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Effects of color schemes on aesthetic response of the work environment

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Abstract

Color can enhance subjective aesthetic judgment and provide an effective work environment. This study investigated the influences of workplace color schemes on participants' aesthetic response. Two monochromatic (red, purple-blue) and two analogous color schemes (warm, cool) were studied in the simulated work environments. 53 interior designers who volunteered to participate in this study, rated evaluative factors using the semantic differential scale on a questionnaire. The results indicated that the different color schemes can affect participants' aesthetic evaluation. The purple-blue space creates a feeling of calmness while red can provoke the feeling of stimulating. The cool colored space is generally perceived more positively regarding visual comfort, being comfortable, and relaxing. The warm colored space tends to provide more vivid, bright and warm sensation. Monochromatic color schemes can create a sense of harmony and simplicity within space. Some of the aesthetic evaluations are rated as equal under the monochromatic and analogous colored space. The results suggested that the color schemes have both positive and negative influences on participants' aesthetic response of the work environment.

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Introduction

The work environment, composed of physical factors such as workplace layout, furniture, color, lighting, etc., appears to have both positive and negative impacts on the perception of workers. Many organizations have implemented open-plan offices to encourage teamwork and collaboration.

Color is one of the most important and influential elements (Küller, Ballal, Laike, Mikellides, & Tonello, 2006; Kwallek, Lewis, Lin-Hsiao, & Woodson, 1996). It is used in workplace design for different purposes of presenting the aesthetical and function. Color is widely suggested to have influences on people's aesthetic response associated with the affective appraisal, physiological response, and behavior (Liu, 2016; O'Connor, 2008). The harmony of color considering appropriate combinations can produce a positive aesthetic

experience. If unsuitable color combinations are selected, these might lead to negative psychological impacts on workers (Kwallek, Woodson, Lewis, & Sales, 1997). Previous research has been carried out in investigating the affective and cognitive effects of workplace colors on people (Küller, Mikellides, & Janssens, 2009; Kwallek & Lewis, 1990). Those studies have often focused on a few prominent hues such as red, blue, and green. Little research has been conducted to analyze the influences of color combinations which may be a more representative color for a real existing work environment.

Blue and red are frequently used in workplace design in Thailand to represent the company brand and takes a predominantly monochromatic approach. Some workplaces tend to add more color for providing creativity particularly in the design firm. However, interior designers are sometimes unaware of the effects of color. Thus, for creating an effective work environment, more studies are required to understand and validate how color combination influences aesthetic response.

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Moreover, previous studies used the semantic differential method to evaluate the influence of color on aesthetical consideration. However, the word pairs varied by meaning depending on culture and context. Accordingly, it is essential in expanding knowledge and understanding how the combination of colors can provide peoples' aesthetic perception. Thus, the aim of this study was to investigate the effects of color schemes on workers' aesthetic response. The study mainly focused on monochromatic and analogous color schemes within the open-plan work environments and proposed the scales to assess overall aesthetic dimension.

Literature Review

The aesthetic response in environmental aesthetic is defined as a subjective experience, judgment, and evaluation of human with aesthetic factors. The probabilistic framework developed by Nasar (1997) clearly explains the relation and interaction between human and the aesthetic considerations; building physical attributes, that results in aesthetic response. Besides, the aesthetic response may vary due to individual differences such as personality, experience, and background. For example, professional interior designers have different preferences with the general public regarding interior environment (Liu, 2016).

A common research method to investigate the effects of room color on the subjective perception of space is the semantic differential scale. Most researchers have created the scale by choosing the word pairs that have related meaning from previous studies. Some problems exist in this area of color research. The aesthetic evaluative factors vary across different studies in different contexts, which may be complicated by meanings among various cultures. Moreover, some set of rating items may not be suitable for workplace investigation.

In the work environment, color is one of the physical factors that influence the perception of space and affect the mental and physiological feeling states of workers. A number of studies have investigated the impact of warm colors (e.g. reds, orange, yellow) and cool colors (e.g. blue, green, purple). For instance, warm colors were perceived as having more activating effects than cool colors. A red office was perceived as causing more anxiety than other colored offices (Kwallek & Lewis, 1990; Kwallek et al., 1997). Managers did not prefer the workplace with mainly warm colors because of over stimulating (Ceylan, Dul, & Aytac, 2008). Yellow could create a sense of cheerfulness and happiness as well as inspired thinking and creative ideas, but too much yellow would cause visual discomfort. Moreover, warm colors tend to make space seem smaller than the spaces with cool colors. The red room was perceived as more enclosed than the blue room (Küller et al., 2009).

On the contrary, cool environments were perceived as pleasant, calm, and comfortable, but unattractive (Stone, 2003; Stone & English, 1998; Yildirim, Cagatay, & Ayalp, 2015). The cool office could boost creativity and let people focus on visual and mental tasks (Ceylan et al., 2008). Blue was found to be the most preferred workplace color among workers (Kamaruzzaman & Zawawi, 2010; Poursafar, Devi,

& Rodrigues, 2016). However, blue was reported to have negative impacts such as drowsiness and depressing (Küller et al., 2009; Kwallek et al., 1997). Green was associated with restful and relaxing. Regarding the neutral, workers preferred white and wanted to work in a white environment (Kwallek & Lewis, 1990; Poursafar et al., 2016). Nevertheless, white was found to be perceived as dull, depressing and causing visual fatigue (Kamaruzzaman & Zawawi, 2010; Kwallek et al., 1996). Using only white color without introducing some chromatic colors may not be suitable for the work environment.

As for color combination, the mix of cool color and neutral could enhance the perception of space (Kamaruzzaman & Zawawi, 2010). Architects preferred the cool together with warm colors (Poursafar et al., 2016). The multicolor workplace might contribute to a more positive mood for workers (Küller et al., 2006) but caused conflict perception if more chromaticity colors were added and not in harmony (Küller et al., 2009). It is widely assumed that the harmonic color schemes (e.g. monochromatic, analogous) can provide aesthetic appeal. However, little research has been conducted to investigate the effects of those combinations.

Therefore, this study aimed to investigate the influences of color schemes in the work environment on aesthetic response. Figure 1 shows the conceptual framework of this study. Research questions of the study were as follows:

1. Are there any differences between the monochromatic red and purple-blue scheme in term of aesthetic response?
2. Are there any differences between the warm and the cool analogous scheme in term of aesthetic response?
3. Are there any differences between the monochromatic red and warm analogous scheme in term of aesthetic response?
4. Are there any differences between the monochromatic purple-blue and cool analogous scheme in term of aesthetic response?

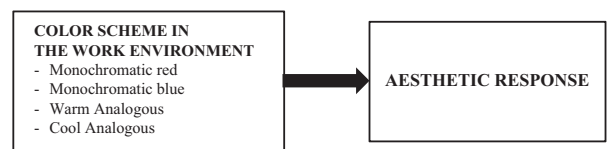


Figure 1 The conceptual framework for the study

Methodology

To identify the influences of workplace color schemes on participants' aesthetic response, the quantitative experimental design was used in this study.

Participants

A total of 53 Thai interior designers participated in this study, including 30 males (56.6%) and 23 females (43.4%). Their age ranged from 21–43, with most of the participants falling between 26–30 years old (56.6%). They were recruited from interior design firms in Bangkok and volunteered to participate in this study. All participants reported normal or correct to normal vision.

Simulated Working Environment

For testing the color effects, the simulate realistic perspective of the workplaces was used as the visual stimuli developed from 3Ds Max. The simulated images had the following dimension: 9.70 x 16.00 x 3.00m (a total area 155m²). Ceiling and floor were white with matte finishes. Windows were covered with blackout roller blinds. Fluorescent lamps were set to provide general lighting level of 500lux, and the temperatures at 4000K. The room was furnished with an open-plan office layout, included 24 workstations with partitions, office chairs, and tall cabinets along the left wall. The color of workstations, cabinets, doors, and window blinds were neutral and kept constant, only colors on the walls and workstation partitions were changed. Some area of the walls remained white to prevent sensory overload.

The sample of colors chosen were from the Color Image Scale of Kobayashi (1990) and applied to the rendering. Four color schemes: two monochromatic and two analogous color schemes, were tested in this experiment. As for the monochromatic conditions (scene 1 & 2), red and purple-blue were used as dominant colors on the wall combined with darker and lighter tones. The warm analogous color condition (scene 3) used predominately red on the wall mixed with yellow-red and yellow on the workstation partitions. The cool analogous color condition (scene 4) used purple-blue predominately on the wall combined with blue and blue-green on the workstation partitions. The four scenes are illustrated in Figure 2.

Questionnaire

The questionnaire for aesthetic response in this study consisted of two parts: the first part contained questions about participants' general characteristics relating to age, gender and color preference; and the second part consisted of seven-point semantic differential scales evaluating the aesthetic response to the differently colored work environment. Lists of adjectives pairs were gathered from the previous studies related to color and environmental aesthetic (Franz, 2006; Odabaşioğlu, & Olguntürk, 2015; Öztürk, Yılmaz, & Ural, 2012; O'Connor, 2008; Valdez & Mehrabian, 1994; Yildirim et al., 2015). The adjective pairs were translated from English to Thai and those that had similar meanings or were not suitable for evaluating the workspace were eliminated. The remaining 21 adjective pairs were divided into five dimensions according to the factor they evaluated (Table 1), and were used in the questionnaire to measure the aesthetic response.

Procedure

The participants were assigned to all four simulated working environments (SWEs). These SWEs were showed to the participants by face to face meetings during a two-week period in 2018. At the beginning, the participants were tested for their color vision with the Ishihara color blindness test. After that, the brief instructions were given. Participants asked to evaluate the four workplace scenes were presented with a tablet device at a resolution of 2224 x 1668 pixels. They took approximately 15 min to complete the questionnaires.

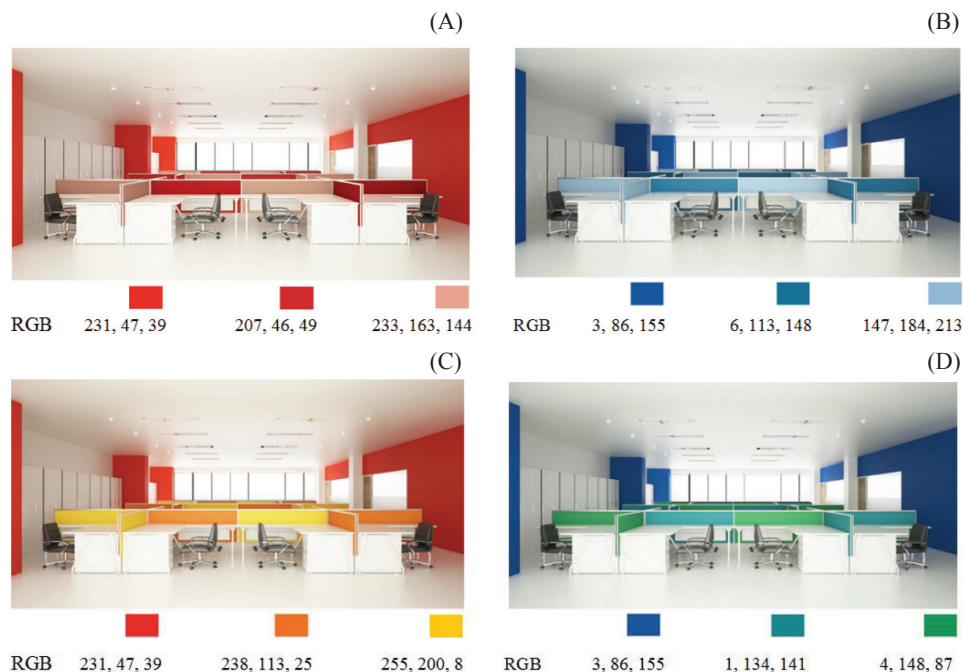


Figure 2 The four simulated working environments: (A) Scene 1 Monochromatic red; (B) Scene 2 Monochromatic purple-blue; (C) Scene 3 Warm analogous color scheme; (D) Scene 4 Cool analogous color scheme

Table 1 The scale with adjective pairs for evaluating the aesthetic response

Dimension	Adjective pairs
Pleasure	Unsatisfying-Satisfying
	Unattractive-Attractive
	Ugly-Beautiful
	Unimpressive-Impressive
	Uncomfortable-Comfortable
	Visual discomfort-Visual comfort
Preference	Dislike-Like
Spaciousness	Cramped-Spacious
	Low-High
	Enclosed-Open
	Complex-Simple
Arousal	Gloomy-Cheerful
	Tense-Relaxing
	Exciting-Calm
	Boring-Interesting
	Dynamic-Static
Color perception	Cool-Warm
	Dark-Bright
	Dull-Vivid
	Not proportional-Proportional
	Inharmonious-Harmonious

Data Analysis

The data gathered from the aesthetic response scale was analysed by using statistical programs. Then, a paired *t*-test was conducted to determine the effects of different color schemes in the work environments on the participants' aesthetic response. The mean scores of the four workplace scenes were compared with each other as following: two monochromatic scenes (scene 1 vs. scene 2), two analogous scenes (scene 3 vs. scene 4), monochromatic red and warm

analogous scenes (scene 1 vs. scene 3), monochromatic purple blue and cool analogous scenes (scene 2 vs. scene 4).

Results and Discussion

Reliability of the dependent variables covering the participant's aesthetic response evaluations of the work environments was tested using the Cronbach Alpha. The reliability coefficient for the set of 21 bipolar semantic differential items was .94. The coefficient of the scale above .70 was accepted for good reliability according to some previous studies (Odabaşıoğlu & Olguntürk, 2015; Yildirim et al., 2015). Therefore, the semantic scale in this study was considered to be reliable. The effects of color schemes of the workplace on aesthetic response were determined by the paired *t*-test (significant, $p < .05$).

According to the comparison between the two monochromatic color conditions: red (scene 1) and purple-blue (scene 2), the results indicated that there were statistically significant differences among participants' aesthetic evaluation of the workplace color schemes ($p < .05$) for most of the adjective items (Table 2). The purple-blue workplace generally received higher mean rating than the red workplace, ranging in order from the top five scores as follows: visual comfort ($M = 2.26$, $SD = 0.68$), harmonious ($M = 2.21$, $SD = 0.77$), calm ($M = 2.09$, $SD = 0.71$), simple ($M = 2.09$, $SD = 0.77$), and satisfying ($M = 2.04$, $SD = 0.71$). On the other hand, the red workplace obtained higher score for bright ($M = 2.11$, $SD = 0.67$), vivid ($M = 2.02$, $SD = 0.72$), warm ($M = 1.81$, $SD = 0.92$) than the purple-blue workplace. There was no statistically significant difference between the two monochromatic conditions with respect to attractive and proportional. In previous studies, some showing blue space was perceived more positively, and some were indicating the opposite (Kamaruzzaman & Zawawi, 2010; Küller et al., 2009).

Table 2 Results of paired *t*-tests between the monochromatic red and blue conditions

Pair	Adjective pairs	Red		Purple-Blue		<i>t</i>	<i>p</i>
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
1	Unsatisfying-Satisfying	0.00	1.74	2.04	0.71	-9.521	.000*
2	Unattractive-Attractive	1.57	0.93	1.28	0.89	1.819	.075
3	Ugly-Beautiful	0.53	1.67	1.74	0.88	-5.462	.000*
4	Unimpressive-Impressive	0.43	1.70	1.51	0.80	-5.036	.000*
5	Uncomfortable-Comfortable	-0.62	1.39	1.87	0.65	-12.286	.000*
6	Visual discomfort-Visual comfort	-0.57	1.47	2.26	0.68	-13.948	.000*
7	Gloomy-Cheerful	1.21	1.22	0.58	1.49	3.229	.002*
8	Tense-Relaxing	-0.66	1.26	1.87	0.88	-14.729	.000*
9	Exciting-Calm	-1.02	1.42	2.09	0.71	-13.846	.000*
10	Boring-Interesting	1.34	0.90	0.28	1.61	5.367	.000*
11	Dynamic-Static	-0.08	1.52	1.42	1.12	-6.729	.000*
12	Dislike-Like	0.25	1.78	1.60	0.97	-6.616	.000*
13	Cramped-Spacious	0.51	1.84	1.58	0.95	-5.295	.000*
14	Low-High	1.00	1.45	1.40	0.93	-2.670	.010*
15	Enclosed-Open	0.04	1.78	0.87	1.59	-2.852	.006
16	Complex-Simple	1.06	1.45	2.09	0.77	-5.505	.000*
17	Cool-Warm	1.81	0.92	-1.89	1.07	16.824	.000*
18	Dark-Bright	2.11	0.67	1.45	1.01	4.480	.000*
19	Dull-Vivid	2.02	0.72	1.00	1.06	7.643	.000*
20	Not proportional-Proportional	1.70	0.93	1.77	0.93	-0.663	.510
21	Inharmonious-Harmonious	1.75	1.18	2.21	0.77	-3.800	.000*

Note. *M* = Mean value ranging from -3 to 3, *SD* = Standard deviation.

It is significant at the level of * $p < .05$.

In the current study, the purple-blue environment was perceived as more positive to create a sense of calm, harmony, and simple and offered the optimal conditions for visual comfort. The workspace with the red scheme was perceived as higher arousal and excitement compared to purple-blue. However, the mean scores were not too high. It is possible that using red with neutral might reduce the impact of the stimulating environment. The finding also suggested that the workplace might appear brighter and vivid in red. People could feel warm or cold influencing from color scheme within the space at the cognitive level.

According to the comparison between the two analogous color conditions: warm colors (scene 3) and cool colors (scene 4), the results revealed that there were statically significant differences among participants' aesthetic response of the workplace ($p < .05$) for most of the evaluated items (Table 3). The cool colored workplace generally received greater mean rating than warm colored workplace, ranging in order from the top three scores as follows: visual comfort ($M = 2.40$, $SD = 0.77$), relaxing ($M = 2.23$, $SD = 0.75$), comfortable ($M = 2.11$, $SD = 0.75$). In contrast, the warm colored workplace obtained higher score for vivid ($M = 2.57$, $SD = 0.54$), bright ($M = 2.28$, $SD = 0.72$), cheerful ($M = 2.17$, $SD = 0.75$), attractive ($M = 2.11$, $SD = 0.64$), and warm ($M = 2.11$, $SD = 0.75$). There was no statistically significant difference between the effect of the two analogous rooms on impressive, interesting, proportional, and harmonious. Similar to the comparing of two monochromatic conditions, the cool space was rated more positively than the warm space.

Participants preferred the cool space to the red one. The findings also suggested that cool color scheme might enhance the feeling of visual comfort, be relaxing and comfortable. These results support previous studies that cool colors are associated with high pleasure emotions and low arousal emotions (Stone & English, 1998; Yildirim et al., 2015). On the contrary, the warm scheme could be more arousing,

tending to make the workspace appear more vivid, bright, cheerful, and warm. The warm scheme might not be particularly relevant to the comfort of the workplace.

Regarding the comparison between the workplace with monochromatic red (scene 1) and warm analogous colors (scene 3), there were both similarities and differences in the results. The warm colored workplace obtained the high score for vivid ($M = 2.57$, $SD = 0.54$), cheerful ($M = 2.17$, $SD = 0.75$), attractive ($M = 2.11$, $SD = 0.64$), warm ($M = 2.11$, $SD = 0.75$) and evaluated to be exciting ($M = -2.06$, $SD = 0.75$) and dynamic ($M = -1.79$, $SD = 0.97$). However, the red workplace got a higher score for harmonious ($M = 1.75$, $SD = 1.61$), simple ($M = 1.06$, $SD = 1.48$) compared to the workplace with warm color scheme. There was no statistically significant difference between the effect of the red and warm colored workplace with respect to comfort, visual comfort, relaxing, interesting, preference, spacious, high, open, bright and proportional.

The finding suggested that the workspace with the warm analogous color scheme was perceived as somewhat more pleasant for emotions compared to the monochromatic red. The warm space was also experienced as higher in arousal and color perception. Yellow and yellow-red added as accent color could evoke the different responses to the environment. It implies that the warm combinations may be applied to the workplaces where the tasks are boring so that those colors can stimulate and excite workers.

According to the comparison between the workplace with monochromatic purple-blue (scene 2) and cool analogous colors (scene 4), there were both similarities and differences in the results. The workplace with cool colors received the higher score ranging in order from the top three scores as follows: relaxing ($M = 2.23$, $SD = 0.75$), cheerful ($M = 1.74$, $SD = 0.92$), open ($M = 1.58$, $SD = 0.93$). However, the purple-blue workplace was perceived to be more harmonious ($M = 2.21$,

Table 3 Results of paired *t*-tests between the two analogous color conditions.

Pair	Adjective pairs	Warm		Cool		<i>t</i>	<i>p</i>
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
1	Unsatisfying-Satisfying	1.38	0.93	2.06	0.72	-4.873	.000*
2	Unattractive-Attractive	2.11	0.64	1.43	0.75	5.284	.000*
3	Ugly-Beautiful	1.45	0.82	1.72	0.84	-2.083	.042*
4	Unimpressive-Impressive	1.47	0.85	1.62	0.86	-1.272	.209
5	Uncomfortable-Comfortable	-0.19	1.52	2.11	0.75	-10.801	.000*
6	Visual discomfort-Visual comfort	-0.70	1.74	2.40	0.77	-11.894	.000*
7	Gloomy-Cheerful	2.17	0.75	1.74	0.92	2.825	.007*
8	Tense-Relaxing	-0.42	1.01	2.23	0.75	-14.602	.000*
9	Exciting-Calm	-2.06	0.75	1.74	0.88	-21.891	.000*
10	Boring-Interesting	1.62	0.93	1.51	0.89	0.772	.444
11	Dynamic-Static	-1.79	0.97	1.04	1.21	-11.766	.000*
12	Dislike-Like	0.75	1.56	1.75	0.90	-4.604	.000*
13	Cramped-Spacious	0.70	1.46	1.57	0.93	-4.424	.000*
14	Low-High	0.74	1.38	1.43	0.93	-3.971	.000*
15	Enclosed-Open	0.00	1.78	1.58	0.93	-7.387	.000*
16	Complex-Simple	-0.98	1.53	0.64	1.82	-7.039	.000*
17	Cool-Warm	2.11	0.75	-1.38	0.84	21.125	.000*
18	Dark-Bright	2.28	0.72	1.40	0.91	6.768	.000*
19	Dull-Vivid	2.57	0.54	1.47	0.82	9.506	.000*
20	Not proportional-Proportional	1.58	1.28	1.62	1.00	-0.351	.727
21	Inharmonious-Harmonious	0.66	1.81	0.92	1.53	-1.095	.278

Note: *M* = Mean value ranging from -3 to 3, *SD* = Standard deviation.

It is significant at the level of * $p < .05$.

$SD = 0.77$), calm ($M = 2.09$, $SD = 0.71$), and simple ($M = 2.09$, $SD = 0.77$) than the cool colored workplace. There was no statistically significant difference between the two schemes with respect to satisfying, attractive, beautiful, impressive, comfortable, visual comfort, static, preference, spacious, high, bright, and proportional. The findings imply that purple-blue and cool color combinations are both appreciated by most participants. As it can be seen, some of the evaluative factors related to pleasure dimension of emotion, preference, and spaciousness were perceived similarly in responses between the two conditions. This evidence may be involved with color preference as participants within this experiment chose blue for their favorite color. The findings here coincide with several previous reports (Kamaruzzaman & Zawawi, 2010; Poursafar et al., 2016).

This would seem to suggest that the preference of color may influence subjective evaluation and enhance positive perception of the work environment. However, it is interesting that the cool space was perceived more positively than the purple-blue space for some of the aesthetic evaluations. The cool colors could make the workspace feel more relaxing, cheerful, open, and interesting. This finding might be explained in that green, which was combined to purple-blue color, could promote a sense of relaxation. It is suggested that the cool color scheme may be useful for workplaces where the tasks are stressful. For the monochromatic space, purple-blue seemed to make the workplace feel more harmonious, calm, and simple.

It is interesting that the proportional item was rated at approximately the same level for all the color conditions. This finding indicated that when the quantity of color in the workplace does not change, the perceptual effect regarding proportional would be similar.

Conclusion and Implication

The contribution of this study has increased knowledge as to how color scheme influences the aesthetic experience in the work environment. In designing workspace, the proper selection of color is critical to the aesthetic appearance. This study suggests some approaches from the designer's viewpoint to choosing color schemes for open-plan work environments. Using a monochromatic color scheme can provide a sense of harmony and simplicity and is suitable for a workplace concerning low level of complexity, whereas the analogous was more favorable for some of the aesthetic considerations than the monochromatic scheme. The analogous scheme can make the workplace more cheerful and interesting. The purple-blue and cool analogous scheme tended to create a more positive workplace than the red and warm analogous scheme. Interior designers require a lot of time using computers. Thus, the color scheme used must consider a scheme for visual comfort such as cool analogous scheme.

A limitation of this study is that only one type of workplace and four color schemes were used in the experiment. Hence, more color combinations within different workspace should be investigated. Besides, the current study considered Thai interior designers. Individual differences (e.g. gender, culture, profession) should be included in future research as well. In

addition to the method development, this research proposed the scales to assess overall dimension of aesthetic responses. The scale needs to be developed and integrated into further studies to provide more effective assessments of the work environment.

Conflict of Interest

There is no conflict of interest.

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