A Study on the LED Renovation Effect in the Station Based on the Impression Evaluation

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ABSTRACT

By the Great East Japan Earthquake in 2011, "power use limitation Ordinance" has been issued, is being carried out actively power-saving operation with a focus on public facilities. Thereby, many stations have adopted a power saving method for lighting only part of the luminaire, has become dark space in general. Such environment is likely to become a cause of accidents.

Therefore, it has increased the introduction of LED lighting equipment of low cost and high efficiency, is currently about 40 percent of public facilities have adopted the LED lighting. The physical performance of the LED illumination are relatively clearly verified, but verification with respect to user psychology and satisfaction under LED illumination environment is not clear.

In this study, compared investigation as a target of 3 station in Tokyo of LED renovation of all the lighting has been carried out at 2014.

Do the actual measurement in the field by dividing the station space to the platform, concourse and stairs, as well as examine the physical changes due to LED renovation, it was also carried out at the same time impression evaluation at that place.

Result of LED renovation, the space becomes more bright, Impression evaluation results, such as "brightness" also increased.

However, glare is generated by the LED illumination, is considered necessary to take measures against it. Especially result of evaluating divided space stairs "look down" and "look up", when looked up, the luminaire is visible in directly, is considered to be the cause of glare.

KEYWORDS

Station, LED Renovation, Energy Conservation, Lighting Environment, Impression Evaluation

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INTRODUCTION

"The energy of the building use" shows 81% of shares in energy used in station space and is overwhelmingly big. Specifically, energy consumption by "the electricity" is 99.4%, and the consumption of the electricity is the most important in administration of the station space.

Power saving operation becomes required by "East Japan great earthquake disaster" of 2011 nationwide and is the situation that lays emphasis on power saving operation in the station space of the public accommodation which many people use.

In the case of a breakdown of the electricity usage of the station space, "illumination energy" is the highest in 44%, and, as for "the air conditioning," 16%, an elevator and the escalator are 14%. Because there is a limit in power saving from air conditioning, power saving from the big "illumination energy" of the share becomes most basic.

Therefore, power saving operation mainly on "the illumination energy" is carried out at many stations.

However, there are many "lighting only part of the luminaire" for a power saving method, and the space whole becomes dark, and it is thought that a problem in the safety is easy to occur.

Therefore, as an effective power saving method, renovation of the illumination environment is carried out lively, and introduction of the high efficiency illumination increases. In addition, by 2020, it is set with an aim to change all illumination of the public accommodation into high efficiency illumination, and the change of the lighting equipment market is accelerated.

In this study, it is intended to clarify the qualitative problems of a general evaluation of the LED and the LED light.

Supply rate of the LED lights is 40% and is with the general lighting equipment which is used in the house now. When it is the illumination that is more effective than a fluorescent lamp, the LED is known, and the physical performance is verified clearly, but there is little examination about the psychology of the user and qualitative problems.

In this study, investigated actual survey for before and after renovation for 3 stations where all illumination turned into an LED light. Through a before and after comparison, examine the physical change and decided to examine psychological influence of the LED by the impression evaluation in the space.

METHOD

This study intended for 3 Station of Tokyo where construction to change all illumination into LED was performed in 2014 and performed in before of renovation and an investigation after the renovation.

The schedule of the investigation was like table 1 and 2 and performed it from 2013 through 2014.

In the case of a subject, it applied to a university student and the member of society of 20-30 generations and decided to make same sex ratio.

Table 1. *An investigation summary and schedule (Before renovation)*

		A station	*B station*	*C station*
Day	Date		2013.8.12	
		14:00	11:30	10:00
	Subjects		8 people	
Night	Date	2013.7.25	2013.7.25	2013.7.24
		22:30	22:00	20:30
	Subjects	12 people	14 people	9 people

Table 2. *An investigation summary and schedule (After renovation)*

		A station	*B station*	*C station*
Day	Date		2014.8.21	
		14:30	11:30	10:00
	Subjects		10 people	
Night	Date		2014.8.20-21	
		19:30	22:00	20:00
	Subjects	12 people	14 people	9 people

Figure 1*. Example of the LED renovation (Platform of station B)*

Show the physical quantity item measured from each spot of each station in table 3.

An item about the illumination included "floor illumination", "horizontal plane illumination", "perpendicular illumination", "downward illumination", and the measurement of "the grid illumination" that was the mean of 25 points of floor illumination was performed every 500mm.

In addition, measured indexes such as "the average luminance" that was the index from a luminance image using Luminocam, "the standard deviation of the luminance" because it was necessary to examine the light environment of the perpendicular to same with distribution of the brightness of the space and human eyes.

Table 3. *Measurement Index of Physical parameter*

Illuminance	*Data from Luminocam*
Floor illuminance	Average luminance (Directions of up, down, left, and right) (Average of Upper half and Lower half)
Horizontal illuminance	
Vertical illuminance	
Downward illuminance	Standard deviation of the brightness
Grid illuminance (Distribution)	Log(Standard deviation of the brightness)
Illuminance from unobstructed sky	Feeling of Brightness

Show the item of the impression evaluation in table 4.

In the case of an evaluation object, divided it into an evaluation for "the whole space", an evaluation for "the light", an evaluation for "the illumination" and an

evaluation of "the easiness in seeing" for a certain object, and, in the case of a scales, both applied "seven phases of polar scales" and "four phases of unipolar scales".

In addition, in the case of the evaluation on stairs, distribute an evaluation position up and down; from "look up" and "look down" evaluated it.

Table 4. *Item of the Impression Evaluation*

Target	*Item*				*Scale*
General	Dark	1 - 7	Bright	Bipolar	Example
	Dislike	1 - 7	Like		
	Anxiety	1 - 7	Reassurance		1: Too dark
	Silent	1 - 7	Bustling		
	Closure	1 - 7	Open		4: Normally
Light	Cool	1 - 7	Warm		
	Sharp	1 - 7	Soft		7: Too bright
General	Composure			Unipolar	Example
	Glare				
Illumination	Appropriateness				
Visibility of Item	Underfoot				1: It is not dazzling at all
	Edge of Platform				
	Sign				
	Advertising plate				
	Sheet				
	Electric bulletin board				4: Very dazzling
	Fare adjustment machine				
	Button of the Elevator				

RESULTS OF PHYSICAL PARAMETER MEASUREMENT

Show the result of a measurement of a platform, a concourse and stairs as follows.

Hold it as a representative figure as a result of night of A Station and, in data, describe it and show it mainly on floor illumination and vertical illumination.

Result of a measurement of the platform, "Platform1" and "Platform3" increased.

However, the tendency that largely decreased was seen in "Platform2", and illuminance distribution of Platform after the renovation became same.

It is the tendency that resembles "floor illumination" in the case of "the vertical illumination".

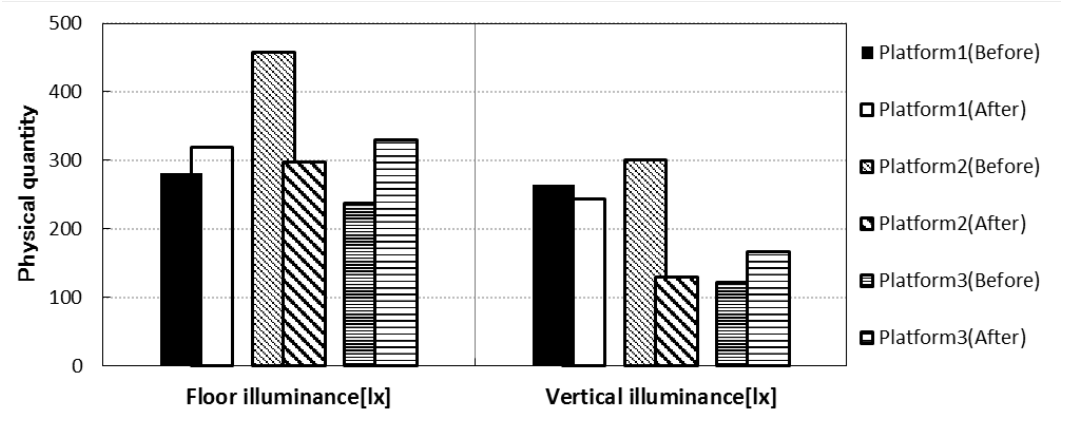

Figure 2*. Results of Measurement (Platform of station A)*

The physical quantity result of a measurement of the concourse is like figure 3.

"Inside of concourse1" where it was considerably dark largely rose after renovation and, in the case of "Outside of concourse" rose too.

In the case of "Inside of concourse2" which was the environment that was bright even before renovation, a change was few tendencies.

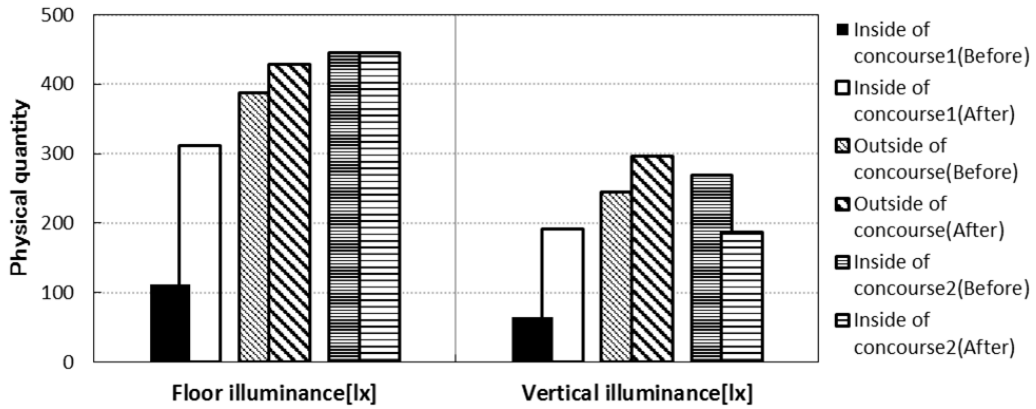

***Figure 3**. Results of Measurement (Concourse of station A)*

Of the quantity except "look down" of stairs1 physical from the spot the whole rose, and "look up" rose than double. Stairs1 which are connected to the concourse because the illumination of the concourse largely rose "look up" rose too.

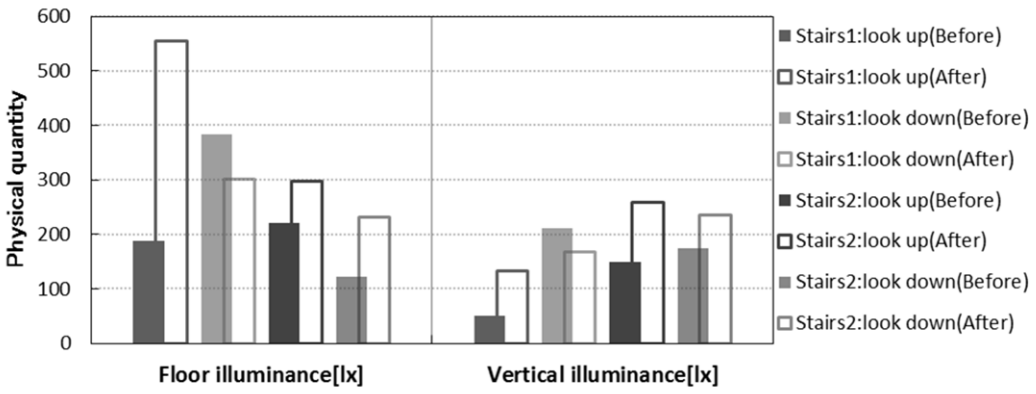

***Figure 4**. Results of Measurement (Stairs of station A)*

RESULTS OF IMPRESSION EVALUATION

As a result of impression evaluation of the platform, "preference" and "feeling of safety" rose after renovation.

The result of 4 point scale items was like figure5, "adequacy of the illumination" had few changes, and "glare" became higher.

It is thought that this is because external environment and the contrast with the indoor environment to be able to see by LED renovation from the inside became strong.

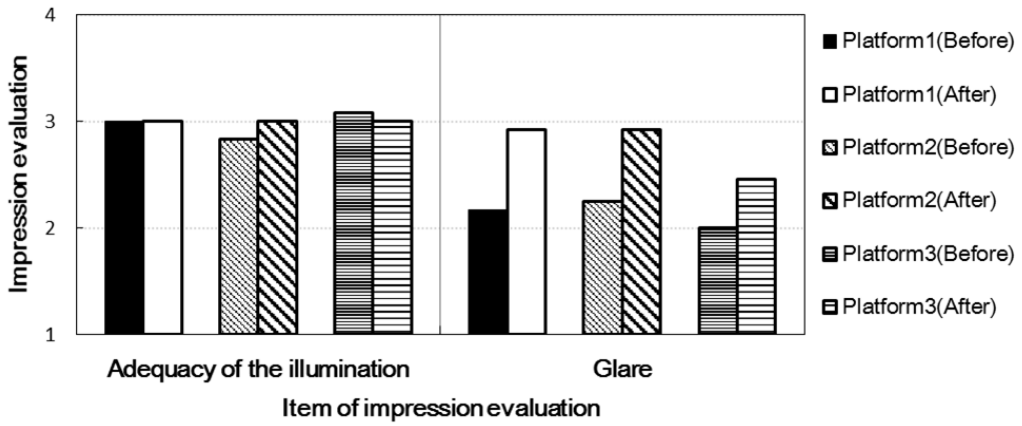

***Figure 5**. Results of Impression evaluation (Platform of station A)*

The impression evaluation result of stairs, "the adequacy of the illumination" were improved, but "glare" rises from all spots and a problem of glare on stairs is big and is surfaced.

Particularly, of "look up" of stairs a "glare" evaluation level from the position becomes higher at all, and it is thought that it is in a problem a source of light to be seen directly when did eyes upward.

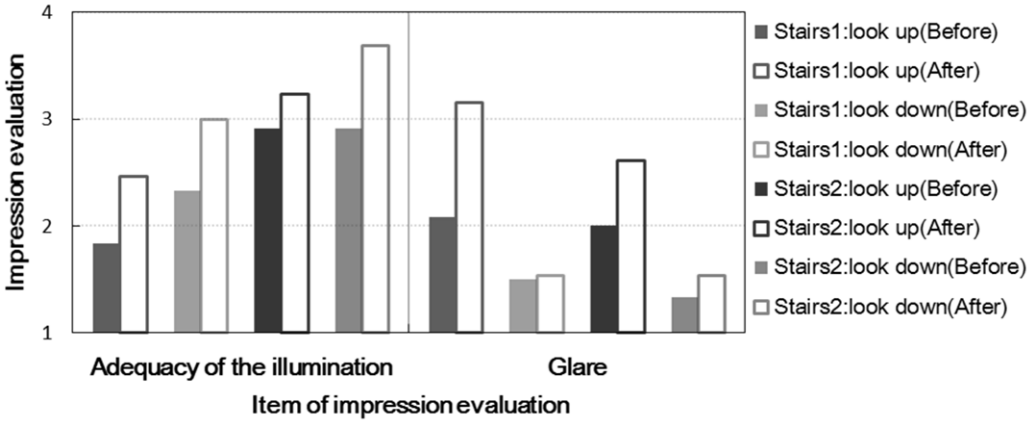

***Figure 6**. Results of Impression evaluation (Stairs of station A)*

SUMMARY

For the physical quantity result of a measurement of the platform, the structure of the half outdoors, "vertical illumination" is distributed in comparison with "floor illumination" low. Therefore, "after renovation", "the floor illumination" rose generally, but a similar tendency was seen whether "the vertical illumination" had few changes. In addition, in the case of B Station and C Station, physical quantity of the space largely rose by the change of the illumination method and the change of the illumination setting position.

The physical quantity measurement result of the concourse, light environment of "before renovation" rose generally around A Station where it was the darkest.

Because a reflective surface is much room space, and illumination efficiency is high space, it is bright and is felt in all spots.

Result of physical quantity measurement of stairs, "look up" and "look down" under the influence of from the illumination environment of a platform and the concourse, and the whole of the physics quantity rose by renovation. As a result of impression evaluation of the platform, after renovation, it was felt to be brighter generally, but "glare" rose together. In the case of a concourse, dependence for the quantity physical than other spots is high.

As a result of impression evaluation of stairs, an evaluation level rises by renovation generally. However, it is not necessarily physical index and proportion relations, and it is thought that come under an influence of a variety of factors.

It is small, and the physical quantity decreased, but the impression in the aforementioned place has risen, and the tendency that rise width of glare grows big in comparison with other spots is seen.

Particularly, glare by the position of the source of light to be able to see directly at time when looked up, in dark outdoors and glare by the comparison of a bright concourse to see from a home when I looked down, it is thought that a plan in consideration of a more qualitative aspect is necessary.

CONCLUSION AND IMPLICATIONS

The physical quantity is accompanied by the quantity of psychology basically and increased by having renovated a fluorescent lamp to LED. As for "the brightness of the space", a tendency decided by "physical quantity" of the space is common, but, by a characteristic of the space structure, "glare" occurs and may adversely affect it.

Therefore, it is thought that the illumination design method that is appropriate for the structure such as "island expression platforms" with a few "half outdoors" and reflectors with the influence of the external environment is necessary.

Particularly, it is one method to prevent contrast effects without lighting up the reflective surface to reduce discomfort by the comparison.

In the case of stairs, when looked up, the position of the source of light to be able to see directly is the same, and outbreak of glare is expected. It is the structure that the stairs are smaller than other spots, and is slim and is the space that is very likely to be the accident because which have a dynamic characteristic.

As main problems of stairs,

1. Being able to see directly the source of light of the wall surface and ceiling side (Cause of the glare).
2. Inequality of the light by the shadow from a user and a structure.
3. Sense of incongruity from top and bottom environment different each

It is thought that the illumination design that considered a more qualitative aspect is necessary to solve these problems, and to make the comfortable illumination environment and is not Glare.

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