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Structural analysis of factors influencing women's perceived safety in district 12 of tehran with an emphasis on smart urban components

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Abstract

The growing sense of insecurity among women is one of the major challenges of contemporary cities, particularly in dense, aging urban areas characterized by high levels of social and physical vulnerability. This phenomenon is not solely the result of crime occurrence; rather, it reflects women's subjective perceptions of urban space, levels of environmental surveillance, quality of urban design, and trust in urban institutions. In District 12 of Tehran one of the city's oldest central districts facing infrastructural deterioration and limited smart technologies women's sense security is influenced by physical, social, and technological dimensions. The present study aims to analyze the structural factors affecting women's sense of security with an emphasis on smart urban components. The research is applied purpose and descriptive–survey in method. Data were collected using a researcher-made questionnaire administered to 384 women residing in Zone 12 of Tehran through simple random sampling. The validity and reliability of the instrument were confirmed using Cronbach's alpha and composite reliability indicators. Data analysis was conducted through structural equation modeling using SmartPLS version 4 software. The findings reveal that smart urban technologies, with a total effect of 0.48, have the strongest influence on enhancing women's sense of security. Environmental quality and responsive environmental design follow with total effects of 0.42 and 0.37, respectively. Social interactions and institutional trust act as mediating variables, with total effects of 0.24 and 0.22, facilitating the transmission of physical and technological impacts to women's perceived security. The coefficient determination (R^2 = 0.61) indicates satisfactory model fit.

Keywords

Women's perceived safety
Smart urban components
Responsive environmental design
Institutional trust
Tehran City

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1. Introduction

In recent decades, women's sense of safety in urban spaces has been seriously considered by researchers and policymakers as one of the fundamental dimensions of spatial justice and sustainable urban development (Zeynali Azim, 2024). Women's safety in the city is not merely defined as the absence of physical threats, but rather reflects a subjective feeling of calm, the possibility of social presence, and trust in the environmental and institutional structures of the city (Pain, 2019). Accordingly, the sense of safety can be regarded as a socio-spatial phenomenon that arises from the interaction between physical characteristics of the environment, the quality of urban design, social cohesion, and technological transformations (Dubey et al., 2025).

In the metropolis of Tehran, particularly in areas with high density, historical fabrics, and physical vulnerabilities, women's sense of insecurity has emerged as a multidimensional challenge. Based on spatial–temporal crime analysis in Tehran, District 12 has the highest rate of urban theft and is considered one of the capital's critical areas in terms of the concentration of petty crimes (Moradpour & Ziyari, 2022). Weak environmental surveillance, insufficient lighting, physical deterioration, and incompatible land uses are among the most important factors threatening residents' safety, especially women, in this district (Seyed Alipour & Mirzaei, 2017). Therefore, it can be concluded that the claim regarding the high-risk nature of District 12 is not merely based on the researcher's subjective perception, but is supported by scientific evidence and empirical data.

In recent years, the development of new urban technologies and the emergence of smart infrastructures have provided a new context for rethinking the concept of urban safety. Components such as smart lighting systems, environmental sensors, surveillance cameras, emergency alert applications, and data-driven infrastructures are recognized as effective tools for enhancing monitoring and rapid response to environmental threats (Maalsen et al., 2022). However, the actual effectiveness of smart technologies in improving the sense of safety depends on the level of social acceptance, trust in urban institutions, and their integration with environmental design (Fang et al., 2023). Accordingly, safety in smart cities is achieved only when technological interventions are integrated within social and spatial contexts compatible with the needs of urban users. In light of the above, the main issue of the present study is why and how smart urban components can influence women's sense of safety in Tehran.

The present research aims to explain the causal relationships among smart urban infrastructures, environmental design, environmental quality, acceptance of smart technologies, and social interactions in shaping women's sense of safety. The research method is quantitative and explanatory, and the data were analyzed using structural equation modeling (SEM) with SmartPLS 4 software.

Based on the theoretical framework extracted from the related literature, the research hypotheses are formulated as follows: smart urban infrastructures have a positive and significant effect on the acceptance of smart technologies; acceptance of smart technologies has a positive and significant effect on women's sense of safety; environmental design has a positive and significant effect on women's sense of safety; urban environmental quality has a positive and significant effect on women's sense of safety; social interactions have a positive and significant effect on women's sense of safety; and social interactions have a positive and significant effect on the acceptance of smart technologies.

2. Theoretical Foundations of the Study

Understanding women's sense of safety in urban spaces results from a complex interaction of physical, social, technological, and psychological factors (Lotfi & Momenpour Akerdi, 2025; Momeni et al., 2024). Unlike traditional perspectives that limited safety solely to the absence of danger or crime control, contemporary urban safety literature has redefined this concept as a subjective, social, and spatial experience (Desai et al., 2022; Arabi et al., 2024). With the expansion of spatial inequalities, the concentration of social vulnerabilities in deteriorated urban fabrics, and the weakness of human-centered design in public spaces, women's safety has become one of the main pillars of urban governance and gender justice (Cosgrave, 2024).

From a theoretical perspective, women's sense of safety in urban spaces is explained through three main pathways: environmental design and the physical quality of space; acceptance of and trust in smart security technologies; and social interactions and institutional trust within the context of urban participation.

First, the theory of Crime Prevention Through

Environmental Design (CPTED), proposed by Newman (1972), states that designing urban spaces with natural surveillance capability, adequate lighting, high visibility, and functional territoriality reduces the likelihood of crime and increases subjective feelings of safety. Recent studies also confirm this view, indicating that the design of illuminated routes, removal of abandoned spaces, use of efficient artificial lighting, and continuous presence of citizens in public spaces are key indicators of increased perceived safety among women (Chang et al., 2022; Momeni et al., 2024; Habibi et al., 2024).

Second, in the technological dimension, Davis's Technology Acceptance Model (1989) provides the main theoretical framework for explaining how women interact with urban security technologies. According to this theory, the decision to use technology is influenced by perceived ease of use and perceived usefulness. Consequently, women's sense of safety is strengthened when urban technologies—such as alert applications, smart cameras, and motion sensors—are perceived as trustworthy, accessible, and user-friendly (Al-Nasrawi, 2019; Yang, 2024; Walczak et al., 2025).

Third, Giddens's theory of social security (1990) emphasizes the relationship between institutional trust and the feeling of safety. From this perspective, subjective safety is formed when social relations, institutional structures, and urban environments are characterized by predictability and responsiveness. Similarly, research shows that women's sense of safety in urban spaces is enhanced when mechanisms for reporting threats, legal follow-up, and social participation in urban decision-making exist (Akinola & Wahab, 2021; teBraak et al., 2025).

On the other hand, Lefebvre's theory of the third space (1991) argues that space is not merely a physical phenomenon, but rather the product of social relations and users' lived experiences. Therefore, women's sense of safety cannot be explained solely through physical or technological indicators, but must be examined within the framework of lived experience and personal perception of the environment.

Finally, the participatory data-driven approach emphasizes that the use of crowdsourced technologies for reporting insecurity and citizen feedback, while enhancing transparency and accountability, also increases the sense of belonging and control over space (Viswanath & Basu, 2019).

Table 1. Supporting theories in explaining women's sense of safety in urban spaces

Supporting Theory	Application in the Study	Focus
Technology Acceptance Model (TAM) – Davis (1989)	Explaining women's behavior in using urban security technologies	Perceived ease of use and perceived usefulness
CPTED – Newman (1972)	Explaining the role of spatial and physical structure in enhancing perceived safety	Environmental design for crime prevention
Third Space Theory – Lefebvre (1991)	Understanding safety as lived experience	Space as a social and mental product
Social Security Theory – Giddens (1990)	Explaining the psychological and institutional dimensions of safety	Institutional trust and social predictability
Participatory Data-Driven Approach – Viswanath & Basu (2019)	Role of data-driven technologies in increasing trust and transparency	Participation and crowdsourced reporting

3. Literature Review

Studies related to women's sense of safety in urban spaces have expanded significantly in recent years and have shifted from purely physical approaches toward social, cultural, and technological analyses. International research initially focused on the physical characteristics of the environment and examined the role of factors such as lighting, environmental surveillance, space usability, and land-use mix in reducing fear of crime. For example, a study in European cities showed that environmental design and the presence of people in public spaces are among the most important factors in increasing women's sense of safety (Pain, 2019).

Subsequently, newer studies with social and behavioral approaches were conducted. A study examining public spaces in European cities concluded that the level of social interactions and sense of place attachment plays an essential role in reducing subjective insecurity (Lindgaard & Bernasco, 2021). Also, a study conducted in Jordan stated that the design of diverse public spaces, visible routes, and appropriate lighting can largely prevent the emergence of fear of crime among women (Abujaradeh & Ababneh, 2022).

With the expansion of urban technologies and the development of smart cities, researchers began to examine the relationship between technology and sense of safety. A study on East Asian cities reported that the use of smart technologies such as environmental sensors and monitoring systems increases the sense of safety when citizens participate in the design and implementation processes (Fang et al., 2023). In this regard, a study in India emphasized that women's digital literacy and their familiarity with urban technologies play a determining role in the acceptance of and trust in smart systems (Chatterjee & Kar, 2024). Furthermore, a study in European and Middle Eastern countries showed that urban smartness indicators can enhance women's sense of safety only when transparent data policies and institutional trust exist (Maalsen et al., 2025).

In Iran, a set of studies has also been conducted on women's sense of safety in urban spaces. A study examining the Narmak and Ekbatan neighborhoods in Tehran showed that factors such as lighting, land-use diversity, and the possibility of natural surveillance have a significant effect on enhancing women's subjective sense of safety (Pourahmad & Maleki, 2017). In another study on women's safety, researchers concluded that adequate lighting, spatial visibility, and the continuous presence of citizens are among the main factors influencing sense of safety (Biranvandzadeh & Abdali, 2019). Also, in a study on open tourism spaces, the authors concluded that the physical quality of space should be aligned with social behavior and cultural norms in order to achieve sustainable safety (Yaran & Tavakoli, 2019).

Several studies have also focused on the relationship between environmental quality and urban insecurity in central districts of Tehran. Based on a study conducted in District 12 of Tehran, due to the high concentration of commercial activities, high population density, and physical deterioration, this district is considered one of the critical areas in terms of crime occurrence and feelings of insecurity (Moradpour & Ziyari, 2022). The results of another study indicate that weak environmental surveillance, insufficient lighting, and incompatible land uses are among the factors intensifying the sense of insecurity in this district (Seyed Alipour & Mirzaei, 2017). In addition, a study using spatial data analysis showed that there is a direct relationship between unequal land-use distribution and increased fear of crime, and this issue is more intense in the central districts of Tehran (Etemad & Rahbari, 2021).

In summary, it can be said that most studies conducted in Iran have focused on physical dimensions and environmental design, and have less frequently examined the simultaneous role of technological and social variables in shaping women's sense of safety. Therefore, a meaningful knowledge gap still exists regarding the structural analysis of the relationship among smart urban components, environmental quality, and women's sense of safety, especially in high-risk areas such as District 12 of Tehran. The present study seeks to fill this research gap by proposing a conceptual model based on structural equation modeling within a localized and empirically grounded framework.

4. Research Method

The present study is applied in terms of purpose and descriptive–survey in nature. Its objective is to analyze the relationships among technological, environmental, and social factors influencing women's subjective sense of safety in District 12 of Tehran. The research design follows Saunders' research onion model.

The study adopts a positivist philosophy and a deductive approach. Data were collected through a researcher-designed questionnaire and analyzed using structural equation modeling (SEM) with the partial least squares (PLS) approach in SmartPLS 4.

The statistical population consists of women residing in District 12 of Tehran, totaling 148,629 individuals. Using Cochran's formula with a 95 percent confidence level, a sample size of 384 respondents was determined. A purposive non-probability sampling method was employed to ensure social and spatial diversity.

The questionnaire included demographic characteristics and main research variables measured on a five-point Likert scale. Content validity was confirmed using CVR and CVI, and reliability was verified through Cronbach's alpha and composite reliability values above 0.7.

Data analysis was conducted using SPSS version 28 for descriptive statistics and SmartPLS version 4 for estimating the measurement and structural models. Model fit and predictive power were assessed using R^2, Q^2, and SRMR indices.

Table 2. Conceptual structure of the analytical research model

Measurable Indicators	Component	Dimension	Main Concept
Coverage and performance of smart cameras, motion sensors, and urban lighting	Smart urban equipment	Data infrastructure	Smart urban technologies
Network stability, connection quality, and data transmission speed	Urban communication and alerts	Connectivity	
Light intensity and uniformity, elimination of blind spots, route clarity	Lighting and direct visibility	Physical safety	Environmental design and quality
Presence of people, active land-use mix, environmental transparency	Social presence	Spatial interaction	
Frequency of reporting and digital communication with institutions	Participation and reporting	Social interaction	Social–institutional factors
Trust in police, municipality, and smart technology operators	Institutional trust and accountability	Institutional support	
Night-time safety perception and pedestrian route safety	Environmental safety perception	Environmental security	Women's subjective sense of safety
Psychological calm and ability to respond in crises	Psychological and behavioral calm	Mental security	

5. Study Area

The study area of this research is District 12 of Tehran, which is located in the center of the capital and in the historical and commercial core of the city. With an area of approximately 16.98 square kilometers, this district includes 6 zones and 14 neighborhoods, and it is bounded to the north by Enghelab-e Eslami Street, to the south by Shoosh Street, to the east by 17 Shahrivar Street, and to the west by Hafez and Vahdat-e Eslami streets. A major part of the district lies within the Tehran-e Naseri boundary and, in terms of physical form, it has a dense and deteriorated fabric and lacks modern urban design standards. Due to high population density, the extensive presence of daily commercial activities, the continuous movement of non-local individuals, and the shortage of safe public spaces, District 12 is considered one of the high-risk areas from the perspective of women's sense of safety. The researcher's field observations show that in some parts of secondary alleys, insufficient lighting, limited visibility, and the low presence of natural surveillance lead to increased subjective feelings of insecurity among women, especially during night-time hours. On the other hand, the implementation of smart pilot projects in recent years—such as the installation of surveillance cameras, the use of smart lighting systems, and the development of emergency reporting applications—has provided an appropriate opportunity to assess the effectiveness of these technologies in improving women's safety perceptions. This simultaneity of physical challenges and technological interventions has turned District 12 into a suitable setting for analyzing the complex relationships among smart infrastructures, environmental quality, and women's subjective sense of safety. Therefore, the selection of District 12 of Tehran for this research has been based on its dual nature—on the one hand, the existence of physical and social vulnerabilities, and on the other hand, the implementation of technological solutions—so that the possibility of scientifically analyzing the impact of these factors on the formation of women's subjective sense of safety at the local scale can be provided

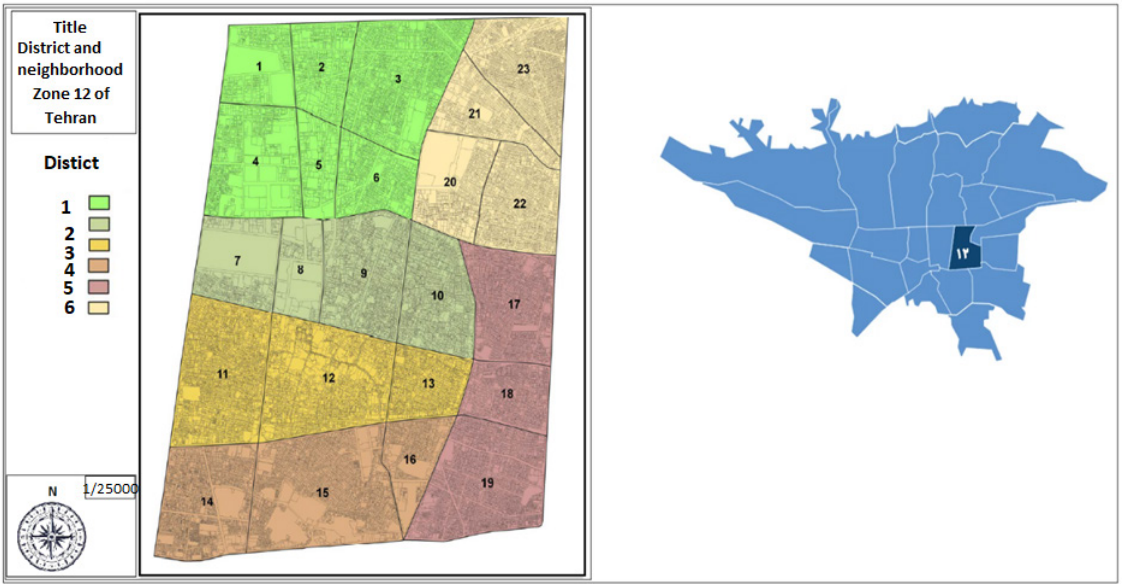

Figure 1. Location of district 12 of Tehran

6. Findings

In order to accurately examine the status of women's safety in urban public spaces and to analyze the role of environmental design, social, and technological factors, the data collected from the selected statistical sample were analyzed. In this section, the research findings are presented by statistical stages, including descriptive statistics, assessment of the validity and reliability of the instrument, confirmatory factor analysis, and structural equation modeling, so that a precise picture of the relationships among the research variables can be drawn.

- Demographic Characteristics of Respondents

The data for this study were collected from 384 women residing in District 12 of Tehran. The demographic characteristics of the respondents include age, marital status, level of education, occupation, and length of residence in the district, which are presented in Table 3. Overall, the results of this section indicate that the sample is diverse in terms of age, education, and occupation, and can appropriately reflect the various viewpoints of women living in District 12 of Tehran regarding their subjective sense of safety.

Table 3. Demographic characteristics of respondents

Characteristic	Number	Percent
Under 20 years	90	23.4
21 to 30 years	126	32.8
31 to 40 years	105	27.3
Over 40 years	63	16.5
Total respondents by age	384	100
Married	210	54.7
Single	153	39.8
Other	21	5.5
Total respondents by marital status	384	100
Diploma	70	18.2
Bachelor's	166	43.2
Master's	118	30.7

Characteristic	Number	Percent
PhD	30	7.9
Total respondents by education	384	100
Housewife	140	36.5
Employed	106	27.6
Student	86	22.4
Other	52	13.5
Total respondents by occupation	384	100
Less than five years	103	26.8
Five to ten years	165	42.9
More than ten years	116	30.3
Total respondents by length of residence in the district	384	100

Based on the data in Table 1, the largest share of respondents belongs to the age group 21 to 30 years with 32.8 percent, indicating that the majority of participants are young and socially active women; women who are more present in public spaces and consequently experience a direct perception of urban safety.

In contrast, the age group over 40 years, with 16.5 percent, has the smallest share, indicating more limited participation of middle-aged women in this study. In terms of marital status, 54.7 percent of respondents are married and 39.8 percent are single. This diversity shows that attitudes and experiences related to sense of safety from the perspective of the two main groups of women, namely married and single women, have been considered in the structural model analysis. With respect to education, the highest frequency is related to the bachelor's level (43.2 percent) and then the master's level (30.7 percent); this indicates that most participants have higher education and possess the ability to evaluate their urban environment in an informed and aware manner. Regarding employment status, housewives (36.5 percent) constitute the largest group and employed women (27.6 percent) are in the next rank. This diversity in employment status includes a wide range of women with different lifestyles, which is important to understand for analyzing urban safety perceptions. In terms of length of residence, 42.9 percent of respondents have lived in the district for five to ten years, indicating their relative familiarity with the environmental and social conditions of the district. Overall, the results of descriptive statistics indicate that the sample has a desirable demographic diversity and can reflect a diverse range of viewpoints regarding women's sense of safety in Zone 12 of Tehran.

Table 4. Descriptive statistics of main variables and research components

Standard Deviation	Mean	Number	Component	Main Variable
0.54	3.81	384	Smart urban equipment	Smart urban technologies
0.57	3.79	384	Urban communications and alerts	Smart urban technologies
0.55	3.80	384	Overall mean of the variable	Smart urban technologies
0.63	3.74	384	Lighting and direct visibility	Environmental design and quality
0.65	3.73	384	Social presence	Environmental design and quality
0.64	3.74	384	Overall mean of the variable	Environmental design and quality
0.58	3.69	384	Participation and reporting	Social–institutional factors
0.60	3.70	384	Institutional trust and responsiveness	Social–institutional factors
0.59	3.69	384	Overall mean of the variable	Social–institutional factors

Standard Deviation	Mean	Number	Component	Main Variable
0.61	3.90	384	Perceived environmental safety	Women's subjective sense of safety
0.62	3.88	384	Psychological and behavioral calm	Women's subjective sense of safety
0.61	3.89	384	Overall mean of the variable	Women's subjective sense of safety

The results of the table indicate that the highest mean belongs to the variable of women's sense of safety with a value of 3.89, which reflects the respondents' positive subjective evaluation of perceived safety and psychological calm in the urban spaces of Zone 12. After that, smart urban technologies, with a mean of 3.80, indicates relative satisfaction with the role of technological tools such as surveillance cameras, motion sensors, and alert systems in increasing the sense of safety. The mean of environmental design and quality is 3.74 and indicates that the quality of lighting, direct visibility, and social presence, from women's perspective, is at a relatively appropriate level, although differences are observed among neighborhoods. The lowest mean belongs to social–institutional factors with a value of 3.69, which indicates a lower subjective feeling regarding institutional trust and the level of participation in safety processes. Overall, all mean values are higher than three, which indicates women's positive subjective experience of urban safety in District 12. This situation shows that the sense of safety is related more than anything to individuals' subjective perception of spatial quality and the functioning of smart technologies, and it is strengthened when a subjective coherence exists among technology, environment, and institutional interactions.

Table 5. Measurement model of research dimensions and indicators

Main Variable	Dimension	Indicator	Factor Loading	Factor Loading	Cronbach's Alpha	CR	AVE
Smart urban technologies	Data infrastructure	Smart urban equipment	0.84	0.82	0.842	0.889	0.683
	Connectivity and communication	Urban communications and alerts	0.83	0.81	0.842	0.889	0.683
	Smart urban technologies	Overall mean			0.842	0.889	0.683
Environmental design and quality	Physical safety	Lighting and direct visibility	0.83	0.84	0.812	0.867	0.657
	Spatial interactions	Social presence	0.81	0.82	0.812	0.867	0.657
	Environmental design and quality	Overall mean			0.812	0.867	0.657
Social–institutional factors	Social interaction	Participation and reporting	0.80	0.82	0.794	0.854	0.609
	Institutional support	Institutional trust and responsiveness	0.79	0.81	0.794	0.854	0.609
	Social–institutional factors	Overall mean			0.794	0.854	0.609
Women's subjective sense of safety	Environmental security	Perceived environmental safety	0.85	0.86	0.869	0.902	0.710
	Mental security	Psychological and behavioral calm	0.84	0.85	0.869	0.902	0.710
	Women's subjective sense of safety	Overall mean			0.869	0.902	0.710

The results of Table 5 show that the measurement model of the study is at a desirable level in terms of convergent validity, composite reliability, and internal consistency. All composite reliability values are above 0.8 and convergent validity values are above 0.5, confirming the acceptance criteria of the model.

The dimension of women's subjective sense of safety, with composite reliability equal to 0.902 and average variance extracted equal to 0.710, has the highest level of consistency among the study dimensions. The indicator of perceived environmental safety, with a factor loading of 0.86, shows that women's subjective experience of safety has a direct relationship with visibility quality, lighting, and control over public spaces.

In the second rank, the dimension of smart urban technologies, with composite reliability of 0.889 and convergent validity of 0.683, is placed. The factor loading of the indicator of smart urban equipment is 0.84, indicating the tangible role of surveillance technologies and urban sensors in creating subjective assurance and behavioral calm among women. The dimension of environmental design and quality, with composite reliability of 0.867 and average variance extracted of 0.657, is evaluated at an acceptable level. This finding shows that lighting, direct visibility, and social presence are among the most important elements shaping women's subjective sense of safety.

The dimension of social–institutional factors has the lowest convergent validity value of 0.609. This indicates that although institutional trust and the level of participation in reporting have been evaluated positively, they still have not fully produced women's inner assurance and calm at the subjective level. Overall, the results of the measurement model show that women's sense of safety in District 12 is more than anything the result of subjective perception of environmental quality and the level of trust in the functioning of smart technologies. In this regard, strengthening the relationship between urban technologies and environmental design can have the greatest effect on improving the subjective experience of safety in public spaces.

Table 6. HTMT discriminant validity matrix among research dimensions

Construct	Women's subjective sense of safety	Social–institutional factors	Smart urban technologies	Environmental design and quality
Women's subjective sense of safety	—	0.57	0.51	0.62
Social–institutional factors	0.62	—	0.55	0.64
Smart urban technologies	0.51	0.55	—	0.66
Environmental design and quality	0.62	0.64	0.66	—

The values of Table 6 show that all relationships among the research dimensions are below the threshold of 0.85; therefore, the discriminant validity of the model is confirmed, and each construct operates as distinct from the others in conceptual and empirical terms.

The lowest HTMT value is 0.51 between women's subjective sense of safety and smart urban technologies, indicating the subjective independence of safety experience from purely technological interventions. This finding shows that technology alone does not guarantee perceived safety; rather, women's subjective sense of safety requires the integration of technology with environmental quality and social relationships.

The highest HTMT value is 0.66 between environmental design and quality and smart urban technologies, indicating that respondents' subjective perception of safety is, to some extent, influenced by the simultaneous improvement of the physical environment and the application of smart technologies. The relatively high relationship between environmental design and women's safety (0.62) also indicates the prominent role of lighting quality, visibility, and spatial transparency in creating psychological calm.

Overall, HTMT values below 0.85 indicate that the conceptual model has sufficient theoretical and empirical distinction, and each dimension explains a separate part of women's subjective perception of safety in the urban spaces of zone 12. This result strengthens the validity of the structural model and the interpretation of relationships among variables.

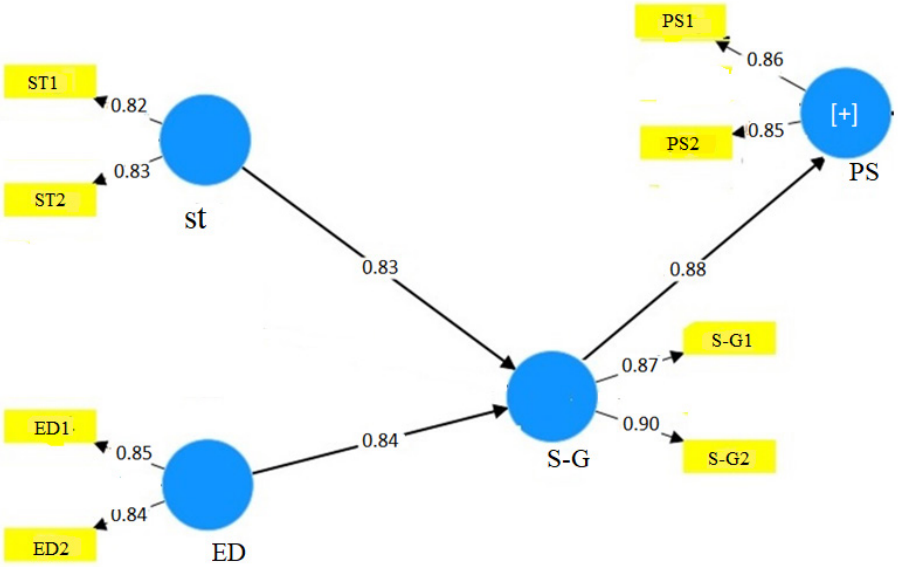

Figure 2. Measurement model validity assessment of factors affecting women's sense of safety in zone 12 of tehran with emphasis on smart urban components

In order to assess the validity of the results obtained from the structural equation model, the collinearity indices among the study constructs were evaluated. High collinearity among variables can reduce the accuracy of path coefficients in the structural model and disrupt the interpretation of relationships among constructs. To control this issue, the "variance inflation factor" (VIF) index was calculated for all independent constructs of the model. VIF values below 5 indicate the absence of critical collinearity and confirm the reliability of the model for path analysis. Table 7 presents the VIF values related to the study constructs.

Table 7. VIF index for collinearity of research constructs

VIF Value	Construct Name
2.92	Smart urban technologies
2.84	Environmental design and quality
3.01	Social–institutional factors
2.78	Women's safety

The results of the table show that all VIF values are below five; therefore, none of the constructs suffer from harmful collinearity. The highest value belongs to the construct of social–institutional factors with 3.01, indicating its close relationship with the two independent variables of the model, namely smart technologies and environmental design. This controlled overlap is natural because this construct plays a mediating role and establishes the link between technological and environmental factors and women's safety. Smart urban technologies with 2.92 indicate that the effect of this variable on other constructs is independent and distinguishable, while environmental design and quality with 2.84 indicate that improving physical elements such as lighting, visibility, and presence, interacts with other dimensions in a balanced manner. Women's safety with 2.78 has the lowest collinearity and, as the dependent variable of the model, remains a distinct and stable concept. These findings generally confirm that the relationships among constructs in the research model are valid and that the conceptual distinction among dimensions has been properly observed.

Table 8. Path coefficients (β), t-statistic, significance level (P), and coefficient of determination (R^2) in the revised research model

Path between constructs	Path coefficient (β)	R^2 of dependent construct	t-statistic	Significance level (P)
Smart urban technologies → Social–institutional factors	0.42	0.56	8.21	0.001
Environmental design and quality → Social–institutional factors	0.37	0.56	7.35	0.001
Social–institutional factors → Women's safety	0.51	0.64	9.08	0.001

Based on the results of Table 8 and the final structural model figure, all assumed paths were statistically significant.The highest path coefficient belongs to the relationship between social–institutional factors and women's safety with β equal to 0.51 and t-statistic equal to 9.08. This result shows that the higher the level of trust, responsiveness, and women's participation in social and institutional systems, the stronger their subjective perception of safety in urban spaces becomes. The relationship between smart urban technologies and social–institutional factors, with a path coefficient of 0.42 and a t-statistic of 8.21, is confirmed, indicating the role of technology in strengthening communication platforms, information transparency, and increasing public trust. Environmental design and quality, with a path coefficient of 0.37 and a t-statistic of 7.35, also has a positive and significant effect on social–institutional factors; in other words, lighting quality, spatial legibility, and social presence increase human interactions, sense of belonging, and social trust. The coefficient of determination R^2 for the variable social–institutional factors is 0.56 and for women's safety is 0.64, indicating high explanatory power and good model fit. This means that 64 percent of the changes in women's safety can be explained by the combination of technological, environmental, and institutional factors. Overall, the results of the structural model confirm that women's safety in Zone 12 of Tehran is a subjective and multidimensional phenomenon formed through the interaction among smart urban technologies, environmental design, and institutional and social networks. These findings emphasize the necessity of smart urban planning that simultaneously focuses on improving environmental quality, strengthening technological infrastructures, and rebuilding institutional trust.

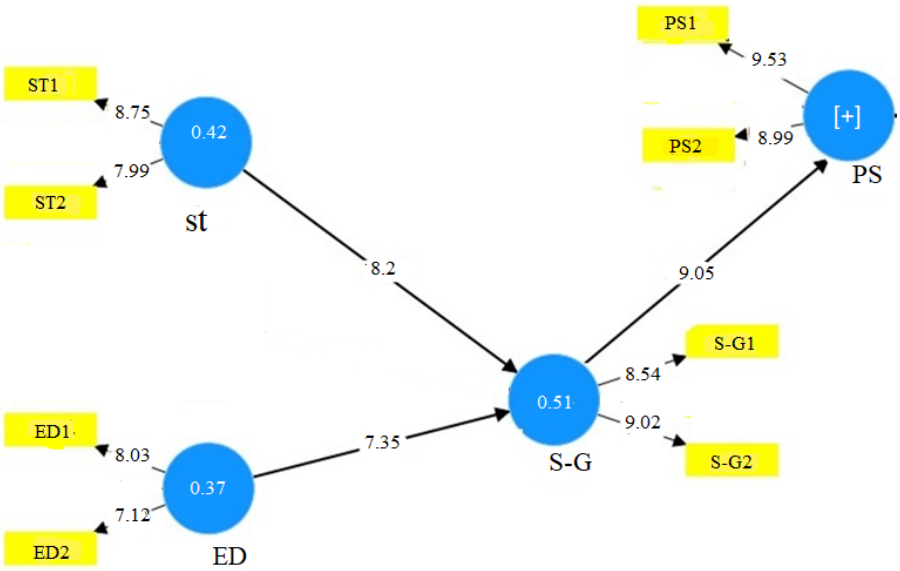

Figure 3. Evaluation of the t-value model of factors affecting women's safety in zone 12 of Tehran

Table 9. Total, direct, and indirect effects of constructs on women's safety in zone 12 of Tehran

Path	Direct effect (β)	Indirect effect (β) through social–institutional factors	Total effect (β)	Total effect rank
Smart urban technologies → Women's safety	0.36	0.18	0.54	1
Environmental design and quality → Women's safety	0.37	0.11	0.48	2
Social–institutional factors → Women's safety	0.43	—	0.43	3
Smart urban technologies → Social–institutional factors → Women's safety	—	0.29	0.29	4
Environmental design and quality → Social–institutional factors → Women's safety	—	0.25	0.25	5

The results of Table 9 show that women's safety in District 12 of Tehran is influenced simultaneously by three main pathways: technological, environmental, and social. Smart urban technologies, with a total effect of 0.54, have the greatest role and operate through both direct and indirect pathways. Its direct pathway, through tools such as surveillance cameras, motion sensors, and safety alert applications, improves women's subjective sense of safety, while the indirect pathway is formed through strengthening communication between citizens and urban institutions and increasing social trust.

Environmental design and quality, with a total effect of 0.48, ranks second and emphasizes that lighting, visibility, eliminating abandoned spaces, and increasing social presence are important factors in enhancing women's psychological calm and confidence. In this pathway, too, a considerable part of the effects is transferred through social interactions and responsive institutions, meaning that well-designed spaces do not by themselves create safety unless social management and urban supervision are also strengthened.

Social–institutional factors, with a total effect of 0.43, indicate a mediating and facilitating role for the technological and environmental relationships with women's safety. Through components such as trust in institutions, responsiveness of urban management, and active participation of women in urban processes, this construct establishes the link between technology and the environment and elevates subjective safety to a more sustainable level. Overall, the findings show that improving women's safety requires an integrative approach in which smart infrastructures, environmental design, and strengthening institutional and social relations operate together. In dense and high-risk fabrics such as District 12, focusing solely on one dimension will not achieve the desired outcome, and only the synergy of these three domains can strengthen the sense of safety in a real and sustainable manner

.Table 10. Overall model fit indices (GOF)

Fit index	Obtained value	Acceptable criterion	Fit status
SRMR	0.056	Less than 0.08	Acceptable
NFI	0.92	Close to 1	Acceptable

The SRMR index is 0.056 and is below the threshold of 0.08, indicating good model fit. The NFI value is also 0.92, which indicates appropriate conformity of the empirical data with the theoretical structure of the model. These results show that the causal pattern among smart technologies, environmental design, social–institutional factors, and women's safety is consistent with the field data and has desirable internal coherence. In other words, the proposed model has been able to properly represent the relationships among technological, environmental, and social variables and to explain women's safety as the final outcome in a realistic context.

Table 11 – Hypothesis testing using path coefficients, t-statistic, and R^2

Hypothesis	Assumed path	β	R^2 of dependent construct	t	P	Test result
1	Smart urban technologies → Social–institutional factors	0.42	0.56	8.21	0.001	Supported
2	Environmental design and quality → Social–institutional factors	0.37	0.56	7.35	0.001	Supported
3	Social–institutional factors → Women's safety	0.51	0.64	9.08	0.001	Supported
4	Smart urban technologies → Women's safety	0.36	0.64	6.43	0.001	Supported
5	Environmental design and quality → Women's safety	0.32	0.64	5.98	0.001	Supported
6	Smart urban technologies & environmental design and quality → social–institutional factors → women's safety	0.21	—	4.85	0.001	Supported

The findings of Table 11 show that all six assumed paths of the model are statistically significant at a high confidence level. The highest effect belongs to the path from social–institutional factors to women's safety with a path coefficient of 0.51, confirming the role of this construct as a connector between technology, environment, and subjective sense of safety. The direct path from smart urban technologies to women's safety with a coefficient of 0.36 shows that technological tools such as sensors, smart cameras, and urban applications have a considerable effect on safety perceptions. The indirect effect of this construct through social–institutional factors with a coefficient of 0.21 also indicates that institutional trust and social participation mediate the transfer of the effect of technology to women's safety. Environmental design and quality also has two direct and indirect paths. Its direct effect with a coefficient of 0.32 and its indirect effect through social–institutional factors with a coefficient of 0.21 indicate that bright, legible spaces with adequate visibility will be effective in enhancing women's safety when accompanied by institutional support and social participation. Overall, the results emphasize that women's safety in District 12 of Tehran is the product of a threefold interaction among smart technologies, environmental design, and social–institutional factors. This combined model indicates that none of these dimensions alone has full functionality, and only through synergy among technological, physical, and social structures can sustainable safety in urban spaces be achieved.

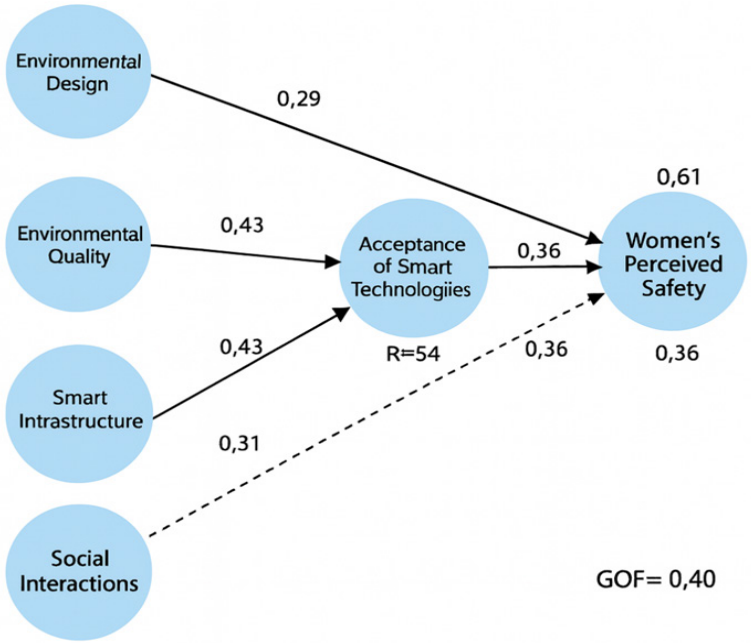

Figure 4. Final structural model of factors affecting women's safety in district 12 of Tehran with emphasis on smart urban components

This model shows the direct and indirect pathways of influence among smart urban components, environmental design, and social–institutional factors on women's safety. Path coefficients, determination and prediction values (R^2 and Q^2), and the overall fit index (GOF) of the model are also displayed in it, which, based on the results obtained from SmartPLS version 4, confirm appropriate model fit and analytical accuracy.

7. Conclusion

The final results of the research show that women's sense of safety in District 12 of Tehran is a multidimensional concept that is formed through the interaction among smart urban components, environmental quality, physical design, and social–institutional factors. Analysis of the structural model showed that the influence of these factors is chain-like and interactive; meaning that smart technologies can play an effective role in increasing women's sense of safety only when they are positioned alongside responsive structures, institutional trust, and appropriate design of urban spaces.

Based on the results of the structural equation model, the greatest effect belongs to social–institutional factors, which assume the mediating role between smart technologies, environmental design, and sense of safety. This finding indicates that the sense of safety, before being the result of technological equipment or physical improvements, depends on women's subjective experience of trust in urban institutions and their perception of the effectiveness of responsiveness mechanisms. In other words, women feel safe when they believe that urban institutions possess the capacity for crisis management, effective surveillance, and social support. In the next step, smart urban technologies were placed as one of the influential variables on the sense of safety. The existence of data infrastructures, smart sensors, urban applications, and stable communication systems increases reassurance and reduces women's subjective concerns about the occurrence of environmental threats. However, the model results showed that the effect of technology without a social and institutional mediator is not complete. This result shows that in Iran's urban contexts, technology can lead to improved safety only when accompanied by the strengthening of social capital and women's participation in decision-making processes.

1. The dimension of design and environmental quality also had a significant and positive effect on women's sense of security in this model. The findings showed that appropriate lighting, high visibility, elimination of blind spots, and recreating worn-out spaces through responsive environmental design are among the most important factors in promoting a sense of security. Environments that have spatial order, active uses, and clear and legible access reduce the likelihood of feeling insecure. This finding is consistent with domestic and foreign studies that have emphasized that the quality of the environment and physical design shape women's subjective perception of security. Compared to previous research, the results of this study provide a more comprehensive perspective. For example, Pourahmad and Maleki (2017) concluded in their study of public spaces in Tehran that lighting and elimination of abandoned spaces can increase women's sense of security. The present study confirmed this finding but added that the effect of these elements is only sustainable if they are combined with technological and institutional components. Also, Abu Jarada and Ababneh, (2020) in their systematic review of Sustainable Development Goals 5 and 11, which are dedicated to gender equality and sustainable cities, have emphasized that new technologies can play a role in promoting gender justice and women's security. The results of the present study have expanded this perspective and shown that technology in the field of feeling safe is not just a technical tool, but also becomes a social mechanism that gains meaning through institutional trust and cultural acceptance. Also, the findings of this study are in line with the results of Faneg et al. (2023), who emphasized social capital, citizen participation, and trust in urban management in their study. The results of both studies indicate that without institutional trust and active social relations, even the best technologies cannot create a real sense of security among women.

2. Overall, the results of this study, while confirming some of the achievements of previous research, provide a comprehensive framework for explaining women's sense of security in smart cities with an integrated approach. This framework shows that women's mental security is the product of synergy between three layers: The technological layer, including data infrastructures and smart systems

3. The environmental layer, including responsive design and spatial quality

4. The social–institutional layer, including trust, responsiveness, and citizen participation

The main contribution of this research compared to previous studies is that it analyzes women's safety not as a physical or morphological condition, but as a subjective and social experience within the context of the smart city. This result indicates a transition from a purely technical perspective to a human-centered and meaning-oriented perspective in urban management. From this viewpoint, District 12 of Tehran can become a model for linking technology, design, and social participation; a model in which women's sense of safety is achieved not through surveillance alone, but through strengthening trust, institutional responsiveness, and the regeneration of urban spaces.

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Ethical Approval

The authors have fully adhered to the principles of publication ethics in publishing the presented article.

Conflict of Interest

No conflict of interest has been declared by the authors. Authors' contribution share: First author 100% .

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