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THE POTENTIAL USE OF GLOW-IN-THE-DARK SAFETY HELMET FOR ENHANCED WORKER SAFETY

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ABSTRACT

Abstract: *Nighttime construction work poses significant safety risks due to poor visibility, increasing the likelihood of accidents and injuries for both workers and drivers. This paper addresses the need for enhanced worker safety during night shifts and proposes the development and marketability of glow-in-the-dark safety helmets. The research questions focus on the construction of a prototype using an improvised design, the importance of demonstrating the helmet's performance, and the development of commercial viability. The study aims to produce a safety helmet that glows in the dark, improving comfort, visibility, and productivity for construction site workers. The report highlights the limitations of conventional safety helmets in low-light conditions and the higher risks faced by night-shift workers. By incorporating photoluminescent coatings, glow-in-the-dark safety helmets emit light after exposure to natural or artificial sources, significantly improving worker visibility in poorly illuminated areas. The advantages of these helmets include increased visibility, reduced risk of head injuries, improved safety awareness, and enhanced worker morale. The paper also emphasizes the marketability of glow-in-the-dark safety helmets, particularly in industries such as construction, manufacturing, and utilities, where worker safety is paramount. Compliance with safety regulations and the integration of innovative technologies further contribute to their appeal.*

Keywords: *construction safety, construction site worker, glow-in-the-dark, safetyhelmet*

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INTRODUCTION

Construction site safety is an aspect of construction-related activities concerned with protecting construction site workers and others from death, injury, disease, or other health-related risks. Report by The International Labour Organization (ILO, 2019) found that falls, electrocution, crush injuries, and caught-between injuries were the most common causes of occupational deaths on construction sites. Although many risks are present on construction sites, the frequency of accidents differs among areas and nations due to different safety cultures and worker safety behaviours. In the Occupational Safety and Health Administration Handbook (OSHA) used by the United States, 2015, fall protection is needed in areas including but not limited to ramps, runways, and other walkways; excavations; hoist areas; holes, formwork; leading-edge work; unprotected sides and edges, overhand bricklaying and related work; roofing: precast concrete; wall openings, floor openings such as holes; residential construction; and other walking-working other countries have regulations and guidelines for fall protections to prevent injuries and deaths.

Safety helmets are among the most often used items of personal protective equipment in settings including construction sites, industrial facilities, and mining operations. According to Huziej (2021), safety helmets can reduce or prevent head and brain injuries by shielding wearers from rain, electric shock, falling objects, and other dangers. Different types of helmets offer various levels of protection against the elements, electric shock, flying objects, and other perils. Various safety helmet options are available in the market. Proper selection can mean the difference between life and death. High-visibility clothing and temporary lights are essential to ensure that workers are visible to all drivers, including those operating work vehicles and equipment. Glow in the Dark Road Studs is an eco-friendly road that lights up at night without needing power. The ability to generate light without heat or an electrical connection makes photoluminescent safety signs helpful. It is, therefore, frequently used in professions where dangerous situations are brought by moving cars or poor lighting. These professions include those in the emergency services, transportation, and train industries. Therefore, the needs of Glow in the Dark are ultimately important as it has already implemented in other industries, and this has become main attention for innovation study.

In addition to the dangers connected with construction site safety, working in dark surroundings presents a distinct set of obstacles and hazards for employees. When vision is reduced due to poor lighting or dark circumstances, the risk of accidents and injuries increases considerably (Government of Canada, 2023). Workers may struggle to recognize trip hazards, debris, or uneven surfaces in these low-light or dark settings, increasing the probability of slips and falls. Furthermore, handling large gear and equipment becomes more dangerous since operators may struggle to see surrounding employees or obstructions. When electrical risks, such as exposed wires or faulty equipment, are hidden in darkness, they become much more dangerous, increasing the risk of electrical shocks and fires. Furthermore, in an emergency, a lack of proper illumination might impede evacuation operations, putting personnel in potentially life-threatening conditions. Employers must establish comprehensive safety procedures and provide appropriate personal protection equipment, such as high-visibility clothes, safety helmets, and photoluminescent safety signs, to meet these unique dangers.

Material and Method

The development of glow-in-the-dark safety helmets represents a sophisticated process that combines materials science and safety engineering to address the unique challenges of working in low-light or dark environments.

First and foremost, the choice of materials is critical. The outer shell of these helmets must be carefully selected to accommodate photoluminescent pigments effectively. These pigments are special compounds that have the unique ability to absorb and store energy from external light sources. Typically, phosphorescent pigments are used due to their efficient light-absorbing and emitting properties.

The integration of photoluminescent pigments into the helmet's outer shell is a precise task. Manufacturers mix these pigments into the helmet's base material, ensuring a consistent distribution. This material is designed to absorb and store energy from light sources, effectively "charging" the helmet for later use.

Charging the helmet is a straightforward process. Workers expose the helmet to natural or artificial light for a specified duration. During this time, the photoluminescent pigments within the helmet absorb and store the light energy. The duration and intensity of the charging process can vary depending on the helmet's design and the specific photoluminescent pigments used (Pacfire, 2019).

Once charged, the helmet is ready to provide its distinctive glow-in-the-dark effect. In low-light or dark conditions, the stored energy is gradually released in the form of

visible light, typically emitting a soft, greenish or bluish glow. This emitted light enhances visibility, allowing workers to remain easily identifiable and safe.

Extensive testing and certification procedures are crucial to validate the effectiveness of these helmets. This includes evaluating how long the helmet remains visible in the dark after charging and assessing its durability under various environmental conditions. These tests ensure that the helmet performs reliably when needed most.

After successful testing and certification, these glow-in-the-dark safety helmets are manufactured on a larger scale and distributed to industries where low-light or dark conditions are prevalent. Such industries include construction, mining, emergency services, and transportation. Training workers in the proper use and maintenance of these helmets is essential. They need to understand the importance of periodically recharging the helmet by exposing it to light to ensure it remains effective in enhancing safety.

Manufacturers continually strive to improve this technology. Ongoing research and development efforts focus on refining the glow-in-the-dark properties, durability, and comfort of these safety helmets, considering user feedback and advancements in materials science. This continuous improvement ensures that these helmets remain at the forefront of safety innovation, serving as vital tools for safeguarding workers in challenging low-light or dark work environments.

Fig. 1 shows the overview of the components for glow-in-the-dark safety helmet. Fundamentally, the glow-in-the-dark safety helmet composes of three parts, namely the outer shell, helmet liner, chin strap and glow in the dark chemical. All the components can be easily purchased from local hardware shop and/or online shop.



Figure 1: The components for glow in the dark safety helmet

A few precisely completed stages go into the making of a glow-in-the-dark safety helmet. First, the helmet's exterior shell is made of sturdy, impact-resistant materials like polycarbonate or ABS plastic. The use of these materials ensures the wearer's

safety since they can endure possible impacts and offer a trustworthy barrier against penetration hazards.

The interior liner of the helmet is made of lightweight Expanded Polystyrene (EPS) foam. EPS foam is particularly developed to effectively absorb and distribute impact energy. This critical layer of foam functions as a cushion, protecting the wearer's head from potential damage in the situation of an accident or collision.

The helmet has a chin strap made of resilient nylon or polyester webbing that ensures a secure and comfortable fit. This adjustable strap keeps the helmet firmly in place on the wearer's head, preventing it from slipping or shifting during usage. The reliable chin strap enhances the helmet's overall stability and protection.

The helmet also has a glow-in-the-dark function to improve visibility in low-light or nighttime circumstances. This is accomplished by mixing strontium aluminate powder and epoxy resin. The powdered strontium aluminate includes phosphorescent pigments or chemicals that may absorb and store light energy. When exposed to ambient light, these pigments or compounds absorb the light energy, allowing them to emit a glow once the light source has faded. The epoxy adhesive acts as a binding agent, successfully bonding the strontium aluminate particles to the safety helmet's surface. This results in a long-lasting glow-in-the-dark effect. This function considerably improves the wearer's safety by making the helmet visible even in low-light or nighttime conditions. It allows for simple identification and guarantees that the user is visible to others, lowering the risk of mishaps or incidents caused by poor visibility.

In summary, the process of creating a glow-in-the-dark safety helmet involves the construction of a sturdy outer shell, the implementation of impact-absorbing EPS foam for the inner lining, the inclusion of an adjustable and secure chin strap, and the application of a glow-in-the-dark material consisting of strontium aluminate powder and epoxy resin. This comprehensive design guarantees both physical protection and increased visibility, ultimately prioritizing the safety of the wearer.

LIMITATION OF STUDY

A study on the efficacy of glow-in-the-dark safety helmets may also have the following limitations:

- This is a conceptual study. There is no data collection or lab testing involved. This due to the time limitation.
- Limited testing conditions: If the helmets are only evaluated in certain lighting scenarios, such as complete darkness or low light, the results might not be generalizable.
- Limited population: The results may not apply to other groups of people who may also use helmets if the study solely included members of one group, such as construction workers.

All of the aforementioned restrictions may have an impact on the study's overall validity and generalizability. When analysing the findings of any research on the efficacy of glow-in-the-dark safety helmets, it is crucial to take these limitations into account.

Ratio Glow in The Dark Materials.

There is no specific ratio for glow-in-the-dark material that should be used in a safety helmet. The amount of material utilized varies based on the manufacturer and helmet model. However, the amount of glow-in-the-dark material used is often modest. This is because the material is not required for the helmet's structural stability. The glow-in-the-dark material is merely applied to increase the visibility of the helmet in low-light conditions.

In most cases, the ratio of glow-in-the-dark material to epoxy used in a safety helmet is 1:3. This implies that for every one component of glow-in-the-dark powder, it requires three grams of epoxy. The amount of glow-in-the-dark powder you use will be determined by the size and thickness of the helmet, as well as the desired brightness of the glow. However, the 1:3 ratio is a suitable starting point for most applications. Table 1 indicates the estimated amount of glow-in-the-dark powder and epoxy are required for different helmet sizes.

Table 1: the estimated amount of glow-in-the-dark powder and epoxy for different sizes of helmets

Helmet size	Glow in the dark powder	Epoxy
12 inches in diameter and 1 inch thick	113.40 gram	340.19 gram
18 inches in diameter and 2 inches thick	170.10 gram	510.29 gram
24 inches in diameter and 3 inches thick	226.80 gram	680.39 gram

Advantages of glow in the dark safety helmet.

Glow-in-the-dark safety helmets are a versatile and indispensable solution that addresses a myriad of workplace challenges, making them an asset in a widerange of industries and settings. These helmets primarily excel in their ability to enhance worker visibility in low-light or dark conditions. By emitting a soft, glowing light, they significantly reduce the risk of accidents that often occur due to reduced visibility, such as collisions between workers or slips and falls on uneven surfaces. Whether it's a construction site at night, a dimly lit industrial facility, or an emergencyresponse situation, these helmets act as beacons, ensuring that workers remain easily noticeable, thereby enhancing overall workplace safety.

Equally crucial, these helmets offer robust head protection. They are engineered with advanced materials and designs that are adept at absorbing and dispersing the force of potential head injuries. In environments where falling objects, debris, or impacts pose inherent risks, these helmets provide an essential safeguard. The assurance of head protection not only contributes to a safer work environment but also bolsters workers' confidence in carrying out their tasks, knowing that they are well shielded against potential accidents.

Beyond their tangible safety benefits, these helmets have a profound impact on safety awareness among workers. The inherent glow-in-the-dark feature serves as an ongoing reminder of the paramount importance of vigilance and attentiveness in the workplace. This heightened awareness becomes an integral part of the workplace culture, effectively reducing the likelihood of accidents caused by lapses in concentration and instilling a proactive safety mindset among employees.

Moreover, these helmets play a pivotal role in enhancing worker morale. When employees perceive that their well-being is a top priority through the provision of advanced safety equipment, they exhibit higher job satisfaction and confidence in their workplace. This, in turn, fosters a positive safety culture within the organization, where employees actively engage in safety practices, leading to fewer accidents and a safer working environment.

From a financial perspective, these helmets offer significant cost savings by preventing workplace injuries, particularly head injuries. Head injuries are among the costliest workplace accidents, often resulting in substantial workers' compensation expenses and medical costs. By mitigating the risk of such injuries, employers can realize substantial financial savings, making the investment in these helmets a sound business decision.

In terms of productivity, the sense of security provided by glow-in-the-dark helmets directly influences worker efficiency. Employees who feel secure and protected in their work environment tend to be more focused and productive. This heightened focus translates into tasks being completed more efficiently and effectively, benefiting the organization. In emergency situations, these helmets prove indispensable. Their glow-in-the-dark feature facilitates swift and efficient emergency response efforts, aiding in the quick identification and location of workers during evacuations. This capability is a critical factor in potentially life-threatening scenarios, where every second counts.

Furthermore, these helmets ensure regulatory compliance with safety standards and regulations that mandate the use of high-visibility gear in specific working conditions. Compliance is not only a legal requirement but also an integral aspect of maintaining a safe work environment and avoiding potential legal liabilities and fines.

Durability and longevity are also noteworthy advantages. These helmets are constructed using premium materials like ABS plastic, fiberglass, and carbon fiber, ensuring exceptional durability and a long lifespan. This longevity not only results in long-term cost savings but also ensures that workers receive reliable and efficient protection throughout the extended lifespan of these helmets.

Lastly, these helmets showcase adaptability to evolving technology. They serve as a platform for integrating advanced features, such as built-in sensors, augmented reality displays, or GPS tracking, into workplace safety protocols. This adaptability positions them at the forefront of safety innovation, ensuring that they remain relevant and effective in addressing emerging workplace challenges.

In summation, glow-in-the-dark safety helmets offer a multifaceted and comprehensive approach to tackling workplace issues. They excel in enhancing safety, preventing injuries, fostering a positive safety culture, improving productivity, and yielding significant cost savings. Their adaptability to emerging technology further cements their role as a dynamic and essential safety solution across various industries, making them an investment that not only safeguards workers but also enhances overall workplace efficiency and financial stability.

CONCLUSION AND RECOMMENDATION

In conclusion, the development of the glow-in-the-dark safety helmet represents a significant breakthrough in the field of safety gear technology. By effectively addressing the issue of visibility in low light environments, this innovation greatly reduces the risk of accidents and enhances overall safety for workers. The helmet's ability to emit a bright glow ensures that users remain highly visible even in poorly lit areas, increasing their chances of being noticed by colleagues, machine operators, or onlookers. This additional layer of visibility significantly mitigates potential hazards and accidents.

The launch of the glow-in-the-dark safety helmet sets a new standard for the industry, showcasing the possibilities that arise when innovation and safety converge. This innovative product serves as an exemplar of how functional and practical upgrades can be incorporated into conventional safety gear, leading to the reinvention of workplace safety standards. Its introduction fosters an environment of innovation, encouraging manufacturers to re-evaluate their designs and prioritize visibility and enhanced safety measures in their products.

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Tarikh : 20 Januari 2023

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