BTS Tower Camouflage Products Design based on Zonation of Urban Area

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Abstract: The era of industrial revolution 4.0 which was marked by digitalization in almost all lines of human life demands the availability of supporting physical facilities and infrastructure. BTS tower (Base Transceiver Station) is one of the important components to accommodate digital activities in the industrial era 4.0. The problem that arises is that there are still negative perceptions from several parties in the community. They assume that the existence of BTS towers in their area has a negative impact on them such as bothering environmental aesthetics, causing health problems, and bringing insecurity. Even though they are unaware, the main users of this facility are actually the community itself. This condition raises challenges for creating telecommunications tower design innovations that are better able to adapt to the environment. Camouflage Tower BTS is a term for BTS towers that are designed to be able to adjust to their environment through their ability to camouflage. The five design criteria formulated by Jayadi and Prasetya, namely friendly, proportional, safe, redesignable, and thematic, and in accordance with the zone of the urban area where the tower was built and used as the BTS tower camouflage design following the criteria. The research was conducted in the city of Yogyakarta using the 6-stage design development method from Ulrich and Eppinger. The result is five selected designs that meet the specified technical requirements and the design criteria.

1 INTRODUCTION

In the present era, which is called the industrial revolution era 4.0, there is a belief that the more the population of a region, the more the number of cellular telephone network needs. Such conditions occur in cities in almost all countries in the world, including Indonesia. The era of industrial revolution 4.0 has a digitizing feature on all fronts (Schwab, 2017). The industrial revolution which began with the use of steam engines in the 18th century (Industrial Revolution 1.0) reached its peak today with the birth of digital technology that had a massive impact on human life throughout the world. The latest industrial revolution or fourth generation encourages automation systems in all processes of human activity. The increasingly massive internet technology not only connects millions of people around the world but also has become the basis for online trade and transportation transactions (Rosyadi, 2018). To face the industrial revolution 4.0, the Ministry of Industry of the Republic of Indonesia has launched the initiative "Making

Indonesia 4.0." The initiative was declared to implement the strategy and Roadmap 4.0 (Industrial Revolution 4.0/ 4IR) in Indonesia (Kementerian Perindustrian Republik Indonesia, 2018; Soesatyo, 2018). Through the Indonesian Ministry of Industry, Indonesia will encourage 10 national priorities in the initiative "Making Indonesia 4.0", namely (Ministry of Industry of the Republic of Indonesia, 2018),

1. Improved flow of goods and materials
2. Redesign of industrial zones
3. Accommodating sustainability standards
4. Empowering MSMEs
5. Building a national digital infrastructure
6. Attract foreign investment
7. Improving the quality of human resources
8. Development of an innovation ecosystem
9. Incentives for technology investment
10. Harmonization of rules and policies

One of the national priorities mentioned above is building national digital infrastructure. Specifically, the Ministry of Industry of the Republic of Indonesia states that Indonesia will accelerate the development

of digital infrastructure which includes high speed internet, and digital capabilities in an effort to support the Making Indonesia 4.0 Road Map. The infrastructure development will involve investment cooperation between the government, the public and the private sector in the field of digital technology such as cloud, data center, security management, and broadband infrastructure.

Indonesia itself, as reported by APJII (Association of Indonesian Internet Service Providers), internet users in 2017 have reached 143.26 million people, equivalent to 54.7% of the total population of the Indonesian people (APJII, 2018b). This number shows an increase from the previous year (132.7 million people). The latest data shows that the number of internet users in Indonesia in 2018 has reached 171.18 million or 64.8% of Indonesia's total population of 264.16 million (Kusnandar, 2019). Most internet users in Indonesia are dominated by people in Java (55%), followed by Sumatra (21%), Kalimantan (9%), and the rest Sulawesi, Maluku and Papua (10%), as well as Bali and Nusa Tenggara (5%).

Therefore, in the millennial era marked by the 4.0 industrial revolution characterized by digitalization on all lines, internet service providers were required to improve the quality of their services, including the scope of their operations. Not only are ISPs (Internet Service Providers) preparing themselves to improve their service infrastructure, but also cellular mobile telecommunications operators as mobile internet providers. Cellular telecommunications operators operating in Indonesia have 5, namely Telkomsel, XL Axiata, Indosat, Three, and Smartfren (Ariansyah, 2014). The five operators, based on a survey of the Emarketer Digital Marketing Research Institute, are expected to serve more than 100 million active smartphone users in 2018 (Rahmayani, 2015). Keep in mind, smartphones are the most widely used devices when accessing the internet beside a computer / laptop. Its use is also spread to several areas as follows, in urban areas smartphone ownership reaches 70.96%, rural urban (45.42%), and rural (42.06%). The use of computers themselves tends to be stagnant, namely urban area (31.55%), rural urban (23.42%), and rural (23.83) (APJII, 2018a). With the description of these conditions, Indonesia is projected to rank fourth in the world with the largest active smartphone users in the world, under China, India and US.

Yogyakarta city, which is a heterogeneous community, is also not expected to be much different in circumstances related to cell phone use. The need for cellular communication networks in the city which can be said as a representation of Indonesia's diversity is increasing from year to year. To improve service quality and coverage of cellular network areas, cellular operators such as Telkomsel, XL Axiata, Indosat, Three, and Smartfren, build more telecommunications towers (BTS / Base Transceiver Station towers) in certain locations in the city. The location of the tower placement must be in accordance with business interests that are in line with the regulatory aspects (Fauzi, 2014; Widyatmoko & Mauludiyanto, 2015). But the problem arises when one operator and another operator points to the same area to set up a tower. The existence of several towers in an area will certainly damage the environment visually, and potentially lead to rejection from the community (Hidayah, 2015; Zam/din, 2014). Even according to a research, the existence of 1 telecommunications tower (BTS tower) alone has the potential to disrupt the environment in terms of beauty (Nagle, 2012). The solution to this problem is usually to use 1 tower that can be used together. The solution will be even better if there is a treatment for the tower itself. The intended treatment is to give a different visual appearance to the tower. The visual appearance is usually applied to monopole type towers (1 pole) which are then referred to as camouflage towers.

To suit the city of Yogyakarta which has a variety of nicknames, from city students, city tourism, cities of struggle, cities of culture, cities of artists, to cities that are warm, it is necessary to design a visual form of camouflage BTS towers that are in harmony with the environmental conditions in the area . Some designs have been obtained with a visual form of taking inspiration and philosophy of the local community, by applying the criteria that have been formulated in previous research, namely friendly design, proportional, safe, redesign, and thematic (Jayadi & Prasetya, 2017), and in accordance with the zone where the tower was built (Jayadi & Prasetya, 2018).

2 MATERIAL AND METHOD

2.1 Camouflage Tower

Why is it called a camouflage tower? So called because the tower design is able to disguise its existence in the middle of the environment where the tower was erected. Camouflage was originally known as one of the techniques to defend animals in the face of threats. Camouflage is the deployment of all abilities involving colour, lighting, or materials to

hide themselves so that they are not detected by their opponents. Basically there are 2 types of camouflage, namely cryptic and mimesis. Cryptic makes animals or objects difficult to see. Cryptic is the ability of animals to avoid observation or detection by other animals. Cryptic can also involve olfaction (with pheromones), or hearing concealment. Visual cryptic can be achieved in various ways, such as living underground or only active at night, and with various other camouflage methods (Forbes, 2009). Changing the colour of its body to the colour of the surrounding environment is included in this visual cryptic. Some animals, such as chameleons and octopuses, are able to actively change their skin pattern and colour, both for camouflage and for signalling.

Mimesis is changing animals or things into something else. In mimesis (also called masquerade), objects that are disguised look like something that is not attractive to observers (Gullan & Cranston, 2014). Some insects have the ability to change themselves to resemble leaves or tree branches so as to avoid them from threats originating from their surroundings. Observer or his opponents are not aware of its existence because both the colour and shape are similar to the environment in which they are located.

In its development, camouflage has become a more general terminology. Camouflage strategies are then used in the military field. In warfare, the ability to hide is one of the keys to victory. Its existence which is difficult to detect by an opponent makes a group of troops can attack suddenly without being noticed by the opposing army. Army uniforms with unique motifs are one form of their efforts to camouflage themselves. Or heavy weapons such as tanks that are designed to resemble unarmed transport trucks become camouflage strategies.

In other fields, such as communication construction, it is known as the BTS (Base Transceiver Station) camouflage tower. BTS tower is one type of telecommunication tower, which is a special building that functions as a supporting facility for placing telecommunications equipment whose design or form of construction is adapted to the needs of telecommunications (Kementerian Keuangan Republik Indonesia, 2017). In general, the BTS camouflage tower has a shape and colour that resembles a tree.

Based on the shape and construction, BTS towers are divided into 3, namely Self-Supporting four-legged Tower, Self-Supporting three-legged Tower, and Monopole Tower (single leg). In general, BTS towers designed to be disguised are monopole

(single-legged) types. The Indonesian Ministry of Finance, in this case the Director General of State Wealth, in its Decree numbering 378 / KN / 2017 concerning Technical Guidelines for Building Evaluation of Telecommunication and / or Broadcasting towers distinguishes the meaning of monopole tower and camouflage tower (minaret). The decree defines monopole tower as one type of tower in the form of a single pile or has only one leg using steel plate forming a profile of a large round or polygon pipe and having a top diameter tends to be tapered and erected on land (Greenfield). The height of monopole ranges from 20 to 40 meters.

Figure 1 : The camouflaged BTS tower becomes a tree (left) and street lights (right). Source: (Jayadi & Prasetya, 2018)

Whereas Camouflage or Minaret towers are not much different from other types of Telecommunication towers and / or Broadcasting, but use certain materials to disguise the devices installed on the tower itself, so that they are aesthetic and more environmentally friendly. The naked eye is no longer like an antenna and a tower, because its placement tends to be adapted to the design or camouflaged with the place where the tower is erected, camouflage examples resemble trees, water towers, or towers of houses of worship (Kementerian Keuangan Republik Indonesia, 2017). With a variety of considerations, this paper is more directed towards the study on the monopole shaped BTS camouflage tower.

2.2 Urban Zoning

Definition of zones in Yogyakarta City Regulation Number 1 of 2015 concerning Spatial Planning and Zoning Regulations of Yogyakarta City Year 2015-2035 are areas or areas that have specific functions

and characteristics (article 1 paragraph 35). The urban zone is divided into 2, namely the protected zone and the cultivation zone. A protected zone is an area within a part of an urban area that is defined by the main function of environmental preservation which includes natural resources and artificial resources.

Figure 2 : Zoning of the Keraton and its surrounding areas (above) and the Malioboro and surrounding areas (below).

Included in the protected zone are the Cultural Heritage Zone (SC), the city's Green Open Space Zone (RTH); and Local Protection Zone (PS). Whereas the Cultivation Zone is an area within a part of an urban area that is defined by the main function for cultivation activities on the basis of the conditions and potential of natural resources, human resources, and artificial resources.

Without ignoring the significance of other zones, this paper will only raise the themes of the BTS Tower camouflage design in the Cultural Heritage Zone. The consideration of determining this zone is inseparable from the predicate of the City of Yogyakarta which has many buildings and heritage areas. The Regional Regulation of Yogyakarta City Number 1 of 2015 concerning Spatial Detail Plans and Zoning Regulations of the City of Yogyakarta Year 2015-2035 states that the Cultural Heritage Zone is set no less than 66 Ha spread across 7 regions. The area or subzone is located in Kota Gede (8 Ha), Vredeburg Fort area (7.5 Ha), Gedung Agung Presidential Palace complex (6 Ha), Great Kauman Mosque (1.5 Ha), Yogyakarta Palace complex (28.5 Ha), Tamansari area (10 Ha), and Puro Pakualaman complex (4.5 Ha). The distribution of these sub-zones is also known as a tourism area which is the main destination for tourists visiting the city of Yogyakarta.

The method used at the beginning of the study is qualitative-explorative (Creswell, 2014; Groat & Wang, 2002). FGD (Focus Group Discussion) is used as a method of collecting data. The study resulted in the formulation of 5 design criteria or specifications of the BTS camouflage tower design based on public opinion. Furthermore, in the second stage, the method used is the design method from Ulrich and Eppinger, namely planning, concept development, system-level design, detailed design, testing and refinement, and production ramp-up (Ulrich & Eppinger, 2012).
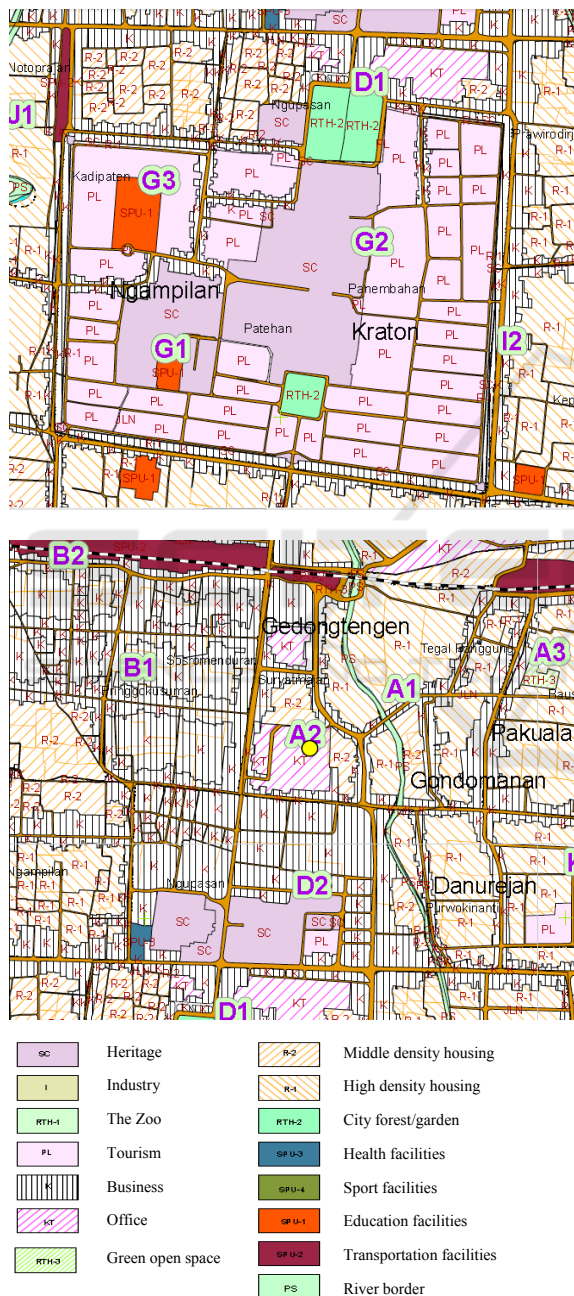
3 RESULT AND DISCUSSION

Every design always starts with planning or planning. This phase occurs before project approval and the actual product development process are launched. Therefore, this phase is often referred to as "zero phase". At this stage, an identification of some of the things needed to start the design is carried out, such as an effective design implementation strategy and methods of achievement. At this initial stage, the design brief formulation is obtained through the mechanism of

the designer team's internal discussion. The agreed formula is "designing the camouflage design of BTS tower that is suitable with the environment within the Yogyakarta City heritage zone".

In the next stage, Concept Development, which is the concept development phase, the target market needs are carefully identified, alternative product concepts are generated and evaluated, and one or more concepts are selected for further development and testing. The concept is a description of the shape, function, and features of the product and is usually accompanied by a set of specifications, competitive product analysis, and economic justification of the project. Because the BTS camouflage tower is included in the infra-structure category that is public in nature, the design goals are clearly identified as a broad community, without exception. This means that its existence is visually accessible to everyone in the environment where the BTS camouflage tower is located. This stage also identifies the icons of Yogyakarta City which have the potential to be excavated and used as inspiration for the BTS tower camouflage design. Data transcript of Focus Group Discussion about Yogyakarta City icons involving 7 participants was categorized and analyzed as shown in the Table 1.

Table 1 : Analysis of FGD Data

Kategori	Ikon	Detil ikon
Physical Building	Tugu Jogja	
	Keraton Yogyakarta	Pendopo, Gapura/gate, ornamentation, Keraton fort, Kandang Menjangan, Tamansari, Great Mosque
	Heritage building	Vredeburg fort, façade of Tugu Train Station, façade of central post office, and BNI building
	Malioboro street lamp	
Unique clothes	Traditional Clothing	Surjan, blangkon, iket, jarik, lurik
	Uniform of Keraton soldier	Topi, *ageman*,
Vehicle	Andong, becak	
Activity	Membatik	Canting, wajan, anglo
Weapons	Keris, tombak	
Culinary	Gudeg, kipo, bakpia	
Figures	Abdi dalem, Keraton soldier, The bride,	
Performance art	Keraton dance, wayang, gamelan	

Figure 3 : Some alternative designs for camouflage BTS towers

The next step is to make design sketches based on the analysis table. Twenty alternative design sketches were produced at this stage (Fig 3 and 4). All of them refer to the analysis table as the basis for design inspiration. Of the 20 alternatives, 4 designs were taken that had high scores in the analysis of design selection with certain criteria. The stage design system (System-level design phase) briefly includes the definition of product architecture camouflage the BTS tower as a whole and breaks it down into small parts per component. Technical specifications and assembly procedures for these components need to be determined.

Figure 4 : The other alternative designs for camouflage BTS towers

The next stage is detail design. This detailed design phase provides detailed and complete information about the material, size, geometric

shape, and about the suppliers of each product component. The output of this phase is a complete and detailed technical drawing that contains all important information as a basis for the fabrication and product assembly process. In addition to the design criteria that must be met, the main source of inspiration of the design is of course that is in harmony with the characteristics of the Yogyakarta region. The inspiration was then poured into 4 selected designs, namely the camouflage design of the Palace Gate, Malioboro Lamp, Canting Batik, and Tugu Jogja.

3.1 Palace Gate Camouflage Design

This design is based on the existence of the Yogyakarta Palace as a cultural centre, with its iconic building form. The building that was used as inspiration for camouflage design is the Palace Gate, which is a building that has access in and out between parts of the palace. The main part quoted as an inspiration for camouflage design is the bottom or the so-called *umpak*, which above is decorated with flower ornaments with the dominant colour typical of the Yogyakarta Palace building, which is green with yellow combs. The top of the design then adjusts to the shape of the camouflage tower (Fig 5).
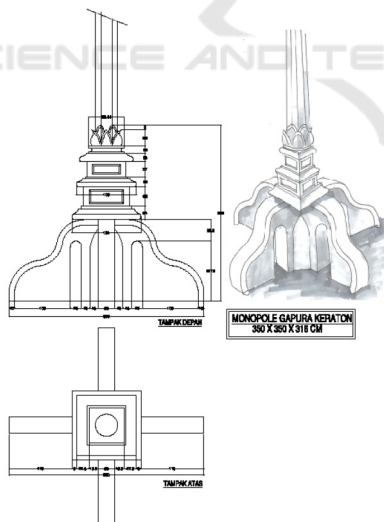

Figure 5 : Palace Gate Camouflage Design

3.2 Malioboro Lamp Camouflage Design

Malioboro as a crowd center which is also a tourist center in Yogyakarta offers a variety of interesting design inspirations. The Malioboro street section whose form is familiar both for local and foreign tourists is street lights. The design is quite simple, which is embodied in a sturdy pillar with vines. The dominant color is the palace's distinctive diatonic color, which is a combination of green with a yellow combing accent. The shape is unique and distinctive and is technically congruent with the shape of the tower. Such a form will better harmonize camouflage design with its environment. This design adds another function to the BTS tower, namely as street lighting (Fig 6).
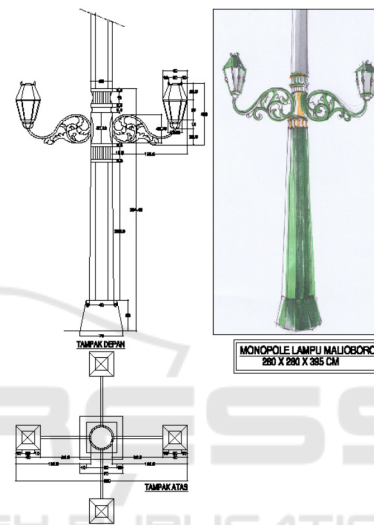

Figure 6 : Malioboro Lamp Camouflage Design

3.3 *Canthing Batik* Camouflage Design

Canthing as referred to in various references to batik is a tool used to move night fluids to make batik. Tonight is a naturally produced liquid wax. The parts that are in canthing are: (1) *Nyamplung*, which is a liquid wax pool or commonly called *'malam'*, which is made of copper; (2) *Cucuk*, which is the tip of nyamplung where the liquid is released at malam; and (3) The handle (canthing stalk which is usually made of bamboo or wood). There are several types of canthing according to their uses.

The function of canthing as a tool for batik makes it very closely related to Javanese or Yogyakarta culture in particular. Batik itself is a cultural product that is well known not only in Indonesia but also the world. At present people don't only wear batik, but more and more also want to understand the manufacturing process. Some tourist locations have even opened opportunities for visitors

to witness the batik process or at the same time take part in batik classes. In addition to the functions of canthing as mentioned above, the typical form of canthing is seen as quite familiar to the public. The community will easily associate it with batik craft. The canthing form is also considered technically feasible if applied to camouflage tower designs (Fig 7).
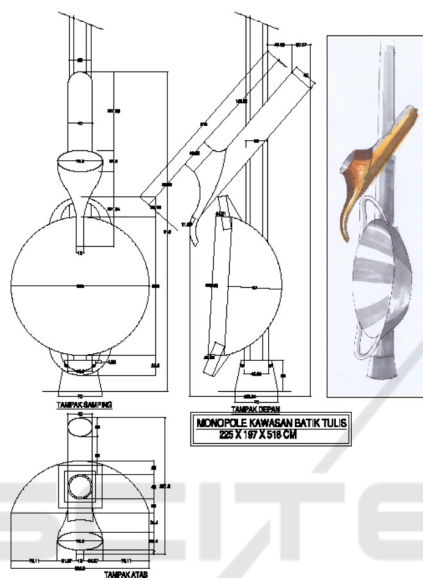
and replaced it with *De Witte Paal* (White Paal Monument) in 1889 in its present form. Even though the philosophy of the 'manunggaling kawula gusti' underlying the Golong Gilig Monument was removed, the new form of Tugu Paal Putih still has a deep meaning. Until now, almost every time the crowd happened at the Tugu, because besides being the main intersection of the road protocol, it was also a favourite tourist attraction to be used as a background for self-photos.
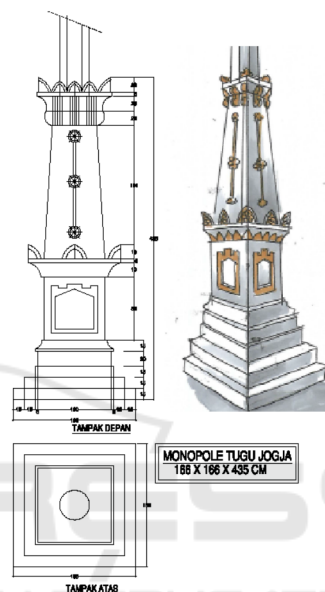

Figure 7 : Canthing Batik Camouflage Design

Figure 8 : Tugu Yogja Camouflage Design

3.4 *Tugu Yogya* Camouflage Design

The most iconic building and a landmark of Yogyakarta is the White Paal Monument or often just called Tugu Jogja or Tugu Yogya. The monument originally built by Sri Sultan Hamengkubuwono I in 1755 was also known as the *Tugu Golong Gilig*. Golong is a cylindrical pole and Gilig is a rounded peak, which is a symbol of *Manunggaling Kawula Gusti*, or the union of the people with kings and kings with God. Tugu Yogya is located in the north of Yogyakarta City and is one part of the imaginary axis between the southern coasts, the palace with the peak of Mount Merapi. His physical form is very distinctive and full of philosophical meanings in every curve (Morin, 2014).

The current form is different from the Tugu Golong Gilig which was collapsed because of the earthquake on June 10, 1867. The basic philosophy was also different. The Dutch government rebuilt

The next phase is testing and refinement. This testing and refinement phase uses a product model, which can be a 1: 1 scale prototype or a smaller scale mock up. Early prototype (alpha), the model on a real scale can be tested in full and real. Smaller scale mock ups are tested in terms of proportions and visual aesthetics. Mock up is used before making a prototype. Production ramp-up is the last phase. At the ramp-up production stage, the product is made using a predetermined production system. The purpose of ramp-up is to train the workforce and to overcome the remaining problems in the production process. Products produced during ramp-up production are sometimes supplied to selected customers and carefully evaluated to identify deficiencies remaining. The last two stages are not discussed in this paper.

4 CONCLUSIONS

The icon of Yogyakarta City has great potential to be a source of inspiration for the BTS tower camouflage design. This has the potential to increase the tourist attraction of the city of Yogyakarta and strengthen its existence as a creative city. The four selected BTS tower camouflage designs are considered capable of representing the existence of the city of Yogyakarta through the BTS tower to blend with the heritage zone where the tower is located. The four designs are expected to provide added value to the environment around the BTS tower. In turn, the community around the tower will actually get a positive contribution from the construction of the tower. Exploration of the basic idea of zoning tower-based camouflage design of urban areas in the city of Yogyakarta needs to be developed so that the existing designs are not monotonous and can be more accepted by the people around the tower. In addition to the cultural preservation zone, several other Yogyakarta City zones are urban green open space zones and local protection zones, housing zones, trade zones and services, office zones, public service facilities zones, industrial zones, and other allotment zones. BTS camouflage towers established in these zones need to be designed creatively and innovatively, adjusting to their environment.

ACKNOWLEDGEMENTS

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