



# Women's perceived safety in public places and public transport: A narrative review of contributing factors and measurement methods

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## ABSTRACT

Women's perception of safety in public spaces is influenced not only by potential risks of crime or accidents but also by diverse built environment, individual, and social characteristics. These impacts can manifest through a disruption of social engagement and outdoor activities, which can negatively affect their mobility, overall quality of life, and well-being. This study employs a narrative review approach of 32 academic articles to identify various factors that can affect women's perception of safety in public places and while using public transport. We further selected 21 studies that provide substantive data on the built environment, individual characteristics, and social factors, while also examining their intersectionality. By adopting an intersectionality framework, we evaluated the relative importance of each factor based on its consistency and prominence in previous research and assessed their significance in contributing to women's perception of safety. The findings highlight the importance of urban design and built environment improvements, such as street lighting and walking path conditions, in enhancing women's perceived safety. They also suggest integrating social and built factors into safety strategies and emphasise the potential of emerging technologies for collecting data and assessing safety perceptions across diverse populations.

## 1. Introduction

Women's concerns related to personal safety is a well-established research domain and the corpus of literature reporting on fear of crime, gender-based violence, and street sexual harassment is large. Past studies have identified various behavioural and spatial consequences of women's fear such as avoiding deluged areas, limited interaction in public spaces at night and restricted travel pattern and mobility. Experiences of crime or victimisation can have a significant impact on women's quality of life and wellbeing, and as a result, such behaviours may be more prevalent among women who have had such experiences.

What, where, and why women feel unsafe has been extensively researched in the last few decades. However, what remains less clear is how women perceive their safety in the absence of fear, which is not yet fully understood. Scholars continue to raise concerns that fear of crime is a distinct construct from commonly used measures such as perceive safety, and that failing to distinguish between these two can potentially lead to an overstatement of the level of fear of crime (Chataway, 2019; Foster et al., 2013; Hinkle, 2015). This suggests that women's feelings of

safety may or may not be associated with or directly influenced by the factors deemed positive to lower fear of crime in urban areas.

Women's perceived safety is not only subject to risk of actual crime, but it must be understood in relation to occurrences of involuntary reaction (feelings) to everyday situations, individual experiences, memories, or spatial-social construct. The term perceived safety therefore refers to "a state in which a person's most important needs are satisfied and it is expected that this state will remain stable" (Eller & Frey, 2019). The narrative of 'feeling of safety' therefore must evolve to widen the understanding of the conditions under which women generally feel safe in their immediate surroundings, their interpretation of safety needs, and overall experience of empowerment and agency over public spaces.

While the majority of the literature aims to impact urban planning, design, and management of public spaces, there appears to be a lack of research that applies the findings to actual shared urban spaces. For example, there is a lack of studies that assess or measure how safe women feel or do not feel in a particular space, in order to apply the research to improve safety measures in that space. One possible explanation is difficulty in measuring perceived safety. Identification of

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unsafe places requires a conceptual framework of what affects perceived safety, and which factors should be considered.

The literature shows a wide array of factors across interdisciplinary studies. While some factors are repeatedly reported significant across different studies, others are unique. Even those common factors have been measured and quantified using different methods and scales. Some factors are objective, and others are highly subjective. There is therefore a lack of standardisation of the factors affecting women safety. Moreover, while some studies looked at actual safety of women expressed through official records on crimes, other studies focused on perceived safety. The latter emphasises that perceived sense of unsafety can be enough to keep women out of the public spaces and therefore lead to reduced civil participation and socialisation. Official records of crime generally underestimate actual safety metrics, as due to shame and fear, many women do not report sexual harassment or assault.

Another issue is methodological confusion, which pertains to the nature of the data analysed to understand and capture the conditions under which women feel safe or unsafe in public spaces. It is fundamental to understand women-specific gender needs and how safety is perceived psychologically when women's most important needs are satisfied. Critics argue that simplistic, numerical evidence cannot showcase a true reflection of social reality and differences in perception levels varying with spatial and time-specific social changes (Ferraro & Grange, 1987). Traditional methods relying on surveys and cross-sectional analysis present 'perceived safety related spaces in a static form,' providing only a snapshot at the time of tangible realities, excluding intangible psychological triggers related to socio-spatial settings.

Numerous studies have questioned the appropriateness of surveys and the phrasing of questions to assess perceptions of safety, questioning whether the findings reflect actual perceived safety or fear of crime (Lee, 2001; Jackson, 2005; Gray et al., 2011). The early indicators of perceived safety surveys included questions such as "how safe do you feel after dark?" or "how safe do you feel walking alone at night?" (Hale, 1996). More recent studies generally inquire about respondents' locations, reference periods, spatial settings, and types of perceived safety. Traditional methods of research lack momentary psychological and emotional responses to feelings of safety or insecurity experienced in public spaces (Chataway et al., 2017). Lack of data, or limited data in varied formats, also leads to lack of standardisation of perceived safety metrics.

This study uses a narrative review to identify factors affecting women's safety perception in public spaces and while using public transport. The factors are categorised in three broad groups: built environments, personal characteristics, and social influences. The study adopts an intersectionality framework to evaluate the relative importance of each factor based on its consistency and prominence in previous research and assessed their significance in contributing to women's perception of safety. Moreover, this study aims to contribute to the understanding of how emerging technologies can play a role in accurately and consistently assessing women's perceived safety in public spaces.

Section 2 outlines the methodology, including the intersectionality framework. Section 3 discusses the global significance of women's safety and the specific nature of perceived safety in urban environments. Section 4 provides an in-depth review of built environment factors influencing women's perceived safety, alongside other considerations such as individual characteristics and community perspectives. Section 5 presents a conceptual framework illustrating the interlinkages of these factors. Section 6 reviews data collection methods, emphasising the use of novel technologies. The conclusion in Section 7 summarises the findings and implications for urban planning and policy.

## 2. Methods

Women safety in urban areas is a wide field of research. This paper

addresses part of this wide spectrum, looking at research focused on measuring or quantifying perceived safety of women in public spaces. This paper identifies five major dimensions to evaluate the achievements and gaps of current research, and to infer opportunities and challenges for future research. They are namely: factors (factors affecting safety); data (data to represent factors); technology (emerging technologies to produce data); measurement (measuring/quantification approaches); and policy (evidence for planning and policy making). These are interrelated dimensions (Fig. 1).

The methodology framework adopts a narrative review to identify various factors including built environment, social, and individual and the degree of impact of each factor has on women's perceived safety. Then, it applies the concept of intersectionality to assess the interlinkage between the identified built environment, social, and individual factors, thereby validating the relationships and complexities associated with each factor affecting women's perceived safety in public spaces.

For the narrative review, a literature search was conducted using two electronic journal databases - Web of Science and Scopus - due to their comprehensive coverage of peer-reviewed journals across disciplines and their focus on high-quality, reputable publications. The search was limited to peer-reviewed journal articles and English language publications, spanning the years 1980 to 2024. Title and abstracts were analysed for several related keywords and phrases, including perceived safety, women's perception of safety, feeling of safety or security, spatial perception, perceived social safety, perceived risk, and women safety. The initial search and review were conducted from September to November 2023. A follow-up search and review took place in July 2024.

The search was then further refined to filter studies focusing on public spaces using the following terms including built environment, public space, physical environment, physical features, environmental cues, social features, social cues, visual cues, CPTED, entrapment, virtual environment, public safety, public disorder, and public transport. Additionally, articles were identified from the reference list of the found research studies using the snowballing technique. A substantial number of studies have focused on women's fear of crime, examining the impact of crime scenes, news articles, and the association with high-crime areas. These studies were excluded from this review.

## 3. Women's perceived safety

### 3.1. The global significance of women's safety

Women's perception of safety is complex and a multi-faceted reality; composed of intersecting attributes all contributing directly or indirectly towards quality of life. Women safety over the years have captured extensive research, yet women and girl's experiences around the world also presents crucial challenges in the public domain in ensuring their "right to the city" (UN-Habitat, 2010). The literature and discourses on women's perceived safety and experience in public realm are deeply concerned about constant exposure of attacks, fear of sexual harassment, humiliation and fear of victimisation in public spaces or while accessing public transport; this infringes women's personal safety and security, often leading to narrow city participation.

The global framework of Sustainable Development Goals (SDG 5) aims "to eliminate all forms of violence against all women's and girls in public and private sphere" (SDG Target 5.2). Urban safety for women is often subjected to both actual and perceived safety. Level of crime and sexual street violence experienced by women is a complex intersection of social, cultural, economic and familial issues which combines to affect women's feeling of safety when in public spaces. Women's bodies have been conceptualised through different mechanisms of socialisation, patriarchal hegemony and gendered power relations which contribute to perpetration of violence against women; objectifying women as objects, especially as sexual objects, or as victims of irrational fear, disempowered, inferior; 'not as fearless subjects, protagonists or social agents with power' (Sweet & Escalante, 2015).

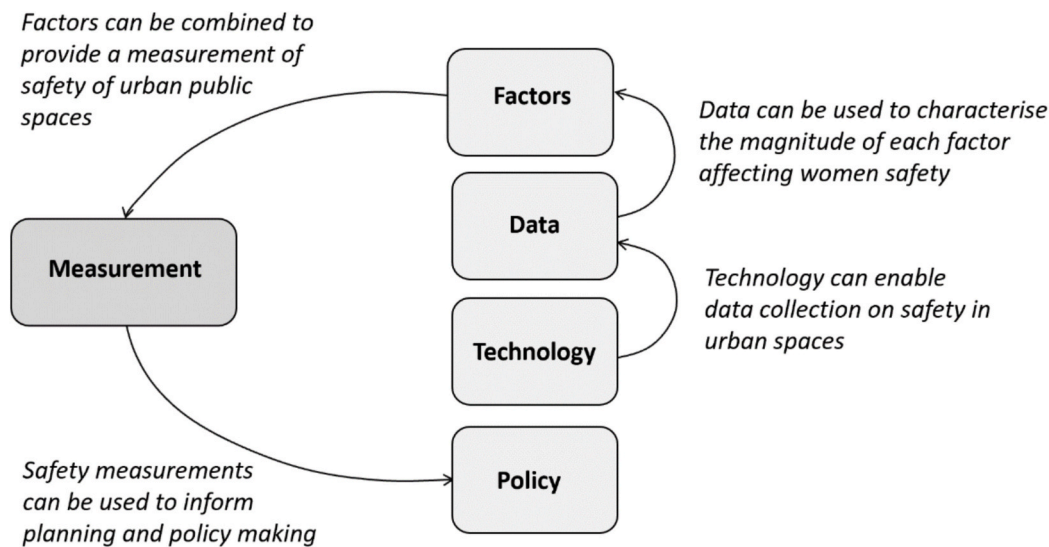


Fig. 1. Relevant dimensions for measuring safety of women's mobility in urban areas.

Reports on violence against women in public spaces are prevalent. In a recent survey conducted in Sydney, Australia, reveals that 60 % of women respondents pinned locations of 'bad experience' on the streets and 20 % of them on public transport (Committee for Sydney, 2019). A survey conducted in Baku, Azerbaijan, out of 200 female commuters, about 81 % had experienced sexual harassment (Jafarova et al., 2014; Asian Development Bank, 2015). Another survey undertaken in 2010 in Delhi, India, found over 90 % women had faced sexual harassment in public spaces, while 51 % women faced sexual harassment inside public transport (Shah et al., 2017). In Mexico City, 90 % of women had experienced sexual violence while using transit services (Dunckel-Graglia, 2013). In Kampala, Uganda, 80 % of girls feeling unsafe in public spaces and only 2.2 % girls in Lima, Peru, reported that they feel safe when in public spaces (Travers et al., 2013).

### 3.2. Women's perceived safety in urban environments

#### 3.2.1. Nature of safety perception

Women safety in public spaces have been conceptualised and generalised to have direct association with fear of crime; a vital concept, diverse and mutually influenced by psychological, physiological, environmental, structural and social construct. Perceived safety is an emotional and physical response. It is unique to each individual and may evoke adverse emotional impact upon women, inducing feeling of isolation or vulnerability. Perceived safety is an elusive concept, and has inherited wide array of definition, composed of interlinked factors, owing to the risk of bias and 'conceptual confusion' (Yates & Ceccato, 2020). Experience of fear in public spaces can be classified into two categories: "concrete fear" meaning actual risk of victimisation and "formless fear" meaning perceived risk influencing women's everyday routine activities (Farrall et al., 1997). Each causes direct health and psychological impact, often scarring women with permanent memories of violence rather than transitory (Natarajan, 2016; Gardner et al., 2017; Gopal & Shin, 2019). Incidence of lewd glances, indecent comments and intimidation stigmatises women's everyday interaction when in public realm. Whether or not, women have experienced any form of potential harassment in public space, perceived risk of insecurity is a bigger deterrent than actual crime (Hawken et al., 2020).

The genesis of fear of crime as established and adopted by many studies repeatedly is defined as "an emotional response of dread or anxiety to crime or symbol that a person associates with crime" (Ferraro & Grange, 1987). Ferraro's definition of fear of crime is useful as it understands and treats fear produced as a psychological response when in

close association with subjects of potential threat or danger evident to an individual in their close socio-physical proximity. The perceived risk of insecurity arising due to situational events in relation to environmental or social cues or physical incivilities invariably impacts women's perceived safety leading to devalued self-esteem and equitable cities.

Women's response to fear manifests itself indirectly in avoidance strategies and practices adopted in public spaces when alone. Women more often navigate and negotiate public spaces with heightened awareness of every approaching voice and noise related to micro design features. They adjust their pace and path, avoid routes deemed unsafe or insecure, and make spatial judgement about their safety in relation to risky urban environment (Valentine, 1989). Moreover, women's perception of safety is triggered due to low lighting, lack of security or surveillance, deserted or isolated location, and many other socio-demographic and situational causes. This is consistently reported by numerous studies reporting about places of fear (Ratnayake, 2016).

#### 3.2.2. Women's perceived safety and its effects on mobilities

The literature reports women are more concerned of crime and personal safety compared to men (Pain, 2001; Ratnayake, 2016). Women's perceived safety in public spaces is a product of spatial paradox (Koskela & Pain, 2000). The literature verbalizing women's experience of fear is continuously drawing attention towards women's complex mobility pattern, socio-urban environment challenges, inadequate knowledge on gender needs and socially inappropriate positioning of women as users of public space (Pain, 2001; Delbosc & Currie, 2012; Currie et al., 2013; Loukaitou-Sideris, 2016; Natarajan, 2016; Gopal & Shin, 2019).

Safety and mobility play a positive role in shaping women's perception of urban public realm, but the approach to understand safety and mobility has remained singular. What emerges from the literature is that physical spatial limitations, lack of appropriate accessibility, and fear of insecurity are key factors that triggers 'social exclusion' of women from urban public realm (Koskela, 1999; Uteng, 2009). In response to their perceived safety and insurance of safety, women could self-regulate their public interaction, hinder their daily activities, change or alter routes deemed 'unsafe', or limit their spatial mobility, which directly affects their overall well-being and quality of life.

Accordingly, women's feeling of safety is established with the sense of social belongingness and spatial confidence, a reflection of gender equality differing in relation to 'culturally specific variation in the construction of gendered power relations' (Koskela, 1997). Women's feeling of safety is not only subjected to risk of actual crime but must be

understood in relation to occurrences of involuntary reaction (feelings) to everyday situations, individual experiences, memories and spatial-social construct.

The term perceived safety therefore refers to “a state in which a person’s most important needs are satisfied and it is expected that this state will remain stable” (Eller & Frey, 2019). The narrative of ‘feeling of safety’ therefore must evolve to widen the understanding of the conditions under which women generally feel safe in their immediate surroundings, their interpretation of safety needs as well as women’s overall experience of empowerment and agency over public spaces, which is particularly important concerning women’s perception of safety in public spaces.

### 3.2.3. Women’s perceived safety and its effects on behaviour

Psychological arousal such as anxiety, personal safety stress, or sense of insecurity is more pronounced among women in public spaces compared to their male counterpart (Pain, 2001). Walking alone at night through dark, isolated, or confined space with limited escape routes; low lighting with strange men around involuntarily evokes feeling of anxiety or fear of victimisation, especially fear of sexual violence. Studies elicit that fear of crime or security-related risk perceptions are major contributors to behaviour constraints (Loukaitou-Sideris, 2014; Stark & Meschik, 2018). Fear evokes stress reaction and can manifest itself enforcing women to avoid, adjust, or cope with the threatening situation either by active (e.g. self-defence) or passive measures (De Silva et al., 2017). Behavioural adaptations may vary according to space, time, and situation. It often results in self-isolation or social distancing for some individuals, particularly vulnerable, ethnic minorities, underprivileged or disabled women. Fear thereby also increases concerns related to personal proximity with heightened awareness of their immediate surroundings, arousing feeling of anxiety in public spaces. (Stark & Meschik, 2018; Yates & Ceccato, 2020).

A study conducted by Hollaback in 22 countries found that 79 % respondents reported feeling anxious in public space, the study also highlights strong emotions evoked by women’s such as of anger, fear, and anxiety due to experience of street harassment (Hollaback, 2015). The majority of female participants in the survey reported that the initial responses to street harassment could lead to long-term effects of low self-esteem and in some cases resulting in depression (Hollaback, 2015).

## 4. Factors influencing women’s perceived safety

Our perceptions create our reality; thus, it is fundamental to understand which factors influence women’s sense of safety in public spaces, restricting their right to mobility. The literature discusses a variety of potential factors influencing women’s perceived safety in urban settings. They may fall into three types including: built environments, individual and community factors.

### 4.1. Built environment factors

Built environment characteristics affect personal sense of safety especially after dark increasing the level of fear. Studies have established that proximate environmental cues such as street lighting, street visibility, walking path conditions, presence of security and surveillance, and degree of openness have a direct association with perceived safety.

Street lighting and its association with fear of crime and perceived safety has been a continual subject of investigation mainly concentrating on women’s vulnerability and risk of victimisation after dark. Fear of crime studies investigation on perceptual drivers of “safe” environment, remains focused on inverse attitudinal response of factors lowering fear of crime, ignoring diverse aspects of other unique features of built and social environment that may be driving the perception of safe public space. Painter (1996) investigated the effects of improved lighting on reduction of fear of crime in three experimental sites in London. The study found that women were more perceptible to environmental

changes and far more likely to realise its effect on their increased outdoor mobility compared to men. However, relighting an area is highly noticeable activity, and the study provides inadequate details on qualitative aspects of women’s perception after modification (Painter, 1996; Boyce, 2019).

Similarly, a study by Herbert and Davidson (1994) found that street lighting modifications at selected experimental sites were acknowledged by 90 % of respondents, but the feeling of safety among females improved 54 % in average. This implies that street lighting may have indirect effect on perceived safety by improving public confidence. However, the question still remains unclear whether lighting could act as a “catalyst to bring about changes in social behaviour which in turn contributes to a reduction in crime and disorder” (Painter, 1996).

Street lighting is an important ‘fear-reducing factor’ (Vrij & Winkel, 1991) particularly when walking through an isolated or deserted location. The reviewed studies observed direct impact of presence of street lighting in public spaces on women’s perceived safety (Haans & de Kort, 2012). Women often rate their safety based on perceived level of anxiety experienced in public spaces associated with physical and socio-demographics composition and self-acknowledgment of personal experiences and individual characteristics (Loukaitou-Sideris, 2014; Stark & Meschik, 2018; Yates & Ceccato, 2020). Effective lighting illuminating immediate surrounding offers improved prospect (i.e. ability to have clear overview) and positively affects individual’s perceived safety.

Women’s perceived safety related to street lighting is characterised on the basis of acceptability of safe lighting level in the community, quality of lighting, brightness, and distribution of lighting in an individual’s immediate surroundings (Johansson et al., 2011; Haans & de Kort, 2012; Boomsma & Steg, 2014). Additionally, other mediating factors associated with street lighting are environmental trust and influence of personal characteristics such as trait anxiety and perceived agency to ensure sense of safety (Johansson et al., 2011; Boomsma & Steg, 2014).

Visibility is an important environmental feature directly affecting perception of safety based on varying lighting conditions. Improved street visibility and openness encourage street usage and elevate women’s sense of safety. Environmental design features such as prospect promotes feeling of safety in direct association with well-lit areas and walking paths and presence of people as well as clear landscaping or vegetation sightlines not impeding view of the street (Cozens & Sun, 2019; Grohe, 2011). On contrary, levels of concealment and escape has negative impact on women’s perception of safety particularly at night (van Rijswijk & Haans, 2018).

The most important feature of street lighting is to enhance individuals’ ability to recognise facial expressions and body language of other people on the same route (Boyce, 2019). The effect of street lighting on perceived safety is partially influenced by changes in ‘people’s appraisal of the safety related to street characteristics such as prospect, escape, and concealment’ (Haans & de Kort, 2012). van Rijswijk and Haans (2018) found that high prospect is positively related to environmental perceived safety and a negative correlation exist between perceived safety and levels concealment and escape at night under different lighting conditions. Opportunities for escape have the largest effect on perception of safety particularly at night, because lack of escape opportunity may increase feeling of anxiety lowering women’s perception of safety. The study also found mediating effects of environmental characteristics on perception of safety indirectly influenced by street lighting. This implies that an individual’s increased perception of safety is associated with the effectiveness of lighting, illumination of the immediate surrounding offering possibility of high prospect as well as good overview of what lies beyond.

Another built environment feature strongly associated with feeling of safety is existence of surveillance. How women respond to the existence of CCTV cameras in public spaces was examined by Koskela (1999). The study found that women are less supportive towards technological surveillance and favoured police patrolling over video surveillance.



Another study conducted by [Zurawski \(2010\)](#) investigated the impact of CCTV cameras on feeling of safety of women. Findings suggest that CCTV causes no direct impact on feeling of safety or “corresponds to the roots of feeling of security”. However, video surveillance acts as a medium to mitigate or detect crime and criminal incidences to assure social control. Feeling of safety may not be directly associated by mere presence of CCTV cameras in public spaces. It is also unidentified if elements of security and surveillance mechanism contribute to the reassurance of feeling of safety.

Perceived safety is a complex association of physical, social, and individual attributes coexisting in spatial setting as a result of space dynamism, individual's ability to counter momentary arousal of fear or insecurity in public spaces as they engage with their everyday routine activities ([Toet & van Schaik, 2012](#); [Piroozfar et al., 2019](#)). It is pertinent to investigate the interactions of the attributes that promote feeling of safety across varied diversity and structural social identities in urban public realm. Although perception of safety is a complex interaction of physical and social environment features experience at individual level, it is important to assess physical and urban environment characteristics such as lighting, walking path conditions, visibility that are important as enhancers of safety.

The walking environment plays an important role in influencing the perceived safety in relation to built environment characteristics. Numerous built environment factors such as sidewalk length, street amenities, land use diversity, commercial and retail density, presence of open spaces and street-level traffic movement affect perceived attractiveness and pleasantness and personal perceived safety ([Basu et al., 2022](#)). [Basu et al. \(2022\)](#) conducted their study using a cross-sectional design and ten web-based experiments that represented environmental scenarios of real-world suburban environments in Brisbane, Australia. Findings suggest that perception of safety is higher while walking through recreational spaces compared to residential areas. Women feel safer in areas with tree-lined streets, whereas the presence of litter and graffiti along the walkway had the opposite effect. Young women feel safer in the night when walking through areas with mixed land uses and commercial activity, due to the vibrancy of the area. The study also found that women's perceived safety to be higher in residential areas compared to commercial areas during the daytime, concluding that familiarity with the walking environment increases the perception of safety compared to unfamiliar areas.

Another study conducted by [Lizárraga et al. \(2022\)](#) also concluded that the perception of safety in the walking environment is attributed to the spaciousness of walking paths, presence of mixed-use commercial and retail activity, segregated pedestrian zones, street lighting, high density of people, and the upkeep of the area. Deterrents to the walking environment played a significant role in lowering the perception of safety. The study also concluded that barriers to walking, such as absence of people, poor street lighting, or walking along unfamiliar locations, had a significant impact on lowering women's perceived safety.

Studies that have specifically explored perception of safety have also given little attention to the “dynamics of places” with majority using cross-sectional surveys that only examines perception at one particular location, at one point in time, ignoring the importance of experience varying with contextual cues. It remains unclear from literature, whether certain elements of built environment that are conducive for feeling of safety in one's immediate proximate space would produce similar effect on feeling of safety when in distinct public space ([Chataway, 2019](#)).

#### 4.2. Individual and societal characteristics

The built environment's impact on perceived safety varies according to individual and societal characteristics. Factors such as age, socio-economic status, and cultural context influence how people perceive and react to their surroundings, highlighting the need for tailored urban design and policy interventions.

Personal identity plays a significant role on perceived safety issues faced by women. [Hidayati et al. \(2020\)](#) examined the complex interplay between spatial configuration within certain built environments, socio-cultural contexts, and how this interrelationship affects mobility. The study utilises a mixed-method approach, combining on-street surveys, video analysis, and space syntax modelling. The results showed that women's perceived safety is associated with individual risk acceptance ability and expectation of risky behaviour from others. Additionally, perceived safety depends on how other user groups negotiate and share public spaces.

The literature has investigated how the built environment affects perceived safety across different age groups. [Johansson et al. \(2011\)](#) found that younger women are likely to feel unsafe in public spaces due to psychological influences, while elderly women are tend to be unsafe because of physical vulnerabilities in public spaces. [Paydar et al. \(2017\)](#) examined the effects of perceived safety of women on their daily walking pattern using 3D maps to identify routes traversed daily by respondents. Their study suggests that built environment factors contributing to perceived safety are consistent across age groups. [Delbosc and Currie \(2012\)](#) also reported that age has no significant correlation with perceived safety during using public transport. However, other studies have highlighted that age may have an indirect impact negatively influencing perceived safety ([Currie et al., 2013](#); [Valentine, 1989](#); [Zavattaro, 2019](#)).

Previous studies examining the association between ethnicity and perceived safety have established that women from ethnic backgrounds have higher safety concerns in public spaces ([Pain, 2001](#)). [Zavattaro \(2019\)](#) found an indirect association between perceived safety and structural social identities (race/ethnicity) depending on how individuals perceive their immediate surroundings. In general, the literature suggests indirect links between an individual's social identity and perceive safety ([Ratnayake, 2016](#); [Valentine, 1989](#); [Zavattaro, 2019](#)). Additionally, socio-economic status and education level are important factors contributing to perceived safety. For example, women from low-income backgrounds are likely to feel under constant threat of social victimisation and sexual harassment ([Hale, 1996](#)). However, another study demonstrated limited significance associated with socioeconomic status and level of education with perceived safety ([Ferretti et al., 2019](#)).

Women's perceived safety is also influenced by community and social factors. According to [De Silva et al. \(2017\)](#), women perceive their immediate surrounding based on numerous static and dynamic contextual factors. The presence of social incivilities, such as public drunkenness, vandalism, anonymity, poor physical upkeep of the area, and a lack of trust or social cohesion, potentially increases the risk of victimisation and consequently lowers feeling of safety, especially for women ([Macmillan et al., 2000](#)).

In the context of urban public realm, the frequency of visits to a particular area or location increase familiarity with the surroundings and other users ([Piroozfar et al., 2019](#); [Zurawski, 2010](#)). Beyond being familiar with an area, it is crucial to know the people and to establish trust within the community. [Paydar et al. \(2017\)](#) observed that activities attracting a balanced mix of people enhance perceive safety. Their study asserts that ‘presence of familiar people’ is a strong indicator of feeling safe, while the ‘presence of others’, such as those perceived as strangers or group of unpredictable men may negatively influence women's perceived safety in public spaces. The presence of other females in public spaces can improve their perceived safety, although this also depends on the perceived acceptance of diversity among the people present.

Familiarity with an area is reportedly one of the strongest predictors of women's perceived safety in public spaces. Familiarity can be strengthened through various dimensions, including trust within the community or strong social ties ([Chataway, 2019](#); [Currie et al., 2013](#)); active surveillance ([Piroozfar et al., 2019](#)); the presence of people ([Crosby & Hermens, 2019](#); [De Silva et al., 2017](#)); time of the day ([Chataway, 2019](#)); frequency of visits and length of residency ([Grohe, 2011](#); [Piroozfar et al., 2019](#); [Valentine, 1989](#); [Zurawski, 2010](#)). Studies

have found that women's perceived safety is higher in areas recognised as socially cohesive. For example, women familiar with a specific place can recognise strangers and seek help from others due to social contacts and spatial confidence (Koskela, 1997).

Overall, the literature shows some inconsistencies regarding individual factors influencing perceived safety. Similarly, some studies indicate no significant interaction between social identities, such as race

and ethnicity, prompting the need for expanded research to include diverse populations to assess the influence of physical and social features on feeling of safety (Ratnayake, 2016; Zavattaro, 2019). It remains uncertain whether individual variables mediate other contributing factors that vary across personal identities, such as past experiences, personality traits, and social factors, which most studies have not acknowledged yet (Crosby & Hermens, 2019; Piroozfar et al., 2019).

Author, Year	Built Environment									Community					Individual			
	Street Lighting	Security personal	Surveillance- CCTV	Walk path- State & condition	Street Visibility	Street Openness	Familiarity with an area	Trust in community	Proximity to public transport	Gender balance	Presence of people	Time of the day	Gender usage-Activity	Frequency of visit	Race	Ethnicity	Age	Employment
(Basu et al., 2022)	Strong	Unassessed	Unassessed	Strong	Strong	Strong	Strong	Unassessed	Unassessed	Strong	Strong	Unassessed	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Lizárraga et al., 2022)	Strong	Unassessed	Unassessed	Strong	Strong	Strong	Strong	Unassessed	Unassessed	Strong	Strong	Unassessed	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Chataway, 2019)	Strong	Strong	Unassessed	Strong	Strong	Strong	Strong	Unassessed	Unassessed	Strong	Strong	Unassessed	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Piroozfar et al., 2019)	Strong	Strong	Weak	Unassessed	Strong	Strong	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Crosby and Hermens, 2019)	Indirect	Unassessed	Unassessed	Indirect	Strong	Strong	Strong	Unassessed	Unassessed	Strong	Strong	Unassessed	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Zavattaro, 2019)	Unassessed	Strong	Unassessed	Unassessed	Strong	Strong	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Cozens and Sun, 2019)	Uncertain	Unassessed	Uncertain	Indirect	Strong	Strong	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(De Silva et al., 2017)	Weak	Weak	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Paydar et al., 2017)	Weak	Unassessed	Unassessed	Weak	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Ratnayake, 2016)	Uncertain	Unassessed	Uncertain	Unassessed	Strong	Strong	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Viswanath and Basu, 2015)	Strong	Weak	Weak	Uncertain	Strong	Uncertain	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Boomsma and Steg, 2014)	Weak	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Currie et al., 2013)	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Haans and de Kort, 2012)	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Delbosc and Currie, 2012)	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Johansson et al., 2011)	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Grohe, 2011)	Indirect	Unassessed	Unassessed	Indirect	Strong	Strong	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Zurawski, 2010)	Unassessed	Strong	Uncertain	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Loewen et al., 1993)	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Vrij and Winkel, 1991)	Unassessed	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
(Valentine, 1989)	Indirect	Unassessed	Unassessed	Indirect	Strong	Strong	Strong	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed



Fig. 2. Heatmap of highly influential attributes impacting perception of safety.

The studies reviewed in this section also demonstrate that community characteristics, particularly familiarity with an area, trust in people, and the presence of people, can be significant predictors of perceived safety. Women's perception of safety in their immediate surroundings is dominantly determined by how well they know or are familiar with their surroundings and how at ease they feel with both social and built environments (Valentine, 1989).

## 5. Analysis

A more comprehensive analysis of the factors of influence was conducted through an in-depth review of the selected studies. This analysis assessed the level of support in the literature regarding the degree of impact of built environment, individual, and community attributes. For the analysis, the following inclusion criteria were applied to screen research findings from the selected literature:

1. Does the study report substantive data on built environment, individual characteristics, and communities and social factors influencing women's perception of safety in public spaces?
2. Does the study report substantive data on intersectionality between built environment, individual characteristics, and communities and social factors enhancing the perception of safety?
3. Does the study employ primary qualitative, quantitative or mixed method to collect, formulate, and model data on the perception of safety using novel technologies?

The 21 selected research studies meeting the inclusion criteria were reviewed and analysed thoroughly, applying an intersectionality lens to extract the relationship between the built environment factors and community and social factors and individual factors that promote women's perception of safety, directly or indirectly in an urban context. This analysis draws upon the number of studies that have examined each factor and their significance for women's perceived safety. Furthermore, it evaluates the consistency of these results across the literature, providing a comprehensive understanding of their relevance and impact.

The heatmap (Fig. 2) shows the level of support by the literature on degree of impact for built environment, individual, and community attributes. "Strong" impact (dark green) was given to the factors showing highly significant influence on women's perceived safety by empirical data demonstrated in the literature. The factors classified as "Weak" demonstrated the factors of low influence on the feeling of safety. Those factors assessed as "uncertain" indicate ambiguous results, whereas dependable factors were not assessed by the respective studies. Factors categorised as indirect or direct impact was based on statistical relevance and linkage established by research studies.

An analysis of the review results reveals that the majority of studies identified a strong correlation between built environment and community factors and perceived safety. Among the built environment factors, street lighting, visibility, walking path condition, and street openness were most frequently correlated with women's perceived safety. Additionally, presence of people, trust in the community, and familiarity with an area, were found to have the significant impact on perceived safety among the community factors. Although numerous studies have examined the influence of personal characteristics, there is a general lack of evidence demonstrating a strong correlation between these individual traits and perceived safety.

Perception of safety is rarely dependent on a single attribute. Most built environment factors, whether directly or indirectly, interact with and are influenced by various other factors, including social and individual characteristics, to contribute to the overall sense of safety in an urban context.

The built environment encompasses a variety of visual elements that significantly contribute to perceived safety, including lighting, visibility, openness, walking path conditions, and surveillance measures. Among

these, street lighting stands out as particularly critical because it affects other built environment factors, such as visibility and walking path conditions, by enhancing their perceptibility. Effective lighting not only illuminates dark areas, making hazards and obstacles more visible, but also creates a sense of security by reducing the opportunities for concealment. Improved lighting can thus play a pivotal role in encouraging women to visit an area more frequently. As women become more familiar with their surroundings through repeated visits, their sense of security naturally increases. This increased familiarity with the area can also enhance the perceived presence of other people, contributing further to a heightened perceived safety.

Moreover, the presence of surveillance measures, such as CCTV, complements these efforts by providing an additional layer of security, even if the direct impact on women's perceived safety might not always be strongly evidenced. The combination of well-maintained walking paths and effective lighting creates an inviting and safer environment, which can significantly improve the overall perception of safety. The interaction of these built environment factors demonstrates that a comprehensive approach to urban design is essential for fostering a secure and welcoming atmosphere for all users.

Trust in the community and social cohesion are further strengthened through active participation in social activities facilitated by community networks. Such involvement not only fosters a gender-balanced environment but also enhances social relatedness and the overall feeling of safe experienced in public spaces. When women perceive that their community is cohesive and supportive, their sense of safety can be significantly improved. The frequency with which women visit certain locations, their familiarity with the people around these areas, and their active engagement in community activities all contribute to a robust perceived safety. Therefore, fostering strong community ties and ensuring the presence of supportive social networks are vital for creating safe and inclusive public spaces.

## 6. Data collection methods and measurement

The literature on measuring the perception of safety is limited, particularly those studies that examine the interlinkage of built environment, social and individual factors affecting women's perceived safety in public spaces. The validity and accuracy of traditional instruments such as street surveys have been questioned in terms of reflecting enduring emotions or experiences and gauging feelings (Jackson, 2005; Chataway et al., 2017). Such survey results provide static knowledge but could be biased due to the narrow descriptions of safety questions such as "how safe do you feel?" or "how safe do you feel walking alone at night?" to gauge perception of safety in a local context (Hale, 1996; Jackson, 2005). It is argued that safety related questions measuring complex process arising from everyday interactions and varying degree of emotional response using traditional methodologies lack sensitive "ecologically valid information" to assess the feeling of safety (Gray et al., 2011; Chataway et al., 2017).

### 6.1. Smartphones and crowdsourced data

The growing capacity of novel technologies, combined with the widespread proliferation of smartphones, offer opportunities for generating and exploring advanced questions in urban safety and security. Mobile technologies in social-psychological science have become a lucrative tool for research. Mobile technology, particularly smartphones, has provided users and researchers with advanced capabilities and functionalities, strengthening data collection processes. These capabilities include flexible control, cost efficiency, context-sensitive investigation, and extensive collection of longitudinal data. These tools can capture the nuances of everyday life, how people interact with their surroundings, how they feel and perceive their immediate environment (Leao & Izadpahani, 2016).

SafetiPin, a mobile app, utilises civic technology supplemented by

crowdsourced data to collect information related to urban safety, with a particular focus of women safety in urban public areas. It uses a set of parameters including lighting, visibility, walk paths, surveillance, openness, people, gender balance, and public transport (Viswanath & Basu, 2015). The app identifies 'safe' and 'unsafe' locations based on ratings and responses provided by the public and trained volunteers regarding their perceived safety at specific locations. It allows users to report their perceived safety level in response to aforementioned indicators, collecting data through citizen participation. This provides researchers with a means to engage with both textual and quantitative data on perceived safety.

The crowdsourced data collection method faces critical challenges. Crowdsourced data often provides insufficient details on gender perspectives on urban safety due to the lack of gender-disaggregate data collection. The issue arises mainly from the reluctance of people, particularly women, to share sensitive socio-demographic information such as their gender, income, race/ethnicity through smartphone applications. Concerns about the technical risks of inappropriate use of information or data inaccuracy contribute to this reluctance. The inadequacy of data produces the risk of bias, and the validity of the data suffers (Raento et al., 2009), particularly when assessing emotional response or feeling subjected to real-time situations. Another limitation is the inherent bias, as participants may avoid certain areas due to safety concerns. Consequently, this approach may fail to log perceived safety in these locations, resulting in data that predominantly reflects spaces already deemed safe, thus skewing the overall analysis.

### 6.2. Ecological momentary assessment: experience sampling method

Ecological momentary assessment allows researchers to measure "experiences as they occur or close to their occurrence, within the context of a person's everyday life" (Solymosi et al., 2015). Chataway (2019) applied the ecological momentary assessment approach to collect data on participants 'perception of a safe environment', combined with mobile-based technology. The author thematically coded the responses and provided insights into how feelings of safety vary across everyday routine activities under the influence of social, physical, and psychological characteristics. This method can provide valid spatial data within natural settings to gain in-depth knowledge on perceptual drivers related to physical, social and psychological structures that arouse feelings of safety or insecurity in specific times, places, and contexts. However, it is an expensive data collection method and places responsibilities on respondents to accurately record and respond to situational and socio-spatial cues, which may lead to compliance and self-selection bias.

### 6.3. Sensing technologies

Another approach for collecting human perception data is the use of sensing technologies, which can extract information on people's interactions with their immediate environment that may not be easily observed using traditional approaches. For example, in response to street surveys on perceived safety, participants' inability to articulate their response to external stimuli, recall, admit or express their feelings, or even the exaggeration of their feelings, may result in data bias (Solymosi & Bowers, 2018). Beyond these limitations, data on feelings of safety also suffers from the overestimation of 'fear' or underestimation of feelings of safety associated with self-reported questionnaire surveys. These surveys often fail to capture the everyday nuances of emotional responses that depend on time, context, and space.

To measure the effects of environmental cues on physiological changes, De Silva et al. (2017) conducted exploratory research using galvanic skin response and a walking speed meter. Participants walked around a designated site area wearing a portable device to measure skin conductance, an indicator of arousal, to investigate the effects of different non-verbal environmental cues on participants' immediate

physiological changes. The study analysed physiological reactions to environmental cues to identify safe and unsafe locations, assessing the feasibility and validity of data in real-time experiments. This study was enabled by triangulating data from multiple sources, such as walking speed data, skin responses, and photographic analysis of the site.

Sensing technology can also be combined with eye-tracking technology to measure people's perception of safety by examining participants' eye movements and attention-dwell time using eye-tracking devices in a lab-assisted experiment (Crosby & Hermens, 2019). The study examined the impact of physical and social factors on participants' visual attention, offering key insights into how people perceive their urban environment and drawing conclusions from the complex spatial decision-making process as people navigate their natural settings.

Sensing technology could further be applied in urban spatial and safety research to investigate people's spatial perspectives, interactions, and the intersection of factors associated with locations offering peak physiological responses. This can also be enabled with eye tracking devices with real time processing capabilities, offering an interactive process and means of data collection (Kiefer et al., 2017; Solymosi & Bowers, 2018). Recent studies have introduced techniques that utilise electroencephalogram (EEG) to measure female perceived safety. Priya Uteng et al. (2019) proposed a method for measuring women's safety using EEG and eye blink signals. The approach involves pre-processing signals, extracting features, and classifying emotions using machine learning methods. Detected emotions are converted into text messages sent to police stations and contacts. Experimental results show the method achieves high accuracy of 98.04 %, making it a promising and effective solution for enhancing women's safety.

From a methodological perspective, the capacity to measure the impact of physical, environmental, social, and individual factors on the perception of safety exists. Most models measure built environment factors in combination with an assortment of social factors. However, not many models measure the interlinkage between those factors on the perceived safety. The literature suggests that well-organised data, collected passively over a period of time and specific to research problems, may provide richer insights compared to traditional methods (Solymosi & Bowers, 2018).

This suggests that the combined knowledge of traditional survey tools (e.g., in-depth interviews, visceral methods) and novel technologies (e.g., smartphone technology, EMA, sensing and tracking devices) may offer new opportunities to assess the interactions of culturally diverse socio-demographic groups within their immediate built and social environments, experiencing safety at both micro and macro levels. The combination of innovative data sources and novel technologies could enable the identification of intersecting spatial dimensions of space. Virtual reality and digital simulation technology offer micro-level assessments of safety parameters in virtual environments, increasing the scope for researchers to manipulate and control multivariable settings (Park et al., 2010; Baran et al., 2018). The accumulation of large data sets and the application of machine learning approaches to analyse data also provide the possibility to carry out comparative studies at a macro scale (Zhang et al., 2018). However, sampling bias remains a consistent limitation across both traditional and novel methodologies, often risking a trade-off between the accessibility of data for researchers and policy-makers and the inclusion of diverse and dynamic aspects of place.

## 7. Conclusion

The theoretical framework for this research adopted a multi-dimensional approach to unpack the influence of women's social structural identities as well as identify the influence and interlinkage of built environment, individual and community factors affecting women's perceived safety in public spaces. The adoption of intersectionality lens, is set under the framework to "highlight the full diversity of women's experiences" (Yuval-Davis, 2006). Women's experience of urban public spaces is constructed from social division of gender-power relations,



subjectively experienced by women in their everyday lives based on inclusion or exclusion, discrimination, marginalisation, socialisation, and differing identities intermediating its roles in creating prejudices and perception about their safety.

The study highlighted some policy implications for urban design and planning and the built environment to enhance women's perceived safety. It demonstrated the crucial role of street lighting in improving visibility and walking path conditions, which directly impacts the perception of safety. It is important to note that improvements in built environment conditions can positively influence community factors, which play an important role in enhancing women's perceived safety. Enhancements in built environment elements can foster a sense of community cohesion and trust. These improvements can encourage more social interactions, increase the presence of people in public spaces, and strengthen social ties within the community. Consequently, such enhancements in the built environment contribute to a more supportive and secure social atmosphere, thereby positively impacting women's overall perceived safety. This interrelationship demonstrates the necessity for urban planners and policymakers to adopt an integrated approach, addressing both built and social dimensions in urban safety strategies. Additionally, future research will need to consider a multi-pronged approach that includes diverse individual characteristics across race, caste, culture, age and identities responding to their immediate surroundings to achieve holistic understanding about perception of safety.

The use of emerging technologies such as smartphone apps, crowd-sourced data, and various sensing technologies, offers new avenues for collecting more reliable and ecologically valid data on safety perceptions. Integrating traditional survey methods with these technologies can provide richer insights into the interplay between built environment, social, and individual factors affecting safety perceptions. Virtual reality and digital simulation technologies can be used to assess perceived safety in controlled environments, allowing for the manipulation of various environmental factors. This will enable experimenting how individuals with varying backgrounds and characteristics respond to scenarios with identical built environment and community settings, as well as how one person's perceived safety changes across different built environments and community contexts, to formulate optimal safety solutions. Future research could leverage these technologies to gather comprehensive data, enabling a more nuanced understanding of safety dynamics across different contexts and demographics.

This study conducted a narrative review on the topic of women's perception of safety in public spaces within the broader field of women's safety. This approach was selected to effectively apply an intersectionality framework. However, this approach presents certain limitations compared to systematic reviews. Additionally, as this review excluded topics related to women's safety concerning crime and accidents, relevant studies from this omitted domain could not be incorporated.

#### CRediT authorship contribution statement

**Shreya Dubey:** Writing – original draft, Methodology, Investigation, Formal analysis. **Ajay Bailey:** Writing – review & editing, Supervision. **Jinwoo (Brian) Lee:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization.

#### 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.

#### Data availability

No data was used for the research described in the article.

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