The Impact of Built Environment Characteristics on Perceived Safety of City Dwellers A Case Study in Mianyang (China)

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Abstract

Associated with Chinese rapid urbanization, disordered environment has resulted in residents' loss of perceived safety. Although literature have suggested the possible influencing mechanism between built environment and perceived safety, existing research often roughly identify feeling of safety with the concept of fear of crime. Through comprehensive literature review, the particular content of feeling of safety is redefined in Chinese urban residential areas. With a more comprehensive understanding of "what the definition of perceived safety is", this paper extends previous research to explore the influence effect from built environment factors, which involve seven categories and twenty-four detailed elements, upon feeling of safety. Paper-based questionnaires were distributed in the selected communities of Mianyang(China) to collect data, and structural equation model was applied to introduce "latent variables" to effectively quantify the abstract value of feeling of safety. Results revealed that except from service facility factor, variables of roads, buildings, green space, environment quality, negative space and defense system all have significant influence on residents' feeling of safety with varying degrees. Although the notion of perceived safety is expanded, the environment variables which are highly correlated with CPTED theory still having the most significant impact effect.

Keywords

Feeling of safety, Built environment, Neighbourhood, Influence effect, Structural equation model

1. Introduction

China is in a period of social transformation, where cities are increasingly concentrated in production and construction during the rapid urbanization development, and the disordered urban areas are turned into the breeding ground for safety problems. Besides, the dramatic increase of urban population and the wide gap between the rich and poor gradually disintegrate the former social structure centered on clan relations, further exacerbate the unsafe feeling of city dwellers.

However, feeling of safety is both the bottom line of health and the prerequisites for people's well-being. Recognized as a vital factor influencing various health-related behaviours^[1], the lack of subjective

neighbourhood safety may increase feelings of vulnerability and psychological stress^[2]. Additionally, accumulative anxiety may even undermine a person's immune system and increase susceptibility to disease^[3]. Thus, it is of paramount importance for the government to manage the growing sense of unsafety^[4].

In order to acquire effective policy implications from urban construction perspectives, a number of studies explored the link between built environment and feeling of safety^[5]. Several research have proved that physical structure of an environment would significantly affect psychological safety of their inhabitants^[6], and discussed how specific environmental characteristics related to peoples' feeling of safety. It must be noted, however, although some research claim "feeling of safety" to be the study object, relative topic always focus on emotional response to criminal incidents, while "fear of crime" is the actual discussing target. Although roughly substitute "feeling of safety" with "fear of crime" is prevailing, some scholars has emphasized that perceived safety should reflect general anxiety or unease with broader perceptions of social and physical environment, rather than the sole dimension of crime-related attitude^[7].

When the connotation and dimension of perceived safety are enriched to reflect broader perceptions of peripheral danger, what environment elements are vital influencing factors? To address this knowledge gap, our research aims to study how environment variables affect feeling of general safety in Chinese urban residential areas. Firstly, through comprehensive literature review, the particular concept of feeling of safety is redefined and possible environment impact factors are selected. Then the data is collected in communities of Mianyang city, China, through on-site questionnaire survey. Next, structural equation model (SEM) is applied to construct a comprehensively robust model to study the statistical relationship between environmental factors and feeling of safety, and family attributes are controlled to relieve possible confounding effects. Through quantitative analysis, empirical evidence is provided to understand which specific environment characteristics could enhance residents' feeling of safety, and policy planners could know how to create a safer feeling neighbourhood.

2. Literature review

2.1. What does feeling of safety mean?

Although objective and subjective dimensions are inextricably linked, it is generally agreed that real accident data could not effectively predict feeling of safety^[8], and the concept of subjective safety fail to reach a consensus. Owing to the rapid development of environmental criminology theory, a large amount of studies referred perceived safe/unsafe to attitudes toward illegal events^[9], and some researchers directly proposed that feeling of safety/security equals to the reverse-coded fear of crime^[10].

Scholars has emphasized that feeling of safety comprising various factors and emotions^[11], which is used to express broader concerns about external threats. Therefore, in this study, feeling of safety is defined as a psychological state in which residents do not perceive extraneous danger in a certain environment. This concept concerns individual consciousness of criminal incidents, while also considers wide range of risk perception such as threatens from strangers and traffics, danger derived from daily accidents and the invasion of personal privacy. More specifically, we could conclude from existing literature that in the particular environment of dwelling district, feeling of safety includes attitudes towards five dimensions: public security, traffic safety, activity safety, communication safety, privacy safety, the specific explanation of single dimension is showed in Table 1.

Dimension	Description
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Public Security	Attitudes towards incidents related to crime within community
Traffic Safety	Attitudes towards traffic problems within community
Activity Safety	Attitudes towards daily accident within community.
Communication Safety	Attitudes towards interpersonal contact with strangers within community
Privacy Safety	Attitudes towards privacy invasion within community

Table 1. The Description of Each Dimension of Feeling of Safety

2.2. What elements would influence feeling of safety?

Literature has proven that both the features of socio-demographic groups themselves and physical characteristics of built environment would contribute to the change of perceived safety. As psychological emotion, there is no doubt that feeling of safety shows variation among individuals. Empirical evidences supported that gender, age, education, family income, marriage status and many other personal features, such as whether had direct experience of victimization^[12], are all significant impact factor^[7].

When studies were carried out in neighbourhood, variables relating to residential buildings would be included into discussion^[10]. Regardless of research background, green design was the most frequently considered element, and it was generally supported that well-maintained vegetation tends to increase people's feeling of safety^{[13]-[15]}. Besides, researchers has realized the importance of walking and evaluated the link between walkability and safety feeling^{[10][16]}. In that case, environment elements associated with walking, such as street design and facilities which influence mixed-used development, have been carefully examined^[17]. Relative findings all demonstrated that an environment with convenient transportation and unobstructed pedestrian paths were served as positive contributor to feeling of safety^[18]. However, the results concerning influence effects between local amenities and perceived safety were mixed and somewhat contradictory, as Wood L has proposed that feeling of safety is positively correlated with the adequacy of service facilities^[19] while empirical evidence of Foster S proved that the existence of facility^[20], especially retail outlets, results in an increased likelihood of risk perception.

Considering that crime is still the major threat to reduced feeling of safety, thus it is of paramount importance to consult the prominent theory, Crime Prevention Through Environmental Design (abbreviated as CPTED), which discusses how integrated environmental components would impact criminal behaviors^[21]. Since CPTED has continuously evolved from its birth, specific elements of urban design were classified differently in relevant research, Glasson based CPTED on three key environmental strategies^[21] and Shach emphasized four CPTED principles^[22], while Clancey focused on seven environmental components^[23]. Although the detailed contents are inconsistent, CPTED research always consider territoriality, physical disorder, activity support and target hardening^[23]. Territorial reinforcement such as access control and other defense system, promote a "sense of ownership" of legitimate users, thereby reduce criminal opportunities and discourage fear of crime while unmaintained surroundings show signs of negligence, such as litters and damage, would do the reverse effect^[21]. The promotion of activity and target hardening aims to cut down negative space such as vacant houses and devious corners^[11], which have the tendency to generate negative attitudes of both offenders and users. Thus, it is recommended to control negative room through thoughtful space design and multiple communal events to create safer place.

3. Materials and methods

3.1. Study design and participants

Relevant Chinese research always conducted in megacity such as Beijing, Guangzhou^[24], while the data of this study was collected in Mianyang, a usual third-tier city of China, with urban area of 20,250 square kilometers and permanent population of 4.836 million (2019). Considering that cities of similar size to Mianyang largely exist in China, thus the research object could bring universal conclusions for medium-sized cities which tend to be overlooked in urban research studies^[25]. Thirteen residential communities in urban area of Mianyang were elaborately selected as specific survey subject. These communities are scattered in map to avoid typical errors(as Figure 1), and all of them share analogous land use pattern, close completion time and housing price range (as Table 2) to control macroscopic urban environmental variables. Although it's not intentional, it should be noted that all these targets are gated-communities, the predominant dwelling pattern in Chinese urban area.

Figure 1. The Distribution Map of Investigative Communities

Community Serial Number	Area (Hectare)	completion (Year)	Housing Price (RMB/m ²)	Building Types
1	21.5	2012	8-10 thousands	High-rise
2	17.3	2015	9-11 thousands	Multi-storey /High-rise
3	18	2011	9-11 thousands	High-rise
4	19.2	2012	11-12 thousands	High-rise
5	13.3	2009	8-10 thousands	Multi-storey /High-rise
6	11.7	2011	8-11 thousands	Multi-storey /High-rise
7	20	2014	10-13 thousands	High-rise
8	17.8	2015	10-12 thousands	High-rise
9	5.8	2009	8-10 thousands	Multi-storey

10	11.8	2013	9-12 thousands	Multi-storey
11	12	2014	10-13 thousands	Multi-storey /High-rise
12	28	2013	10-13 thousands	Multi-storey /High-rise
13	11.7	2001	7-9 thousands	Multi-storey

Table 2. Basic Information of Investigative Communities

Questionnaire survey was chosen as the data acquisition method, which is claimed to be a effective way to assess diverse dimensions of perceived safety^[10]. Paper-based questionnaires were filled out from April 2020 to June 2020 in the selected communities. Surveys were conducted throughout the day on both weekdays and weekends to avoid leaving out office workers. Besides, participants were required to age between 18 and 75 years old, cause this age group could clearly reflect their own perception. Finally, a total of 620 questionnaires were sent out and 573 were recovered (92% response rate). After eliminating the questionnaires with missing answers and conflicting information, 535 pieces of valid data were finally obtained with an effective rate of 86.3%.

3.2. Scale measurement

The questionnaire survey can be divided into three sections: socio-demographic information, residential built environment characteristics, feeling of safety measurement. Questions concerns socio-demographic information were built according to previous studies, which include 11 items in total as show in Table 3

Characteristic	Category	n (%)
Gender	Male	262(48.9%)
	Female	273(51.0%)
Age(years)	18-30	163(30.5%)
	31-45	225(42.1%)
	45-60	128(23.9%)
	61-80	19(3.6%)
	High school or below	196(36.6%)
Education	Bachelor degree	228(42.6%)
	Master degree or higher	111(20.7%)
	Public institution	158 (29.5%)
Occupation	private company	174(32.5%)
	freelancer	70(13%)
	others	133(24.8%)
Marriage Status	unmarried	130(24.3%)
	married	387(72.3%)
	divorced or widowed	18(3.3%)
Family Annual Income	less than 30 thousands RMB	62(11.6%)
	40-120 thousands RMB	218(40.8%)
	130-300 thousands RMB	205(38.3%)

	exceed 300 thousands RMB	50 (9.3%)
Experience of Victimization	no	500(93.5%)
	yes	35(6.5%)
	purchase	475(88.8%)
Housing Ownership	rent	51(9.5%)
	lend	9(1.7%)
Length of Residence	Within 1 year	16(3.0%)
	1-5 years	270(50.5%)
	6-10 years	138(25.8%)
	More than 10 years	110(20.6%)

Table 3. Socio-demographic Information of Interviewees

(1) The measurement of residential built environment characteristics

Through comprehensive literature review, the environment elements may affect perceived safety of residents are summarized. A total of 24 questions were set from seven perspectives: roads, buildings, green space, service facilities, environment quality, negative space and defense system. Respondents were asked to evaluate their residential environment according to their own feelings with a five-point Likert scale, higher points generally represent more related elements are perceived, and higher evaluation for buildings and negative space stand for perception of larger space dimensions and less unutilized areas respectively.

(2) The measurement of feeling of safety

The scale for feeling of safety was specifically developed for this study, which is in line with its definition. Residents were asked to evaluate their feelings of safety through 23 questions in five dimensions: public security, traffic, activity, communication and privacy. Seven-point Likert scale was chosen to effectively distinguish the nuances between respondents' perceived safety. Initially, higher scores represented lower feeling of safety, while through later data processing, the perceived safety statistics were reverse-coded to guarantee greater values corresponding to higher safety feeling.

3.3. Statistical method and validation

This study applied Structural Equation Model (abbreviated as SEM) to explore the specific impact of built environment on residents' feeling of safety. The statistical method of SEM is composed of two components, the measurement model and the structural model^[26]. The measurement model could effectively quantify abstract conception, which is known as latent variable, through observational items or indexes. The structural model allows researchers to investigate the statistical correlations between different variables, of which path coefficient estimates represent the impact effect.

Thus, in this study, SEM could successfully estimate the latent variable of perceived safety and categorize environmental perception variables, and the model presented the structural relationship between latent environmental perception and multidimensional feeling of safety, where socio-demographic data was also enrolled as manifest variable to control individual differences. The data was analyzed using software IBM AMOS 22.0, and maximum likelihood estimator formula was applied to calculate the model parameters.

As an initial step before formal analysis, the value of the Cronbach's alpha and the Kaiser-Meyer-Olkin (KMO) were calculated to verify the internal reliability and sample adequacy of the data. As shown in Table 4, the results indicated perfect internal reliability and validity of both built environment characteristics scale and all portion of perceived safety scale, with all the value of Cronbach's alpha greater than 0.8 and KMO higher than 0.9^[27].

Scale	Dimension	Items	Cronbach's alpha	KMO
Environment Characteristics	-	25	0.871	.921
	public security	4	0.932	
	traffic safety	4	0.910	
Feeling of Safety	activity safety	4	0.855	.932
	communication safety	5	0.907	
	privacy safety	5	0.879	

Table 4. Questionnaire Reliability Test

Then confirmatory factor analysis was performed to confirm the acceptable fits of the SEM measurement model. Modification indices were considered to improve the goodness-of-fit of an individual construct by pairing error terms. Items with lower factor loading and relative high correlated residuals were crossed off, finally twenty-two variables of built environment elements (twenty-four initially considered) and fifteen variables of perceived safety (twenty-three initially considered) were kept. The goodness-of-fit for revised measurement model of both built environment characteristics scale and feeling of safety scale are displayed in Table 5, including the value of Incremental Fit Index (IFI), Tucker-Lewis index (TLI), Comparative Fit Index (CFI), Root Means Square Error of Approximation (RMSEA), showing that the overall fitting degree of the two measurement model is high and the data structure is statistically significant.

Index	Acceptable Criterion	Perfect Criterion	Index of Environment measurement model	model evaluation	Index of safety measurement model	model evaluation
CMIN/DF	<5	<3	2.956	Perfect	3.479	Acceptable
GFI	>0.7	>0.9	0.913	Perfect	0.936	Perfect
AGFI	>0.7	>0.9	0.883	Acceptable	0.904	Perfect
NFI	>0.8	>0.9	0.899	Acceptable	0.956	Perfect
IFI	>0.8	>0.9	0.931	Perfect	0.968	Perfect
TLI	>0.8	>0.9	0.930	Perfect	0.958	Perfect
CFI	>0.8	>0.9	0.930	Perfect	0.968	Perfect
RMSEA	<0.08	<0.06	0.061	Acceptable	0.068	Acceptable

Table 5. Confirmatory Factor Analysis: the Fitting Index of Measurement Model

4. Results

In order to explore the relationship between environment perception variables and feeling of safety, the structural equation model was established as shown in Figure 2. A series of covariates were also considered in the model, including gender, age, education, occupation, marriage status, family income,

experience of victimization, housing ownership, length of residence, to control the possible influence of individual differences.

Figure 2. Built Environment—Feeling of Safety Standardized Structural Equation Model

As shown in Table 6, the standardized coefficients illustrate that except the service facility factor have no significant effect on endogenous variable, positive associations are found between all the other environmental perception variables and perceived safety. Among which the factor of environment quality has the biggest standardized regression coefficient as 0.295, the positive relation reveals that feeling of safety tends to increase as residents find environment quality to be favorable. Additionally, positive and significant correlation were also found between negative space (Coef. = 0.285, SE = 0.087)、defense system (Coef. = 0.281, SE = 0.083)、green space (Coef. = 0.242, SE = 0.047)、roads (Coef. = 0.229, SE = 0.055), which further imply the improvement of various environment elements within community would effectively raise residents' feeling of safety. However, the variable of building has negative influence impact on perceived safety with tiny coefficient of -0.095, revealing that in the context of Chinese gated community, large-scale architecture design will bring threats and unsafe feelings to residents.

Dependent Variable	Independent Variable	Standardized Coefficients	S.E.	C.R.	P
Feeling of Safety	Buildings	-0.095	0.054	-2.068	0.039
	Roads	0.229	0.055	4.928	***
	Green Space	0.242	0.047	5.123	***
	Service Facility	-0.012	0.088	-.283	0.777
	Environment Quality	0.295	0.061	6.156	***
	Negative Space	0.285	0.087	5.368	***

<---	Defense System	0.281	0.083	5.519-	***
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Table 6. The Standardized Coefficients Results of SEM

As for personal attributes, feeling of safety is highly correlated with gender, women usually have lower level of safety perception. And those who live longer in the community are more likely to trust the surroundings. All the other variables such as age and marriage status are not statistically significant, these personal factors do not necessarily increase the resident's perception of safety.

5. Discussion and conclusion

This research built a quantitative model to investigate the influence impact of built environment characteristics on perceived safety of urban residents. Different from those studies born in the field of environmental criminology, this experiment expanded the cognition of previous research by considering multiple relevant safety domains. We argue that feeling of safety contains rich subjective emotions more than the sole dimension of fear of crime, which emphasizes the possible daily risk perception. Results revealed that except from service facility factor, variables of roads, buildings, green space, environment quality, negative space and defense system all have significant influence on residents' feeling of safety with varying degrees.

When the environmental variables are arranged in rank order according to the influence coefficient, the top three are environment quality, negative space and defense system successively. It is worth noting that although the notion of perceived safety is expanded, these elements which are highly correlated with CPTED deriving from the field of criminology, still have the most significant impact effect. The findings highlight that environment design aiming at preventing crime could not only effectively control objective illegal events and affect subjective fear of crime, but also contribute to the increase of perceived general safety and comprehensive trust towards environment, which further reveal that the theory of CPTED has widespread application than crime and could be applied to explore environment-psychology study^[14].

Additionally, the study's outcome indicates that the adequacy and exuberance of vegetation tend to significantly increase the resident's feeling of safety, which is in consistent with Seresinhe research^[28]. As explained in his research, that varied shapes, colors and designs of green space add to the ornamental and aesthetic value of the environment and bring people with a sense of relief, thus they are more likely to perceive the environment to be safe^[29]. Besides, our model reveals that reasonable road design, such as clear traffic zoning with few congestion, makes crucial contributions to enhancing residents' feeling of safety. Served as connecting tool within community, roads also provide residents with important space for daily activities like exercise. Therefore, the attention towards the street forms natural social surveillance net, where observers around the street may lend a helping hand because of their public identity, thereby enhance internal members' perceived safety. Although significant relationship is found between buildings and perceived safety, the data indicates that the increased architectural scale (include volume, height and enclosure) would slightly decrease people's feeling of safety. Possible explanation may be that larger architecture could hinder the communication of sight and voice, through which residents' perception ability and sense of control would be greatly damaged. This situation may also lead to residents' avoidance behavior, especially the attitudes to avoid chatting and gathering with strangers, so it has negative impact on feeling of safety. What's more important, the interviewees were limited in Chinese gated communities, where the volume of residential buildings becomes ever-greater to accommodate more population during the market-led construction. Under such research background, target respondents prefer modest and friendly architecture sizes.

Although many studies have shown that feeling of safety is positively correlated with the adequacy of service facilities^{[19][30]-[31]}, this research found opposite conclusion that different facility situation do not necessarily change residents' perceived safety. Previous studies were always conducted in non-central suburbs of developed countries which were usually characterized by comparatively sparse population, thus the existence and increase of service facilities could appeal pedestrian flow and make residents feel safe. While this effect may not apply to densely populated urban communities as this research testify. However, the simple generalization of service facilities may weaken the findings, that some sort of facility such as fitness equipments may contribute positively to safe feeling while shops are inversely related to feeling of safety, thus the possible compound effect from facilities upon feeling of safety may lead to final insignificant result. Therefore, in future study, researchers could try to explore how would the sub-groups of service facility affect residents' feeling of safety to bring enlightenment to detailed urban planning.

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7. References

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