Studies on Visual Environment Phenomena of Urban Areas: A Systematic Review

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Abstract. The visual environment in the development of urban areas plays an essential role, especially in the case of Transit-Oriented Development (TOD). The development of TOD facilitates many human activities, so it requires a high-quality visual environment. This study aims to identify and map visual environment phenomena that occur in TOD using a keyword from eight TOD principles and analyze through a systematic review method. Two hundred sixty articles are selected from scopus.com and go through the analysis process, and only 31 articles used in this review. The results arranged based on its importance at TOD: visual performance, visual comfort, and visual experience. Based on the phenomena in visual performance, stakeholders must consider the fulfilment of users activities, namely cyclist, elderly, and pedestrian. Based on phenomena in visual comfort, stakeholders must consider all places in the urban area, namely neighbourhood, building, and street. Lastly, based on phenomena in visual experience, stakeholders must consider the effect on the health, social life and safety of users and also the face of the city. The purpose of this mapping is to raise awareness of its importance and drive more research in the field of the visual environment in urban areas. The stakeholders can consider this mapping to determine the TOD development policy.

1. Introduction

Transit-oriented development is an urban development approach that integrates land use, transportation, people, activity, and opportunities. There are eight main principles of TOD, namely, walk, cycle, connect, transit, mix, densify, compact, and shift [1]. The adaptation of the TOD concept can provide a livable, accessible, and attractive urban environment. Some elements of urban design that show positive results can use by taking local context into account [2]. Some studies have begun to look at the possibility of TOD concept in big cities like Seoul and Bandung [3, 4].

The built environment is the interaction between humans and light. Humans need sunlight to meet their biological needs; give hints about the three-dimensional shape around them, and provide information about the orientation and the weather conditions [5]. Night street lights increase visibility, provide direction, and contribute to human perception of comfort and safety at night [6]. By providing an excellent visual environment, it can foster comfortable and pleasant feelings following the intended use of space [4].

There is not much research on the visual environment of urban areas, especially in the TOD area. Several studies related to the TOD try to compare it to green urbanism, wind environment, and thermal comfort. [7, 8, 9]. Physical design (visual quality and livability) is an essential aspect of TOD planning [2]. Therefore, knowledge mapping in the field of the visual environment in urban areas is needed. The study
aims to identify and map the phenomena regarding the visual environment of urban areas through a systematic review. So, it will raise awareness and drive more research in the field of the visual environment in urban areas.

2. Methodology

The method used in this literature review is a systematic review. The study used a systematic method through 4 stages: identification, screening, eligibility, and included [10]. The analysis conduct from September 2019 to February 2020.

Table 1. Keywords from TOD Principle

| No | TOD Principle | Keywords |
|----|---------------|----------|
| 1  | Walk          | Visual, frontage, walk, urban, area, visual, spatial, material |
| 2  | Cycle         | Visual, cycling, network, urban, area |
| 3  | Connect       | Pedestrian, safety, visual, walk |
| 4  | Transit       | Public, transit, visual, comfort |
| 5  | Mix           | Visual, access, park, vegetation, urban, night, active, lightscape, livability |
| 6  | Densify       | Urban, area, outdoor, density, visual, permeability, visual, high, building, quality, life, glare, pollution, sunlight |
| 7  | Compact       | Compact, urban, area, visual, spatial, surface, tropic, weather |
| 8  | Shift         | Roadway, visual, comfort, quality |

In the identification stage, the article accessed via scopus.com (IP address: Institut Teknologi Bandung). The search only focuses on the peer-review journal and empirical studies. By using the search string or keyword from eight TOD principles, obtained 260 articles (see table 1). Nineteen duplicate articles excluded, so only 241 articles process to the screening stage. Based on analyzing the title and abstract, 154 articles that not contain topics in the urban visual environment, non-English publication, paper review, books, or report excluded. A total of 87 full-text articles were downloaded and entered the eligibility stage. In the eligibility stage, 56 articles that do not have topics in the urban visual environment, review paper, or books excluded. Subsequently, only 31 full-text articles reviewed in this study.

![Figure 1. Systematic review process](image)

3. Findings

The findings obtained from 31 articles divided into three categories based on the image forming process that occurs through the human eye [11]. The phenomena arranged on its importance in TOD, namely visual performance, visual comfort, and visual experience.
Visual performance is a term that describes the speed and accuracy in processing visual stimuli that defined through the adaptation of luminance, contrast, and size of target objects [12]. Five articles have a topic in visual performance. The phenomena divided into three categories based on users of the urban environment, namely cyclists, elderly, and pedestrians. From a cyclist's visual behaviour, the discontinuity of the path (i.e., intersections and crosswalks), presence of pedestrians, physical and visual separation are important visual objects that need attention to not endanger themselves [13]. Elderly need time to visual exploration of the surrounding environment before deciding to cross the street [14]. Path designs such as car-free islands, pavements, lanes, and curb must minimize the risks that could endanger them [15]. In recent years, a new phenomenon has emerged, namely, pedestrians using their cellphones when using sidewalks. Research shows that mobile phones affect adaptation to where humans see (visual search behaviour) [16]. Consideration of visual quality in outdoor activities is something that must be considered [17].

3.2 Visual Comfort
Visual comfort interpreted as the 'absence of visual discomfort' [18]. Visual dis(comfort) can be in the form of disability glare, discomfort glare, dazzling glare, or insufficient contrast [11]. Ten articles have a topic in visual comfort. The phenomena divided into three categories based on spaces in the urban environment, namely neighbourhood, building, and street. A lower score in height, density, and
cleanliness of the neighbourhood result in higher visual comfort [19]. There are two visual comfort phenomena in the building, namely, colour scape and glare. The colour scape or architectural colour tones in the urban areas affect the visual comfort of pedestrian and road users, especially in hazy weather [20].

Figure 3. Architectural colour tones in hazy and clear weather
Source: [20]

The glare phenomenon in the building occurred because of material and the form of the building. Visual comfort deteriorates with albedo increasing. However, there are indications that humans would prefer to use natural materials with low albedo to reduce glare from road/roof coatings such as grass [21, 22].

Figure 4. Material albedo of road or roof
Source: [22]

The combination of facade materials (such as glass curtain wall, highly reflective material, and heliostat fields) and specular form of the building can be the source of glare [23, 24, 25, 26, 27]. The source of glare in urban areas can cause visual discomfort for pedestrians and road users. The planner, designer, and engineer should understand this complicated relationship for designing a visually better city [28].

Figure 5. Glare from façade reflections
Source: [23, 24, 25, 28]
There is also some visual discomfort from urban comfort that researcher found, which are:

a. Glare from the low point of the sun in the morning and afternoon, especially on roads with a west and east orientation.
b. Glare from objects in urban environments such as cars in parking lots and urban street furniture.
c. Reduced visibility due to excessive contrast.

![Figure 6. Another visual environment phenomena in urban areas: left (a), middle (b), right (c)](image)

3.3 Visual Experience

There are three aspects of visual experience, namely perceptual clarity, evaluative impression, and spaciousness. Even so, humans have high selectivity in the process of visual experience and try to find meaningful information in it [29]. Sixteen articles have a topic in visual experience. The phenomena divided into three categories, namely transparency, visual integration, and night light.

There are three topics in transparency, namely, visual permeability, beautiful scenery, and visual pollution. Visual permeability of groundfloor frontages increased activities on the sidewalk [30]. Large trees in the urban environment block the view but also create beautiful scenery [31]. Street greenery should be a priority strategy in promoting high visual quality [32]. Visual pollution is objects or graphics in the urban area that give an impression of disorder face of the city. Understanding the mechanism for quantification of visual pollution can help planners and the government to understand the prevalence of visual pollution [33, 34].

![Figure 7. Visual Pollution and method to calculate it source: [33]](image)

The urban area needs a visual integration to nature and neighbourhood. There is proof that nature visibility and spatial connectivity influence social interaction in the neighbourhood [35]. Some people prefer views of water more than grass [36] or vice versa [37], but both of them have a substantial effect on visual quality [38]. Using water elements can have a similar effect of fascination and "being away" [39]. Higher visual integration of public transportation in the neighbourhood leads to a better integrated spatial structure within complex [40]. Visibility of layout and spatial configuration of a neighbourhood affect social networks and cohesion [41].
Figure 8. Urban elements: water and trees
source: [38]

Night light consists of lightscape and safety. Lightscape can be the range of visual impressions of the space [42], and the nocturnal image that involves both technical and cultural aspects [43]. Safety and security at night is an essential function of the night light. Street lighting needs to pay attention to the ability of lights to respond to dry and also wet roads [44]. Human vision also needs to be integrated into the future planning process of smart street lighting systems [45].

Figure 9. Smart city lighting
Source: [45]

4. Discussion
From the literature review, several visual environment phenomena found in the urban area. The use of keywords from the eight principles of TOD and the method of systematic review allows the discovery of various visual environment phenomena typical of TOD. Based on its importance at TOD, the phenomenon arranged in order: visual performance, visual comfort, and visual experience to make it easier to see the application in TOD.

| No | Visual Environment | Phenomenon and Application in TOD |
|----|--------------------|-----------------------------------|
| 1. | Visual Performance | 1. Visual and physical separation for cyclists and pedestrians.  
2. Path design must consider the elderly and users with special needs.  
3. The use of signage on the surface of pedestrian space and roads will be more accommodating to users visual search behavior, compared to signage poles that are difficult to be accessed visually by some users. |
| 2. | Visual Comfort     | 1. High, density and cleanliness of the neighbourhood.  
2. Glare caused by building material and form.  
3. Weather type and visibility capabilities of road users and pedestrians. |
3. Visual Experience

1. Transparency between shops and pedestrian spaces, green spaces in the city, and visual pollution provides a variety of face of the city and visual experience.
2. Visual integration with nature and the neighbourhood will have a positive impact on the user's health and social life.
3. The night light is not only used to provide safe and secure in any weather but also can create an impression and nocturnal image.

5. Conclusion

Stakeholders must consider the visual environment in the development of urban areas. Based on its importance at TOD, the phenomena arranged in order: visual performance, visual comfort, and visual experience. Based on the phenomena in visual performance, stakeholders must consider the fulfilment of users activities, namely cyclist, elderly, and pedestrian. Some of the phenomena that need to be mention are the visual and physical separation for cyclist and pedestrian, path design for elderly and users with special needs, and signage that accommodate visual search behaviour from users. Based on phenomena in visual comfort, stakeholders must consider all places in the urban area, namely neighbourhood, building, and street. Some phenomena that need to be mention are density, cleanliness, and glare of building and neighbourhood, also people's visibility in any type of weather. Lastly, based on phenomena in visual experience, stakeholders must consider the effect on the health, social life and safety of users and also the face of the city. Some of the phenomena that need to be mention are transparency, visual integration, and safety at night.

Understanding this visual phenomena map can raise awareness of its importance and drive more research in the field. Designers, urban planners, and engineers can use this mapping to consider and to make decisions about urban planning, especially in the development of TOD.

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