

ГРАДОСТРОИТЕЛЬСТВО, ПЛАНИРОВКА СЕЛЬСКИХ НАСЕЛЕННЫХ ПУНКТОВ / CITY PLANNING OF RURAL SETTLEMENTS

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VISUAL QUALITY OF PEDESTRIAN PATH LIGHTING BASED ON VISUAL PERCEPTION OF THE PEDESTRIANS

Abstract

Safety, security, and comfort of pedestrians are important to be accommodated by a pedestrian path, especially at night. This study aimed at measuring the quality of artificial lighting in the pedestrian path at Malioboro Street in Yogyakarta, Indonesia. This study employed a qualitative method by measuring visual perception of the pedestrian paths through semantic differential scale method. Results of visual perception of the quality of nighttime lighting were then analyzed by comparing the quantity of light at nighttime measured using a light meter. The quantity and quality of daylight were also measured as a comparison in the analysis process. From field observations, measurements and analysis, it was found that the quality of artificial lighting in the pedestrian path at Malioboro Street, did not meet the visual needs of pedestrians. In contrast, at daytime, the visual perception of the pedestrians indicated good results, but the lack of lighting led to different results at nighttime. It can be concluded that the quality of the lighting in pedestrian paths at Malioboro Street, should be improved through lighting design, which is able to meet the visual needs of the users. Good pedestrian path lighting will promote comfort, safety, and security of the users.

Keywords: pedestrian paths, lighting, visual perception, visual quality.

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ВИЗУАЛЬНОЕ КАЧЕСТВО ОСВЕЩЕНИЯ ПЕШЕХОДНЫХ ПУТЕЙ ПО ВИЗУАЛЬНОМУ ВОСПРИЯТИЮ ПЕШЕХОДОВ

Аннотация

Безопасность, защита и комфорт пешеходов очень важны для пешеходной дорожки, особенно ночью. Цель этого исследования – измерение качества искусственного освещения на пешеходной дорожке на улице Малиоборо в Джокьякарте, Индонезия. В этом исследовании использовался качественный метод, измеряющий зрительное восприятие пешеходных дорожек методом семантической дифференциальной шкалы. Результаты визуального восприятия качества ночного освещения затем анализировались путем сравнения количества света в ночное время, измеренного с помощью прибора для измерения интенсивности света. Количество и качество дневного света также измерялись как сравнение в процессе анализа. На основе полевых наблюдений, измерений и анализа установлено, что качество искусственного освещения на пешеходной дорожке на улице Малиоборо не соответствует визуальным потребностям пешеходов. Напротив, в дневное время зрительное восприятие пешеходов показало хорошие результаты, но отсутствие освещения привело к разным результатам в ночное время. Можно сделать вывод, что качество освещения на пешеходных дорогах на улице Малиоборо должно быть улучшено за счет дизайна освещения, который способен удовлетворить зрительные потребности пользователей. Хорошее освещение пешеходной дорожки будет способствовать комфорту, и безопасности пользователей.

Ключевые слова: пешеходные дорожки, освещение, зрительное восприятие, визуальное качество.

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Introduction

Yogyakarta is the second tourist destination in Indonesia after Bali [1]. It has many tourist destinations, in particular, cultural and natural tourism. One of the destinations most visited by domestic and foreign tourists is Malioboro Street. Malioboro plays an important role for Yogyakarta City, both historically and economically. From an economic standpoint, Malioboro Street is a commercial area and one of the tourist destinations in the Province of Yogyakarta Special Region. It has existed since the establishment of the Sultan Palace of Yogyakarta in 1755 and plays a considerable role in tourism [2].

Playing a role as a commercial area and tourist destination, Malioboro Street is regularly visited by both domestic and foreign tourists. Every day it is visited by more than four thousand people with a pedestrian growth of 5.2% [3]. It also contributes to the extensive use of pedestrian paths at Malioboro Street.

Steffy argues that the perception of lighting is the result of brain interpretation on physiological reaction to the lighting settings [4]. Therefore, lighting plays an important role in creating the perception of pedestrian path users so that they can access and use the pedestrian path well.

This study was conducted to measure the visual perception of the pedestrian path users to the visual quality produced by lighting elements in Malioboro Street and its effects on aesthetics, safety, and security of the users. The results of the study would play a role in the development of visual quality through lighting design for Malioboro Street at nighttime.

Methods

This study employed quantitative and qualitative research methods. The quantitative approach was adopted to measure the quantity of light, while the qualitative approach was employed to measure the visual perception of respondents. Data were collected at daytime (at 9:00 am to 12:00 pm) and at nighttime (07:00 pm to 09:00 pm) in order to obtain quantitative and qualitative data concerning the quantity and quality of natural and artificial lights in the pedestrian path. In this study, the parameters measured were the quantity of natural light (daytime), the quantity of artificial light (nighttime), quality of natural light (daytime) and quality of artificial light (nighttime). The quantity of light was measured using a light meter, while the light quality was measured using questionnaires and interviews.

In order to measure the lighting quality, respondents were selected based on age category and not distinguished based on gender. Respondents were men and women of productive age. Meanwhile, the elderly were not included in the category of respondents due to their reduced ability for visual senses. According to Calefato et al., elderly people and children are similar, because of their physical condition, they were categorized as vulnerable generations [5]. Gordon says that people over 60 years old need a light intensity three times that of people aged 20 years, while those over 80 years old need four times as much light [6]. Children were also not included in the category because they might not understand the topic questioned. In addition, the respondents did not have a visual impairment (not wearing glasses).

The semantic differential scale is a seven-point scale of pairs of adjectives which has the opposite meaning [7,8]. The study was conducted in several stages, namely measuring the quantity of light using a light meter; measuring the quality of light using semantic differential scale method by using words describing the visual quality of lighting; conducting interviews to explore information from the pedestrian path users; doing literature review; and analyzing data by comparing all data obtained.

Review of the Literature

Pedestrians are road users highly vulnerable to risks when walking, so that road and pedestrian paths should be designed by taking the safety of pedestrians into consideration. Lighting does not affect walking speed of pedestrians, but lighting has an important role to pedestrian visibility for motorists. [9]. Chen & Takamatsu argues that an appropriate lighting will make the city look more impressive. According to them, evaluating impression using the semantic differential scale is a method of evaluation to measure respondent's perception at a certain level as a given level. This method can be used to measure the value of evaluation for each impression. Chen & Takamatsu measured visual perception of respondents towards the quality of urban lighting in the urban landscape on LRT (light rail transit) track using 20 pairs of adjectives with seven scales, consisting three scales for negative adjectives, three for positive adjectives and one for neutral [10]. Meanwhile, as a part of urban design, pedestrian lighting needs not only to accentuate elements of the landscape but also help pedestrians. Street lighting creates a conducive environment at nighttime for speed, accuracy, and convenience for motorists and pedestrians [11]. The three factors are important for road or pedestrian path users, which can be achieved with good quality of lighting. Pedestrians should be able to see details of facilities for pedestrians and can recognize the presence of the other pedestrians and bikers, and can recognize objects around them. Meanwhile, according to Moyer [12], street lighting includes light level, safety, material, light patterns and fixture selection.

According to Palmer, visual perception is the result of the use of the entire visual system and not just an eye activity and perception is perception is a human effort to stay connected with the world [13]. Meanwhile, according to Sanoff, based on the visual information we can find out more about forms, activities, and interpretation obtained from environmental settings [14]. Therefore, it can be concluded that adjectives can be used to measure the road user's perception of the pedestrian path lighting because it is qualitative.

Results

Location

Figure 1 shows the location of the research divided into four areas of observation to sharpen the research results. The quantity and quality of light were observed and measured pedestrian paths located on the east side of the road at all four locations. Location 1 was in front of Hotel Inna Garuda, location 2 in front of the Tourism Office, location 3 in front of the Office of Province Regional House of Representative, and location 4 in front of Malioboro Mall.

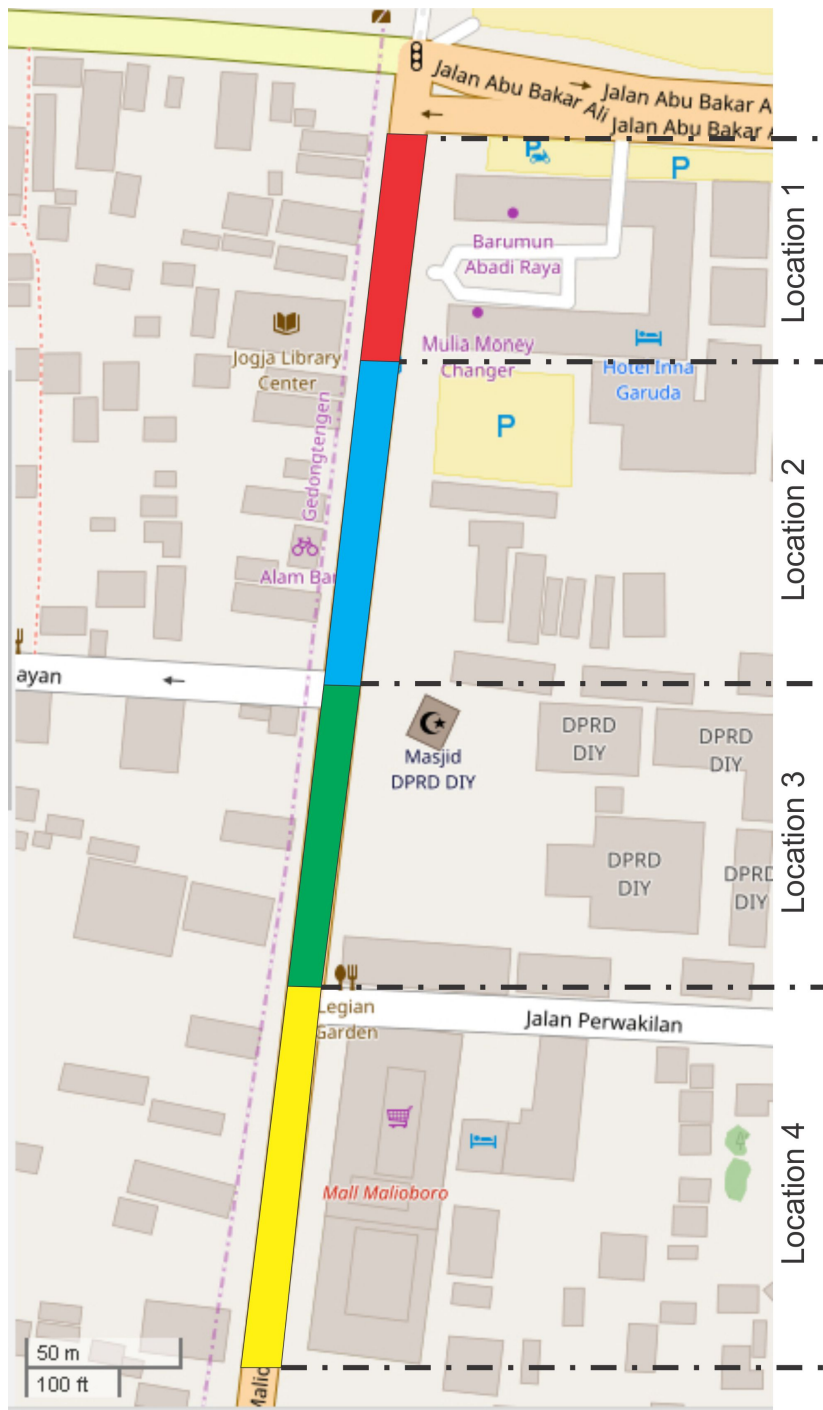


Fig.1 - The location of the research (Source: <http://www.openstreetmap.org> – edited by author)

Figure 2 shows the existing conditions of four locations of observation at nighttime. In the Location 1 located in front of the Parliament Office of Yogyakarta Special Region, it could be seen that the lights that illuminated the pedestrian paths were mostly from the lights of *warung lesehan* located along the pedestrian paths. At this location lamps specially designed for pedestrian paths lighting were not found. In addition to the lights from *warung lesehan*, pedestrian paths were also illuminated from streetlights on the west side.



Fig. 2 - Existing condition at nighttime

The results of the measurement of the quantity of light

The light intensity was also measured at night to obtain the quantity of light that fell in the area of pedestrian paths. The measurements were performed at four locations of observation as the measurements during the daytime. The results of measurements of light intensity at the four locations of observation conducted at 07:00 pm – 09:00 pm are as follows:

1. **Location 1.** The measurements on this location were divided into grid patterns; the width was divided into three spots while the length was divided into fourteen spots with a distance of 5 meters respectively. The measurement results indicated that the lowest intensity was 2.3 lux and the brightest was 64.5 lux. The intensity of light at each spot varied greatly because the light source available was unequally distributed.

2. **Location 2.** At this location, the lowest light intensity was 3.4 lux and the highest was 10.4 lux. The highest intensity was on the east side of the pedestrian path, which indicated that the light coming from *warung lesehan* contributed to illuminating the area of the pedestrian path. On the other hand, the light intensity on the west side close to the streetlights was only approximately 6.3 lux.

3. **Location 3.** Like locations 1 and 2, on the east side of location 3, there were *warung lesehan* that contributed lights to the pedestrian path. The measurement results indicated that the location 3 had the lowest light intensity of only about 1 lux and the highest of 34.1 lux.

4. **Location 4.** The measurements at the location 4 in front of Malioboro Mall indicated the lowest light intensity of 1.97 lux and the highest of 21.2 lux. This was different from the locations 1, 2 and 3 that had public lighting lamps with a distance of 60 meters between the lamps. Although the quantity of lights was not sufficient, they provided better light intensity than the location 4.

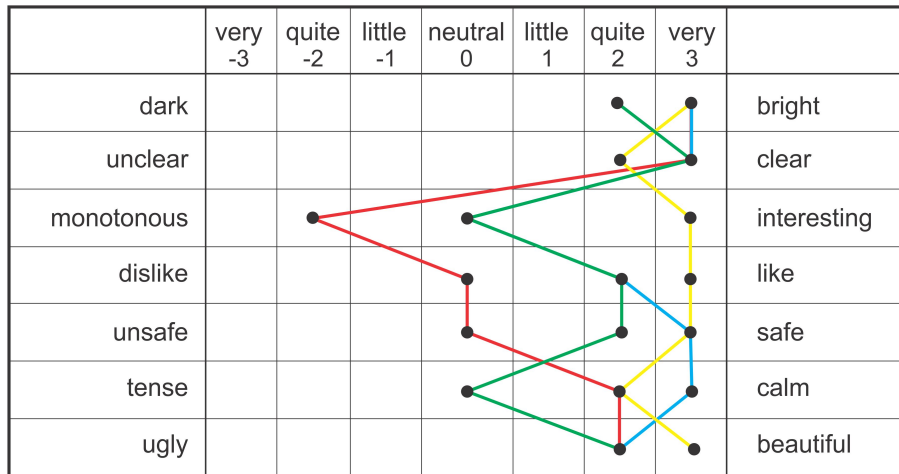
The results of measurement of the visual perception

This study used seven antonyms of adjectives to obtain the respondent's perception of the quality of light in the pedestrian path and its influence given to road users. The seven antonyms of adjectives used were: "dark-bright"; "unclear-clear"; "monotonous-interesting"; "dislike-like"; "unsafe-safe"; "tense-calm"; and "ugly-beautiful". They were divided into seven scales with 0 (zero) as the middle value or neutral. Respondents were asked to select a value to represent their perceptions of the seven antonyms of the adjectives.

The results of measurements of road users' perception were data that indicated the quality of pedestrian path lighting. The number of respondents in each location of observation was 45 to 50 pedestrians, the respondents selected did not wear glasses or have problems in their sense of sight.

Daytime

The results of measurement of visual perception on 50 pedestrians at the location 1 are shown in Figure 3. On average, the respondent said that the lighting condition was "bright", "clear" and "monotonous", while regarding the question "dislike-like" and "unsafe-safe" on average they answer "neutral". For other questions, on average the respondents answered "quite calm" and "quite beautiful".



legend:

- location 1
- location 2
- location 3
- location 4

Fig. 3 - The results of measurement of the visual quality at daytime

In the measurements at the location 2, on average the respondents said that the lighting provided "bright", "clear" and "safe" atmosphere. For the word "monotonous-interesting", on average they chose a middle value or neutral, whereas the words "dislike-like" and "ugly-beautiful" the average was at point 1 or "quite like".

Figure 3 shows the results of a survey of 45 respondents of pedestrian path users that on average the ratings were positive. The results of the survey at daytime at location 3 indicated positive results for the words "bright", "clear", "like", "safe" and "beautiful". Meanwhile, for the word "monotonous-interesting" and "tense-safe", on average the respondents chose neutral or "zero".

Figure 3 shows that on average the respondents at the location 4 gave positive value regarding the entire selection of words such as "bright", "interesting", "like" and "safe", while "clear", "tense" and "beautiful" belonged quite or at point "1".

Overall, the entire locations could provide a positive visual perception to the respondents of pedestrian path users. This could be seen from the overall responses at all seven pairs of words they chose. The word that tended to be negative (point -1) was only the word "monotonous" at the location 1, while the words "bright" and "clear" obtained positive assessment in all locations of observation, especially at the locations 1 and 2.

Nighttime

The visual perception at nighttime was measured at the location of observation at 07:00 pm until 09:00 pm. Such timing was determined based on two considerations. First, the condition of the sky was dark and relatively the same at that time range. Second, at that time range shops on Malioboro Street were still open so that many visitors were still on and used the pedestrian path. The results of the measurement of visual perception at nighttime can be seen in Figure 4.

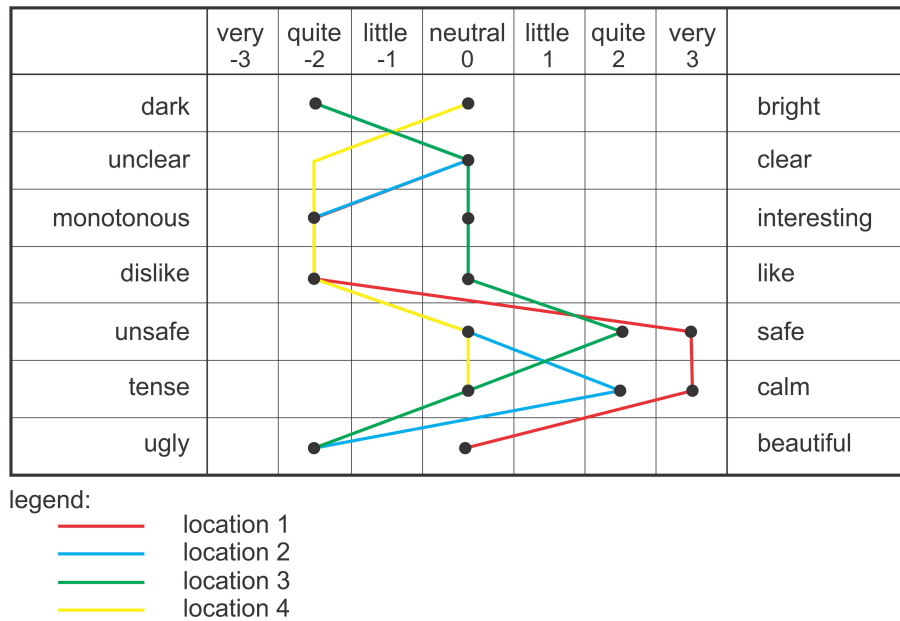


Fig. 4 - The results of measurement of the visual quality at nighttime

On average, the respondents at the location 1 said the lighting was less bright or chose "quite dark" on the given word, while the word "unclear-clear" was chosen neutral. Other perceptions indicated that "somewhat monotonous" atmosphere and on average the respondents "somewhat dislike" the nighttime lighting conditions at the location 1. Although on average the respondents rated the atmosphere or the quality of lighting tended to be "dark", "monotonous" and "dislike", most of them felt "safe" and "calm". When given an open question about it, the majority gave such answers because the crowded atmosphere contributed to the feeling of safety. For the word "ugly-beautiful", on average the respondents chose neutral.

Respondents at the location 2 gave almost similar responses to the location 1 as shown in Figure 4. The words that tended to be negative were "dark", "monotonous", "dislike" and "ugly". Meanwhile, the words "obscur-clear" and "unsafe-safe" tended to be neutral. The positive word selected by the respondents was only the word "calm". The respondents' response at the location 2 had in common with the location 1 because the character to the two locations was not much different that they gave relatively similar perceptions in the respondents in both locations.

Location 3 had a tendency to have a graph similar to the locations 1 and 2 as shown in Figure 4. Although the lighting visual condition was relatively dark, the majority of respondents still felt "safe" at this location. The same reason was given to the location 1 served as the basis of respondents' perception.

Although the location 4 was located in front of Malioboro Mall, the visual response of respondents tended to go to negative choice of words. However, if compared with other locations, the visual condition at the location 4 was rated brighter by respondents. The reason was that the light from the mall contributed to the light intensity in the pedestrian area. Although quite bright, the atmosphere seemed to be "somewhat obscure", "monotonous", "dislike" and "somewhat ugly" felt by respondents. In regard to the choice of words "unsafe" and "tense-calm" on average, they chose neutral.

The results of visual perception at nighttime indicated a different response from that at daytime. At nighttime, the relative assessment led to the negative choice of words. However, although negative words were mostly selected, the word "unsafe" tended to be chosen by respondents in all four locations. The reason is that the crowded atmosphere could provide a sense of safety for the respondents of pedestrian path users in Malioboro Street.

Discussion

Quality of Daylight

The majority of respondents in all four locations of pedestrian paths chose the word "bright" and "clear". Such choice of words was in line with the results of measurements made with high-intensity light so as to give a "bright" visual impression. Brightness corresponding to visual needs would provide a "clear" visual condition so that the road users could perform their activities well.

Unlike the words "bright" and "clear", the word "monotonous" was preferred by respondents, particularly at the locations 1, 2, and 3. This word was chosen because it was related to flat and evenly lighting conditions due to the sunlight. Flat and evenly light resulted in unvaried and monotonous visual atmosphere. A different condition occurred at the location 4 that the majority of respondents chose the word "attractive". If observed, the visual conditions and characters at the location 1, 2, and 3 had in common, while at the location 4 was different because it was located in front of a mall with more varied facade designs, creating an unmonotonous visual impression.

For the word "dislike-like", "unsafe-safe", "tense-calm" and "ugly-beautiful", on average at the four locations the majority of pedestrian respondents chose positive words. The word "dislike-like" on average obtained point 1, the word "unsafe-safe" tended to be in point 2, the word "tense-calm" in point 1, and the word "ugly-beautiful" in point 2. at each location, the four words at the location 1 tended to be in points 1, location 2 in point 2, location 3 in point 1 and location 4 in point 2. Therefore,

it can be concluded the visual impression at the four locations regarding the four words was more likely towards positive words or in points 1 and 2. This indicated the visual condition at daytime could give a positive impression to the users of pedestrian paths. Graphically, the results of visual perception at four locations are described in Figure 5 which shows a tendency of every word chosen by respondents to describe their visual perception of the daytime lighting.

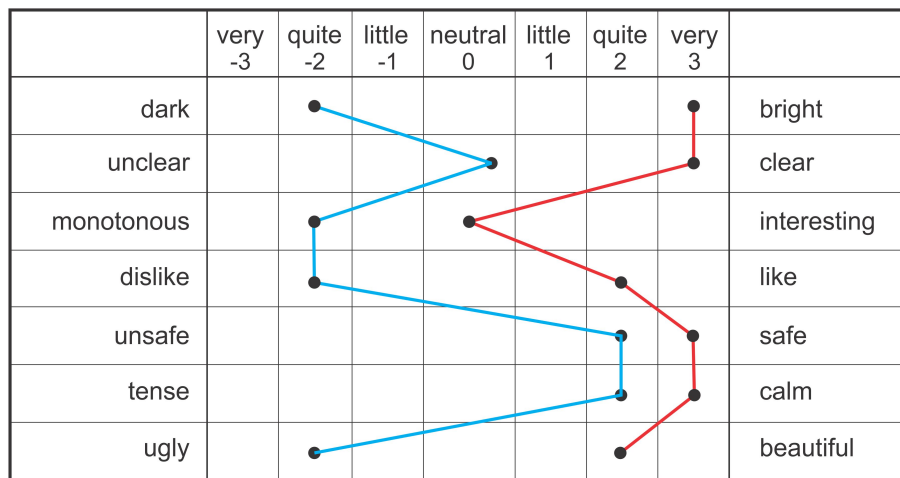
Quality of Nighttime

At nighttime, the quantity of light at the pedestrian path was very small due to the absence of pedestrian path light. Therefore, the lighting or illumination only relied on the lights from the street light. Lights from *warung lesehan* and general lights were at a distance of more than 60 meters and there were only two. Lack of light intensity at each location resulted in the overall average intensity at the four locations very small. The lowest average light intensity was only 2.15 lux and the highest average was approximately 47.55 lux. These results could present an overview on the inadequacy of light intensity for pedestrian paths on Malioboro Street.

Qualitatively, the lighting at the research location indicated that the pedestrians' response had a tendency toward negative words, especially for the word "dark-bright". The majority of respondents in all locations of the observation chose the word "dark" to describe the quality of nighttime lighting. When compared with the results of the quantitative measurement, this condition was reasonable because the light intensity was very low. Meanwhile, when compared to visual conditions at the daytime, the condition of nighttime was very different both qualitatively and quantitatively.

For all four, the word "unclear-clear" had a tendency to neutral or was at point 0, while the word "monotonous-interesting" tended to be negative and at point 2 or monotonous. Similarly, the words "dislike-like" and "ugly-beautiful" were at point 2. Only the word "unsafe-safe" and "tense-clam" received a positive response in point 1. In an open question why the respondents tended to choose "safe" and "calm" although the light conditions tended to be dark? the majority of respondents stated that the level of crowdedness on the pedestrian path was high and the existence of *warung lesehan* almost along the path made them feel safe and calm.

Overall, the visual perception graph depicting the visual quality of the lighting according to the respondent's pedestrians can be seen in Figure 5. The graph below shows that the visual quality of nighttime lighting tends to be low and corresponds to the result of measurement of light intensity. When compared to daytime conditions, the quality of nighttime visual is very low and shows the effect of the quantity of lighting on visual quality produced.



legend:
— daytime
— nighttime

Fig. 5 - The comparison of pedestrian's visual perception at daytime and nighttime

6. Conclusion

From the aforementioned discussion, it can be concluded that the quantity and quality of light at the daytime in the pedestrian path of Malioboro Street are good. This can be seen from direct measurements using a light meter and the results of visual perception by using a semantic differential scale. Visual conditions based on visual perception can be seen from the conditions of the measurement results, especially on the choice of the word "bright" and "clear".

At nighttime, the measurement results indicate a low light intensity and affect visual perception, which tends to be negative, especially for the word "dark" and "unclear" that are chosen by the majority of respondents. At nighttime, only the word "safe" and "calm" that have a positive tendency for respondents because of the crowded atmosphere and many *warung lesehan*. When compared to visual conditions at the daytime that tend to be positive, the nighttime visual conditions have negative tendency due to the poor quantity of lighting. This is also the cause of the poor quality of lighting at nighttime.

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