

An Analysis on Illumination Distribution and Residents' Perception in a Traditional Town for Streetlight Planning

Raheon Min, Nobuo Mishima, and Takayuki Fuchikami

Abstract—Streetlights are very necessary for security of residents at night and for night townscape also in traditional towns, although they were originally unequipped when the towns were built especially before the middle of the 19th century, and their installations have been not well-considered for traditional values of the towns in Japan. To plan streetlights in a traditional town, fundamental issues and procedures including residents' perception should be clarified. This research attempts to reveal problems on a traditional area as a fundamental study for installation of streetlights in traditional towns.

Index Terms—Illumination, safety, streetlight, traditional town.

I. INTRODUCTION

A. Background

Many traditional towns also in Japan were built before streetlights were introduced and lots of streetlights have been installed after modern era. It needs to be considered carefully for historic towns when introducing something new that didn't exist before. Otherwise, it may unsuitable for preservation plan. Meanwhile, residents living in town need streetlights for security reasons.

In this research, target sites are Hamanaka-Machi Happongi-Shuku (hereafter, HMHS) area and Hamashozu-Machi Hamakanaya-Machi (hereafter, HMHM) area located in a traditional town called Hizenhamashuku, Kashima city, Saga prefecture, Japan(Fig.1). These two sites were selected as an important preservation district of traditional buildings in 2006.

Disaster and crime prevention is one of the crucial topics for resilience of historic towns. Mishima et al. study evacuation routes in a historic town [1]-[3]. In addition, there are many types of research about street light and crime prevention. First, some papers focus on the results of a coordinated program of research designed to evaluate the impact of street lighting improvements on crime and fear of crime [4]-[7]. Second, they analyzed illumination of street light using computer simulation programs to make a safe the city [8]-[10]. There are no studies on security street lights in a historic preservation town in Japan.

This study aims to reveal fundamental problems and procedures for installing streetlight in a traditional town by analysis of residents' range of activities and consciousness

about security based on distribution of streetlight.

B. Housing and Living Environment Development Plan of Saga Prefecture

Saga prefecture conducts street environment maintenance projects from 2016 to 2020 by the housing and living environment maintenance plan of Saga prefecture. This plan includes the installation of utility poles, beautification of roads, installation of security lights, and so on.

There will be installed 13 security lights on a street in front of Hizenhama station, 10 security lights on the Sakagura street in HMHS and 9 security lights in HMHM. And 9 old streetlights on the street in front of the station and 4 streetlights in places where there was nothing, so a total of 13 streetlights were already replaced with new security lights [11] (Fig. 2).

In 2008, Kashima City relocated the utility poles of Sakagura street which is the main street of HMHS to the behind of school and private houses for improving the scenery.

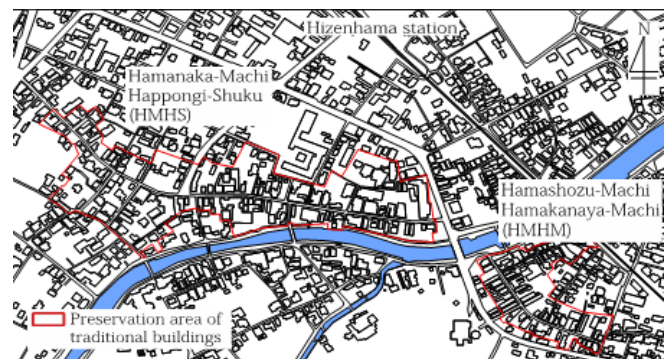


Fig. 1. Target sites of Hizenhamashuku.

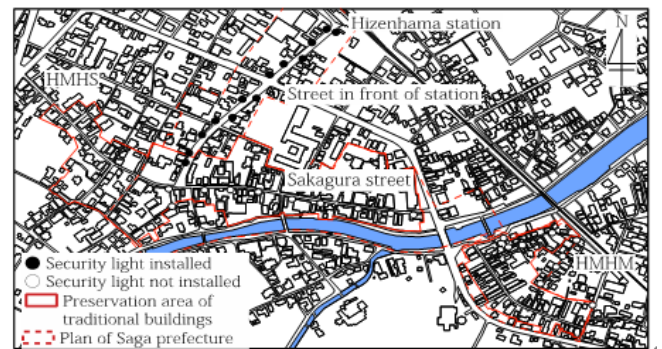


Fig. 2. Housing and living environment development plan of Saga prefecture.

C. History of Introduction of Streetlights in Japan

Starting to light the oil lamp an experimentally on the shore of Yokohama in September 1870 in Meiji era, streetlights were introduced in Japan. Two years later, in

Manuscript received January 2, 2018; revised May 2, 2018.

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September 1872, a gas light that lighted in Yokohama was Japan's first streetlight. In 1874, a gas plant was built in Shibahamasaki-Cho, Tokyo, and a gas pipe was laid to Ginza, so the gas lamp was lit between Ginza and Kyobashi. In March 25, 1878, the opening ceremony of the Central Telegraph Bureau was held at the Engineering University in Toranomon, Tokyo, and the arc lights were first ignited at the university hall. To commemorate this, March 25 is the anniversary of the Electricity. 4 Years later, in 1882, an electric streetlight with an arc lamp was lit in Tokyo, and it became visible to the public for the first time. In 1887, the lighting fixtures of Rokumeikan were changed into incandescent light, and they were the first street lamps produced by the electric bulb [12].

the road surface in the residential area of the road with low traffic volume must be 3 lx or more [13] (Table I). Yet, among these, 33 out of 49 streetlights in HMHS and 12 out of 20 streetlights in HMHM were less than 3 lx. Thus, 65% of the total streetlights were not enough for the Japanese Industry Standard, so these places need to be improved (Fig. 4).

TABLE I: ROAD LIGHTING FOR PEDESTRIANS BASED ON JIS

Pedestrian Traffic at Night	Area	Illumination (lx)	
		Horizontal Surface Illuminance ⁽¹⁾	Vertical Surface Illuminance ⁽²⁾
High-traffic Road	Residential Area	5	1
	Commercial Area	20	4
Low-traffic Road	Residential Area	3	0.5
	Commercial Area	10	2

⁽¹⁾ Horizontal surface illuminance is the average illuminance on the road surface of the sidewalk.
⁽²⁾ Vertical surface illuminance is the minimum illuminance on the vertical surface perpendicular to the road axis at the height of 1.5m above the road surface on the center line of the sidewalk.

II. METHODS OF INVESTIGATION AND ANALYSIS

Our investigation takes three steps to investigate the illumination of streetlights and residents' opinions about safety.

First, investigation survey is conducted especially on positions and numbers of the streetlights as well as on their shapes and colors taking photos to record both before and after the lights are turned on. Then, illumination and range of lights at 15 places are measured at intervals of 2 meters for each streetlight (Fig.3). This is an investigation to grasp the current situation of the streetlight.

Second, questionnaire surveys for the residents of the target sites are conducted through visiting house to house. The questions are about roads where they usually walk, streetlight, the fear of crimes, the presence or absence of security items and so on, marking the route (road) they usually go and they feel unsafe to walk on map.

Third, illumination distribution is analyzed using RELUX program which is an illumination simulation program to create an illumination distribution diagram. The types of the streetlight in the target sites cannot be specified because a date of product introduction does not remain in a government office. An illumination distribution diagram is, therefore, created with the streetlight of the most similar illumination in the RELUX program with reference the illumination of the streetlight examined by ourselves.

Compare these analyses to analyze the current problems in the region. Residents' opinions are used to grasp the current situation of streetlights that they are feeling.

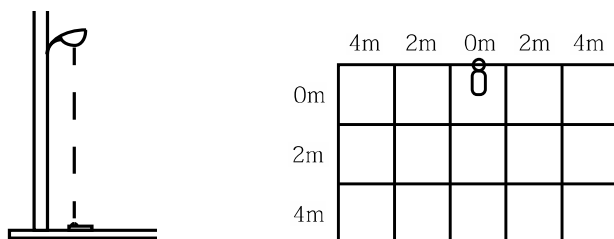


Fig. 3. Methods of measuring illumination.

III. RESULTS AND ANALYSIS OF SURVEYS

There were 49 streetlights in HMHS and 20 streetlights in HMHM. According to standards for road lighting for pedestrians based on Japanese Industrial Standards (JIS), the horizontal illumination, namely the average illumination on

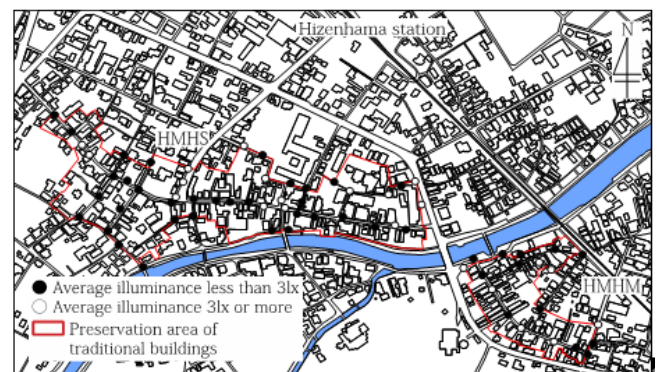


Fig. 4. Positions of streetlights and distribution of streetlights less than 3lx.

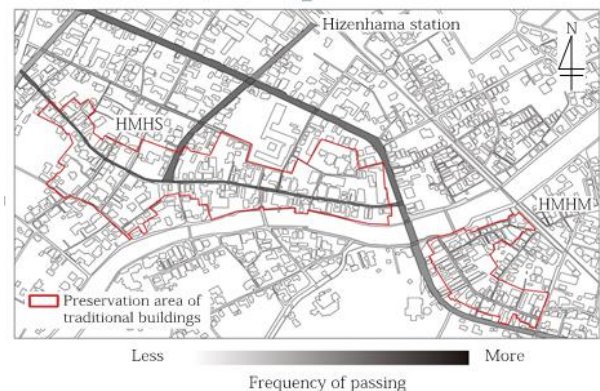


Fig. 5. Routes the residents go frequently.



Fig. 6. Places where the residents feel unsafe to walk.

Also, according to the results of the questionnaire, it was found that the Sakagura street in HMHS was a route most

found that the Sakagura street in HMHS was a route most people go frequently, but unsafe for residents to walk. From these results, we could find that the Sakagura street had too

much traffic in spite of the narrow width with a waterway, as well as it was an important road in the area as connecting the HMHS and the HMHM (Fig.5-6).



Fig. 7. Brightness of the area.



Fig. 8. Calculation result of illuminance of the area.

TABLE II: RESIDENT'S PERCEPTION ON THE STREETLIGHTS

	Gender/Age	Opinions	Keywords
01	Male/60s	There is no streetlight at the HamaShuku parking lot.	Streetlight
02	Male/60s	I want to unified streetlights in accordance with the atmosphere of the town.	Streetlight, Atmosphere
03	Male/60s	I don't think there are enough streetlight for the historic town. It would be nice to have unifying streetlights if it matches the atmosphere of the town.	Streetlight, Historic town, Atmosphere
04	Male/70s	I will expect a crime prevention, if new streetlights don't spoil the aesthetic of this area.	Streetlight, Aesthetic
05	Female/Over than 80s	It is scary to walk outside where there are few streetlights especially narrow streets. I want more streetlights.	Streetlight, Narrow Streets
06	Female/10s	Some streetlights are turned out, so I would like to change it or install a new one and increase streetlights. I didn't hear of any crime in Sakagura street but still feel anxious. I think there is a lot of crime in dark place and afraid to go outside when it is dark, so it would be nice if there are more streetlights.	Streetlight, Night, Dark place

07	Male/60s	It will be dark at night, if the number of visitors increases. There is no disability in private life. I hope residents, neighbors, and new residents can socialize more than ever before and build a trust relationship from these results of the questionnaire survey. I think that if all the people in this area greet with a smile to anyone, and if installed security streetlights make this town safe and secure, then crime will be reduced.	Streetlight, Visitors, Night, Communication
08	Female/70s	In the HMHS, volunteers who lead the group in the heyday of Sakagura street, installed stores as streetlights. And because the shops closed its shutters, electricity charges became a burden. And changed streetlights to security lights, the cost of electricity charges became a district burden. About 50 years, the electricity charges have been borne by local residents. So, we want to change streetlights management in Sakagura street from district to city	Streetlight, Volunteers, Management
09	Male/60s	We need security camera at entrance of Garyugaoka park.	Security camera
10	Female/40s	Because the place to rely on is so far, so I think it would be nice to have some crime prevention base here and there in this town.	Crime prevention base
11	Female/60s	I feel anxious about the empty house. And they are decaying.	Empty house
12	Male/70s	We need additional measures if visitors increase and go around at night.	Visitors, Night
13	Male/60s	I would like to make further improvements to the area while talking with people in this district.	Communication

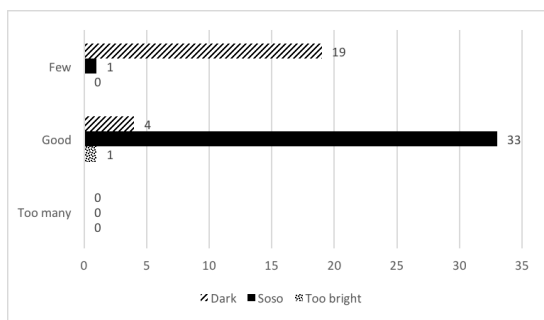


Fig. 9. Brightness and the number of streetlights.

The answers to the other items of the questionnaire survey on streetlights and residents' opinions were as follow (Table II). (58 people answered.)

First, it was about the brightness and the number of streetlights. They answered current streetlights are fine, but, many people answered there are few streetlights and very dark (Fig. 9).

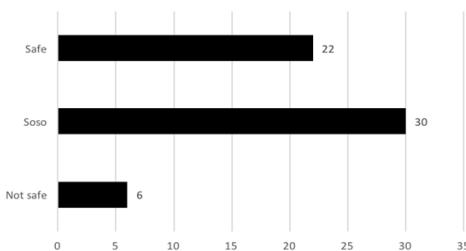


Fig. 10. Perception of residents on safeness in the area.

Second, it was about whether you feel safe or not in this town (Fig. 10). There were opinions from those who answered that they feel safe: 'Because people who live here are acquainted with each other.' and 'Because of the security of the town.'. There were opinions from those who answered that they feel normal: 'It may be a little dangerous because there are few people in the alley.', 'There were a crime a while ago.', 'Because sometimes I feel anxious when tourist came here.' and 'There are so many vacant houses.'. Finally, there were opinions from those who answered that they feel unsafe: 'Because so many houses are not locked. (Especially elderly people don't lock the door, so I think they are defenseless.)', 'I am scared of the night because there are few streetlights' and 'I think it is important to protect the aesthetic

of the town (street), but it is dark at night so I think it is necessary to increase the streetlights.'

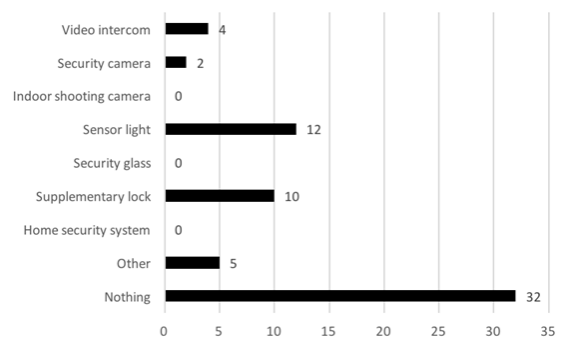


Fig. 11. The security items or systems they are using in house.

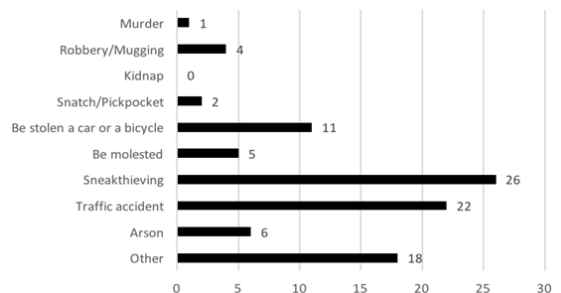


Fig. 12. The crimes they feel unsafe in their daily life.

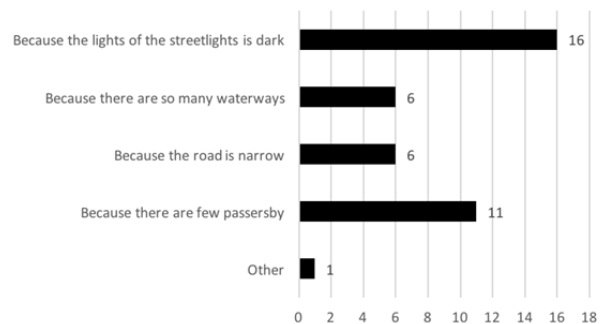


Fig. 13. The reasons why they feel hard to walk outside at night.

Third, it was about the security items or systems they are using in house or store, and many people answered they didn't install any items or systems, and security sensor lights were the second answered. Other answers included the police

security alarms installed by Kashima city, fire alarm, automatic buzzer of door and sensor chime. The reasons for installed the security items or systems are as follows: 'Just in case.', 'Because it is dark.', 'Because I worried about the damage of crimes.', 'Because there is a step in the entrance of store, so I installed it for visitors don't get hurt.', 'I can know when visitors come.' and 'Countermeasures against burglars.'(Fig. 11).

Fourth, it was about the crimes they feel unsafe in their daily life, and they said they felt unsafe in order of sneak thieving, traffic accidents, and robbery of a car or a bicycle. Other answers included the 'nothing special', 'fraud phone call', 'when seeing a stranger', 'fire', 'theft' and 'peep' (Fig.12).

Fifth, it was about why they feel hard to walk outside at night. The reasons why they feel hard to walk are as follows: 'Because the lights of the streetlights are dark', 'Because there are few passersby', and so on (Fig.13).

IV. CONCLUSION AND FUTURE WORKS

In this study, we could compare the results of the illumination survey and the simulation diagram with the JIS standards, and we were able to understand the current situations of streetlights in Hizendamashuku. Based on the results of the questionnaire survey, we were able to know the residents' opinions about streetlights and crime prevention, and what they were thinking about to make this sites into a safe and secure area. There were overwhelmingly many opinions that they want the bright lights. Moreover, we need to consider not only increasing the number of streetlights to brighten up, but also matching shapes and colors of streetlights to the atmosphere of area.

As a future work, the residents' opinions about the streetlights should be considered and reflected to the security lighting plan of the target area in accordance with the residential environment maintenance project supported by Saga prefecture. Also, the procedure of measurement should be developed considering survey method of luminance of streetlights viewing from eye level.

ACKNOWLEDGMENT

This study is supported by JSPS KAKENHI Grant Number JP16H04478. We would like to thank residents in Hizendamashuku and all who understood and cooperated our on-site field work. We also wish to appreciate valuable discussions and comments with project members.

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