

The Evaluation of Urban Landscape upon Japanese Representative LRT Cities Using Visual Engineering

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ABSTRACT : Light Rail Transit (LRT) is also considered the key to achieving a compact city in the future, and is being actively introduced to many cities in recent Japan. By with introducing the LRT system, it becomes very necessary to research the evaluation of urban landscape along the LRT line in order to improve landscape and urban planning as well as to provide a more attractive city for citizens and visitors. In this study, visual engineering and psychophysical measurement method was used to analyze people's subjective responses for urban landscape. We selected two Japanese representative LRT cities (Hiroshima and Toyama) as models, and the appearance of daytime and nighttime landscapes were evaluated on the basis of actual photographs by using the semantic differential method. From the results, the chief findings are showed as follows: 1) overall evaluation of the nightscapes was better than that of the daytime landscapes. 2) Landscape lighting played the important role in the charming nightscapes. 3) Three dimensions were produced by factor analysis. The first seemed to relate to how inspiring the urban landscape was, and it was termed the factor of "activity". The second dimension related to how comfortable the exterior of the landscape was, and it was called the factor of "Pleasantness". The third was termed the factor of "regularity".

Keywords-LRT, urban planning, visual engineering, urban landscape, SD method, factor analysis

I. INTRODUCTION

In June 2004, the landscape act was enacted as the first comprehensive act on landscape in Japan. The purpose of this act is to build a beautiful and dignified land, create an attractive and comfortable living environment and realize vibrant communities with distinct personalities by taking comprehensive measures to develop good urban and rural landscapes such as formulating landscape plans, in order to improve the quality of life of the people of Japan and contribute to the growth of the national economy and sound development of society. [1][2]

In particular, the urban landscape is an important component of the landscape act and has great significance in the construction of a comfortable, livable, and ecologically friendly city. Urban landscape also contributes to the cityscape in terms of visual quality. Within dense built environments, it creates a sense of openness and more attractive places to live for citizens and visitors. As the rapid development in most Japanese cities, urban landscape has become an important part of their urban planning. Well designed and managed urban landscape can improve citizens' quality of life, it is more efficient to evaluate the urban landscape for the future city planning. [3]

Therefore, there are many studies on the evaluation of urban landscape such as:

Prof. Higuchi, Dr. Tamagawa et al. (1988) [4] analyzed the identifiableness of urban landscape, to research how nightscapes differ from daytime landscapes and find how we can make identifiable nightscapes.

Dr. Ahn Hyun, Dr. Kim et al. (2007) [5] the survey was also carried out for the analysis of people's subjective responses to the images of urban night streetscapes. For analysis of the result of the survey, the SPSS 10.0 statistical program was used along with statistical techniques, such as frequency analysis, correlation analysis, and variance analysis.

Prof. Kawasaki, Dr. Tsuchida et al. (2008) [6] researched the relation between a whole image and a part of the image for urban landscapes from high points in the center of Kanazawa city, one of Japan's most traditional cities. The results of the SD method were analyzed with factor analysis, and four factors were extracted mainly. It was found that all whole pictures evidence the strong impact on the image of each factor compared with the parts.

Prof. Nakamura, et al.(2010) [7] Chofu area in Shimonoseki city was taken up as an example of the analysis, and the landscape is evaluated based on an actual photograph. “Image held in landscape and image of points the region” was analyzed.SD scaled questionnaire is taken in the experiment and multivariate analysis, and self-organizing neural network(SOM) were used as methods of the data analysis.

Prof. Matsumoto, Dr. Kacha etal. (2015) [8] studied on the evaluation of impression in streetscapes in Algeria and Japan. It was the semantic evaluation of the visual attributes of dataset of streetscape images. It focuses on the emotional impressions of the participants who evaluated the visual richness of the dataset.

On the other hand, urban transportation systems are being reviewed in countries around the world against a backdrop of chronic traffic congestion, exhaust air pollution and a rapidly aging society. Light Rail Transit (LRT) system is also considered the key to achieving a compact city design in the future, and is increasingly being adopted to many cities in Japan. By with introducing the LRT system, urban landscape around the LRT route is being play an important role in developing strategies for urban renewal. It becomes very necessary to research the evaluation of urban landscape along the LRT line in order to improve landscape and urban design as well as to provide a more attractive city for citizens and visitors.

In present study, we used visual engineering and psychophysical measurement method to analyze people's subjective responses for urban landscape. Two Japanese representative LRT cities were chosen as samples, Hiroshima city and Toyama city, which were successful introduction LRT systems in 2005 and 2006(Figure.1).The appearance of the daytime and nighttime urban landscapes along the LRT lines were evaluated on the basis of actual photographs by using the semantic differential method. Through by factor analysis, this study tried to analyze the effects and influence of urban landscape and described the characteristics of urban landscape along the LRT lines. It is expect to provide the basic data to create more beautiful and attractive urban landscape of the LRT city in the future.



(a)Toyama Port-ram-line (b)Hiroshima Green-mover-line
Figure.1LRTsystemin Japan

II. EXPERIMENTAL

2.1 Semantic Differential (SD) method

Semantic Differential (SD) technique is a typical method in performing landscape image evaluation test, was developed by C.E.Os good [9][10]. Impression evaluation by SD method, for a given impression measure, is an evaluation method for numerical select the degree to which subjects felt. This method, it is possible to quantify the evaluation value for each evaluation item, and that is also possible to comparative analysis between a pluralities of target. The analysis of the evaluation data of the SD method, we used the factor analysis method. This analysis made it possible to grasp the overall impression to the target from the impression words that are similar to adjectives. The evaluation is digitalized for each evaluation item, and comparative analysis becomes possible among multiple object. In determining impression evaluation words used in this experiment, 25 persons of subject were asked to freely write the impression toward sample pictures.

Table 1Judgment standards of adjectives[11][12]

[1]	Not to use adjectives that are used as special meaning by specialists, or adjectives that change the meaning depending on the knowledge of a subject.
[2]	To use a variety of words without concentrating on similar words.
[3]	To add words that are not connected to the sense of value, without leaning to adjectives related to value.
[4]	To avoid words that are easily judged on the purpose of surveying.
[5]	To use soft, sensory and intuitive adjectives.
[6]	To avoid obscure words.
[7]	To make the adjectives can be used in precedent studies as much as possible.

In the questionnaire, based on the after-mentioned judgment standards of Table1,20 contrastive adjectives were selected as suitable for evaluation the impression of Toyama and Hiroshima urban landscapes among 287 items of written impression words, including two overall indicators of the adjectives were adopted. Also, for the evaluation by a quantification theory, seven-grade system [+3, +2, +1, 0, -1, -2, -3] was used in evaluation sheet of SD method. (Fig.2)[13][14]

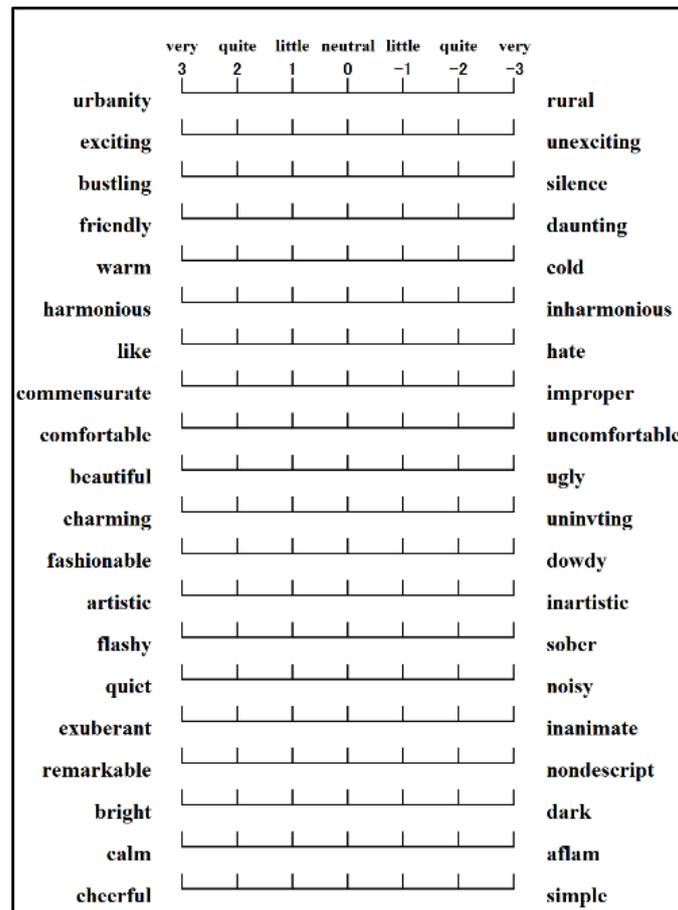


Figure.2 Evaluation sheet of SD method

2.2 Selection of experimental samples

Hiroshima city is the capital of Hiroshima Prefecture, and the largest city in the Chugoku region of western Honshu, the largest island of Japan. Hiroshima is best known as the first city in history to be targeted by a nuclear weapon when the United States Army Air Forces (USAAF) dropped an atomic bomb on the city on August 6, 1945, near the end of World War II. Hiroshima city having a population of 1,170,000 is a city in Japan with the most users of the streetcar. The network of LRT system is 35.1km,55 million users took in 2009.

Toyama city, which introduced the Japan’s first full-scale LRT system in the spring 2006, located on the coast of the Sea of Japan in the Chubu region on central Honshu, about 250 km north of the city of Nagoya and 380 km northwest of Tokyo. Historically, the modern city was incorporated on April 1, 1889, withdrawing from Kaminiikaw a district. As of 2014, the city had an estimated population of 337,324. Toyama LRT line passed through the center of Toyama city, such as ring water’s park, Toyama castle, Toyama glass art museum access etc.[15]

According to the characteristics of the cities, we selected a total of 40 places from 2 typical (historical and commercial) of the urban landscapes along the Hiroshima LRT and the Toyama LRT line as well as those have been widely recognized by the citizens and visitors. The urban landscape photography samples were selected an observation point that can understand the whole pictures and characteristics of the landscapes.[16]

(a) Photographic equipment as the shooting conditions digital camera (Canon Eos Kiss X5), lens focal length 35mm equivalent and 28mm equivalent, dedicated tripod.

(b) Take photos’ date and time to be selected in the good weather of summer, during 10:00 to 15:00, and after sunset 19:30 to 21:30.

(c) Shoot position in the LRT wayside road centerline supplementary near and then, the height from the

ground to the center of the camera lens is set to 1500 mm.

(d)Photography quality can be maintained at high quality pixels, the alignment condition of the four or more points. Our vision and visual angle also taken into consideration, and conscious so that it becomes a natural scenery samples as possible.[17][18]

According the above-described criteria were taken photographic samples. In reading all the photos have taken a personal computer, we have created daytime samples 40 pieces, nighttime samples40 pieces of a total of 80 points of the experimental observation for the urban landscape with LRT route. Actually used somedaytime samples are shown in Fig.3



a. Hiroshima Peace Memorial Park b. Hiroshima Castle c. MAZDA Zoom-Zoom Stadium d. Itsukushima Shinto Shrine



e. Toyama Ring Water's Park f. Toyama Castle g. Toyama Glass Art Museum h. Toyama Electrical Building

Figure.3Example of daytime sample photos

2.3 Experiment method

We did all of experiment under the conditions of a dark room. The distance of the subject's anterior 4 m place the screen (W2.4m × H1.8m) for presenting the landscape sample, using a projector, and is presented in a random one by one slide experimental landscape samples on the entire surface of the screen.

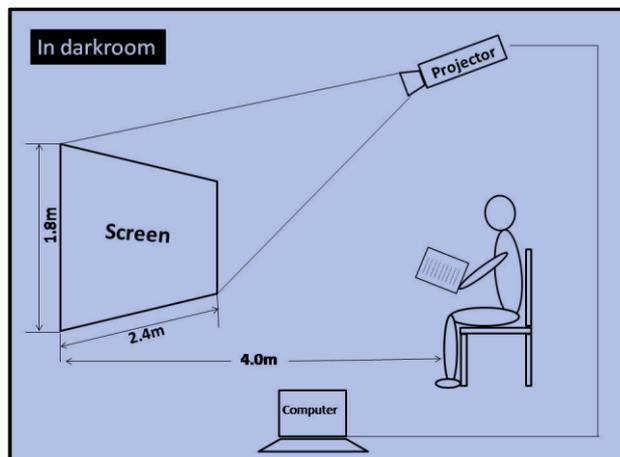


Figure.4Image of experimental

Subject observed the presentation of the landscape sample in one minute, thereafter, evaluates the impression felt the scene sample data sheet using the SD method of psychological techniques. In order to prevent accidental filling, etc., it is assumed that fill one by one for one scene sample.[19]

The configuration of the subject are25 students (17 males, 8 females) of the faculty of engineeringwith 21.9 average age, both are familiar to the SD method. In addition, psychological subject, namely in consideration of feeling and physical condition etc., in order to measure and reduce the error as much, experiments were performed while taking a break at fixed intervals.[20]

III. RESULTS AND DISCUSSION

3.1 Experiment results

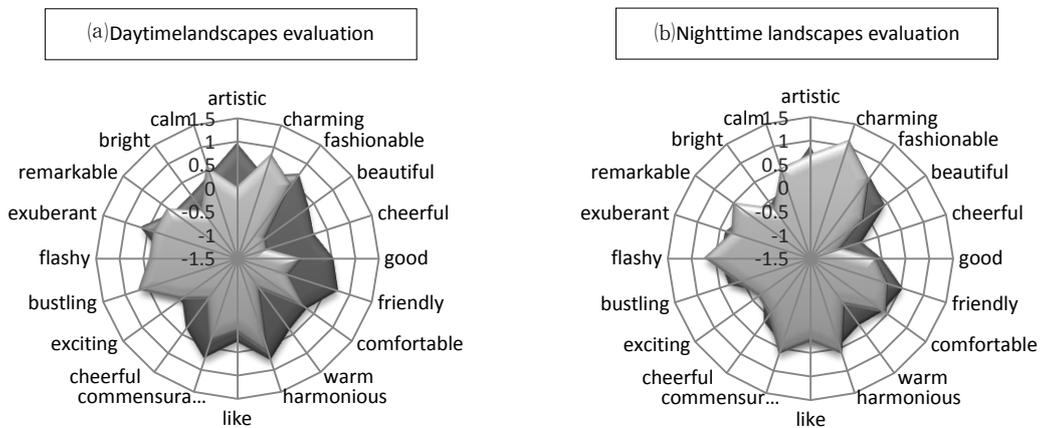


Figure.5 Average result for all samples (■ Hiroshima ■ Toyama)

We showed average impression evaluation result of all samples in Fig.5. For all landscape samples, it is intended that the average value of all image evaluation results of the displayed on the polar coordinates. In each figure, placing the adjective of positive impression in the circumferential direction. The radially taking an evaluation value, the evaluation value of each adjective enough to be located outside the circle indicating that is high. The parameter is "■ Hiroshima" and "■ Toyama".

First, Fig.5 (a) showed the average value in daytime, it can be said that shows the respective landscape evaluation trend "Hiroshima" and "Toyama". The variation of the daytime urban landscape evaluation value is large, compared with "Hiroshima", the area surrounded by the closed curve in the order of "Toyama" is larger. That is, in the evaluation of the daytime landscape samples showed that the image evaluation of the "Toyama" is above it in the overall the "Hiroshima". Specifically, the difference was remarkable in adjectives such as (artistic), (beautiful), (cheerful), (good), (friendly) and (warm).

Then, in Fig.5 (b) showed the average value at night both "Toyama" and "Hiroshima", different from the previous result, higher overall trend compared image evaluation is that of the daytime urban landscapes can be seen. The difference was obviously in adjectives such as (charming), (friendly), (harmonious), (commensurate), (flashy) and (calm). In particular, the evaluation of "Toyama" such as (cheerful), (warm), (exciting) and (bright) value that has been shown very low.

3.2 Factor analysis

Toyama and Hiroshima city totally 80 pieces samples of experimental data that used in this experiment, in order to more quantitatively assess the results, we were subjected to factor analysis. By the analysis to better interpret the landscape sample results factor analysis, on the basis of the results obtained from the subjects and subjected to factor analysis with respect to average data of an image evaluation of each adjective pair in the landscape sample it was showed in Table 2.

With performing the factor analysis, principal component analysis was performed for firstly determining the number of factors. The Eigen values of the factor for the correlation matrix between each adjective pair is 1.0 values or more factors are three extraction cumulative for the contribution rate was 79.14%, in consideration of the possibility of semantic interpretation is the number of three factors was conducted factor analysis.

Table 2. Result of factor analysis

Axis	Label	Adjectives Name	Factor 1	Factor 2	Factor 3
1st Axis	Activity	Urbanity Rural	0.901043	0.207936	0.105482
		Exciting Unexciting	0.825898	0.418232	0.260493
		Bustling Silence	0.798481	0.294507	0.348639
		Flashy Sober	0.738077	0.550268	0.128313

		Exuberant Inanimate	0.697234	0.376081	0.532197
		Remarkable Nondescript	0.664421	0.540431	0.230119
		Bright Dark	0.644894	0.437176	0.161598
		Calm Aflame	0.615687	0.480708	0.107348
2nd Axis	Pleasantness	Good Bad	0.254288	0.857552	0.282212
		Friendly Daunting	0.379473	0.838978	-0.07758
		Comfortable Uncomfortable	0.526019	0.786869	0.159778
		Warm Cold	0.505595	0.761755	0.126943
		Harmonious Inharmonious	0.277914	0.736685	0.555638
		Like Hate	0.235191	0.680509	0.577099
		Commensurate Improper	0.110587	0.635546	0.482484
		Beautiful Ugly	0.488222	0.624323	0.498644
3rd Axis	Regularity	Charming Uninviting	0.226523	0.554423	0.869139
		Fashionable Dowdy	0.511379	0.091644	0.742833
		Artistic Inartistic	0.319054	0.563368	0.696762
		Cheerful Simple	0.148995	0.289834	0.644631
Contribution Rate (%)			39.14%	28.11%	11.89%
Cumulative Contribution Rate(%)			39.14%	67.25%	79.14%

As a result, it shows the contribution rate after varimax rotation until the resulting second factor and the factor loadings of each adjective pair in Table 2, Factor loadings indicates the influence factors on each evaluation item, factor of interpretation which went in load factors.

Results of factor analysis, three factors were deposited roughly, was estimated meanings representing each factor from the factor loadings adjective pairs in each factor. (Table 2)

1. The first factor was 39.14% contribution rate and it was high factor loadings of urbanity, exciting, bustling, flashy, exuberant, remarkable, bright and calm. Then, it was interpreted as Activity factor.
2. The second factor was 28.11% contribution rate, high factor loadings of good, friendly, comfortable, warm, harmonious, like, commensurate and beautiful. From these features, it was named Pleasantness factor.
3. The third factor is 11.89% contribution rate at high factor loadings of charming, fashionable, artistic and cheerful, it was termed Regularity factor.

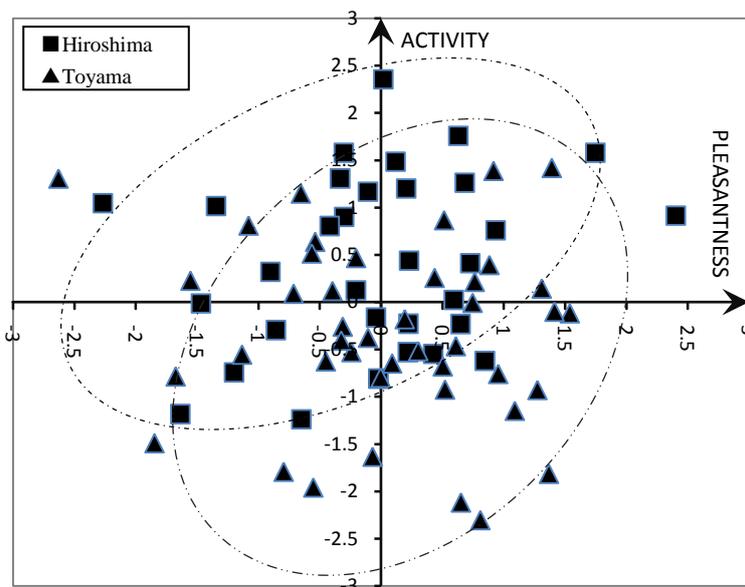


Figure.6 Factor analysis points evaluation for all samples (Activity factor to Pleasantness factor)

Based on the factor analysis results, it showed two graphs plotted together factors score of each sample (Fig.6) and (Fig.7). In Fig.6, the horizontal axis is first factor [Activity], and the vertical axis is one that took the [Pleasantness]. The parameters are the two stages of the points indicated by "■Hiroshima" and "▲Toyama". In Fig.7, the horizontal axis is second factor [Pleasantness], and the vertical axis is the third factor [Regularity]. The parameters are the two stages of the points indicated by "◆Hiroshima" and "●Toyama".

From Fig.6, [Activity] in the night time landscape as a whole tendency, and [Pleasantness] means that has been shown to be higher than the day time landscape. In particular, in the [Activity] of the vertical axis, they tend to factor score can be greatly increased in the nighttime landscape was seen. This difference is mainly is due appropriate landscape lighting effects at night, as compared to it more lively than daytime landscape, it is believed that because gave a certain impression of vitality.

Specifically, particularly high landscape sample of evaluation in the [Activity] of the vertical axis, Urban place, ANA hotel and Mazda zoom-zoom Stadium etc., neither of which are nighttime urban landscape. Day and night of Hiroshima castle, day and night of Toyama castle, which are very low factor score The main cause of such negative evaluation is due to the "vibrant and lively" of the commercial and tourist facilities scenery, historical landscape, such as Itsukushima Shinto Shrine and Toyama castle is an all-quiet is calm. It is considered to be because the relatively susceptible to impression.

Also in Fig.7, the [Regularity] of the horizontal axis, daytime and night landscape of high evaluation such as Toyama ring water's park, day and night of Koshinokuni cultural center, Toyama castle it is a night scene. On the other hand, evaluation low landscape, JR Toyama Station, there was a daytime scenery and night view of the CIC building. From the above, a high valuation landscape, a lot of green, lighting tended to stand out landscape and beautifully lit up the Toyama Castle unique landscapes such as an LED illumination, such as maintenance has been Toyama ring waters' park. On the other hand, low landscape of the valuation, the commercial ones, are in the city, such as station building, include the landscape to receive the mundane impression. Further, the main cause of negative evaluation in night view of the CIC building may be due to fluorescent mercury lamp has been used to light up. As a feature of the fluorescent mercury lamp illuminance for low color rendering property but can be secured, the landscape can be mentioned disadvantages would appear dimensionally such as gray color. In addition, JR Toyama Station, it is believed to inhibit the [Evaluation] of the landscape due to the impact of the wire such that has been spread around in large utility pole and sky before station building.

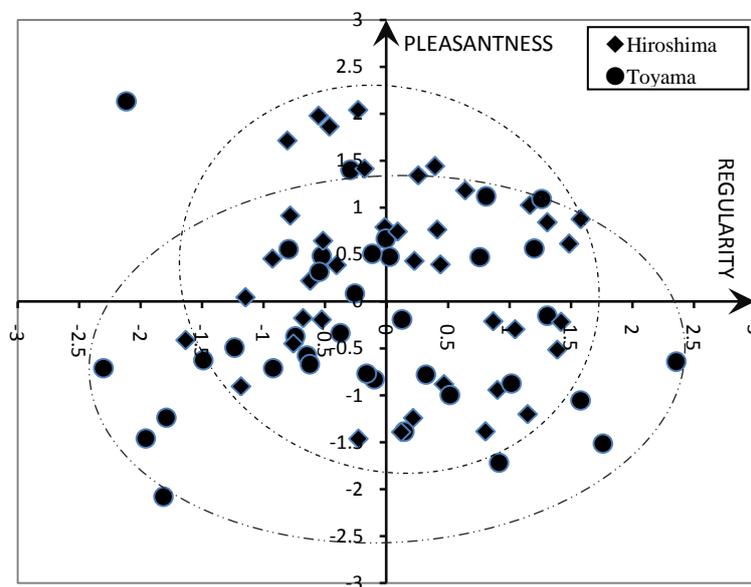


Figure.7Factor analysis points evaluation for all samples
(Pleasantness factor to Regularity factor)

From the results of the factor analysis, in the commercial landscape, daytime landscapes although more of Toyama is highly rated, it is reversed when it comes to nighttime landscapes, that of Hiroshima evaluation is higher. This evaluation value over the nighttime landscape from daytime landscape both two cities are rising, but is due to better Hiroshima landscape is large rise width of the evaluation. The landscapes of Hiroshima, such as Mazda stadium and peace memorial park are many place such as illumination and light up have been made

effective, in such a landscape sample "exciting", "flashy", "bright" and "beautiful" evaluation value adjective pairs such as are rising. However, The urban landscape of Toyama excluding the place where illumination such as Toyama ring water park have been made, is not observed areas the evaluation value is increased greatly. Consequently, it is considered that the difference between the evaluation value in the daytime and nighttime occur.

In addition, in the historical landscapes, the same with commercial landscapes, from daytime to nighttime landscape on the overall evaluation values between the two cities is increased and the difference of the evaluation value is shortened, but Hiroshima both daytime and nighttime towards the wayside of the landscape it became a result of the evaluation is higher than that of Toyama. The reasons is by Hiroshima wayside of landscape to the ingenuity, such as using the illumination light to match the appearance of the building, although a high evaluation value at daytime landscape also maintains at night scene, Some landscapes of Toyama LRT wayside, light-up were not performed, the evaluation value has become a generally low value.

The urban landscapes of Toyama LRT, since although daytime commercial urban landscapes obtained a good evaluation, but evaluation in the others were below that of Hiroshima LRT. It may be desirable to go conducted to improve the light-up and urban design in the future.

IV. CONCLUSION

As mentioned above, the overall image evaluation of the night urban landscape was better than that of the daytime along the LRT lines. We found that the appropriate light-up was more important in improving the image of the urban landscape and activating the citizen's life at night. The importance of nighttime urban landscape along the LRT line has been recognized again. In order to produce a beautiful attractive urban landscape, the role of the landscape lighting are very important, rather than merely applying illumination, I considered there is a need to be done with an understanding of the landscape of the characteristics and purposes.

From factor analysis, three dimensions were produced by factor analysis. The first seemed to relate to how inspiring the urban landscape was, and it was termed the factor of "activity". The second dimension related to how comfortable the exterior of the urban landscape was, and it was called the factor of "pleasantness". The third dimension related to how harmonious the urban landscape, and it was termed the factor of "regularity".

By comparing the image evaluation of Toyama and Hiroshima of urban landscape along the LRT line, only the daytime commercial landscape in Toyama LRT wayside is good for evaluation, the obtained became the evaluation below the urban landscape along the line of landscape Hiroshima in other. With the March 2015 opening of the Shinkansen, Toyama LRT line running through the center of Toyama currently in service, the number of user increases are being expected. In order to produce a beautiful attractive urban landscape, we considered there is a need to be done light-up and urban design go made improvements that may be desirable around Toyama LRT line in the future.

Finally, this experiment was limited to subjects before and after 20s students, it is considered that it is necessary to measure in consideration of the age of the subject in the future.

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