiveness at contributing to an improved user experience of construction helmets.

The ratings provided on the questionnaire were explicitly defined as:

> 5 = Strongly agree: Respondent had no doubt on the certainly of question being asked.
>
> 4 = Agree: Respondent generally agreed with the issue or principle underlying the issue being questioned.
>
> 3 = Uncertain: Respondent was not sure and could not confirm or deny the importance of the issue under discussion or being questioned.
>
> 2 = Disagree: Respondent did not agree with the issue or the principle underlining the issue being discussed or questioned.
>
> 1 = Strongly disagree: Respondent was completely aware that the issue under consideration was not possible from his/her perspective.

Each question was read aloud for all participants to hear and was translated verbatim into the Akan language to enable easy understanding for the operatives. Respondents indicated complete understanding of the questions before providing answers. The researcher expressed gratitude to the teams for their contribution to the research process.

Results of the validation

Based on the responses to the questions in the questionnaire, the results are as summarised in Table 6.

Table 6. Summary of Validation Results on the Proposed BBS Intervention

	Description of Intervention	Average	
		Score	%
	The Intervention Stage	4.51	90.21
1	Consideration of anthropometric characteristics before procuring PPE	4.16	83.16
2	Consideration of ambient temperature	4.89	97.89
3	Consistent persuasion and encouragement to exhibit safe behaviour	4.53	90.53
4	Direct involvement of workers in the selection and procurement of PPE	3.95	78.95
5	Regular periodic safety inductions using audio visuals to increase awareness of PPE need	4.58	91.58
6	Participatory toolbox meetings	4.58	91.58
7	Periodic selection of Safety Champions to motivate colleagues towards safe behaviour	4.89	97.78
	The Reinforcement Stage	4.65	93.02
8	Public recognition and praise for safe behaviour	4.89	97.89
9	Group and individual incentive schemes to reward safe behaviour	4.47	89.47
10	Reward scheme for Safety Champions for leading peers to observe safe practices	4.68	93.68
11	Consistent encouragement to exhibit safe behaviour	4.83	96.67
12	Denying workers liberties for engaging in unsafe behaviours	4.37	87.37
	The Feedback Stage	4.63	92.63
13	Exhibiting safety performance improvement statistics on notice boards	4.79	95.79
14	Verbal communication of safety performance improvements	4.63	92.63
15	Making modifications to the listed interventions	4.47	89.47

Comments and recommendations from the validation exercise

The results presented in Table 6 indicate that all three categories of respondents were confident that the listed interventions would be successful in improving the attitude of construction workers towards the use of safety helmets.

A few comments were, however, made by respondents purported to improve the framework. With regards to the intervention stage, respondents in the "Construction managers" category indicated that the use of PPE should be regulated by law on all construction projects irrespective of size to compel its

appropriate use. Respondents in the "Academics" category advised the inclusion of a medium that would detect errors in Tier 1 of the intervention stage.

Comments on the reinforcement stage suggested that although group and individual incentives were acceptable, expulsion or dismissal of a recalcitrant employee is too harsh. In their opinion, the payment of a fine or temporary suspension from the work premises instead would be a suitable alternative. Respondents proposed that clear notifications should be placed at vantage points to remind workers that PPE needs to be consistently worn while on site. Respondents again indicated that safety officers should be hired and dedicated to ensuring full compliance with PPE protocols.

Under the feedback section, respondents indicated that safety improvement statistics should be presented at morning meetings instead of being displayed on notice boards, and that they should be trade specific.

Limitations of the Study

A focus group discussion was preferred for testing the framework because it enabled the provision of a clear explanation of the background to the study, the results obtained and the need for the validation process, especially to construction operatives who are mostly semi-literate. Even though a large number of construction industry stakeholders were invited, the validation process was limited to the opinions of 20 respondents who willingly attended the programme.

Female construction workers were not encountered during the study. Thus, the study results are limited to male construction workers. However, the consideration of anthropometric characteristics ensures that female peculiarities are considered in any procurement process.

CONCLUSION

This study addressed the issue of discomfort with safety helmets by targeting an improved procurement process of this form of PPE through an adaptive selection process that actively involves users and considers their physical characteristics as well as the weather conditions in their physical environment. The improved procurement process, coupled with scheduled activities (based on the Operant Conditioning Theory, the Social Cognitive Theory and BBS) aimed at improving the safety behaviour of construction workers, is presented in a simple framework to improve the attitudes of construction workers towards safety helmets and to facilitate their acceptance and use on the sites. The order of the framework is described in a very simplified format for easy adoption and implementation on any construction site. Additionally, the processes in the framework are more suggestive than declarative, making it easily adaptable.

The successes achieved in the testing of the BBS Intervention Framework are an indication that BBS intervention processes are successful in improving safety helmet use within the construction industry. These results also support research on how BBS can be applied to improve the performance of the construction industry.

Although the use of the BBS Intervention Framework would not automatically propel construction workers into full compliance with PPE protocols, it provides a roadmap that will enable workers to develop a sense of ownership for their safety and develop consistent good safety behaviour.

The study is optimistic that the proposed framework will ensure that construction workers use safety helmets more effectively.

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