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ANALYSIS OF A CORPORATE IDENTITY COLOR AND ITS EFFECT ON CORPORATE IMAGE

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งานวิจัยนี้ศึกษาถึงผลของการใช้สีต่าง ๆ เป็นสีเอกลักษณ์ขององค์กรต่อภาพลักษณ์ขององค์กร โดยเริ่มจากการศึกษาถึงผลของสีเอกลักษณ์ขององค์กรต่อความจำของผู้บริโภคโดยการใช้แบบสอบถาม หลังจากนั้นทำการทดลองประเมินความรู้สึกต่อภาพลักษณ์ด้วยการมองดูตัวอย่างสี โดยทำการคัดเลือกตัวอย่างสีจำนวน 29 สีจากระบบสี PCCS ซึ่งประกอบด้วยสีแดง สีส้ม สีเหลือง สีเขียว สีน้ำเงิน สีม่วง สีขาว สีเทา และสีดำ แต่ละสียกเว้นสีขาว สีเทา และสีดำแบ่งออกเป็น 4 ระดับได้แก่ Vivid, Light, Soft และ Deep ทำการทดลองโดยให้ผู้สังเกตมองดูตัวอย่างสีแล้วประเมินความรู้สึกต่อภาพลักษณ์ด้านต่าง ๆ เมื่อสีนั้นใช้ในองค์กรทั่วไปและองค์กรในอุตสาหกรรมการพิมพ์ โดยใช้แบบสอบถามแบบ semantic differential scale ทำการวิเคราะห์ผลการทดลองโดยหาความสัมพันธ์ระหว่างผลการประเมินสีและค่าสีในระบบสี CIE หลังจากนั้นทำการวิเคราะห์เปรียบเทียบผลการทดลองขององค์กรทั่วไปและองค์กรในอุตสาหกรรมการพิมพ์ โดยใช้วิธีการทดสอบค่าเฉลี่ย independent samples t-test จากผลการทดลองพบว่าเมื่อนึกถึงสีต่าง ๆ กลุ่มตัวอย่างสามารถระบุชื่อองค์กรหรือตราสินค้าที่ใช้สีนั้น ๆ เป็นสีเอกลักษณ์ขององค์กรได้ ความสว่าง ความอิ่มตัวสี และสีสัน มีผลต่อการรับรู้ภาพลักษณ์ในด้านต่างๆ ของผู้สังเกตแตกต่างกัน นอกจากนี้ผลการทดสอบด้วยสถิติ t-test พบว่าความรู้สึกต่อภาพลักษณ์ขององค์กรทั่วไปและองค์กรในอุตสาหกรรมการพิมพ์ในด้านความน่าเชื่อถือ การบริการ และความมั่นคง มีความแตกต่างกันอย่างมีนัยสำคัญที่ระดับ 0.05

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This research aimed to investigate an effect of the corporate identity color on the corporate image. Firstly, the influence of corporate identity color on the audience's memory was observed. Secondly, the effects of color on the corporate image in general purpose and graphic arts industry were observed through visual assessments. Twenty-nine color samples selected from the PCCS color system were employed to assess the feeling of the observer by means of the semantic differential scale questionnaire. The color samples consisted of six hues (Red, Orange, Yellow, Green, Blue, and Purple) varied in four different tones (Vivid, Light, Soft and Deep) and three achromatic samples (White, Grey and Black). The experimental raw data were analyzed to derive the correlations coefficient between visual results and CIE colorimetric values. In addition, a difference between the visual results of general purpose and graphic arts industry was analyzed by using an independent samples t-test. The results showed that the observers were able to recognize the company as a corporate identity color while the interpretation of the corporate images were varied depending on the dimensions of color such as lightness chroma and hue. Moreover, by using independent samples t-test, the corporate image of reliability, service and stability were found to be statistically different at a significant level of 0.05.

Department: Imaging and Printing Technology Student's signature.....

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CHAPTER I

INTRODUCTION

Nowadays, the competition among companies selling the similar product in the marketplace is becoming higher. Consumer's thinking is affected by the change of social environment and the progress of technology. This means that the quality of product is not the only factor considered by customers when buying a product. A company's identity is becoming an important factor for customers when making a choice between one company and another. Therefore, communication through a corporate identity is an important strategy for a company to differentiate itself from others. It also produces a good image of a company when viewed by customers, investors and suppliers.

Identity is expressed as names, symbols, logos colors and methods which are used to create brands and constituents of companies. At one level, it encapsulates and makes a collective sense of belonging and purpose. At another level, it represents consistent standards of quality and therefore encourages consumer loyalty (1). It has to be well designed for communicating anything that the company needs to tell to the audiences.

A corporate identity color is one of the important corporate communication strategies because color can express the meaning. Colors are used in many ways to assert recognition because they are fairly easy to read and understand. Color is one of the most fulfilling elements in our lives. Color can attract our attention or change our mood. It can refer to who we are, how we feel and where we are going. Color can give information and is used to symbolic object, such as traffic light. Colors have a demonstrable psychological effect; as a result our automatic reaction to colors is so strong. Color is an important factor in the production of materials and is often vital to the commercial success of products, such as in fruit cases, color is used to classify and judge the quality of materials or products. Also, color and design of packaging are important to attract customers (2).

The visual perception of colors is one of the five senses, which is perceived by the eye and processed in the brain. There are three basic factors in order to perceive color: light sources, objects and human eyes. Light is part of the electromagnetic spectrum. It is part of a continuous band of radiation that includes X-ray, ultraviolet (UV), visible, infrared (IR), or thermal radiation, radio and television waves. The perception of color occurs when some of the incident light is absorbed by the object and some is reflected entering to human eyes, which have receptors for the perception of color. The composition of the eye is like a camera equipped with an autofocus lens. It has, as in the camera, a variable aperture (the iris) that controls the incoming light. After the aperture is a lens with changeable focus. It displays the object view focused sharply on the retina. The retina has the same function as the film in the camera, which contains two kinds of light-sensitive receptor cells, called cones and rods. The cones are responsible for vision at high illuminant and for color vision. The rods are responsible for vision at low illuminant. At these cells, light is converted into electrical signals and then generates nerve impulse transmitting to the brain (3).

Many previous studies on the perception of color showed that different colors affected the human sensation in different ways (4). Differences in dimensions of color such as hue, lightness and chroma also affect human's emotional responses as shown in Gao and Xin's study (5) on investigation of human's emotional responses on colors. And in the research of Kaya and Epps (6) on a study of color memory and preference showed that there was not any effect of color preference on color memory; moreover, the result also showed that observers could remember some colors better than others. It is important to carefully choose the color for using as corporate identity color because different colors will express different meanings.

Effects of colors used as a corporate identity on the corporate image perceived by consumers in graphic arts industry were evaluated in this study. Firstly, the influence of corporate identity color on the audience's memory was observed. Secondly, the effects of color on the corporate image in general purpose and graphic arts industry were observed through visual assessments. Twenty-nine color samples selected from the PCCS color system were employed to assess the feeling of the observer by means

of the semantic differential scale questionnaire. The experimental raw data were analyzed to derive the correlations coefficient between visual results and CIE colorimetric values.

1.1 Objective

To evaluate the effect of colors on corporate image sensations perceived by consumer of a company in graphic arts industry.

1.2 Scope

This thesis covers the study using a questionnaire and visual assessments of twenty-nine PCCS color samples with Thai observers. The visual assessments took place under daylight illuminant by observers with age between 19-35 years old. It was divided into two assessments. The first assessment was done to investigate the corporate image sensation induced by colors for general purpose. The other was carried out for the graphic arts industry.

1.3 Contents

Chapter 2 consists of an overview of the theoretical consideration and literature reviews relevant to this research. Chapter 3 describes the experimental procedures and apparatus. Chapter 4 is about discussions on the results of the questionnaire and the visual assessments, the relationship between the corporate image sensation and the colorimetric values, and a comparison in terms of the similarity or difference in corporate image sensations between the results for general purpose and graphic arts industry. Finally, Chapter 5 gives conclusions and suggestions.

CHAPTER II

THEORETICAL CONSIDERATION AND LITERATURE REVIEW

2.1 Theoretical considerations

2.1.1 Corporate Identity

Corporate identity is the term most commonly used to define the program of communication and change that a company undertaken in conjunction with an external consultancy. It is unique and formed by an organization's history, its beliefs and philosophy, the nature of its technology, its ownership, its people, the personality of its leaders, its ethical and cultural values and its strategies. The identity is very difficult to change. It is the core of an organization's existence (7).

Every organization is unique, and the identity must spring from the organization's own roots, its personality, its strengths and its weaknesses. The corporate identity must be so clear that it becomes the indicator which its products, behavior and actions are measured. This means that the corporate identity must be affirmed by everything the organization does. The products that the company makes or sells must project its standards and its values. The corporation's communication material, from its advertising to its instruction manual, must have a consistent quality and character that accurately and reflect the whole organization and its aims. Therefore, design is a significant component in the identity mix.

A corporate identity can be expressed by the names, symbols, logos, colors and the methods which the organization uses to distinguish itself. It encapsulates and makes a collective sense of belonging and purpose. Moreover, it makes a good image of the corporation to the customer's perception (1).

Corporate identity applies to all aspects of an organization and is a significant part of the total communication. Thus, it becomes associated not only with marketing and advertising but with employee, shareholder, dealer, consumer, financial and other

relations. Therefore, the creation of the corporate identity project is often a PR responsibility.

To achieve an effective and distinctive corporate identity is not easy. It is a costly process to put the scheme into practice. This could involve all print and advertising, the decoration of all vehicles, and clothing of staff, including the design of item such as tableware and give-away. Print includes business cards and office stationary. It is necessary to create not only distinctiveness but uniformity. Sometime corporate identity may be presented by corporate brand, because the image of the organization on the consumer perception has a significant effect on the product or service buying. A corporate identity in term of corporate brand may high effective use in service business such as financial, airline, restaurant and insurance.

A corporate identity may be found necessary when there are mergers or takeovers, and a new identity is required, or where there is need to respond to changes in an organization (8).

2.1.2 Corporate communication

Corporate communication is the process that translates corporate identity into corporate image. It is an important part of the process because a corporate identity has to be communicated to employees, shareholders and customers. Without communication the values of the organization will not be understood and the company will not have any clear sense of identity.

The corporate communication cannot just be defined in the narrow sense of word. It is more than just advertising and PR. It is everything a company does from the way that telephones are answered to the way product brochures are presented. The most important audiences and communicators in any company are the employees. As an audience their perceptions of the organization will determine their attitudes and behavior which affect the way they communicate with everyone outside in their everyday dealings. Thus, communicating with employees is required in corporate identity program.

2.1.3 Corporate image

Corporate image is the picture of an organization that an audience has through the accumulation of all received messages. It will be determined by all a company's actions. An organization may transmit a message about itself to its employees, its investors, its customers, and all its internal and external audiences. Consideration of the corporate image is very important part of the corporate identity process. An organization has to specify the image that they want the audiences to receive. The corporate image should be appropriate with the company, supports the organization's culture and associate to the strategy of the company.

A company may face the problem that different audiences will interpret a message in different ways. Thus, the management of the corporate image is an important task (9).

2.1.4 The human color perception

The visual sensation of human is achieved by three basic factors; light source, object and human eye. Light is part of the electromagnetic spectrum. The human visual sensation can detect the electromagnetic waves between approximately 380 and 760 nanometer wavelengths. The shorter wavelengths are the ultraviolet rays. As the wavelength increases we can perceive it as blue, green, yellow, orange and red respectively and the longer wavelengths are the infrared rays. Sir Isaac Newton showed many years ago, by using a prism to disperse light into spectrum, white light is made up of all the visible wavelengths. That mean when all visible wavelengths are combined in nearly equal proportions we get the sensation of white light. The following illustration (Figure 2-1) shows the visual spectrum approximately as a typical human eye experiences it.

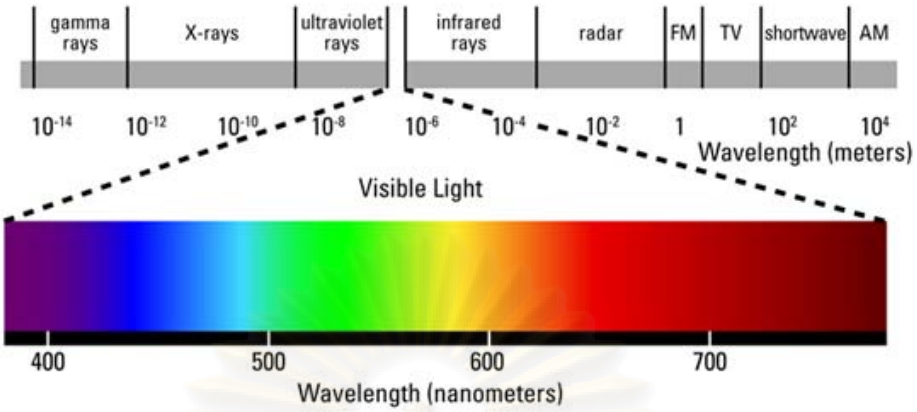

Figure 2-1 Electromagnetic spectrum.

Source: http://www.revisionworld.com/grades-8-10/physics?q=category/export/html/24 (2008, July 1)

When electromagnetic waves fall on any object they may be transmitted through or reflected by the surface of the object. Depending on the nature of the surface the light waves may be absorbed, refracted or diffracted at the surface. The surface of an object which appears red viewed in day light will absorb a predominance of the shorter wavelengths of the visible spectrum and reflect or transmit the remaining light to the eye of the observer.

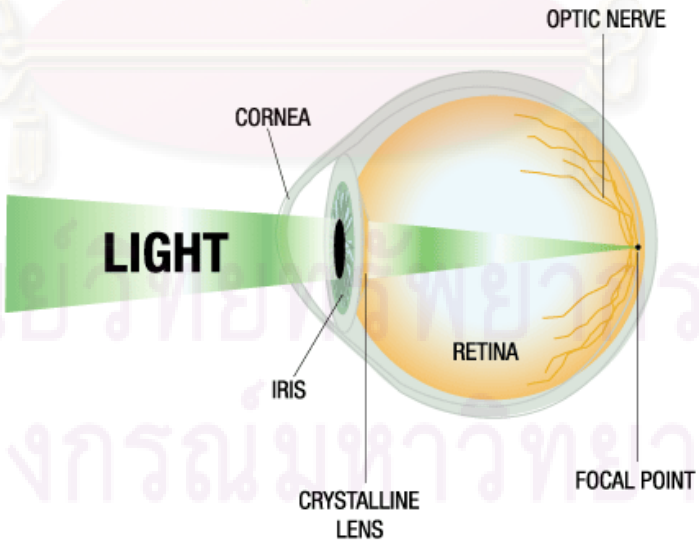

Figure 2-2 Light passed through lens to strike retina in the eye.

Source: http://www.visioninfocus.com/110.asp (2008, July 1)

The conversion of light energy into nervous energy takes place in the retina at the back of the eye (Figure 2-2). The retina is made up of a complex network of cells and neurons. It contains a great number of photoreceptor cells that sensitive to light. There are two kinds of the photoreceptor cells that are called the rods and cones as shown in Figure 2-3. The rods are sensitive to light of short wavelengths and operate at low levels of illumination. The cones operate in vision at daylight levels of illumination. There are three types of cones which response to short, medium and long wavelengths so these allow us to distinguish between different colors. These photoreceptor cells contain a photopigment that changes its structure or form when absorbs light. This change activates a physiochemical reaction with an accompanying electrical change in the receptor itself. The action of light on this photopigment gives rise to electrical charges that travel to the brain via the optic nerve (10, 11).

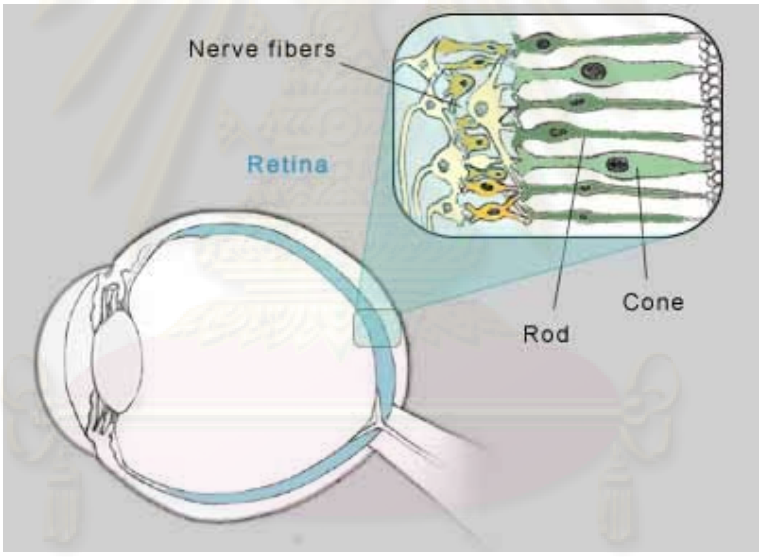

Figure 2-3 Human eye in cross-section and showing the photoreceptor cells.
Source: http://res.hcpss.org/StudentDeveloped/eyes/howeyeswork.html (2008, July 1)

2.1.5 CIE color system

The CIE (International Commission on Illumination) system is established in 1931. This system makes it possible to specify and to communicate colors by three numbers without having color chips to look at. The stimuli for color are derived from three factors of the human color perception. The coordinates of a given color stimulus are the relative amounts of three specific primary stimuli that match the color in question.

The CIE color system has been used successfully for many years. It has become the internationally practiced method in commerce and research (12).

2.1.5.1 CIE standard Illuminants and sources

The CIE distinguishes the sources and illuminants as following; a source refers to a physical emitter of radiant energy, such as a lamp or the sun and the sky, while an illuminant refers to a specific spectral power distribution incident on the object viewed by the observer. The spectral power distribution which defines an illuminant may not necessarily be exactly realizable by a source (13).

The CIE has established a number of spectral power distributions as CIE illuminants for colorimetric based on the spectral power distribution of a black body radiator, an ideal thermal radiator providing a spectral power distribution that depends on the temperature alone. The spectral power distribution of a black body radiator can be specified using Plank's equation as a function of a single variable, absolute temperature (in Kelvin). Therefore, if we know the absolute temperature of a black body, its spectral power distribution will be known. It is called color temperature. However, there are many other light sources, such as fluorescent lamps; emitting light primarily by processes other than raising the temperature of a body. This means the emitted radiation does not follow the form of a black-body spectrum. These sources are assigned with a correlated color temperature (CCT). CCT is a specification of the color appearance of the light emitted by a lamp, relating its color to the color of light from a black body when heated to a particular temperature.

In 1931 the CIE recommended the standard sources A, B and C. CIE standard illuminant A represents spectral power distribution of a black body radiator with color temperature of 2856 K and is used for all colorimetric application that involve the use of incandescent illumination. CIE standard illuminant B and C are daylight simulators. They were produced by filtering illuminant A by using a particular liquid filters defined by CIE. Illuminant B represents direct sunlight or noon sunlight with a correlated color temperature of approximately 4870 K, while illuminant C represents average daylight with a correlated color temperature of 6770 K. Both illuminant B and

illuminant C are no longer used in color measurement because the filtered light has a spectral power distribution that corresponds to daylight in the UV region. In this wavelength range the energy is much too low as compared with daylight (14, 15).

The recently established standards are CIE illuminant D65 and D50. They are part of the CIE D-series of illuminants that have been statistically defined based upon a large number of measurements of real daylight. Illuminant D65 represents an average daylight with a correlated color temperature of 6504 K and D50 represents an average daylight with correlated color temperature of 5003 K. They are based on numerous spectroradiometric measurements of daylight at different locations in the United States, Canada and Great Britain. Illuminant D65 is commonly used in colorimetric applications, while D50 is often used in graphic arts applications (16). Figure 2-4 shows the relative spectral power distributions of CIE standard illuminants.

The other standards are CIE illuminant F series that represent typical spectral power distribution for various types of fluorescent sources, such as F2 represents a cool-white fluorescent with correlated color temperature of 4230 K and F11 represents a triband fluorescent source with correlated color temperature of 4000 K.

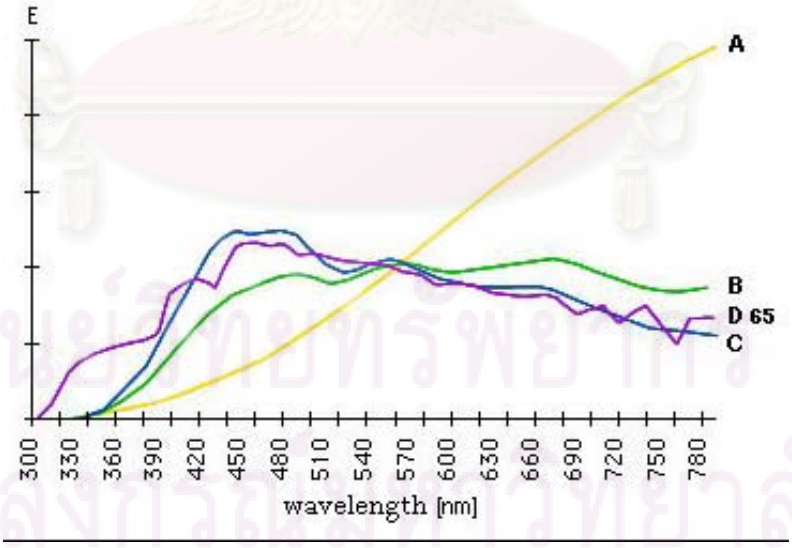

Figure 2-4 Relative spectral power distributions of CIE standard illuminants. Source: http://www.tsi.enst.fr/tsi/enseignement/ressources/mti/correl_couleur/illuminant.html (2008, July 2)

2.1.5.2 CIE standard observer

It has been known for a long time that the color sensation can be matched by the mixing of three color lights. The amount of each light is related to the sensitivity of the receptors of the eye. We can determine the sensitivity of the receptors with mixing experiments. In 1931, the experiments were done under controlled conditions by Guild and Wright. The number of observers was small (17 persons) because the experiment required a lot of work. The experiments were done by projected light which contained only one wavelength from a test lamp to one part of the white screen as shown in Figure 2-5.

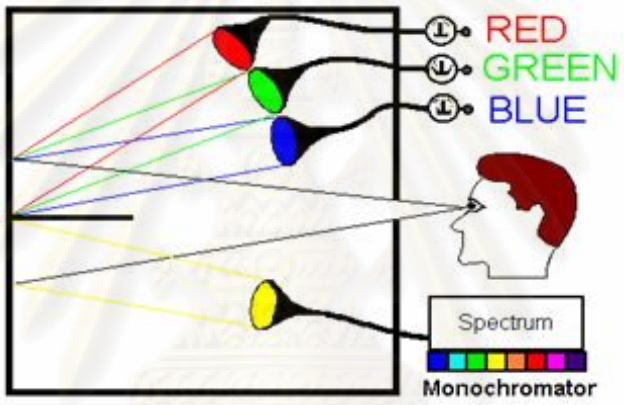

Figure 2-5 An arrangement for producing color by mixing the light from three different colored lamps.

Source: http://www.saleecolour.com/science.php (2008, July 2)

The wavelength of light from the test lamp was changed step by step from 380 to 780 nm. The other part of the screen was illuminated with an additive mixture of light that contained three different wavelengths, red, green and blue. The observers made their combined color on the screen to match the color of the test lamp by adjusting the intensities of these lights. The amount of light of the three spectral colors can be measured. In a few case, many spectral lights could be matched only when one of the three color lights was added to the test spectral light. For describing these test colors, this light can be thought of as being subtracted from the other primaries. Thus the test color can be described by a combination of negative and positive amounts of primary light colors. These experiments were done with 2° angle of

vision. CIE adopted the result of this experiment as the experimental definition of the CIE 1931 standard observer or CIE 2° standard observer. As shown in Figure 2-6, the curves generated from this data were mathematically manipulated so that all the curves were positive and the $\bar{y}$ was equal to the spectral luminance efficiency factor of the eye (17).

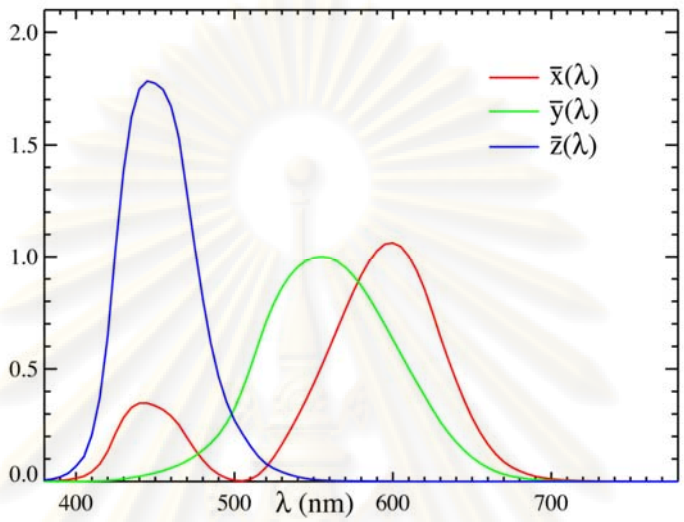

Figure 2-6 Color matching functions of the 2° observer.

Source: http://www.answers.com/topic/planckian-locus (2008, July 2)

In 1964 the experiment of color matching were repeated with a 10° visual field which more accurate correlation with visual perception for the large samples. The CIE recommended the results of this experiment as the 10° standard observer or the 1964 supplementary standard observer. The experiments leading to the 1931 standard observer were performed using only the fovea, which covers about a 2° angle of vision. The 1964 supplementary standard observer was based on color-matching experiments using a 10° area on the retina. The observers were instructed to ignore the central 2° spot. The 10° standard observer is recommended when visual perception of more than about 4° is desired (18). Figure 2-7 shows the comparison of CIE 2° and 10° standard observer.

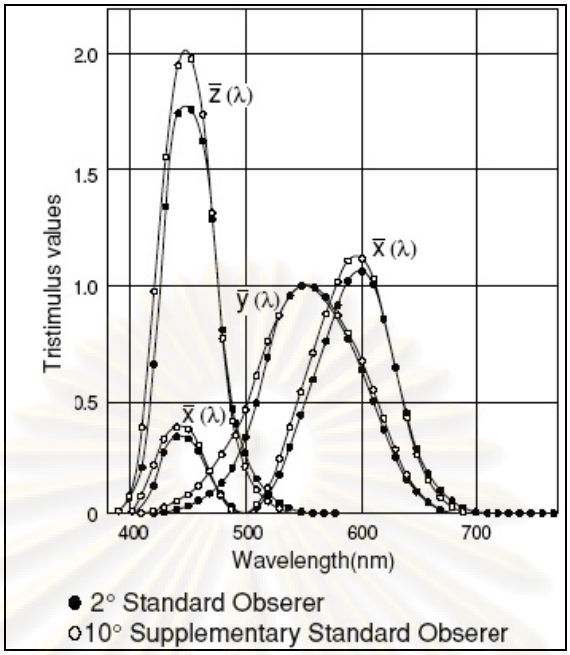

Figure 2-7 Comparison of CIE 2° and 10° standard observer.

Source: http://www.navy.mi.th/science/BrithDay46/Brithday_data/mycolor2.htm (2008, July 2)

2.1.5.3 CIEXYZ Tristimulus values

The CIE Tristimulus Values are calculated from the CIE standard observer functions by the equations 2.1-2.4, taking into account the type of illumination and reflectance of the sample.

$$X = K \int_{380}^{780} S(\lambda)\bar{x}(\lambda)R(\lambda)d\lambda \qquad (2.1)$$

$$Y = K \int_{380}^{780} S(\lambda)\bar{y}(\lambda)R(\lambda)d\lambda \qquad (2.2)$$

$$Z = K \int_{380}^{780} S(\lambda)\bar{z}(\lambda)R(\lambda)d\lambda \qquad (2.3)$$

$$K = \frac{100}{\int_{380}^{780} S(\lambda)\bar{y}(\lambda)d\lambda} \qquad (2.4)$$

Where, $S(\lambda)$ is the relative spectral power distribution of the illuminant

$\bar{x}(\lambda)$, $\bar{y}(\lambda)$ and $\bar{z}(\lambda)$ are the color matching functions

$R(\lambda)$ is the spectral reflectance of specimen

K is the normalizing constant

At each wavelength $\bar{x}$, $\bar{y}$ and $\bar{z}$ are multiplied by the spectral energy emitted by the light source. Then that value is multiplied by the reflectance of the sample at each wavelength as shown in Figure 2-8. The values for all the wavelengths are then summed. The XYZ values are calculated based on the luminosity of a perfect reflecting diffuser which has a reflectance of 100 at each wavelength. The sums are divided by the sum of the spectral energy times $\bar{y}$ at each wavelength because Y for the perfect white must equal 100 by definition. CIE Publication 15.2 (19) contains information on the XYZ color scale and CIE Standard Observer functions.

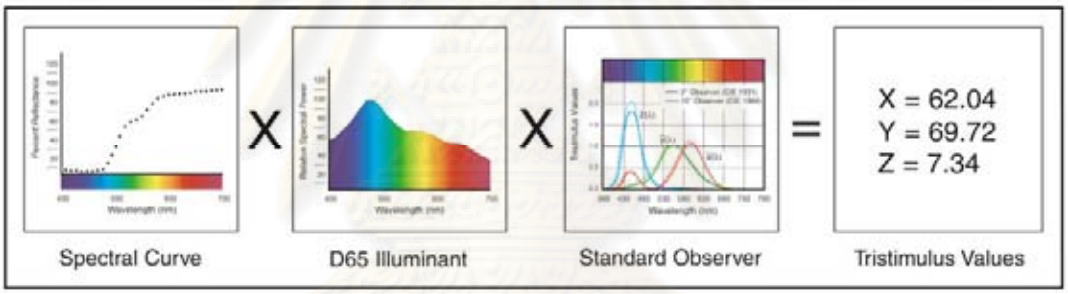

Figure 2-8 CIE Tristimulus value X, Y and Z.

Source: http://www.navy.mi.th/science/BrithDay46/Brithday_data/mycolor2.htm (2008, July 2)

The XYZ color scale may be used to quantify the color of an object. The reflectance curves of different colored objects are different so their XYZ values will also be different. However, the XYZ values do not fit into a color solid, so it is difficult to determine the actual color of an object based solely on its XYZ values. The XYZ values are most often used as a starting point for the calculation of other color values which fit into various color solids and, therefore, yield values from which the actual color of an object may be more easily determined based on the numbers alone. The colors of standard tiles are usually determined and listed in XYZ values. The Y value is also the

luminous reflectance for the sample since $\bar{y}$ is equal to the luminosity function. Y is sometimes used to quantify the brightness of an object (20).

2.1.5.4 CIE chromaticity diagram

Tristimulus values have limited use as color specifications because they correlate poorly with visual attributes. While Y relates to value or lightness, X and Z do not correlate to hue and chroma. Therefore, the CIE recommended chromaticity coordinates xyz to completely specify a color stimulus. These coordinate are used to form the chromaticity diagram in Figure 2-9. In this diagram, hue is represented at all points around the boundary of the diagram. Chroma is represented by the movement from the central white reference point out toward the boundary.

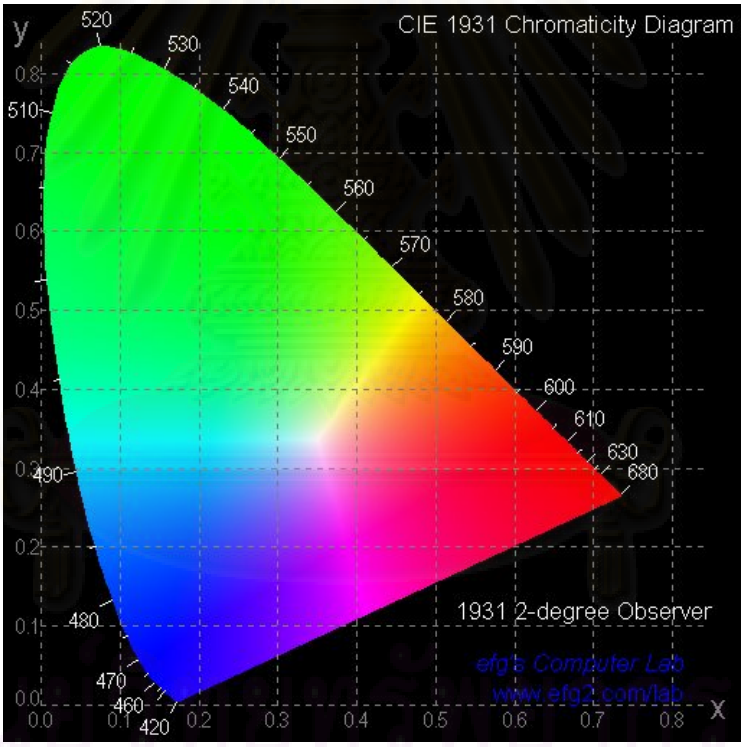

Figure 2-9 CIE1931 (x, y) Chromaticity diagram.

Source: http://colour-emotion.co.uk/funda.html (2008, July 2)

In the CIE system, the chromaticity coordinates x, y and z are obtained by Equations 2.5-2.7.

$$x = \frac{X}{X+Y+Z} \quad (2.5)$$

$$y = \frac{Y}{X+Y+Z} \quad (2.6)$$

$$z = \frac{Z}{X+Y+Z} \quad (2.7)$$

Color as described in the CIE system can be plotted on a chromaticity diagram, usually a plot of chromaticity coordinates x and y. The derived color space specified by x, y and Y is known as the CIE xyY color space and is widely used to specify colors in practice (21).

2.1.5.5 CIE L*a*b* color space and CIE L*C*h color space

There are limitations of the use of the chromaticity diagram because its distribution of the color is non-uniform. In 1976, the CIE recommended the CIE 1976 (L*a*b*) or CIELAB and CIELCh as a uniform chromaticity scale diagram to overcome the limitations of the CIE chromaticity diagram. These color scale describe the colors in three dimensional spaces that correlate with the perceived lightness, chroma and hue of a stimulus. When a color is expressed in CIELAB, L* defines lightness, a* denotes redness or greenness and b* as the correlate of yellowness or blueness. Figure 2-10 shows the color-plotting diagram for L*a*b*.

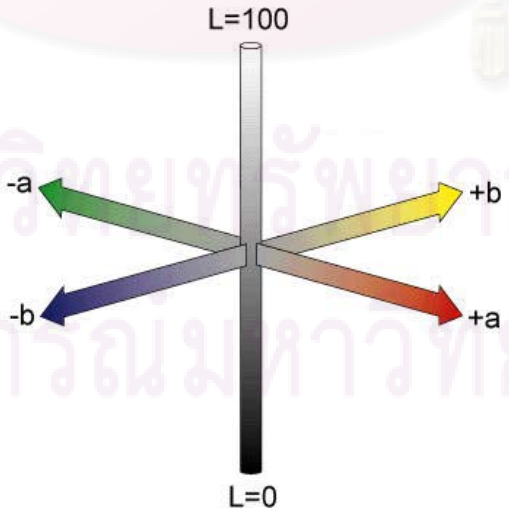

Figure 2-10 CIEL*a*b* color space.

Source: http://www.digitalexposure.ca/sub1.html (2008, July 2)

A color measurement movement in the +a direction represents a shift toward red. Along the b* axis, the movement in +b represents a shift toward yellow. The central L* axis shows L*=0 at the bottom means black or total absorption. The movement upward to the top of the axis, which shows white, represents more lightness increase.

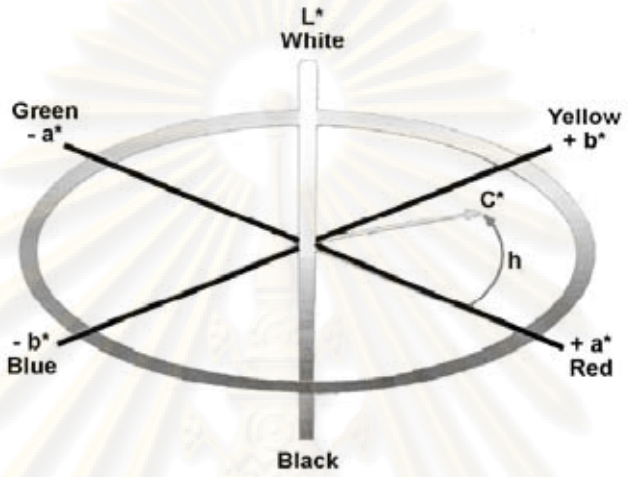

Figure 2-11 CIEL*C*h color space.

Source: http://www.cis.rit.edu/research/thesis/bs/2000/ochs/thesis.htm (2008, July 2)

The CIELCh or CIEL*C*h color scale is an approximately uniform scale with a polar color space. Its scale values can be derived from the CIELAB scale values. The L* defines lightness as in the CIELAB color scale, C* specifies chroma and the h denotes hue angle. C* and h are calculated from a* and b* of the CIELAB scale. Figure 2-11 shows the color plotting diagram of the CIELCh. The CIELAB and CIELCh values are defined by Equation 2.8-2.13 (22).

$$L^* = 116(Y/Y_n)^{1/3} - 16 \qquad \text{for } Y/Y_n > 0.008856 \qquad (2.8)$$

$$L^* = 903.3(Y/Y_n) \qquad \text{for } Y/Y_n \le 0.008856 \qquad (2.9)$$

$$a^* = 500[f(X/X_n) - f(Y/Y_n)] \qquad (2.10)$$

$$b^* = 200[f(Y/Y_n) - f(Z/Z_n)] \qquad (2.11)$$

where

$f(I) = I^{1/3}$ for $I > 0.008856$

$f(I) = 7.787(I) + 16/116$ for $I \leq 0.008856$

$I = X / X_n$, Y / Y_n or Z / Z_n

$$C^*_{ab} = \left(a^{*2} + b^{*2}\right)^{1/2} \quad (2.12)$$

$$h_{ab} = \arctan(b^* / a^*) \quad (2.13)$$

where

X, Y and Z are the tristimulus values

X_n, Y_n and Z_n are the tristimulus values of the reference white

2.1.6 PCCS (Practical color co-ordinate system) color system

In 1964, PCCS was made by the Japan color research institute. It was developed as a color system based on new color co-ordinate theory, derived from over 10 years of study and research on color harmony. It has greatly contributed to the education and practice of color harmony in beaux-art and designing, and is recognized as a color system of Japanese origin.

This system is composed of three separate parameters of color perception, that is, hue, value and chroma, and is characterized by its capacity to be used functionally as a hue/tone, two-dimensional system.

The hues in the PCCS are basically made of 8 colors including psychological four primary colors, red, yellow, green, blue, and their four complimentary colors plus four in-between colors with the same degree of difference. Between these 12 colors, further colors are added to compose a hue circle of a total of 24 colors. In this hue

circle, the three optical primary colors and colors close to the three primary colors of color materials are included, as shown in Figure 2-12.

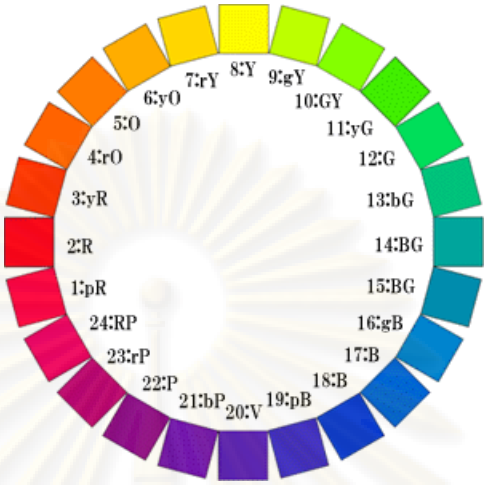

Figure 2-12 Elementary colors of the PCCS color system.

Source: http://www.stylista.biz/blog/pccs/ (2008, July 7)

The tone in the PCCS color system is a compound concept of value and chroma. It indicates the tone of color such as bright or dark, strong or weak. By using the adjectives for representing the tone of colors as shown in Table 2-1, the systematic naming of color is facilitated, thereby enabling the user to familiarize more easily.

Table 2-1 Abbreviated letters of the 12 PCCS tones.

Symbol	Tone	Symbol	Tone
V	Vivid	sf	Soft
dp	Deep	d	Dull
dk	Dark	b	Bright
G	Grayish	s	Strong
Lt	Light	p	Pale
Ltg	light grayish	dkg	dark grayish

PCCS color system represented colors by combining the hue number from 1 to 24 and the tone in abbreviated letters. For example as shown in Figure 2-13, v2 means

vivid red and dk18 means dark blue are examples of the two-characteristic (hue/tone) representation. The association of the numbers and hues was shown in Table 2-2.

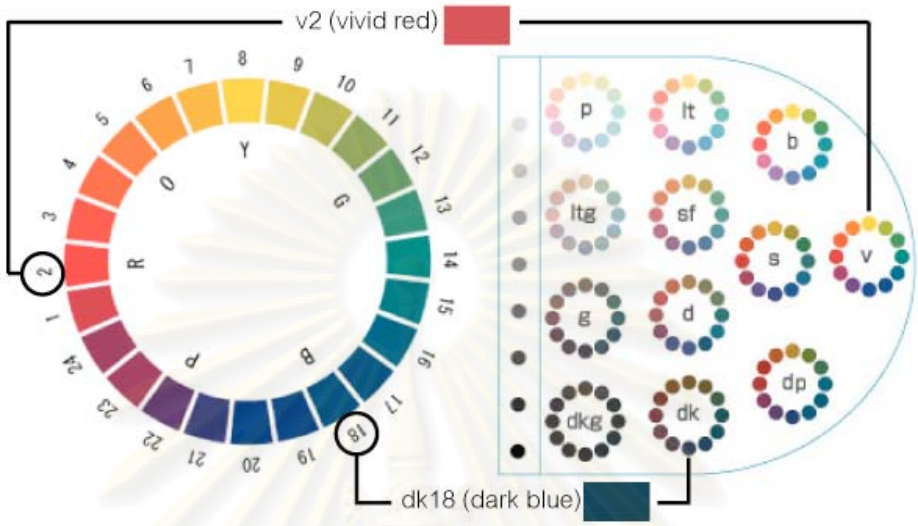

Figure 2-13 Combining name of PCCS color system.

Table 2-2 Hue and relevant number in PCCS color system.

No.	Hue	No.	hue
1	purplish red	13	bluish green
2	red	14	blue green
3	yellowish red	15	blue green
4	reddish orange	16	greenish blue
5	orange	17	blue
6	yellowish orange	18	blue
7	reddish yellow	19	purplish blue
8	yellow	20	violet
9	greenish yellow	21	bluish purple
10	yellow green	22	purple
11	yellowish green	23	reddish purple
12	green	24	red purple

PCCS has the advantage of enabling the user to intuitively understand the representation of color (23).

2.1.7 Semantic differential scale

The semantic differential scale is a scaling tool which designed to measure the connotative meaning of objects, events, and concepts or attitudes. Typically the scale is a seven-point bipolar rating scale using adjectival opposites, although some studies have used five and six-point scales. The respondent is asked to choose where his or her position lies, on a scale between two bipolar words, or a range of words or numbers ranging across a bipolar position.

Semantic differentiation is a procedure that involves rather standard scaling practices and a variety of analytical methods. The concepts are selected according to the researcher's interest. The scales may be specially constructed for a particular task or selected from existing sets by any of several criteria. Differences in the patterns of check marks on the scales are assumed to represent differences in meanings of the concepts judged and/or differences in groups of subjects judging the same concepts. Figure 2-14 shows an example of semantic differential scale (24).

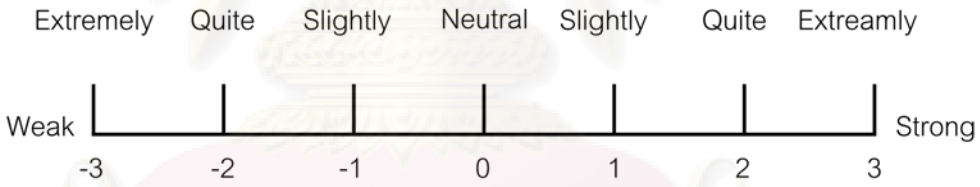

Figure 2-14 Example of a semantic differential scale.

Usually, the position marked 0 is labeled "neutral," the 1 positions are labeled "slightly," the 2 positions "quite," and the 3 positions "extremely." This scale measures directionality of a reaction (e.g., good versus bad) and also intensity (slight through extremely). Ratings are combined in various ways to describe and analyze the person's feelings (25).

2.2 Literature Reviews

Ide et al. (26) investigated what color that Japanese consumers match with each of industrial categories and compare with colors which were used as corporate identity colors by companies in each industrial category. They used some questionnaire and a

visual assessment, and also collected real corporate identity color from company's web site. With the result of this research, they found that most Japanese companies used the Red-Orange and Blue but Purple was used only rarely. The results suggested that there was a relationship between CI colour and national sentiment. In addition, corporate identity colors for each industrial category were different from another.

Wang et al. (27) investigated the effects of area proportion on color emotion using psychophysical method. The results suggested that the effect was significant only for color combinations having great difference in color emotion values between the constituent colors, especially for the "heavy-light" scale.

Harrington and Lechner (28) examined a hypothesized existence of color language, one that is anchored in color-emotion associations that carry specific meanings, is held by individuals and is used to communicate experiences, brand images, new product positioning and so forth. US-based gender balanced subjects, half of which were color professionals, were given a questionnaire that presented twenty-nine emotion descriptors (joy, anger, love, etc) and ten color selections and asked for their associations. Overall we found consistency of colors – emotion associations across subjects with minor differences attributed to gender, age and professional background. Study results present initial yet promising support to the existence of color language and require a cross-culture expansion to determine the universality of this language.

Nobbs et al. (29) studied the relationships between scales of emotional response and instrumental measures of color. The results of studies of the "exciting-calming" emotional response from 50 observers to 42 simples, two-colour designs were reported. Studies of the response to designs with a central colored shape on a colored background showed that the shape of the central color area (circle, triangle and square) had only a slight influence on the number of "exciting" decisions. The color of background had a strong influence on the number of "exciting" decisions. The relative area of the central shape to the background shape was found to have a modest influence on the observer responses. It is suggested that the visual contrast between the

color of the central shape and the color of the background has a strong influence on the response of the observers.

Satake et al. (30) elucidate sensory words for describing automotive exterior colors in East Asia; the words chosen by about 300 observers were analyzed, The experiments were conducted at Kyoto Institute of Technology, Nippon paint Co., Hong Kong Polytechnic University, Dong Hua University and Chulalongkorn University by using a set of questionnaires and 12 colors of painted panels. Prior to this experiment, they selected 31 words and 12 colors from 104b Color Chart produced by Japan Color Enterprise Co., Ltd., based on the results of like-dislike tests of 101 people in Hong Kong and Japan. These results were compiled from the subjects of from 19 to 67 years old. Distinctively, the emotion assessments that they conducted revealed that while “bright” and “light” were chosen in Japan as the sensory words of the impression induced by Light Green, “young” and “fresh” were selected in Hong Kong.

Yamaguchi et al. (31) investigated the use of Kansei words for assessing colors of sportswear, and quantitatively analyzed color emotion expressed by the Kansei words. They also derived empirical formulae to express the color emotions through an instrumental method. In this study they discussed about the application of the numerical expression, and also suggested an interface model for assisting the color planning of the sportswear design assisted tool based on human color emotion.

Cheng et al. (32) studied the corresponding feeling or emotion induced in the observer’s mind during the color perception process. The study aimed at evaluating the human color emotion and quantifying the color emotion with standard color specifications. All the subjects were Hong Kong Chinese and the semantic words describing color emotions were expressed in Chinese language. The color emotions described by these words were mathematically model using standard CIE colorimetric attributes. The similarity and difference towards color emotion of male and female were studied and reported.

Xin (33) evaluated the color emotions, in which visual experiments were conducted in Hong Kong, Japan and Thailand using a set of 114 color samples. The

color emotion results obtained from these regions were compared quantitatively to investigate the influence of cultural and geographical differences on them. In their study, twelve pairs of color emotion described in opponent words. “warm-cool”, “light-dark”, “deep-pale”, “heavy-light”, “vivid-sombre”, “gaudy-plain”, ‘”strike-subdued”, “dynamic-passive”, “distinct-vague”, “transparent-turbid”, “soft-hard’ and ‘”strong-weak”. The influences of lightness and chroma were found to be more important than that of the hue on the colour emotions studied.

CHAPTER III

METHODOLOGY

3.1 Materials

Color samples used in this study were selected from the PCCS color system. They consisted of 6 hues, 4 tones and 5 achromatic colors as shown in Figure 3-1. Six hues consisted of red (2), orange (4), yellow (8), green (12), blue (18) and purple. The numbers in the brackets refer to the hue numbers in the PCCS color system. The 4 tones were Vivid (v), Light (lt), Soft (sf) and Deep (dp) and the 5 achromatic colors were white (W), three levels of gray (gy2.5, gy5.0 and gy7.5) and black (BK).

Figures 3-2 and 3-3 show the distributions of the samples in the CIELAB a* b*, and L* C^*_{ab} plane, respectively.

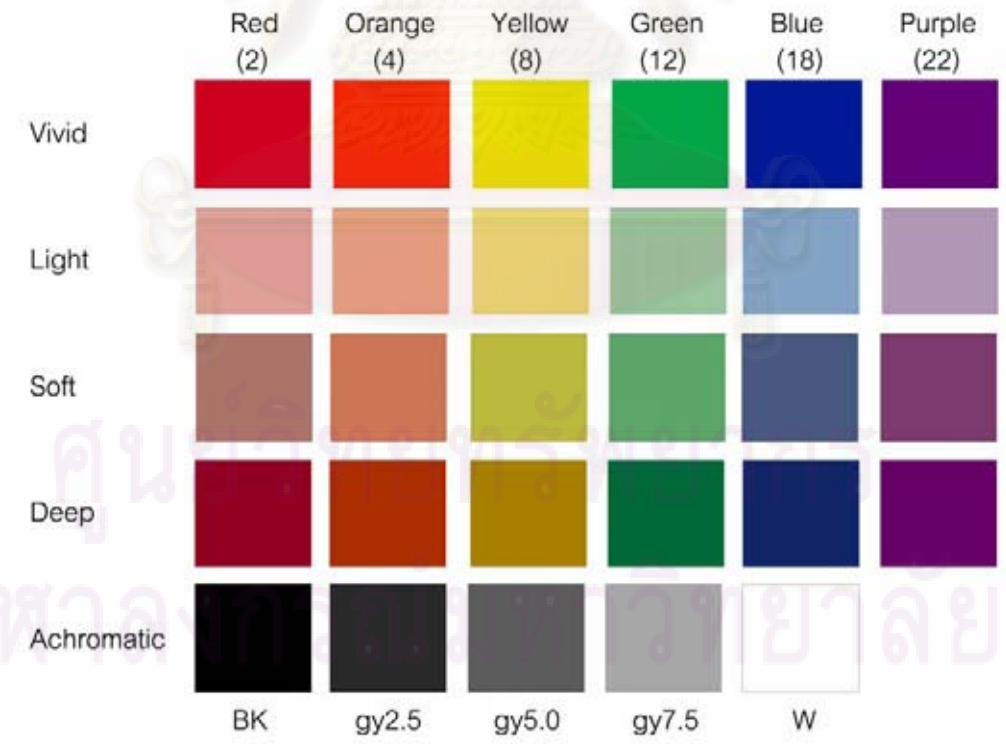

Figure 3-1 Color samples used in the experiment.

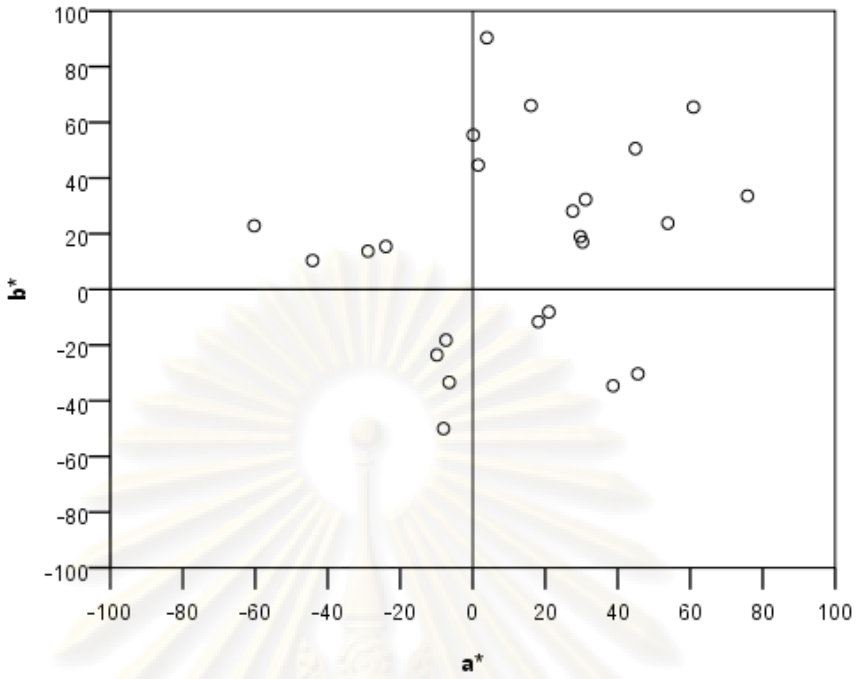

Figure 3-2 Colorimetric data of the specimens plotted on CIELAB a* b* diagram.

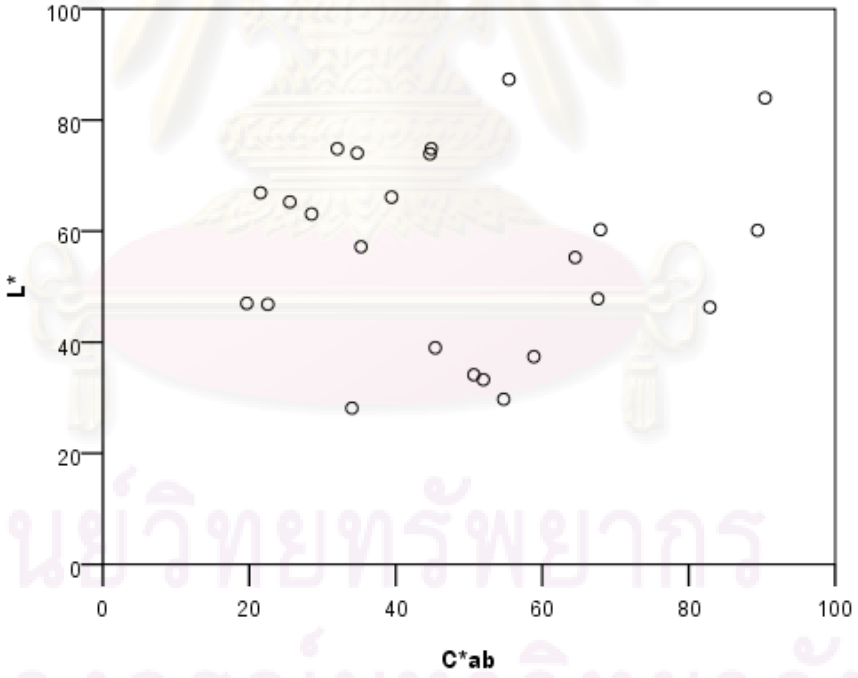

Figure 3-3 Colorimetric data of the specimens plotted on CIELAB L* C^*_{ab} diagram.

3.2 Apparatus

-Spectrodensitometer: Xrite-530 (geometry $45^{o}/0^{o}$, 400-700 nm spectral range, gas pressure light source)

3.3 Observers

1. One hundred Thai people aged from 19 to 40 years old (42 males and 58 females) participated in Experiment 1(to be discussed in the following section).

2. Forty-three Thai people aged from 19 to 35 years old (28 males and 22 females) took part in Experiment 2 (to be explained in the following section). There were two assessments in Experiment 2 (Part 2 and Part 3). Nineteen observers participated in Part 2, seventeen observers participated in Part 3 and seven observers took part in both parts.

3.4 Procedure

This study was divided into 2 experiments. Experiment 1 was conducted using a questionnaire. Experiments 2 involved visual assessments of color samples in connection with corporate images, Figure 3-4 shows the experimental process.

3.4.1 Experiment 1 : Questionnaire

The questionnaire consisted of 3 questions. The first question was aimed at investigating an effect of colors on the observer's brand recognition. Observers were asked what the brand or company that immediately came to their mind when they imagined color relevant to color names assigned in the questionnaire. Ten color names were used, i.e. red, green, blue, yellow, orange, purple, pink, white, gray and black. These color names were chosen because they are the basic color names in Thai language. The second question investigated a color preference. The observers were asked to choose the color from the list assigned in the questionnaire that they most like and dislike. Finally, the third question investigated the words representing a corporate image of a company in graphic arts industry. The observers were asked to write a word suitable for describing a corporate image of a company in graphic arts industry. The

observers could answer more than one word. The average time to complete the questionnaire was about 15 minutes. All questions were in Thai language.

3.4.2 Experiment 2 : Visual assessment

Experiment 2 was divided into 3 parts. Part 1 was the preparation of words representing the corporate images using in the visual assessment. Part 2 was a visual assessment in which the color sensation on corporate images of a general company was evaluated. Finally, part 3 was a visual assessment in which the color sensation on corporate images of a company in graphic arts industry was evaluated. Figure 3-4 shows a flow chart of this experimental process.

Part 1 : Ten words representing a corporate image of a company in graphic arts industry were selected from the results of Experiment 1. A scale of seven magnitude levels (+3 to -3) was applied to each word that describes a corporate image, so that the magnitude of color sensation associated with corporate image could be quantified. Positive values on the scale represented positive sensation and negative values represented negative sensation of the corporate images. For example, positive values (1, 2, 3) on a scale of a corporate image of quickness represented the color sensation of quick in an ascending degree. On the other hand, negative values (-1, -2, -3) represented the color sensation of slow. The middle scale “0” means that colors do not relate to the given corporate image.

Quickness slow -3 -2 -1 0 1 2 3 quick

Part 2 : The visual assessment took place by putting color samples on a medium gray background under daylight illumination. Observers looked at the color samples at approximate 45° to the normal with distance around 30 cm. The order of the color samples was random. Observers were asked to look at the color samples and choose their magnitude of color sensation for each of the corporate images. The average time to complete the whole visual assessment (29 colors with 10 scales) was about 45 minutes.

Part 3 : The observers were asked to look at the color samples again under the same condition and choose their magnitude of color sensation when they are used in graphic arts industry as a corporate identity color. The average time to complete the whole visual assessment (29 colors with 10 scales) was about 45 minutes.

3.4.3 Analysis of the results from the visual assessments

1. The color samples were measured with the Spectrodensitometer: Xrite-530 under illuminant D50 with 2 degrees standard observer condition in terms of colorimetric values as L*, a*, b*, C^*_{ab} and h_{ab}.

2. The average values of the corporate image color sensations were calculated from the answers of all observers.

3. The data were analyzed to obtain the relationship between the average values of each of the corporate image and the three basic attributes (lightness, chroma and hue) of the color samples.

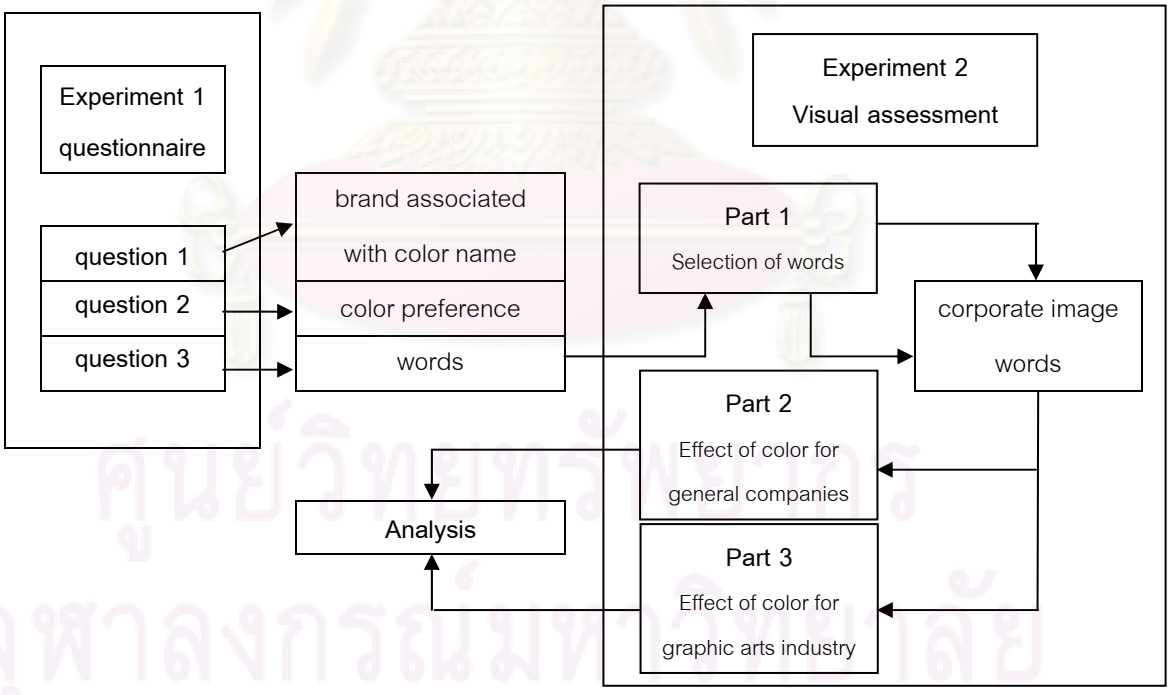

Figure 3-4 Process of the experiments.

CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Experiment 1 Questionnaire

4.1.1 Effect of color on the observer's brand recognition

Based on 100 observers (42 males and 58 females) from 31 students and 69 employees with age ranging between 19-40 years old, the results given in Table 4-1 showed that the observers could identify a brand or company name which uses the colors assigned in the questionnaire as its corporate identity color. It was found that red was the color that the observers could response the brands or company names with the highest frequency of 99% responses and 1% non-response. The least one was gray with 61% responses. The brand or company name which was identified by the observers for red is Coca-Cola (27%). The highest frequency of the identified brand or company name was Siam Commercial Bank for purple (59%) and Epson and Government Savings Bank for gray were the least ones (4%).

Over 50% of the observers could associate brands or company names with colors based on the given color names assigned in the questionnaire; this is because those companies use these colors as their corporate identity colors. Coca-Cola is a very favorite beverage and it uses red as its corporate identity color, so observers associated it with red. In the case of purple it had the highest frequency of identified company but low responses because not many companies use purple as a corporate identity color. Siam Commercial Bank is a popular company, which most observers associated it with purple.

It should be noted that the observers could response the brands or company names which use achromatic colors (with exception of black) less than those using chromatic colors. This could be that achromatic colors are not widely used as a corporate identity color and companies which use them do not advertize so much. These might also be the cause of low frequency of identified brands or company names

which use white and gray. In the case of gray, Government Savings Bank does not use gray as its corporate identity color. It has just changed to use magenta but the observers still remembered its old corporate identity color. In the case of white, Apple also dose not use white as its corporate identity color but the observer identified it as white because most of its popular products use white.

Table 4-1 Brands or company names having highest frequency of observer recognitions.

Color	Brand/company name	Frequency (%)	Response (%)	Non-response (%)
red	Coca cola	27%	99	1
yellow	Bank of Ayudhya	19%	90	10
orange	True move	43%	98	2
green	Kasikorn bank	20%	97	3
blue	Pepsi	19%	95	5
purple	Siam commercial bank	59%	88	12
pink	Kitty	21%	91	9
white	Apple	8%	73	27
gray	Epson and Government Savings Bank	4%	61	39
black	Johnny walker black label	21%	83	17

4.1.2 Color preferences

Regarding the question which color, from the list assigned in the questionnaire, observers like or dislike, the results are shown in Figures 4-1 and 4-2. It was found that the most favorite color was red while gray was the least favorite color.

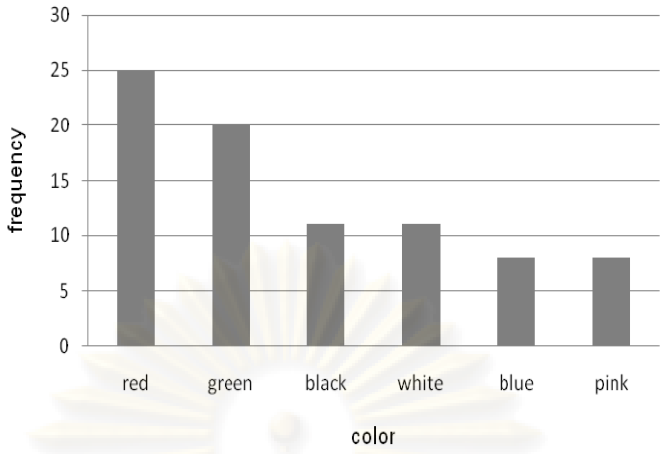

Figure 4-1 Ranking of colors which observers like.

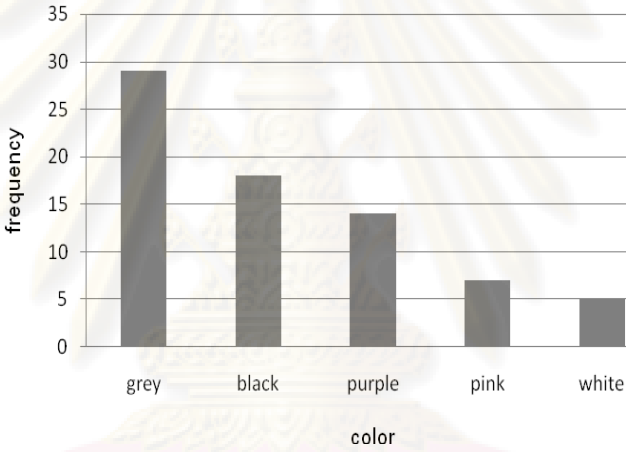

Figure 4-2 Ranking of colors which observers dislike.

There was a relationship between the corporate identity color recognition and color preferences. Red was the color observers could easily recall the brands or company names related to its corporate identity color as well as being the most favorite color. On the other hand, gray was the color observers had most difficulty to recall the company names related to its corporate identity color as well as being the least favorite color.

4.1.3 The words representing a corporate image of a company in graphic arts industry

Regarding the question : which words observers thought to be suitable for describing a corporate image of a company in graphic arts industry. The result, given in Table 4-2, showed that there were many words associated with graphic arts industry. The highest frequency was the word “quality”. It could be because quality was the most important factor required by a customer. In addition, the word “quick” was highly responded by the observers.

Table 4-2 Results of descriptive words for corporate images of graphic arts industry.

Word	frequency	Word	frequency
Quality	24	be on time	3
Quick	21	convenient	2
Service	14	interesting	2
low price	12	strange	1
Accurate	12	accepted	1
Modern	7	customer's satisfaction	1
Variety	6	insurance	1
Stable	4	environmental care	1
Reliable	3	pollution	1
Honest	3	high technology	1

4.2 Experiment 2 : Visual assessment

4.2.1 Preparation of the words representing the corporate image using in the visual assessment

Ten descriptive words chosen from the third question of the questionnaire in Experiment 1 were used in a visual assessment. To choose the words for using in the visual assessment, the same meaning words were assembled together as shown in the

Table 4-3. The chosen words were Quality, Quickness, Price, Reliability, Service, Modernity, Environmental, Variety, Stability and Interestedness.

A semantic differential scales with 7 points was applied to each word (see Figure 4-3). Note that all words were in Thai language while doing the experiment. The middle scale “0” means that colors do not relate to the given corporate image. The positive scale on the right side (1, 2 and 3) shows the tendency of colors positively relevant to the corporate images. The negative scale on the left side (-1, -2 and -3) represents the tendency of colors negatively relevant to the corporate image.

Table 4-3 Chosen words from the result of questionnaire in Experiment 1.

Word	Chosen word	Word	Chosen word
Quality	quality	service	service
Accurate		convenient	
Accepted		customer's satisfaction	
Quick	quickness	insurance	
be on time		environmental care	environmental
low price	price	pollution	
Reliable	reliability	variety	variety
honest		strange	
modern	modernity	stable	stability
high technology		interesting	interestedness

Quality	:	bad	-3 -2 -1 0 1 2 3	good
Quickness	:	slow	-3 -2 -1 0 1 2 3	quick
Price	:	expensive	-3 -2 -1 0 1 2 3	cheap
Reliability	:	less	-3 -2 -1 0 1 2 3	much
Service	:	bad	-3 -2 -1 0 1 2 3	good
Modernity	:	obsolete	-3 -2 -1 0 1 2 3	modern
Environmental	:	careless	-3 -2 -1 0 1 2 3	attentive
Variety	:	less	-3 -2 -1 0 1 2 3	much
Stability	:	instable	-3 -2 -1 0 1 2 3	stable
Interestedness	:	unattractive	-3 -2 -1 0 1 2 3	interesting

Figure 4-3 Semantic differential scales used in the experiment.

4.2.2 Visual assessment of color sensation on general purpose and graphic arts industry

Results of the visual assessment, in Table 4-4, showed that v12 (vivid red) color sample have the highest visual score in corporate image sensation of quality on both general purpose and graphic arts industry. The lowest was sf4 (soft orange) for general purpose and sf2 (soft red) for graphic arts industry. In case of quickness, the highest visual score color was v4 (vivid orange) for general purpose, and v2 (vivid red) and v4 (vivid orange) for graphic arts industry. The lowest was sf8 (soft yellow) for general purpose and sf2 (soft red) for graphic arts industry. In case of price, the highest was W (white) for general purpose and dp12 (deep green) for graphic arts industry. The lowest was dp2 (deep red) for general purpose and v2 (vivid red) for graphic arts industry. In case of reliability, the highest was v12 (vivid green) for general purpose, and v12 (vivid green) and v18 (vivid blue) for graphic arts industry. The lowest were sf4 (soft orange) and dp8 (deep yellow) for general purpose and sf2 (soft red) for graphic arts industry. In

case of service, the highest was v18 (vivid blue) for general purpose and lt18 (light blue) for graphic arts industry. The lowest were sf8 (soft yellow), sf18 (soft blue) and sf22 (soft purple) for general purpose and gy7.5 (light gray) for graphic arts industry. In case of modernity, the highest was v4 (vivid orange) for general purpose and v2 (vivid red) for graphic arts industry. The lowest was sf4 (soft orange) for general purpose and sf2 (soft red) for graphic arts industry. In case of environmental, the highest was v12 (vivid green) for both general purpose and graphic arts industry. The lowest was gy2.5 (dark gray) for general purpose and BK (black) for graphic arts industry. In case of variety, the highest was v4 (vivid orange) for general purpose and v2 (vivid red) for graphic arts industry. The lowest was BK (black) for general purpose and sf2 (soft red) for graphic arts industry. In case of stability, the highest was v12 (vivid red) for general purpose and v18 (vivid blue) for graphic arts industry. The lowest were sf4 (soft orange) and dp8 (deep yellow) for general purpose and gy7.5 (light gray) for graphic arts industry. In case of interestedness, the highest were v4 (vivid orange) and v12 (vivid green) for general purpose, and v2 (vivid red) for graphic arts industry. The lowest was sf4 (soft orange) for general purpose and gy7.5 (light gray) for graphic arts industry.

It should be noted that most of the colors which had highest scores were vivid tone and most of the colors which had lowest scores were soft tone. This reveals that vivid colors or high chroma colors gave more positive corporate image sensation than those colors with softer or lower chroma.

Table 4-4 Average values of the color sensation from the visual assessments. (a) general purpose (b) graphic arts industry.

Color	Quality		Quickness		Price		Reliability		Service		Modernity		Environmental		Variety		Stability		Interestedness	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
v2	1	1.33	1.23	1.83	0.38	-0.88	0.62	0.79	0.54	1.17	1.08	1.79	-0.19	-0.42	0.65	1.63	0.65	1.33	1.08	2.04
v4	0.27	0.58	1.31	1.83	0.31	0.04	0.04	0.63	0.92	0.71	1.19	1.29	-0.23	-0.25	1.08	0.92	0.35	0.50	1.19	1.25
v8	0.73	1.04	0.50	1.67	0.42	0.17	0.38	0.75	0.35	1.21	0.81	1.54	-0.12	0.63	0.77	1.25	0.31	0.83	1.04	1.42
v12	1.50	1.67	0.81	1.42	0.58	0.13	1.19	1.54	0.96	1.25	1.15	1.08	1.62	2.58	0.77	0.83	1.12	1.38	1.19	1.29
v18	0.77	1.46	0.62	1.17	0.19	0.25	0.77	1.54	1.12	1.46	0.92	1.46	0.69	1.04	0.73	1.04	1.04	2.00	0.85	1.29
v22	0.23	1.54	0.12	1.17	0.04	-0.79	0.19	1.38	0.12	1.04	0.12	1.42	-0.27	0.04	0.15	1.13	0.38	1.29	0.08	1.33
lt2+	0.62	0.63	0.54	0.04	0.46	0.21	0.08	-0.21	0.12	0.83	0.46	0.63	0.08	0.17	0.73	0.46	0.00	0.04	0.38	0.75
lt4+	0.46	0.71	0.23	0.75	0.73	-0.29	0.27	0.42	0.15	0.83	0.65	0.75	0.00	0.21	0.77	0.83	0.00	0.29	0.77	0.96
lt8+	0.62	1.25	0.54	1.33	0.54	-0.17	-0.04	0.71	0.50	1.04	0.62	1.17	0.23	0.83	0.65	0.88	0.35	0.71	0.65	1.13
lt12+	0.77	1.04	0.23	0.79	0.42	0.42	0.65	0.88	0.58	1.33	0.96	0.75	1.23	2.00	1.04	0.79	0.65	0.58	0.96	1.21
lt18+	1.23	1.50	0.65	1.00	0.27	-0.50	1.00	1.25	0.62	1.67	1.15	1.38	0.69	1.17	0.81	1.17	1.08	1.08	0.96	1.38
lt22+	0.08	0.58	0.58	0.21	0.15	-0.29	-0.08	0.00	0.38	0.50	0.46	0.58	0.12	0.38	0.58	0.33	0.35	0.13	0.31	0.42
sf2	0.35	-0.71	0.42	-0.63	0.23	0.46	0.12	-0.58	0.04	-0.08	-0.08	-0.75	-0.35	-0.38	0.42	-0.46	0.27	0.00	0.35	-0.50
sf4	-0.54	0.00	-0.04	-0.13	-0.12	0.13	-0.23	-0.08	0.19	0.00	-0.23	-0.04	-0.31	0.04	0.23	0.04	-0.31	0.29	-0.15	-0.13
sf8	0.23	0.08	-0.23	-0.13	0.38	0.67	-0.04	-0.29	-0.04	0.29	0.31	-0.13	-0.08	0.21	0.31	0.21	0.23	-0.08	0.38	-0.17

Table 4-4 (cont.)

Color	Quality		Quickness		Price		Reliability		Service		Modernity		Environmental		Variety		Stability		Interestedness	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
sf12	0.38	0.63	0.08	0.33	0.00	0.17	0.00	0.63	0.08	0.83	0.23	0.38	1.04	1.96	0.23	0.54	0.54	0.88	0.65	0.96
sf18	0.58	0.29	0.35	-0.33	-0.04	0.63	-0.15	0.54	-0.04	0.25	0.62	-0.08	-0.23	0.33	0.65	-0.25	0.85	0.88	0.69	0.25
sf22	0.04	0.08	0.19	0.00	0.38	0.08	0.23	0.17	-0.04	0.08	0.46	-0.29	-0.12	-0.33	0.35	-0.33	-0.04	0.29	0.42	-0.13
dp2	0.65	0.33	0.69	0.96	-0.31	-0.08	0.46	0.71	0.54	0.33	1.00	0.58	-0.42	-0.38	0.54	0.50	0.46	0.75	1.04	0.46
dp4	0.81	-0.33	0.65	0.17	0.15	0.13	0.19	-0.04	0.00	-0.04	0.15	-0.17	-0.38	-0.21	0.88	0.00	0.50	0.13	1.00	-0.21
dp8	0.38	-0.67	0.38	-0.54	0.58	0.29	-0.23	0.00	0.31	0.04	0.38	-0.17	-0.12	0.00	0.69	-0.38	0.23	0.17	0.62	-0.08
dp12	0.35	1.33	0.08	0.46	-0.08	0.96	0.27	1.21	0.42	1.04	0.04	0.75	1.00	2.17	0.58	0.58	0.54	1.58	0.38	1.00
dp18	0.88	1.17	0.58	0.63	0.08	-0.21	0.81	1.46	0.58	0.67	0.73	0.75	0.27	0.38	0.69	0.33	0.62	1.67	0.77	0.75
dp22	0.35	0.79	0.19	0.83	0.46	-0.54	0.27	0.75	0.15	0.96	0.58	1.33	-0.08	-0.17	0.58	0.92	0.27	1.08	0.27	1.13
BK	0.31	0.42	0.46	0.46	0.04	0.00	0.31	1.29	0.38	0.92	0.46	1.21	-0.81	-0.54	-0.04	0.33	0.65	1.75	0.31	0.96
gy2.5	0.38	0.79	0.19	0.38	0.15	0.08	0.23	1.17	0.15	0.50	0.46	0.79	-1.04	-0.33	0.58	0.29	0.50	1.50	0.42	0.54
gy5.0	0.96	0.25	0.69	0.25	0.46	0.46	0.38	0.50	0.42	0.00	0.23	0.08	-0.23	0.08	0.23	-0.17	0.12	0.75	0.19	0.17
gy7.5	0.00	-0.29	0.04	-0.46	0.04	0.25	0.19	-0.04	0.12	-0.17	0.08	-0.21	-0.31	-0.29	0.08	-0.29	0.35	-0.29	-0.12	-0.83
w	0.35	1.13	0.62	0.67	0.77	0.58	0.62	1.25	0.62	1.25	0.08	1.08	0.92	1.83	0.27	0.29	0.38	1.08	0.23	0.42

4.3 Analysis of the results from the visual assessments

4.3.1 Color measurement

The color samples were measured with the Spectrodensitometer: Xrite-530 under illuminant D50 with 2 degrees standard observer condition in terms of colorimetric values as L*, a*, b*, C^*_{ab} and h_{ab}. Table 4-5 shows the colorimetric values of the color samples.

Table 4-5 CIE colorimetric values of the color samples used in the experiment.

color sample	a*	b*	L*	C^*_{ab}	h_{ab}
v2	75.79	33.57	46.29	82.89	23.89
v4	60.89	65.47	60.13	89.41	47.08
v8	3.88	90.34	83.98	90.42	87.54
v12	-60.30	22.87	55.26	64.49	159.23
v18	-8.07	-50.01	34.13	50.66	260.83
v22	38.73	-34.63	33.27	51.95	318.20
lt2+	30.29	17.00	74.06	34.73	29.30
lt4+	31.14	32.27	74.83	44.84	46.02
lt8+	0.15	55.45	87.33	55.45	89.85
lt12+	-28.92	13.74	74.84	32.02	154.59
lt18+	-9.89	-23.54	65.25	25.53	247.21
lt22+	18.10	-11.64	66.91	21.52	327.26
sf2	29.71	18.97	57.18	35.25	32.56
sf4	27.60	28.15	66.12	39.42	45.57
sf8	1.52	44.65	73.91	44.68	88.05
sf12	-23.96	15.43	63.08	28.50	147.22
sf18	-7.38	-18.21	47.00	19.65	247.94
sf22	21.01	-8.12	46.82	22.52	338.87

Table 4-5 (cont.)

color sample	a*	b*	L*	C^*_{ab}	h_{ab}
dp2	53.84	23.78	37.40	58.86	23.83
dp4	44.88	50.56	47.83	67.61	48.41
dp8	16.07	66.02	60.25	67.95	76.32
dp12	-44.19	10.39	39.00	45.40	166.77
dp18	-6.50	-33.39	28.13	34.02	258.98
dp22	45.58	-30.31	29.73	54.74	326.38
BK	2.01	-1.94	5.85	-	-
gy2.5	0.03	-0.19	23.60	-	-
gy5.0	-0.58	3.10	47.24	-	-
gy7.5	-0.03	5.71	73.93	-	-
W	1.48	2.14	92.94	-	-

4.3.2 Analysis of the relationships between corporate image sensation and CIE colorimetric lightness and chroma

To analyze the relationship between the obtained data of the corporate image sensation (Table 4-4) and CIE colorimetric values; lightness and chroma (Table 4-5), thus SPSS was used to calculate correlation coefficients. Results, given in Table 4-6, showed that most of the corporate image sensation did not linearly relate to the L* and C^*_{ab} colorimetric values as low correlation coefficient. However, it was interesting to note that the corporate image sensation of price could relate to lightness values with correlation coefficient of 0.501. Thus, if lightness increases, the corporate image sensation of price becomes cheapen. Figure 4-4 shows the scatter diagram of the relationship between corporate image sensation of price and lightness. In addition, the corporate image sensations of quickness and interestedness related to chroma values with correlation coefficient of 0.529 and 0.486 respectively. Figure 4-5 and 4-6 showed the scatter diagrams of the relationship between corporate image sensations of quickness and chroma, and interestedness and chroma respectively.

Table 4-6 Correlation coefficients of general corporate image sensation against lightness and chroma.

Corporate image	Lightness (L*)	Chroma (C^*_{ab})
Quality	-.064	.231
Quickness	-.043	.529
Price	.501	.258
Reliability	-.155	.102
Service	-.024	.367
Modernity	-.059	.324
Environmental	.354	-.213
Variety	.191	.353
Stability	-.291	.019
Interestedness	.028	.486

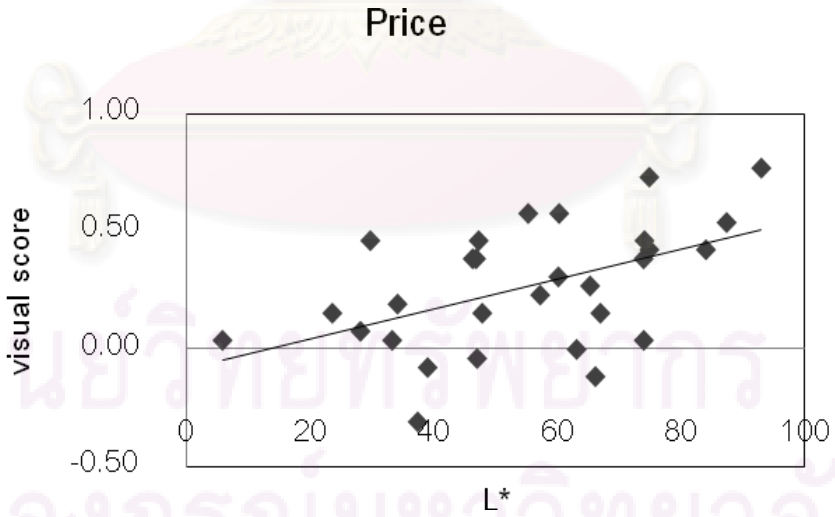

Figure 4-4 Relationship between general corporate image sensation of price and lightness.

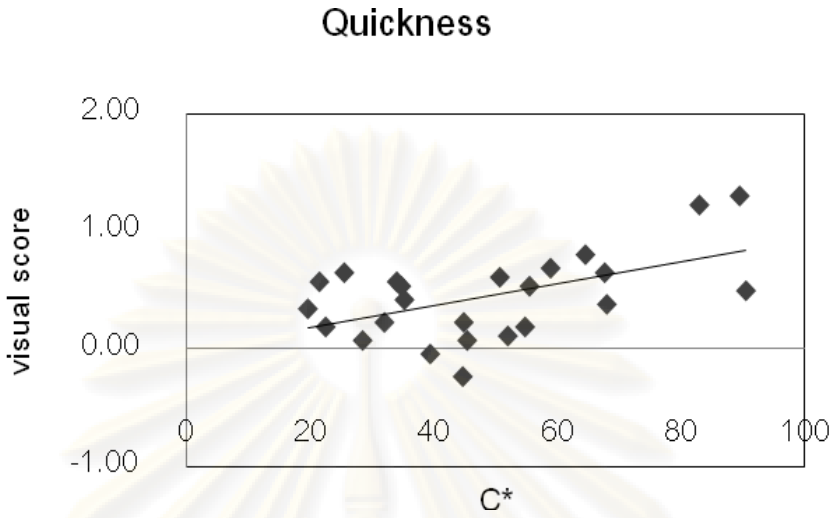

Figure 4-5 Relationship between general corporate image sensation of quickness and chroma.

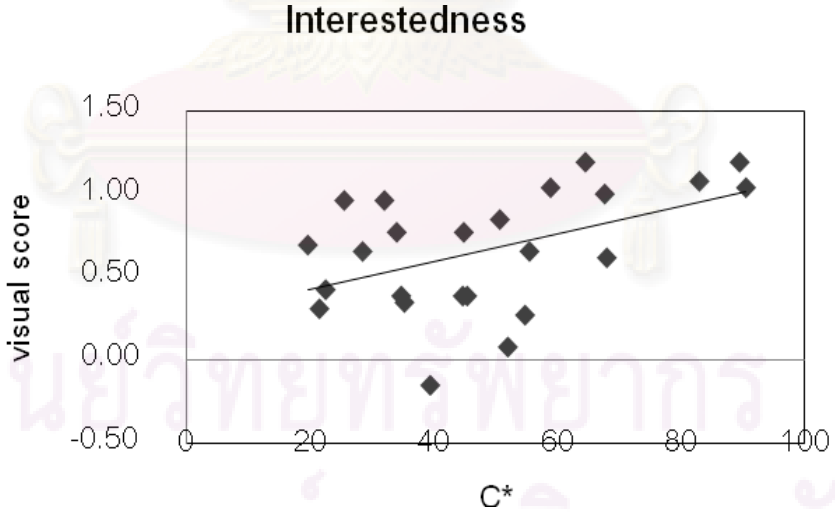

Figure 4-6 Relationship between general corporate image sensation of interestedness and chroma.

Regarding the relationship between the corporate image sensation in graphic arts industry and CIE colorimetric values, Table 4-7 gives the negative relationship data between lightness values and the sensation of reliability and stability with correlation coefficient of -0.399 and -0.598 respectively. Thus, if lightness increases, the sensation of reliability and stability will become lower. Figure 4-7 and 4-8 show the scatter diagrams of the relationships between the lightness values and the sensation of reliability and stability. The quickness sensation also related to chroma values with correlation coefficient value of 0.608. While the modernity and variety sensation give values at 0.450 and 0.449 respectively. This implies that the relationship between the corporate image sensations of quickness, modernity and variety, of companies in graphic art industry and the chroma values is unidirectional. Figure 4-9 to 4-11 show the relationships of chroma values and the corporate image sensations of quickness, modernity and variety respectively.

Table 4-7 Correlation coefficients of corporate image sensation in graphic arts industry against lightness and chroma.

Corporate image	Lightness (L*)	Chroma (C^*_{ab})
quality	-.054	.101
quickness	-.018	.608
price	.219	-.195
reliability	-.399	.150
service	.060	.151
modernity	-.121	.450
environmental	.337	-.186
variety	.022	.449
stability	-.598	.130
interestedness	-.123	.370

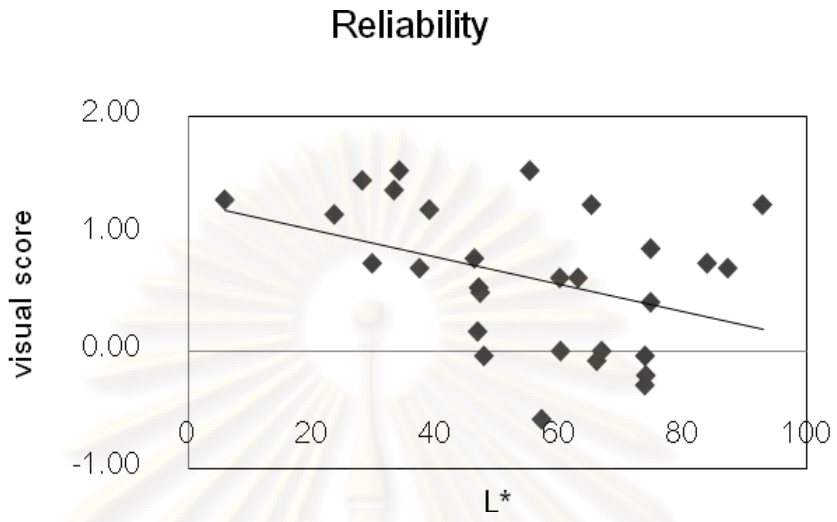

Figure 4-7 Relationship between corporate image sensation in graphic arts industry of reliability and lightness.

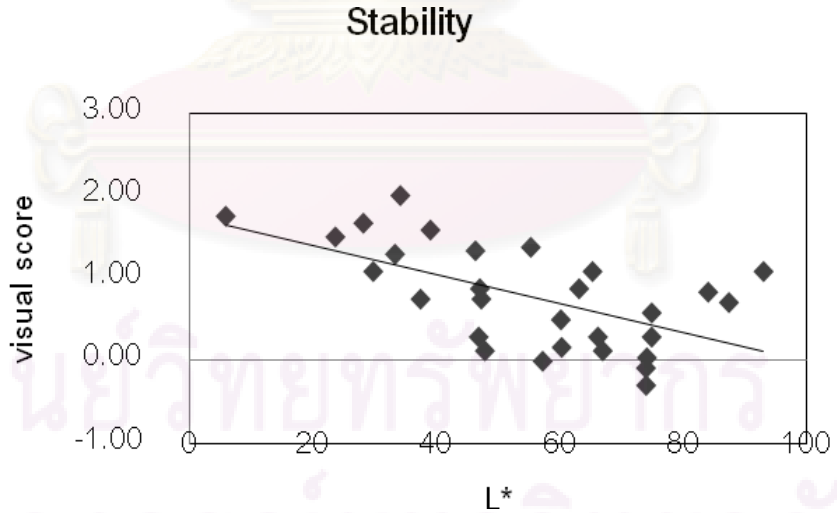

Figure 4-8 Relationship between corporate image sensation in graphic arts industry of stability and lightness.

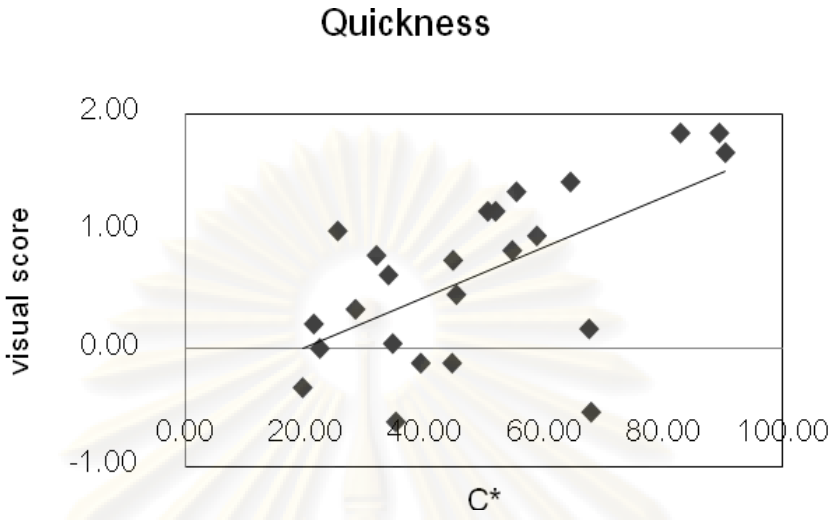

Figure 4-9 Relationship between corporate image sensation in graphic arts industry of quickness and chroma.

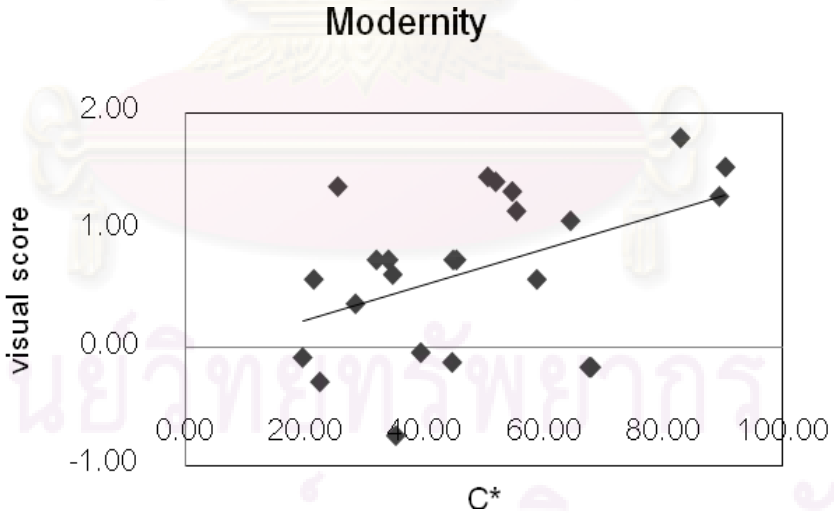

Figure 4-10 Relationship between corporate image sensation in graphic arts industry of modernity and chroma.

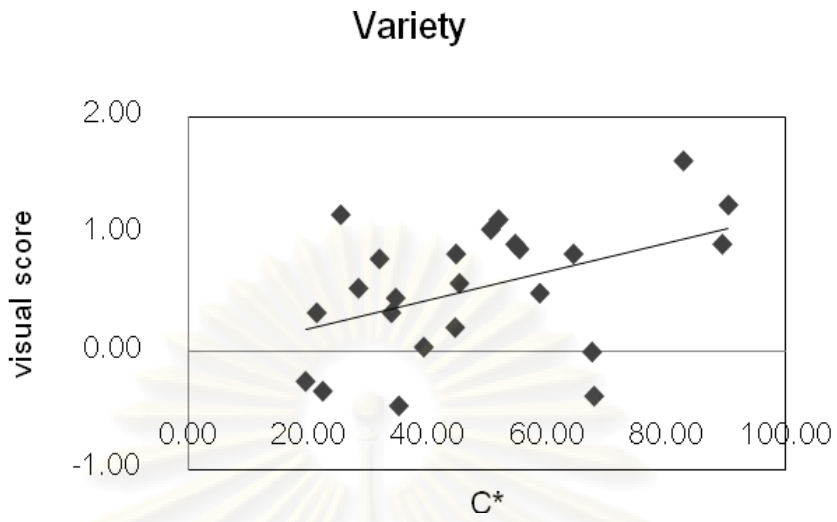

Figure 4-11 Relationship between corporate image sensation in graphic arts industry of variety and chroma.

4.3.3 Analysis of the relationships between corporate image sensation and hues

To examine the relationships between the visual results and hues, bubble chart were used to consider how magnitude of the visual scores on each of area in CIE a* b* diagram. Size of bubbles represents magnitude of visual scores. Black bubbles represent positive visual scores and white bubbles represent negative visual scores. It was found that the results of both visual assessments were similar. The diagrams in Figure 4-12 and 4-13 show the visual results of the corporate image of stability and environmental for general purpose and graphic arts industry. There were big bubbles in green and blue areas implied that green and blue produce positive effects on the corporate image sensation of stability and environmental. Especially in the case of the environmental corporate image, there were big bubbles only in green areas.

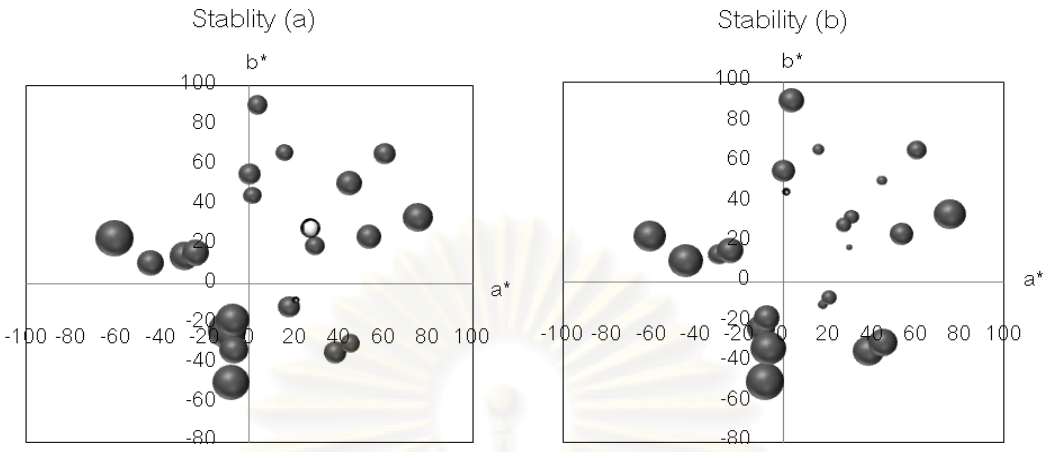

Figure 4-12 Visual results of the stability image plotted on CIELAB a* b* diagram.

(a) General purpose

(b) Graphic arts industry

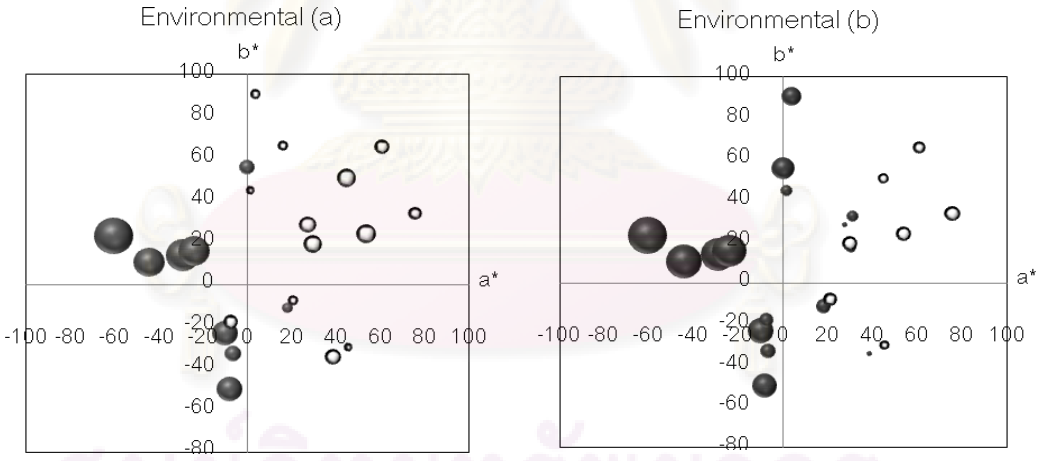

Figure 4-13 Visual results of the environmental image plotted on CIELAB a* b* diagram.

(a) General purpose

(b) Graphic arts industry

4.3.4 Analysis of the relationships between achromatic colors and the corporate image sensation

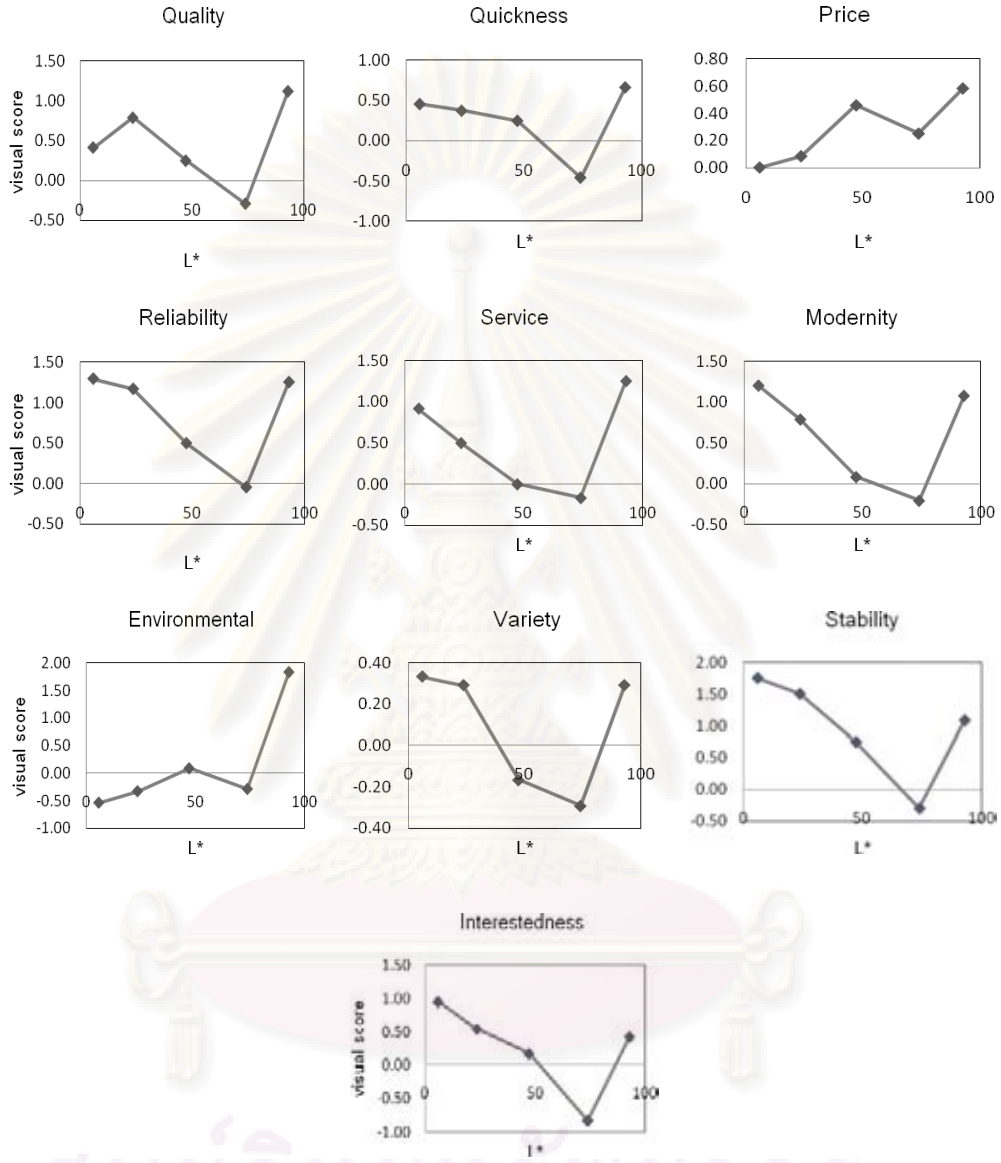

Figure 4-14 Results of the visual assessment of corporate image using achromatic color.

To investigate the effect of the achromatic color on the corporate image sensation, in Figure 4-14, there was a tendency of high visual score for nearly entire corporate images in black and lower in gray. It was noted that the visual score reduced as the lightness increased, and to be rebound again when it became white. This tendency occurred with all corporate images excepting the corporate images of price

and environmental which showed almost low visual score in black and increased in white. Thus, the corporate images of a company in graphic arts industry, black and white offer the positive sensation to the observer perception more than gray. There were just only on price and environmental corporate images that black gave negatively response.

4.3.5 Comparison of the visual assessment for general purpose and graphic arts industry by statistical analysis

The visual results of two assessments were compared using independent samples t-test with the use of SPSS software. The hypotheses were as following.

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

Where H_0 the population means are equal, H_1 the population means are different. The null hypothesis, H_0 will be accepted at the 0.05 level of significance with a 95% confidence when -1.96 $\geq$ critical t-value $\leq$+1.96, or the calculated t-value is equal or lower than the critical t-value at the 0.05 level of significance, then the color sensation of two assessments is considered as accept null hypothesis “no significant difference”, while if the critical t-value is upper than the critical judged as reject null hypothesis and accept alternate hypothesis, or -1.96 >critical t-value <+1.96. It means that the difference is significant.

The results of hypothesis test are shown in Table 4-8. The table shows that the corporate image of reliability, service, and stability failed the test, which means that the results obtained specifically for graphic arts industry were significantly different from those for general purpose. As for the other corporate images, there was no significant difference between the results for graphic arts industry and general purpose. It could be that the corporate image sensations of reliability and stability of companies in graphic arts industry much more related to lightness than those of general companies. And corporate image sensation of service in general companies much more related to chroma than that in graphic arts industry as shown in Table 4-6 and Table 4-7.

Table 4-8 A statistical analysis of visual assessment, using an independent samples t-test. Highlighted figures represent cases that the results are significantly different.

Corporate image	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Quality	-.928	56	.357	-.134	.144	-.423	.155
Quickness	-.820	56	.416	-.118	.144	-.407	.171
Price	1.966	56	.054	.183	.093	-.003	.369
Reliability	-2.589	56	.012	-.339	.131	-.601	-.077
Service	-2.931	56	.005	-.333	.114	-.561	-.106
Modernity	-.922	56	.361	-.134	.145	-.425	.157
Environmental	-1.741	56	.087	-.350	.201	-.753	.053
Variety	.778	56	.440	.089	.115	-.141	.319
Stability	-2.688	56	.009	-.350	.130	-.611	-.089
Interestedness	-.510	56	.612	-.074	.145	-.366	.217

CHAPTER V

CONCLUSIONS

5.1 Conclusions

This thesis aimed at studying an effects of colors used as a corporate identity on the corporate image perceived by consumers in graphic arts industry. The study was carried out by using a questionnaire and visual assessments. The questionnaire investigated the influence of corporate identity color on the audience's memory. Then, the effects of color on the corporate image in general companies and graphic arts industry were observed through visual assessments by using twenty-nine color samples selected from the PCCS color system.

Thai observers could recall a brand or company name in relation to its corporate identity color. Red was the color which most of the observers gave high responses as well as being the most favorite color while gray showed lowest responses and least-favorite color.

The visual results gave the tendency to have a relationship with colorimetric values. In the case of general purpose, observers interpreted the corporate image sensation of price related to lightness while the corporate image sensation of quickness and interestedness related to chroma. For graphic arts industry, the corporate image sensation of reliability and stability was shown to have negative relationship with lightness while the corporate image sensation of quickness, modernity and variety were positively related to chroma. In addition, it was found that green and blue hues produced positive effects on the corporate image sensation of stability and environmental on the observer's perception.

Regarding the achromatic colors, the observers interpreted most of the corporate images in the same manner only for the graphic arts industry, with the exception of price and environmental. For example, black and white showed higher

visual scores than those by gray. In the case of price and environmental, black had the lowest visual scores while white had the highest.

Results of the paired t-test with the critical t-value at the 0.05 level of significance showed the difference of the visual results between general purpose and graphic arts industry, for the corporate images of reliability, service and stability. The corporate images of quality, quickness, price, modernity, environmental, variety and interestedness had no significant difference.

5.2 Suggestions

This thesis reveals the effect of colors on consumers' corporate image sensation in general purpose and graphic arts industry. In this regard, the relationship between the corporate image sensations and the colorimetric values were exposed. However, it is interesting to carry out future research on various conditions, for example, corporate image words, samples materials, light sources, color system, industries, languages and observer's regions. Especially on a cross-cultural study, it is very useful to investigate the difference and similarity of different regions or cultures on color sensation. The research may enable publicists or designers to easily select the suitable colors for companies with different cultures. Moreover, the investigations on other industries are very interesting, for example, food, banks, automotive and so on. These studies can be used as a basis for the determination of local consumers' sensation on corporate image to support color planning in the corporate identity design.

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APPENDICES

APPENDIX A

DIAGRAMS OF RELATIONSHIP BETWEEN GENERAL CORPORATE IMAGE SENSATION AND CIE COLORIMETRIC VALUES

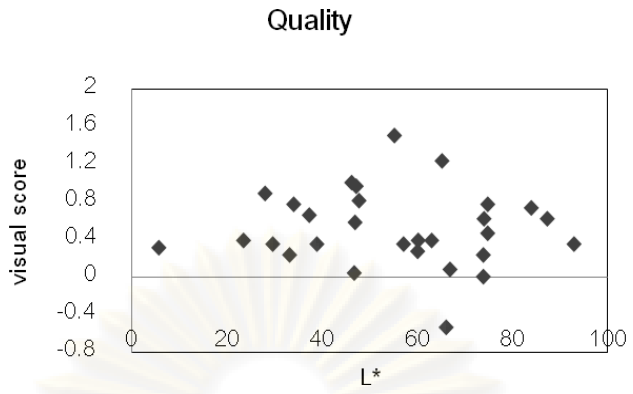

Figure A-1 Relationship between general corporate image sensation of quality and lightness.

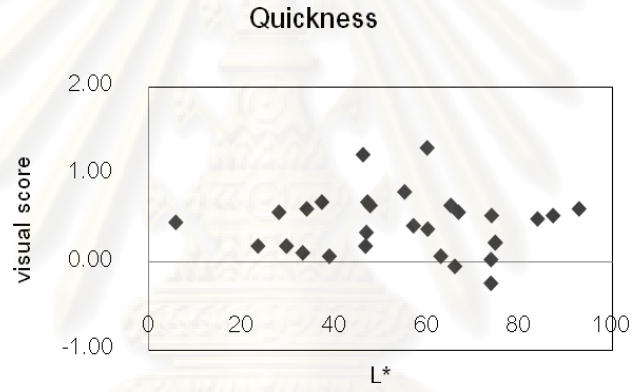

Figure A-2 Relationship between general corporate image sensation of quickness and lightness

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Figure A-3 Relationship between general corporate image sensation of price and lightness.

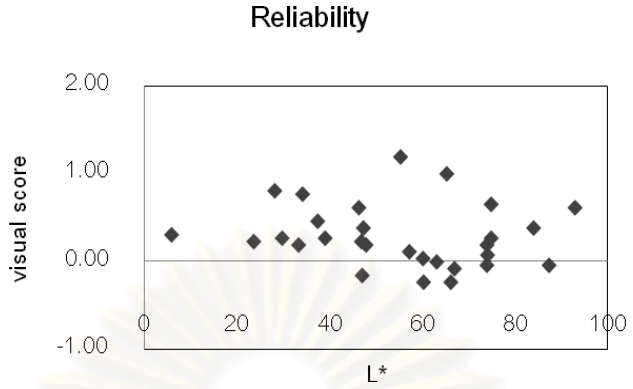

Figure A-4 Relationship between general corporate image sensation of reliability and lightness.

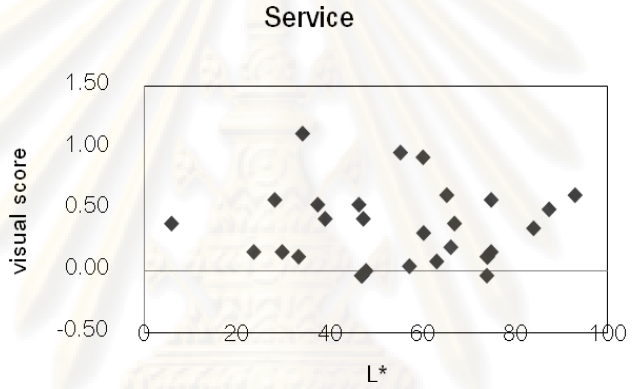

Figure A-5 Relationship between general corporate image sensation of service and lightness.

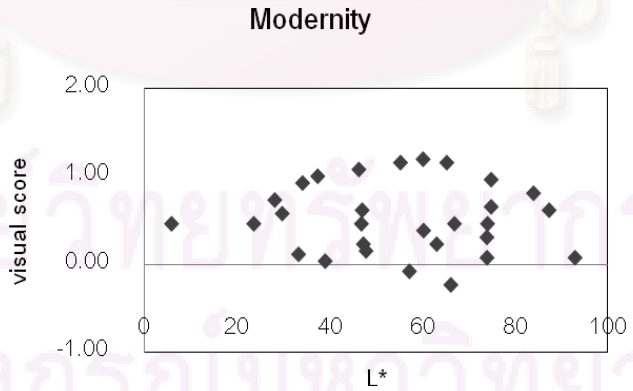

Figure A-6 Relationship between general corporate image sensation of modernity and lightness.

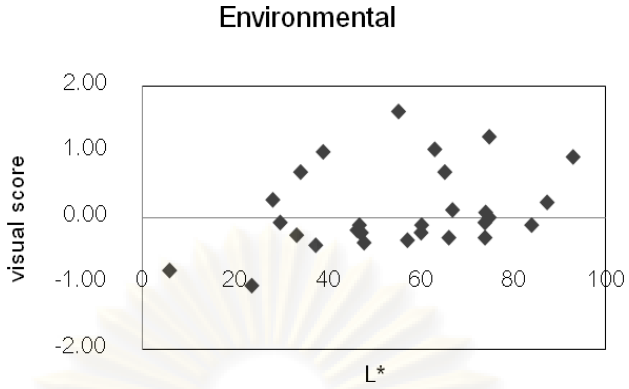

Figure A-7 Relationship between general corporate image sensation of environmental and lightness.

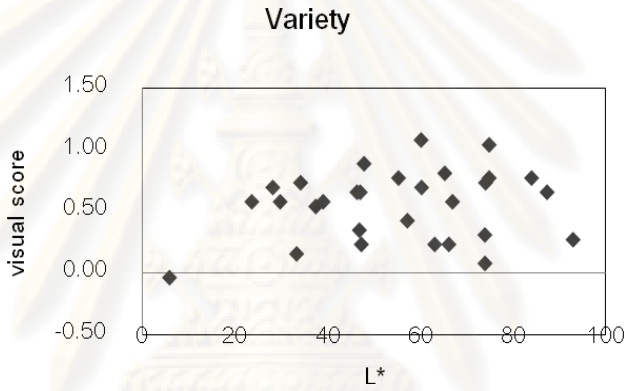

Figure A-8 Relationship between general corporate image sensation of variety and lightness.

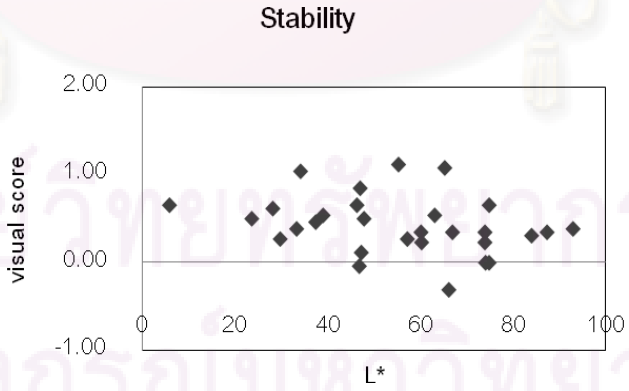

Figure A-9 Relationship between general corporate image sensation of stability and lightness.

Figure A-10 Relationship between general corporate image sensation of interestedness and lightness.

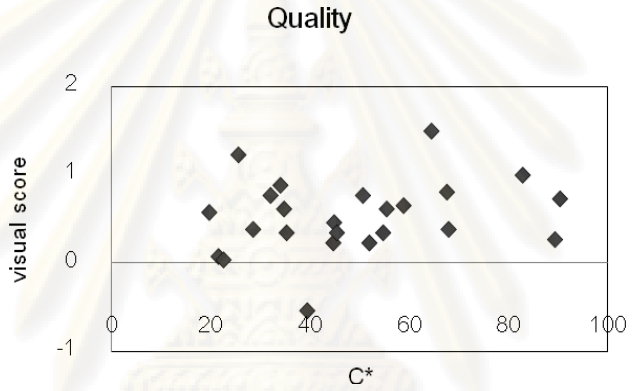

Figure A-11 Relationship between general corporate image sensation of quality and chroma.

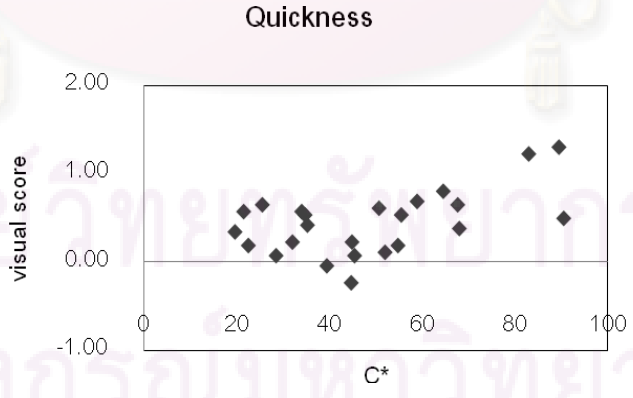

Figure A-12 Relationship between general corporate image sensation of quickness and chroma.

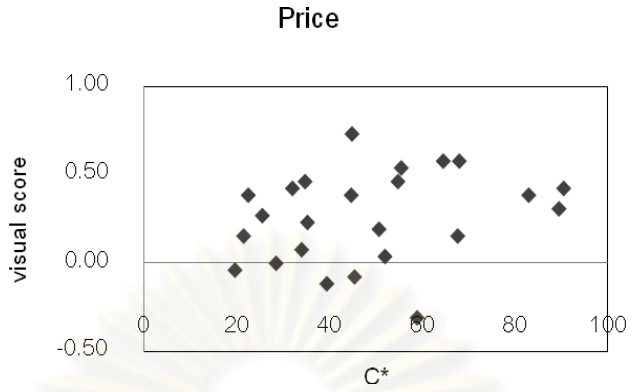

Figure A-13 Relationship between general corporate image sensation of price and chroma.

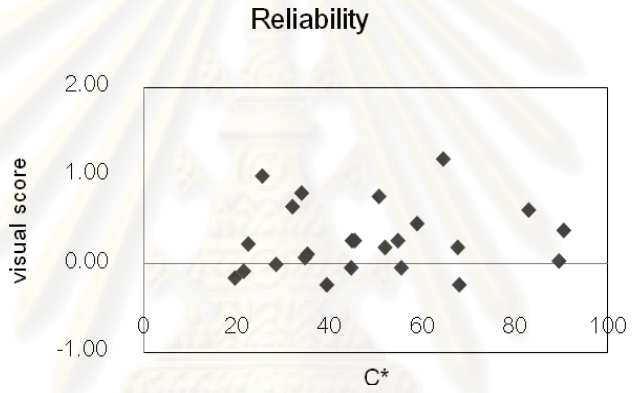

Figure A-14 Relationship between general corporate image sensation of reliability and chroma.

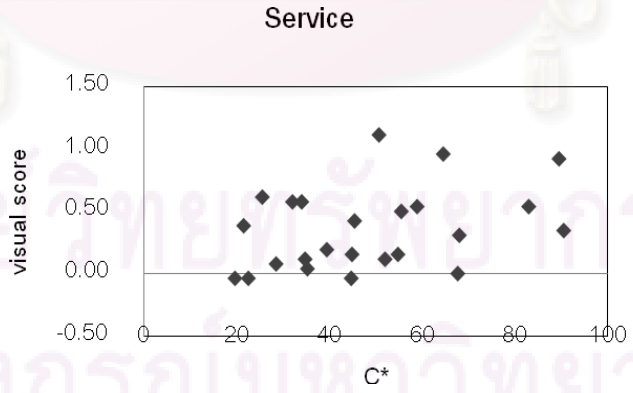

Figure A-15 Relationship between general corporate image sensation of service and chroma.

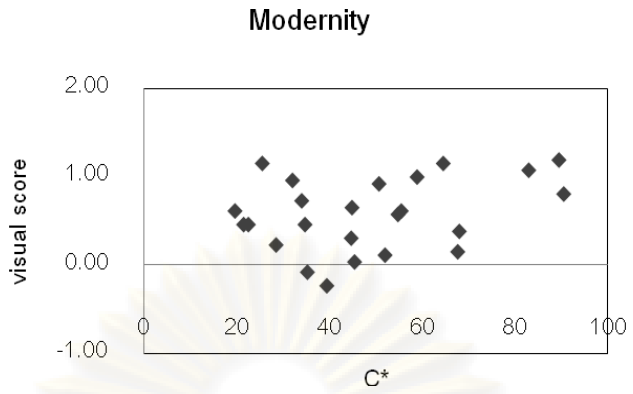

Figure A-16 Relationship between general corporate image sensation of modernity and chroma.

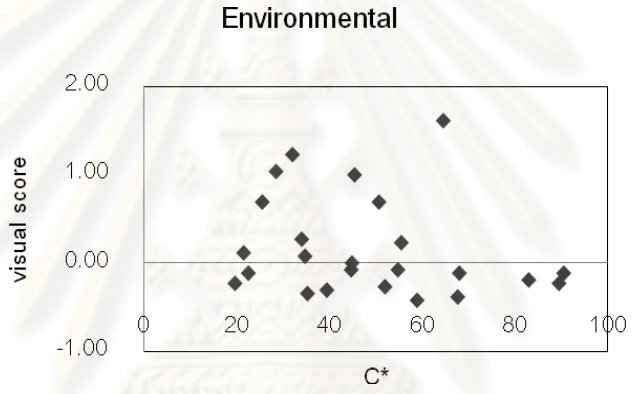

Figure A-17 Relationship between general corporate image sensation of environmental and chroma.

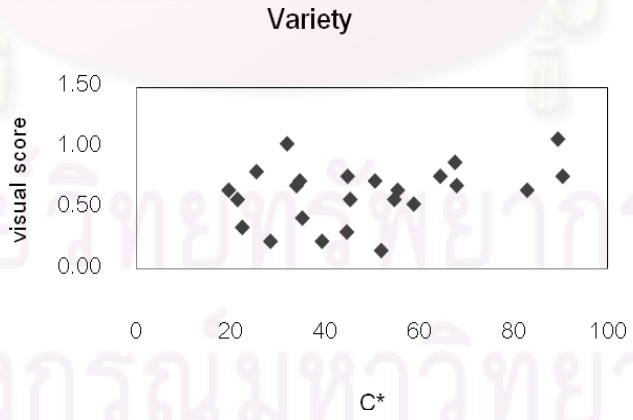

Figure A-18 Relationship between general corporate image sensation of variety and chroma.

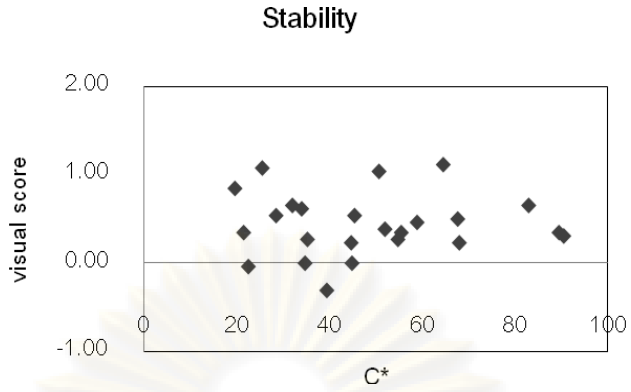

Figure A-19 Relationship between general corporate image sensation of stability and chroma.

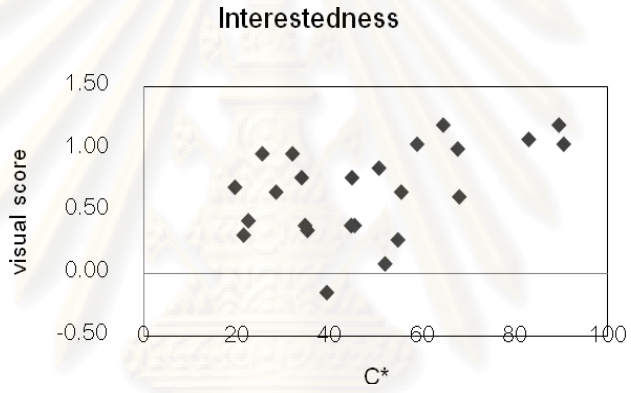

Figure A-20 Relationship between general corporate image sensation of interestedness and chroma.

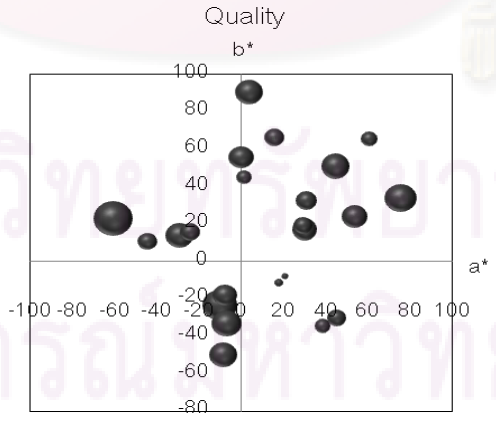

Figure A-21 Relationship between general corporate image sensation of quality and CIELAB a*b*.

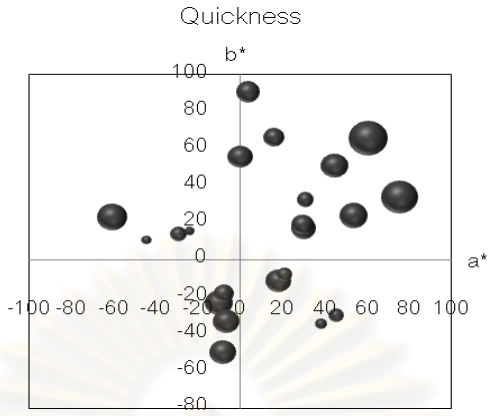

Figure A-22 Relationship between general corporate image sensation of quickness and CIELAB a*b*.

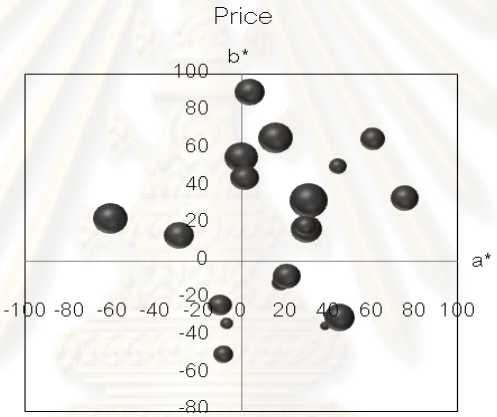

Figure A-23 Relationship between general corporate image sensation of price and CIELAB a*b*.

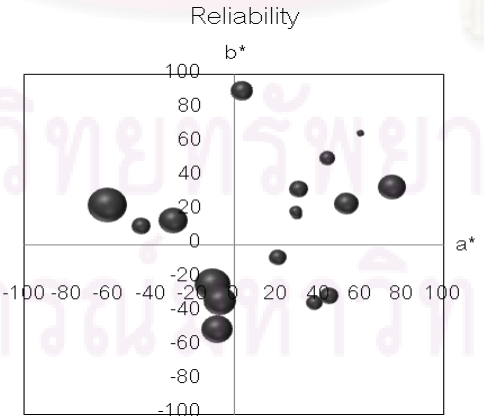

Figure A-24 Relationship between general corporate image sensation of reliability and CIELAB a*b*.

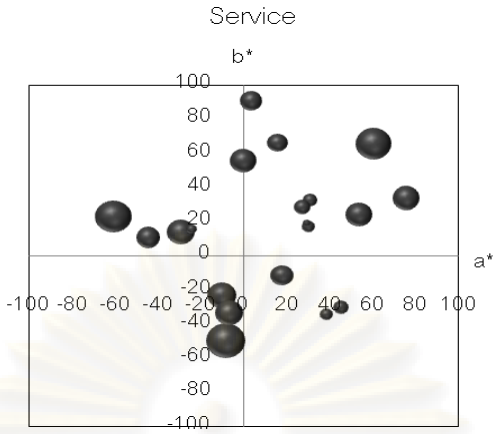

Figure A-25 Relationship between general corporate image sensation of service and CIELAB a*b*.

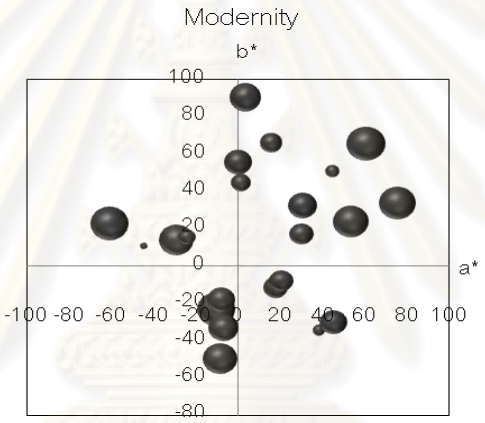

Figure A-26 Relationship between general corporate image sensation of modernity and CIELAB a*b*.

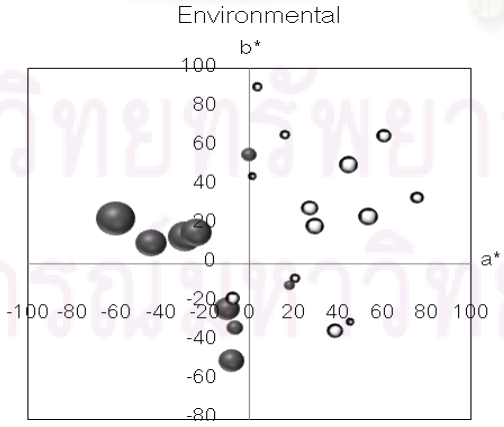

Figure A-27 Relationship between general corporate image sensation of environmental and CIELAB a*b*.

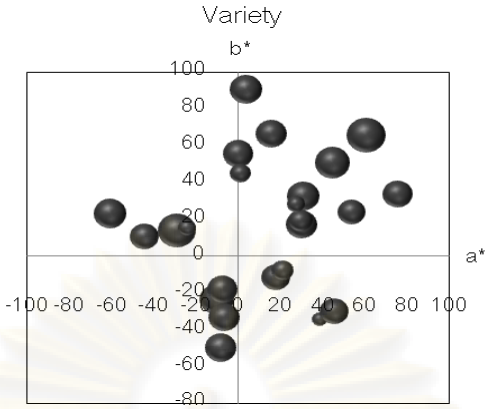

Figure A-28 Relationship between general corporate image sensation of variety and CIELAB a*b*.

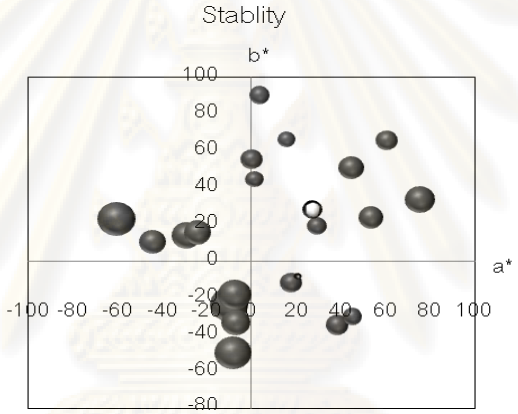

Figure A-29 Relationship between general corporate image sensation of stability and CIELAB a*b*.

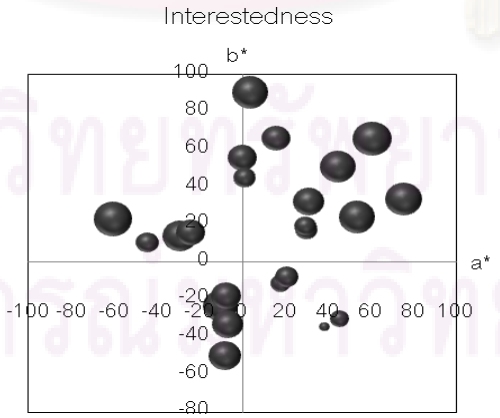

Figure A-30 Relationship between general corporate image sensation of interestedness and CIELAB a*b*.

APPENDIX B

DIAGRAMS OF CORPORATE IMAGE SENSATION IN GRAPHIC ARTS INDUSTRY AND CIE COLORIMETRIC VALUES

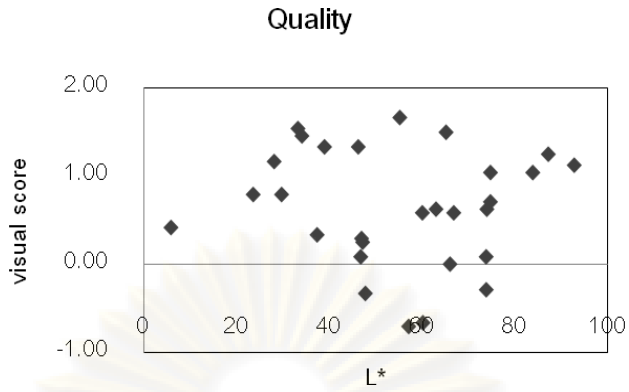

Figure B-1 Relationship between corporate image sensation in graphic arts industry of quality and lightness.

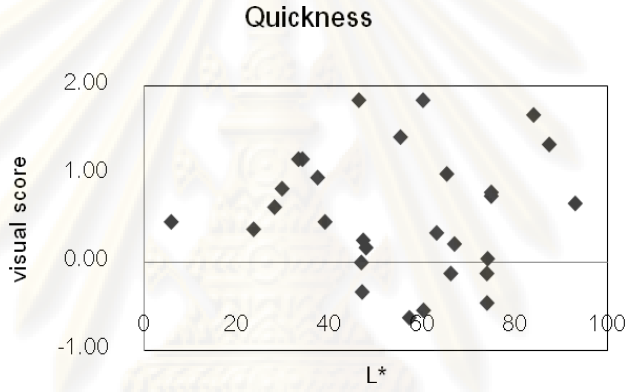

Figure B-2 Relationship between corporate image sensation in graphic arts industry of quickness and lightness.

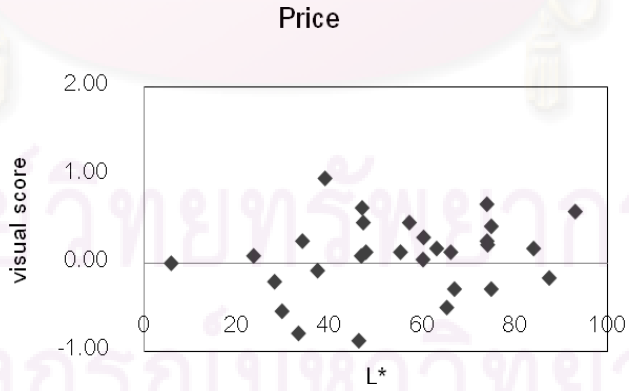

Figure B-3 Relationship between corporate image sensation in graphic arts industry of price and lightness.

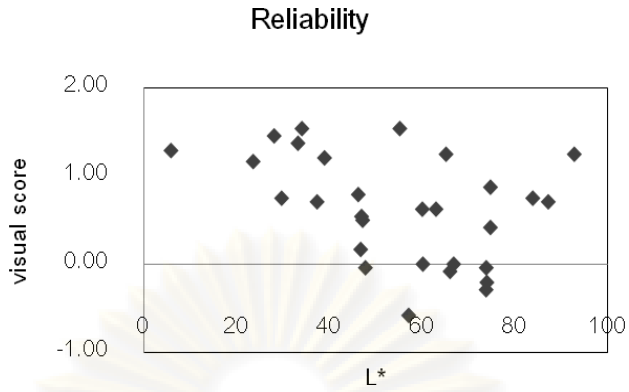

Figure B-4 Relationship between corporate image sensation in graphic arts industry of reliability and lightness.

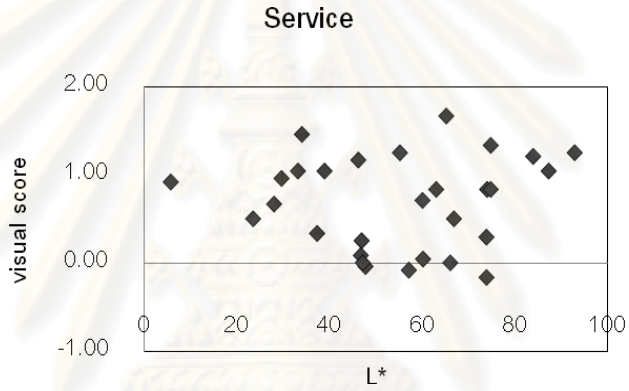

Figure B-5 Relationship between corporate image sensation in graphic arts industry of service and lightness.

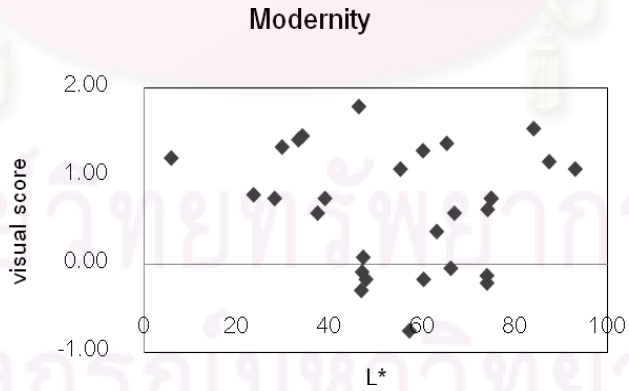

Figure B-6 Relationship between corporate image sensation in graphic arts industry of modernity and lightness.

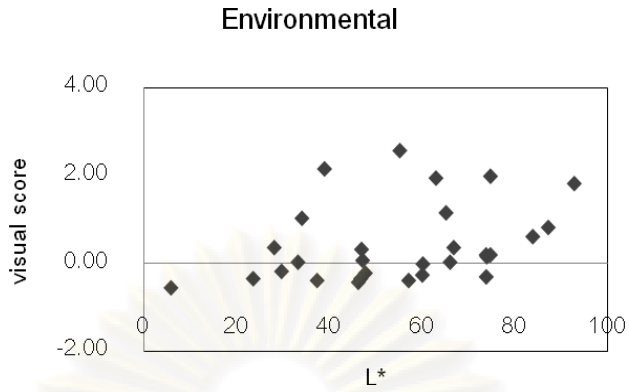

Figure B-7 Relationship between corporate image sensation in graphic arts industry of environmental and lightness.

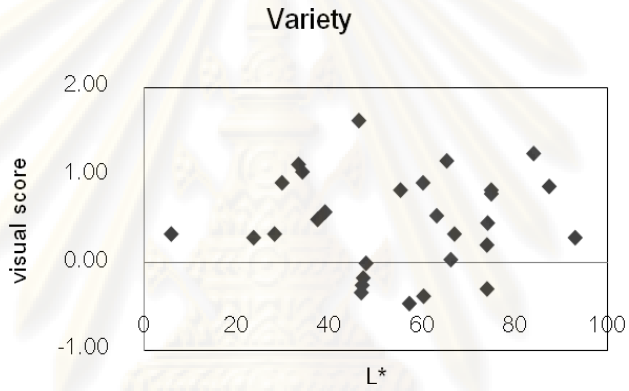

Figure B-8 Relationship between corporate image sensation in graphic arts industry of variety and lightness.

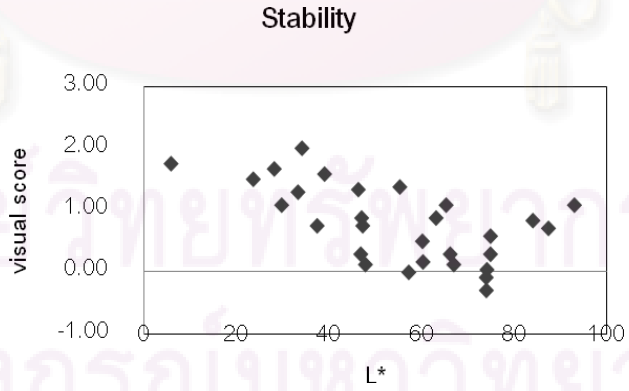

Figure B-9 Relationship between corporate image sensation in graphic arts industry of stability and lightness.

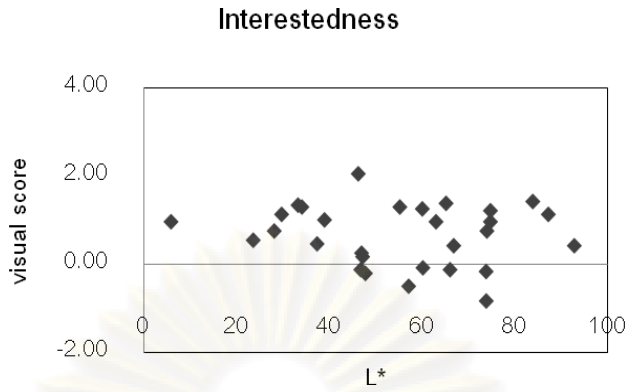

Figure B-10 Relationship between corporate image sensation in graphic arts industry of interestedness and lightness.

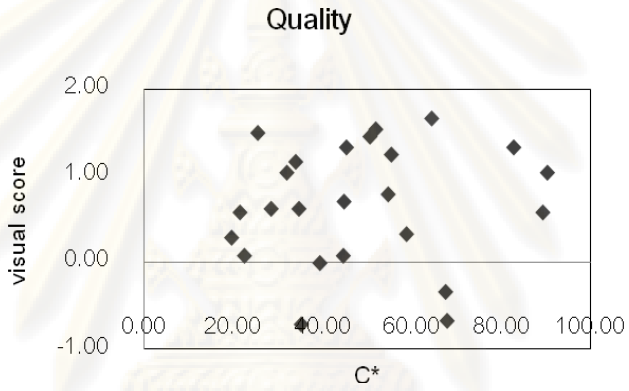

Figure B-11 Relationship between corporate image sensation in graphic arts industry of quality and chroma.

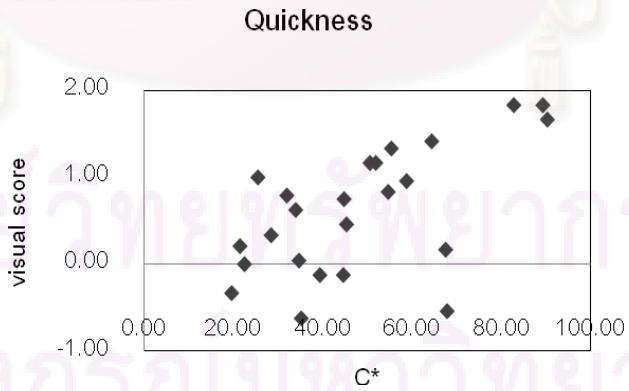

Figure B-12 Relationship between corporate image sensation in graphic arts industry of quickness and chroma.

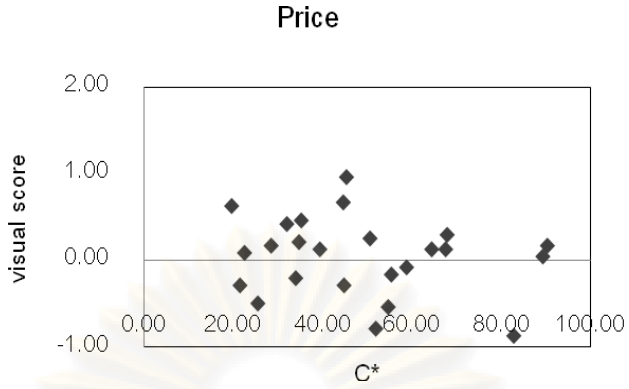

Figure B-13 Relationship between corporate image sensation in graphic arts industry of price and chroma.

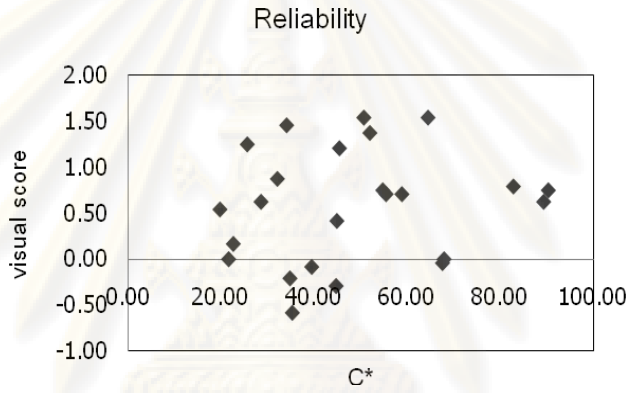

Figure B-14 Relationship between corporate image sensation in graphic arts industry of reliability and chroma.

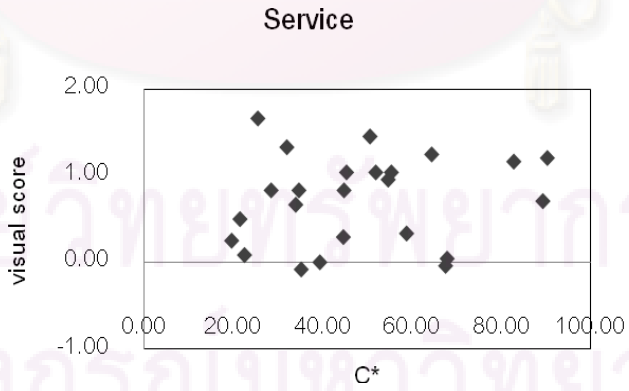

Figure B-15 Relationship between corporate image sensation in graphic arts industry of service and chroma.

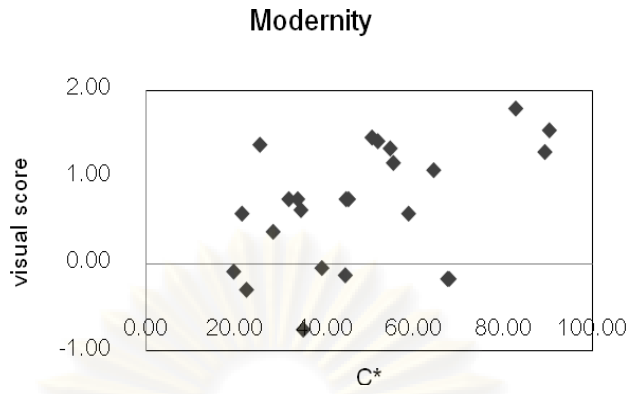

Figure B-16 Relationship between corporate image sensation in graphic arts industry of modernity and chroma.

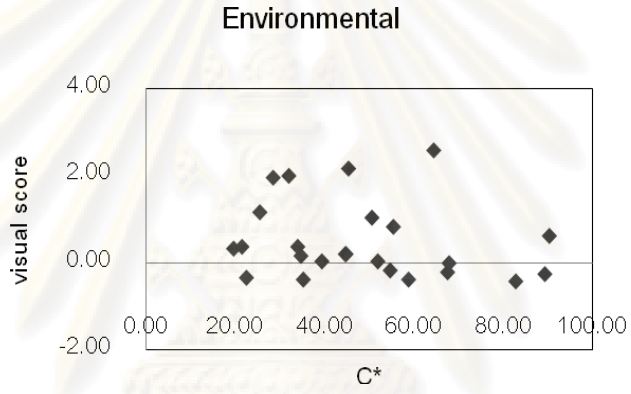

Figure B-17 Relationship between corporate image sensation in graphic arts industry of environmental and chroma.

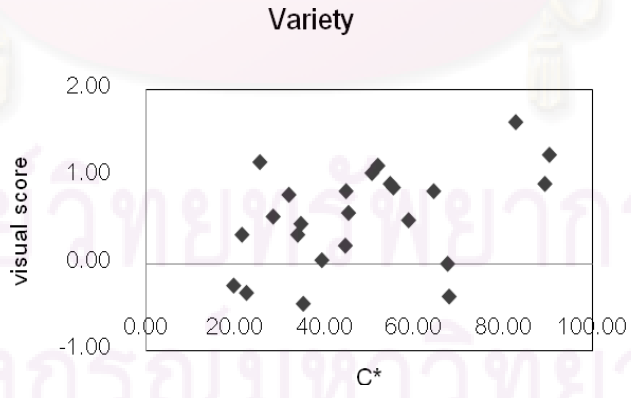

Figure B-18 Relationship between corporate image sensation in graphic arts industry of variety and chroma.

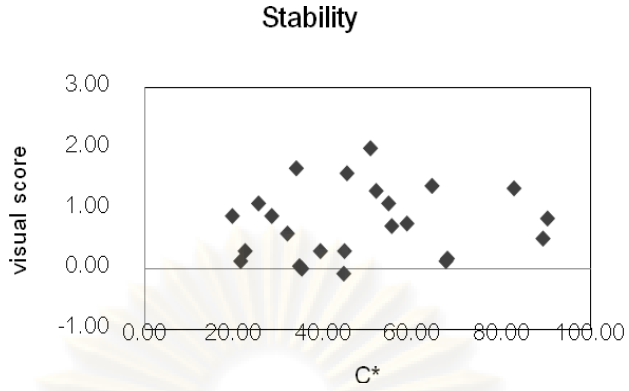

Figure B-19 Relationship between corporate image sensation in graphic arts industry of stability and chroma.

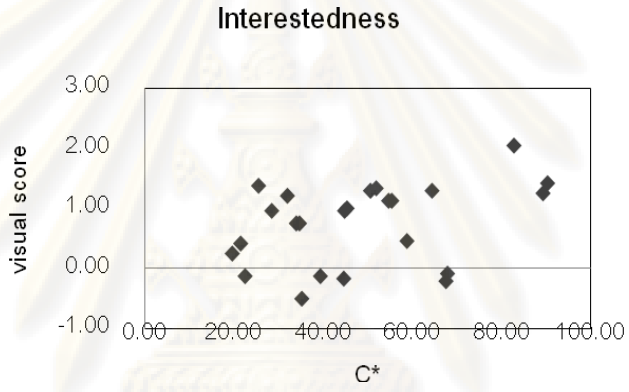

Figure B-20 Relationship between corporate image sensation in graphic arts industry of interestedness and chroma.

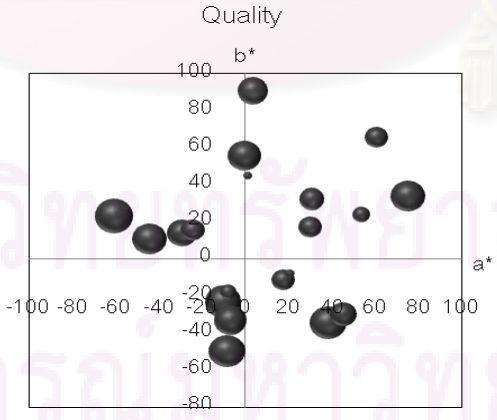

Figure B-21 Relationship between corporate image sensation in graphic arts industry of quality and CIELAB a*b*.

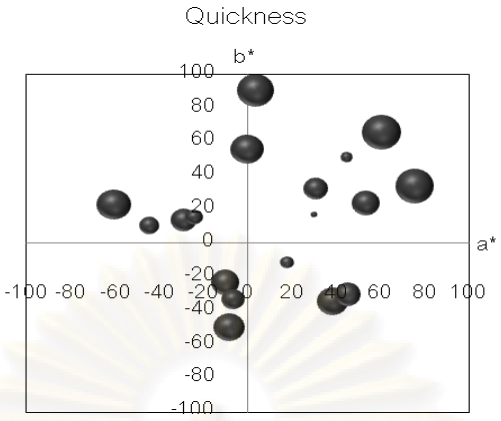

Figure B-22 Relationship between corporate image sensation in graphic arts industry of quickness and CIELAB a*b*.

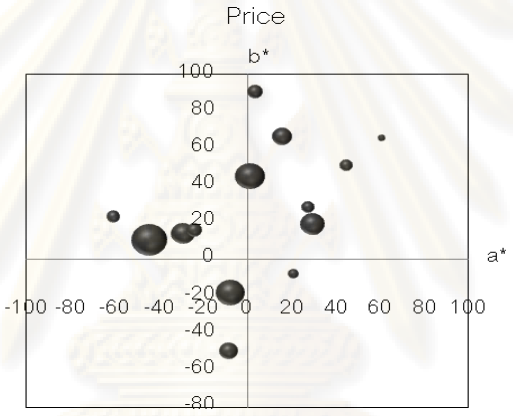

Figure B-23 Relationship between corporate image sensation in graphic arts industry of price and CIELAB a*b*.

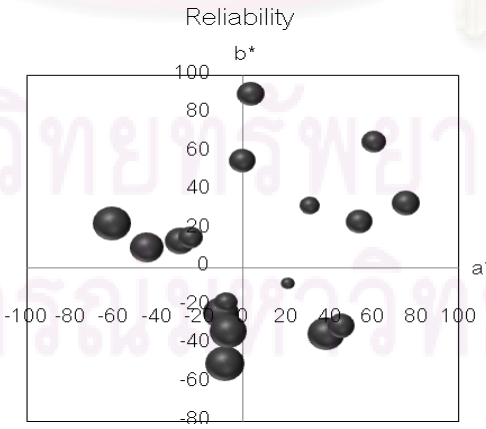

Figure B-24 Relationship between corporate image sensation in graphic arts industry of reliability and CIELAB a*b*.

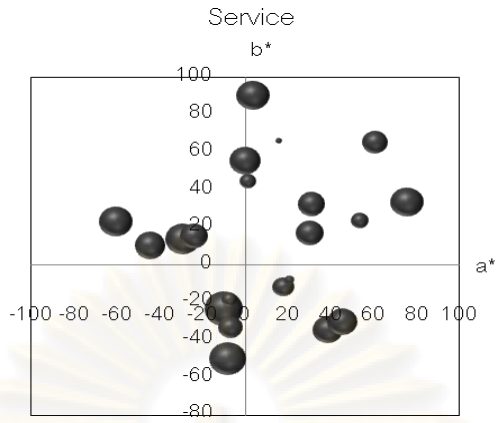

Figure B-25 Relationship between corporate image sensation in graphic arts industry of service and CIELAB a*b*.

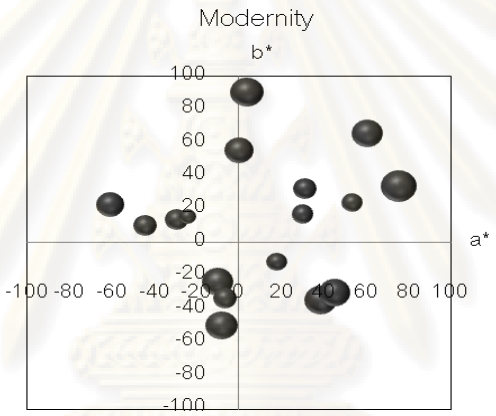

Figure B-26 Relationship between corporate image sensation in graphic arts industry of modernity and CIELAB a*b*.

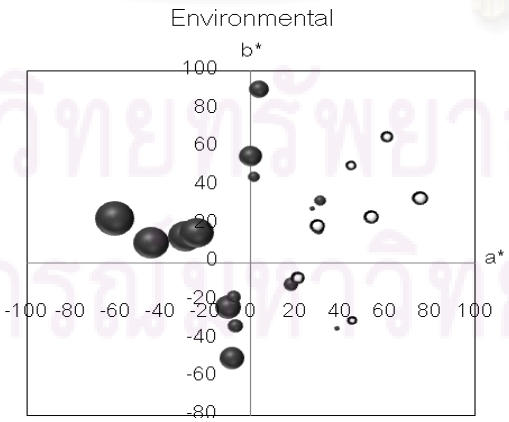

Figure B-27 Relationship between corporate image sensation in graphic arts industry of environmental and CIELAB a*b*.

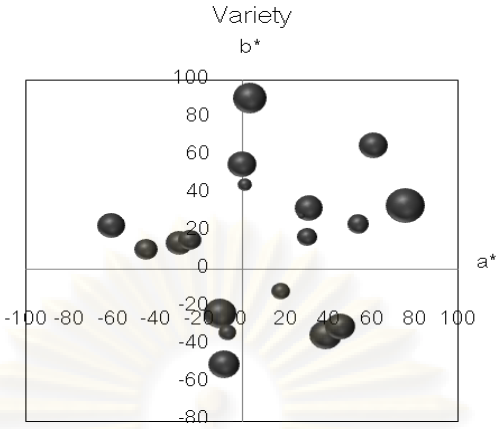

Figure B-28 Relationship between corporate image sensation in graphic arts industry of variety and CIELAB a*b*.

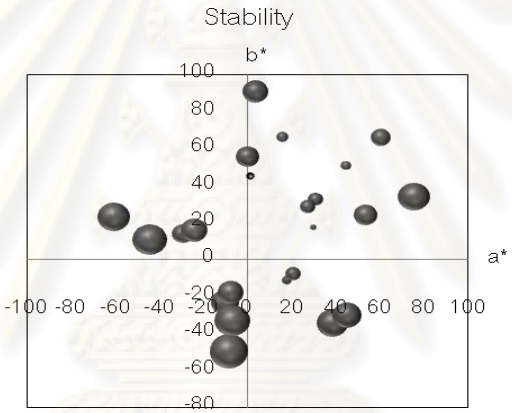

Figure B-29 Relationship between corporate image sensation in graphic arts industry of stability and CIELAB a*b*.

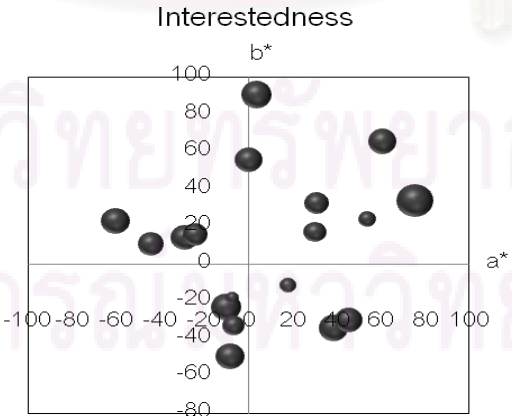

Figure B-30 Relationship between corporate image sensation in graphic arts industry of interestedness and CIELAB a*b*.

VITA

Panom Vikairungrod was born on May 25, 1981 in Bangkok, Thailand. He received his Bachelor degree in Printing Technology from the Faculty of Agricultural Engineering and Technology, Rajamangala Institute of Technology in 2002, and he has been a graduate student in the Imaging Technology Program, Graduate school, Chulalongkorn University since 2006.