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Original Research Article

An Evaluation of Environmental Indicators Affecting Emotional Responses to Personal Space Violations in Public Environments

(A Case Study of Tehran Metro)

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ABSTRACT

Increasing urban population density and crowding in public spaces have become significant challenges of modern urban life. Violations of personal space elicit diverse emotional and behavioral responses, which are profoundly influenced by cultural context. Architecture plays a pivotal role in striking a balance between fostering social interaction and safeguarding individual privacy. Through the thoughtful design of urban spaces, it is possible to enhance occupant comfort and security while simultaneously promoting positive social dynamics. The present study aims to analyze the spectrum of emotional responses elicited by personal space violations and to categorize these reactions based on their perceived level of risk or intensity. The research methodology is grounded in a qualitative, ethnographic approach, enabling an in-depth examination of nuanced human behaviors and reactions. Data were collected via direct observation within the Tehran Metro environment over seven consecutive days during the summer of 2024. A structured observation checklist was employed to facilitate a precise and systematic analysis of the findings. The results indicated that the most frequent reactions to personal space infringement were verbal warning or confrontation (19.35%) and leaning against the wall or train cabin (12.9%). These findings underscore the significant influence of environmental and physical design factors, particularly deficiencies in adhering to standard metro design principles, in shaping emotional responses to privacy violations. The study concludes that the physical parameters of an environment play a fundamental role in triggering emotions related to territorial intrusion. Consequently, the appropriate design of public environments can serve as a critical tool in mitigating such interpersonal tensions.

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Introduction

Individual behavior is an outcome of needs, motivations, capabilities, and environmental perception, which takes on different forms under the influence of individual and environmental factors (Pakzad & Bozorg, 2021). Social behavior influences relations among citizens and defines how humans use the environment (Sotoudeh, 2023). Altman considers the four concepts of privacy, personal space, crowding, and territoriality as the basis of individual and social behaviors (Shahcheraghi & Bandarabad, 2015). Privacy is important in human rights, and individuals can choose to share or maintain this space (Nazemi Harandi et al., 2021). In today's society, violation of personal privacy leads to numerous conflicts and crimes, threatening the security of individuals in public places. By raising cultural awareness and educating families, students, and university students about the importance of respecting privacy, these criminal behaviors can be reduced. Furthermore, identifying people's emotional reactions when facing privacy violations and modifying the effective environmental factors helps reduce crimes. These measures will lead to increased security and peace in society. The problem of the present study is to identify the factors affecting the violation of individuals' personal space in the Tehran Metro, explain the indicators of people's emotional output, and provide proposed solutions to reduce the identified factors, through which we can witness the minimization of unwanted conflicts in society.

Research Background

Numerous studies indicate that invasion of personal space in various environments from hospitals to airplanes and public spaces has negative psychological and behavioral effects on individuals.

In a study titled "A Study of Privacy from the Perspective of Western Thinkers, Islamic Jurisprudence, and Iranian Law," privacy is considered a part of every individual's life for which they are not accountable, and others do not have the right to enter or interfere without their consent. Individuals have autonomy in decision-making within their private sphere. The scope of privacy may be limited or expanded depending on the culture and governance of a society. Privacy and understanding its concept and boundaries for members of society is one of the fundamental principles for safeguarding individuals' rights and protecting their domain from violation, and legal systems should have a better conception of the infringement of privacy and citizens' rights (Bi-Gham Barozh, 2023). In an article titled "Security and Gender in Urban Spaces: A Qualitative Study of Women's Right to the City, a qualitative approach was adopted and semi-structured interviews were used to examine the component of security in the city, and some spatial factors contributing to the perception of insecurity among female citizens were identified. This research demonstrated that only 45.4% of women in Tehran feel secure in urban public spaces, while the rest identify spaces as insecure. Four factors were recognized as influential in women's attitudes and perceptions of urban security: characteristics of urban space, human intermediaries, collective memory, and temporal fragmentation. However, this study did not propose suitable strategies for enhancing the sense of security among women (Rafatjah et al., 2014). In the article "A Study of Sense of Territory and Territorial Behavior in Urban Parks," the influence of territory in space and methods to enhance the sense of territory and improve security were examined, and the results emphasized careful design, creating spaces with natural sightlines, proper placement of urban furniture, and lighting (Ansari et al., 2010). Marin et al. (2018) reported that nursing staff behaviors, such as touching patients' belongings without permission and disclosing illnesses, lead to violations of privacy and patient distress, especially for patients who had greater privacy at home. Lewis et al. (2017) showed that the invasion of airplane passengers' personal space is not solely due to physical contact but is also related to the absence of personal space boundaries, environmental density, and prolonged proximity. Based on Argyle and Dean's Affinity-Conflict Theory, individuals in crowded spaces like elevators use non-verbal personal space defense behaviors such as holding bags, pretending to use a mobile phone, and adopting defensive postures (Shahcheraghi & Bandarabad, 2015). Kaya and Erkip (1999) showed that withdrawing money from an ATM requires maintaining privacy, and although gender influences the tendency to maintain distance, situational variables such as environmental density also play a significant role. Evans Wener (2007), in a study on crowded trains, found that reduced personal distance and high density increase stress and negative reactions. Furthermore, Kaya and Weber (2003), in examining cross-cultural differences in the perception of crowding and privacy between American and Turkish students, emphasized that men tend to desire more privacy, and crowding is perceived under the influence of cultural norms; students who had less than optimal privacy felt more crowded.

These studies highlight the importance of environmental, cultural, and individual factors in the experience of personal space invasion and privacy maintenance, indicating that reducing density, respecting spatial boundaries, and cultural education can help improve individuals' psychological and social comfort. In previous research, the focus has largely been on identifying factors affecting privacy violations and defensive strategies, with less attention given to providing practical solutions for reducing these violations. This study aims to fill this gap by examining privacy violations in the Tehran Metro

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and, using a qualitative and ethnographic approach, seeks to identify influencing factors and propose suitable strategies to reduce tensions arising from privacy invasion.

Research Method

This study employs an ethnographic research method with a qualitative approach. Ethnography, as a descriptive art and science, is used in qualitative research to study a group or culture. In this approach, the researcher is sensitive to the social world and interprets it based on their own concepts and meanings (Pouya & Maleki, 2012). Ethnography was established as a research strategy by anthropologists, focusing on the relationship between human behavior and culture. This method primarily involves studying the beliefs, social interactions, and behaviors in small communities through participation and observation over a period of time, interpreting and collecting data (Naidoo, 2012).

In this study, after reviewing and analyzing past research and defining keywords, observations were conducted over one week in August 2024 at various times across 28 different stations of the Tehran Metro, with the researcher acting as a passenger. When initial instances of potential privacy violations occurred, closer observation was used to identify the issue, and significant instances were documented. A total of 124 observed instances resulted in a reaction to personal space invasion. In 72 cases where the situation was suitable for conversation and individuals were responsive, brief dialogues were held with metro users. Their opinions were heard and noted, and their experiences with privacy violations were incorporated into the research. Based on the frequency of human reactions to privacy invasion found in previous studies, a checklist was developed. The results were then analyzed to derive a model and, ultimately, propose practical solutions.

Theoretical Foundations

• The concept and reaction to rersonal space violation

Personal space is defined as the area surrounding an individual's body that others cannot enter without causing discomfort. It is not a fixed geographical location; rather, it moves with the person and expands or contracts depending on the situation. It is often described as a "bubble" of space enveloping the individual (McAndrew, 1993/2008). Personal space is an invisible boundary encompassing the human body, which unauthorized persons are not permitted to enter (Mortazavi, 2001). If another person enters this space, the individual feels disturbed and displays their dissatisfaction (Goffman, 1961). Intrusion into a person's personal space is a stressful and arousing event, often leading the individual to avoid the intruder (McAndrew, 1993/2008).

Table 1 presents several theories related to personal space and its violation:

Spatial behavior, referring to interpersonal interactions and the choice of appropriate distance between individuals, plays a crucial role in social life and often goes unnoticed until unusual events occur. Emotional reactions to personal space violations, such as unexpected touch, are influenced by others' spatial behavior and personality traits like extroversion and introversion (McAndrew, 1993/2008). Edward T. Hall, in his book "The Hidden Dimension," identified four interpersonal distances: intimate (0 to 46 cm), personal (46 to 122 cm), social (122 to 366 cm), and public (366 to 762 cm) (Hall, 1966/2013). These distances are significant in public environments like metros and elevators, where people maintain their distance to prevent privacy invasion, as entering personal space is often stressful and unpleasant. Violation of personal space increases emotional arousal, which can trigger various behavioral responses. This arousal is influenced by the non-verbal behaviors of others, particularly interpersonal distance and eye contact, and changes in these act as moderating factors in an individual's reactions. Variables affecting personal space include situational factors, age, gender, and racial, cultural, and ethnic backgrounds (McAndrew, 1993/2008). Humans inherently establish territory and separate themselves from others to create a comfort zone. Territorial behavior is one of several mechanisms for regulating the boundary between self and others (Shahcheraghi & Bandarabad, 2015). Territorial violation is the unauthorized crossing of the boundary surrounding an individual or group and is associated with human emotions. Emotions, as subjective phenomena, cause us to feel angry or happy in specific ways. They are also social phenomena; when we become angry, we send recognizable facial, gestural, and verbal signals that communicate the quality of our emotional state to others (e.g., eyebrow movement, tone of voice). Reactions to violation and efforts to protect territory vary in intensity, ranging from full alert, sharp and aggressive signals, verbal and non-verbal cues, leaving the location, to creating environmental markers for physical separation and demarcation (Altman, 1975/2003). These reactions underscore the profound importance of territory and privacy in individual and social life.

The factors influencing personal space are closely interrelated and directly affect one another. Generally, it can be stated that the level of intimacy between individuals in different situations depends on their age, gender, the culture they live in, and even their personality. The diagram below (Fig. 1) illustrates the overlap of factors affecting an individual's personal space.

When personal space boundaries are violated, individuals experience anxiety, psychological pressure, and behaviors such as flight or aggression (Altman, 1975/2003).

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Table 1. Selected theories concerning personal space and its violation. Source: Authors.

Theorist	Explaining the theory
John Lang	Personal space is an invisible zone around an individual that intruders cannot enter. It does not necessarily have a volumetric shape, nor does it extend equally in all directions.
Goffman	If another person enters one's personal space, the individual feels disturbed and shows their dissatisfaction.
Whyte	People adapt to comfort conditions or move furniture for their own comfort. Movable chairs are among people's preferred elements.
Hall	Unwanted entry into personal space is tolerated.
Altman	Personal space is a mechanism used for interpersonal interaction and achieving desired privacy.
Argyle	Equilibrium Model: Individuals establish a balance in regulating the distance between themselves and others.
Sommer	Portable Territory: Personal space is an area with invisible boundaries surrounding the human body, which unauthorized persons are not permitted to enter.
Goffman	Personal space is the area around individuals such that another's entry causes them distress; if they feel violated, they express discomfort and withdraw.
Heidacker	Personal space is defined as the environment around a person's body, which others cannot enter without causing issues.
Barash, Philip Sommer	Violations of personal space often cause people to yield and change their position.

Behavior is the most objective human reaction to the environment, conveying messages without words (Shahcheraghi & Bandarabad, 2015). Psychological theories state that a precise understanding of inner life, desires, needs, and human values helps predict individual behavior (Mortazavi, 2001). Furthermore, culture, society, time, and space influence behaviors; society controls human behavior by defining boundaries and norms, while space controls it by enabling or eliminating certain behaviors. Space and humans mutually influence each other and cannot be considered separately (Pakzad, 2010). The breaching of personal space boundaries leads to negative behaviors such as anxiety, psychological pressure, flight, and aggression, underscoring the importance of maintaining these boundaries for individuals' mental health.

Privacy is defined as a regulatory process that controls access to an individual or group and involves the protection of personal information and affairs (Madanipour, 2003/2010). This concept consists of multiple layers that protect the individual from unauthorized intrusion; these layers are established by society and assigned to individuals for use in social relations (Altman, 1975). Fig. 2 illustrates the stages from the initial violation of an individual's territory to the emergence of personal emotions and the corresponding reactions at each stage.

• Human emotions and reactions to the environment

Emotions are complex, multidimensional phenomena encompassing behaviors, physiological changes, and subjective experiences. The level of physiological arousal, such as increased adrenaline, heart rate, and cognitive activity, constitutes a significant part of the emotional experience (McAndrew, 1993/2008). Individuals' reactions to an environment vary based on their tendencies to approach or avoid it; unfamiliar or more complex environments induce greater arousal

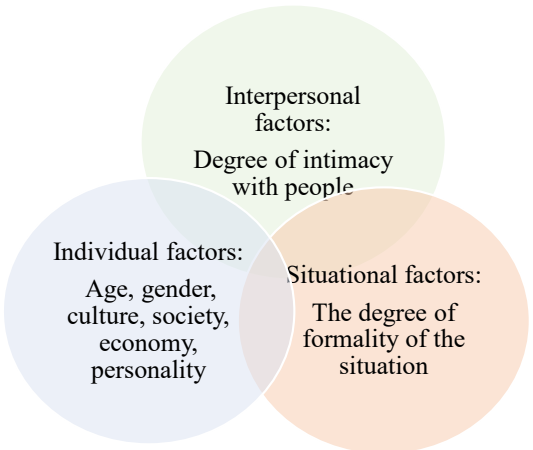


Fig. 1. Overlapping factors affecting personal space. authors' source based on Altman's book Environment and Social Behavior.

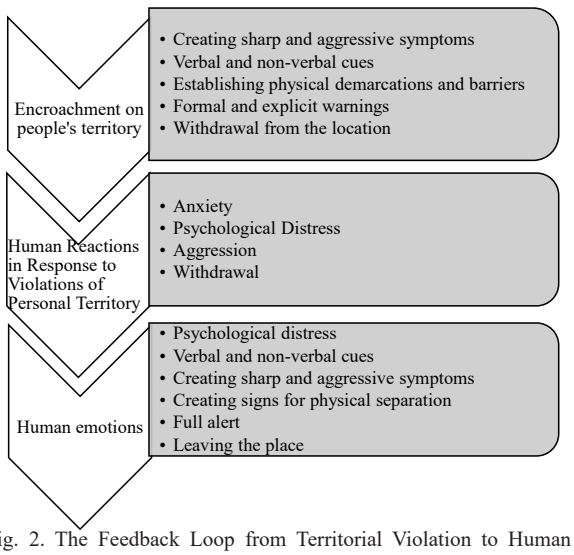


Fig. 2. The Feedback Loop from Territorial Violation to Human Emotional Responses. Source: Authors.

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(Russell & Mehrabian, 1976; Rapoport, 1990). The three-factor theory of emotion posits that the dimensions of arousal, dominance, and pleasure best explain emotional responses to the environment. The invasion of personal space causes feelings of disturbance and physiological reactions such as skin flushing (Goffman, 1963; Evan & Howard, 1973).

Overall, environmental factors, particularly physical-spatial ones, play a crucial role in eliciting emotions and influencing human behavior. Human emotions are shaped by physiological, psychological, and environmental factors, with the level of physiological arousal playing a key role in the emotional experience. Individuals' reactions to an environment differ based on its familiarity, complexity, and controllability, and the invasion of personal space can trigger negative emotional and physiological responses. In situations where an individual cannot alter an unsatisfactory environment, a sense of helplessness arises. Consequently, understanding and managing environmental factors, especially physical ones, is essential for maintaining psychological well-being and enhancing quality of life.

Findings

• A conceptual model of human responses to personal space violation

A violation of personal space elicits two primary types of responses in individuals. The first category involves no perceptible human emotion; this reaction has no impact on the individual's emotional state. The second category, however, triggers distinct human emotions, classified into six groups and color-coded from green to red based on their level of perceived risk (Fig. 3).

• Field Studies in the Tehran Metro Environment

Currently, the Tehran Metro, with 7 active lines and more than 150 stations, transports over 2.5 million passengers daily. Despite the developments that have been implemented, the shortage of train cars and overcrowding on certain lines remain significant challenges for this public transportation system (Fig. 4).

Based on the UK platform design guide standards, a strip with a width of 0.5 meters is placed at the edge of the platforms. This strip is distinguished from the rest of the platform by a change in color and material and represents the platform's safety zone. Generally, a width of 2 meters is allocated for waiting and another 2 meters for the circulation area. Consequently, the standard platform width is 4.5 meters for side platforms and 9 meters for island platforms (Bagheri Sadeghi, 2001).

The absence of wide corridors, insufficient escalators, and lengthy passageways (physical factors) in certain areas, combined with high public usage, lead to emotional responses among individuals. The density of the crowd during boarding increases significantly, creating conditions conducive to the violation of personal space (Fig. 5).

The maximum implemented platform width in the Tehran Metro is approximately 3 meters, which falls short of the standards identified in studies. Furthermore, the presence of retail kiosks has further reduced the effective width of the platforms. Consequently, this has created numerous difficulties for many users. A prevalent issue, frequently observed, is the violation of personal and private space, which sometimes occurs unintentionally but often deliberately. This specific issue will be the subject of the field study and research in this paper.

According to the UK Platform Design Guide of 1992, the Table 2 is provided. While the first criterion (existence of island platforms) is not applicable in the Tehran Metro, as there are none, in many stations, we observe that the

Table 2. A Comparison of Platform Construction Standards in the UK and the Tehran Metro. Source: Authors.

Platform indicator	Length	Situation in Tehran Metro
Minimum width from the platform edge to the nearest obstacle	2.5 meters	This standard has been observed in the Tehran Metro.
Minimum Width for Island Platforms	9 meters	Island platforms are not present in the Tehran Metro system
Recommended width for high-traffic stations	8 meters	This recommended width has not been observed in the Tehran Metro
Platform Length	Maximum Length + 12 meters	This recommended width has not been observed in the Tehran Metro



Fig. 4. Tehran Metro – Darvazeh Dowlat Station (Crowding and Train Car Shortage).

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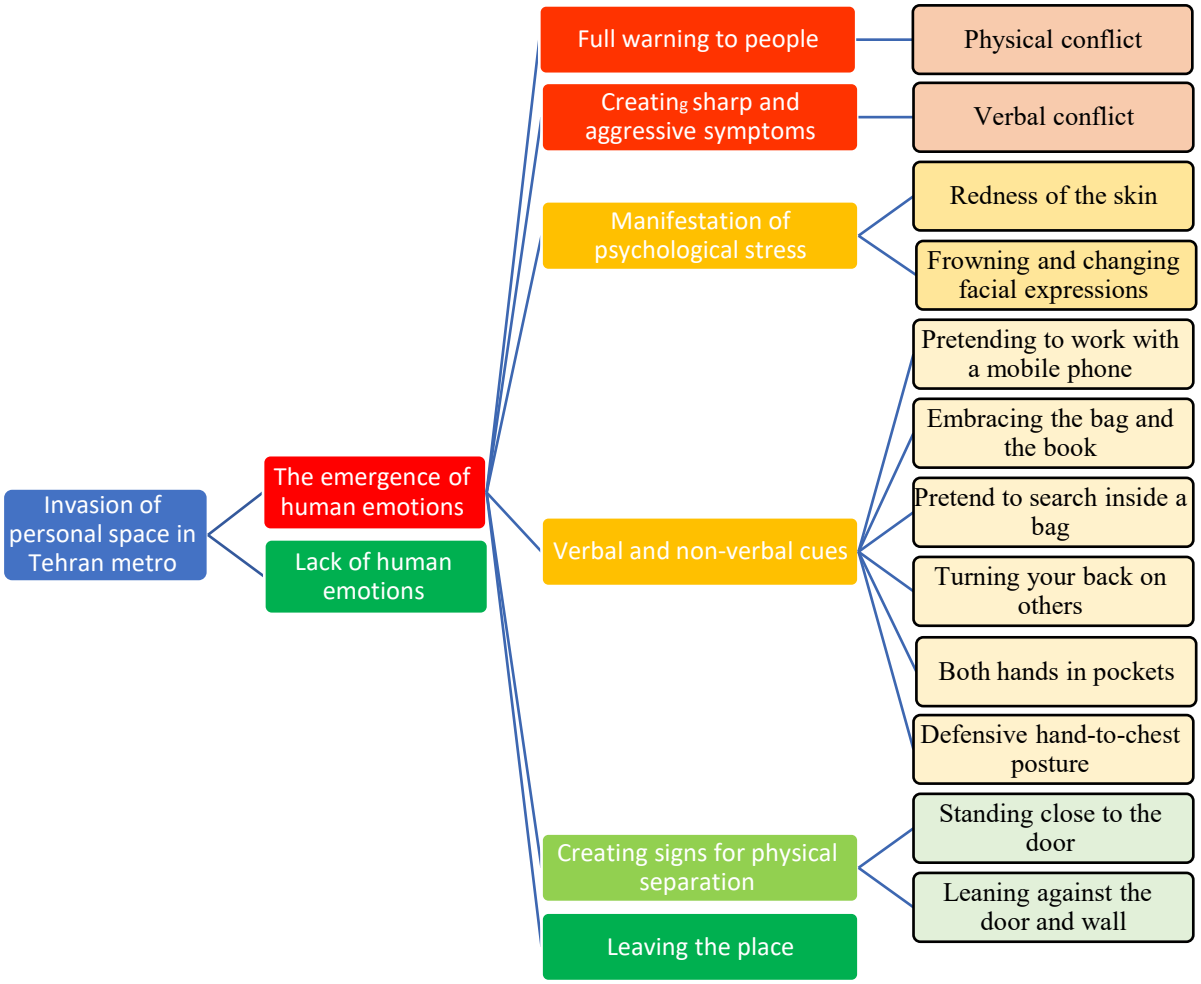


Fig.3. Conceptual model: human responses to personal space violation. Source: Authors.



Fig. 5. Existing Conditions in the Tehran Metro - Kohdad station.

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necessary standard widths have not been implemented. This deficiency is a direct cause of the excessive crowding and congestion witnessed in these stations.

According to international standards (Neufert - Graphic Standards - Time Saver) and based on human dimensions and scales, each individual requires a width of at least 62 centimeters for movement on stairs. If carrying an object such as a suitcase or a package, a width equivalent to 80 centimeters is needed. These dimensions correspond to 110 to 115 centimeters for two people, and 1.5 to 3 meters for three people (Table 3).

In some high-traffic stations, the maximum width is 2. 5 meters, which, based on the assumption of five people standing side-by-side, should be 3 meters. Furthermore, in certain areas, the maximum width reaches 3 meters, whereas for seven people standing side-by-side, it should be 4.2 meters (Fig. 6).

At most metro entrances, the entrance width is 2.5 meters, which, while adhering to the standard, is insufficient to accommodate the crowd density given the station's high traffic levels (Fig. 7).

The structural problems of the Tehran Metro can be summarized in the Table 4:

Checklist 3: Manifestation of Symptoms in Personal Space Violations serves as a comprehensive instrument for documenting and analyzing individual reactions to the infringement of personal boundaries. This checklist captures demographic data, such as gender and age, alongside a spectrum of behavioral responses elicited by personal space violations. These documented reactions are categorized to include: physically leaving the vicinity (e.g., creating distance or standing away from the immediate area); establishing signals of physical separation (such as leaning against a door or wall, or maintaining distance from objects); a range of verbal and non-verbal cues (including turning away from others, adopting defensive postures, feigning to search through a bag, clutching personal items like a bag or book, and engaging with a mobile phone); indicators of psychological distress (for instance, frowning, observable changes in facial expression, and blushing); and more intense, aggressive reactions (such as issuing verbal warnings or engaging in verbal and physical altercations). Furthermore, a dedicated section is included for recording unforeseen responses, examples of which are staring blankly into space, uttering curses, or displaying an indifferent smile. This tool is designed for application in field and behavioral research. Guided by its underlying conceptual model, it was employed through direct observation within the Tehran Metro system over seven consecutive days across several lines: from Qeytariyeh to Darvazeh Dowlat, Sadeghiyeh to Baharestan, Nowbonyad to Rahahan, Darvazeh Dowlat to Kolahdooz, and Meydan-e Emam Hossein to Shahr-e Aftab. The collective findings from these observations are poised to facilitate a more precise and nuanced analysis of passenger behaviors in situations where personal space is compromised (Table 5).

Following the field data collection, observations of symptoms, and interviews with individuals regarding personal space violations over a one-week investigation period, which amounted to a total of 196 documented cases, the results were entered into Excel software. The frequency of each behavior was calculated, and its corresponding percentages were determined. The Fig. 8 below was generated as the final outcome of this analysis.

Table 3. Staircase standards for platform access. Source: Authors.

Stairs Indicator	Standard
Height of Each Step	15 cm
Width	Minimum Width: 120 cm Maximum Width: 180 cm (without an intermediate handrail)
Number of Steps	Minimum Number of Steps: 3 Maximum Number of Steps: 16
Accessibility for Persons with Disabilities	Maximum number of steps between landings: 8
Stair Handrails	Continuous on both sides of the stairs, with a diameter of 5 centimeters and a height of 85 centimeters.

Table 4. Spatial Limitations and Problems in the Tehran Metro. Source: Authors

Row	Problem
1	Mismatch between User Capacity and Spatial Provision
2	Insufficient Stairs and Escalators
3	Inadequate Width of Circulation Routes
4	Long Corridors to Reach Metro Cars
5	Insufficient Width of the Boarding Waiting Area

Conclusion

The rapid growth of urbanization and the extensive use of public spaces have heightened concerns regarding violations of personal space, which often occur unconsciously and receive limited attention. Environmental structures and factors play a significant role in triggering emotional reactions among individuals, with these responses varying based on culture, gender, age, and location. Field observations indicate that privacy violations are reported more frequently by women than men, with the highest incidence occurring among the 20 to 40 age group. The most common reactions include verbal warnings, creating physical distance such as leaning against doors or walls, and pretending to use a mobile phone. Less frequently observed behaviors include blushing or rummaging through a bag. These findings suggest that most individuals initially respond to personal space violations with verbal reactions, which may escalate into conflicts if the situation intensifies. To

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Table 5. Checklist Prepared for Field Investigation. Source: Authors.

Age	Leaving the place	Creating signs for physical separation			Verbal and non-verbal cues					Psychological stress			Creating sharp and aggressive symptoms		Full alert	Unexpected reaction
	Leaving the place	Leaning against the door and wall	Standing close to the door	Packing up	Defensive hand-to-chest posture	Both hands in pockets	Turning your back on others	Pretending to search inside a bag	Embracing the bag and the book	Pretending to work with a mobile phone	Frowning and changing facial expressions	Redness of the skin	Verbal warning or confrontation	Physical conflict		
35																Staring at a blind spot
27																
25																
23																
37																
34																
35																
21																Swearing
25																
28																
40																
45																
30																Smiling completely indifferently
54																
26																

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(A)



(B)

Fig. 6. Access points in high-traffic stations of the Tehran Metro – Darvazeh Dowlat station (A) and Panzdah-e-Khordad station (B).

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Figure 7. Entrance of a Tehran Metro station - Panzdah-e-Khordad station.

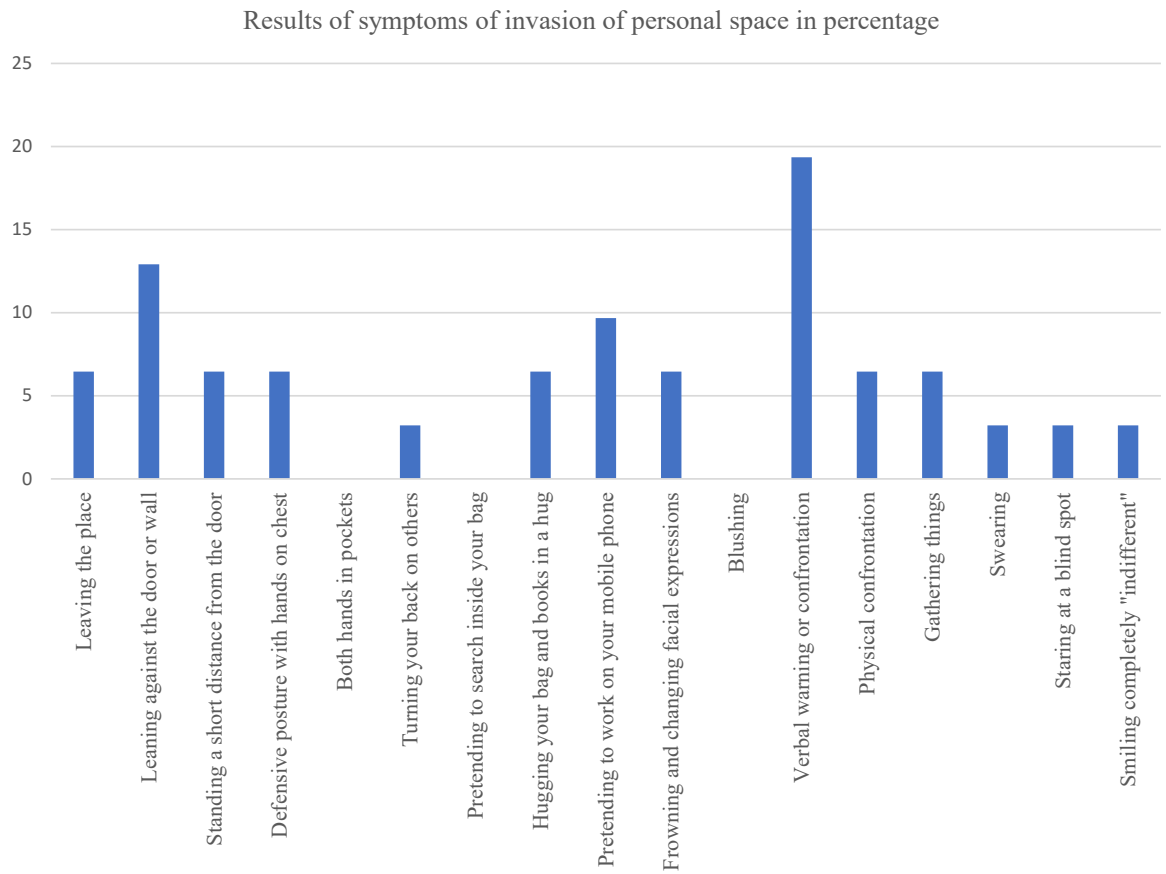


Fig. 8. Results obtained from data analysis. Source: Authors.

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improve conditions, it is recommended to delineate social and personal spaces, promote awareness and respect for privacy through media campaigns, and enhance facilities such as escalators, appropriate lighting, and widened corridors, along with introducing entertainment options in metro waiting areas. Such measures would help alleviate tensions and improve the quality of public space utilization (Fig. 9).

Research suggestions and limitations

To enhance privacy conditions in public spaces, particularly in the Tehran Metro, it is recommended to establish a clear distinction between social space and individual territory. This can be achieved through appropriate environmental design and the use of intelligible spatial cues. Concurrently, public awareness campaigns and educational content on the importance of respecting personal boundaries can help mitigate social tensions. Increasing the number of escalators along passenger routes within the metro would alleviate crowding and contribute to the preservation of individual space. Optimized corridor design and adequate lighting can create a safer and more comfortable environment for users, thereby reducing violations of personal privacy. Furthermore, widening waiting areas and introducing entertainment options in these zones would help disperse congestion and improve passenger satisfaction. However, the implementation of these recommendations faces several constraints. Financial limitations may hinder investments in expanding escalator infrastructure and widening corridors. Sociocultural barriers also present challenges, as behavioral change and cultural shift require time and sustained effort. Physical restrictions, such as the confined space in certain stations, may complicate the full execution of proposed designs. Additionally, some measures demand extended timelines for planning and execution, while fostering a culture of respect for personal privacy necessitates continuous education and awareness-raising initiatives. Given these considerations, acknowledging both the proposed solutions and their inherent limitations can significantly contribute to improving personal space quality and reducing tensions within the metro system.

Conflict of Interest

The authors declare that there was no conflict for them in conducting this research.

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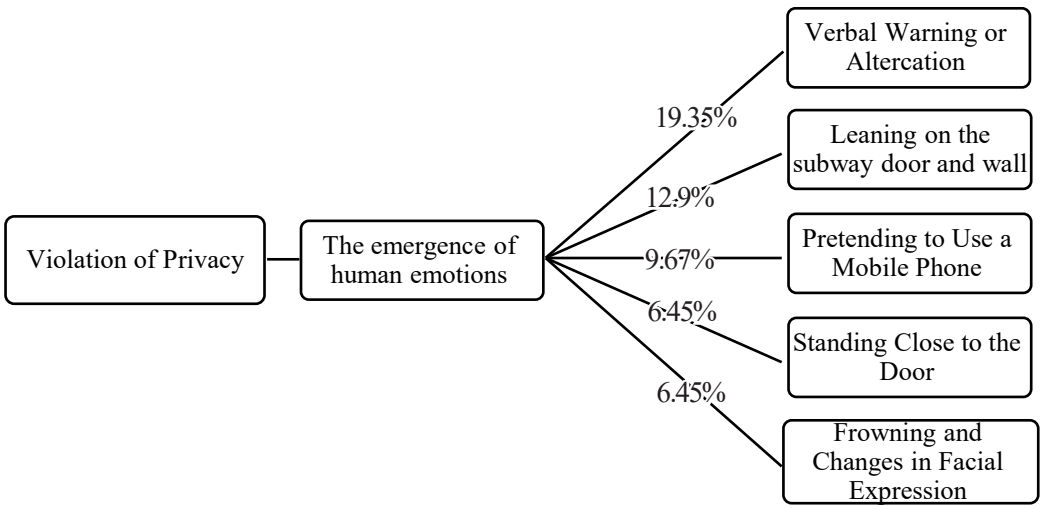


Fig. 9. Frequency percentage of reactions to personal space violations in the Tehran Metro. Source: Authors.

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