The Design of Space based on Architectural Geometry

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Keywords: Expressional space; geometry architecture; pure geometry; composition of geometry; mural art; skateboard; space form.

Abstract: Aim of expressional space is to facilitate the public to explore their hobby and talent autodidactically. The space for expression in Makassar City is necessary for mural artists and youngsters who have a hobby to play skateboard. Their talent receives insufficient attention from the government, thus creating negative attitude because there is no space to accommodate their activity. Therefore, this paper presents a design idea of expressional space by implementing architectural geometry. The architectural geometry design principle is based on simple geometry form application as a realization of form from the space. An experience of the space for the user is realized by the relationship between the space and the interaction with the environment through geometry and form processing as the basic of the creation process in the architectural works. Content analysis method provides a landscape layout and transformation of form and building mass in form of the implementation of architectural geometry principles. The principles are pure geometry, composition of geometry, direction wall, and opening for the transformation process of expressional space form to produce and increase aesthetic value of the environment.

1 INTRODUCTION

The definition of architecture, based on the book of Hybrid Space, is "*The art or science of building, specifically, the art or practice of designing structures, especially inhabitable ones*". This definition sharply defines the architecture as an art. An art definitely addresses something in aesthetic value. Kimberly Elam expresses "*Architecture has some of the strongest educational ties to geometric organization because of the necessity for order and efficiency in construction, and the desire to create aesthetically pleasing structures*". She explained that the architecture has a strong relationship with geometry. One of the connections between architecture and geometry is aesthetic value. Therefore, obviously more services in architecture, such as building architectural service, landscape architecture, the city architect, and etc., are popular nowadays.

According to the definition, geometry is one of elements to present an aesthetic value in architectural works. In fact, in order to create aesthetic value, the architecture work should follow the geometry principles. This principle will define the result of the architecture form. One of the examples in geometry principles is the golden section.

A roman architect, Marcus Vitruvius, explained that the developer must always practice the precise ratio in the development of a temple, he stated "*for without symmetry and proportion, no temple can have a regular plan*". Every existing temple at that time must practice the golden section. As a result, the form of most temples at that time were fairly similar and standard. According to the limitation of the golden section, there is a creative ideas limitation on the architects and architecture diversity at that time.

"*The purpose of geometry of design is not to quantify aesthetics through geometry, but rather to reveal visual relationships that have foundations in the essential qualities of life, such as proportion and growth patterns as well as mathematics. Its purpose is to lend insight into the design process and to give visual coherence to design through visual structure. It is through this insight that the artist or designer may find worth and value for themselves and their own work*". Description from Kimberly Elam on the

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geometry function has explained that geometry has relevant function to express the visual relationship of an object based on its proportion and also the development pattern of the object.

The geometry function is practiced on the building architecture. If the painting and the building have no geometry principles then the building is considered to not have aesthetic value at that time. However, there are a lot of paintings and forms without geometry norm and those works may still be categorized as an aesthetic works. Obviously, the geometry rules in a design would limit the result of design variation. Other than as visualization relationship and a proportion of an object, geometry has a function as a norm to present a size in a building and shape.

Geometry is one of mathematics sciences that is implemented in the architectural world and one of the branches of science that is associated with size, composition, and proportion. One chapter in the essay of Dr. Joachil Langhein has stated that "*Proportion as a guiding pattern for establishing beauty*." Moreover, the proportion has a close relationship with geometry, even non-geometry procedure possibly presents a proportion. The proportion in a geometry is related to symmetry that controls axis reflection, rotation, stretching, and etc. The geometry presents because of proportion and building symmetry. A geometry with symmetrical element provides a beauty in a building. According to Mangunwijaya definition, "*Beauty is a matter of subjective. A culture of humanity will define the standard of a beauty based on their community (Dayak and Buginese ethnic group probably will have a different understanding in the definition of beauty)*". Their definition of beauty will be passed down through generations and create a specific 'beauty' mindset. Architectural aesthetic of traditional building is one of the origins of the culture.

Mangunwijaya has interpreted that a beauty is from a cultural, traditional building. Additionally, more definitions of freedom of expression in the context of geometry are: Every people who follows design processing will present a different product, even if they have an equal trigger. A diversity that exists in respective products is one of illustrative examples in term of 'freedom of expression'. This freedom refers to an understanding where geometry does not limit freedom of expression in architecture. This definition draws a conclusion which stated that geometry principle in a design could restrict the result of a design variation. This understanding has changed along with the exploration of form, function, and various expressions of architecture with the application of geometry.

Finally, we will return to the basic of architecture. Mangunwijaya, in the book of Wastu Citra, has written: "Berarsitektur *or how to make an architecture is a language in terms of space and aspect or* gatra*, along with line, plane, material, and ambiance. We should create a proper architecture according to the culture, accompanying the feelings and responsibility in the application of a proper architectural language*." A beauty in architecture is architecture that is aware of the value-in-use, following the aesthetic value as spiritual level inside the design. The result is not only a product that is placed as "a statue", but the result is also something that should provide an investigation on a meaning or three dimensions (or even four dimensions). Geometry never limits the expression in an aesthetic. In fact, geometry offers a freedom in the language of space, line, and plane.

Briefly, geometry will present a beauty in architectural art, either in form of place or ornament and symbol. Geometry can represent an expression in a space. A difference in respective space function is frequently explained with a different expression. In other words, the function will produce an expressional form. Generally, the expressional space is an accessible public area for all society. The public area is part of an environment completed by a pattern and function as a socialization and communication area in the society. Principally, the public area will be defined as a place to facilitate specific activity or interest for the people either individually or in the community.

The existences of expressional space have an influence on the economic development and social conflict that occur between young people because the expressional space becomes a facility to express their interest and individual skill. Examples of hobby activities are skateboarding and mural painting. Skateboarding and mural painting are activities that heavily consume more physical and mental energy. These activities become popular activities in metropolitan cities in Indonesia, including Makassar.

Based on this phenomenon, an idea was hit upon to create an open space to facilitate skateboarding and mural community in Makassar to limit the problems of street dysfunction and vandalism of public facilities on some streets in Makassar. The design of the public area is expected to become a space for skateboarding community to express their hobby. Additionally, mural community will have benefit too. They can exhibit and sell their artworks. Moreover, the result may bring an increase in creative economy

sector for youngsters in Makassar. Furthermore, the aim of the design will welcome the existences of skateboarding and mural community in Makassar and these communities can socialize with the society. As an open space to facilitate sport and art community, then the inspiration of space concept is architectural geometry concept that emphasizes the space aesthetic art.

The other side of geometry is the order in geometry creation. People tend to produce a set of rules in their lives. Architecture is a facility to meet the needs of life and to require the application of an order. The form creation cannot be separated from the regular forms. The geometric shapes appear to reinforce the impression of space and to create an interior in geometry.

2 METHODS

The research method is site observation data about a potential condition and land suitability for arts and sports area. Then, the data are processed by content analysis method. Content analysis approach conducted in this study will realize the result of the design with architectural geometry application. Fundamental concept in 'image' design of expressional space for mural art and skateboarding refers to object-oriented geometry form. Therefore, the design concept may be categorized into architectural geometry approach method, specifically pure geometry; the composition of geometry; direction wall; and opening. During the design process, the fundamental concept is combined with the planning of geometry calculation with symmetry principle. Architectural geometry principle emphasizes building aesthetic and high-quality of the environment. As a result, the design creates a building mass forms, correlates environment potency, and solves the landscape problem.

The analysis in design approach is to identify the architecture component of geometry, including:

a) Geometry principles include an explicit composition of geometry form which is the pure geometry forms: square, rectangle, circle, and triangle.
b) The composition of geometry. A shape of geometry is not absolute. Therefore, the form is part of the transformation process, a form transformation may be understood as a result of variance from existing basic form manipulation.
c) Direction wall consists of wall to cover a space and building. Sometimes the wall may refer to a building envelope. The wall is one of important elements to present a form of a building. The wall visual is dominant rather than the element of floor and roof plane as part of the building envelope.
d) The opening. There is a close relationship between the opening and the wall. The visual space quality is certainly determined by the opening. For example, the wall opening organization will produce a reflection of illuminance. Generally, the opening will frame and receive the landscape view enjoyment from the interior area, as part of indoor and outdoor confrontation. The opening may be identified as a large opening. The large opening is a result of size reduction of form, or vertical opening, of the building mass volume. It is also an opening from the interval between every wall surface.

Early design concept determines transformation theme definition that will be applied in the building design. Figure 5 describes the correlation between definition and application of building theme.

a) Appearance

Appearance definition approach of the building will exist in the building facade. The form completed by presenting the theme is geometry form, which describes a beauty in architectural art, either in form of place or ornament and symbol, and contains the concept of balance, rhythm, vocal point, scale, and building integration.

b) Well-Defined

The building should have a well-defined space organization. Design finishing process is area division which is according to space function, commercial area, and facility area; organization of space division area is based on characteristic and space feature.

c) Opening

Approach of the open definition in the building will be manifested in building interior, space organization, and building facade. Open/transparent design of most interiors apply natural air ventilation and glass material for natural lighting in interior shading art.

3 RESULTS

3.1 Landscape Layout Transformation Based on Architectural Geometry Principles

The landscape layout transformation is needed to get a good view

3.1.1 Pure Geometry

The site pattern was created from the combination of pure geometry shapes, such as square, rectangle, circle, and triangle. Each pure geometry shape will be synchronized with the function of the facilitated activity. The square shape represents the supporting facility area and mural area. The rectangle shape represents skateboarding area, field, Bosowa sport centre, and management office. The circle represents a rounded green area and fountain spot. The triangle represents the triangular park area, parking area, and mural area. The shape of pure geometry was organized carefully to create and improve the aesthetic value of the site plan. The combination result of pure geometry shapes, such as square rectangle, circle, and triangle, is described in Figure 1.

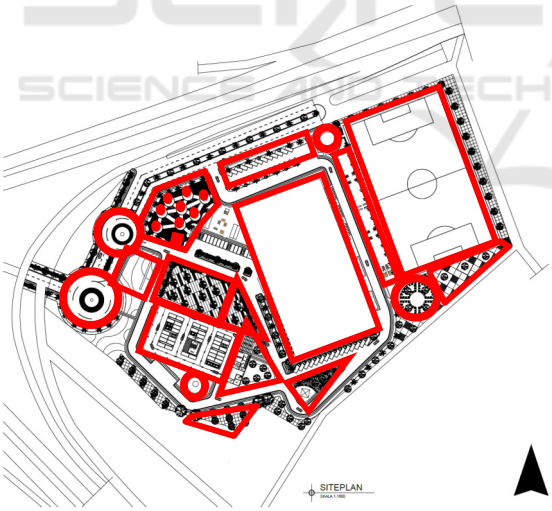

Figure 1. Combination of pure geometry shapes, square, rectangle, circle, and triangle is a basic of site plan layout pattern formation for expressional space.

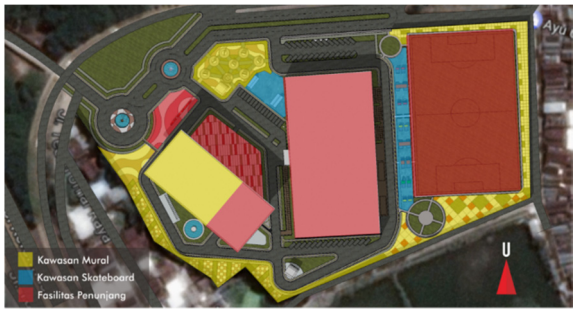

Figure 2. Allocation of space function based on activity types in the area.

Figure 3. Realization of expressional space with the application of pure geometry shapes element.

3.1.2 Geometry composition

As described in Figure 1 and Figure 2, there is a form transformation which is a result variances of existing basic shapes manipulation, such as the combination of rectangle and triangle shape and the combination of square and triangle shape. The processes of basic form manipulation can be seen on figure 4 below:

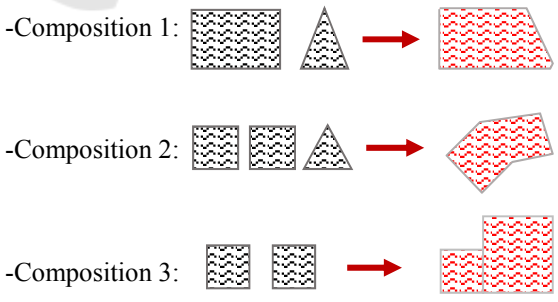

Figure 4. The processes of basic form manipulation.

There is a complex form composition in the site plan design of the front of mural area entrance. The composition shapes are square, triangle, circle, and rectangle that create a pure geometry form. In

addition, there is a separate part of pure geometry form, but the form has been transformed.

Figure 5. Mural area perspective

3.2 Transformation of Form and Building Mass Based on The Architectural Geometry Principles

3.2.1 Pure Geometry

There are mass buildings in the site plan design, a sport center, and skateboarding area. These areas are supported with infrastructures, such as management office, cafeteria, musalla, and other infrastructures. The building shape consists of rectangle and circle as the basic form, based on the skateboard form which is distorted into the main building form idea in the site plan design. Additionally, the main building facade has implemented geometry pattern to strengthen the geometry concept as a design approach concentration. Geometry pattern in the facades consists of a circle, triangle, and square as the basic forms.

Figure 6. The skateboard basic form consists of rectangle and circle forms.

3.2.2 Geometry composition

The building formation is similar to a rigid box of rectangle completed with a massive wall that covers the entire building. The rectangle and circle, which are pure geometry forms, gradually has transformed and categorized as a simple transformation form. The form is a result of metaphor process from a skateboard form. Moreover, the final result of the building design adapted the traditional house of Makassar Bugis ethnic group. According to the structure, the vertical building consists of foot, body, and head. As a result, the vertical main building consists of three main parts, similar to Buginese traditional house structure, which also has three structures (foot, body, and head).

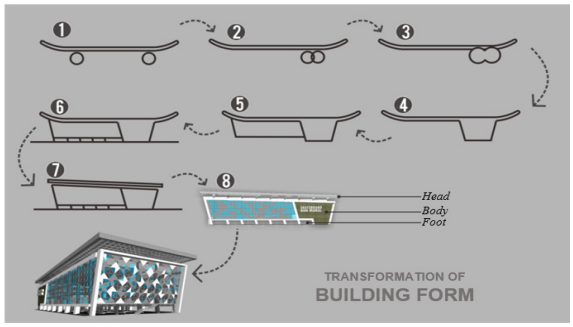

Figure 7. Transformation of building form

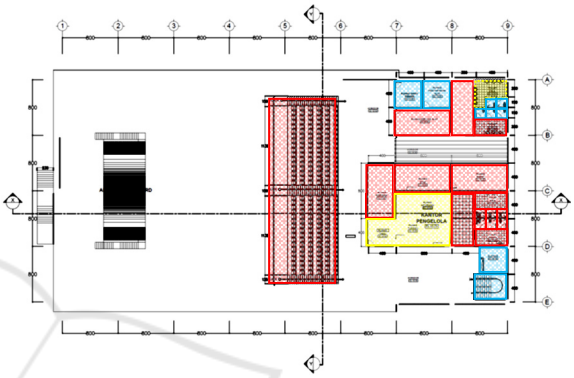

Figure 8. Main building ground plan on the second floor. Colour: Red (rectangle shape), Blue (square shape), Yellow (composition 3), Grey (building corridor).

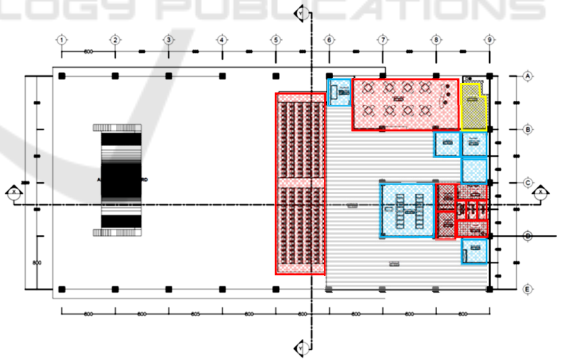

Figure 9. Main building ground plan in the third floor. Colour: Red (rectangle shape), Blue (square shape), Yellow (composition 3), Grey (building corridor).

According to the building ground plan, the square and rectangle structure is an intersection. The free-standing wall of the building is the intersection from one space to another space to create the interlocking entrance area. The free-standing wall positioning with similar pattern creates an interior room with an opening in the wall as illuminance area receiver. The

geometry composition is a simple transformation form but the composition creates a visual interaction inside and outside the building.

3.2.3 Direction wall

Basically, the function of the wall is as the cover of a space and building, and the part of building envelope. According to Tadao Ando, walls are the most basic elements of architecture. Wall is a border between the interior and exterior, but at the same time, wall can also be the most enriching element that will transform the form of a place and create a new form or new space.

Wall is an important element to present a form of a building because the wall is visually more dominant rather than the ground plane and the roof plane, which are also the building envelope element. The floor is not directly visualized because the floor area is hidden by the wall and the roof plane is usually a flat cover plane. The sport centre main building with dynamic wall positioning creates and divides the space. The wall function is as a direction wall of a movement or user circulation line in the building, although the circulation track impression is in form of straight line and fairly simpler than the building entrance towards to other rooms inside the building.

The exterior wall of sport centre building includes and covers most part of the site. The building contains glass material to support the visitor with two atmospheres simultaneously, the indoor with modern vintage ambiance and a fascinating outdoor view (a collaboration between mural art and the park). The glass material is from geometry pattern with triangle and square form combination.

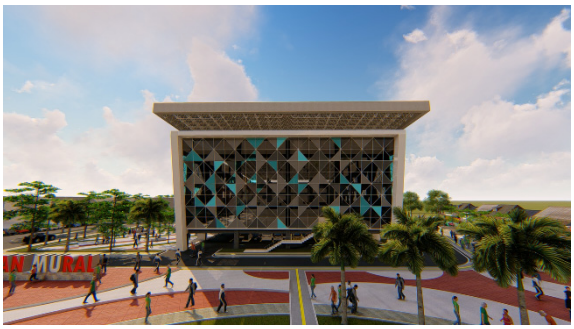

Figure 10. Geometry pattern in the exterior wall

3.2.4 Opening

The opening and wall in the main building design of sport centre are two closely interrelated parts because the quality of visualization room is exactly determined by the opening. The opening becomes the part that organizes the wall panel to create illumination possibility in natural ways. Most of the openings are to frame and receive the landscape view in order to enjoy it from the interior room and also as an indoor and outdoor confrontation. Indoor expressional space is an opening in form of a vertical and large opening in building mass volume and an opening from the interval of the wall surface.

The third floor has an opening in the wall panel continuously to provide a natural illumination inside the building and to improve the quality of space. These openings are located on every side of the building. This is one of the efforts to gain a benefit of landscape condition around the building as supporting aesthetic element from inside the building. In addition, the second floor has a touch of glass material opening to include the illumination element as a lighting in the transition area from inside to the outside, or vertical opening. The second-floor opening will frame and present a vista, such as park and mural art display, as a technique to combine the inside and outside of the vertical opening. A patterned-glass material creates a reflection with geometry forms.

Figure 11. Opening in the main building. *Number: 1 (Opening on the third floor), 2 (Opening of the second-floor building with a patterned-glass material)*

4 DISCUSSION

The site pattern design practiced the basic principles of geometric architecture. The implementation is gradually from the shape of pure

geometry covering triangle, square, rectangle, and circle. The basic form was transformed into a new pattern and the transformation process is categorized as a simple transformation form.

Basically, the site plan area has three functional area categories, skateboarding attraction area, mural area, and infrastructure for skateboarding and mural areas. Skateboarding attraction area is indicated by a blue color in Figure 2 and located on two different areas, which are on both sides of the main building of Bosowa sport centre. The mural works exhibition display is located in the main street of site plan area. A decision of skateboarding attraction area location is based on the accessibility reason, creating an accessibility for the visitor. Consequently, the skateboarding area is located in the parking area as the strategic area. Meanwhile, the mural area is located in two different areas which are along the site border in form of a high wall. The wall functioned as mural media and another area is located right in the entry point of the site. As a result, the visitor who enters the site will directly experience mural art atmosphere emphasizing the architectural geometry principles in expressing an aesthetic value.

In the main building, geometric shape is visible on the building's facade with a patterned-glass material. The pattern comes from triangular and square shapes with color degradation that aims to produce shadow geometric pattern which is dynamic with the movement of the sun. Meanwhile, the covering wall of space in the building is simple with a grid pattern formed from the arrangement of a square and rectangular shapes to maximize the use of space for various activities.

The design should create a balance between complex form composition of art mural display and simple spatial layout patterns. Although the geometry form is applied quite simply, but the application of architectural geometry principle emphasizes building aesthetic and high-quality of the environment.

5 CONCLUSIONS

Geometry form will generate an aesthetic architecture art, either in form of space or ornament. Geometry can represent an expression in a space. Geometry will produce an expressive form. The geometry design principles -in form of pure geometry, a composition of geometry, direction wall and opening- are a representative form that is explained in expressional space design. The design idea is an architecture works that combine basic form variations: square, circle, rectangle, and triangle. These forms are carefully organized to create and improve the aesthetic value of the area. The presentation of geometry form is fairly simple but has a variation. As a result, the creation of circulation pathway is simple. The circulation track is created by the direction wall. The application of simple geometry form is an effort to maximize the space as an area for skateboarding activity inside the building. Moreover, most of the opening building parts are vertical opening with a standard of user eye level. Patterned-glass material opening produces a harmonic geometric shadow formation.

ACKNOWLEDGEMENTS

Geometry will always exist in architecture in a variety of building angles. Either the application of the floor plan or the building facade, in two dimensional or three dimensional, is not separated from the geometric shape, judging from the elements of the whole. The shape of this form may affect design in the architectural concept. The other side of geometry is the order of the creation. Humans tend to produce a set of rules in their lives. Architecture that is a facility to meet the needs of life is also required to apply for an order. Therefore, the forms creation cannot be separated from the regular forms.

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APPENDIX

In this appendix, we present the collected data about dimensions of the built space used for optimization of spatial distribution based on the activity proportion.

Table 1. The size of build space

No	Space Name	Size (m^2)
1	Ground Floor (Parking and Service Area)	466.57
2	1st Floor (Skateboard Arena and Management Office)	570.05
3	2nd floor (Cafeteria and Musalla)	434.33
4	Security Room	33.8
6	Site plan	3811.08
Total of built space		**5315.83**

Based on the data obtained, the number of space utilization planning area are:

- Built space of 5315.83 m²
- Planning footprint area of 39122.51 m2
- Percentage of constructed land is: 5315.83 m² / 39122.51 m2 x 100 = 13.587 m² or 14%
- Open space of 33.806 m²
- Percentage of open space : 33.806 m² / 39122.51m² x 100 = 86.410 m² or 86%

The percentage of master plan of expressional space for skateboarding and mural communities in Makassar city is 86% as the main functional area, and 14% as supporting facilities within the planning area.