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How gender differences and perceptions of safety shape urban mobility in Southeast Asia

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ABSTRACT

Despite numerous studies on how gender differences affect transport mobility choices and perception of safety, there has been little emphasis on the influence of spatial and socio-cultural constructs on it, particularly in the Southeast Asian context. This article investigates this relation through (1) an on-street survey involving 383 participants in eight neighbourhoods in Jakarta and Kuala Lumpur, (2) analysing videos taken with the walking with video approach, and (3) a computational analysis of the street network using space syntax. Findings suggest that a large proportion of women ascribed to negative perceptions of safety as compared to men. Negative perceptions of safety were related to wariness towards motorcycles in Jakarta and absence of other pedestrians and the image of the place in Kuala Lumpur. This difference can be attributed to distinctions in spatial configurations and socio-cultural constructs between both cities. Findings provide practical insights – mode segregation or changes to street design – to address gendered mobility for sustainable urban transport in the region.

1. Introduction

Numerous policy advices and projects in recent years focus on differences in gender for transport planning (GIZ-SUTP, 2018; Peters, 2013; UN Women, 2019). However, gendered mobility or how gender affects one's mobility choices and behaviour (among other definitions, see Hanson, 2010; Loukaitou-Sideris, 2016), particularly on the aspect of women's perceptions of safety in public space and how their mobility choices are affected, is left largely unaddressed. This overlooks how gendered mobility disadvantaged women in particular, despite women being a major user group of public transport and walking (Greed, 2019; Uteng and Turner, 2019). Previous studies indicate that women often experienced fear of sexual harassment or street crimes on public transport and when walking in a public space (Graglia, 2016; Seedat, MacKenzie, and Mohan, 2006; Stark and Meschik, 2018). In addition, mainstream media often depicted women as the victim of street crimes, such as how a woman have died during a brutal bag snatching in a major thoroughfare in Jakarta, Indonesia (Kompas, 2019), or how a women being dragged by a motorcycle in a bag theft incident in Kuala Lumpur, Malaysia (The Sun Daily, 2019). These depictions have created a gender socialisation that women are physically more vulnerable to street

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crime and assault, which contribute to women's low perception of safety (Chataway and Hart, 2019; Cossman and Rader, 2011).

Women use and perceive public spaces and streets in a different way than men due to their lower perceptions of safety (Loukaitou-Sideris and Fink, 2009; Ratnayake, 2013; Valentine, 1989). This can be attributed to the internal factors (e.g. age, previous experience) and external factors (e.g. the design of a built environment, socio-cultural constructs). In particular, built environmental cues such as visibility, the reputation of a place, and presence or absence of types of land uses can increase or decrease the feeling of being safe (Koskela and Pain, 2000). Women often associate underpasses or dead-end alleyways with street violence and harassment even when they themselves have no first-hand experiences (Anciaes and Jones, 2018).

Women's heightened concern for personal safety can affect their daily mobility as it poses place, time, and mode constraints on mobility choices and behaviours (Stark and Meschik, 2018). These include avoiding an isolated place with limited lightings or refraining from travelling at night (Macmillan, Nierobisz, and Welsh, 2000; Sohail, Maunder, and Cavill, 2006). In a context where the extreme wariness of one's personal safety persists, such mobility constraints can lead to voluntarily and involuntary social and physical exclusion, limiting equal socio-economic opportunities.

Unfortunately, women's heightened safety concerns of badly designed public space are rarely acknowledged in conventional transport planning research and practice. A recent project in a densely populated area in Jakarta show that women reported more safety concerns since they perceive the street also as a place for children to play and other social activities such as chatting with neighbours (ITDP Indonesia, 2019). In general, women have more space–time fixity closer to home due to their domestic role (Kwan, 1999). Therefore, women spent a larger proportion amount of time on the streets within their neighbourhood than men and perceive the street more than just as a channel for movement. Unfortunately, most planning process neglect women's concerns and neighbourhood development proposals are dominated with solutions to improve traffic flow by widening streets or add asphalt paving instead of addressing traffic safety for children on the street. It does not help also that most of the decision makers are male (Peters, 2013).

This highlights the challenge of understanding and addressing gendered mobility as one of key aspects towards sustainable urban transport. In the Southeast Asia region, sustainable urban transport initiatives consider transport impacts on gender as one amongst a multitude of social indicators (ASEAN, 2019). However, in practice, women's safety concerns in public transit and walking on the streets are often associated with overcrowding and cultural norms (Bachok et al., 2014; Ng and Acker, 2018; Turner, 2012). This perspective provides a fragmented solution for gendered mobility choices. For instance, in Jakarta and Kuala Lumpur, separated train carriages for women are provided on the commuter line, but the safety for the first and last mile travel for women to access the public transport is not considered.

This article investigates the complex interplay that shapes perception of safety, especially in relation to spatial configuration within a certain built environment and its socio-cultural constructs and how this interrelation affects gendered mobility. Using case studies of eight neighbourhoods in Jakarta and Kuala Lumpur metropolitan area, this article focuses on the emerging research question: *How do spatial configuration and socio-cultural constructs affect the perceptions of safety and generate gendered mobility*?

Here, we employ an understanding of structural perceptions of safety through spatial configuration with the proxy of walkability as walking holds a significance importance in Southeast Asian cities (Mateo-Babiano and Ieda, 2007). This article offers empirical insights and innovative approach by using a mix of quantitative and qualitative methods through combining on-street surveys of 383 participants, qualitative analysis of video recordings totalling 15 h in the selected neighbourhoods, and space syntax analysis of eight street network models. The on-street surveys recorded the participant's self-reported perceptions of safety when traversing a certain street. The videos provide the context of how the streets are being used, inferring the socio-cultural constructs of the study area. The computational analysis provides insights on how spatial configurations correlate with safety perception. This novel method builds on previous studies on women's safety in public space and public transport (Koskela and Pain, 2000; Seedat et al., 2006; Stark and Meschik, 2018) by including the factor of street network configuration as one of determinants of the perception of safety. The findings contribute to the discussions of gendered mobility (Hanson, 2010; Loukaitou-Sideris, 2016), mobility inequality (Kwan and Schwanen, 2016; Ohnmacht, Maksim, and Bergman; 2009), and gender in planning (Greed, 2005; Roberts, 2016). The complexity of how gender differences and perceptions of safety shape mobility behaviour highlights the interplay between external spatial and socio-cultural constructs and internal psychological factors. Findings provide insights for gender-sensitive transport planning in the arena of transport and behavioural research since it can help in formulating an inclusive transport policy to further improve gender equity, as part of sustainable urban transport initiatives in the Southeast Asia region (ASEAN, 2019; Ng & Acker, 2018).

2. Gender and the perceptions of safety in transport planning

Research on gender and transport explain how gender differences are institutionalised in planning practice (Greed, 2005; Roberts, 2016) and how gender shapes and is shaped by transport mobility (Hanson, 2010; Law, 1999). Gender differences influence travel pattern, transport mode, and travel constraints. In general, women's travel patterns are characterised by short-multiple trips that combine domestic, social, and work purposes (Blumenberg, 2004; Miralles-Guasch, Melo, and Marquet, 2016; Turner and Grieco, 2000). Women often take walking or public transport due to less access to private vehicle (Mahadevia and Advani, 2016; Miralles-Guasch et al., 2016; Peters, 2002; 2013) and their mobility is often constrained by

cultural norms (Adeel, Yeh, and Zhang, 2017; Uteng, 2009), limited financial capability (Peters, 2013; Salon and Gulyani, 2010), and concern for personal safety (Seedat et al., 2006; Graglia, 2016; Stark and Meschik, 2018). Such gendered mobility choices could affect women's subjective well-being (Sweet and Kanaroglou, 2016). Geographic location also plays a role in these differences. Women in the rural area show a higher space–time limitation compared to those living in an urban area due to stronger domestic responsibility and unreliable public transport services (Peters, 2002; Venter, Vokolkova, and Michalek, 2007). Although studies indicate a general understanding of gendered travel patterns and behaviours, research on gender and transport are highly contextual as women's need differ across cultures and geographies. For instance, studies from South Asia highlight socio-cultural constraints – e.g. the need for a male guardian – for women to travel independently unthinkable in western contexts (Adeel et al., 2017). African cases mostly focus on the low-income contexts (Salon and Gulyani, 2010; Venter et al., 2007), while the Latin American research emphasised women's safety in public transit due to a high rate of violence and harassment (Graglia, 2016).

Throughout these different socio-cultural constructs, gender differences appear to affect transport mobility choices, in part through the perception of safety, in varying levels and forms (Fig. 1). From a transport perspective, women tend to have lower perception of safety which influences their transport choices in terms of route, travel time, and mode. From the gender perspective, the transport system and the built environment induce or reduce the perception of safety (e.g. related to violence and harassment) affecting activities depending on gender. We will discuss the perceptions of safety through (1) spatial configuration and socio-cultural constructs as external factors and (2) individual characteristics as internal factors.

2.1. External factors: Spatial configuration and socio-cultural constructs

Spatial configurations, in combination with socio-cultural constructs, acts as external factors influencing perceived safety. For instance, street network configurations that induce desolated streets can create unconducive environment for women (Ferrer, Ruiz, and Mars, 2015; Macmillan et al., 2000; Nguyen and van Nes, 2013). Here, we choose space syntax – a mathematical modelling of street network configuration – to approximate a general and non-subjective perceptions of safety due to the large basis of application the method has enjoyed in various contexts (Hillier, 2004; 2012; Karimi, 2012; Sharmin and Kamruzzaman, 2018; van Nes and Yamu, 2018). The way a street segment is arranged to other street segments in an urban system influences people's use and perception of space. For instance, people tend to choose a route with less angular deviation or straightest route as it is less confusing (Dalton, 2003). Streets with more connection to other streets is more accessible, thus attracts more movements and become potential destination for socio-economic activities (Hillier et al., 1993). These streets, such as shopping streets, attract women through the presence of others and activities that can be undertaken (Güney, 2014). Contrary to this, a segregated street with only one connection to other streets, such as dead-end, is likely to be perceived as unsafe due to the absence of fellow pedestrians and limited public activities (Nguyen and van Nes, 2013). As conventional planning and design of a built environment rarely consider these factors, the existing spatial structure inadvertently maintains the socio-cultural constructs supporting gendered mobility (Law, 1999).

Socio-cultural constructs, such as norms and values related to gender and mobility behaviour, shapes gendered travel pattern and behaviour (Loukaitou-Sideris, 2016). For instance, the belief within certain cultures that women are more bounded to the domestic realm has curbed women's mobility beyond the home (Adeel et al., 2017; Uteng, 2009). The assumption that a woman has to be escorted in public spaces suggests a stereotype that women are more vulnerable and unsafe in public spaces. These socio-cultural constructs act as external factors that influence the internal factors of choice, manifesting in route and travel time avoidances or relying on limited transport modes. In some contexts, the use of private vehicle is considered as the only viable way for women to get about while negotiating their fears in public space (Dobbs, 2005; Masood, 2018). However, this option is not always feasible due to economic and cultural reasons nor is it particularly sustainable.

These external factors construct one's perceptions of safety by regarding the spatial configuration of a given built environment as an objective space. The interaction of external and internal factors will generate a subjective view of a place being positively or negatively stereotyped due to an individual's previous experiences or internalised cultural values.

2.2. Internal factors: Individual characteristics and place

Perceptions of safety is highly individualised and subject to personal risk acceptability thresholds in relation to age, physical ability and socio-cultural background (Green & Singleton, 2006; MacMillan et al., 2000). Older people tend to be overly conscious of their limited physical ability, thus they displayed risk-adverse behaviour and take extra precautions such as lowering of speed or barrier avoidance while walking (Bernhoft and Cartensen, 2008). Those with physical disabilities often have a fear of collision with fast moving motorised vehicles (Kaparias et al., 2012) and avoidance of physical barriers such as footbridges and underpasses (Anciaes and Jones, 2018). Women who associate street crimes and sexual assaults as occurring in public spaces would develop anxiety in wayfinding in public spaces in an unfamiliar setting (Lawton and Kallai, 2002). Women with previous negative experiences also tend to judge the built environment with biases (Seedat et al., 2006; Stark and Meschik, 2018). There is however an exception where a generally acknowledged unsafe space might encourage usage in certain individuals with risk-seeking behaviour, while discouraging it in risk-adverse individuals.

The interaction of individual characteristics with socio-cultural constructs shapes how people attribute meaning to a certain place. A positive association of a place creates a place attachment (for an overview see Korpela, 2012), which can help to lower street crimes and improve perception of safety (Brown, Perkins, and Brown, 2004). Contrary, a weak place attachment,

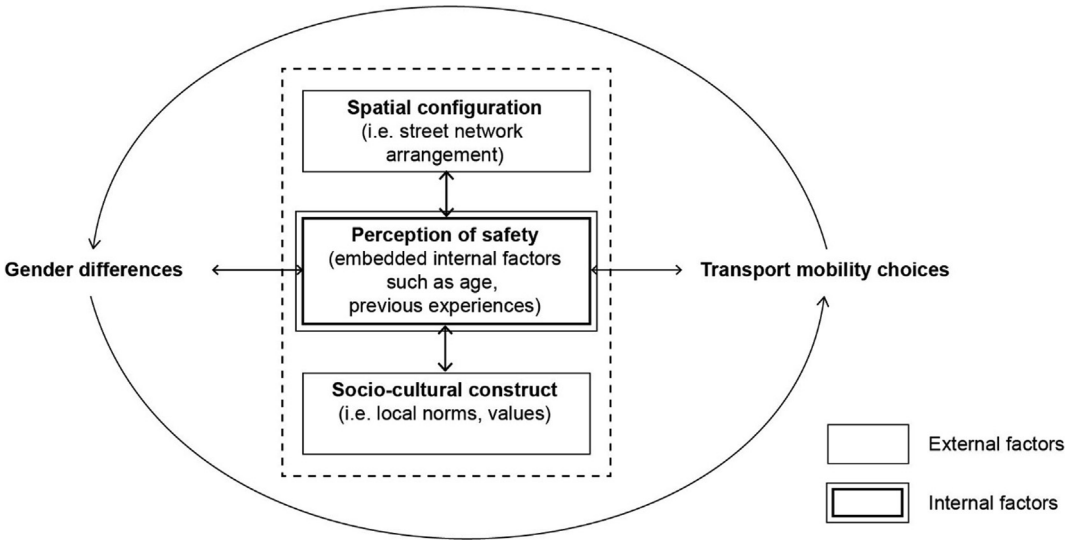


Fig. 1. Relating gender differences, transport mobility choices, and the perception of safety.

often manifested in abandoned and desolated places, can generate a negative image since such places are seen as hotspots for crime. Place attachment affects the perceived safety in combination with an individual's upbringing and previous experiences. For example, those with risk-adverse behaviour might avoid a particular place upon hearing the news that somebody got assaulted there.

3. Data and methods

3.1. Case studies context and selection

Four neighbourhoods each in the Jakarta and the Kuala Lumpur metropolitan area are selected as multiple embedded case studies (Yin, 2003). The selection is based on (1) high density of the street networks and (2) the presence of low-income residential areas since the inhabitants are often marginalised in the planning process. For Jakarta, the low-income area is represented by an urban kampong, originally an informal settlement inhabited by rural in-migrants to gain easy access to the city centre (see Nas et al., 2008 or Kusno, 2015 for further reference on kampong). For Kuala Lumpur, the low-income settlement is represented by the low-cost housing called PPR (*Program Perumahan Rakyat*) with the exception of Kampung Baru[1]. Since 1970s, Malaysian government have relocated slum residents into these low-cost flats, intensifying efforts after the enactment of the "Zero Slum Vision" in 1996 (Shuid, 2016).

As a result of the above criteria, our case studies for the Jakarta metropolitan area are: (1) Kampong Angke, one of the densest populated area in Jakarta located near the Angke train station, (2) Kampong Menteng, near the Manggarai train station, (3) Kampong RW 06 in Cilandak, which residential streets are often used as short-cuts, and (4) Kampong Dadap located in the peripheral area in Rawa Buntu, Tangerang regency. For case studies in the Kuala Lumpur metropolitan area, we choose (1) the neighbourhood around PPR Taman Wahyu, near the KTM (commuter train) station Taman Wahyu, (2) Kampung Baru, near the LRT (light rapid transit) station Kampung Baru, (3) the neighbourhood around Sri Penara Flat, near the LRT station Salak South, and (4) the neighbourhood around PPR Kerinchi in Pantai Dalam, near the LRT Universiti (Fig. 2).

The number of cases provides external validity potential to identify a repetitive pattern across a variation of socio-spatial settings in each metropolitan area (i.e. Jakarta and Kuala Lumpur are typical Southeast Asian metropolitan area).

3.2. Research design

This article aims to identify the interplay between gender differences, perceptions of safety, and transport mobility choices whereby the perceptions of safety is assumed to be correlated to spatial configuration and socio-cultural constructs. Hence, the following key variables are operationalised as follows:

- Gender differences: observed (visible or presented) gender per respondent.

[1] Kampung Baru is the only remaining traditional settlement in Kuala Lumpur with dilapidated houses located in an upscale commercial and business district.

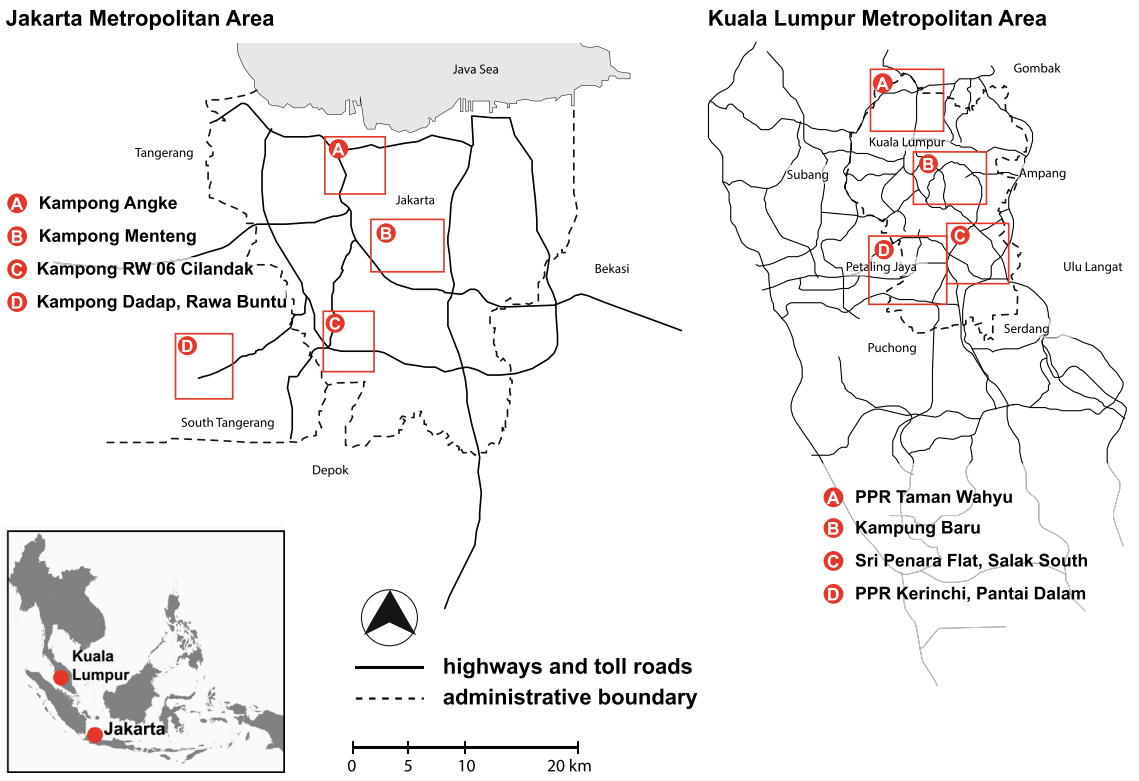


Fig. 2. Overview of case studies location.

- Perception of safety: self-reported perceptions of safety measured as very negative (e.g. very unsafe), negative (e.g. unsafe, wary, afraid), positive (e.g. safe, relaxing), very positive (e.g. very safe) represented by emoticons chosen by respondents during on-street interviews.
- Transport mobility choices: walking (including those who walk to use public transport) and using private motorised vehicles (motorcycle or car), as indicated by respondents or observed.
- Spatial configuration: street network arrangements and how a street segment is correlated to other street segments in the system in terms of accessibility and wayfinding. This serves as the basis to define potential pedestrian route choices or walkability potential, calculated using a mathematical street network model.
- Socio-cultural constructs: implied local norms and values on how people behaved differently when using or moving along the street. Registered through observing activities on the street and street profiles and inferred from respondents' responses from on-street surveys. Initial findings indicating socio-cultural constructs were presented and discussed with experts (i.e. transport practitioners in Jakarta and Kuala Lumpur) in in-depth interviews for confirmation, however, these interviews are not part of empirical data to be analysed in this paper.

As an initial exploratory study, empirical data for each variable (except spatial configuration) were collected through field observation consisting of on-street surveys and video recordings. For spatial configuration data, we constructed a mathematical street network model for each neighbourhood based on OpenStreetMap (OSM) and verified through on-site observation.

3.3. Methods

A mixed method approach is employed here, consisting of (1) on-street surveys, (2) video analysis, and (3) spatial analysis of mathematical street network models using space syntax. The on-street survey provides self-reported perceptions of safety from respondents. The videos allow an objective observation of on-street use and user behaviour. The space syntax models provide an understanding of spatial configuration through the proxy of walkability potential. These three methods and the variation of data sources allows for triangulation of our findings.

3.3.1. On-street surveys

The on-street survey is conducted by asking street users on the street (e.g. walking, chatting with the neighbour, waiting for public transit): "*How do you feel when you walk or drive on this street?*". A short but easy to understand question is

necessary since potential respondents will be intercepted from their activities. The on-street approach is selected because it provides the in-situ advantage compared to having a memory recall in a conventional survey.

Respondents were presented with a printed table with four columns ranging from very negative (e.g. very unsafe) to very positive (e.g. very safe) and were given an emoji sticker in the corresponding column. We use an even-scale measurement appropriate and sensitive of the cultural behaviour of Southeast Asia respondents, which tend to choose a midpoint if available (Lee, Jones, Mineyama, & Zhang, 2002), although a separate column is provided for those who prefer to not state their perception of safety and later is recorded as *neutral* response. This approach was chosen to offer full transparency on how answers were recorded and suited to the context were literacy levels were low. Upon answering, respondents were asked to elaborate on their choice (e.g. why he/she feels safe or unsafe) and their response were recorded on a separate sheet by the researcher (see examples in Table 1). The on-street survey also registered the respondent's age, gender, and frequent transport mode, if they choose to provide it. On average, each respondent took less than five minutes to complete the survey. The on-street survey recorded 383 entries in total with respondent's ages ranging from 16 to 82 years old (42 years on average). Prior to data collection, the researcher obtained an oral permission from the head of the neighbourhood in Jakarta (*pak RW* in Indonesian) to ease suspicion from the local residents, especially in the areas where relocation was hotly debated. Such oral permission was not required in Kuala Lumpur. The on-street surveys were administered on November to December 2018 in Jakarta and January to February 2019 in Kuala Lumpur, in parallel with the video recordings (see Section 3.3.2).

The on-street surveys data were analysed through:

1. Cross-tabulation of gender and the self-reported perception of safety.
2. Binary regression to investigate the correlation of internal factors (i.e. age, gender, frequent transport mode) to the self-reported perception of safety. For the regression, respondent's self-reported perceptions of safety are categorised into two: negative and non-negative. This is because the distribution of neutral and extreme (e.g. very negative and very positive) were too small. For Jakarta, the regression model includes the variable of frequent transport mode by contrasting those who walk and those who do not walk (e.g. use motorcycle or car). The same regression model was applied for Kuala Lumpur, but the variable of frequent transport mode is not included since the on-street survey were conducted around transit stations, and hence, all respondents were assumed to walk and use public transport.
3. A qualitative analysis of the respondent's spoken response elaborating their perceived safety. Respondent's answers were transcribed, translated to English by the researcher, coded, and categorised based on the similarity of keywords using an inductive coding approach (Table 1). These responses also provide insight as to socio-cultural constructs present in the observations.

3.3.2. Video analysis

Videos of the cases were taken with the walking with video approach (Pink, 2007) to record the sensorial elements while being mobile along with the presence of other users, thus provides insights on the latent socio-cultural constructs within a certain spatial context. The videos were taken by the researcher while walking or riding a motorcycle as a passenger. Recordings were conducted in three different time periods: peak-hour weekday, off peak-hour weekday, and weekend, in parallel with the on-street surveys. In total, there are 24 recordings with an average of 37 min per video. The walking with video approach gave an added value of recording the mobility experiences and behaviour compared to the conventional method of installing a video camera in a static place.

The recorded mobility experiences are analysed by:

1. Counting of pedestrians and motorcycle riders, both differentiated by visible gender cues, to identify how gender differences affect mode choice. The counting is conducted per case study and normalised for every 15 min.
2. Identification of stationary activities on the street (e.g. chatting with the neighbours, laundry, cooking), and street profiles (e.g. width, pavement, condition, sidewalk) through screen capture per street segment. This identification provides insight on the street usage (who and how the street is being used).

3.3.3. Spatial analysis using space syntax

Analysing spatial configuration with the space syntax logic (Hillier, 2012; Karimi, 2012; Sharmin and Kamruzzaman, 2018), we identify how certain street network arrangement correlates to the perceptions of safety through the proxy of walkability potential. The potential of a street segment, relative to other street segments in the system, to be traversed or used as main route is calculated by considering the easiness to access and navigate (van Nes and Yamu, 2018). The potential through-movement is referred as *choice* and computed using local radius to infer the pedestrian movement (for in-depth explanation refer to Al-Sayed et al., 2014; van Nes and Yamu, 2018). Street segment with high potential of pedestrian through-movement, or pedestrian route choice, is assumed to be associated with safety because it provides high natural surveillance (Hillier, 2004; Jacobs 1996) through the presence of other pedestrians, while a street segment with low potential of pedestrian route choice can induce the feeling of unsafe.

Table 1
Examples of on-street survey transcription with keywords and categories.

Respondent ID	On-street survey transcription (keywords highlighted)	Code categories
JKTC17	(I feel) **unsafe** if women/teenager/children drive a motorcycle	**Bold:** perceived safety *Italic*: past experience Underline: reasons for perceived safety
JKTC18	(I feel) **wary**, especially at night when (the alleyway) get crowded with motorcycles, (I) have to be accompanied and become dependent to be mobile	
JKTD20	(I feel) **wary** but *so far* there is no problem, (I) just warned those that are driving too fast	
JKTD17	(I) feel **wary** but *so far* it is safe	
KLC25	*Never experienced* any problems	
KLB24	Although there were *bad cases*, but *so far* the area is quite peaceful	
KLC18	Feeling **safe** because lots of people around	
KLB16	Because there is a dedicated sidewalk, lots of people in the surrounding area	

Analysing the street network models drawn as axial maps in DepthMap (the drawing is based on OSM data for an area within a 2 km buffer of each selected case), we investigated:

1. *Pedestrian route choice* (angular segment) with the local radius defined as 10% of the whole system, calculated using the well-established normalised angular choice (NACH) formula (Hillier, Yang, and Turner, 2012; Al-Sayed et al., 2014).
2. Pedestrian route choice results are then correlated with self-reported perceptions of safety. Each response from the on-street survey is assigned to a geographically closest street segment and its respective value.
3. Street segments representing high, average, and low pedestrian route choice values are selected and examined in relation to perceptions of safety, i.e. presence and condition of a sidewalk, presence of pedestrians, presence of shops, and street-facing buildings as observed from the video recordings.
4. For each selected street segment, a quote from respondents representing the most frequent response is provided allowing the nuances of perceived safety to be correlated with the spatial configuration.

3.4. Limitations

There are limitations of the method given this initial exploratory study on the perceptions of safety and gendered mobility in the region. First, the method does not incorporate biometrical data, such as heart rate, blood pressure, and sweat, and uses a simple 4-point scale for measuring perceptions of safety. Second, the on-street surveys were conducted in a short time, thus an in-depth explanation underlying a given answer cannot be revealed, such as respondent's previous experience of street crimes or respondent's attachment to the neighbourhood. Respondent's answers of on-street survey were treated as individual response and were not controlled with individual-within-group answer. Third, the spatial modelling incorporates street network configuration and excludes other built environment cues such as lighting and visibility. Also, the observations can only indicate an assumption of gender and not the actual gender identity of the respondent.

These limitations were necessary considering the practicality of implementing the data collection and the safety of both researcher and respondents since the study areas were low-income settlements where strangers are distrusted or prone to street crimes. Future studies can build upon on these limitations, for instance: (1) adding biometrical measurements and employing a more elaborate scale of measurement to complement the analysis of perception of safety, (2) performing an in-depth survey on the perception of safety and comparing between individual and individual-within-group responses, and (3) incorporating other spatial analysis of built environment cues, such as visibility analysis.

4. Results and discussion

The results reflect the interrelation between gendered mode choice, perception of safety, socio-cultural constructs, and spatial configuration. On-street survey and video analysis reveal the gendered mode choice and the latent socio-cultural constructs within the case studies. Further statistics and qualitative analysis of on-street surveys inform respondents' perceptions of safety and how it influences gendered mode choice. Spatial analysis using space syntax explain how spatial configuration affects the perceptions of safety and generate gendered mode choice.

The on-street survey recorded 383 entries, in which 282 are from Jakarta and 101 from Kuala Lumpur. In terms of gender, 192 respondents are female (50.13%) and 191 are male (49.87%). In terms of transport mode, in Jakarta, 50% respondents stated that they walked, 28.72% used the motorcycle, and 21.28% combined walking and motorised transports. It should be noted since the on-street surveys focused on low-income settlements, few respondents indicated that they have a car. In Kuala Lumpur, respondents were assumed to walk and use public transport since the on-street surveys were conducted around transit stations.

Table 2
Counting of pedestrians and motorcycles from video analysis (normalised using 15-minutes average).

	Pedestrians						Motorcycles*					
	Weekday peak hours		Weekday off-peak hours		Weekend		Weekday peak hours		Weekday off-peak hours		Weekend	
	F	M	F	M	F	M	F	M	F	M	F	M
Jakarta												
Kampong Angke	57	75	19	22	23	25	11	88	11	79	7	60
Kampong Menteng	28	14	12	17	33	25	10	71	6	21	6	74
Kampong RW 06 Cilandak	9	16	5	12	6	6	5	35	3	14	3	19
Kampong Dadap, Rawa Buntu	6	3	4	4	9	7	1	12	6	10	8	28
Proportion of female to male	0.93		0.74		1.13		0.13		0.20		0.13	
Kuala Lumpur												
around PPR Taman Wahyu	2	7	11	6	3	7	3	40	3	35	3	49
Kampung Baru	15	17	13	19	11	25	6	49	3	44	3	24
around Sri Penara Flat	44	39	11	11	14	13	2	93	1	44	3	49
around PPR Kerinchi	5	10	20	23	10	23	2	40	5	63	3	77
Proportion female to male	0.88		0.93		0.56		0.06		0.06		0.06	

F = female; M = male.
* Only count the rider, not the passenger.

4.1. Gendered mode choice and socio-cultural constructs

In our observations from video recordings, we see gender differences influencing mode choice. Focusing on the observable modes of walking and riding a motorcycle, we see (Table 2):

- In 18 of the 24 recordings (75%), we see less female than male pedestrians. However, there are six recordings, including two extreme cases where female pedestrians were double that of male pedestrians. This was in Jakarta in Kampong Menteng and Kampong Dadap during peak hours on a weekday.
- For both Jakarta and Kuala Lumpur, there were more male motorcyclists observed. There are however more female motorcycle riders in Jakarta than in Kuala Lumpur.
- On average, the proportion of female to male pedestrians is 0.93 in Jakarta and 0.79 in Kuala Lumpur indicating that female pedestrians are more common in Jakarta than in Kuala Lumpur.
- The proportion of female to male rider on average in Jakarta (0.15) is larger than in Kuala Lumpur (0.06).

Looking at the above findings, we see nuances between Jakarta and Kuala Lumpur that could relate to different socio-cultural constructs. We define these socio-cultural constructs as how users are observed (or reported) to behave differently in each case due to social norms and values. In Jakarta, the street had a communal function as observed in our videos. In Kuala Lumpur, the street is seen as a commercial extension space. For example, in Jakarta's kampongs there were more social interactions on the street observed, such as chatting with neighbours, conducting domestic activities, and children playing in comparison to Kuala Lumpur where on street activities were mostly interactions with street vendors (Appendix A). The differences here have to do with how the users perceive the street as an extension of their daily social activities. This explains why we observed more pedestrians in Jakarta than in Kuala Lumpur (Table 2).

These social cultural constructs are also related to the different spatial conditions (Fig. 3). In Jakarta's kampong, most streets are often used as a residential extension for cooking and laundry even though the streets are considered narrow and unable to accommodate a car. Here, streets become an active space and walking facilitates social interactions instead of being a mere mode of transport. In Kuala Lumpur, where most housing units are modern multi-storey flats and apartments, the streets are rarely used for domestic activities and thereby discourages pedestrians and intense social interactions. These conditions can be seen in most of residential streets, regardless of the street width. It does not help that low-income residential areas in our case studies in Kuala Lumpur provide on-street parking and thus encourages vehicular movement.

At times, gender roles (as part of socio-cultural constructs) are also present in mode choice. For example, female respondents in Jakarta stated that when they use motorcycle as the passenger, the rider is often a male family member, neighbour, or a driver from ridesourcing services (e.g. Gojek, Grab). This confirmed Ng and Acker's (2018) study on gendered mode choice in Southeast Asia region.

4.2. Perception of safety

The on-street surveys demonstrate that more female respondents reported negative perceptions of safety compared to male respondents (Table 3). In Jakarta, 41.8% female respondents reported a negative (40.3%) or a very negative (1.5%) perception of safety in comparison to 33.1% of male respondents who reported negative (30.4%) or a very negative (2.7%) per-

Fig. 3. Street profiles in Jakarta and Kuala Lumpur.

Table 3
Cross tabulation of self-reported perceptions of safety and gender.

	Self-reported perceptions of safety (%)					
	Very negative	Negative	Positive	Very positive	Neutral	Total
Jakarta						
Female	1.5	40.3	3.7	53.7	0.7	100.0
Male	2.7	30.4	7.4	57.4	2.0	100.0
Kuala Lumpur						
Female	12.1	15.5	34.5	37.9	0.0	100.0
Male	0.0	9.3	60.5	30.2	0.0	100.0

ception of safety. Extreme gender differences were found in Kuala Lumpur with 12.1% female respondents indicated a very negative perceptions of safety compared to none from male respondents, and 15.5% female respondents indicated negative perceptions of safety as compared to 9.3% male respondents. Gender differences in perceptions of safety between Jakarta and Kuala Lumpur is linked to differences in street profiles that are more encouraging for walking in Jakarta (Fig. 3), and thus generating less negative perception of safety since there are more people on the street as evidenced from the video recordings (Table 2).

As Table 3 indicated gender differences in the perceptions of safety, further analysis of the internal factors (age, gender, frequent transport mode) affecting this is conducted through a binary logistic regression ($\alpha \leq 0.05$) and presented in Table 4. Looking at significant correlations with self-reported negative perception of safety, it positively correlates with transport mode (walking) in Jakarta and gender in Kuala Lumpur. In Jakarta, those who walk as a primary transport mode (including

Table 4
Logistic regression of internal factors (age, gender, transport mode) and the self-reported perceptions of safety.

City		B	S.E.	Wald	Df	Sig.	Exp(B)
Jakarta[a]	Age	−0.007	0.010	0.473	1	0.492	0.993
	Gender	0.498	0.263	3.576	1	0.059	1.646
	Walking	1.575	0.338	21.678	1	**0.000**	**4.831**
	Constant	0.177	0.466	0.144	1	0.704	1.194
Kuala Lumpur[b,*]	Age	0.016	0.018	0.834	1	0.361	1.016
	Gender	1.319	0.604	4.769	1	**0.029**	**3.741**
	Constant	0.403	0.670	0.361	1	0.548	1.496

Note: For the regression, the self-reported perceptions of safety is grouped into two: 0 for negative responses (very negative and negative answers) and 1 for non-negative responses (positive, very positive, and neutral answers).
[a] Variable(s) entered: age, gender, walking.
[b] Variable(s) entered: age, gender.
[*] For Kuala Lumpur case, the data of frequent transport mode were not available from the on-street surveys.

public transport and non-motorised transport) are 4.8 times likely to feel negative perceptions of safety (e.g. unsafe, wariness) compared to those who do not walk. In Kuala Lumpur, female respondents are 3.7 times likely to feel such negative perceptions of safety compared to male respondents.

Findings from Table 4 implied how safety is perceived differently, with heightened safety concern from pedestrians in Jakarta and from female respondents in Kuala Lumpur. This difference is further corroborated using the qualitative analysis from the on-street survey, which hinted on different socio-cultural constructs in Jakarta and Kuala Lumpur.

In Jakarta, female respondents who indicated negative perceptions of safety frequently mentioned the wariness towards the presence of motorcycle on the street (among other re-occurring keywords, see Appendix B):

"*... if (I) walk, (I feel) wary because (I am) afraid of getting hit by a motorcycle.*" (female, 50, on-street survey in Kampong Angke)
"*(I) cannot drive a motorcycle, if (the motorcycles) pass by too fast, (I) warned them.*" (female, 40, on-street survey in Kampong Dadap)
"*(I feel) wary, especially if a child drives a motorbike.*" (female, 50, on-street survey in Kampong RW 06 Cilandak)
"*(I) cannot drive motorcycle, so I give my right of way, (I have) to be cautious.*" (female, 42, on-street survey in Kampong Menteng).

In Jakarta, respondents' wariness towards motorcycles can be explained by our observations from walking with video. Here, pedestrians have to give a way to motorcycles when sharing the same street and are therefore cautious. In addition, motorcycle riders often displayed reckless driving behaviour (Susilo, Joewono, and Vandebona, 2015). For women, who spend more time around their homes and use the residential streets, these conditions are seen as a high safety risk. Women perform domestic activities such as washing and cooking on street spaces, making them vulnerable to the risk of collision with faster movement of motorcycle. Female respondents also mentioned the safety consideration for their children who often play on the kampong street.

In Kuala Lumpur, female respondents associate the lack of presence of other pedestrians and the perceived image of certain areas with negative perceptions of safety (for more, see Appendix B):

"*around this area not really safe, lots of news (about crimes).*" (female, 32, on-street survey around KTM station Taman Wahyu)
"*(I) feel safe because lots of people walking around but may be not really safe at night.*" (female, 21, on-street survey around LRT station Universiti)
"*not so many people around, potential street crimes.*" (female, 26, on-street survey around LRT station Kampung Baru)

The answers from Kuala Lumpur respondents represent a vicious cycle where women avoid walking on empty streets and taking short cuts as they lack fellow pedestrians. This resonates with Macmillan et al. (2000) and Seedat et al. (2006) studies on women's fear of victimisation as female pedestrians. This condition could make women unable to utilise street networks that are available to them and instead preferring to take a detour or use other transport modes. This represents barriers to taking a rationale mobility decision of minimising transport cost and time. The influence of other pedestrians and place's notoriety represents how socio-cultural constructs and internal factors generate the perceived safety (see Fig. 1). For instance, walking alone in a place stereotyped as unsafe would generate different perceptions of safety than walking without any knowledge of the area. The perceived safety creates mode choice constraints, which might explain fewer female pedestrians in our video recordings from Kuala Lumpur.

Interestingly, Jakarta respondents did not indicate these constraints. To understand this difference between Jakarta and Kuala Lumpur, we conducted a further analysis on the spatial configuration, following (Green & Singleton, 2006) suggestion that the perceived safety risk is not only socio-culturally, but also spatially constructed.

Table 5
Correlation of NACH local analysis and self-reported perceptions of safety.

City			Self-reported perceptions of safety
Jakarta	NACH local analysis (pedestrian route choice)	Pearson Correlation	**−0.127**
		Sig. (2-tailed)	**0.034**
		N	282
Kuala Lumpur	NACH local analysis (pedestrian route choice)	Pearson Correlation	0.070
		Sig. (2-tailed)	0.488
		N	101

4.3. Spatial configuration in relation to the perception of safety

The spatial configurations (i.e. street network arrangement) of the case studies was analysed using the normalised angular choice (NACH) local analysis assuming that high potential of pedestrian route choice indicates increased walkability potential, and thereby increase a positive perception of safety. The results show a high walkability potential in eight case studies (Appendix C), particularly in the kampongs in Jakarta. The NACH local analysis showed a significant correlation (Pearson correlation, $\alpha \leq 0.05$) with the perceived safety for Jakarta case studies (Table 5). The correlation value of −0.127 indicates that for Jakarta case studies, the lower potential of pedestrian route choice is connected with negative perceptions of safety. Kuala Lumpur case studies, on the other hand, did not show a significant correlation.

For detailed insights, we examined selected street segments with high, average, and low values of pedestrian route choice in relation to natural surveillance, i.e. presence of pedestrians, presence of shops, and numbers of street-facing buildings, that are known to influence the perceptions of safety (Hillier, 2004; Jacobs, 1996; Loukaitou-Sideris, 2005). Fig. 4 shows that pedestrian route choice in Jakarta is correlated with the presence of pedestrians and street-facing buildings providing a strong natural surveillance on the street. Especially in a densely populated area such as a kampong, such spatial settings encourage social interaction between local residents on the street. Observations of stationary activities from the videos revealed that chatting with neighbours is a common occurrence in Jakarta (Appendix A). This contributes to natural surveillance and increases the perceptions of safety for local residents, but might deter strangers or outsiders from traversing the kampong.

On the other hand, Fig. 5 suggested that in Kuala Lumpur, pedestrian route choice is correlated with the presence of pedestrians and presence of shops (including street food hawkers). Observations from videos of Kuala Lumpur show that stationary activities are due to interactions with street vendors while chatting with neighbours rarely occurs (see Appendix A). Unlike in Jakarta, the pedestrian route choice is not correlated with street-facing buildings. Flats and apartments' entrances in Kuala Lumpur are often positioned away from the main street, discouraging potential social interaction on the street and lessening the natural surveillance potential.

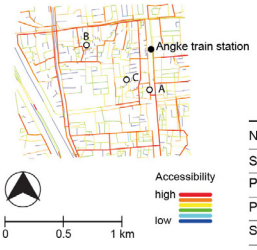
Figs. 4 and 5 illustrated how different spatial contexts generate different perceptions of safety. In Jakarta, the kampongs' spatial configurations indicate high walkability potential corresponding with street-facing entrances that provide natural surveillance. Here, the perceptions of safety are about negotiating space and safety among different transport users (i.e. pedestrians versus motorcyclists). Negative perceptions of safety in Jakarta result from transport modes with high accident affliction risk, which cannot be completely averted through natural surveillance. Reckless driving and risk-taking behaviour from motorcyclists (mostly men) result in traffic violations and lack of respect to other street users (Susilo et al., 2015) thereby creating an image of the street as an unsafe place or a place to be wary or afraid. Subjective perception of safety influenced by the behaviour of other street users highlights an internal to external mechanism in perceptions of safety (see Fig. 1).

For Kuala Lumpur case studies, the spatial configuration depicts a configurational logic similar to Jakarta. The spatial difference is street-facing entrances were less, thus contribute to the lack of natural surveillance and less pedestrian movements. The natural surveillance is diminished with the introduction of upscale apartments and flats with lack of public space on ground level. This street typology does not encourage more pedestrian use, unless there is an attractor (e.g. hawkers, street vendors). Lesser pedestrians then project an image of being unsafe. Local knowledge of the area or its notoriety also informs one's perception of safety. Thus, the perceptions of safety in Kuala Lumpur occurs from expected street violence or harassment due to the lack of natural surveillance from other pedestrians or residents. Here, the spatial and socio-cultural constructs in Kuala Lumpur case studies act as external factors affecting internal factors for the perception of safety, representing an external to internal mechanism (Fig. 1) contrary to Jakarta.

Comparing Jakarta and Kuala Lumpur reflect differences in socio-cultural constructs, especially for walking. The video recordings of Jakarta show walking as part of social interactions beyond being a mere transport mode. In Kuala Lumpur, walking is a transport means to reach certain destination, and in the absence of attractors (e.g. food hawkers) the area is likely to be devoid of other pedestrians. These socio-cultural constructs influence the perceptions of safety through what is considered to be safe or unsafe.

Our findings corroborate how gender differences affect transport mobility choices (Hanson, 2010; Loukaitou-Sideris, 2016), whereby women's lowered perceptions of safety acts as a constraint that generate gendered mobility. Unfortunately, the notion that perceptions of safety are socio-culturally and more importantly spatially constructed is neglected in the

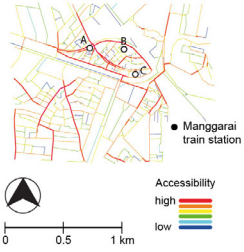
Kampong Angke





	street segment **A**	street segment **B**	street segment **C**
NACH local	1.31 (high)	0.97 (middle)	0.84 (low)
Sidewalk	No	No	No
Presence of pedestrian	Yes	Yes	Yes
Presence of shops	Yes, food hawkers	No	No
Street-facing buildings	100%	100%	50%
On-street survey	I feel relaxed, sometimes wary, but so far it is safe (female, 65)	I feel safe because I am familiar with the place (female, 54)	I feel safe because nothing bad ever happened before (male, 66)

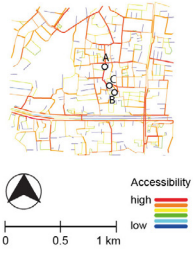
Kampong Menteng





	street segment **A**	street segment **B**	street segment **C**
NACH local	1.35 (high)	1.11 (middle)	0.18 (low)
Sidewalk	No	No	No
Presence of pedestrian	Yes	Yes	Yes
Presence of shops	Yes	No	Yes
Street-facing buildings	100%	100%	70%
On-street survey	So far there is no problem (male, 27)	I feel very safe because I am used to the place (male, 42)	I feel cautious when walking (female, 45)

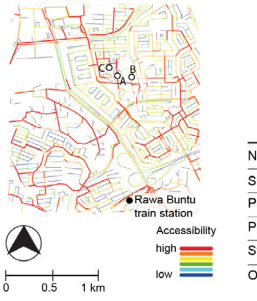
Kampong RW 06 Cilandak





	street segment **A**	street segment **B**	street segment **C**
NACH local	1.36 (high)	0.96 (middle)	0.74 (low)
Sidewalk	No	No	No
Presence of pedestrian	Yes	No	No
Presence of shops	No	No	Yes
Street-facing buildings	56%	40%	50%
On-street survey	It is easy to walk around (female, 51)	I feel unsafe (female, 46)	It is easy to move around as I drive carefully (male, 47)

Kampong Dadap, Rawa Buntu

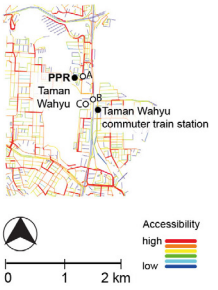




	street segment **A**	street segment **B**	street segment **C**
NACH local	1.34 (high)	0.97 (middle)	0.84 (low)
Sidewalk	No	No	No
Presence of pedestrian	Yes	Yes	No
Presence of shops	Yes	Yes	No
Street-facing buildings	100%	33%	50%
On-street survey	if I met reckless driver, I warned them (female, 40)	So far, I feel safe (female, 41)	I feel wary when walking, since I cannot drive (female, 43)

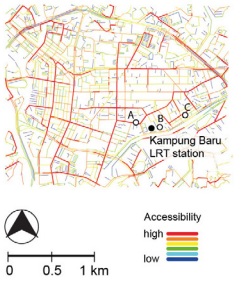
Fig. 4. Spatial configuration in relation to perceptions of safety in Jakarta case studies.

around PPR Taman Wahyu



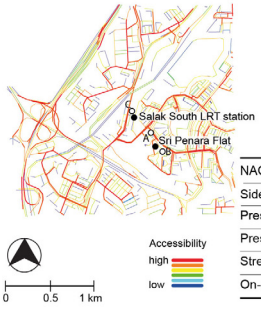
	street segment **A**	street segment **B**	street segment **C**
NACH local	1.28 (high)	0.98 (middle)	0 (low)
Sidewalk	Yes	Yes	No
Presence of pedestrian	Yes	Yes	Yes
Presence of shops	Yes, food hawkers	No	No
Street-facing buildings	50%	-	100%
On-street survey	I feel unsafe, there are news reported that this area is not really safe (female, 32)		

Kampung Baru



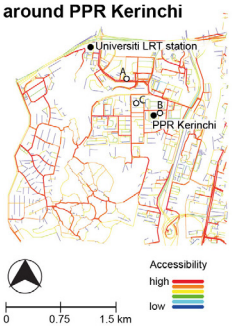
	street segment **A**	street segment **B**	street segment **C**
NACH local	1.34 (high)	1.02 (middle)	0.64 (low)
Sidewalk	Yes	Yes	No
Presence of pedestrian	Yes	Yes	No
Presence of shops	Yes (food hawkers)	Yes	No
Street-facing buildings	100%	81%	0%
On-street survey	I feel safe as a man, but unsure if I were a woman, because some areas are dark (male, 32)		

around Sri Penara Flat



	street segment **A**	street segment **B**	street segment **C**
NACH local	1.27 (high)	1.02 (middle)	0.50 (low)
Sidewalk	Yes	Yes	Yes
Presence of pedestrian	Yes	Yes	No
Presence of shops	Yes (food hawkers)	No	No
Street-facing buildings	0%	0%	0%
On-street survey	I feel very safe, (this area) always have pedestrians (female, 46)		

around PPR Kerinchi



	street segment **A**	street segment **B**	street segment **C**
NACH local	1.44 (high)	0.99 (middle)	0.22 (low)
Sidewalk	Yes	Yes	No
Presence of pedestrian	Yes	No	No
Presence of shops	Yes (malls)	No	No
Street-facing buildings	100%	0%	100%
On-street survey	I feel safe because a lot of people walking around, but may be not really safe at night (female, 21)		

Fig. 5. Spatial configuration in relation to perceptions of safety in Kuala Lumpur case studies.

conventional urban and transport planning (Turner, 2012; Bachok et al., 2014). As a result, gendered mobility remains institutionalised in the planning and design of our built environment (Greed, 2005; Roberts, 2016) creating vicious cycle disadvantaging women (see Fig. 1). In an extreme situation, the negative perception of safety acts as the (in)voluntarily avoidance of certain route or transport mode that can reduce access to social and economic opportunities, suggesting a widening gap of mobility inequality (Ohnmacht et al., 2009; Kwan and Schwanen, 2016).

5. Conclusion and future study

This article provides insights on how gender differences and perceptions of safety shape urban mobility in Southeast Asia using a mixed method that combines on-street surveys, video analysis, and spatial modelling using space syntax. Gendered mode choice and the enabling socio-cultural constructs were identified from video analysis and resulting in street profile analysis. Our findings show that there are less female than male pedestrians in general (see Table 2) and this is traceable to socio-cultural constructs in relation to street profiles and usage patterns. The relation of gender differences and perceptions of safety was deduced from cross-tabulation and logistic binary regression using on-street survey data, revealing that women are more likely report a negative perception of safety compared to men. The qualitative analysis of on-street survey responses provides different nuances of perception of safety. In Jakarta, an internal-external mechanism is at play as safety is related with individual risk acceptance and expectations of risky behaviour from other user groups (such as pedestrians being wary of motorcyclists), and how users of different modes negotiate and share the space. In Kuala Lumpur, an external-internal mechanism is seen where an individual's expectation of presence of other pedestrians and the perceived image of the area dictates travel choice. Furthermore, in Jakarta, the perceptions of safety is significantly correlated with walkability potential (i.e. the more walkable an area is the more likely respondents reported a non-negative perception of safety). This is not observed in Kuala Lumpur. There is therefore room for similar research to confirm generalisability.

Our results confirm previous studies on women heightened concern for personal safety (Seedat et al., 2006; Stark and Meschik, 2018), and how the perceived safety is correlated with spatial configuration (Nguyen and van Nes, 2013; Mahadevia and Advani, 2016) and socio-cultural constructs (Uteng, 2009; Greed, 2019). This article provides additional understanding on the different nuances by relating perceptions of safety with socio-cultural constructs and spatial configurations. This provides us with actionable advice for transport policies and street-level guidelines. In addition, we have provided new empirical data for the often neglected context of Southeast Asia which is prone to gendered mobility challenges (Turner, 2012; Ng and Acker, 2018). For instance, we recommend discouraging reckless motorcyclist behaviour in Jakarta through raising awareness about safe driving and physical design to restrict vehicular speed on residential streets. In Kuala Lumpur, efforts should concentrate on encouraging social activities on street through street-facing building typologies on streets with a high potential of pedestrian route choice. Attracting more pedestrians and social activities can provide the natural surveillance conditions that female users associate with safety.

The authors recommend that the study can be improved by including personalised data such as biometric measurements, employing a more elaborate measurements for perceptions of safety, providing control for comparing individual and individual-within-group responses, and expanded across more cases in Southeast Asia. However, our exploratory approach with first-hand data analysed with statistical, visual, and spatial analytic methods indicate how the perceptions of safety are socio-culturally and spatially constructed to result in gendered transport mobility choices.

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CRediT authorship contribution statement

Isti Hidayati: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Wendy Tan:** Conceptualization, Methodology, Formal analysis, Writing - review & editing, Supervision. **Claudia Yamu:** Methodology, Formal analysis, Visualization, Supervision.

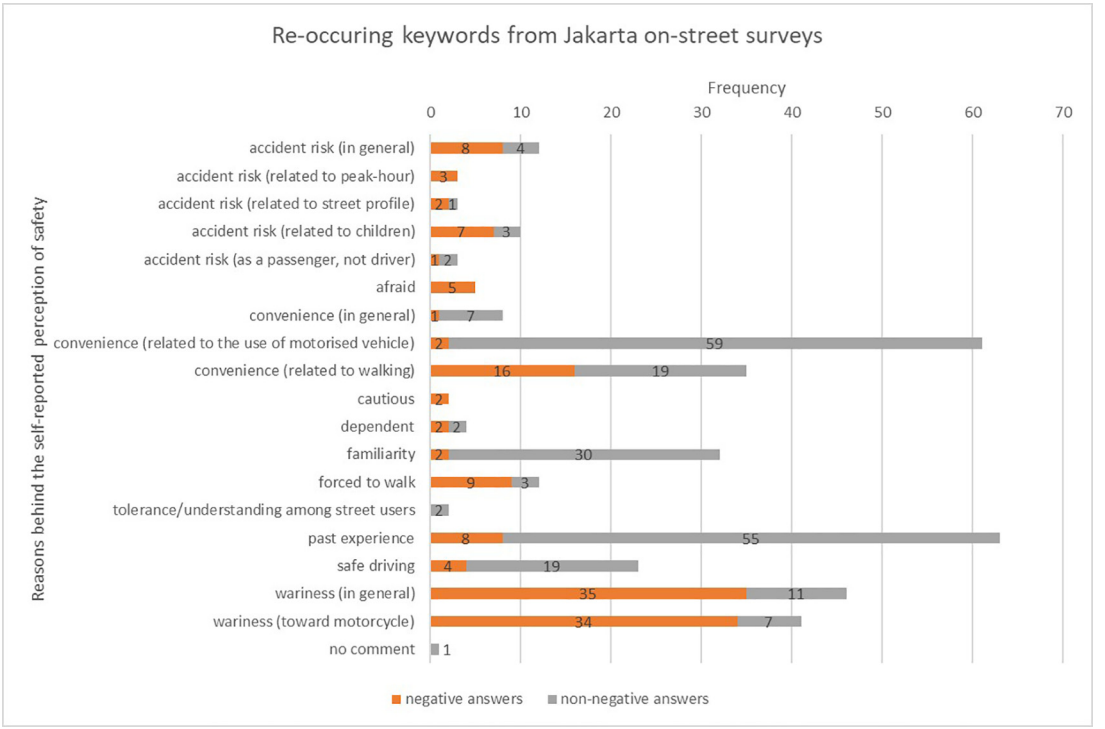
Declaration of Competing Interest

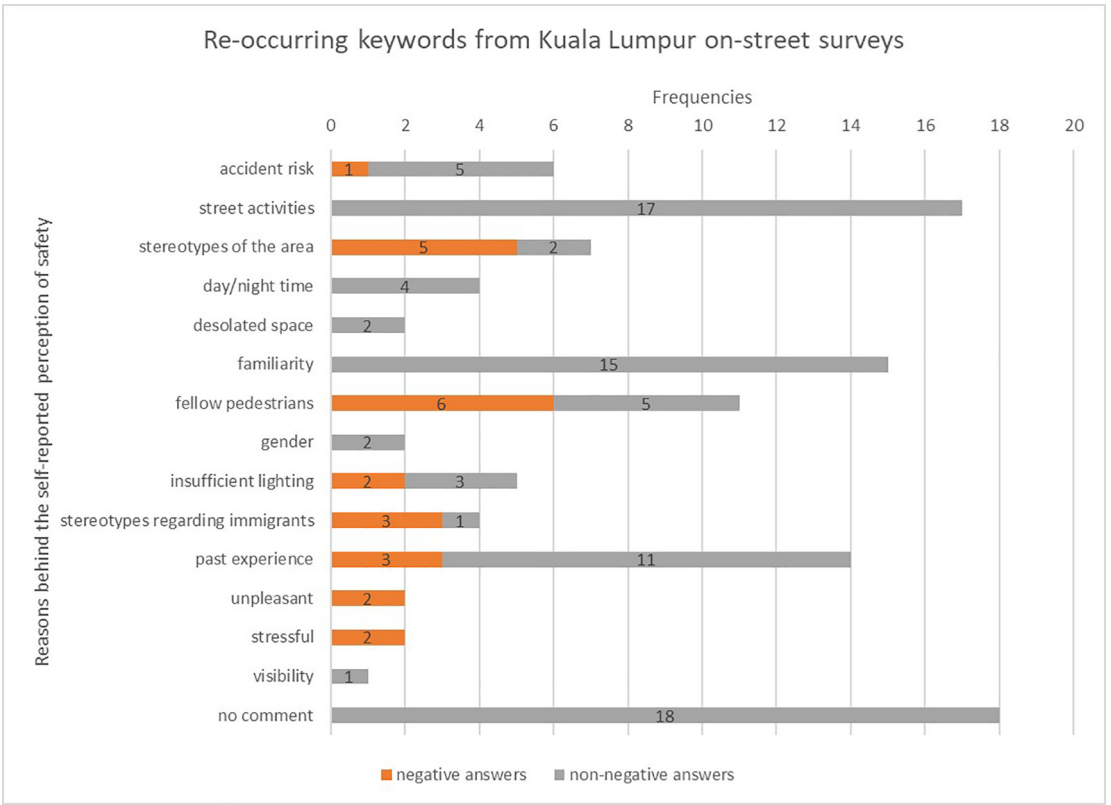
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Counting of stationary activities from video analysis (normalised using 15-minutes average)

	Street vendor (selling and buying)			Chat with neighbours			Domestic activities (e.g. cooking, laundry)			Children playing			Watching people, waiting		
	Weekdaypeak hours	Weekdayoff-peak hours	Weekend	Weekdaypeak hours	Weekdayoff-peak hours	Weekend	Weekdaypeak hours	Weekdayoff-peak hours	Weekend	Weekdaypeak hours	Weekdayoff-peak hours	Weekend	Weekdaypeak hours	Weekdayoff-peak hours	Weekend
Jakarta															
Kampong Angke	40	22	31	18	26	89	1	6	12	1	16	41	4	6	12
Kampong Menteng	20	13	39	17	34	45	3	6	10	1	25	28	5	11	20
Kampong RW 06 Cilandak	12	2	8	7	3	16	4	1	1	3	0	10	1	1	3
Kampong Dadap, Rawa Buntu	2	2	1	0	1	18	1	0	4	0	3	11	0	1	1
Kuala Lumpur															
around PPR Taman Wahyu	2	6	1	0	0	0	1	0	0	0	0	0	3	6	6
Kampung Baru	10	14	10	0	1	0	1	0	1	0	0	1	4	5	6
around Sri Penara Flat	47	11	5	0	0	0	1	0	0	0	0	0	13	3	5
around PPR Kerinchi	5	2	7	0	0	2	0	0	0	0	0	0	6	15	10

Appendix B. Re-occurring keywords from reasons behind the self-reported perception of safety





Appendix C. NACH local radius analysis for eight neighbourhoods

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