An analysis of lighting design in a football stadium

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Abstract. Lighting is an essential element for human life. Based on the decree of the Minister of Health No.1405/Menkes/SK/XI/2002 Date: 19 November 2002 concerning the requirements and procedures for the implementation of healthy working environment. Indonesian National Standard 16-7062-2004 states that the quality of the inadequate lighting gives bad effects for visual function, the environment around the workplace, and psychological aspects that can be felt as fatigue, feeling less comfortable, less alertness until the effects of the most serious such as accident. The purpose of the study was to determine the intensity of the lighting, the spread of light, lighting design, type of lamp, light bulb conditions, efficiency of energy usage, and maintenance of the football stadium lights. This study employed a qualitative descriptive approach using the type of evaluation research. The subject of this research is Harapan Bangsa Football Stadium in Banda Aceh. Data analysis techniques are: data reduction, data display, and drawing conclusion. The findings of the research showed that the lighting intensity of Harapan Bangsa Football Stadium was 341 lux. Meaning that it was deficit of 458.8 lux of the standard set by PT Liga Indonesia (800 lux), deficit of 959 lux of the standard set by AFC (1.200 Lux), and deficit of 1659 of the standard set by FIFA 2000 Lux. Lighting in the Harapan Bangsa Football Stadium spread unevenly. The lighting intensity design of the stadium was 594 lux. The kind of light bulb used was mercury. The electric power needed to support all of lamps was 377. 200 Watt. The type of light bulb used was Philips trademark. Most of the light bulbs were broken and expired. The use of mercury lamps has not been efficient in energy use. The maintenance of the lamps has not maximized yet.

1 Introduction

Stadium is a training center as well as a football game center. The establishment of a stadium building has to meet several criteria, one of the supporting criteria of football stadium is to have lighting. Says that lighting and visual clarity is a prerequisite for a person in the visual system [1]. Says that lighting plays a very important role in human life, even other living beings also have a heavy reliance on light. Human beings need light to obtain visual information about conditions around them [2]. Based on the decree of the Minister of Health No. 1405 / Menkes / SK / XI / 2002 Dated November 19, 2002 regarding the requirements and procedures for the implementation of office working environment health [3].

In order to make the lighting meet the health requirements, it is necessary to do the followings: 1) natural lighting or artificial lighting does not cause glare and has the intensity as intended. 2) placement of the light bulbs can produce optimum lighting and the bulb cleaned frequently. 3) The light bulbs which are not working properly must be immediately replaced [4]. Any kind of activity has a minimal standard value of light intensity. Lighting is a lighting tool that helps clarify our vision in the workplace while working, without an illumination device work activity could be

disrupted, but the lighting must also meet the appropriate standard of light intensity [5, 6]. So is the light intensity at the football stadium. Eligibility standards of stadium lighting according to Regulation of the Indonesia Super League is 800 lux for the match in the evening [6]. While the AFC criteria says that the whole stadium must be illuminated with recommended minimal force is from 1,200 to 1,400 lux or more. Stadium should also provide a generator in case of a blackout; the power of the generator is at least 900 lux for the entire stadium [7]. The lighting standard set by FIFA is 200 lux for the practice field or the daily games, 500 lux is recommended by FIFA for amateur competitive matches. FIFA also recommends 750 lux for national scale matches that are not televised, while for the televised national game must have an illumination minimum of 2000 Lux [8, 9].

Banda Aceh has one largest football stadium called Harapan Bangsa Football Stadium lies in Lhong Raya, Banda Aceh. It has a capacity of 45.000 seats. It is a community pride of the rencong land (Acehnese people) that was one of the most magnificent stadiums in Indonesia in 1997. For the match in the evening, Harapan Bangsa Football Stadium becomes the best choice. It should have been equipped with the set standard light bulbs. Indonesian National Standard 16-7062-2004 stated that the bad quality of the lighting

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gave bad effects to visual function, the environment around the workplace, as well as psychological aspects that can be felt as fatigue, feeling less comfortable, less alertness that leads to the toughest effect such as accident.

2 Research Metodology

This research is a kind of evaluation. That the evaluation research is a scientific procedure which systematically measures the results of a program or a project whether it is in accordance with the plan or not by collecting data, analyzing data and reviewing the implementation of the program fairly [10].

The subject of research was Harapan Bangsa Football Stadium Banda Aceh. The reason as to why the researchers took the stadium as the subject of the research was that it is frequently used for the national-level soccer match in the evening. The Instrument used to measure light intensity of the football stadium was a light meter. The instrument is as follows.

Fig 1. Light Meter instrument

Observation format was used to obtain data on the condition and state of the headlights and the lights on stands, while interview was used as a support instrument in collecting data. This study was conducted on May 21, 2015 in Harapan Bangsa Football Stadium, Lhoong Raya Banda Aceh.

3 Results and Discussion

3.1 The Results of Lighting Intensity Measurement

After measuring 77 points of the lighting intensity in Harapan Bangsa Football Stadium Banda Aceh, it was found that light intensity on the average was 341Lux.

3.2 Lighting intensity scattering scheme

Scheme for distributing the lighting intensity of Harapan Bangsa Football Stadium Banda Aceh can be seen in the image below.

Fig 2. The scheme of scattering of light at Harapan Bangsa Stadium

3.3 Interview Data

Tabel 1. Interview Data

No	Questions	Answers
1	What types of light bulbs used for lighting the Harapan Bangsa Football Stadium ?	The main light on the pole using a mercury spotlight model. The light on the stands using ordinary mercury light bulbs.
2	What was the trademark the light bulbs used for lighting in the Harapan Bangsa Football Stadium ?	Both Light bulb brand and panel such as ballasts, philips, ignitor, condenser and NCB that used were trademarks or registered
3	How long have these light bulbs used ?	Since the Harapan Bangsa stadium was built in 1997
4	How many watts of main light bulb was on a pole ?	2000 watts for a single lamp
5	How many watts of light bulbs were on the stands	200 watts for a single lamp
6	What causes all of the light bulbs did not work well ?	Damage of the light panel due to the usage time was expiredDamage of the light panel due to seepage of rain as the stadium roof was leaking and caused the lamp panels charred
7	How many light bulbs were there in the spectator stands ?	The western stand were 59 light bulbs Eastern stand were 59 light bulbs Northern stand were 44 light bulbs Southern stand were 44 light bulbs However, all the light bulbs in the stands did not work anymore due to damaged panels

8	Usually, how many years / months are the light bulbs replaced ?	Erratic, depending on the needs and usage. Usually, they were replaced when there were events.
9	What is the height of main light poles ?	30 meters
10	As a manager, what steps should be taken to overcome the bad condition of the lighting ?	Making a proposal to the supervisor namely the Department of Sports. Replacement of the light bulbs highly depends budgeting

3.4 Observasion Data

Tabel 2. Observation Data

No	Things Being Observed	Observation Results
1	The conditions of the light bulbs	Most of the main lights did not work as well as those lights on the stands
2	Number of the main lights	The main lights that were on poles totaling 148 lamps. The Harapan Bangsa Football Stadium has four poles and each of which has 42 light bulbs.
3	Number of the stand lights	There were 206 lamps on the stands. All the lights scattered on four stands with details of 59 lights on the western stand, 59 lights on the eastern stand, 44 lights on the northern stand, 44 lights on the southern stand
4	The working main lights	The condition of the lights on the main poles, namely : 1) the condition of the north lights in the east side were only 30 of 42 lights worked well. 2) The condition of the north lights in the west side were 34 of 42 lamps worked well. 3) The conditions the south lights in the west side were only 35 of 42 lamps worked well. 4) The conditions of the south lights in the west were only 21 of 42 lamps worked well
5	The working stand lights	The results of observation showed that there was none of the stand lights worked. He lights on the spectator stands did nor work.

4 Discussion

4.1 Standard Lighting Intensity of the Harapan Bangsa Stadium

Referring to the regulations set by PT Liga Indonesia, the minimum intensity of a football stadium was 800 lux or 42.65% [10]. Thus, the light intensity of the

Harapan Bangsa stadium Banda Aceh did not meet the criteria set by the PT Liga Indonesia because it deficit 458.8 lux or 57.35%. According to AFC, the minimum standard lighting of a football stadium is 1200 lux, it means that the Harapan Bangsa stadium deficit 959 lux or lack of 71.58%. Lighting standard regulations set by FIFA for international matches lighting specifications televised is 2000 lux, So, the Harapan Bangsa stadium deficit 1659 lux or 82.95%. The light intensity of the Harapan Bangsa stadium at this time can interfere visual clarity of soccer players and can create conditions which are not convenient for the players. If these conditions continue to occur in the long term period then the players will have problems in their vision systems

4.2 The Lighting Spread

The scheme data of the measurement results above show that the spread of the light of the Harapan Bangsa Football Stadium Banda Aceh was uneven. The chart of the spread of the lights of the stadium can be seen in the graph below

Fig 3. The spread graph of the light spread

4.3 Lighting Design of the Harapan Bangsa Stadium

The result of the design of the lighting intensity of the Harapan Bangsa stadium Banda Aceh is 594 lux. The intensity can be used for a non-televised league games. See the lighting specifications set by FIFA below.

Lighting specifications for non-televised events

Activity level	Horizontal Illuminance	Uniformity	Lamp colour temperature	Lamp colour rendering
Class I International games	750	0.7	> 4,000	a ≥ 85
Class II League and clubs	500	0.6	> 4,000	a ≥ 85
Class I Training and recreation	200	0.5	> 4,000	a ≥ 85

Fig 4. Lighting specifications for non-televised events. Source: (*Football stadiums technical recommendations and requirements* :89).

4.4 Lamp Type

The main types of lamps used in the lighting pole is the high light itency discharge lamp. Mercury vapor

lamps are the oldest models of HID lamps. Although they have long life and low initial cost, these lamps have a poor efficacy of 30 to 65 lumens per watt. These lamps have the lowest efficiency of HID family.

4.5 Lamp Condition

Illumination of the stands from the observation showed that none of the lights could be used due to the damage to the circuit panel of lamps. The total number of the main lamps on all of poles was 148. The Harapan Bangsa Stadium Banda Aceh has four lighting poles with each of which has 42 lamps. The results of the observations showed that none of the lamps was working. Malfunctioning of the lamps was due to the damage to the lamp panels.

4.6 Use of Electricity

The total power of the lighting at Harapan Bangsa Stadium Banda Aceh was 377.200 Watts. PLN (the state electrical power supplier) as a major supplier of electrical power to the stadium must provide a minimum of 377.200 Watts.

4.7 Efficiency of Energy Use

Energy use of High Intensity Discharge lamps at the Harapan Bangsa Stadium Banda Aceh is 2000 watts for one lamp, the amount of the main lamps on the poles are 148. If they are calculated, 2000 watts times 148 lamps equals to 296.000 Watts. Emission Diode Light lamp is a solid state functioning rectify the electric current [11]. Comparison of power consumption between LED lights and mercury lamps can be seen in the figure below :

Some silent comparison Watt Calculator (electrical power consumption)

- 1W LED - LOW Incandescent, example LOW LED LIGHT replaces 100W
- Shining light
- 1W LED • 6W halogen, eg LOW LED floodlights replace halogen floodlights
- 60W
- 1W LED • SW mercury lamp. An example of a high bay sowl lamp using mercury
- Ugh 2SOW
- 1W LED - 2W high pressure mercury lamp. Example of 90W Ngh bay light get
- 180W. high pressure mercury lamp
- '1W LED • 1W metal halide lamp.
- 1W LED- 2.5W fluorescent lamp. Example of 14w led tube replace fluorescent 36W light light

Based on the comparison in the figure above, it can be concluded that the use of 148 pieces of mercury lamps consume power of 296.000 Watts. While the use of 148 LED light bulbs only consume power of 14.800 Watts.

4.8 Lamp Trademark

Based on interviews, the brand of lamps used in the Harapan Bangsa Stadium Banda Aceh is the Philips trademark. The use of lamps of philips brands in the sports arena is very prevalent as the use of LED vision spotlights on Chelsea FC soccer field that provides the convenience for the football players. Football club KAA Gent has a big stadium with a capacity of 20,000 peoples also use Arena Vision spotlights of Philip brand for high-quality sports field lighting in order to produce a clear visibility for players and spectators. Ensure flicker-free performance super slow motion camera can record footage perfectly [12].

4.9 Maintenance of Lamps

Interview results showed that the maintenance of the lamps under the management of Harapan Bangsa Stadium Banda Aceh was not regularly done. The process of maintenance was done only when it was needed and used for certain events. There are several key factors that led to the loss of light in the lighting system as described, that the lamp lumen depreciation, light soiling and armature, low voltage shutdown, inefficient armature and dirty depreciation rooms [13-18].

5 Conclusions

1. Lighting intensity of Harapan Bangsa Stadium Banda Aceh was 341 lux, It is very much less than the lighting intensity standard set by FIFA, 2000 lux.
2. Spreading light in the Harapan Bangsa Stadium Banda Aceh was not even due to unequal distribution of the amount of light that produced by the light bulbs on the main poles.
3. Design of the lighting intensity of Harapan Bangsa Stadium Banda Aceh reached an average of 594 lux that can be used for non-televised league games.
4. The type of lamp used at Harapan Bangsa Stadium Banda Aceh was mercury lamp which is the oldest types of lights from High Intensity Discharge, these lamps have a poor efficacy of 30 to 65 lumens per watt.
5. Condition of the most of lamps both those on the main poles and those on the spectator stands of the Harapan Bangsa Stadium lights Banda Aceh were damaged.
6. Power consumption of Harapan Bangsa Stadium Banda Aceh amounted to 377 200 Watt.
7. The efficiency of energy use of the mercury lamps was bigger than the current modern lamps. Such conditions lead to wasteful usage cost. To conserve power usage it is advised to use models of LED lights.
8. The Brand of the lamps used in the Harapan Bangsa Stadium Banda Aceh was Philips.
9. Maintenance of lamps of the Harapan Bangsa Stadium Banda Aceh was not good yet.

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