

# Community Behavior in Public Gray Open Spaces, Case Study: *Merbau* Square, Banyumanik-Semarang

Maria Damiana Nestri Kiswari<sup>1,2,\*</sup>, Nany Yulastuti<sup>1</sup>, Budi Sudarwanto<sup>1</sup>

<sup>1</sup>Doctor in Architecture and Urbanism, Diponegoro University, Indonesia

<sup>2</sup>Department of Architecture, Soegijapranata Catholic University, Indonesia

Received February 21, 2024; Revised May 1, 2024; Accepted June 16, 2024

## Cite This Paper in the Following Citation Styles

(a): [1] Maria Damiana Nestri Kiswari, Nany Yulastuti, Budi Sudarwanto, "Community Behavior in Public Gray Open Spaces, Case Study: *Merbau* Square, Banyumanik-Semarang," *Civil Engineering and Architecture*, Vol. 12, No. 4, pp. 3040 - 3052, 2024. DOI: 10.13189/cea.2024.120440.

(b): Maria Damiana Nestri Kiswari, Nany Yulastuti, Budi Sudarwanto (2024). *Community Behavior in Public Gray Open Spaces, Case Study: Merbau Square, Banyumanik-Semarang*. *Civil Engineering and Architecture*, 12(4), 3040 - 3052. DOI: 10.13189/cea.2024.120440.

Copyright©2024 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

**Abstract** The provision of open space in urban settings is one indicator of the Sustainable Development Goals. Humans create space as a place to carry out their activities. Urban public open space has impervious areas, namely gray space. The gray space is a place for recreational activities, including fitness activities, social activities, and activities to enjoy visual facilities in public open spaces. Various community activities are carried out simultaneously in the gray space. Community behaviour shows community dynamics and social interactions in a neighbourhood public space. This research aims to understand various community behaviours in gray spaces at *Merbau* Square. This research uses the qualitative method and descriptive analysis, which describes the condition of the square and the behaviour of the people who are active in it. Data was obtained through interviews and observing the situation and the conditions. The space syntax method that uses the Depth Map application is for the data analysis. The analysis results by Depth Map strengthen the identification of places in gray space that have the potential for various activities because they are easier to see and accessible. People's activities are tied to their behaviors. The diversity of community activities in the gray space is mapped through behavioural mapping, namely the place-centred map. So that we will gain an understanding of how people behave in the gray space of *Merbau* Square as a public facility that has been developed, comprehending the community behaviour will illustrate the sustainability of public facilities in a neighbourhood.

**Keywords** Community Behavior, Public Open Space, Gray Space, Square

## 1. Introduction

Humans create space as a place to carry out their activities. Public open space is a land where human activities and behaviour can occur [1]. People feel comfortable and free in public open spaces because they can get a fresh breeze [2]. People of all ages, ethnicities, physical disabilities, and other characteristics can access public open spaces [3]. The utilization of public open spaces that meet social and psychological needs significantly impacts a sustainable place [4][5]. Public open space in the urban neighbourhood is formed by two types of space: green space and gray space [6][7][8]. The green spaces are vegetated areas. The gray space is called an impervious artificial surface [9]. The spaces are areas that can be used for community activities, and it is not vegetated [7][10][11]. This gray space is for recreational activities, including fitness activities, social activities, and other activities to enjoy visual facilities in public open spaces [12][13][14][15][16]. The problem that often arises related to gray space is that activities and use of this space do not follow the planning intent [17]. Planners hope to develop public open spaces that are orderly and consistent. However, the facts on site are that there is a diversity of

uses of public open spaces that are not even their intended use. Efforts to put the public open spaces in order will result in a loss of diversity and can have negative consequences [18].

The availability of open space intended for the public in urban areas is one indicator of the Semarang City Sustainable Development Goals [19].

This research focuses on gray space as part of public open space, and the existing users' behavior. This gray space is the area around the grass field. The existing users' behaviour in the public open spaces can change the way of utilization, so this will influence the formation of new public open spaces [20]. Concerns about people's behaviour in public open spaces include the impact of microclimate conditions, like air temperature, on user behaviour [21][22]. The physical shape, availability of facilities, image of public open spaces, noise levels, and safety considerations from crime and accidents such as falls or slips all have an impact on the comfort of the elderly who use public open spaces [22][23][24]. The facilities in the gray space often do not match the activities carried out. Public open space facilities that have been repaired and developed are expected to be able to serve the activities of their users. Musical sounds in public spaces influence people's behaviour in those places. Playing music can help create social cohesion besides adding to the attractiveness and pleasant atmosphere of public spaces [25]. Gray space influences mental health [10]. The results of behavioural studies in public open spaces will be able to determine usage patterns of public open spaces [26]. Next, gray space is formed by socio-physical construction and has power and influence on the surroundings [27]. The role of gray space is as functional space and civic space. Functional space means spaces provided for practical purposes, such as for circulation and means of transportation. This gray space includes roads, sidewalks, and parking lots. The function of civic space is space that can be accessed for public enjoyment, namely for physical activities, leisure,

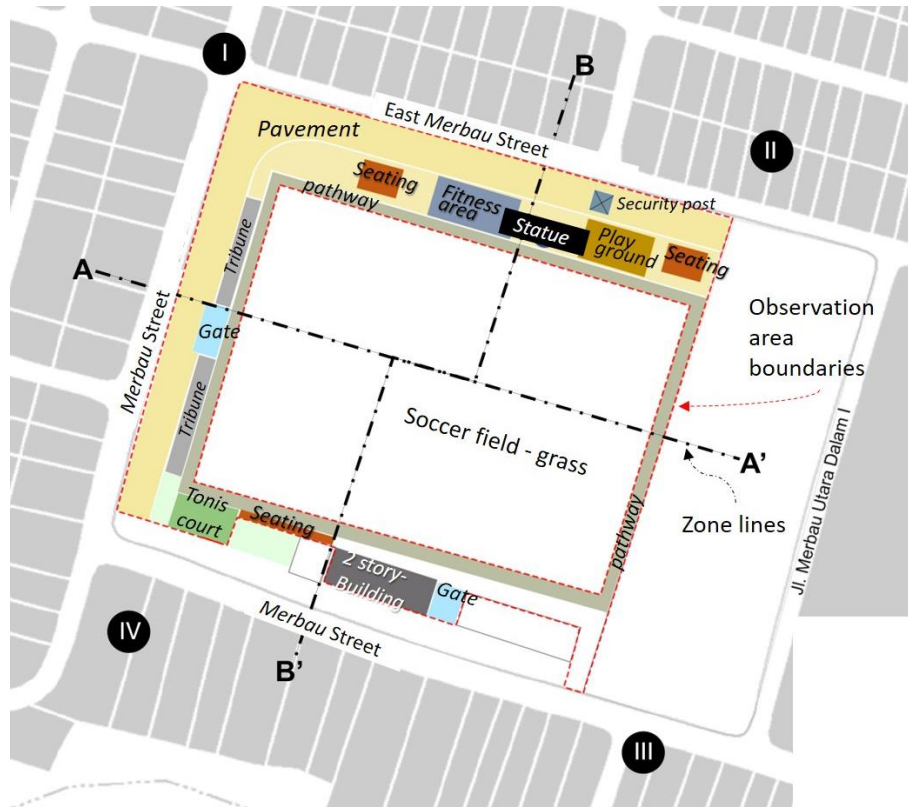
and recreation. This type of space is a square, plaza, and pedestrian path, which is not only a walking facility but also a place for various outdoor activities that allow [28]. Gray space is also interpreted as a *sociotope*. The *sociotope* is a public open space area that has valuable value as a place for people to do activities [29]. Sociotope mapping is related to public open gray spaces, which show the social character of community activities in urban areas [30].

The research addresses gaps in understanding diverse activities in gray open spaces and their impact on behavior [10]. Differences in the location of public gray open spaces influence people's behaviour. Comprehending people's behaviour in gray spaces, which are civil and functional in public open spaces, supports the achievement of sustainable development goals. Social behaviour and interactions, including feelings of mutual trust and bonding between members of society, are influenced by social cohesion [31]. The social cohesion that occurs in public open spaces supports the creation of a sustainable neighbourhood [32][33][34][35]. Therefore, this research aims to understand various people's behaviour in gray spaces that support the sustainability of the neighbourhood.

## 2. Methods

### 2.1. Research Area

The *Merbau* Square has existed since the beginning of the *Banyumanik* Housing Complex, built around the 1980s. *Merbau* Square is in the administrative area of *Padangsari* Sub-district, *Banyumanik* District, Semarang City. The location of *Merbau* Square was 1.5 hectares. Meanwhile, currently recorded by the Semarang City Government through the Spatial Planning Service, the total square area is 1.1 hectares [36]. *Merbau* Square is in the middle of a residential area (see Figure 1). The gray space in *Merbau* Square surrounds the grass field for football games.



**Figure 1.** Zoning Merbau Square and the facilities

The square has already existed since the housing was first built. At that time, it was gradually used as a place to build garages for residents' cars, places to sell, and other buildings. In August 2021, the *Merbau Square* demolition project began. The project aimed to build representative public facilities and a water catchment area [37]. Merbau Square is a public facility in the neighborhood that has been repaired and rebuilt at the *Banyumanik Housing Complex*, Semarang City. This public facility is a sports facility for the public, consisting of a grass field for football and a pavement area surrounding the field. The community carries out various activities in this gray space.

After the Square construction project was completed, the *Semarang City Government* imparted Merbau Square to the *Banyumanik District*. For management, the district assigned it to the *Padangsari* sub-district. The *Padangsari Head* formed a team consisting of residents to manage Merbau Square.

## 2.2. Research Methods

This research uses a qualitative method that describes Merbau Square's original conditions (natural setting) and the behavior of the people who carry out activities in it (Picture 1, 2, 3). The approach focuses on humans as users of gray public open spaces. The research was divided into three stages. The first stage is to understand the function of the gray spaces in Merbau Square. Facilities such as seating include a tribune area, children's play facilities, and fitness

equipment are provided. The activities carried out are more diverse compared to the facilities available. Space function data based on the activities carried out is shown in a zoning map, which shows the locations and the table of the activities.



**Picture 1.** The square's place has high connectivity and integration on a weekend morning.



**Picture 2.** The place has a high visibility. There are parking cars, street vendors, and their buyers.



**Picture 3.** The 2<sup>nd</sup> floor of the MSMEs building is an open space used as a public facility.

### 2.3. Data Collection

Data was obtained through field observations and supplemented by interviews with the *Padangsari* sub-district Head, the *Merbau Square* management, and field visitors, most of whom were residents of settlements around the field. Observations and interviews were carried out separately. One visit is used to observe and record field visitor activities fully [38]. The other day, interviews were conducted with these sources. Researchers observed the condition of Merbau Square on weekdays and weekends, from 06.00 – 10.00 AM in the morning and 04.00 – 06.00 PM in the afternoon. A public open space has active hours during certain hours. Usually, there is a specific time for people to visit public open spaces: in the morning and evening [2]. Merbau Square is in the middle of a residential area (see Figure 1). The gray space in Merbau Square surrounds the grass field for football games.

### 2.4. Analysis Depth Map

The second stage is an analysis using the Depth Map application's space syntax method. This analysis system is a visibility graph analysis system, which is based on the field of view visible to people. The Depth Map application uses the visual range overlay approach to calculate visual analysis, resulting in color gradations in the spatial arrangement [39][40]. The generated gradient color is used as a value parameter when computing the value of the space. Dark blue has the lowest value level, whereas red has the most outstanding value level [41][42]. So, the busy areas of the gray space can be easily identified. The connection between the regions and the other spaces is visible. These

spaces have the potential to become gray spaces that are most frequently and widely used by the public.

### 2.5. Behavioral Map

The third stage is a behavioral map of the spatial areas identified in the second stage with a depth map. So, we get a picture of the variety of people's behaviour related to their place in the gray space. Behavioural mapping is an activity of visually displaying the presence of people in a space, explaining what they do and how their behaviour is distributed [38]. Ittelson [43] Developed a procedure for general behavior mapping, which consists of five essential elements, as follows: 1) Create a basic drawing of the area to be studied. 2) A precise specification of the types of behaviour that will be observed, documented, and diagrammed. 3) Clear time planning information on when observations will be carried out; 4) Clear systematic procedures must be followed during observations; 5) Efficient coding or marking system to make observation work more efficiently. Behavioural maps are presented in place-centred mapping which shows the location of people in a particular environment carrying out various activities [38]. This mapping is used to identify how each individual or group uses their behaviour in a particular situation and place [44]. This technique seeks to discover how persons or a group of individuals exploit, employ, or accommodate their behaviour in a particular situation at a specific time and place.

Researchers identify the types of behaviour in each area of gray space and estimate the interrelationships of the place's characteristics that influence behaviour. The results of this identification are depicted in a map, namely a place-centered map [43][38]. Researchers describe the symbols on the base map that has been prepared (Figure 4a, 4b, 5a, 5b). Figure 4a shows field activities in the morning, and Figure 4b shows weekday activities in the afternoon—meanwhile, Figure 5a shows activity in the morning, and Figure 5b in weekends' afternoons. The symbol is a circle with different colors according to the activity behavior in that place. One circle (○) represents activities of 1 to 5 people. The narrative of each activity and behavior is explained in Table 1. A detailed explanation of community behavior in gray open spaces can be obtained from the results of the depiction of field user behavior maps and narratives for each activity and behaviour.

**Table 1.** Physical settings and behaviour on certain days and times

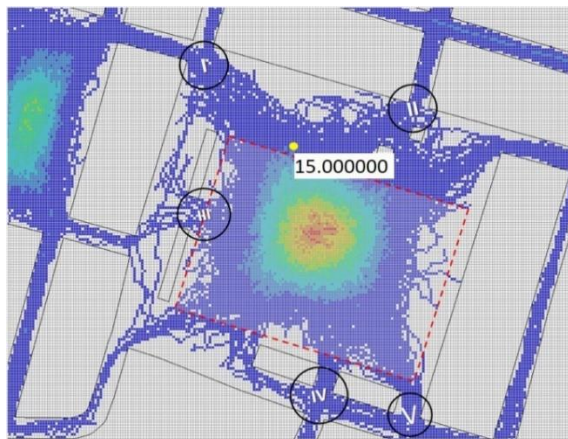
No	Physical settings – Zone	Behaviour	People	Day and Time			
				Mon - Fri		Sat - Sun	
				AM	PM	AM	PM
1	Jogging track – I; II; III; IV	Take a leisurely walk while chatting, jog, and run around the field.	Male or female: adults, teenagers, children, and older people.	**	**	***	***
2	<i>Tonis</i> court (badminton tennis) – IV	Playing tennis, playing ball, sitting on the floor, and chatting	<i>Tonis</i> community or the general public: teenagers or children	*	*	**	**
3	Playground - II	Playing on slides, scales, and swings, climbing, and walking around the play area alone, with peers, or accompanied by parents.	Children, toddlers, parents, or adults, male or female, accompanying them to play	*	**	***	**
4	Tribune - I; IV	They were sitting watching or waiting for those playing sports, playing on their cellphones, resting after going around the field, drinking and eating, chatting, and playing with drones.	Male or female, teenagers and children, as well as older people.	**	**	***	**
5	Seating area, including the location of landmarks – I; III, and IV	Sitting and waiting for those who are playing sports or in the children's play area; sometimes several kids play around and climb the landmark; resting after touring the field; drinking and/or eating, and chatting and chatting; recording the activities of other visitors who are dancing or doing other activities; setting up tents and placing things; and using the sound system when there is an event in the field.		**	**	***	***
6	Fitness area - I	Sitting on the floor at the edge. While sitting, chatting, eating, or drinking. Standing in relaxed chatting or making a telephone call. Hanging exercises or warming up individually.	Male or female: adult, teenagers, elderly.	*	*	***	**
7	The second floor of the 2-story building for MSMEs - III	Sitting and resting after exercise; Snacking – drinking - hanging out ( <i>kongkow</i> ); Playing along the ram, which is the access from inside the field	Males or females who have finished their activities are adults, teenagers, and children.	*	*	**	*
8	Parking area	Parking for motorbikes and cars; organizing parking vehicles; selling food and drinks in vehicles or putting them on a portable table; chatting while standing.	Male or female; parking attendants; street vendors; hawkers with vehicles; residents	*	**	***	**

\*= low crowds \*\*= moderate crowds \*\*\*= high crowds



### 3. Results

Gray space is an area of pavement covered with different materials. They were paving the floor for the parking area. Patterned and colored paving was laid for the fitness area and seating area. Near the fitness and seating area is a layer of plastered flooring with stones attached for foot reflection when walking on it. Another seating spot is on the south side near the MSME building, and the floor is covered with paving and grass blocks. The floor for the entrance to the field, namely areas I, II, III, IV, and V, see Figure 2, is covered with andesite stone pavement. The tribune areas are plastered and used as a seating area. The jogging track floor that surrounds the grass field is a tartan track.



**Figure 2.** The convergence place has the highest gate count value

The track surrounding the field is used for sports such as walking, jogging, and running. Nearby, the pavement areas are often used for group or individual exercise, fitness training, and other sports or physical activities. Apart from that, visitors also carry out recreational activities such as sitting back and chatting or simply enjoying the atmosphere of the field. People visit this field in the morning and afternoon. Meanwhile, during the day, the square is empty of visitors. On weekends, the square is busier with visitors, and more traders sell food and drinks. Square visitors vary from adults, elderly, and teenagers to children. The general public lives around the square and outside the residential area. Visitors go to the square on foot, by bicycle, motorbike, or car. The pavement area around the square is used for vehicle parking. Several housing residents also use it to park their cars. In peak times, most parking vehicles are two-wheeled motorbikes, and several street vendors sell food and drink on some corners of the parking area.

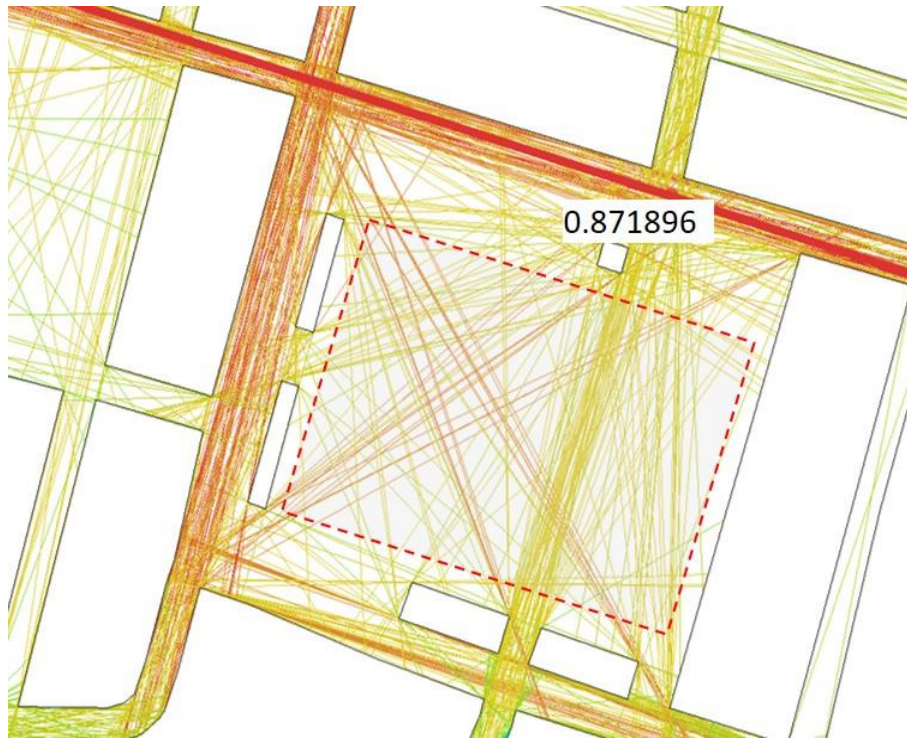
There are "tonis" court facilities, which combine badminton and tennis. The public can use this facility. There are seating spots in the gray spaces around the field. The visitors sit or stand in groups chatting, or sometimes you can see a group of ladies recording their dance or exercise movements on social media applications. On the west side of the square, there are tribunes for terraced seating overlooking the football field. There is a playground area for children and a fitness area marked by fitness equipment, although much of this equipment is

damaged and not functioning. On the south side of the Square, there is an adjoining two-story building where the first floor was developed for micro, small, and medium enterprises (MSME) kiosks [45]. Meanwhile, the second floor of the MSME building is an open space that can be accessed directly from inside the square. The open space on the second floor is utilized to enjoy the view of the field, chat, and do group or individual exercises. The community behavior in carrying out their activities in the physical setting of the gray space at *Merbau Square* is shown in Table 1. Every behavior in places in the gray space is stated in terms of time, whether in the morning or evening, on weekdays or weekends. During these times, categories of crowd levels are shown.

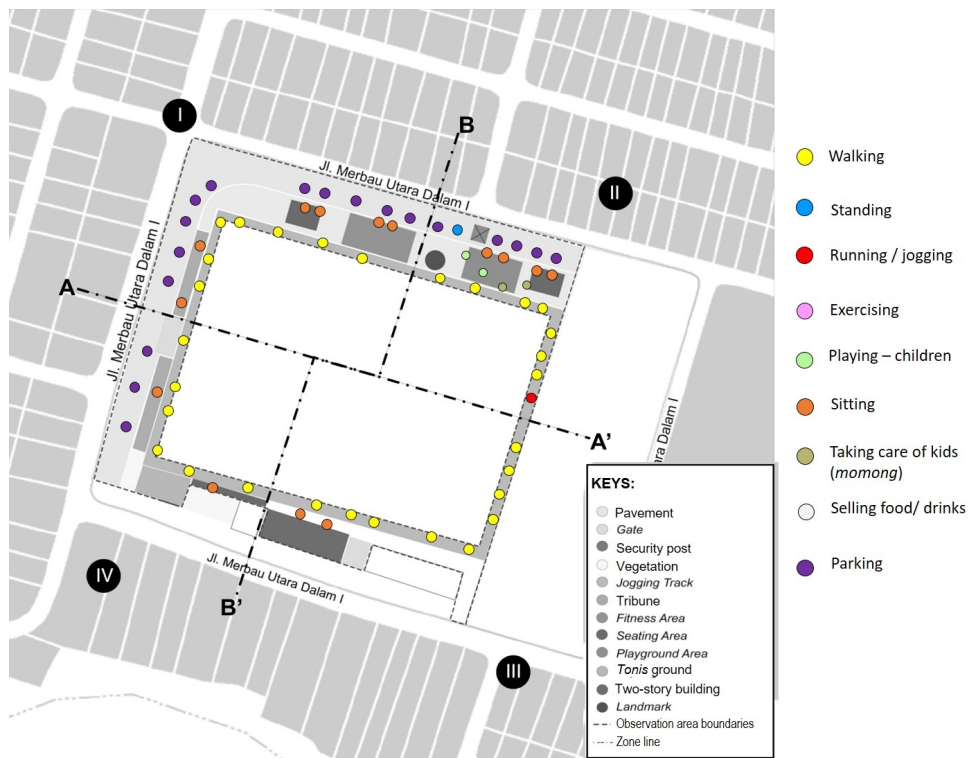
The analysis results with the Depth Map show areas of gray space with high visibility values. The infield area is not included in the discussion because it is a grass field, not an area covered with pavement. Depth Map analysis shows the values of visibility, convergence place, and integrated place. The highest visibility level value is 15661. The place with the highest value has a broader view of the spaces in *Merbau Square*. The spatial atmosphere of *Merbau Square* can be seen well from this point. The highest visibility is in zone I. It is on the North side of *Merbau Square* at the corner of *Merbau Street (Jalan Merbau Raya)* and *East Merbau Street (Jalan Merbau Timur)*. This corner is one of the access points for entering the area. Most visitors from outside the neighborhood take this street to access the square. They ride motorbikes or cars and then park their vehicles in the nearest place.

Gate counts measure how many paths pass through a specific place in the gray space of *Merbau Square*. The highest gate count is 221, which is in the middle because it is the convergence of five accesses to the square. However, it is not considered because it is a green space. So, the highest score for the gray space is 17, which is the meeting place for entrance No. I and II are on the edge of the grass field; see Figure 2. This place with the highest value is an essential node in the gray space of *Merbau Square*, where most of the visitors' activities are carried out. This place is near the place with the highest connectivity value.

The area as the access intersection to the square, which is *East Merbau Street*, and the neighborhood street to Entrance II has a value of 759. This area is filled by parked vehicles and belongs to visitors and housing residents. Near this parking area are a pos gambling (neighborhood security) and a monument as a field landmark. This area is used to sit or stand and chat casually. It has the highest integration value, 0.871896, because it is directly connected to Entrance II and other gray space areas, see Figure 3. So, this place can be called a gathering place. The gathering place lies in Zona I and II. Zone I and II are busier zones than the other zones, see Picture 4, because more people doing their activities are in the place. A mapping of the various people's behavior from the activities of sports, leisure, and snacks bought from the street vendors is presented in Figures 4a, 4b, 5a, and 5b.



**Figure 3.** The highest value of integrated place



**Figure 4a.** Place-centered map in the morning on weekdays

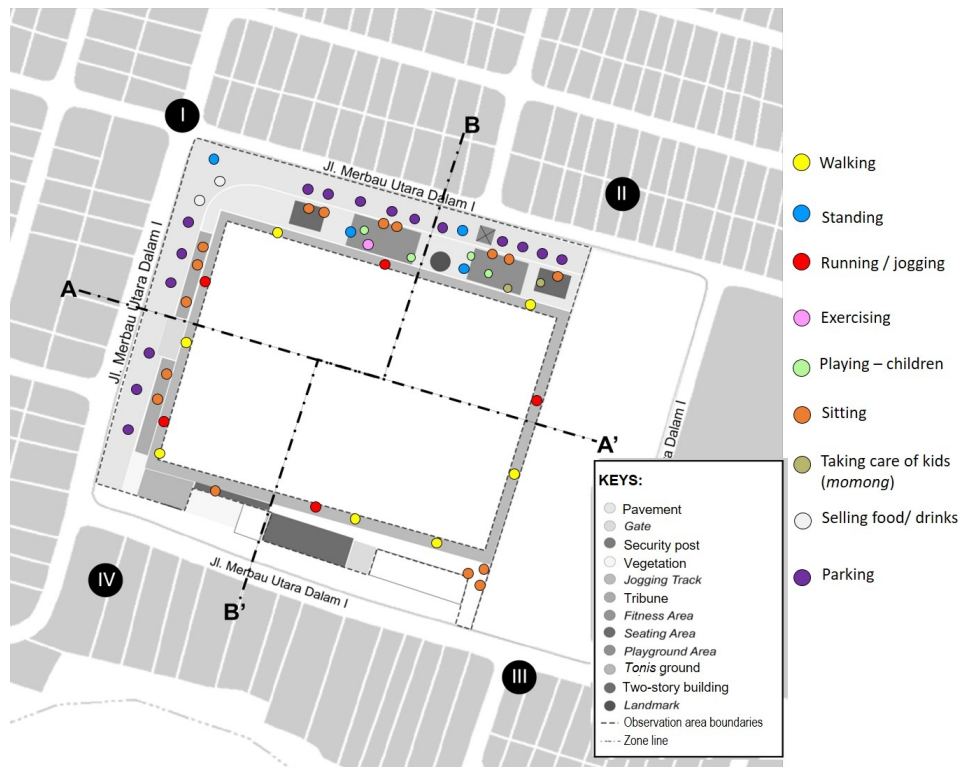


Figure 4b. Place-centered map in the afternoon on weekdays

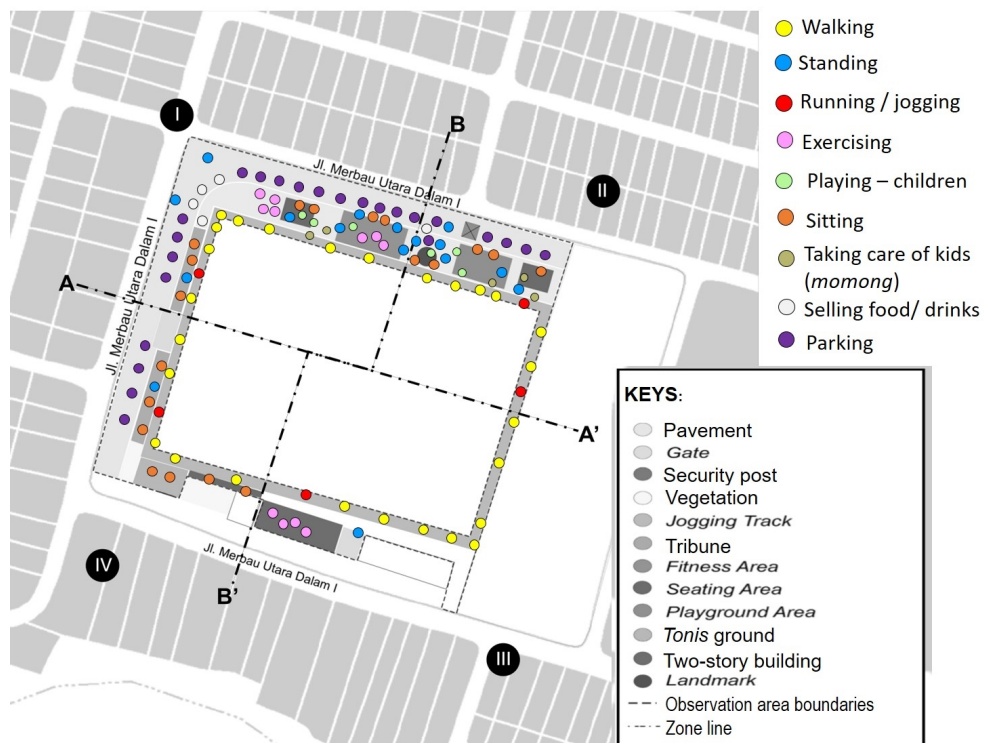


Figure 5a. Place-centered map in the morning on weekends



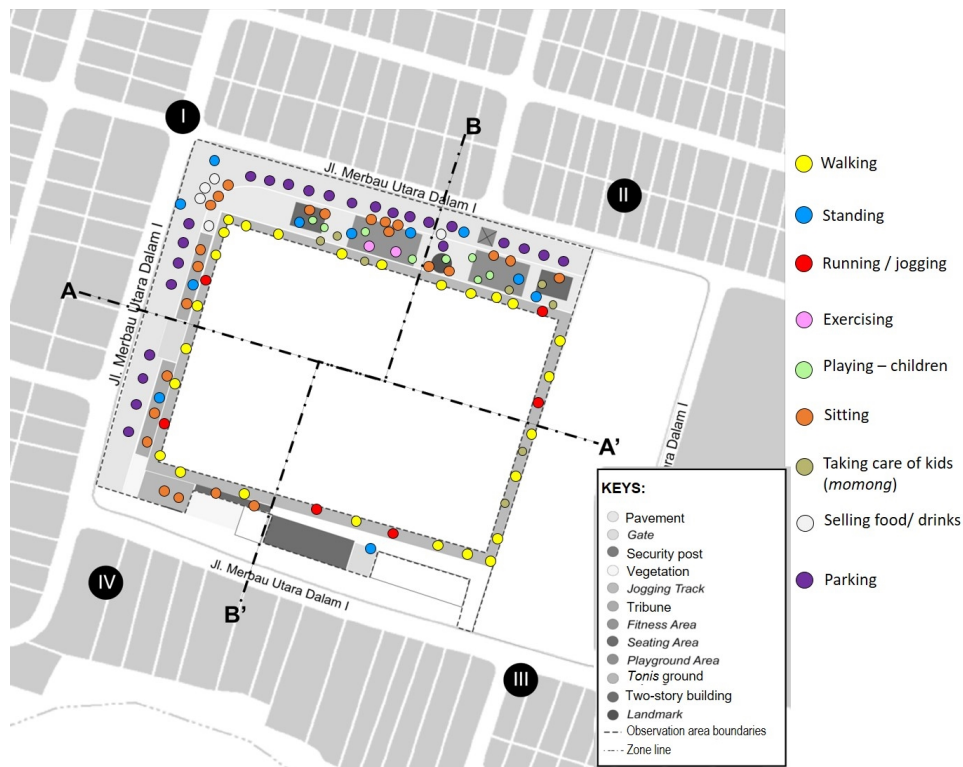


Figure 5b. Place-centered map in the afternoon on weekends



Picture 4. The situation in Zone I and II as the busiest place

Meanwhile, the other zones, III and IV, accommodate sports activities such as walking and jogging around the grass field, playing “tonnis”, and some exercises. Both zones also have leisure activities such as sitting, chatting, or sightseeing. The details of the behaviors are shown in Table 1.

## 4. Discussion

### 4.1. The People Activities

Field observations focus on human activities because of the behaviors related to their activities in the gray spaces. The observation found that most visitors were older adults active in walking or breathing exercises for health. These older adults feel comfortable and safe in their activities at

*Merbau Square*. These feels are influenced by the location of the square, which is in the middle of a residential area, where the road is not comprehensive, and in its surroundings, the number of vehicles passing is low, as well as adequate facilities such as the availability of public toilets, good quality pavement areas so that reduce the risk of slipping [23]. The layout of the spaces utilized for activities gives the impression of protection because there is a surrounding gray area boundary consisting of a 2-story building, a fence in the tribune area, and an intermediate space used for vehicle parking as a boundary with the neighborhood road. Older people can more easily access the field by vehicle or on foot [23][24]. From the results of interviews in the field, it was found that there were non-physical factors influencing it, namely the sense of ownership of this public facility [24]. They have been in the *Banyumanik* area for a long time, and this open space already exists, so when this open space was built, they were even more enthusiastic about using it. Some older adults in a group have exercise starting in the early morning, at 5.00 AM. Then more elderly do sports activities in the morning than in the afternoon [22].

The other groups of users are adults, male and female, and children. Adults are also active in sports such as walking or leisurely walking, jogging, or group exercises such as aerobics and Zumba. This user is not only from around the residential area but also from outside the area. The children exercise and play in the playground area, the jogging track, the grandstand and seating area, and the field landmark monument. Children ride bicycles or roller skate

around the field. Apart from physical sports activities, those visitors also use the gray space to relax, namely sitting and chatting, making telephone or video calls, and enjoying snacks they bought from the street vendors on the square's edge.

#### 4.2. The Utilization of Gray Space

The various activities that occur in this gray space are designated as *socio-tope* space [30]. The gray space as a *sociotope* space shows that social interaction occurs when visitors are active. Fellow visitors in the same place can chat for a moment even if they don't know each other. When the researchers sat on the edge of the field, other visitors greeted and talked to them. Researchers also had time to chat with residents, other visitors, and parking attendants. Visitors to the field, including parking guards, can recognize other regular visitors, residents, or new people. They behaved naturally and allowed people to come and do activities in the field. Social cohesion is visible in the gray space of the *Merbau* field. Social cohesion in that gray space where the visitors can mingle in their activities [31]. When there is a mass morning exercise event for *Padangsari* sub-district residents in this square, the atmosphere becomes more lively; that is, music is played and morning exercise is done together, attracting non-resident visitors to join in the mass exercise [25]. The aroma of food being fried or baked by food sellers also attracts people to come and buy. They come and flock around, waiting and sometimes chatting with customers [46]. *Merbau* Square is a gray space where activities are carried out, either sports, casual exercise, or leisure. In the afternoon, more adults, teenagers, and children visit the area than older people. Meanwhile, most visitors are on the weekends.

The existence of gray space in *Merbau* Square influences the surroundings. Several houses around the square opened stalls selling food and drinks and small shops. The order and the beautiful and comfortable square will attract people and influence the quality of the surroundings [27]. The people around the square care about this area. There are written rules and warning signs installed in several places to remind visitors to maintain cleanliness, order, and security in their activities at *Merbau* Square. Verbal and spontaneous warnings are also given when there are dangerous and disturbing actions, such as children playing at climbing landmark monuments. This endangers the children and also disturbs other visitors who are sitting nearby.

#### 4.3. Behavior in Gray Space

The pattern of utilization of *Merbau* Square can be known from studying the behavior of visitors [26]. In the morning, between 06.00 - 09.00 AM, and in the afternoon, between 04.00 - 06.00 PM, the atmosphere in the area is shadier than during the day [21][22]. The shadow is

influenced by the buildings surrounding and the trees. Some trees lie on the edges of the square. However, not all the shady areas are the most utilised places. The proximity of the place to the parking area and the entrance to the field area affects the number of people there. The results of behavioural analysis from the place-centred map, see Figure 4, show that the gray space with the most activity and variety of visitor behaviour is the north side, namely zones I and II. This area is less shady than areas in zones III and IV, close to the 2-story building for MSMEs, and big trees provide sufficient shade. The gray space around the building is shady because of the shade of the building and trees, but fewer people access that place. Analysis with Depth Map shows this area has the highest integration and connectivity values; see Figures 2 and 3. More people access the square from zones I and II and carry out activities in these zones. Both zones are connected directly to the parking area. Visitors walking or jogging around the field often start and end at points in these two zones. After encircling the square, they will sit relaxed in the existing seating area near the landmark statue or sit on the floor (*lesehan*) at the edge of the field. Another behaviour is that after going around the field to warm up, they join their group for group exercise. There is a walking sports community, where people gather first on the side of the field, usually near the more spacious fitness area. They warmed up together and received instructions from their coach. Then, they walked around the square using trekking poles. The behaviour of visitors after exercising is that some sit and rest and then chat with friends; some not only chat but also take photos or dance together to music recorded with a camera on one of their phones. Some sit and rest for a while, then leave the place. There is a playground for the children to do their activities, playing with swings, slide boards, climbing monkey bars, and a seesaw. However, the children could use the other gray areas for playing. There are some children riding bicycles. They ride around zones I and II or encircle the jogging track. There are also a few girls' rollers skating encircling the track. Toddlers play near their parents. So, they could play in the seating area by walking, running around, or playing ball. At the tribune, adults sit chatting, eating and drinking, or playing with their phones, and the children play up and down the steps of the tribune. The tribune spans along zones I and IV. Many people are in this place when it is shady. It is in the morning before 9 AM and afternoon after 3 PM. This place is connected directly to the parking area and is near the street vendors' place. The parking area is used for parking vehicles and for selling drinks or food by street vendors. The number of street vendors in this area is different day by day. The number is higher when the square is complete on the weekend, and they stay longer in this area. There are few street vendors on weekdays. Sometimes, one or two vendors only sell for a short time. These street vendors occupied the parking area by putting up a table or related equipment. Vendors can sell through the on-site parking attendant after obtaining permission from the field

management. The ramp, which is access to the second floor of the MSMEs building, is also utilized for socialising places. Some male or female people stand and chat on the ramp, or children play along it. Usually, after exercising, they rest and meet friends or neighbours, then take their place on it by standing.

The visitor's behaviour in the gray spaces of *Merbau* Square changes the way the utilization is [20]. *Merbau* Square's grey spaces accommodate socializing activities and are places with various behaviours. Every area and the facilities are utilised for sport and meeting people as long as they are shady and accessible.

## 5. Conclusions

Community behaviour in the gray space of *Merbau* Square is related to the interaction among visitors in recreational activities such as sports and relaxation in the Banyumanik neighborhood. As a public facility that has undergone development, the gray space' facilities are to improve *Merbau* Square's quality. The facilities help to identify the function of the area, such as the availability of seating, which is called the sitting area, the facilities for children's games for the playground area, the tennis court for tennis sports, and other areas. People use areas in this gray space to meet, *kongkow*, eat, and drink. If no seats are available, they can chat while standing or *lesehan*. An area that is easily visible and strategically accessible to enter the square is used to sell and gather, while this place is for parking vehicles. A shaded and easily accessible place becomes more comfortable for activities and can potentially make people's behaviour more diverse. Meanwhile, spaces exposed to more sunlight become circulation spaces so visitors pass through. This gray space became a *sociotope*, a space that functions as a place for interaction with the people within it. Place-centred behavioural mapping shows places in the gray space where community interactions occur. The results of the Depth Map analysis prove critical areas with high levels of social interaction. The Depth Map analysis results substantially impact socio-spatial patterns by revealing complicated links between spatial configurations and human behaviour. The depth analysis helps to characterise and predict socio-spatial experiences. Community behaviour in gray spaces forms social interactions due to social cohesion. Finally, this interaction between community behaviour and spatial design might potentially lead to changes in the function and utilization of gray spaces, emphasising the relevance of amenities, accessibility, and strategic positioning.

## Acknowledgements

The authors thank Mr. Mardi and Mrs. Sri Agustin Wulandari for providing facts and essential information about *Merbau* Square. We thank the visitors to *Merbau*

Square for allowing us to participate in the events. We also thank the Doctoral Program of Architecture and Urban Engineering, Faculty of Engineering, Diponegoro University, and the Architecture Program, Faculty of Architecture and Design, Soegijapranata Catholic University, for their assistance.

## REFERENCES

- [1] D. T. Do, "Public park behaviour in Da Nang: An investigation into how open space is used," *Front. Archit. Res.*, vol. 8, no. 4, pp. 454–470, 2019, doi: 10.1016/j.foar.2019.05.006.
- [2] A. M. Radja, A. Harisah, and M. M. Sir, "The Pattern of Public Space on Barrang Lompo Island as High-Dense Environment in Makassar-Indonesia," *Civ. Eng. Archit.*, vol. 10, no. 6, pp. 2322–2329, 2022, doi: 10.13189/cea.2022.100607.
- [3] L. Van Hecke *et al.*, "Public open space characteristics influencing adolescents' use and physical activity: A systematic literature review of qualitative and quantitative studies," *Heal. Place*, vol. 51, no. April, pp. 158–173, 2018, doi: 10.1016/j.healthplace.2018.03.008.
- [4] M. K. Firdaus, J. Sumabrata, D. M. Tampi, and ..., "Public Open Space in Realizing Sustainable Urban Development (Study: Environmental Park in East Jakarta, Indonesia)," ... *Ser. Earth ...*, 2019, doi: 10.1088/1755-1315/264/1/012005.
- [5] N. A. MALEK, "MEASURING SUCCESSFULNESS OF MALAYSIAN GREEN OPEN SPACES AN ASSESSMENT TOOL," *Theor. Empir. Res. Urban Manag.*, vol. 13, no. 2, pp. 21–37, 2018, [Online]. Available: <https://www.jstor.org/stable/10.2307/26422067>.
- [6] R. Suligowski, T. Ciupa, and W. Cudny, "Quantity assessment of urban green, blue, and gray spaces in Poland," *Urban For. Urban Green.*, vol. 64, no. August, p. 127276, 2021, doi: 10.1016/j.ufug.2021.127276.
- [7] K. S. AL-Hagla, "Towards a Sustainable Neighborhood: the Role of Open Spaces," *Int. J. Archit. Res. ArchNet-IJAR*, vol. 2, no. 2, pp. 162–177, 2008, doi: 10.26687/archnet-ijar.v2i2.239.
- [8] P. James *et al.*, "Towards an integrated understanding of green space in the European built environment," *Urban For. Urban Green.*, vol. 8, no. 2, pp. 65–75, 2009, doi: 10.1016/j.ufug.2009.02.001.
- [9] M. A. Benedict and E. T. McMahon, "Smart Conservation for the 21st Century.," *Green Infrastructure.*, vol. 20, pp. 12–17, 2002, [Online]. Available: <https://www.merseyforest.org.uk/files/documents/1365/2002+Green+Infrastructure+Smart+Conservation+for+the+21st+Century..pdf>.
- [10] L. R. Larson *et al.*, "Gray space and green space proximity associated with higher anxiety in autistic youth," *Heal—place*, vol. 53, no. June, pp. 94–102, 2018, doi: 10.1016/j.healthplace.2018.07.006.
- [11] K. Campbell, *Rethinking open space, open space provision and management: A way forward, report presented.*

- Edinburgh: Scottish Executive Central Research Unit, 2001.
- [12] S. Han *et al.*, "Behaviour in public open spaces: A systematic review of studies with quantitative research methods," *Build. Environ.*, vol. 223, p. 109444, Sep. 2022, doi: 10.1016/J.BUILDENV.2022.109444.
  - [13] M. J. Koohsari, "Public open space, physical activity, urban design and public health: Concepts, methods and research agenda," *Heal. Place*, vol. 33, pp. 75–82, 2015, doi: 10.1016/j.healthplace.2015.02.009.
  - [14] W. ZHU, J. WANG, and B. QIN, "Quantity or quality? Exploring the association between public open space and mental health in urban China," *Landsc. Urban Plan.*, vol. 213, no. May, p. 104128, 2021, doi: 10.1016/j.landurbplan.2021.104128.
  - [15] I. Y. Jian, E. H. W. Chan, Y. Xu, and E. K. Owusu, "Inclusive public open space for all: Spatial justice with health considerations," *Habitat Int.*, vol. 118, no. March, p. 102457, 2021, doi: 10.1016/j.habitatint.2021.102457.
  - [16] J. Lee, "Understanding outdoor gyms in public open spaces: A systematic review and integrative synthesis of qualitative and quantitative evidence," *Int. J. Environ. Res. Public Health*, vol. 15, no. 4, 2018, doi: 10.3390/ijerph15040590.
  - [17] Y. Liem and R. C. Lake, "The Meaning of Public Space of Kupang City Nostalgia Park," *ARTEKS J. Tek. Arsit.*, vol. 2, no. 2, pp. 149–158, Jun. 2018, doi: 10.30822/arteks.v2i1.48.
  - [18] J. Jacobs, *The death and life of great American cities*. Random House, 1961.
  - [19] Semarang City Government, *Regulation of the City of Semarang Regarding the Medium-Term Regional Development Plan (Peraturan Daerah Kota Semarang Tentang Rencana Pembangunan Jangka Menengah Daerah (RPJMD) Kota Semarang) 2021 – 2026 Semarang City Government*. Indonesia: Regional Regulation of the City of Semarang (Peraturan Daerah Kota Semarang), 2021.
  - [20] R. Buil and M. A. Piera, "Multi-agent system simulation for urban policy design: Open space land use change problem," *Int. J. Model. Simulation, Sci. Comput.*, vol. 7, no. 2, pp. 1642002–1, 2016, doi: 10.1142/S1793962316420022.
  - [21] Z. Guo, T. Setoguchi, N. Watanabe, and ..., "Public open space design study based on microclimate and spatial behaviour in hot and cold weather conditions in the downtown area," *Mod. Appl. Scinece*, vol. 12, no. 2, 2018, [Online]. Available: <https://pdfs.semanticscholar.org/2866/a92edd7158507d288c738e791e01422242f1.pdf>.
  - [22] S. Peng and M. Maing, "Influential factors of age-friendly neighbourhood open space under high-density high-rise housing context in hot weather: A case study of public housing in Hong Kong," *Cities*, vol. 115, p. 103231, 2021, doi: 10.1016/j.cities.2021.103231.
  - [23] X. Sun, L. Wang, F. Wang, and S. Soltani, "Behaviors of seniors and impact of spatial form in small-scale public spaces in Chinese old city zones," *Cities*, vol. 107, no. July, p. 102894, 2020, doi: 10.1016/j.cities.2020.102894.
  - [24] A. Lak, R. Aghamolaei, H. R. Baradaran, and P. K. Myint, "A Framework for Elder-Friendly Public Open Spaces from the Iranian Older Adults' perspectives: A Mixed-Method Study," *Urban For. Urban Green.*, vol. 56, no. September, p. 126857, 2020, doi: 10.1016/j.ufug.2020.126857.
  - [25] F. Aletta, "An experimental study on the influence of soundscapes on people's behaviour in an open public space," *Appl. Sci.*, vol. 6, no. 10, 2016, doi: 10.3390/app6100276.
  - [26] M. N. Al Ghifari and S. Z. Firdausan, "Perilaku masyarakat pada ruang terbuka publik di kampung Kebangsren Surabaya," *Sinektika J. Arsit.*, vol. 16, no. 2, pp. 80–86, 2020, doi: <https://doi.org/10.23917/sinektika.v16i2>.
  - [27] M. Carmona, "Place value: place quality and its impact on health, social, economic and environmental outcomes," *J. Urban Des.*, 2019, doi: 10.1080/13574809.2018.1472523.
  - [28] C. Swanwick, N. Dunnett, and H. Woolley, "Nature, role and value of green space in towns and cities: An overview," *Built Environ.*, vol. 29, no. 2, pp. 94–106, 2003, doi: 10.2148/benv.29.2.94.54467.
  - [29] A. Ståhle, "Sociotope mapping - exploring public open space and its scape planning practice," *Nord. J. Archit. Res.*, vol. 19, no. 4, pp. 59–71, 2006.
  - [30] W. Shih, J. Handley, and I. White, "Mapping Biotope and Sociotope for Green Infrastructure Planning in Urban Areas Wan-yu Shih, John Handley, Iain White," in *REAL CORP 2009*, 2009, vol. 6, no. April, pp. 22–25, [Online]. Available: [https://www.corp.at/archive/CORP2009\\_145.pdf](https://www.corp.at/archive/CORP2009_145.pdf).
  - [31] A. Kalolo, J. Mazalale, A. Krumeich, and M. Chenault, "Social cohesion, social trust, social participation and sexual behaviours of adolescents in rural Tanzania," *BMC Public Health*, vol. 19, no. 1, pp. 1–9, 2019, doi: 10.1186/s12889-019-6428-7.
  - [32] C. Wan, G. Q. Shen, and S. Choi, "Underlying relationships between public urban green spaces and social cohesion: A systematic literature review," *City. Cult. Soc.*, vol. 24, no. March, p. 100383, 2021, doi: 10.1016/j.ccs.2021.100383.
  - [33] SDGS National Secretariat (Sekretariat Nasional SDGS), "SDGs at a Glance (Sekilas SDGs)," *Ministry of National Development Planning (Kementerian PPN/ BAPENAS)*. <https://sdgs.bappenas.go.id/sekilas-sdgs/>.
  - [34] I. Y. Jian, J. Luo, and E. H. W. Chan, "Spatial justice in public open space planning: Accessibility and inclusivity," *Habitat Int.*, vol. 97, no. January, p. 102122, 2020, doi: 10.1016/j.habitatint.2020.102122.
  - [35] UN, "THE 17 GOALS | Sustainable Development," *United Nations*. <https://sdgs.un.org/goals> (accessed Oct. 16, 2021).
  - [36] F. A. Seti Putra, "State Islamic University (UIN) Walisongo Students and Padangsari Residents Cleaning Up at Merbau Field Semarang (Mahasiwa UIN Walisongo dan Warga Padangsari Resik-resik Lapangan Merbau Semarang)," *TribunJateng.com*, 2023. <https://jateng.tribunnews.com/2023/01/19/mahasiwa-uin-dan-warga-padangsari-resik-resik-lapangan-merbau-semarang#:~:text=Luas Lapangan Merbau yang tercatat,masuk Aset Pemerintah Kota Semarang>.
  - [37] Andika, "Hendi inspects Merbau and Gaharu squares, ensures the areas can be used as water catchments (Hendi Tinjau Lapangan Merbau dan Gaharu, Pastikan Area Bisa Difungsikan Jadi Resapan Air)," *Suaramerdeka.com*, 2021. <https://www.suaramerdeka.com/nasional/pr-04162149/hendi-tinjau-lapangan-merbau-dan-gaharu-pastikan-area-bisa-difungsikan-jadi-resapan-air>.



- [38] C. F. Ng, "Behavioral mapping and tracking," *Res. Methods Environ. Psychol.*, pp. 29–51, 2015, doi: 10.1002/9781119162124.ch3.
- [39] W. Zerouati and T. Bellal, "Evaluating the impact of mass housings' in-between spaces' spatial configuration on users' social interaction," *Front. Archit. Res.*, vol. 9, no. 1, pp. 34–53, 2020, doi: 10.1016/j.foar.2019.05.005.
- [40] H. Ji and W. Ding, "Mapping urban public spaces based on the Nolli map method," *Front. Archit. Res.*, vol. 10, no. 3, pp. 540–554, 2021, doi: 10.1016/j.foar.2021.04.001.
- [41] A. H. Sa'diyah, R. Nugroho, and O. Purwani, "Space Syntax as a Space Design Method in Creative Galleries in the City of Surakarta (Space Syntax Sebagai Metode Perancangan Ruang Pada Galeri Kreatif Di Kota Surakarta)," *Senthong*, vol. 2, no. 2, pp. 807–816, 2019.
- [42] J. Gehl and B. Svarre, *How To Study Public Life*. Washington: Island Press/Center for Resource Economics, 2013.
- [43] W. H. Ittelson, H. M. Prohansky, and L. . Rivlin, "The Use of Behavioral Maps in Environmental Psychology," in *Environmental Psychology: Man and His Physical Setting* Holt, L. . Rivlin, Ed. New York: Rinehart & Winston, 1970, pp. 658–668.
- [44] Haryadi and B. Setiawan, *Architecture, Environment, and Behavior: An Introduction to Methodology Theory and Applications (Arsitektur, Lingkungan, dan Perilaku: Pengantar ke Teori Metodologi dan Aplikasi)*. Gadjah Mada Univ. Press, 2014.
- [45] D. N. Hayati, "Improving Public Facilities, Mayor Hendi Efforts to Build Sports Fields Starting in 2021 (Tingkatkan Fasilitas Publik, Wali Kota Hendi Upayakan Pembangunan Lapangan Olahraga Dimulai pada 2021)," *Kompas.com*, 2021. <https://kilasdaerah.kompas.com/semarang/read/2021/03/04/09500361/tingkatkan-fasilitas-publik-wali-kota-hendi-upayakan-pembangunan-lapangan>.
- [46] M. Ba, J. Kang, and Z. Li, "The effects of sounds and food odour on crowd behaviours in urban public open spaces," *Build. Environ.*, vol. 182, no. 66, p. 107104, 2020, doi: 10.1016/j.buildenv.2020.107104.