Colours Convey Lanna Identity in Lamphun and Chiang Mai Area

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Abstract. Colour control is a specific tool to identify local environment. Especially in the historic area or conservation area, to promote colour control is very necessary. Therefore, there are many standards of colour to control such as Munsell, colour name, and L*a*b*. This research is aimed to analyze the appropriate colour control by using a Munsell standard colour which is suitable to visual perception. The study area is scoped in northern region of Lanna culture in Thailand which nowadays used names of colours to control. Chiang Mai and Lamphun are selected to be case study because they are in a center of Lanna Empire of Thailand and have many historic significant things such as city wall, temple, monastery, palace, and city moat. The mainly procedure conducts in this article is based on the analysis of material colour. The study chose local natural materials which are used in the historic significant things. Earthen clay tile, wooden roof tile, burnt clay brick, laterites, hard wood, bamboo, silver, and gold are evaluated. The procedure used the DIC application of android processor on smart phone. This application has a conversion data to switch a colour value from pick-up point in photo to many colour values such as RGB, CMYK which Munsell value is included. The photos were taken within the historic area of Chiang Mai and Lamphun by random. The result can scope a range of colours of Munsell standard of natural colour (N), red (R), yellow (Y), and yellow-red (YR). A natural colour (N) can be suggested a range 1.0-9.0 (N 1.0-9.0). Red can be ranged the value between 3.0-7.0 and chroma between 3.0-9.0 (R 3.0-7.0/3.0-9.0). Yellow can be ranged the value between 6.0-9.0 and chroma between 4.0-12.0 (Y 6.0-9.0/4.0-12.0). Yellow-red can be ranged the value between 2.0-8.0 and chroma between 2.0-11.0 (YR 2.0-8.0/2.0-11.0). The results can be revealed a process of colour analysis of historic colour control and may offer to be an ordinance in further.

1. Introduction
Colours can convey region, mostly natural colours found in materials such as brick, rock, soil or hard wood in that area. These materials lead to the analysis of architectural creation, which mean colours can reveal the characters and surroundings. But colours on the materials could be different due to many factors, components, processes or time and usages. The colours on architectural works can make the colours recognition in local people and outsiders about tradition, types and region.

In the northern area of Thailand, it is obvious that Lanna culture had created many cultural products especially the unique architectures. The area which Lanna culture can easily be found in communities and architectures are Lamphun and Chiang Mai. They are promoted and conserved in many interesting ways such as the usage of the architectural format and component, materials and colours are from nature.
So, the information about colours from the natural materials collected in Lamphun and Chiang Mai can provide the basic information series about colours and materials which could reflect the Lanna architecture, and can also fulfil the information about colours and materials to control colours and conserve the cultural identity buildings.

2. Literature Review

2.1 Colour recognition and Colour selection are related to experiences and surroundings.

Gestalt, the psychologist, said that the harmony was like the center that could create the recognition and understanding which conform in the same way and lead the recognition to connect with senses [1], for example, to conjecture the material’s weight by colours or using colours to indicate the volume and temperature of the materials. The recognition results the various types of usage of colour.

The constancy of colour recognition depends on each person’s experience which comes from the memories in the past related to the familiar of the colours. So that the colour influences of the surroundings impact the constant of colour and brightness. The colours also impact the physical traits of the architecture which affects the recognition and remembrance directly [2]. So, the colours in architectures and surroundings reflect the beauty, substance, attitude, history and traditional value.

Colours found in architectures are from natural and synthesis materials. These colours are some kind of stimulation which can cause the sight attraction from the people who see them and it’s also effect the beauty and identity of the architecture and surrounding [3] which leads to the acknowledgement and acceptance of types of architectures, materials and regions.

Some parts of architecture which is easy to acknowledge is partition and roof because they are easy to see from the outside. The appearance of colours can indicate the importance of culture, social; economy and resource in that area and connect to the recognitions and activities also [4]. The colours from the attachment and colours in the architectures are related to the local cultures such as rocks, bricks or hard wood.

Because colours are the international languages, colours are used to show the connection of emotions and impressions in architectures and also reflect the abundance of resources and the identity of the regions. The use of colours is accepted in socials and communities. Those share the recognitions. The use of colours is influenced by traditions, cultures, religions, politics, geography, preferences and level of educations [1].

The expression of concrete identity can also use colours to push on and create the recognition in the same direction as in many type architectures, locals or contemporary. There can be a co-character by using the same natural materials and colours. Most of Thai architectures are related to the lifestyles that collaborate with natures which indicate the individuality under the local architecture, traditional architecture and Vernacular architecture that lead to the creation of contemporary Thai architecture [5].

2.2 The principle of Munsell colours system

Hue is the elements of colours weight are different based on the colour strips, red, yellow, green, blue and purple which are main colours. When these main colours are combined with the adjacent colours, they will create 10 more colours which are Red (R), Red Yellow (RY), Yellow (Y), Green Yellow (GY), Green (G), Blue Green (BG), Blue (B), Purple Blue (PB), Purple (P) and Purple Red (PR). In the colours cycle, there will be a rank of colours in numbers, 2.5, 5, 7.5, 10, and the outside of the cycle are divided into number 1-100 for telling colours range. These will create more specific relations of colours [6].

In case of the colour which is similar to one or more colour such as burgundy red, maroon red and pink, these colours have similar hue, even if they are different colours. Furthermore, in case that some colours which is achromatic, white, grey and black, they still have the hue to divide the weight of colours. So, the principle of hue is used to divide colours into chromatic and achromatic colours [1].

Chroma or the saturation is used to refer the intensity, brightness or colour which can specify the quality of colours by divided the highest colours intensity, for example, to divide the burgundy red and the bright red into two colours which have the same hue but different intensity. This shows that they have different chroma. The examples of Munsell colours system such as the pink which is read at 5R
8/4 means this colour has hue at 5R, value at 8 and chroma at /4. In the research about colours, there are a lot of references about Munsell colours system which can be used to create group of colours for harmony creation in architectures by using tools and technologies to measure and convert colours into Munsell system. Raksawin (2015) [7] has said about the data collection tools about colours to conserve the physical traits of Chiang Mai such as app DIC and Adobe Photoshop program can be used to compile the colours in architectures to analyze and define the standard score which is harmonious with the former architectures under the condition that the original photos must have no shadows in order to analyze the most realistic colours and brightness.

3. Methodology

The study area is in Chiang Mai and Lamphun, Thailand. Colours from the materials which show Lanna identity located at the pagodas, house, row building, or walls of houses. The photos are divided to roof parts and building’s wall parts. The materials of roof parts are earthware and wooden roof tile and in the building’s wall parts are red brick, laterite, mortar wall, bamboo, hard wood, gold and silver.

The tool that used to analyze colour is DIC application of IOS which provides the Munsell System. The procedure starts by taking photos via DIC application and pick a colour in the area of material and component, then, obtains a Munsell values.

4. Results

The real value of the material colours was gathered from the material itself. The colours changing turned up from the usage which can be recognized by vision and the identity can be understood through the value of the material colours.

4.1 The roof parts

There are 2 types of materials which have the results as followings.

4.1.1 Clay roof tiles

This earthenware is divided to normal earthenware and coated earthenware which are made by the local industries and also matched with the Lanna buildings both inside and outside the city and can easily be found in Lamphun and Chiang Mai. According to the sample photos of Figure 1, there are 3 different types of roofs which make 9 different groups of colours toned from the orange to brown. The result from Table 1 reveals that most colours of the earthenware roofs are in the YR (Yellow Red) group which is the materials real colour and some are in the R (Red) group which has a small error but still acceptable and some are in the PR (Purple Red) group which has more error because the data is collected from the material which has a moss on its surface. This group is not included to the colours value.

4.1.2 Wooden roof tiles

Besides the clay roof tiles, there are also wooden roof tiles in the architectures in the northern area because they are easy to find in the past but they must be retained along with good quality woods. Nowadays, this type of roof tile is rarely to find because they are expensive. The appearance of wooden roof tile which is made from overlapped wood make them perfectly matched the Lanna surroundings as shown in Figure 2. From table 2, it is found that wooden roof tile has various colour value range such as YR (Yellow Red) and R (Red) which are materials real colour and also N (non-colour) which is the shade of materials that transformed through the time. The colours in RP (Red Purple), P (Purple) and PB (Purple Blue) group are the colours that distorted from the real colours by the moss on the roof and also a reflective light while taking photos.

4.2 Building’s wall part

The colours value is collected from burnt clay bricks, laterites, mortar wall, hard wood walls, bamboo walls, Django gold, and silver. The colours can be grouped by the materials into 7 groups with 75 colours.
4.2.1 Burnt clay brick
Burnt clay brick walls are commonly found in Lanna architectures because bricks are the materials that can be made in the local area, durable and can easily be placed into many shapes. The photos can be grouped to 9 colours, mostly brown and grey shown in Figure 3. The Munsell system shows that most of the bricks are in YR (Yellow Red) group and some are in R (Red) group. From the tendency in Table 3, it can be convinced that they are both real colours and the error colours causes by the moss which make the colours turn to PB (Purple Blue) group.

4.2.2 Laterite
Laterite is a natural material which has unique surface and colour. These architectures mostly are religious places as in Figure 4. According to the photo, the colours of the walls are brown and grey and can be converted in Munsell system as in Table 4. It is found that laterite colour is in the YR (Yellow Red) group which can be acceptable to be a real colour. In addition, some of the laterite colour is in R (Red) group which is also acceptable. But the table showed a colour in PB (Purple Blue) group which caused by the stain, it is not the real colour of the materials.

4.2.3 Mortar wall
This type of wall was lime mix with cement and glazed on the structure surface. Mostly used as a building walls or barricades those need to be strong and elegant such as temples, fences or residences (Figure 5). This kind of wall has a white-clean surface, but when the time passed it turned to various colours. Table 5 shows the Munsell colours in shades of light grey to dark grey and brown. Passing time makes colour of mortar wall changed to various colours which are in YR (Yellow Red), N (non-colour) and R (Red).

4.2.4 Bamboo
Bamboo is a plant that easily found in every area, so bamboo is used in various ways including Lanna architectures such as friction-tight rope house which bamboo is the only material used. Friction-tight rope house is likely to be the prototype for creating Kalare house which is the identity of Lanna architectures. Furthermore, bamboo is also found as part of other architectural components such as walls or fences as in Figure 6. The colours are various due to the usability through the time. These colours can be converted to Munsell system as in Table 6. The result from the bamboo colours shows that most of the colours are in YR (Yellow Red) group which is the material real colour, some are in R (Red) group which can also be acceptable because the colours is resemble to the YR group. Other than that, there are also the colours in RP (red Purple) group on the materials, but these colours are from dust stain, not the real colour of the materials.

4.2.5 Hard wood
Hard wood is the most popular used materials to construct the domicile because it is easily found in the local area. Moreover, hard wood is also durable and flexible materials which suit the tropical climate. Hard wood in Lanna architectures has been developed to be the identity in many kind of craftsmanship with beauty and value. Figure 7 shows the images of hard wood residences in Chiang Mai and Lamphun which are the whole wooden constructed and the mixed wooden constructed with other materials. The colours collected from the residences are in brown tone. These colours can be converted to Munsell system as in Table 7. The colours found in hard wood are mostly in R (Red) and YR (Yellow Red) group which are the materials real colours. N (non-colour) is also found by the change of materials colour through the time which can be accepted. In addition, the colours in P (Purple) group can also be found. This group of colours is the error colours caused by the reflecting light on the surface.

4.2.6 Django gold (thin golden sheets)
Django gold is not usually found in residential architectures. It is mostly used in religious places such as pagodas, vihara and monastery to represent the religious worth, value and faith. The metal material
which is usually used in the Lanna architectures is the thin golden sheets. They are used to cover the pagoda surface or be the part of the decorations (Figure 8). The colours can be converted to Munsell system as in Table 8. It shows that colours of the thin golden sheets are in Y (Yellow) group. The minority is in YR (Yellow Red) group which is similarly to be accepted.

4.2.7 Silver
One more material which is usually found in Lanna architectures is silver. It is used as the components of the architectures of walls and the decorations of vihara and monastery as shown in Figure 9. In Table 9 shows the value of colours is mostly in N (Non- colour) group which is the real colour of silver. The colour in PB (Purple Blue) turns up which is the result of light reflected on the surface occurred while taking the photos. The colour reflection of the surroundings on the shiny surface of silver could cause the apparent of R (Red) group.

### Table 1 Munsell value of clay roof tile

| Material          | Hue Value | Chroma Value | Hue Value | Chroma Value | Hue Value | Chroma Value |
|-------------------|-----------|--------------|-----------|--------------|-----------|--------------|
| Clay roof tile    | 3.3-8.5   | 1.7-6.3      | 6.4-6.5   | 2.3-6.0      | 5.4       | 1.0          |

### Table 2. Munsell value of wooden roof tile

| Material | Hue Value | Chroma Value | Hue Value | Chroma Value | Hue Value | Chroma Value |
|----------|-----------|--------------|-----------|--------------|-----------|--------------|
| wood     | 6.1-7.2   | 1.2-2.9      | 7.5       | 2.4          | 5.4       | 1.0          |

### Table 3. Munsell value of burnt clay brick

| Material | Hue Value | Chroma Value | Hue Value | Chroma Value | Hue Value | Chroma Value |
|----------|-----------|--------------|-----------|--------------|-----------|--------------|
| wood     | 6.1-7.2   | 1.2-2.9      | 7.5       | 2.4          | 5.4       | 1.0          |

**Figure 1.** Clay roof tile

**Figure 2.** Wooden roof tile

**Figure 3.** Burnt clay brick
Table 3. Munsell colour of burnt clay brick

| Hue | YR | Value | Chroma | R | Value | Chroma | PB | Value | Chroma |
|-----|-----|-------|--------|---|-------|--------|----|-------|--------|
| Burnt clay brick | 2.0-6.8 | 1.1-7.8 | 4.1-6.4 | 4.2-6.0 | 3.4 | 0.7 |

Figure 4. Laterite

Table 4. Munsell colour of laterite

| Hue | YR | Value | Chroma | R | Value | Chroma | PB | Value | Chroma |
|-----|-----|-------|--------|---|-------|--------|----|-------|--------|
| Laterites | 3.3-5.4 | 1.5-5.2 | 3.9 | 4.3 | 3.2 | 1.4 |

Figure 5. Mortar wall

Table 5. Munsell colour of mortar wall

| Hue | YR | Value | Chroma | R | Value | Chroma | PB | Value | Chroma | N | Value |
|-----|-----|-------|--------|---|-------|--------|----|-------|--------|---|-------|
| Mortar wall | 3.9-6.6 | 1.5-3.8 | 5.1-6.1 | 1.4-2.2 | 4.6-8.3 | 0.7-2.2 | 1.9-7.6 |

Figure 6. Bamboo
**Table 6. Munsell of bamboo**

| Material | Hue | YR  | Chroma | R  | Chroma | RP  | Chroma |
|----------|-----|-----|--------|----|--------|-----|--------|
| bamboo   |     | 2.1-7.9 | 1.2-5.1 | 5.2 | 2.1    | 2.7-3.4 | 1.8-2.2 |

**Figure 7. Hard wood**

**Table 7. Munsell colour of hard wood**

| Material | Hue | YR  | Chroma | R  | Chroma | P  | Chroma | N  |
|----------|-----|-----|--------|----|--------|----|--------|----|
| wood     |     | 3.1-6.9 | 1.7-6.8 | 2.3-6.5 | 2.4-9.0 | 2.2 | 2.6    | 0.8 |

**Figure 8. Django gold**

**Table 8. Munsell colour of Django gold**

| Material | Hue | Y  | Chroma | YR  | Chroma |
|----------|-----|----|--------|-----|--------|
| Django gold |     | 5.5-9.2 | 3.8-12.5 | 4.6 | 11.2 |

**Figure 9. Silver**

**Table 9. Munsell of silver**

| Material | Hue | R  | Chroma | PB  | Chroma | N  | Chroma |
|----------|-----|----|--------|-----|--------|----|--------|
| silver   |     | 4.3 | 1.8    | 4.0-8.9 | 1.1-2.2 | 3.9-7.9 |
5. Discussions
The information from the colours gathered shows the different kind of results regards the natural materials including the traces from the usage. Only Hue in the group Y (Yellow), YR (Yellow Red), R (Red) and N is used in the analysis. They are the real colours of materials. Value and chroma of each material are also recorded. The other colours caused by stains, lichen or moss occurred along with time or the colours from the reflecting lights are not included to the analysis. These research information leads to find out the basic information of colours in Lanna architecture.

The colours in Munsell system are divided into hue, value and chroma by the materials, clay roof tiles, wooden roof tiles, burnt clay brick, laterites, mortar wall, bamboo, Django gold, and silver, as shown in Table 10.

Table 10. Munsell colours of Lanna material

| Material            | Y Value | Y Chroma | YR Value | YR Chroma | R Value | R Chroma | N Value |
|---------------------|---------|----------|----------|-----------|---------|----------|---------|
| Clay roof tile      | 3.3-8.5 | 1.7-6.3  | 6.4-6.5  | 2.3-6.0   | -       |          |         |
| Wooden roof tile    | 6.1-7.2 | 1.2-2.9  | 7.5      | 2.4       | 5.3-9.4 |          |         |
| Burnt clay brick    | 2.0-6.8 | 1.1-7.8  | 4.1-6.4  | 4.2-6.0   | -       |          |         |
| Laterites           | 3.3-5.4 | 1.5-5.2  | 3.9      | 4.3       | -       |          |         |
| Mortar              | 3.9-6.6 | 1.5-3.8  | 5.1-6.1  | 1.4-2.2   | 1.9-7.6 |          |         |
| Bamboo              | 2.1-7.9 | 1.2-5.1  | 5.2      | 2.1       | -       |          |         |
| Hard wood           | 3.1-6.9 | 1.7-6.8  | 2.3-6.5  | 2.4-9.0   | 0.8     |          |         |
| Django gold         | 5.5-9.2 | 3.8-12.5 | 4.6      | 11.2      | -       | -        |         |
| Silver              | -       | -        | -        | -         | -       | 3.9-7.9  |         |

6. Conclusions
The information is collected from the materials which are really used, these make the colours appear in many shades depends on materials and time. The apparent colours are the basic information which can be used for repair and conserve Lanna architectures to get the closest colours to the original materials and can also be applied with the architectures that need colours to represent the Lanna identity in Lamphun and Chiang Mai.

The result in Table 10 shows that hue, value, and chroma of 4 main colours which are Y, YR, R, and N. To suggest to the regulations or the recommendation to control an appearance of colours in Lamphun and Chiang Mai old city, it can be suggested as followings: Y 5-9/4-12, YR 4/not exceed 5, R 5/ not exceed 6, N not lower than 2.

References
[1] Mahnke FH. Colour, Environment, and Human Response. Canada: John Wilay & Sons, Inc.; 1996.
[2] Robador DM, Albardoneda A., Perez-Rodriguez LJ. Evolution Study of Colours throughout the History of Facades of the Royal Ordinance Factory of Seville. Procedia Engineering. 2016; 161: 1678-1682.
[3] Thomas D. Architecture and the Urban Environment. Great Britain: Architectural Press; 2002.
[4] Porter T. Architecture Colour a Design Guide to Using Colour on Building. New York: Watson-Guptill Publication; 1985.
[5] Tzonis A, Lefaivre L. Critical Regionalism: Architecture and Identity in a Globalized World. New York: Prestel; 2003.
[6] Kuehni GR. The early development of the Munsell system. Colour Research and Application. 2002; 27: 20-24.
[7] Raksawin K. Building Colour for environmental conservation of Thapae area. Chiang Mai: Faculty of Architecture, Chiang Mai University; 2015.