Flexible Smartlight for Loading and Unloading Process: A Safety Features

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Abstract

The Flexible Smartlight is a vital tool designed to enhance safety during warehouse operations, especially for loading and unloading at docks. It addresses key safety concerns, improves operational efficiency, and reduces downtime, thus boosting overall productivity in warehouse logistics. The main aim of the Flexible Smartlight is to prevent product damage and minimize productivity losses due to accidents. Unlike traditional forklifts and inadequate warehouse lighting, it offers advanced, precisely positioned illumination options that align with modern technological trends. This innovation significantly improves warehouse safety technology, providing a comprehensive solution to mitigate risks and ensure the safety of both personnel and assets. Furthermore, the Flexible Smartlight aligns with several Sustainable Development Goals (SDGs). Researchers predict widespread commercial adoption of the Flexible Smartlight, extending beyond PKT Logistics to other warehouse firms, further reinforcing its positive impact on sustainable development.

Keywords: Flexible Smart light, Loading and Unloading, Safety Features, Sustainable Development Goal.

1.0 Introduction

Micro-credential (MC) is gaining global attention as a flexible learning The innovation project focused on addressing a critical safety concern within dock operations: poor visibility within containers during loading and unloading process with low visibility conditions, particularly when forklifts move over inside containers to retrieve pallets (Nenneh M, 2023). These conditions not only pose a threat to the safety of personnel but also increase the likelihood of accidents and damage to goods.

To tackle this issue, the project embarked on a comprehensive research phase to understand the root causes of poor visibility within containers and to identify viable solutions. This involved conducting site visits, consulting with industry experts, and reviewing existing safety protocols and technologies. Through this process, it became evident that a targeted lighting solution could significantly improve visibility and mitigate safety risks.

The development phase focused on designing a Flexible Smartlight system tailored to the unique requirements of container operations. The system incorporated robust, energy- efficient light emitting diode (LED), strategically

positioned to illuminate key areas within the container, ensuring optimal visibility for forklift operators. The LED lights are known for their energy efficiency and long lifespan, contributing to sustainability goals (SDGs) by reducing energy consumption and maintenance costs (Zafar S, 2023).
Objectives of study as follows:
a. Identify area with minimum lighting levels.
b. Build a flexible smartlight ensuring that light is emitted evenly and without distracting shadows.
c. To establish energy consumption reduction targets by choosing LED lights as well as implementing a good automatic lighting regulation system to control energy consumption of the PKT Logistics workers.

Technological advancements in lighting, such as the integration of LEDs with intelligent light control systems, have significantly reduced energy consumption in industrial environments. For instance, combining LEDs with advanced motion and occupancy sensors can further decrease energy usage by ensuring that lights are only on when necessary (Singh et al., 2021). Moreover, the incorporation into lighting systems enables automatic light control with closed-loop feedback, enhancing service provision while cutting energy consumption (Zhang et al., 2023). Research in this field explores how emerging technologies can be integrated with existing infrastructures, identifying both the challenges and opportunities for seamless incorporation across various industries. This ensures compatibility with legacy systems, standards, and protocols while promoting energy efficiency and sustainability.

Maintaining regulatory compliance and adhering to industry standards is crucial for operational efficiency and safety. A comprehensive Fleet Vehicle Policy, for instance, outlines effective driver hiring, training, scheduled maintenance, and compliance with federal and state regulations, thereby preventing the loss of company assets (Alternative Fuels Data Center, 2023). In recent years, advancements in energy efficiency and renewable energy have been driven by innovative solutions that extend from smart homes to smart grids, and the future of smart cities and factories (Pitchai P. et al, 2023). New lighting technologies, such as LEDs, have become popular due to their energy efficiency and long lifespan. Research in regulatory compliance and industry standards critically examines how businesses meet legal requirements and industry benchmarks, aiming to understand compliance challenges, identify best practices, and develop effective implementation strategies across various sectors.

Increasing pressures from a variety of stakeholders, such as investors, consumers, media, and society, are making sustainability a key driver in logistics decision-making processes (Dobers et al., 2019). This is also true for logistics sites, where sustainability is closely related to the efficiency of resources and materials employed. Digital technologies and energy-efficient systems have become increasingly widespread, such as LED lighting and light sensors, lithium-ion batteries for material handling equipment, and fast chargers (Rajput and Singh, 2020). Research in environmental sustainability

and energy efficiency aims to identify strategies for reducing carbon emissions and mitigating climate change through the adoption of renewable energy, energy-efficient technologies, and sustainable practices.

2.0 Methodology

Several types of instruments are used to gather information in this study. One of the instruments related to qualitative methods is the use of structured interviews. The study involves conducting structured interviews with 50 workers and supervisors regarding the safety challenges faced, particularly the lack of clear visual indicators in the loading dock area. Additionally, it is noted that existing safety measures, such as signage or lighting, may be inadequate or insufficient. These structured interviews are conducted formally, carefully planned in line with the research objectives. The questions prepared for the interviews are kept concise to avoid straying from the research objectives and to simplify the process of managing and analyzing data.

This method is employed to gather information and aid in the development of the Flexible Smartlight. The interview questions with workers and supervisors aim to identify the specific safety needs before designing and implementing the safety innovation project (Table 1).

Table 1: Simple Yes/No Interview Questions

No	Interview Questions
1	Is good lighting important in warehouse areas?
2	Do you feel that bad lighting in the warehouse will launch warehousing activities?
3	Have you ever had an incident due to a lighting problem?
4	Is the warehouse you work in equipped with enough lighting?
5	Do you find it difficult to operate in low-light conditions?

Innovation project carried out based on the results of interviews. This innovative project is called the Flexible Smartlight. To develop this safety feature, several hardware and software are necessary, including LED lighting technology, mounting hardware, wiring, control panels or switches, and optionally, a mobile phone for remote monitoring. Furthermore, the Flexible Smartlight aims to enhance safety measures during loading and unloading operations by providing clear visual signals of potential hazards. It serves as an integral part of promoting a culture of safety within PKT Logistics facilities.

Figure 1: Components for Flexible Smartlight

All the components in Figure 1 were prepared. First, use four 1.3cm heading nails to cross- tie the eight number boards, then fix them with four orange fixing rings, and finally use six 1.3cm heading nails to connect all the No. 1 boards and use six orange fixing rings.

Figure 2: Assemble all Components

Figure 2 shows the installed components. Figure 3 shows an illustration of the Flexible Smartlight installation in the loading and unloading area of the container.

Figure 3: Flexible Smartlight Installation

A set of questionnaires will be distributed involving 50 workers of PKT logistics after the installation of the Flexible Smartlight. This questionnaire uses a Likert scale (Robinson J, 2023) which will be analysed using the level of tendency through the mean score (Mohamad Rasit R, 2020)..

3.0 Result and Discussion

The innovation project carried out involves several levels of analysis. The first analysis begins with the findings obtained based on the analysis of interview before the innovation project was produced. While the second analysis refers to the findings of the questionnaire after the innovation project was installed.

Table 3: Findings of the Interview BEFORE Production of the Innovation Project

No	Interview Questions	Yes (%)	No (%)
1.	Is good lighting important in warehouse areas?	100	-
2.	Do you feel that bad lighting in the warehouse will launch warehousing activities?	-	100
3.	Have you ever had an incident due to a lighting problem?	80	20
4.	Is the warehouse you work in equipped with enough lighting?	20	80
5.	Do you find it difficult to operate in low light conditions?	100	-
6.	Have you ever voiced your opinion to the superiors to improve the lighting?	80	20

Table 4 is the findings of level of tendency after the installation of Flexible Smartlight use in daily operations. Based on the analysis in table 4 above, it was found that the respondents were on a medium-high tendency between 3.00 - 4.00 (Mohamad Rasit R, 2020). It can be concluded that the respondents agree that this project can facilitate the workers in daily operations. More than a majority of employees expressed their approval of this effort, reflecting their joy and enthusiasm for the changes experienced.

Table 4: Results of Mean Score versus Tendency Level

No.	Feedback	Mean Score	Tendency
1.	I understand function Flexible Smartlight	4.16	High
2.	Flexible Smartlight designed to be user-friendly	3.90	Medium High
3.	The information in the manual provided is easy to understand	3.98	Medium High
4.	Flexible Smartlight is easy to install?	3.88	Medium High
5.	Flexible Smartlight can be customized according to the desired use	3.92	Medium High
6.	The use of safety dock light has helped the work operation	3.78	Medium High
7.	Flexible Smartlight helps reduce accidents	3.86	Medium High

8.	Flexible Smartlight is a device that uses low electricity	3.78	Medium High
9.	Flexible Smartlight can be commercialized in fields other than warehousing	3.84	Medium High
10.	I would suggest a safety dock light for use in all parts of the warehouse	3.88	Medium High

Upon implementation (Figure 4), the Flexible Smartlight system demonstrated remarkable effectiveness in enhancing visibility and safety during loading and unloading activities. Not only did it reduce the likelihood of accidents and injuries, but it also improved operational efficiency by facilitating smoother and more precise move over within the container environment. Overall, the project represents a significant advancement in dock safety practices and underscores the importance of innovation in addressing industry-specific challenges.

Figure 4: Functional Flexible Smartlight

4.0 Conclusion

This topic covers the conclusion and recommendations referring to the results of the conducted innovation project. It provides an overall summary of the project based on SWOT analysis, which includes Strengths, Weaknesses, Threats, and Opportunities, to generate suggestions and improvements in this study. Additionally, the study presents new ideas or innovations based on research findings. The significant implications of the study on the field of innovation projects are also emphasized. The Table 5 below list the SWOT analysis with a detailed description of each relevant important content.

Table 5: Swot Analysis

No.	Strengths	Weaknesses	Opportunities	Threats
1.	Improved Safety	Dependency on Electricity	Technological Advancements	Market Competition
2.	Reduced Accidents	Installation Costs	Compliance Opportunities	Regulatory Changes
3.	Increased Productivity	Limited Usage	Global Market	Technical Risks

The SWOT analysis presented in Table 5 above outlines the strengths of the Flexible Smartlight project, which aims to enhance safety measures in their dockyard operations. This innovative solution provides numerous benefits, including improved visibility and safety for workers and vehicles navigating the dockyard. By installing Flexible Smartlight, can significantly reduce the risk of accidents and injuries, thus enhancing overall operational efficiency.
One of the strengths of this project is its effectiveness in mitigating safety hazards and minimizing the likelihood of accidents. The Flexible Smartlight serve as a visual aid, clearly marking the boundaries and hazardous areas within the dockyard, thus reducing the risk of collisions and incidents. Additionally, the implementation of these lights demonstrates commitment to safety and regulatory compliance, which can enhance its reputation and credibility in the industry.

Moreover, the Flexible Smartlight is designed to be durable and weather-resistant, ensuring reliable performance even in harsh environmental conditions. This reliability ensures continuous operation and minimizes the need for frequent maintenance, resulting in cost savings in the long run.
However, one potential weakness of this project is the initial investment required for the installation of the Flexible Smartlight. While the long-term benefits outweigh the costs, the upfront expenses may pose a financial challenge. Additionally, there may be logistical challenges involved in the installation process, such as coordinating with other ongoing operations and ensuring minimal disruption to workflow.

Despite these challenges, there are several opportunities associated with the Flexible Smartlight project. For instance, can leverage this initiative to differentiate itself from competitors and attract new clients who prioritize safety standards. Furthermore, the implementation of innovative safety measures can position as an industry leader in safety practices, potentially leading to partnerships and collaborations with other organizations.
However, it is essential to consider potential threats to the success of this project. One such threat is the possibility of technological advancements or regulatory changes that could render the Flexible Smartlight obsolete or non-compliant with industry standards. Additionally, competitive pressures from other logistics companies may necessitate continuous improvement and innovation to maintain a competitive edge in the market.

In conclusion, the Flexible Smartlight stands out as a critical innovation in enhancing warehouse safety and efficiency. Its advanced features address key operational challenges, making it an essential tool for modern logistics. Moreover, its alignment with multiple Sustainable Development Goals underscores its broader impact on sustainable development. As the Flexible Smartlight gains commercial traction, it promises to set new standards in warehouse safety and operational excellence, contributing significantly to the global efforts towards sustainable industrial practices.

The commercialization process of the Flexible Smartlight system for PKT Logistic was well- planned and thorough. It started with market research and

understanding PKT's operations and safety standards. The system was customized to fit PKT's needs through joint efforts and pilot testing. A comprehensive training program was implemented for PKT staff. Ongoing technical support and maintenance ensured smooth operation. Monitoring systems tracked performance and user satisfaction. A focused marketing campaign highlighted the system's benefits. Overall, the Flexible Smartlight system enhanced workplace safety and operational efficiency at PKT Logistic, setting a new standard for industry practices and innovation.

To enhance the effectiveness of the Flexible Smartlight system, several innovative features and strategies can be implemented. Integrating solar power technology for illuminating dock areas provides a sustainable and efficient lighting solution, ensuring visibility in low-light conditions without relying on traditional power sources. This enhances safety measures by maintaining consistent illumination. Additionally, implementing arm swing safety lights that workers can wear will increase their visibility and signal their movements in real-time, thereby enhancing overall safety awareness and response within the dock environment. Furthermore, ensuring the Flexible Smartlight system is user-friendly and easily accessible to all personnel is crucial. Comprehensive training sessions should be conducted to familiarize employees with the system and its functionalities, promoting efficient utilization of the safety measures and fostering a safer working environment.

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Conflicts of Interest
The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its submission and declare no conflict of interest in the manuscript.

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