ORIGINAl ARTICLE

Functionality of Signboard in Considering Landscape

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Abstract: Recently, regulations governing outdoor advertisements have been enacted in Kyoto, and elsewhere, based on landscape and cityscape planning considerations. Commonly, such regulations are based on desires to preserve historical townscapes and permit development of more attractive cities. In this study, we aimed to clarify conditions by which signboards can be made to harmonize with their surrounding landscape from the viewpoint of color, while maintaining a sufficient level “functionality” in locations where we normally live. The experiment was conducted using a personal computer monitor on which colored signboards were displayed against various backgrounds. The results are suggested that coloring patterns in which white is used as the background or lettering color are highly evaluated for “harmony”, and coloring patterns of black or chromatic color background × white lettering are likely to remain in the viewer’s “impression”.

Keywords: Harmony, Signboard, Landscape

1. INTRODUCTION

The Landscape Act was enacted in 2004, and local governments became possible an individual outdoor advertisement policy. Recently, regulations governing outdoor advertisements have been enacted in Kyoto [1], Tokyo [2], Yokohama’s Minato Mirai area [3], Kanazawa City, Ishikawa Prefecture [4], and elsewhere, based on landscape and cityscape planning considerations. Nonaka [5] clarified the actual situation of landscape planning by local governments. Ochi et al. [6] reported that the municipalities that established outdoor advertisement ordinance were 8% of the total. Ezaki et al. [7] examined the contents of the regulation by the landscape plan based on the Landscape Act and clarified that the proportion of the contents of the regulation differed for each district classified by the landscape resource. Doumoto et al. [8] clarified the actual situation of color standard in official landscape plan. Kato [9] investigated the color restriction using the Munsell color system in the landscape plan and reported that there was a difference for each topographic attribute in the setting of saturation. Kunihiro et al. [10] investigated the actual condition on control of outdoor/indoor advertisement and reported that the ratio of qualitative description by language was the largest for color standard. Narita [11] considered required elements for landscape plan and suggested the possibility of color regulation could be done even if it was not quantitative. Harada et al. [12] analyzed restrictions on actions related to lighting in landscape plan. Commonly, such regulations are based on desires to preserve historical townscapes and permit development of more attractive cities. However, studies on the outdoor advertisements harmonized with the surrounding landscape outside of regulated areas have not reported. In this study, we will clarify conditions by which signboards can be made to harmonize with their surrounding landscape from the viewpoint of color, while maintaining a sufficient level “functionality” in locations where we normally live. “Functionality” indicates the functionality of the signboards including impression received from the signboards and conspicuousness.

2. EXPERIMENT

In this study, a visual experiment was conducted to clarify the coloring patterns of signboard harmonized with the surrounding landscape having sufficient functionality. Our findings are based on an experiment that was conducted using a personal computer (PC) monitor (EIZO FlexScan EV2436W) in a darkroom on which colored signboards were displayed against various backgrounds, and from which test subjects made subjective evaluations of the signboards.

In this experiment, in order to prevent the object coloration from being influenced by light contamination, all external lights in the darkroom were turned off and the color temperature of the monitor was set to 6500 K (white). In addition, the angle at which test subjects...
viewed the object image was set to 20° horizontal and 15° vertical, which is assumed the functional visual field of a pedestrian that a pedestrian can reliably recognize a signboard, and the distance between the test subjects and monitor was set to 120 cm in order to ensure that the object was fully visible.

Experimental images were synthesized using the free and open source GNU Image Manipulation Program (GIMP). Tables 1 and 2 show the color codes and coloring patterns, respectively, that were used in this experiment. We selected seven colors that were black and white which are achromatic colors, and red, green, blue which are the three primary colors of light, yellow which is called warning color, and brown which is often seen in the city as a representative example of the regulation in Kyoto. The color code used in this experiment was determined by extracting values from actual photographic images of the seven colors to be used. The following color combinations were presented: white background color × colored lettering (excluding white), colored background (excluding white) × white lettering, and chromatic background color (excluding brown) × chromatic lettering color (excluding brown).

Figure 1 shows the signboard patterns used in this experiment. Figure 2 shows the example of experimental images. The background images were set to three kinds of different areas around experimental area. The first area is “residential area with open space” where houses are gathered. The second area is “road area”, and the third area is “downtown area”. Test subjects were asked to make subjective evaluations using the seven-stage (−3 to 3) semantic differential (SD) method in which eight word pairs (calm/restless, conspicuous/inconspicuous, colorful/quiet, harmonious/unharmonious, comfortable/uncomfortable, clean/messy, impressive/unimpressive, easy to see/hard to see) were employed. Note that “eight word pairs” were presented in Japanese.

The test subjects were eight males in their twenties with normal color vision.

The following procedure was used in the experiment:

1. The subjects observe randomly presented evaluation images.
2. The subjects provide subjective evaluation judgments via oral response.
3. Steps (1) to (2) are repeated for 24 patterns.
4. Steps (1) to (3) are repeated in the order “residential area with open space”, “road area”, and “downtown area”.

| Table 1: Color codes |
|---------------------|
| color | color codes |
| W(White) | ffffff |
| B(Black) | 2f3130 |
| R(Red) | e03c4a |
| G(Green) | 23a54d |
| B(Blue) | 017eec |
| Y(Yellow) | ffd900 |
| Br(Brown) | 963e30 |

| Table 2: Coloring patterns |
|---------------------------|
| | [W × B] | [B × W] | [R × G] | [G × R] | [B × R] | [Y × R] |
| [W × B] | [W × B] | [R × W] | [R × B] | [G × B] | [Y × B] | [Y × G] |
| [W × G] | [W × G] | [R × Y] | [G × Y] | [B × Y] | [Y × B] |
| [W × Br] | [Br × W] |

Figure 1: Signboard patterns

(a) Residential area with open space (b) Road area (c) Downtown area

Figure 2: Example of experimental images
3. RESULTS

Among the results obtained via subjective evaluation were two excerpts, “harmonious/unharmonious”, which is considered to be most relevant to the aim of this study, and “impressive/unimpressive”, which is thought to be important for signboard functionality. Here, the evaluation score of “harmonious/unharmonious” is called “harmony”, and the evaluation score of “impressive/unimpressive” is called “impression”. “Harmony” indicates that signboards are harmonized with the landscape, and “impression” indicates the impression received from the signboards. In order to ensure that the coloring harmonized with the landscape while maintaining “conspicuity”, regardless of background image, we decided to select coloring patterns that resulted in the highest total evaluations scores for “harmony” and “impression”.

Figure 3 shows the relationship between “harmony” and “impression” in the residential area with open space, and vertical axis is the harmony score and horizontal axis is impression score. The data in the figure show the average of the evaluation scores of the subjects. Figure 4 shows the coloring patterns for which the evaluation scores for “harmony” in the same area were 0 or more. We picked out the coloring patterns that evaluations on harmony were not negative since the aim of this study is to clarify the coloring patterns of signboard harmonized with the landscape. These figures show that the evaluation scores of the coloring patterns G × W, G × R, and Bl × W were high in the residential area with open space. Furthermore, we found that the chromatic color combinations were difficult to harmonize, even though they were evaluated highly in the “impression” score range. The reason for this result is considered to be that the subjects have a calm image in the residential area, and the subjects feel that chromatic color combinations does not harmonize the surrounding environment.

Figure 5 shows the relationship between “harmony” and “impression” in the road area, and vertical axis is the harmony score and horizontal axis is impression score. The data in the figure show the average of the evaluation scores of the subjects. Figure 6 shows the coloring patterns for which the evaluation scores for “harmony” in the same area were 0 or more.

![Figure 3](image1.png)
![Figure 4](image2.png)
![Figure 5](image3.png)
![Figure 6](image4.png)
area were 0 or more. As can be seen in these figures, the road area evaluation scores for the coloring patterns W × B, B × W, W × Br, Br × W, G × Y, and B × Y were high. It can also be seen that the road area evaluation scores for blue patterns were high, in addition to white and green coloring patterns that were evaluated highly in the residential area with open space. The reason for this result is considered to be that the blue sky appeared in the background image.

However, the Bl × W scores show a large difference between the “harmony” and “impression” scores. Since the signboard is positioned close to the tree shadows, it is thought that the black background became difficult to see and did not make a strong “impression” on the test subjects. In addition, it is thought that the black background combined with the tree shadow to produce a high “harmony” score.

Figure 7 shows the relationship between “harmony” and “impression” in the downtown area, and vertical axis is the harmony score and horizontal axis is impression score. The data in the figure show the average of the evaluation scores of the subjects. Figure 8 shows the coloring patterns for which the evaluation scores of “harmony” in the same area were 0 or more. Together, these figures show that the coloring pattern evaluation scores of Br × W, W × Br, W × G, G × W, B × W, Bl × W, and W × R are high in the downtown area. Furthermore, Fig. 7 shows that the evaluation scores of black or chromatic color background × white lettering, or white background × chromatic color lettering are high in the downtown area. The reason for this result is considered to be that the patterns using white were easy to see because the background image was dark.

Figure 9 shows the coloring patterns for which the evaluation scores of “harmony” and “impression” were 0 or more in each area along with the sum of the evaluation scores of “harmony” and “impression”. As can be seen in this figure, the total score of the coloring pattern G × W is the highest score in the residential area with open space, B × W is the highest score in the road area, and Bl × W is the highest score in the downtown area. These results indicate that these coloring patterns are harmonious with the landscape and made a strong “impression” on viewers.

In the residential area with open space, it is thought that the G × W score is high because numerous plants were shown in the background image. In addition, it is thought that green is a suitable color for a quiet residential area sign because it has a calming effect on viewers. The coloring pattern B × W is used commonly for traffic signs, and it is a coloring pattern that has very high visibility. Therefore, it is thought that the evaluation score was high in the road area. In the downtown area, it is thought that the score of Bl × W is high because the building in the background image was black and the image showed a dark alley.
4. DISCUSSION

Here, factor analysis with the principal factor method and varimax rotation were performed on the results of the subjective evaluation. Table 3 shows the resulting factor loadings. Primary factors, having a factor contribution rate of 0.62, are called “environmental harmony factors”. Secondary factors, having a factor contribution rate of 0.38, are called “functionality factors”. Next, in order to ascertain the relationship between the coloring patterns and background conditions and each factor, a factor score was computed. We examined the relationship between factor scores for two factors under the experimental conditions. Figure 10, 11, 12 shows the relationship between “environmental harmony” and “functionality” in the residential area with open space, road area, downtown area, respectively and the coloring patterns for which the factor scores of “environmental harmony” in each area were 0 or more are shown in Figures 13, 14, 15.

Compared to Figures 4, 6 and 8 it is shown that the factor scores of the patterns using red are high. It is thought that this functionality factor scores increased because the red color effectively attracts attention. Furthermore, in the background used in this study, it is considered that red was not a negative evaluation from the viewpoint of environmental harmony.

Figure 16 shows the coloring patterns for which the factor scores of “environmental harmony” and “functionality” were 0 or more in each area along with the sum of the factor scores of “environmental harmony” and “functionality”. As can be seen in this figure, the total score of the coloring pattern R × W is the highest score in the residential area with open space, B × W is the highest score in the road area, and B × W is the highest score in the downtown area. Here, compared to Figure 9, the coloring patterns of highest score have changed from G × W to R × W in the residential area with open space and B × W to B × W in the downtown area. In an attempt to understand the reason for the difference G × W and R × W, the luminance contrasts between the background color and the lettering color in the images displayed on the PC monitor were measured.

| Table 3: Factor loadings |
|---------------------------|
| SD scales                  | Factor                      |
|                           | Environmental harmony | Functionality |
| Comfortable - Uncomfortable | 0.9732                     | -0.0401       |
| Clean - Messy              | 0.9266                     | -0.1028       |
| Harmonious - Unharmonious  | 0.8835                     | -0.3446       |
| Calm - Restless            | 0.8832                     | -0.3607       |
| Easy to see - Hard to see  | 0.7765                     | 0.4638        |
| Conspicuous - Inconspicuous| -0.1185                    | 0.9393        |
| Colorful - Quiet           | -0.3255                    | 0.8899        |
| Impressive - Unimpressive  | 0.0394                     | 0.8648        |
| Contribution Rate          | 0.6200                     | 0.3800        |
From these results, we found that G × W has a luminance contrast of 3.0, whereas R × W has a luminance contrast of 3.8. This indicates that R × W became easier to read because the luminance contrast increases. The reason for the difference between Bl × W and B × W, Bl × W harmonized with the dark background of the downtown area, but it was less conspicuous. On the other hand, it is thought from Figure 15 that B × W harmonized with the background and had sufficient functionality as a signboard. Furthermore, in this factor analysis result, it was considered that the factor scores of G × W and Bl × W became negative, because “Colorful – Quiet” was included in the functionality factors.

Since R × W and B × W are used for road signs, it seems that subjects were hard to feel uncomfortable. These results indicate that these coloring patterns are harmonious with the landscape and made a strong impression on viewers.

5. CONCLUSION

In this study, a visual experiment was conducted to clarify how the coloring patterns of signboard harmonized with the landscape while maintaining “functionality”. The results are summarized as follows:

1. Coloring patterns in which white is used as the background or lettering color are highly evaluated for “harmony”.

2. Coloring patterns of black or chromatic color background × white lettering are likely to remain in the viewer’s “impression”.

In this study, Coloring patterns R × W in the residential area with open space, B × W in the road area, and B × W in the downtown area were harmonious with the landscape and maintain functionality. However, since the display method of the signboard at each area is different, it is necessary to conduct the experiment in which the display method is unified. Furthermore, we need to consider so that it can be applied to more background situations such as images of more residential areas and downtown areas and other areas behind a signboard.

REFERENCES

1. Kyoto City Official Website; https://www.city.kyoto.lg.jp/tokei/page/0000056450. html (accessed 2019.09.09).

2. Bureau of Urban Development Tokyo Metropolitan Government Homepage; http://www.toshiseibi.metro.tokyo.jp/kenchiku/koukoku/ (accessed 2018.08.24).
3. Yokohama City Urban Development Bureau Homepage; http://www.city.yokohama.lg.jp/toshi/mm21/keikan/ (accessed 2018.08.24).

4. City of Kanazawa Homepage; http://www4.city.kanazawa.lg.jp/29020/keikan/keikan/1_1_b.html (accessed 2018.08.24).

5. Nonaka, K.; A study on the intention of outdoor advertisement administration in municipality by landscape plan. Journal of the City Planning Institute of Japan, 43(3), pp.649-654, 2008. (in Japanese)

6. Ochi, A., and Mukaiguchi, T.; A study on relation of preservation districts for groups of historic buildings and the control of landscape and outdoor advertising matter. Proceedings of Tokai Chapter Architectural Research Meeting, 54, pp.505-508, 2016. (in Japanese)

7. Esaki, T., Ikaruga, S., and Kobayashi, T.; Study on the landscape control and landscape character about important area based on landscape planning. Proceedings of Annual Research Meeting Chugoku Chapter, Architectural Institute of Japan, 39, pp.773-776, 2016. (in Japanese)

8. Doumoto, Y., Okazaki, A., and Matsui, D.; Color standard in official landscape plan – Focussing on accent color and discretionary standard –. AIJ Journal of Technology and Design, 21(49), pp.1235-1240, 2015. (in Japanese)

9. Kato, Y.; A study of actual conditions of color restriction standards by Munsell Color System in landscape planning – For case studies of 274 enforced landscape plans –. Journal of the Color Science Association of Japan, 42(3), pp.151-154, 2018. (in Japanese)

10. Kunihiro, Y., and Nozawa, C.; Actual condition and issues on control of outdoor / indoor advertisement based on landscape plan – The nationwide questionnaire survey for municipalities of landscape administrative organization –. AIJ Journal of Technology and Design, 24(57), pp.825-828, 2018. (in Japanese)

11. Narita, I.; Relation of the good color landscape formation and landscape plan. Journal of the Color Science Association of Japan, 42(3), pp.147-150, 2018. (in Japanese)

12. Harada, M., and Yokoe, A.; Landscape design standards for lighting established by landscape plans prescribed in the landscape act. Journal of the Illuminating Engineering Institute of Japan, 102(2), pp.71-79, 2018. (in Japanese)

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