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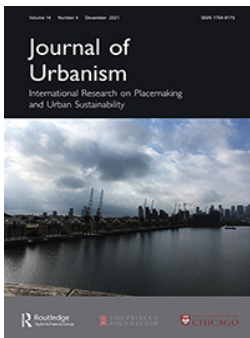
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Realised pedestrian accessibility of an informal settlement in Jakarta, Indonesia

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ABSTRACT

To date, little is known about the interplay between transport, land use and the social systems that influence potential and realised accessibility in Southeast Asia. This paper aims to understand these relationships in an informal settlement – a *kampong* – at the edge of the upscale Menteng district, Jakarta. We applied a mixed-methods approach of (1) a computational street network analysis using space syntax, (2) video analysis to understand travel behaviour and land use and (3) an analysis of street users' experiences collected through interviews. Our findings indicated that the pedestrian accessibility was not fully realised due to unsupportive land uses and negative perceptions of walking experienced by kampong inhabitants. Marginalised groups became captive pedestrians limited in their mobility choices. This study provides insights into Jakarta's informal settlements and how urban planning can contribute to sustainable development for inclusive, safe, and resilient cities.

1. Introduction

Numerous international transport and planning frameworks and guidelines mention the importance of achieving "access for all", defined as providing everyone with equal access to socioeconomic opportunities regardless of their age, gender, or race (United Nations 2016; World Bank 2016), which is often adopted into policy documents at the national and city levels. This is usually measured as potential accessibility, defined in transport literature as the ease of reaching certain destinations (Bertolini 2017; Ferreira et al. 2012; Geurs and van Wee 2004). Spatial cognition and natural movement theories define accessibility in terms of wayfinding (Hillier and Hanson 1984; Hillier et al. 1993). In practice, accessibility is often measured in relation to key urban functions such as the required time to reach schools or health-care services by using specific transport modes (Weiss et al. 2018).

However, the interplay between the transport and land-use system (Geurs and van Wee 2004; Wegener and Fürst 1999), the socioeconomic system and individual capabilities (Cass, Shove, and Urry 2005) creates different levels of accessibility. Individual characteristics such as age, gender, and familiarity with an area can influence pedestrian route choices beyond the wayfinding process (Willis et al. 2004). Pedestrians also tend to

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exhibit spatially related tendencies such as choosing the straightest path that affects route choice decisions (Dalton 2003; Hillier 2012). This results in differences in realised accessibility.

Conventional urban and transport planning practice often use and refer to the potential accessibility measures which disregard individual influences on realised accessibility (Preston and Rajé 2007). It neglects those who live in a highly accessible location but have insufficient capabilities to travel; for example, due to the unavailability of transport services, having physical disability, or inability to afford transport costs (Tan 2019). The challenge to planning and designing inclusive and sustainable cities is to understand realised accessibility through individual characteristics in a specific societal and spatial context.

This above challenge is especially true for urban kampongs as examples of unplanned and informal settlement usually with low-income inhabitants (Nas et al. 2008). These informal settlements are a common phenomenon in rapidly growing metropolitan cities of Southeast Asia due to intensifying rural-urban migration (Buijs, Tan, and Tunas 2010). In Indonesia, 3.9 million households live in informal settlements scattered throughout the megacity and often in close proximity to planned developments (Cities Alliance 2015).

For kampong inhabitants, car ownership is not common due to limited finances. They mainly rely on walking, motorcycles and public transport to access key urban functions. In a car-oriented city such as Jakarta, the economic situation of kampong dwellers poses a challenge to achieving "access for all". Women, children, the elderly and those with disabilities are particularly affected (Witoelar et al. 2017).

Focusing on an urban kampong at the edge of Jakarta's upscale Menteng district, our study explores how the interplay of the transport, land use, and the social systems affects potential and realised access to key functions. Building upon current debates on land use and transport integration (Bertolini 2017; Geurs and van Wee 2004), transport-related social exclusion (Church, Frost, and Sullivan 2000; Lucas 2012), and mobility inequality (Ohnmacht, Maksim, and Bergman 2009), we propose a mixed-methods approach to collect empirical data and analyse the kampong's socio-spatial structures to juxtapose potential accessibility with realised accessibility to key urban functions.

This mix of quantitative and qualitative methods distinguishes our study from previous urban studies on Jakarta (Cybriwsky and Ford 2001; Lo 2010; Susantono 1998) by incorporating an objective spatial configurational analysis and an analysis of street user's perspective. Through the use of on-site and off-site mapping, we aim to improve the current data on street networks and use within informal settlements. The use of multiple data sources (i.e. mapping, interviews and videos) allows for a triangulation of our findings. Our analysis combines quantitative methods such as spatial and statistical analysis with qualitative methods such as interviews that are analysed through coding to present multiple facets of how realised accessibility is constructed and experienced. This mix of methods also provides a voice for marginalised groups, who are often neglected in official planning processes in Jakarta.

2. A mixed-methods approach for realised accessibility

Access to educational facilities is considered a basic human right necessary for individual wellbeing and is seen as a pathway towards social equality (United Nations 2019). By

focusing on this key function, our exploratory approach to a single case study (Yin 2003) allows for an in-depth understanding of the interplay between transport, land use and social challenges to potential and realised access to key functions. The kampong in Menteng is typical of the many informal settlements coexisting with upscale residential units and commercial blocks in Jakarta (Nas et al. 2008). The contrast of formal and informal settlements makes this a typical case of differences between potential and realised accessibility for marginalised inhabitants beyond the formal planning process.

To analyse the realised accessibility of an informal settlement, we employ a mixed-methods approach combining (1) a computational analysis of the street network using space syntax, (2) visual analysis of video recordings, and (3) street interviews on inhabitants' experiences of using the street. The computational analysis provides empirical evidence about Jakarta and Menteng's spatial structure and street network. The visual analysis of video recordings allows for the study of unmapped areas, mobility behaviours and land uses. The street interview provides information on social interactions and user experiences.

2.1. Computational analysis with space syntax

Space syntax reveals how spatial configuration influences people's perception and the use of space. This relation shapes movement patterns (Hillier and Iida 2005) and can be used to infer the flow and patterns of movement (Dalton 2003; Hillier 2012). Space syntax, as a graph theory approach to understanding urban structures, works with the concept of a hierarchy of centrality represented as accessibility (Yamu 2014). Further inference of movement through specific spatial configurations such as spatial integration or segregation, walkability, or crime prevalence can be generated and tested based on this relation. The relational analysis of street network configurations correlates with actual movement and can be used to explain land uses and location choices (van Nes and Yamu 2018). However, the interpretation of space syntax analysis should be linked to the understanding of human behaviour and socio-spatial processes (van Nes and Yamu 2018).

To start, we generated a georeferenced street network model for Greater Jakarta using road-centre lines downloaded from OpenStreetMap (OSM) following Turner (2007). Building upon this model, we applied a hybrid modelling approach combining the OSM data with a manually drawn axial map for the Menteng neighbourhood. An axial map – an abstraction of urban space for space syntax analysis – comprises of a minimum set of axial lines that depict sightlines and movement paths (Hillier et al. 1993). This hybrid model allowed us to overcome the limited data available for Jakarta and further integrate data (gathered from the video recordings) on informal paths within the informal settlement. The axial map of the kampong was verified via three field visits in November – December 2018 as the authors marked the route from "walking with video" and compared it to the OSM data. The Menteng street network models include (1) a pedestrian model covering all streets accessible by walking and (2) a vehicular model covering streets for general public access by vehicle, whereby streets with restricted access for vehicles (e.g. gated streets) are not taken into consideration.

The space syntax method uses the following two main measures to understand accessibility: (1) integration representing *to-movement* or where potential destinations might be within the spatial configuration and (2) choice representing *through-movement* or potential route choices (Al-Sayed et al. 2014; Karimi 2012; Yamu 2014). In mathematics, the integration

measure is also known as "closeness", while the choice measure refers to "betweenness". In this paper, we applied the analysis of normalised angular integration (NAIN) for the former and normalised angular choice (NACH) for the latter. NAIN indicates the likeliness of a street segment as a destination and highlights activity centres. NACH, on the other hand, refers to potential route choice (Dalton 2003; van Nes and Yamu 2018), which measures the likeliness of a street segment to be traversed among all possible pairs of start and end points within a certain radius. The normalisation adjusts both measures according to a network's geographical size to allow for eventual comparison (Hillier, Yang, and Turner 2012). For both measures, we applied a citywide (N radius) to represent vehicular movement and a local radius to represent pedestrian accessibility (Hillier 1999). The local radius was set at 650 meters, which is defined from 10% of the system coordinates of the model (Yamu and van Nes 2019).

The results from the space syntax analyses were then superimposed with georeferenced locations of educational facilities (n = 340) in GIS (geographic information system) software. For better readability, the visual representation of the space syntax results is simplified by highlighting only highly accessible street segments (colour range of red to yellow). The school data set consisted of four categories: (a) 61 data points for preschools for children under the age of 6, (b) 150 data points for primary schools for children aged 6 to 12 years, (c) 92 data points for secondary schools for students aged 13 to 18 years, and (d) 37 data points for tertiary educational facilities for students older than 18 years. A Pearson correlation was conducted to identify a relationship between the distribution of educational facilities and NACH values for each street segment.

2.2. Visual analysis from video recordings

Videos were taken by the authors while walking or riding a motorcycle as a passenger in the informal settlement to collect observational data about social activities, mobility behaviour and land uses. Using the "walking with video" approach for recordings allows authors to experience the context (Pink 2007) as compared to observing travel behaviour through installing a static camera.

Recordings were conducted on three different days and at different times: (1) weekday off-peak hours on 23 November 2018 from 11am to 1pm, (2) weekend off-peak hours on 24 November 2018 from 11am to 1pm, and (3) weekday peak hours on 7 December 2018 from 8am to 10am. For the video recordings, the authors asked for permission from the Head of the neighbourhood (*pak RW* in Indonesian) to ease suspicion from kampong residents. In total, there were three videos with an average recording time of 42 minutes. Analysis was conducted by taking video stills for each street segment to identify the following: street width, dominant land-use functions, transport modes, sidewalks, presence of pedestrians, barriers for pedestrians, and street activities. Video observational data for each street segment are juxtaposed with space syntax analysis to provide detailed insights into socio-spatial interactions.

2.3. Analysing social interactions and experiences from street interviews

To obtain insights into the socio-spatial dynamics in relation to mobility and access to key urban functions of kampong inhabitants, we conducted interviews on the streets in the

Table 1. Examples of coding for analysing street interviews.

| Respondent ID	Street interview transcription	Code categories
JKTB29	(I) cannot drive a motorcycle, so I give my right of way, (I have) to be **cautious**	**Bold**: perceived safety *Italic*: past experience
JKTB40	(I feel) **wary** if someone drive too fast	Underline: reasons for safety
JKTB12	already used to, no problem *so far*	
JKTB33	*so far* it is **safe** because (I) walk slowly and carefully	

informal settlement. We approached people on the street who were engaged in social interactions such as chatting with their neighbours or purchasing items from street vendors. First, respondents were asked to indicate their feelings or emotions when they are traversing the street (e.g. walking, driving). They were then asked to rate their mobility experience on a table with a 4-point Likert scale. The scale ranged from very negative to negative, positive, and very positive. The neutral rating was for respondents who indicated that they had no attached emotions to their individual travel experiences. Based on the responses, we followed up with an open-ended question on their rationale. In addition, we registered the respondents' age, gender and most frequently used transport mode.

75 responses were gathered in total, of which 25 respondents were female and 50 were male with ages ranging from 16 to 78 years. The quantitative responses (i.e. rating of mobility experience, gender, and most frequently used transport mode) were analysed using descriptive statistics. The qualitative responses were coded using an inductive coding tree, whereby code categorisation emerged from the interview instead of a predefined theoretical framework (Fereday and Muir-Cochrane 2006) (Table 1).

3. Case: an urban kampong at the edge of the upscale Menteng district, Jakarta

Jakarta, the capital of Indonesia, is a typical Southeast Asian megacity undergoing rapid urban growth. The radius between the city centre and the urban fringe has expanded from 10 km in the 1970s to 45 km in 2015 (Winarso, Hudalah, and Firman 2015). The city now covers 662 km^2 with over ten million inhabitants (Jakarta Bureau of Statistic 2017), while the Greater Jakarta covers 7,500 km^2 with an estimated thirty million inhabitants (Winarso, Hudalah, and Firman 2015). The urban expansion is mainly geared towards private vehicle use driven by road expansion strategies, while the pedestrian networks are left fragmented (Hidayati, Yamu, and Tan 2019).

Jakarta is a car-oriented city characterised by high motorisation rates, inadequate non-motorised and public transport infrastructures, unintegrated transport and land-use planning connecting to widening socioeconomic divide (Cybriwsky and Ford 2001; Lo 2010; Susantono 1998). This is confirmed by our citywide integration analysis (Figure 1) where the inner and outer ring roads for vehicular traffic in the south are the most integrated and accessible roads. The highlighting of Jakarta's southern inner and outer ring roads in the analysis indicates the distribution of key activities along these roads, such as universities, hospitals, offices, and big-box shopping malls. These key activities are at locations conveniently accessible mainly by cars and have large parking lots. In the absence of a well-connected and reliable public transport system (ITDP 2019), these street
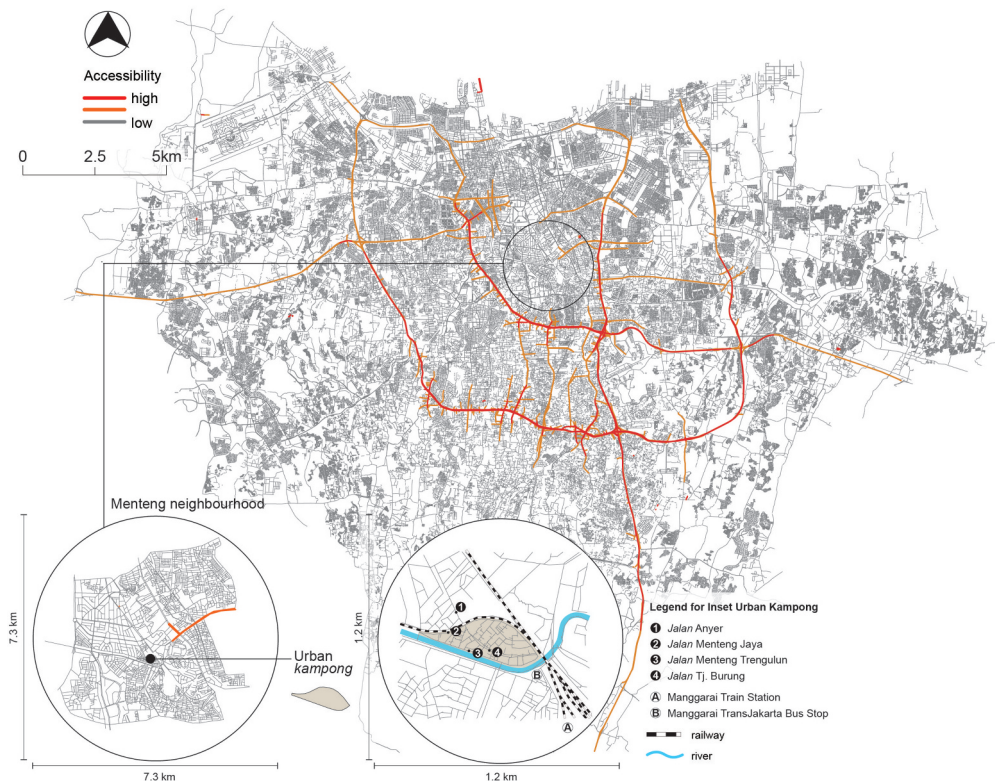
Figure 1. Citywide integration analysis for Greater Jakarta with a zoom in for Menteng neighbourhood and the informal settlement (NAIN radius N).

network configurations disadvantage those without access to a private motorised vehicle as their mobility options to access these key activities are limited. Here, walking is problematic across the city since sidewalks are rare (except for areas with high economic importance such as *Jalan* Thamrin), pedestrian safety is compromised by chaotic traffic and high levels of air pollution (Kompas 2019a).

In this context, low-income inhabitants are the most disadvantaged as they are captive pedestrians due to their limited transport options. Inhabitants of our case study – the urban kampong in Menteng district – belong to this group. The kampong is located in Central Jakarta within 5–10 minutes walking distance from Manggarai train station and the Manggarai TransJakarta bus stop (Figure 1). While the kampong location indicates a high potential for public transport accessibility, the use of public transport might be less preferable due to unreliable schedules, route indirectness, and inadequate facilities for first and last mile connectivity (ITDP 2019; Susilo, Joewono, and Santosa 2010). In general, there have been negative perceptions of public transport in Jakarta as reported in the media (Media Indonesia 2016; Kompas 2019b; Detik Finance 2020), which is reflected in the public transport mode share of only 19% (CNN Indonesia 2019). Despite public transport improvements, such as the operation of mass rapid transit in March 2019, public

transport ridership remains low compared to the massive use of private transport (Kompas 2019c).

Although it is not officially named as such, the informal settlements are known as the "Menteng urban kampong" by locals and consist of an area of 0.12 km^2. This kampong is a typical representation of the socioeconomic divide in Jakarta with posh commercial centres, offices and elite dwellings interspersed with informal settlements inhabited by the urban poor. The kampong in our case study is spatially challenged, squeezed in between the West Flood Canal – also known as the Ciliwung River to the locals – and the railway tracks leading to Manggarai train station (Figure 1).

The kampong is characterised by a high population density, small housing plots, and narrow alleys of less than 2 metres in width. In general, urban kampongs emerged through a self-organising process where low-income inhabitants occupied vacant lands or leftover plots – such as riverbanks or along railway tracks – with no proper infrastructure (Kusno 2015; Nas et al. 2008). Historically, a kampong is a settlement unit with inhabitants from the same origin, such as Kampong Melayu that was formed by Malay dwellers during the Dutch colonisation (Nas et al. 2008; Zaenuddin 2018). Over time, kampongs were divided or merged into a new administrative territory and some kampongs remain only through local knowledge. Most of the kampongs are perceived as slums due to their deprived conditions (for details about government' standards of slums, see Department of Public Work 2006). Despite government efforts to provide the basic infrastructure through the Kampong Improvement Program since 1969, there are still around 350 kampongs categorized as slums in Jakarta (Supriatna and van der Molen 2014).

In the kampong streets, social interactions such as children playing, neighbours chatting, and grocery shopping are mixed with motorised and non-motorised traffic. The kampong's spatial configuration and strong community ties create a safe environment for the locals with "eyes on the streets" (Jacobs 1961) allowing for a natural surveillance (Hillier 2004). Outsiders who use its streets as shortcuts to the station and the surrounding areas therefore often feel uncomfortable. This is confirmed during our walking with video process as some kampong inhabitants are seen exhibiting suspicions toward our research activity. Local suspicions toward strangers are not unusual or surprising and have been widely recognised as a challenge of studying informal settlements in Indonesia (Adianto, Okabe, and Ellisa 2014; Chandra and Diehl 2019). To avoid further suspicion, formal permission was requested and obtained from the Head of the neighbourhood (*pak RW*), which greatly eased the process of video recording and street interview activities and enabled an "insider perspective".

4. Results and discussion

4.1. Computational analysis with space syntax and key urban functions

The through-movement analysis at N radius indicated a high potential for vehicular movement by highlighting Jakarta's main street and road network (Figure 2). Important streets highlighted by the analysis are, for example, (a) *Jalan* Salemba Raya, a main road leading to Jakarta's economic hubs such as Senen Market; (b) *Jalan* Sultan Agung connecting Manggarai train station with the main thoroughfare *Jalan* Sudirman-Thamrin, and (c) *Jalan* Pramuka collecting commuters from East Jakarta and the town of Bekasi to offices
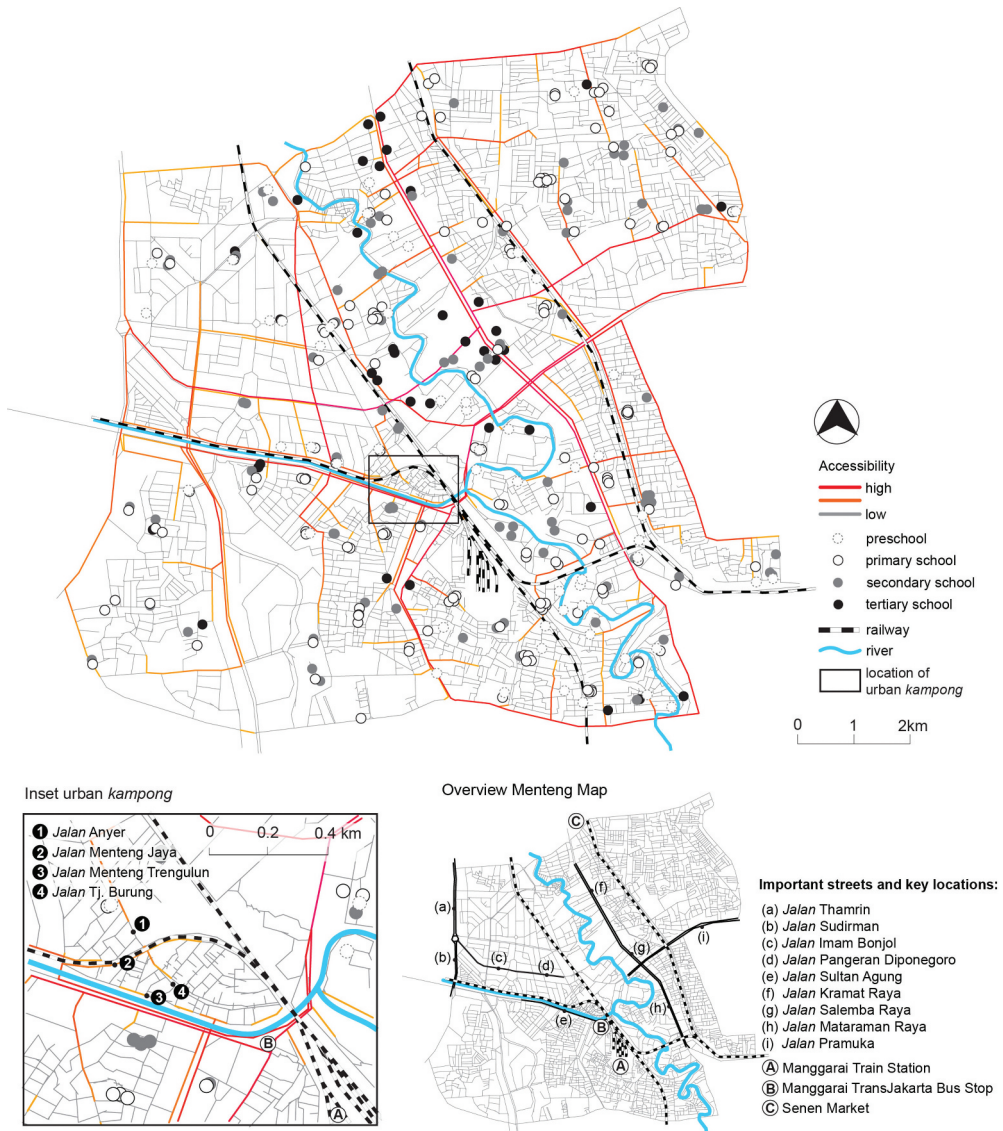
Figure 2. NACH N radius: Vehicular through-movement analysis for Menteng neighbourhood and the urban kampong with mapped educational facilities.

located in Central Jakarta. Furthermore, an indication of high potential vehicular movement can also be found in streets in wealthy neighbourhoods such as (d) *Jalan* Pangeran Diponegoro, which traverses consulate offices and ambassadors' houses (Figure 2). *Jalan* is an Indonesian term used to describe a thoroughfare regardless of its hierarchy, from a highway, road, street, to a main alley, such as the entrance street to a kampong. Inside the kampong, a small alley is generally referred to as a *gang*. For the urban kampong, the NACH N radius analysis highlighted the entrance streets to the kampong (i.e. *Jalan* Menteng Trengulun and *Jalan* Menteng Jaya, Figure 2 inset). These streets are the endpoints where cars can be used before getting to the narrow kampong's inner streets.

Juxtaposing the NACH N radius with educational facilities, we can discern a pattern that tertiary schools are mostly located along highlighted streets, such as *Jalan* Salemba Raya. This might imply that the location of tertiary schools follows the logic of vehicular through-movement.

In comparison to the analysis for vehicular movement, the potential through movement analysis at local radius (Figure 3) depicts a pedestrian movement with no clear hierarchical structure. Highlighted streets in NACH local radius analysis appear as fragmented short lines. Streets with a high potential for pedestrian movement form a dispersed network for the Menteng neighbourhood. In the urban kampong, however, the local pedestrian network forms a continuous spatial backbone (Figure 3 inset). This is represented by the two main kampong streets that are highly integrated, *Jalan* Menteng Trengulun and *Jalan* Menteng Jaya, and the radial street (i.e. *Jalan* Tj. Burung) (See Figure 3 inset).

While the radial street in the kampong has a high potential of pedestrian through-movement, it lacks the potential for vehicular movement. The narrowness of the kampong streets adds to the "island behaviour" of the kampong. Informal settlements are known to be lively within their boundaries but disconnected from the remaining city (Budiarto 2003). Kampong residents can easily access key functions located within walking distance but face difficulties accessing key functions across the city (Budiarto 2003) unless they have access to private-motorised vehicles. In Figure 3, the location of educational functions at all levels do not appear to follow the logic of pedestrian network. A zoom in of the urban kampong indicates that only some schools are located along the highlighted pedestrian through-movement routes. This implies that the options of accessing educational functions from the kampong through walking are limited.

Merging the data points for educational facilities, especially their entrances, with the street network model using a spatial joint operation in GIS, we analysed the spatial correlation between potential access for vehicular and pedestrian movement to educational facilities (Table 2).

Employing a bivariate correlation ($\alpha \leq 0.05$), we found a significant correlation between school locations for pre, primary and tertiary educational facilities and potential accessibility by vehicular movement. No significant correlation was found between all school levels and potential pedestrian accessibility (Table 2). The weak correlations might be attributed to the number of schools located in dead ends, which generated a very low numerical value for both NACH analyses with N and local radius. These dead ends are quite common in Menteng, particularly towards the river or railway tracks.

The negative correlation between preschools and primary schools' locations and vehicular through-movement indicates less accessibility to these education facilities by vehicles. This could be attributed to the Indonesian planning standards (SNI 03–1733–2004), which states that preschools and primary schools should be accessed without crossing the highway to ensure traffic safety for children going to school. However, these schools do not correlate with higher potential pedestrian accessibility. The reason for this might be the discontinuous pedestrian network (see Figure 3).

On the contrary, the positive correlation of tertiary educational facilities (i.e. universities) with potential vehicular accessibility suggests that these facilities are easily reached by motorised vehicles. For tertiary schools, accessibility by motorised modes can increase the attractiveness for potential students; especially, considering students and employees
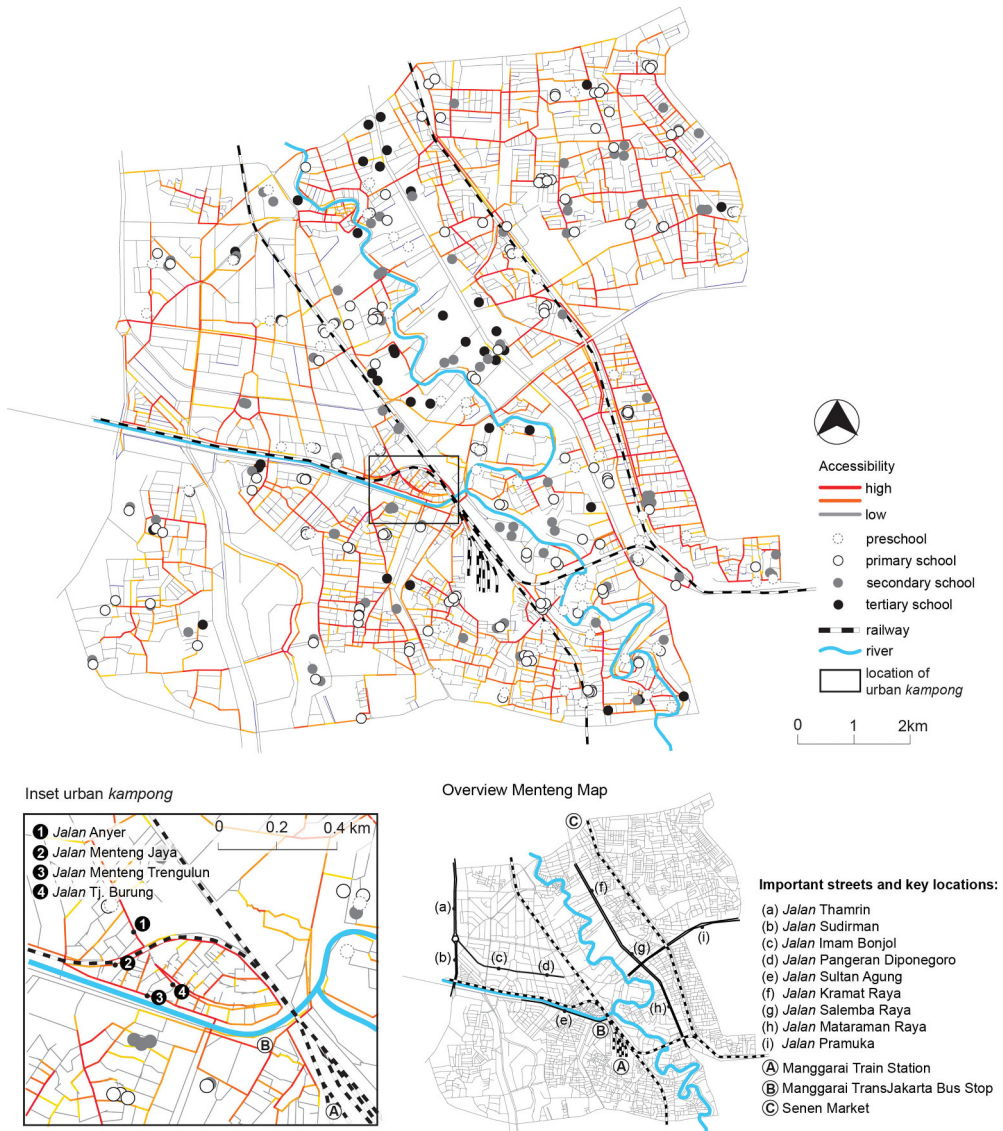
Figure 3. NACH local radius: Pedestrian through-movement analysis for Menteng neighbourhood and the urban kampong with mapped educational facilities.

Table 2. Correlation of educational facilities location and potential through-movement.

		Preschool	Primary	Secondary	Tertiary
NACH N-radius (potential vehicular through-movement)	Pearson Correlation	**−0.109***	**−0.143****	0.096	**0.226****
	Sig (2-tailed)	0.045	0.008	0.076	0.000
NACH local radius (potential pedestrian through-movement)	Pearson Correlation	−0.084	−0.064	0.104	0.055
	Sig (2-tailed)	0.124	0.242	0.055	0.308

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

are at an eligible age to have driving license. This, in turn, supports an extensive use of motorised vehicles by students and employees.

As pedestrian accessibility was not found to correlate with the location of educational facilities, this implies difficulties in accessing such facilities by walking. This suggests how social disadvantages (e.g. low income) coupled with transport disadvantages can result in limited option to access educational opportunities, and further lead to social exclusion (Church, Frost, and Sullivan 2000; Lucas 2012). These conditions impact the mobility choices and behaviour of kampong inhabitants. To compensate for discontinuous pedestrian networks, inhabitants appear to opt for using motorcycle, including the use of ridesourcing services to improve their personal mobility and accessibility. Although using a motorcycle has a lower carbon footprint and occupies less space in traffic compared to a car, the collective greenhouse gas (GHG) emissions from motorcycles can surpass those from cars and public transport (Suatmadi, Creutzig, and Otto 2019). Recent news has claimed that the extensive use of motorcycles in Jakarta has contributed to 45% of air pollution compared to 21% from buses and 16% from cars (Kompas 2019a). While the polluting characteristics can be reduced through legislation, licensing, and testing, the extensive use of motorcycles due to the mismatch in spatial configurations and access to key urban functions still contributes to Jakarta's vehicular-dominated society, which is counterproductive to sustainable development.
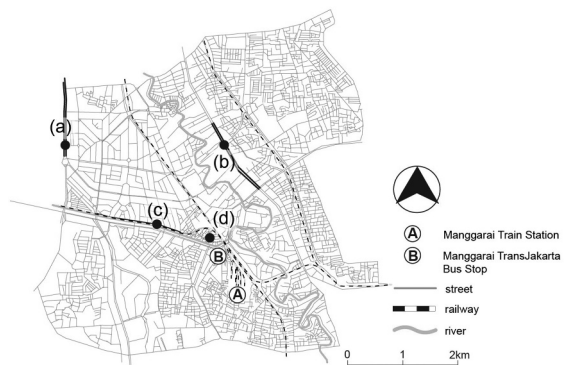
4.2. Video analysis findings

The analysis of the video recordings verified the spatial analytical results of accessibility in Menteng and its urban kampong. First, we identified examples of different street profile typologies connected to land uses and space syntax analysis results for both potential vehicular (NACH N radius) and pedestrian accessibility (NACH local radius) (Figure 4(a–d), Table 3). The numerical values of NACH N radius and NACH local radius are divided into three categories: high (the highest quartile), intermediate, and low (the lowest quartile). For NACH N radius, street segments with a value of >1.091 are categorised as high and <0.805 as low, while for NACH local radius, street segments with a value of >1.164 are categorised as high and <0.843 as low. Street segments with a value in between high and low are categorised as intermediate.

Major roads such as *Jalan* Thamrin and *Jalan* Salemba Raya show a high potential for vehicular movement, but low potential for pedestrian movement (Table 3). The video depicts dominant vehicular use on these roads. On *Jalan* Thamrin, it is mostly white-collar employees walking on the sidewalk (Figure 4(a)). As one of Jakarta's major thoroughfares, with mostly high-end shopping and office spaces, *Jalan* Thamrin has recently undergone pedestrian improvement projects such as sidewalk widening (Kompas 2019d). On *Jalan* Salemba Raya, the video revealed slight differences. Here, pedestrian movements are often interrupted by on-street parking and street hawkers (Figure 4(b)). Land use along *Jalan* Salemba Raya is dominated by offices and public facilities.

Streets in the upscale neighbourhood, such as *Jalan* Laturharhary, showed high potential for vehicular accessibility and intermediate potential for pedestrian accessibility in the spatial analysis (Figure 4(c), Table 3). However, the recordings indicated a high presence of cars with very few pedestrians on the street. This can be attributed to the large block of residential houses creating an unconducive environment for walking.

(a) Major road (*Jalan* Thamrin)
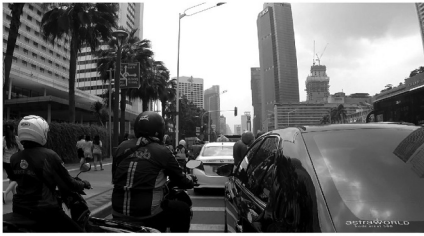
(b) Major road (*Jalan* Salemba Raya)

(c) Street traversing wealthy residential area (*Jalan* Latuharhary)

(d) Urban kampong street

Menteng Neighbourhood

Ⓐ Manggarai Train Station
Ⓑ Manggarai TransJakarta Bus Stop
— street
━ railway
~ river

0   1   2km

Figure 4. Different street profiles.

Different block sizes form different urban grains that are linked to land use (Schlossberg et al. 2015). Larger blocks in residential areas have a coarser urban grain, which directly affects pedestrians' route choices since they naturally discourage pedestrian movement. Moreover, residents of this upper-class neighbourhood along *Jalan* Latuharhary tend to travel by car instead of walking. This further hints at the socioeconomic importance of our analysis.

Conversely, the urban kampong's narrow alley (Figure 4(d)) demonstrated a high potential for pedestrian movement and low potential for vehicular movement. The streets here showed an emerged shared space logic (Speranza 2018) where different speeds mingle such as pedestrians, motorcyclists, people chatting with a neighbour, and street hawkers. Contrasting street usage and activities in the kampong's streets versus main roads such as *Jalan* Thamrin illustrates a vast difference in street layouts and corresponding socioeconomic divides. There is a car-dominant spatial configuration of areas inhabited by the urban rich within a mere two kilometres from the self-organised pedestrian movement and motorcycles of the urban poor in upscale Menteng.

To summarise, our video analysis showed that route choices as represented by vehicular and pedestrian accessibility are indeed intertwined with land use (Bertolini 2017; Wegener and Fürst 1999). Land-use functions influence transport modes through activities and

Table 3. Examples of different street profile typologies, land uses, and space syntax results for Menteng neighbourhood.

	Jalan Thamrin(Figure 4(a))	Jalan Salemba Raya (Figure 4(b))	Jalan Latuharhary (Figure 4(c))	Unnamed Street(Figure 4(d))
Typology	Major Road	Major Road	Traverse in wealthy residential area	Urban kampong
Potential vehicular through-movement(NACH N radius)	High(1.283)	High(1.419)	High(1.263)	Intermediate(0.968)
Potential pedestrian through-movement(NACH local radius)	Low(0)	Low(0.743)	Intermediate(1.074)	High(1.253)
Street width (approximation, exclude sidewalk)	20 metre (8 lanes, 2 directions, with median barrier)	20 metre (8 lanes, 2 directions, with median barrier)	5 metre (2 lanes, one direction)	2 metre (1 lane, 2 direction, only for motorcycle)
Dominant land use functions	Commerce and offices	Offices and public facilities (e.g. school, hospital)	Houses (large plot size), embassy, offices	Houses (small plot size)
Dominant transport mode	Car, motorcycle	Car, motorcycle	Car, motorcycle	Motorcycle, walking
Presence of sidewalks	Yes (10 m)	Yes (3 m)	Yes (2 m)	No
Presence of barrier for pedestrian movement	No	On-street parking, street vendors	Street vendors (few)	On-street parking, street vendors, pedestrian have to give way for motorised vehicles to pass through
Presence of pedestrian	Yes	Yes	Yes (few)	Yes
Activities on the street	Motorised traffic	Motorised traffic	Motorised traffic	Motorised and non-motorised traffic mixed with stationary activities

destinations available within a given urban grain. A coarser urban grain encourages car-based transport, whereas a finer urban grain facilitates pedestrian movement. This interplay affects the realisation of vehicular and pedestrian movement accessibility. For example, *Jalan* Latuharhary has a higher potential for pedestrian movement compared to *Jalan* Thamrin and *Jalan* Salemba Raya (Table 3). However, the large residential blocks of *Jalan* Latuharhary discourage street users from realising their pedestrian accessibility.

In the kampong, the videos showed that during weekday peak hours, students (recognisable by their school uniforms) were walking, cycling, or taking motorcycle rides. These motorcycles were either driven by their guardians or the students used ridesourcing services. This extensive use of motorcycles during peak hours poses an unsafe environment for children who walk to school, the elderly and those with physical disabilities (Figure 5). Students on the motorcycles are also exposed to safety issues and pollution when riding in streets with high volumes of traffic. The safety risk is highest at the entrance points of the kampong where streets with higher capacities and speeds meet with slower streets from the kampong's internal street network. With the kampong's streets filled with motorcycles during peak hours on a daily basis, the potential pedestrian accessibility of the kampong is also not fully realised.

4.3. Street interview findings

We conducted 75 street interviews with kampong inhabitants to get their perception of their mobility experience. Regarding frequent transport modes, 52% of respondents walked, 24% drove a motorcycle or car (only 2 respondents stated they drove a car), 23% used a combination of walking and driving, and 1% used a bicycle. Almost half of the respondents, associated their mobility experience with positive (49.3%) and very positive (4%) emotions

Figure 5. Video still of a wheelchair user struggling its way through the urban kampong street.

such as feeling safe and relaxed. This was attributed to their familiarity with the neighbourhood:

> … (I am) already familiar with the neighbourhood so it is safe. (male, age 68, described the mobility experience as safe).

26.7% of the respondents indicate their mobility experience as being unsafe, wary and stressful, in addition to 8% respondents who ascribed a very negative emotion. These negative responses were related to wariness towards reckless driving behaviour and the associated traffic accident risks:

> … (It is) very unsafe. […] depends on the time, during the morning peak hour it is super crowded. (female, age 35, described the mobility experience as very unsafe).

> … (I) walk for health reason, although (I) have to be cautious, (I) walk on the side of the street. (male, age 60, described the mobility experience as wary).

Figure 6 describes mobility experience differentiated by gender and frequent transport mode. In relation to gender, women were more likely to ascribe negative scores to their
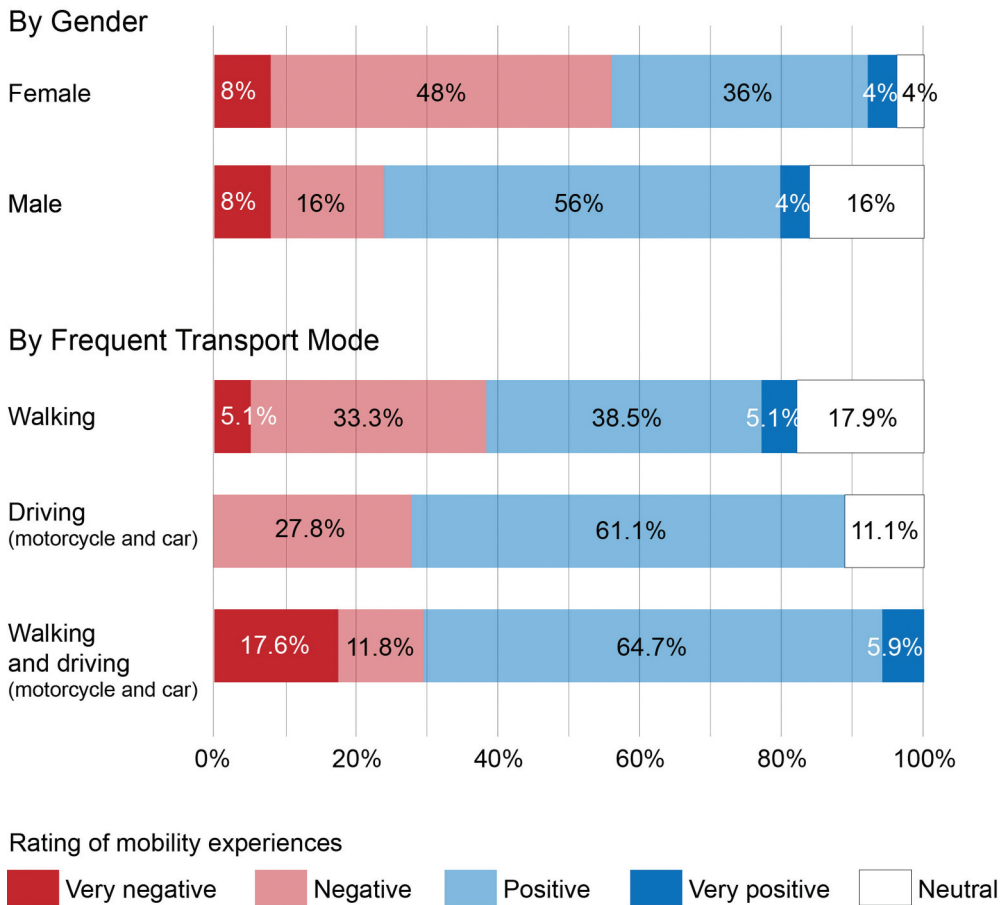

Figure 6. Mobility experiences from street interviews.

mobility experience as compared to men: 48% of women expressed negative emotions compared to only 16% of men. Women often reported concern for their own safety or that of their children playing on the kampong streets.

In terms of frequent transport mode (Figure 6), those who walked mostly expressed negative (33.3%) and very negative (5.1%) mobility experiences compared to those who drove (27.8% expressed negative mobility experiences) or engaged in mixed modes (11.8% expressed negative and 17.6% very negative mobility experiences). Those who drove and walked indicated the highest positive (64.7%) and very positive associations (5.9%) compared to those who drove (61.1% expressed positive experiences) or walked (38.5% expressed positive and 5.1% very positive experiences). Those who walked frequently mentioned their wariness of other traffic users and modes.

Comparing the space syntax analysis with the street interview results, we arrived at an interesting contrast between potential and realised pedestrian accessibility. Although our spatial analysis (Figure 3) highlighted a high potential for pedestrian through-movement for the kampong, around one-third of the kampong residents associated walking with negative and very negative emotions (Figure 6). Here, the realised pedestrian accessibility was impeded by perceptions of an unsafe walking environment, which was partially attributed to the wariness toward motorcycle use. Given the kampong's labyrinthian system of narrow alleys (Figure 4(d)), motorcycles are extensively used; mainly because, they are cheap, fast and highly manoeuvrable. However, most of motorcycle riders conducted reckless driving behaviour (e.g. speeding, riding against the traffic flow), which requires not only a regulation on the motorcycle use but also a tougher law enforcement (Susilo, Joewono, and Vandebona 2015) to ensure the safety of motorcyclists and other street users, especially pedestrians sharing the same street space.

Although the street interview did not specifically enquire about access to educational facilities, the negative remarks ascribed to walking in contrast to positive associations of riding a motorcycle could influence how children access school facilities on a daily basis. Children who become accustomed to the perception of an unsafe walking environment tend to prefer private-motorised modes when they get older (Yagi, Nobel, and Kawaguchi 2012). This is unconducive for encouraging use of sustainable modes such as walking or taking public transport in the long term.

The inability to realise walking potential in the kampong could expose the kampong's inhabitants to an ever-growing socioeconomic gap in the future. The gap between those who own and use cars and motorcycles and those who do not (Sheller and Urry 2000; Ohnmacht, Maksim, and Bergman 2009) can negatively affect their socioeconomic participation through the ability to reach key functions such as education, which then later affects their employment options. This creates a vicious cycle of inhabitants being forced to adopt an unsustainable transport mode such as riding a motorcycle due to socio-economic limitations.

5. Conclusions

Exploring the case of spatial configurations and use in the upscale Menteng district and the urban kampong, we set out to understand the realisation of potential accessibility through the interplay between transport, land use, and the social systems. In our case, we identified a fragmented and discontinuous pedestrian network. Most of the educational

facilities are located following the logic of vehicular movement instead of pedestrian movement. For kampong inhabitants (and urban poor in general), this discourages them from walking and using public transport, despite a high potential for pedestrian accessibility in their kampong. Hence, the encouragement of sustainable transport modes conflicts with how the street configuration is connected to land use and street profiles. Our videos and interviews show that street users' perceptions and socioeconomic status influence their transport mode choices and further restrict pedestrian movement. The findings were particularly interesting in showcasing the kampong inhabitants' negative image of walking and its perceived inferiority to vehicular modes. The fear of using the street as a pedestrian when there are high-speed vehicles (motorcycles or cars) or a lack of a proper sidewalks available is a reality in this region. This is in spite of the kampong having a high potential for pedestrian movement according to our street network analysis.

We have also identified a connection between land uses, urban grains, and pedestrian movement (Figure 4(a–d)). In Jakarta, interventions have recently been made to create pedestrian-friendly sidewalks where active land use in the form of shopping occurs. We have shown that in residential areas (Figure 4(b)) a coarser urban grain due to larger plot and block sizes does not support vital pedestrian accessibility. This was further influenced by the economic status of this neighbourhood's inhabitants and resulting mode choice.

Our findings further indicate that there is a mismatch between potential and realised accessibility due to spatial configuration limits, pattern of transport and land use, and how users perceive such accessibility. Although the kampong's current spatial structure has the potential to support pedestrian movement, inhabitants' negative perceptions of walking and an unsafe walking environment can impede the use of walking as a daily mobility choice in Menteng. Similar situations can be observed throughout Jakarta. This is evidenced by the growing use of private-motorised vehicles (Tan 2019). Meanwhile, public transport might remain a less preferable option due to unreliable services and route indirectness (ITDP 2019; Susilo, Joewono, and Santosa 2010), although future preferences towards using public transport might change due to the operation of a new mass rapid transit system (Agarwal and Sabandar 2019). In most Southeast Asian cities, this condition is prevalent and neglects the potential to encourage the use of more sustainable modes (Tan 2019). Consequently, the captive pedestrians – who are often women, children, the elderly, the disabled and those living in extreme poverty – face difficulties in accessing key urban functions, be it educational, health care or even cultural facilities. The lack of access contributes directly to and exacerbates social immobility (i.e. the inability to break out of poverty cycles). By ignoring these contextualised socioeconomic dynamics and the current street network patterns, potential accessibility cannot be realised.

In addition to raising awareness for planners and policymakers about the gap between formal transport planning goals and the realised objectives, we suggest a shift from conventional urban and transport planning practices, which consider potential place-based accessibility as an absolute measurement for accessibility (Mehta 2008; Negron-Poblete, Séguin, and Apparicio 2016; for walkability measurement see Lo 2009) to more inclusive measures of accessibility considering socioeconomic characteristics. This includes paying attention to the socioeconomic profiles of users and how that affects their realisation of potential accessibility. Our findings highlight that planners and

policymakers should practice the ethics of care to provide for the most vulnerable parts of society when formulating transport policy goals. This can include a focus on walking and public transport beyond just locating them in a neighbourhood but evaluating by whom and when access is possible. There are also lessons here about the mixing of modes such as walking and motorcycles, which improve accessibility but reduce the sense of safety and how certain speeds and modes might actually discourage a broader user group such as women, children and the elderly.

Our methods, therefore, provide a critical examination of current situations to fine-tune transport and urban planning to support the realisation of inclusive, safe, and resilient cities and communities as mandated by the United Nation's Sustainable Development Goals. The Indonesian government has been committed to these goals through the Presidential Decree 59/2017, which set the implementation agenda. However, the efforts remain at the metropolitan and city scale and often neglect the economic and socio-cultural dynamic at the local scale (BAPPENAS 2019). To bridge this gap, our findings suggest a policy insight to improve access to transport services for the marginalised groups in the kampong. The improvement includes not only the improvement of potential access by providing transit stations within walking distance from the kampong, but also supporting the realised accessibility of inhabitants to reach those stations. For instance, provision of well-functioning sidewalks connecting the kampong and the nearest transit station would be crucial.

The use of Menteng and its kampong as a single case was to facilitate the testing of our proposition and methods, as well as to provide detailed data at the neighbourhood level in the context of an informal settlement in Jakarta. The application of space syntax, however, has its limitations since the results have to be interpreted with an understanding of local sociocultural dynamics, such as the existing socioeconomic inequalities within a society or the living conditions in an isolated area. Through combining space syntax, video, and street interviews analysis as a novel method for investigating potential and realised accessibility, our findings conclude on (1) how socioeconomic differences and people's perceptions of mobility can impede their realised accessibility, (2) how safety and ease of orientation impacts pedestrian accessibility, (3) how the urban grain can be an indicator for pedestrian movement shaped by land use, and (4) how current transport policies contribute to social divides and disadvantage already vulnerable groups with reduced access to educational opportunities.

We suggest that to enhance external validity, further research should investigate the access to other key functions such as employment and healthcare facilities in different neighbourhoods across Southeast Asian cities. We were particularly surprised by the effects of increased use of ridesourcing services such as Grab and Gojek in the kampong as part of the daily mobility routines. We suggest further research be conducted to investigate both the positive and negative features of the ridesourcing and its implications on the interplay of transport, land use and social dynamics. Although ridesourcing (mostly motorcycle-based services) can improve personal mobility by providing a "last mile" connection to places existing public transport cannot reach, the safety issue remains for pedestrians and riders, who use the same street space. The "shared" street use where motorised vehicle has the highest hierarchy continues to be a challenge for transport planning in Jakarta and other Southeast Asian cities. While the current Jakarta

government seems to invest more in developing public transport infrastructures (e.g. the extension plan of mass rapid transit services), future investments should prioritise the understanding of spatial behaviour and socio-cultural innovation (including how to manage the extensive use of motorcycles in a given socioeconomic context) to ensure well-functioning transport and mobility systems are inclusive to all inhabitants.

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