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## Project Aslag: An Assessment of Material Application between Photoluminescent Line Marking and Traditional Line Marking at Santa Rita and Porac Mega Dike in Pampanga

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### ABSTRACT

*Car accidents happen around the world, it does not matter if it is a third world or first world country. Stopping accidents from happening is impossible, but prevention and lessening the chances of road accidents are the next ideal step. Hence, this study in Sta. Rita and Porac Mega dike was conducted to assess the effectiveness of photoluminescent line markings to lessen the accidents on the area due to this area having virtually little streetlights, having an elevated road that is several feet above and being a common route for cars, trucks, and motorcycles. Raosoft was used to determine the minimum recommended population. With a total population size of 20,000, a margin of error of 10%, and a 90% confidence level, the minimum recommended sample size is 68. The major instrument that has been used in this study was a survey questionnaire. The questionnaire was validated by a research expert, statistician, and an engineer. This study proved the effectiveness of photoluminescent line marking and is also helpful in reducing accidents along the Sta. Rita and Porac Mega dike. Likewise, it can be used as a guide for the motorist. It can also be easily seen because it is glow-in-the-dark paint. Further, findings about the durability of the photoluminescent line marking indicated that it is reliable in terms of quality and longevity.*

**Keywords:** Photoluminescent, Glow in the Dark, Line markings, Sta. Rita and Porac Mega dike

# 1. THE PROBLEM AND A REVIEW OF RELATED LITERATURE AND STUDIES

## 1.1 Introduction

Driving at night is dangerous and challenging for most people. When distance traveled is considered, fatality rates are higher at night than during the day, particularly for pedestrians and cyclists. Though there are numerous contributing factors, but low nighttime light levels are thought to be the leading cause of nighttime collisions.

with pedestrians and cyclists, most likely due to their reduced visibility. Understanding the visibility issues involved in nighttime driving is critical given the increased risk to road safety. Although dim street lighting is often provided on roads at night, the driver's line of sight is shortened due to the limited brightness and range of this illumination. Low-light conditions at night also impair drivers' judgment of road conditions (Liu J et al., 2019).

People benefit from the use of light at night in a variety of ways. Benefits include increased pedestrian and driver safety, decreased crime fear, increased use of outdoor facilities after dark, increased economic growth, and the creation of beautiful and entertaining built and natural environments. This suggests that the use of light at night is linked to some very basic human motivations, implying that people value such benefits and will not willingly give them up.

Road markings are used to provide information to drivers and pedestrians by applying paint or other materials on the road surface. These markings can be found on roads, sidewalks, and other paved areas, and are used to convey important information such as lane directions, speed limits, and pedestrian crossings (Mathew, 2009).

## 1.2 Review of Related Literature

Road markings vary depending on the country, region, and purpose, but they typically use a standard system of lines, colors, and marks to convey important information. These markings can indicate directions, lanes, zones, speed limits, parking, stopping, and safety rules. By using a standardized system, road markings help to ensure that drivers and pedestrians can easily understand and follow the rules of the road (Babic, 2022).

According to Asdrubali (2013), the most used materials in road and floor marking include water-based paints, thermoplastic, MMA (methyl methacrylate), polymer tape, and epoxy resin. These materials are chosen for their durability, ease of application, and ability to withstand the demands of vehicular and pedestrian traffic. Each material has its own specific characteristics and is used for different purposes, depending on the type of marking being applied and the conditions of the road or floor.

Glow in the dark is another type of luminescence, these materials can keep the energy and as a source of light. This is called phosphors. Phosphors will energize and then radiate light. This is called phosphorescence. When phosphors release energy, they will emit light, which will be glowing. Glow in the dark materials is divided according to technology and the process in which they produce light. The different types of glow technologies are chemical glow, UV light glow, and phosphorus glow (Wieseet al. 2015).

The glow in the dark concept is tried in Netherlands where a road was built using solar panels that are arranged in a serial manner. The principle of these solar roads is that they can store high amounts of energy which can then be transformed in the form of electricity. The energy generated leads to some level of self-sufficiency that can light roads, local amenities, and homes. The glow in the dark project is currently under trial and a stretch of 500 m of road in the N329 Oss Highway has been constructed. These roads, apart from glowing in the dark, also give information regarding the conditions of the weather. This is also supported by life cycle assessment (LCA) that has been used to assess the environmental impact of a product throughout the design phase. These need to be considered for a sound and safe road design with proper signage.

The photoluminescent road line marking innovation utilizing green technologies (the use of technology and science to reduce human impacts on the natural environment) noticeable, ecological, and capable of bringing sustainability. Road markings on highways provide drivers with information on the road conditions and directional assistance that enables them to stay in their lane and gives useful details about the road (IAEME, 2019).

According to Tarmac (2022), the photoluminescent markings used in their new road line system are significantly brighter than traditional white lines. Unlike regular glow-in-the-dark paint, these markings are designed to last throughout the night, providing consistent visibility even on winding roads. The photoluminescent 6 markings are said to have the same lifespan as other thermoplastic coatings, which is typically around three to five years.

A solution that greatly simplifies life for persons who drive at night was presented by Australian businesses Tarmac Linemarkings, OmniGrip, and Vic Roads. On Golden Glow Rd Tara QLD 4421 in Queensland, businesses begin to hit the traffic line with fluorescent thermoplastics that have a durability of more than ten years.

As a result, nighttime drivers are more aware of depth, curve angles, and the very edges of the roadways. Human vision loses a significant amount of its effectiveness at night due only to a lack of light.

The applied layer, which is a few millimeters thick and has excellent mechanical resistance, contributes to the product's relatively high durability.

Photoluminescent materials and technologies can potentially have several applications in the field of civil engineering. Some possible ways that photoluminescent materials could be used by civil engineers include:

As road markings, to improve visibility and safety for drivers and pedestrians at night or in low-light conditions. As emergency exit signs or markers, to help guide people to safety in the event of a power outage or other emergency. As markers or indicators on bridges, tunnels, or other structures, to help guide maintenance workers or emergency responders. In pavement materials, to improve the visibility of roadways and reduce the need for streetlights (RuaSeguridad, 2020).

Overall, the use of photoluminescent materials in civil engineering has the potential to enhance safety, lower energy use, and increase the sustainability of infrastructure. However, before incorporating these materials into their designs, 7 civil engineers must carefully consider the costs and potential drawbacks of doing so.

Photoluminescent road markings are a type of road marking that are designed to be highly visible in low light conditions, such as at night or in bad weather. They use a photoluminescent material that absorbs light during the day and then glows in the dark, providing a visible guide for drivers (Bencheng, et al., 2021).

There are several potential advantages to using photoluminescent road markings. For example, because they are highly visible in low light conditions, they can help improve safety by making it easier for drivers to see where they are going. They are also more environmentally friendly than traditional road markings because they do not require electricity or other external sources of power to function. Additionally, photoluminescent road markings may be more durable than traditional markings, which can fade or become damaged over time (Anderson, et al., 2022).

However, there are also some potential disadvantages to using photoluminescent road markings. For example, they may not be as visible in bright light conditions, such as during the day, when they are not glowing. Additionally, they may be more expensive to install than traditional road markings, which could be a barrier for some organizations or governments. Finally, photoluminescent road markings may require more regular maintenance than traditional markings, to ensure that they continue to function properly (Cornes, 2018).

Overall, using photoluminescent road markings has the potential to improve road safety, have a smaller negative environmental impact, and be more durable. However, before deciding whether to use them, it's crucial to carefully weigh the potential drawbacks and restrictions of these markings.

### 1.3 Background of the Study

Sta. Rita and Porac Mega dike in Pampanga is a dike that has a distance of 12.9-kilometer. According to Sta. Rita Municipal Police Station, Pampanga Police Provincial Office, for the last five years, there were 25 accidents that had already taken place in the area.



Figure 1.1: Vicinity of Sta. Rita and Porac Mega dike in Pampanga



**Figure 1.2:** Street View of Sta. Rita and Porac Mega dike in Pampanga

With approximately 1.35 million road traffic deaths in 2018 worldwide, night road traffic accidents were the leading cause of death for people aged 5 to 20. The global rate of road traffic deaths is around 18 per 100,000 populations, (WHO, 2018). With 20.7 road traffic deaths per 100,000 people, South-East Asia is one of the most affected regions.

The risk factors for nighttime travel are poor nighttime vision and insufficient lights on natural roads. Road line markers, delineators, and signs for the highways and major roadways must all be provided in built-up areas, according to policies that must be developed. (Williams Ackaah et. Al, 2020). A study by the University of Manchester Institute of Science and Technology found that low illumination is a major contributor to the night-time fatality rate (The Royal Society for the Prevention of Accidents, 2018). A European study found that one-third of pedestrian casualties had difficulty seeing the vehicle that had struck them, while two-fifths of drivers had difficulty seeing the pedestrian (The Royal Society for the Prevention of Accidents, 2018).

These findings are like the situation in the Philippines, where the absence of streetlights on roads is a major concern for 15.9% of Filipinos, according to a survey conducted by Ulat ng Bayan (Manila Bulletin, 2017). The current administration must address this issue to improve road safety in the country.

The photoluminescent line markings could supplement or even replace existing streetlights in nighttime walkways, adding another potential contribution to modern technology and ensuring public safety at night. Additionally, these markings are efficient because they do not rely on electricity, but instead it uses ultraviolet. This can help track people's movements and reduce energy consumption. Plus, a more durable pavement could improve daily life in the present time.

#### **1.4 Objectives of the Study**

The study aims to propose a photoluminescent line marking in Sta. Rita and Porac Mega dike in Pampanga.

##### **1.4.1 General Objective**

The study assessed the advantages of photoluminescent line marking over traditional line markings. It aimed to enhance the safety of people who travel, particularly at night. It aimed to benefit and be environmentally responsible for the safety of motorists and pedestrians and to serve as a guide to prevent and lessen accidents within the area. It also aimed to improve nighttime driving visibility along Sta. Rita and Porac Mega dike in Pampanga that has insufficient streetlights.

##### **1.4.2 Specific Objectives**

The researchers wanted to meet the following objectives:

- a. To assess the road accidents within the area.
- b. To propose photoluminescent line marking.
- c. To compare the cost of photoluminescent line marking to traditional line marking.

#### **1.5 Statement of the Problem**

Will this Photoluminescence line marking address the problem that exists in the area?

1. Is this material effective to solve the existing problem? 2. Is this durable compared to the existing line markings? 3. Is this cost-efficient?

### 1.6 Significance of the Study

The findings that will be found in this study may benefit certain groups and the benefits that they may gain in this study are as follows:

- **Drivers.** With the information gathered, they could prepare and take necessary remedies to cope up with the issues of road safety specifically road markings and lightings.
- **Transport Officials.** The research consists of information that could help them improve their service. Transport officials could use this as a guide in improving people's safety on road usage.
- **Researchers.** It will improve the researchers' idea and concept based on their prior knowledge about the photoluminescent paint, as they seek to fill into their gap in knowledge and answer the problem in current and even in later situations, as they contribute potential information to the body of knowledge satisfying the researchers' curiosity through this study.
- **Future Researchers.** For future researchers who might want to undertake the same study, this could be a further resource that they can use as a source of information and proof.

### 1.7 Scope and Limitations

This study focused on the assessment of material application between photoluminescent and traditional line marking at Santa Rita and Porac Mega dike in Pampanga, not on road development. One type of luminescence is "glow in the dark"; these materials can store energy and serve as a source of light. This assessment was conducted to aid the motorists on their way along the mega dike road which was not well lit during the night due to lack of streetlights. The researchers gathered some data on accident records at the police station located at the vicinity of Sta. Rita and Porac Mega dike in Pampanga. Due to confidentiality, some information were not provided in full and were limited, the option was conducting a survey and searched for engineers who were material experts and/or quality control personnel and/or someone who has expertise with photoluminescent line markings. Through the strategy, the researchers were able to know if the proposed project was beneficial.

This study only focused on the road along the Sta. Rita and Porac Mega dike in Pampanga; other areas which were not necessarily connected were outside the scope of the study. The main source of data was a survey questionnaire, which was prepared by researchers.

### 1.8 Conceptual Framework

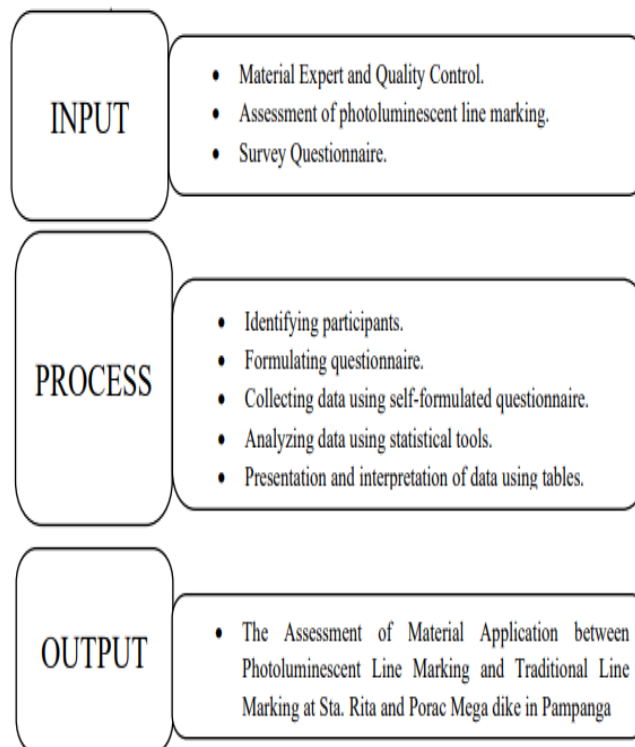


Figure 1.3 Paradigm of the

Study

Above was the conceptual framework which illustrated the input, process, and output of the research study.

For the input, the civil engineers who are material experts and/or quality control personnel and/or someone who has

expertise with photoluminescent line markings were the main focus for respondents since they were the ones who has adequate knowledge regarding the photoluminescent line marking. The second input was the assessment of photoluminescent line marking which was evaluated by the respondents. These two (2) inputs stated were the bases to generate survey questionnaire.

The process showed the flows of the study conducted. The self-formulated questionnaires were distributed through survey questionnaires for the data collection. For data analysis, statistical tools were used to interpret the results of the data gathered. Lastly, the researchers used tables for data presentation.

Lastly, the output was based on the result of the data analyzed. It determined the Road Hazard and Risk at Santa Rita and Porac Mega Dike as a Basis for the Application of Photoluminescent Line Marking Glow in the Dark Highway Paint.

### **1.9 Definition of Terms**

The following terms were defined by the researchers to make the readers understand the terminologies used in the study:

Assessment - the evaluation or estimation of the nature, quality, or ability of someone or something.

Application – the action of using or putting something.

Dike – an embankment for controlling or holding back the waters of the sea or a river.

Driving - is the controlled operation and movement of a vehicle, including cars, motorcycles, trucks, buses, and bicycles.

Glow in the Dark - or photoluminescent materials carry inorganic phosphors that absorb light in the visible and ultraviolet wavelengths and then re-emit visible light, or a "glow".

Line Marking - is the process of applying, spraying, painting, or drawing lines on a surface for the purpose of identifying points of interest or indicating traffic directions.

Material - the components, ingredients, or materials from which something is formed or can be manufactured.

Pedestrian - a person walking along a road or in a developed area. Photoluminescence - is when light energy, or photons, stimulates the emission of a photon from any matter. It is a non-contact, nondestructive method of probing materials.

Road Accident - is defined as an accident involving at least one vehicle on a road open to public traffic in which at least one person is injured or killed.

Visibility - is the measure of the distance at which an object or light can be clearly discerned.

## **2. METHODOLOGY**

This chapter presented the research design, population, research instrument, data collection procedure, and data analysis of this study. These methodologies served as guidelines for the proponents in conducting the relevant procedures needed from the collection to the analyses of data.

### **Methodological Framework**

#### **Research Design**

An Explanatory Mixed Method Design was used as both Quantitative and Qualitative approach were most needed for this study. The study used a mixed methods approach, which combined both quantitative and qualitative data collection and analysis to gain a more comprehensive understanding of the phenomenon being studied (Cameron, 2015). This approach allowed researchers to obtain more detailed and informative insights than they would with a single quantitative or qualitative study (George, 2022).

Thematic analysis is a method of analyzing qualitative data by looking for patterns in meaning and extracting themes from the data set. This technique involves a reflective process in which the researcher's own experiences play a key role in interpreting the data. This may include reading through transcripts of interviews or focus groups, for example, to identify common themes and understand the underlying meanings in the data.

Data were typically gathered using qualitative research methodologies in the location where participants are having issues or challenges. Real-time data rarely required participants to leave their immediate surroundings in order to gather information. Instead of relying just on one data source, qualitative researchers generally collect data in several formats, such as interviews, observations, and documents. By breaking down complex problems into clear, easily legible, and understandable deductions, this form of research methodology aims to resolve them. People are more likely to trust the researchers because it is a more communicative strategy, and the information gathered in this way is accurate and unfiltered (Morrill et al.,2000).

## Population

The study used a purposive sampling technique. According to Ashley Crossman (2017), in purposive sampling, the respondents of the study would be chosen according to their characteristics and the objective of the study. From the word itself “purpose” meaning the respondents are chosen particularly because the study is precisely applicable to them. The researchers collected data about the cause of the accidents that happened on Sta. Rita and Porac Mega dike and ensured the accuracy of the data acquired that were used in the study.

Raosoft was used to determine the minimum recommended population. With a total population size of 20,000, a margin of error of 10%, and a 90% confidence level, the minimum recommended sample size is 68.

This study applied specific criteria to ensure that the right respondents were chosen. The respondents of the study were material experts/quality controllers who had the necessary knowledge to respond to the questions provided by the researchers. The participants were expected to respond to the questionnaire, which gave data and information that benefited the study. Additionally, the participants had adequate insights about photoluminescent line markings and had the capacity to respond to such queries.

## Research Instrument

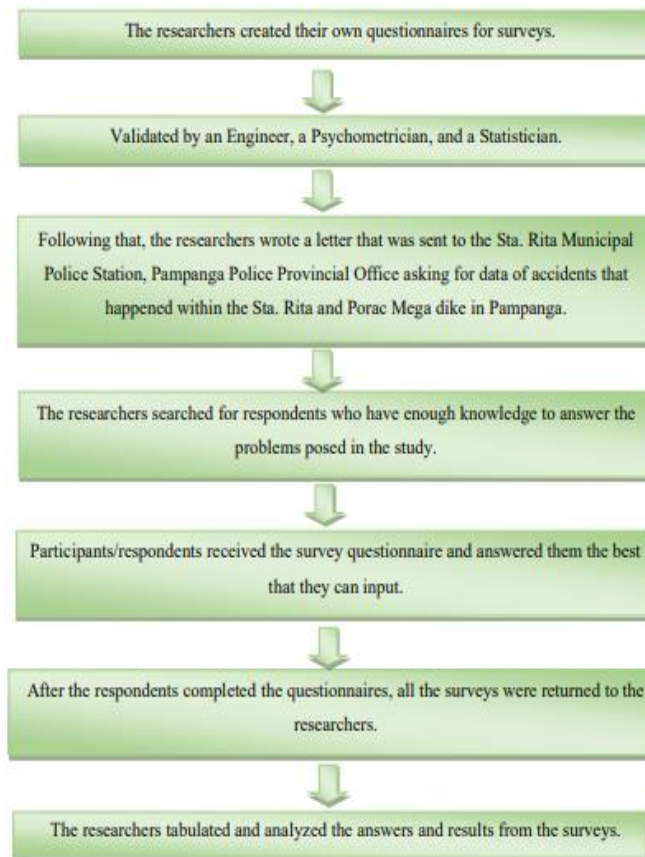
Survey research involves asking questions of respondents to measure certain variables. Surveys can be conducted over a short period of time (cross-sectional surveys) or over a longer period (longitudinal surveys). The specific type of survey used depends on the research goals and the time frame of the study. The researchers used guided response type surveys as a research tool to gather the data needed for the study (Columbia University, 2020).

The major instrument that has been used in this study was a survey questionnaire. The questionnaire was validated by a research expert, statistician, and an engineer. They checked and validated the questionnaire to make it simple, direct, and legitimate for precise information and results. In addition, the survey questionnaire underwent pilot testing and reliability test using the Cronbach's alpha. According to Chelsea Goforth (2015), Cronbach's alpha is a statistic used to evaluate the internal consistency or reliability of a group of scale or test items. Cronbach's alpha is one approach for determining the strength of such consistency. In other words, the reliability of any measurement relates to the degree to which it is a consistent assessment of a concept. The calculated value of alpha from the reliability test is 0.90985, which has an interpretation of excellent internal consistency.

## Data Collection

After conducting the actual data collection, the researchers submitted a letter of approval to the university to validate the processes and formalize them. After being signed, the actual instrumentations were conducted among the participants of the group. On the other hand, the researchers visited the police station along Sta. Rita and Mega dike and submitted a formal letter of request to gather data about accidents in the area. Once favored and accommodated, the researchers performed the actual methods upon the agreed date and time of both parties. The researchers maintained an unbiased and neutral environment during the procedures to preserve the validity of the data to be gathered.

## Flow Chart of Procedure



## Data Analysis and Evaluations

The data analysis procedure of this study was described in this section.

Qualitative Data - analyzing qualitative data with thematic analysis the process of exploring a data set to find, evaluate, and communicate recurring patterns (Braun and Clarke 2006). It is a technique for expressing data, but when codes are chosen and themes are built, interpretation is also a part of the process. Thematic analysis stands out because it can be used to a wide range of study questions, designs, and sample sizes and may be employed within a wide range of theoretical and epistemological frameworks. The flexibility of using thematic analysis within a variety of theoretical and epistemological frameworks is a defining characteristic of the method be utilized with regards to a variety of study topics, plans, and sample sizes.

The result from thematic analysis process generated the thematic map. This map displayed the spatial distribution of one or more distinct data themes. Before moving forward with the study, the extracted themes were evaluated to see if they were pertinent to the goals and challenges described therein, putting together an academic report analysis. In order to protect the confidentiality of the participants, only selected parts from a small number of data transcripts were used to support the research. These data were analyzed using the Likert Scale shown below.

Weighted Mean	Verbal Interpretation
1.00 – 1.80	Strongly Disagree
1.81 – 2.60	Disagree
2.61 – 3.40	Neither
3.41 – 4.20	Agree
4.21 – 5.00	Strongly Agree

**Table 2.1:** Likert Scale Verbal Interpretation

The qualitative data were transcribed, analyzed, and classified. The data were used for the improvement of the product.



**Quantitative Data** - Survey research is a technique used to gather data from a group of people by posing multiple questions. It is a quantitative research method that involves finding and selecting participants, gathering data, and analyzing it. The researcher created appropriate survey questions that are both grammatically correct and logically sound. The researcher finalized the target audience. After the researcher finalized the target audience, the researchers sent out surveys as per target audience. The results of the questionnaire were analyzed in real-time.

### 3. RESULTS AND DISCUSSIONS

This chapter presented the findings and outcomes drawn from the preceding chapter’s analyses. The results were obtained from a survey questionnaire collected from the respondents who participated in this study: the civil engineers who are material experts and/or quality control personnel and/or someone who has expertise with photoluminescent line markings. The discussion included the table, mean and standard deviations.

#### A. Assessment of Material Application between Photoluminescent Line Marking and Traditional Line Marking at Santa Rita and Porac Mega Dike in Pampanga

**Table 2:** Assessment on the Effectiveness of the Photoluminescent Line Marking

Indicators	Weighted Mean	Verbal Interpretation
1. The photoluminescent line markings can reduce or lessen the accidents in the area.	4.64	Strongly Agree
2. The photoluminescent line markings can be easily seen by the motorist.	4.64	Strongly Agree
3. The photoluminescent line markings can provide a guide even for pedestrians walking on the road.	4.64	Strongly Agree
<b>General Mean</b>	<b>4.64</b>	Strongly Agree

Table 2 showed the assessment of the respondents on the effectiveness of photoluminescent line markings. The respondents were generally satisfied to its effectiveness with a general mean of 4.64 with a verbal interpretation of strongly agree. Meaning, effectiveness of the product is good enough to meet the approval of the material engineer/quality controller personnel; especially to those personnel who know the effectiveness of the photoluminescent line marking. The photoluminescent line markings can help reduce accidents caused by insufficient night lighting. Thus, this assessment can bring safety and additional protection to motorists as well as pedestrians. The table indicated that the assessment regarding the effectiveness of the photoluminescent line marking was accepted to most of the respondents. Below were the comments/suggestions of the respondents.

“This would help to those people passing by within the area, gusto ko yung idea. Magiging effective to especially sa chosen area since walang ilaw sa megadike at night.” (R2)

“Photoluminescent line is important especially during night because they serve as light also for motorists for road guide.”(R18)

“I think the line marking is useful.” (R56)

**Table 3:** Assessment on the Durability of Photoluminescent Line Marking

Indicators	Weighted Mean	Verbal Interpretation
1. The photoluminescent line marking last longer than the traditional line marking.	4.03	Agree
2. The photoluminescent line marking withstand the different weathers in the area.	4.14	Agree
3. The photoluminescent line marking is strong enough to keep its structure for the long period of time.	4.11	Agree
<b>General Mean</b>	<b>4.09</b>	Agree

Table 3 showed the assessment of the respondents on the durability of photoluminescent line markings. The respondents were generally satisfied to its durability with a general mean of 4.09 with a verbal interpretation of agree. With that, the respondents were satisfied with the durability of the photoluminescent line marking in terms of its structural strength. As a result, it can withstand such a wide range of weather conditions in the area. The data showed that the majority of respondents believe the

photoluminescent line marking is durable. Below were the comments/suggestions of the respondents.

“According to research, these markings would last longer.” (R11)

“If it is high quality, I think it can be as durable as standard line markings.” (R54)

“According to some study that I read; this paint would last longer than traditional line markings.” (R58)

**Table 4:** Assessment on the Cost Efficiency of the Photoluminescent Line Marking

Indicators	Weighted Mean	Verbal Interpretation
1. It helps save more money in the long run than the existing traditional line marking.	4.09	Agree
2. The glow in the dark line marking is more economically viable than the installation of streetlights.	4.04	Agree
3. The consumed cost of the photoluminescent line marking is worth the price for the sake of safety if this will be implied to the general public	4.28	Strongly Agree
<b>General Mean</b>	<b>4.13</b>	<b>Agree</b>

Table 4 showed the assessment of the respondents based on the cost efficiency of the photoluminescent line markings. The respondents generally acknowledged its cost efficiency with a general mean of 4.13 with a verbal interpretation of agree. Meaning, the respondents were satisfied with the long-term price of the photoluminescent line markings and agreed that it is economically viable. Thus, the photoluminescent line markings can be worth the price. The table showed that most respondents agree on the cost-effectiveness of the photoluminescent line markings. Below are the comments/suggestions of the respondents.

“Well, implication of streetlights much better but it will cost too much compared to the photoluminescent line markings so beneficial pa rin if mag apply ng line markings. Second, okay siya kasi naleless paggamit ng electricity since it will glow through sunlight lang.” (R3)

“We should not compare the cost of the streetlights & glow in the dark line markings for the safety of the general public.” (R38)

“It all depends in the priority and budget.” (R53)

**B. Cost Comparative Analysis of Traditional Line Marking and Photoluminescent Line Marking**

**Table 5:** Cost Comparative Analysis

Cost Category	Traditional Line Marking	Photoluminescent Line Marking
Initial Installation Cost	Moderate - typically between P13.91 to P55.65 per linear foot of line marking, including materials and labor	Moderate - typically between P27.82 to P83.47 per linear foot of line marking, including materials and labor
Maintenance Cost	Moderate - requires periodic repainting of line markings, typically between P5.56 to P27.82 per linear foot per year	Low - requires minimal maintenance, such as occasional cleaning, and has a long lifespan of up to 10 years
Longevity	Moderate - typically lasts between 1 to 3 years before requiring repainting or touch-ups	High - has a long lifespan of up to 10 years without the need for frequent replacements
Visibility and Performance	Moderate - visibility may diminish over time, especially in poor weather conditions or low light situations	High - provides consistent visibility, especially in low light conditions, as it emits a visible glow
Environmental Impact	Low - traditional line marking materials may contain harmful chemicals and require regular repainting, leading to waste generation	Low - photoluminescent line marking is non-toxic and non-polluting, and does not require frequent repainting, reducing waste
Safety Enhancement	Standard line markings without additional visibility features	Enhanced safety through its glowing properties, aiding visibility in low light conditions

Table 5 compares the costs of traditional line marking and photoluminescent line marking, shedding light on the key differences between the two options. Traditional line marking involves the use of standard materials for marking roads, walkways, and other surfaces. It typically has a moderate initial installation cost, ranging from P13.91 to P55.65 22 per linear foot, including materials and labor. However, regular maintenance is required, including repainting or reapplication of line markings, which incurs additional costs ranging from P5.56 to P27.82 per linear foot per year. The longevity of traditional line marking is moderate, lasting between 1 to 3 years before requiring repainting or touch-ups. Over time, visibility may diminish, especially in poor weather conditions or low light situations. Traditional line marking also has an environmental impact as the materials used may contain harmful chemicals, and frequent repainting leads to waste generation.

In contrast, photoluminescent line marking offers several advantages. The initial installation cost is comparable to traditional line marking, ranging from P27.82 to P83.47 per linear foot, including materials and labor. However, the maintenance cost is significantly lower. Photoluminescent line marking requires minimal maintenance, such as occasional cleaning, and has a long lifespan of up to 10 years. This longevity is a significant advantage over traditional line marking, as it reduces the need for frequent replacements and lowers maintenance expenses. Photoluminescent line marking provides consistent visibility, especially in low light conditions, as it emits a visible glow. This enhanced visibility contributes to safety, particularly during nighttime or adverse weather conditions.

Moreover, photoluminescent line marking has a low environmental impact. It is non-toxic and non-polluting, and does not require frequent repainting, thereby reducing waste generation. The materials used in photoluminescent line marking are designed to be environmentally friendly, aligning with sustainability goals.

Overall, while traditional line marking has been widely used, the advantages of photoluminescent line marking are evident. With comparable initial installation costs, photoluminescent line marking offers long-term cost savings due to lower maintenance requirements and a longer lifespan. Its enhanced visibility and reduced environmental impact make it an appealing choice for applications where consistent visibility, durability, and sustainability are essential.

#### **4. SUMMARY, CONCLUSION, AND RECOMMENDATION**

This chapter presents the summary of the findings, the conclusion of the study, as well as recommendations to individuals and groups concerned with the findings of the undertaking. Further study and research were recommended at the end of this section.

##### **4.1 Summary of Findings**

The following are from preceding chapter's data output wherein summary of findings was drawn as regards to the effectiveness of the photoluminescent line marking to the motorists along Santa. Rita and Porac Mega dike in Pampanga, the durability and cost efficiency of the photoluminescent line marking. The following data were drawn to address the objective of the study, which was to assess road accidents within the area, to propose photoluminescent line marking, and to compare the cost of photoluminescent line marking to traditional line marking.

##### **4.2 Conclusions**

Based on the findings the following are concluded:

1. Photoluminescent line marking will be effective. It is helpful in reducing accidents along the Sta. Rita and Porac Mega dike in Pampanga, and it can be used as a guide for the motorist. It can also be easily seen because it is glow-in-the-dark paint.
2. Findings about the durability of the photoluminescent line marking indicated that it is reliable in terms of quality and longevity. To conclude, the respondents think that it can be durable as a standard line marking.
3. In the cost efficiency, the respondents acknowledge the price of the photoluminescent line marking. The respondents' answers indicated that cost effectiveness of the photoluminescent line marking will have impact to the road budgeting but worth the price as long as it is economically viable and beneficial.
4. The researchers conclude that the photoluminescent line marking may be the most cost-effective option in the long-term among the two.

##### **4.3 Recommendations**

In line with the conclusion the following are suggested:

1. Future researchers should explore more about photoluminescent line marking and its availability in the country.
2. Future researchers should assess another road location wherein it can be applicable.
3. Future researchers should conduct an impact assessment to determine the effectiveness and potential advantages of photoluminescent line marking, aiming to enhance road safety and visibility in various conditions.

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