

## ORIGINAL ARTICLE

# Subjective Preference of New Prototypes Safety Helmets Device among Palm Oil Plantation Harvesters in Sandakan, Sabah

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## ABSTRACT

**Introduction:** Safety helmets are one of the personal protective equipment (PPE) that to decrease the impact of any falling object to the skull and to avoid head and brain injury by many industries, including palm oil plantation. Nevertheless, the level on the usage of the current safety helmet is very low due to a few factors that lead to the discomfort. Among the common issues for the non-compliance of safety helmets are their discomfort, ventilation, weight and safety. This study aims to determine subjective preference of the new prototypes' safety helmets device among palm oil plantation harvesters. **Methods:** A cross-sectional study conducted among 124 harvesters in three palm oil plantations located in Sabah, Malaysia. A set of questionnaires used to collect data on their socio-demographic background, perceptions toward existing safety helmets and their subjective preference of new safety helmets prototypes. Apart from that, six harvesters were randomly choosing to attend an interview session for qualitative study. **Results:** The descriptive analysis indicate that among the emphasized issues regarding non-compliance of existing safety helmet were due to discomfort (66.1%), poor ventilation (97.6%), load of safety helmet (83.3%) and safety issues (68.5%). In terms of new safety helmets prototypes, 72.6% of the harvesters preferred Design C to be worn for work in the plantation. **Conclusion:** It can be suggested that the existing safety helmet is uncomfortable and was not design ergonomically namely loose size and discomfort. Design C was the most preferred to be worn for work in the palm oil plantation.

**Keywords:** Subjective preference; Palm oil plantation harvester; New prototypes safety helmets

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## INTRODUCTION

In Malaysia, the palm oil industry is one of the main generators of income (1). For quite some time, Malaysia has been perceived as one of the leading makers and exporters of palm oil in the world. It has produced more than 18 million tons of crude palm oil (CPO) in 2012 (2). Although with these positive contributions, both in terms of economic output and employment, there is a big concern in terms of safety and health of the workers in the agricultural sectors. In addition, the high prevalence of ergonomic injuries also related with production of the palm oil industry that contributing from severe manual labor and also harvesting period. Based on previous studies, the prevalence of injury among palm oil harvesters is 34.4% (3). Among the injury by body parts, such as injury involving eye, head and neck, can

be related to the use of safety helmet (4). Therefore, personal protective equipment is the best prevention methods from work-related injuries and illness among palm oil plantation harvesters. It is due to the purpose of safety helmet about the hazard from falling fresh fruit bunch (FFB) when harvesting (20).

In a case study reported that a man sustained brachial plexus injury caused by a falling fruit bunch (6). The FFB weighed somewhere in between 10 to 20 kg and fell from a palm tree of a height of 5.5 meter<sup>2</sup>. Thus, the usage of PPE especially safety helmets in palm oil plantations is a must to prevent occupational accidents during work (3). In addition, safety helmets need to be worn in case of a falling or flying object (7). Besides, in agriculture sectors especially in palm oil plantations, a safety helmet is one of the most important PPE for the protection of the head, eyes and neck. Even though personal protective equipment (PPE) is the last option in the hierarchy of control, but because of relatively inexpensive to establish, PPE becomes the most widely applied in many industries.

Despite being given a safety helmet by the employer, accidents and work-related injuries still occurred because of the non-compliance of the safety helmet provided (8). The workers complained about their decision not to use the safety helmets at work. For instance, the workers were feeling uncomfortable to wear personal protective equipment when working (9). Moreover, heavy materials, loose size and also lack ventilation becomes strong rejection reasons to use current industrial safety helmets in tropical developing countries (10).

Therefore, by analyzing all the issues mentioned above of existing safety helmets, this study brings new prototype designs of safety helmets device to the palm oil plantation harvesters in order to know their subjective preference toward safety helmets. This will involve the participation of harvesters and their perception regarding safety helmet. In consequence, this will increase harvester's satisfaction in order to increase the usage of safety helmet among them. Thus, the objective of this study is to determine the subjective preference of new safety helmets prototypes device among palm oil plantation harvesters in Sandakan, Sabah.

## **MATERIALS AND METHODS**

### **Sampling**

A cross-sectional study was conducted in three palm oil plantations located in Sabah, Malaysia. There are two types of sampling methods involved in this study which were divided into plantation and respondents respectively. For the selection of the plantations, purposive sampling was used as the plantations were determined by the management. Among the palm oil plantation company in Malaysia, Boustead Plantations Berhad has agreed to cooperate in this study. Thus, three plantations were selected purposively by approval from the management of Boustead Plantations Berhad itself, namely plantation A, B and C. The selection considered the accommodation, facilities, availability and the distance among each of the plantation. For the selection of the respondents, a total of 124 harvesters were selected by a simple random method. It was based on the complete harvester's name list provided by the management of Boustead Plantations Berhad. A set of questionnaires was used to gather information from the selected harvesters. Apart from that, the qualitative assessment was carried out by using a random sampling to choose six harvesters who are involving with the interview session.

### **Questionnaire**

A new set of questionnaires was used to collect data on the harvesters' socio-demographic background, their perception toward existing safety helmets and subjective preference of new safety helmets device prototypes. Questionnaires was validated through face validity, expert validity and pilot study. The harvesters were

approached after working hours and the distribution of questionnaire session was held at the management office. Written consent was requested to be filled before answering the questions.

### **Interview**

The interview session was conducted by taking six harvesters that enthusiastic to join the research and were randomly selected from plantations as a qualitative assessment. This interview session was conducted by using a video camera to record the harvesters' verbal perception toward the current safety helmets. The interview took about five minutes for each session. The interview was based on two questions only, which were issues or problems regarding the existing safety helmet and harvesters' perception toward the existing safety helmets.

### **New Prototypes of Safety Helmet Device**

There are four new designs of safety helmet prototypes were used for the harvesters to evaluate and observe the physical properties. The difference of the safety helmet is depending on the shape and exterior design. They then described their perception and subjective preference in the questionnaire. The new designs of safety helmets are being developed based on the needs and existing problems from the existing safety helmet worn by the workers. About 66.7% of the harvesters complained that the existing safety helmets had poor ventilation which made them feel hot while wearing it during harvesting (8). Therefore, the new designs of safety helmets were developed by the addition of ventilation holes to increase airflow inside the safety helmet. The ventilation holes on the safety helmets were developed with a different kind of design for each safety helmet.

By taking consideration of emotionally design which not only focusing on the functionality or physically, the new prototype of safety helmets is developed to be functional and aesthetically pleasing safety helmet. Safety helmets not only function to protect the head but they also have their design value. Designs of the new safety helmet prototypes are different from current safety helmets with the improvement of design, aesthetics, comfort and ventilation. The new, different designs of safety helmets were named as Safety Helmet A, Safety Helmet B, Safety Helmet C and Safety Helmet D. Figure 1 below shows the four new, different designs of prototypes safety helmets device.

### **Data Analysis**

Descriptive data were reported using frequency and percentage. Descriptive analysis was used to describe the basic feature of data in this study. Descriptive statistics were used to present data in a manageable form to make it simpler and easy to understand. In this study, the frequency and percentage were used to identify the descriptive values for all objectives. The data that had been collected for this study were analyzed by using



**Figure 1: Different designs of prototypes safety helmets device**

(Statistical Package of Social Science) SPSS Version 22.

### Ethical Consideration

This study had been approved from the Ethics Committee for Researches Involving Human Subjects (JKEUPM) Universiti Putra Malaysia (Ref No: JKEUPM-2017-188). All respondents were briefed regarding the study and written informed consent was requested from the harvesters who were selected to participate in this study before the data was collected. Privacy of information and confidentiality of harvesters were protected and secured by not filling the name, phone number and identification card number.

## RESULTS

### Main Issues Related to the Existing Safety Helmet (Questionnaire Session)

The result showed that there were 97.6% of the harvesters complained that they were profusely sweating when using the existing safety helmet. Meanwhile, in terms of safety, 68.5% of the harvesters complained that the existing safety helmet limits their range of vision when conducting their work and 71.0% complained that the existing safety helmet disturbed them in conducting their work appropriately especially caused by tips of the safety helmet by 43.5%. As for the comfort aspect, 66.1% of the harvesters experienced discomfort when using the existing safety helmet which most of them experienced discomfort at the neck and head part by 34.7% and 26.6% respectively. Details are shown in Table I.

### Main Issues Related to the Existing Safety Helmet (Interview Session)

The findings showed that there were some elements on the existing safety helmet that led to the non-compliance

**Table I: Main issues related to existing safety helmet**

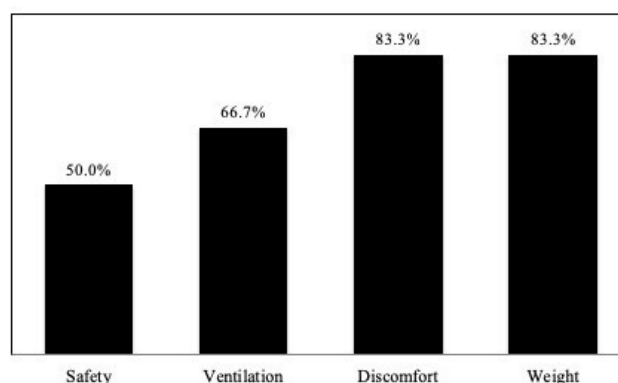
Emphasized issues	Frequency (n)	Percentage (%)
<b>Did you feel hot in the head when using the existing safety helmet?</b>		
Yes	114	91.9
No	010	8.1
<b>Did your head is profusely sweating when using the existing safety helmet?</b>		
Yes	121	97.6
No	003	2.4
<b>Did the existing safety helmet limit the range of vision when conducting your work appropriately?</b>		
Yes	85	68.5
No	39	31.5
<b>Did existing safety helmet disturbing you in conducting your work appropriately?</b>		
Yes	88	71.0
No	36	29.0
<b>Which part of safety helmet disturbing you in conducting your work appropriately?</b>		
Tips	54	43.5
Back	19	15.3
Rigid outer	04	3.2
Chin-strap	07	5.6
Buckles	02	1.6
Inside shell	20	16.1
Edge	02	1.6
<b>Did you ever experience discomfort when using the existing safety helmet?</b>		
Yes	82	66.1
No	42	33.9
<b>Which part you feel discomfort?</b>		
Head.	33	26.6
Neck	43	34.7
Shoulder	02	1.6
Chin	06	4.8
Cheeks	02	1.6
Forehead	25	20.2
Ear	23	18.5

N=124

due to uncomfortable. Based on the interview session, 83.3% of the complained were about the discomfort and weight of the existing safety helmet. There were 66.7% of the complained about poor ventilation of the existing safety helmet which makes them felt very hot and profusely sweating. As for the safety issue, 50.0% from the harvesters made a complaint. Details are shown in Figure 2.

### Harvesters' Perception toward the Existing Safety Helmets

There were 79.0% of the harvesters liked the existing safety helmet and 61.3% of the harvesters found that the



**Figure 2: Main issue from interview session**

existing safety helmet was attractive. Meanwhile, in term of safety, 98.4% of the harvesters thought the existing safety helmet can help them in avoiding any injuries at the workplace. Furthermore, harvesters also were asked about the durability of the safety helmet where 86.3% of the harvesters agreed that the existing safety helmet was durable. Details are shown in Table II.

**Table II: Harvesters' perception towards existing safety helmet**

Worker's Perception	Frequency (n)	Percentage (%)
<b>Do you like the existing safety helmet?</b>		
Yes	98	79.0
No	26	21.0
<b>Did the existing safety helmet is attractive?</b>		
Yes	76	61.3
No	48	38.7
<b>Did the existing safety helmet can help you in avoiding any injuries at workplace?</b>		
Yes	122	98.4
No	002	1.6
<b>Did the existing safety helmet is durable?</b>		
Yes	107	86.3
No	017	13.7

N=124

### Subjective Preference of New Prototypes Safety Helmets Device

72.6% of the harvesters preferred prototype of safety helmet C to be worn for work in the plantation. Moreover, for the perceptions based on visual, 71.8% of the harvesters preferred prototype of safety helmet C in term of design's aspect. Prototype of safety helmet C also was the most preferred in term of comfortable and functionality by 65.3% and 41.9% respectively. Details are shown in Table III.

**Table III: Subjective preference of new prototypes of safety helmets device**

Worker's Preference	Frequency (n)	Percentage (%)
<b>Most preferred</b>		
A	09	7.3
B	17	13.7
C	90	72.6
D	08	6.5
<b>Most preferred</b>		
A	09	7.3
B	17	13.7
C	90	72.6
D	08	6.5
<b>Design</b>		
A	05	4.0
B	21	16.9
C	89	71.8
D	09	7.3
<b>Comfortable</b>		
A	17	13.7
B	17	13.7
C	81	65.3
D	09	7.3
<b>Functionality</b>		
A	21	16.9
B	39	31.5
C	52	41.9
D	12	9.7

N=124

## DISCUSSION

### Main Issues Related to the Existing Safety Helmet (Questionnaire Session)

Among the common issues related to the current safety helmet was regarding the ventilation, safety and also discomfort. There were 97.6% of the harvesters complained that they were sweating profusely when using the existing safety helmets, which indicates the issues of ventilation. The existing safety helmet designs do not have ventilation holes on the top and at the side of head, which can make harvesters feel suffocated during harvesting, especially during the hot weather. Design of safety helmet with no ventilation holes results in poor air circulation inside the safety helmet which can cause them to sweat during harvesting. As illustrated in the study that states where the temperature and humidity inside the helmets were higher than outside of helmets by as much as 5 °C and 39% respectively (11). The head is pivotal in removing body heat. It has presented that there is drop of resting metabolic heat around 30% and 19% is decline from heat from work due to head cooling. (12). In addition, when the body in relaxing situation, almost 30% of the body's heat dissipation takes place over the head (13). Consequently, a helmet may significantly block the discharge of body heat, it becomes the source of discomfort to the wearer in a hot environment (10).

Meanwhile, in term of safety, 68.5% of the harvesters complained that the existing safety helmets limit their range of vision when conducting their work, 71.0% complained that the existing design of safety helmets disturbed them when they want conducting work. These situations cause by tips of the safety helmet that agreed by the harvesters for 43.5%. These safety issues can lead to multiple ergonomics risk factors of developing musculoskeletal disorders (MSD). The harvesting task for cutters requires the harvesters to naturally tilt up their head during harvesting in order to get the fresh fruit bunches from the tree (14). As the palm oil trees grow, the height oil palm increases correspondingly. Oil palms are capable of growing up to 20 meters. Thus, the harvesters are required to continuously tilt their heads upward in order to discover the ripe fruits which will be more strenuous for them. Therefore, if the current safety helmets disturb the harvesters in conducting their work properly, it can indirectly reduce the performance and productivity of their work. This is not aligning with the concept of ergonomic which is to optimize the human well-being and overall work performance (15).

As for the discomfort aspect, 66.1% of the harvesters experienced discomfort when using the existing safety helmets. Most of them experienced discomfort at the neck and head part by 34.7% and 26.6% respectively. The study conducted at the palm oil estate found

that harvesting task includes the mixture of adverse ergonomic postures in awkward posture that neck is tilted upward, extension of hands and arms and the shoulder were flexed beyond the shoulder height for an extended duration (14). Moreover, trunk and neck were also detected to be slightly rotated and flexed forward during cutting. The arduous harvesting tasks cause the harvesters to experience severe discomforts. Therefore, from this study, it can be suggested that harvesters felt that the safety helmets increase more discomfort for them during harvesting. Every safety helmet that does not suit the users' comfort will cause adverse health consequences which can reduce their job performance (8).

### **Main Issues Related to the Existing Safety Helmet (Interview Session)**

Besides giving out the questionnaire, the findings were also obtained from the interview sessions with six respondents from the plantations as a qualitative assessment. Among emphasized issues related to existing safety helmets were regarding the weight, discomfort, ventilation and also safety. From the findings, 83.3% of the complaints were about the weight of the existing safety helmets. Based on the interviews with the harvesters, the weight of the existing safety helmets was quite heavy and exerts pressure onto their heads and necks, causing them to feel discomfort. The previous study also indicates that the ideal weight of the existing hard hat was 425g (16). However, the weight of the existing safety helmet recorded used by the harvester was 410g from the Proguard Company's model. In order to fully understand the problem, there were several possibilities that could explain the different types of discomfort. For instance, the discomfort issue is may due to mental perception than a physical burden (17). This contradicts the findings because the weight of the existing safety helmet was considered light in comparison to the standard of the ideal weight.

However, most of the harvesters worked for 10 to 12 hours per day and the harvester used the safety helmet while harvesting the oil palm with its height within 3 to 5 meters from the ground (8). From the observation, although harvesters wore the safety helmet, they tend to remove the safety helmet while working especially during the hot weather or when they felt discomfort. 83.3% of the complaints were about the discomfort of the existing safety helmet. Interestingly, only 5% to 10% of the workers wore their helmets in the field study (9). This suggests that the discomfort of the existing safety helmet which caused the harvester to refuse to wear the safety helmet. A helmet essential to be established with satisfactory weight, comfort, fit and adequate ventilation (17).

Meanwhile, there were 66.7% of the harvesters who complained that they were profusely sweating when using the existing safety helmet which indicates the

issue of ventilation. From the interview, the harvesters said the helmet is very hot and eventually can contribute to headache and also cause the loss and damage hair. This situation indicates the health consequences from wearing the existing safety helmet given by the management. This contradicts with the responsibilities of companies and self-employed persons to their workers that a need to ensure the practicable, safety, health and welfare at workplace in the greatest situation (18). Lack ventilation, heavy weight and loose size is the psychophysical causes which that accumulate for the negative effect towards comfort influences of the helmet (17).

**The Harvesters' Perception of the Existing Safety Helmet**  
This study also has identified harvesters' perception of the existing safety helmet device. Based on the meeting session with management, harvesters tend to just accept any personal protective equipment (PPE) provided by the management without complaining. In addition, the workers at work must use protective equipment or clothing supplied by the company for whole working hour in order to inhibit risks (18). Therefore, it is very crucial for the management to provide the safety helmet that can give enough protection and comfort to the harvesters. This is because every employer should take all reasonable steps to ensure that any protective equipment provided to the employee is appropriately used (19).

Meanwhile, in terms of safety, 98.4% of the harvesters thought the existing safety helmet could help them in avoiding any injuries at the workplace. Based on the previous field study, about 91.6% of the harvesters know that the use of safety helmet is compulsory while about two thirds (84.8%) of harvesters agreed that wearing safety helmet during work makes them feel safer. However, about 66.3% of harvesters stated that they wear a safety helmet just to meet the needs of management in case of audit and quality control (3).

Furthermore, harvesters also were asked about the durability of the safety helmet during the interview where 86.3% of the harvesters agreed that the existing safety helmet was durable. However, most of the harvesters' complaints about the durability of the suspension located inside of the safety helmet other than the outer shell of the safety helmet itself. Harvesters commented that the suspension inside the safety helmet needed to be changed frequently in every month need to get the replacement as it will be easily damaged.

Nevertheless, based on the observation, harvesters did not perform the safe practice regarding care and maintenance of the safety helmet. They agreed that there are a training regarding the maintenance of safety helmet but they did not practice to care the hygiene of helmet. The safety helmet should properly be stored, cleaned and inspected periodically in providing the intended

protection to workers over the intended service life of safety helmet. Indeed, the safety helmet can never be effective unless it is adequately worn for the purpose (20).

### Subjective Preference of New Prototypes Safety Helmets Device

Subjective preference of the new prototypes safety helmets device was collected from 124 palm oil plantation harvesters. The results showed that safety helmet C was the most preferred by the harvesters in many aspects. From the observation, most of the harvesters attracted to the design of safety helmet C which had more ventilation holes on the top and the side of the head compared to other prototypes. This can be associated based on the questionnaire session which there were 97.6% of the harvesters complained that they were profusely sweating when using the existing safety helmet which indicates the issues of ventilation. Thus, harvesters would attract more to the design of a safety helmet which can give more ventilation to the head. The excessive sweat will be predictable due to the hot climate and also insufficiency ventilation of the safety helmets. The amendment of safety helmet design is required in order to reduce heat and sweat (9). The function of ventilation holes that located at the top of helmet shell is to provide comfort to the user as the increasing of air distribution inside the helmet (10).

Besides, harvesters are also attracted to the weight of the safety helmet C which was light compared to other prototypes. This can be associated based on the interview session where 83.3% of the complaints were about the weight of the existing safety helmet. The heavy materials that cause extra weight of the helmet contributes to discomfort (21). The minor reduction of weight, such as 45g in helmets weighing about 350g, the change weight was noticed by the wearers (10). The previous study also presented the workers complained about the deficient of existing helmet even though they are only wearing it for one month (9). Figure 3 below shows the new design for the prototype of safety helmet



**Figure 3: The new design for the prototype of safety helmet**

C which is the most preferred by the harvesters.

### CONCLUSION

Throughout this study, it can be suggested that the existing safety helmet used by the palm oil plantation harvesters is found to be uncomfortable and was not ergonomically designed. In order to solve the emphasized issues from the existing safety helmets, four new safety helmets designs were proposed to the harvesters as a preference. The aim of this study is to determine the subjective preference of a new prototype safety helmet device among harvesters. The preferences factors of safety helmet C is due to sporty design, extra ventilation holes and trendy design. Thus, the results of this study show that safety helmet C was the most preferred by the harvesters for many reasons. With regard to the subjective preference of the safety helmet among the harvesters, it is highly recommended for further study that involves testing of safety helmet C being conducted to confirm the effectiveness of the safety helmet preferred by the harvesters.

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