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► **To cite this version:**

Sepideh Zarepour Sohi, Saeed Banihashemi, Moslem Sheikhhoshkar, Poriya Abdollahi Roshan. From data to design: Social network insights for urban design and regeneration. *Frontiers of architectural research*, 2024, 13 (6), pp.1377-1399. 10.1016/j.foar.2024.04.006 . hal-04604395

HAL Id: hal-04604395

<https://hal.univ-lorraine.fr/hal-04604395v1>

Submitted on 7 Jun 2024

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RESEARCH ARTICLE

From data to design: Social network insights for urban design and regeneration

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Received 6 February 2024; received in revised form 26 March 2024; accepted 9 April 2024

KEYWORDS

Urban regeneration;
Urban public space;
Social media data;
Social network
analysis (SNA);
Sustainable cities

Abstract Urban public spaces are pivotal to the welfare and prosperity of modern cities. Recognizing their importance, this research addresses the critical gap in understanding and enhancing the qualities of these spaces through advanced analytics, focusing on Tehran's main traditional market, the Bazaar. A novel methodological framework combining Social Network Analysis (SNA), and Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, supported by location-based social media reviews, was employed. This innovative approach assessed the Bazaar's comfort, vitality, and safety, analyzing real-time public interactions and perceptions through social media data. The findings highlighted the Bazaar's central role in Tehran's urban landscape and identified the need for strategic design interventions. These interventions aimed to improve walkability, comfort, safety, and diversity, and have been successfully implemented, significantly enhancing the Bazaar's quality and usability. This study not only advances urban studies and planning by providing a model for urban public space analysis but also underscores the value of social media data in urban analytics. The successful revitalization of Tehran's Bazaar sets a precedent for enriching urban experiences and boosting city vitality through similar interventions in other urban spaces.

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Peer review under responsibility of Southeast University.

<https://doi.org/10.1016/j.foar.2024.04.006>

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Please cite this article as: S. Zarepour Sohi, S. Banihashemi, M. Sheikhhoshkar et al., From data to design: Social network insights for urban design and regeneration, Frontiers of Architectural Research, <https://doi.org/10.1016/j.foar.2024.04.006>

1. Introduction

Urban public spaces are integral to the social, cultural, and recreational fabric of city life. They serve as vibrant hubs where diverse social activities unfold, significantly influencing the urban experience (Kim et al., 2018). These spaces, including parks, green spaces, and streets, offer a respite from the fast-paced urban life, allowing individuals from varied backgrounds to engage in community gatherings, events, and festivals (Schwartz and Hochman, 2014). Beyond serving as communal gathering spots, urban public spaces contribute substantially to physical health, mental well-being, social cohesion, and the economic and ecological value of local communities (Tabadkani et al., 2022). Their role is thus fundamental to the overall prosperity and wellness of contemporary cities (Song et al., 2020). Given their importance, the quality analysis and investigation of these spaces are crucial.

However, traditional methods of evaluating urban public spaces, such as on-site observations, surveys, and interviews, are fraught with challenges. These include high costs, time-intensive processes, low response rates, outdated information, oversimplification, labor intensity, and issues with consistency. Additionally, these methods often fall short in long-term data collection, which is essential to assess variations in the built environment and human behavior across diverse social, cultural, and political contexts (Kim et al., 2018; Song et al., 2020). Consequently, these conventional approaches may neither be cost-effective nor adequately responsive to the dynamic and evolving nature of public spaces.

In contrast, the advent of big data, characterized by its significant volume, high velocity, and diverse variety (Laney, 2001), offers a new paradigm for understanding patterns of human behavior in urban public spaces with high spatial and temporal resolutions (Banihashemi and Sohi, 2022). Comprehensive analyses are now possible through big data sources, including social media data, which provide extensive coverage across both time and space. This technological advancement enables a more accurate and real-time perception of how public spaces are used and experienced, thereby offering an innovative and efficient approach to public space evaluation (Fattahi Tabasi et al., 2023; Song et al., 2020).

Hence, this research leverages social media data to evaluate three key aspects of urban public spaces: comfort,

vitality and diversity, and safety. The goal is to develop inclusive and sustainable design intervention strategies for space regeneration. The paper is structured as follows: Section 2 presents a theoretical framework, outlining the significance of urban public spaces and reviewing literature on their main qualities, along with an introduction to social media as a big data source. Section 3 describes the materials and methods, including the study area and analysis methodology. Section 4 offers a qualitative assessment through Social Network Analysis (SNA), followed by a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis in Section 5. Section 5 details design principles and interventions for the case study area, Tehran's Bazaar. Finally, Section 6 summarizes the study and explores future research directions.

2. Literature review

• Main Qualities of urban public space

Urban public space points out to the openly accessible spaces which are indoor or outdoor (Weijs-Perrée et al., 2020), available to the public for the daily life and social activities of urban residents, including urban squares, streets, parks, and other outdoor spaces (Carr et al., 1992). It is an indispensable ingredient in metropolitan environments which improves the urban quality (McPhearson et al., 2016), maintains urban vitality and vibrancy (Whyte, 2001), helps carry public life (Gehl, 2010), and cultivates a public identity (Kweon et al., 1998). At a larger scale, formal public spaces have long had a key role as the perceived centers of settlements of all types and as the core of public life, activities and events. At a smaller scale, they might simply be a place to rest, hang out, or play whilst providing a visual pause in the flow of streets through urban areas (Carmona, 2019). Public spaces are also essential for sustainable urban development and healthy cities, if these can be designed and planned to meet the quality space requirements (AL-Fadala, 2020).

Table 1 indicates the main qualities of urban public spaces discussed and applied in the literature and identified as the following. Evans et al. (2019) pointed out that five fundamental dimensions of public space are safety, comfort, meaningful activities, inclusivity and pleasurability. Zamanifard et al. (2019) concluded that comfort, inclusiveness, diversity, vitality, image and likeability are the

Table 1 Main qualities of urban public space.

Author	Year	Main qualities of urban public space
Tibbalds	1992	Pedestrian freedom, access for all, mixing uses and activities
Gehl	2010	Good weather at eye level, lively city (vitality) and diversity
Mehta	2014	Inclusiveness, meaningful activities, safety, comfort, and pleasurability
Carmona	2014	Comfortable, free & delineated, diverse, social, and meaningful engaging
Linde Van Hecke	2018	Features, condition, aesthetics, safety, policy
Zamanifard et al.	2019	Comfort, inclusiveness, diversity, vitality and image, and likeability
Bilge	2020	Social interaction, physical characteristics, physical comfort and safety
Al-Fadala	2020	Accessibility, connectivity, sociability, uses and activities, user comfort and wellbeing
Almahmood et al.	2022	Spatial qualities, accessibility, walkability, safety, delightful, comfortably Socio-spatial qualities, livable, inclusive, sociable

experiential qualities of public spaces. [Bilge \(2020\)](#) argued that space quality components include social interaction, physical characteristics, physical comfort and safety at the core. [Almahmood et al. \(2022\)](#) classified the universal qualities of human-centered public spaces to spatial and socio-spatial qualities. Spatial qualities include accessibility, walkability, safety, delightful, and comfortably, while socio-spatial category refers to livable, inclusive and sociable spaces. [AL-Fadala \(2020\)](#) considered accessibility, connectivity, sociability, uses and activities, user comfort and wellbeing as the criteria for assessing the aspects of the public space. [Van Hecke et al. \(2018\)](#) categorized specific public open space attributes to features (facilities, amenities and general features of the public open space), condition (maintenance, incivilities and upkeep), aesthetics (attractiveness and appeal), safety (personal security and fear) and policy (management, rules and restrictions). [Carmona \(2014\)](#) identified four features for experiential qualities of public spaces including comfortable, free and delineated, diverse, social and engaging places. [Mehta \(2014\)](#) considered five essential criteria for urban public space including, inclusiveness, meaningful activities, safety, comfort and pleasurability. [Gehl \(2013\)](#) presented good weather at eye level, lively city (vitality) and diversity as vital qualities of urban public spaces. [Tibbalds \(1992\)](#) assumed three main features of pedestrian freedom, access for all, mixing uses and activities for primary qualities of urban public space ([Table 1](#)).

Based on the literature review and analysis, safety, comfort, and vitality are among the most frequent used and discussed factors for urban public space. Thus, these factors are chosen as the frame of reference for this study and presented in more depth in the next subsections.

1) Safety

Safety is often cited as the first concern in public spaces. A feeling of safety may be attained easily by the permanent presence of people and “eyes on the street” where the space becomes self-policed. Regardless, perceptions play a substantial role in making places appear safe or unsafe. Safety from traffic is another important factor related to the use of public space ([Evans et al., 2019](#)). The perception of safety and security both physically and psychologically creates a safe place against traffic, crime, and unpleasant encounters ([Almahmood et al., 2022](#)). “Safety” points out to both actual and perceived safety and is a necessary indicator, as it influences the way people use a place.

2) Comfort

The perception of comfort in a public space relies on a large number of factors, including perceived levels of safety, familiarity of the setting and people, weather, physical conditions and convenience. Comfort by itself refers to the physical and environmental effects of the public space ([Mehta, 2014](#)). It deals with the ease of access, safety, security, desirable microclimatic conditions, greenery, cleanliness, seating provision, walkability and

readability of a place ([Whyte, 2001](#)). It is pointed out to the state in which users feel safe and at ease to comfortably move around a place in a stress-free manner ([Zamanifard et al., 2019](#)). [Gehl \(2013\)](#) delineates comfort feasibilities for walking, standing and sitting. It also means to spend time in and engage with various activities such as walking, standing, sitting, people watching, and talking ([Almahmood et al., 2022](#)).

3) Vitality

The concept of vitality was first proposed by Jacobs, who believed that vibrant streets play a decisive role in urban development. Later, Lynch evaluated urban vitality by assessing how the physical environment meets human activity requirements ([Ding et al., 2023](#)). Vitality is also considered as a character of good urban public space, where a place is vibrant, animated and playful. Vitality is generally assessed by the number of people using a place; formal or informal collective and cultural events, festivals and public performances; active frontages; the presence of children and women; active and safe street life in late evenings and the existence of playgrounds ([Zamanifard et al., 2019](#)).

Vitality can be measured by pedestrian flows and activities, the use of public facilities, and the existence of business destinations. Many studies have verified that the built environment, such as functional mix, intensity of development, street facility, scale, and commercial service, can effectively enhance this future ([Wu et al., 2022](#)). Literature analysis indicates that built environment indicators, including mix land use, accessibility, and building density have thoroughly influenced the formation of urban vitality ([Jacobs 2016](#); [Lu et al., 2019](#); [Montgomery, 2007](#)). This roots from the people and their activities in a space where the factors including degree of compactness, walking and humanity scale, functional mixing, and appropriate building density, dense population distribution, street accessibility are influential elements ([Wu et al., 2022](#)).

Based on the definitions and discussions above, the keywords, presented in [Table 2](#), are chosen for the analysis of social media data and the evaluation of urban space qualities ([Table 2](#)).

• Location-based social media data

The development of the Industry 4.0 and big data bring innovative opportunities for communication with people through social media data which embrace tremendous amounts of data about people’s behavior, mobility and feelings about places ([Nummi, 2019](#)). In fact, people operate as a sensor through their smartphones to produce huge amount of datasets related to urban and social aspects ([Santala et al., 2017](#)), and can comfortably share their experiences and opinions. Social media is a powerful tool which offers new opportunities to collect user-generated behavioral data with the space–time dimension ([Kim et al., 2018](#)) and provides reliable geographic information ([Song et al., 2020](#)). Moreover, intangible

Table 2 The selected keywords for urban space qualities and social media data analysis.

Qualities of urban space	Reference	Quality assessment factor	Selected keywords
Comfort	Mehta (2014)	Physical condition and psychological level of comfort	huge, big, large, grand, crowd-crowded-crowdedness-crowdy-crowds-crowded-enjoy, enjoyable, enjoying, enjoyed, enjoyment, enjoys, joy, noise-noisy, good (place)/great
	Whyte (2001) Almahmood et al. (2022) Gehl (2013)	Accessibility Possibility of doing various activities	metro-subway-station-taxi walking-walked-walk-pedestrian, stepping, stand-standing, stand-standing, siting-seating, bench, shop-shopping-shopper-shopkeeper-shops-shopping mall, waiting, waited, wait, visit, visited, visiting, watches-watching, drink-drinks-drinking, restaurant, Sharafoleslami (name of restaurant, café, museums, food, juice, cuisine
Vitality	Whyte (2001) Francis (1989); Gehl (2013); Tibbalds (1992)	Walking convenience Possibility of doing various activities and mix land use	walking-walked-walk-pedestrian, stepping walking-walked-walk-pedestrian, stepping, stand-standing, stand-standing, siting-seating, bench, shop-shopping-shopper-shopkeeper-shops-shopping mall, waiting, waited, wait, visit, visited, visiting, activity, watches-watching, drink-drinks-drinking, restaurant, Sharafoleslami (name of restaurant, café, museums, food, juice, cuisine
	Lu et al. (2019)	Presence of large number of people	crowd-crowded-crowdedness-crowdy-crowds-crowded-
Safety	Lu et al. (2019)	Walkability	walking-walked-walk-pedestrian, stepping
	Almahmood et al. (2022)	Crime	thief, theft, thieves, crime, burglary, unsafe
	Evans et al. (2019) Jacobs (2016)	Traffic Presence of people (eye street)	accident, crash, traffic crowd-crowded-crowdedness-crowdy-crowds-crowded-

aspects of urban life can be investigated through information extracted from location-based social media (Martí et al., 2019a,b), where the social networks produce and disseminate data to other users about what happens, when and where it happens (Wu et al., 2016). Location-based Social Networking (LBSN) user-generated data represent the people-based perspective as citizens use these platforms to record their activities, opinions, perceptions, presence and interests in urban spaces, as well as their geographical location (Martí et al., 2019a,b; Song et al., 2020). People voluntarily post geo-tagged social media through networks such as Twitter, Instagram and Facebook containing of semantic and contextual information and the explanation of a specific place, activities and feelings of users in the different formats including visual, audio and written (Banihashemi and Sohi, 2022; Kitchin, 2014; Liu et al., 2020).

• Urban public space and social media data

With respect to the presented features and characteristics, social media data has been widely applied for the analysis of urban public spaces. This section analyses the studies which have utilized various social media in order to assess urban public spaces in different aspects (Table 3).

Schwartz and Hochman (2014) utilized geo-tagged social media data from locative media platforms including Instagram and Yelp from three public parks in New York City. In this analysis, spatial patterns (discovering high density locations) and temporal patterns of use (weeks and days) of these spaces were identified. Moreover, different types of activities performed in spaces were discovered by different textual analysis techniques. Hu et al. (2015) used geo-tagged flicker photos from six different cities in six countries for probing urban area of interests (AOI); the areas within an urban environment which fascinate people and receive a large number of visits. They applied DBSCAN clustering algorithms for categorizing the geo-tagged photos. They also used chi-shaped algorithm for constructing AOI from point clusters. Following that, semantic layers (textual tags and photos) were applied to discover and interpret AOI.

Agryzkov et al. (2016) analyzed successful public spaces in the downtown of the city of Murcia (Spain) and found the most popular ones. They utilized data extracted from two social networks of Foursquare and Twitter in order to determine the most important plazas based on the preferences of foursquare users and high frequency of tweets. It was identified that there is a correlation between a high frequency of tweets and spaces with high activities. Martí et al. (2017) used foursquare data as one of the most

Table 3 Social media and urban public space literature.

Year	Case study	Social media source	Methodology–Technique	Finding	Reference
2014	Three public Parks in new york city, manhattan: madison square park, bryant park and union Square park	Instagram and Yelp	<ul style="list-style-type: none"> - Spatial and temporal analysis - textual analysis technique (word cloud) 	<ul style="list-style-type: none"> - Finding spatial (discovering high density location) and temporal pattern (week and day) of using public space - Discovering types of activity in space (watching, sitting, eating) 	Schwartz and Hochman (2014)
2015	6 cities. New york city, london, paris, shanghai, mumbai, and dubai	Geo tagged photo-flicker photo	<ul style="list-style-type: none"> - Bscan clustering algorithm - Chi shape algorithms Using semantic layer (textual tags)	<ul style="list-style-type: none"> - Uncovering interesting urban areas 	Hu et al. (2015)
2016	Murcia, spain	Social Networks foursquare and twitter	<ul style="list-style-type: none"> - A centrality algorithm - Counting frequency of tweets 	<ul style="list-style-type: none"> - Finding the most important public spaces - Finding relation between space with high frequency tweets with high activities 	Agryzkov et al. (2016)
2017	Province of Alicante (Spain)	Location-based social network Foursquare	<ul style="list-style-type: none"> - Counting the number of visitors for plazas - The methodology consisted of using and combining three sources of Information: social media networks; specific cartographies and specialized Bibliographic references Regression models	<ul style="list-style-type: none"> - Identify the most socially relevant plazas in the province of Alicante and Evaluate their position within the city's urban structure, namely, the historic City centre area and the main urban axes 	Martí et al. (2017)
2018	New York City, 2143 diverse Parks	Geolocated Flickr and Twitter postings	<ul style="list-style-type: none"> - Social media analytics - Content analysis - Network analysis - Spatial sentiment analysis - Pre-processed through text-mining techniques - Word frequency analysis, hashtag analysis and topic modeling - Mention network and co-hashtag analysis - Anselin Local Moran's I statistic 	<ul style="list-style-type: none"> - Identifying most visited parks - Identifying the relation between visitation and different factors 	Hamstead et al. (2018)
2018	The High Line in New York City	Social media-Twitter	<ul style="list-style-type: none"> - Social media analytics - Content analysis - Network analysis - Spatial sentiment analysis - Pre-processed through text-mining techniques - Word frequency analysis, hashtag analysis and topic modeling - Mention network and co-hashtag analysis - Anselin Local Moran's I statistic 	<ul style="list-style-type: none"> - Understanding activities and features of public space - Understanding behaviors in public space - Provide more detailed and readable information about people's experiences and opinions - Understanding overall sentiment toward space 	Kim et al. (2018)

(continued on next page)

Table 3 (continued)

Year	Case study	Social media source	Methodology–Technique	Finding	Reference
2019	Two central districts of Ho Chi Minh City in Vietnam	-Instagram (geo-tagged posts) in 2016 and 2017	- upss' check-in times - kernel density estimation (KDE) - Pearson's correlation	- the detailed descriptions of citizens' activities - Identification of activity categories - Spatial and temporal distribution of activities in public space during the weekday and weekend - predict future trend patterns of citizens' activity	Nguyen et al. (2019)
2020	Bryant Park in New York City	Social media reviews (Tripadvisor.com)	- Topic modeling analysis - Latent Dirichlet Allocation - A natural language processing - Machine learning technique	- Revealing how users describe the designs and Operations of space - Perceiving site qualities and experiences	Song et al. (2020)
2020	Tropical Singapore-public park	Geo-located Photographs, Flickr platform	- Contents analysis of photo and classification - Google Cloud Vision API was used to interpret photograph content, Hierarchical clustering method	- Understand human –environment interactions - Assess behavioral patterns - Examining the variation in recreational behavior - Better understanding of public interest in visits to nature areas, as well as tourist and local hotspots	Song et al. (2020)
2021	Russia –32 monotowns in Russia	Social media platform vkontakte (later VK)	- Gehl theory metrics - Using convolutional neural networks (CNN) - Using scene recognition algorithm - Studying temporal distribution	- Answering to Gehls metrics about urban spaces	Cerrone et al. (2021)
2021	Spain, Alicante, ("Las Cigarreras" area)	Foursquare, Twitter, Google Places, Airbnb	- Spatial and temporal analysis - Finding urban activity pattern - Social media urban analyzer - reclassification of social media data category	- Identifying urban opportunity spaces for urban regeneration	Martí et al. (2019)
2022	50 most Popular urban parks in Beijing	Dianping website Users' comments	- word frequency analysis - social network and semantic network analysis - the importance–performance analysis method (ipa)	- identifying factors which related to positive and negative evaluation of parks - recognizing the opinion of different gender from	Cheng et al. (2022)

2022	99 urban parks within the fifth ring road of Beijing	Sina Weibo	<ul style="list-style-type: none"> - Sentiment analysis - Correlation analysis and random forest 	<ul style="list-style-type: none"> - different region on various aspects of park - identifying spatial and temporal pattern of park usage - Discovering reason of positive and negative emotion toward urban parks - Investigating the relationship between the positive emotions of visitors and the types and landscape features of parks 	Kong et al. (2022)
2022	–	Social media data	<ul style="list-style-type: none"> - Literature review (PRISMA method) 	<p>Understanding:</p> <ul style="list-style-type: none"> - Activities of urban green space visitors - Park attributes - Spatial and socio-cultural aspects influencing urban green space visitation 	Zabelskyte et al. (2022)
2023	Four cities in the central Spanish Mediterranean Arc	Google Places, Foursquare, Twitter and Instagram	[1] delimitation of Historic centre areas; [2] identification of socially preferred open public Spaces; [3] selection of the open public space considered as case study For each city; [4] delimitation of the influence area surrounding each Public space selected; [5] general characterisation; and [6] thematic Characterisation.	The success of public plazas is strongly associated to: (1) the functional complexity of buildings located at the intersections of streets leading into the plazas; (2) having other landmarks or venues of interest and/or clustered activities within 3–5-min walking distance from the plazas; (3) good connectivity to other neighborhoods (2–3-min walking distance) with provision of good pedestrian infrastructure; and, (4) the importance of hosting local festivities and celebrations which generate a sense of community and belonging	Bernabeu-Bautista et al. (2023)
2023	Bryant park- new york	Instagram hashtag data	Data automation, descriptive statistics, and SNA.	The identification and quantification of meaningful park activities, scenes, sentiments and perceptions of users	Zhang et al. (2023)

(continued on next page)

Table 3 (continued)

Year	Case study	Social media source	Methodology–Technique	Finding	Reference
2023	100 Urban green space in Xi-Amen, China	Sina Weibo, a social media	<ul style="list-style-type: none"> - Semantic classification model. - Linear regression modeling - Natural language processing (NLP) classification methods 	<ul style="list-style-type: none"> - Understanding of the differences in daytime and nighttime activities, -the discovery of planning tools to promote human leisure activities in ugss - Inferring the total number of daily activities - Inferring the intensities of optional and social activities, and the daily touring experience 	Fan et al. (2023)
2023	Zhongshan city	Weibo's review data, a social media	Semantic word frequency analysis, image semantic segmentation	<ul style="list-style-type: none"> - Perceive and analyse image city - Obtaining clear image structure 	Su et al. (2023)

popular location-based social networks for identification of preferred public spaces (plazas) in the province of Alicante in Spain. Some features including category and sub-category, venue name, geographical location—latitude and longitude, total check-ins, total visitors, user-shared pictures, tips and pictures were extracted from Foursquare data. Outdoor and recreation and subcategory of plaza were chosen for finding the preferred public space. Following that, the plaza with highest number of visitors from Foursquare data was considered as the most relevant and the best ranked public space.

Hamstead et al. (2018) applied Geo-located flicker and Twitter data to analyze the variations in parks usages. They surveyed the correlation between the rate of visitation in social media platforms as a dependent variable and park facilities and characteristics, park accessibility and neighborhood characteristics as independent variables through regression models. It was concluded that several aspects of park characteristics, neighborhood socio-demographics and accessibility are important determinants of park uses based on the visitation data from two social media platforms. Kim et al. (2018) employed user generated contents, Tweeter over 14 months for evaluating the urban public space; The High Line in New York City. Public opinion data about this space were collected. Following that, analytical techniques including content, network and spatial sentiment analysis were used to assessing the public space. It was understood that the activities and features about the High Line that people prefer, or want to communicate with others in their social networks. Through the analysis, general evaluation from the current situation of High Line as a new urban public space was obtained with social media data instead of using traditional methods such as interview and/or survey.

Nguyen et al. (2019) applied a check-in database from Instagram in 2016 and 2017, for analyzing the spatial-temporal distribution of urban activities during the weekdays and weekends based on Mathew Carmona's classification of urban public space in two central districts of Ho Chi Minh City in Vietnam. They utilized two design indicators of urban public space check-in times and the surrounding environments to evaluate how the surrounding built environment has an effect on urban public space visitation. Song et al. (2020) perceived qualities and experiences of people from urban space, through using social media data in Bryant Park, New York City. Trip advisor review data were used as a proxy to examine how visitors use and value Bryant Park as a public space. Content analysis, Latent Dirichlet Allocation which is a type of topic modeling was used for classifying the documents to various topics. Five specific topics including amenities, holiday favorite, summer hotspot, place to relax, and general experience were recognized in the data and the weights of topics were analyzed during the different weekdays and various months. Overall, the distribution of different types of activities which happen in different weekdays and months were recognized.

Song et al. (2020) used geo-located photographs on Flickr to evaluate behavioral patterns across various groups of park users in tropical Singapore. They applied location and contents of photographs to assess differences in recreation behaviors between multiple groups of park users. Photograph data assisted to understand behaviors

and preferences of users for outdoor recreation. Geo-located social media data were applied to assess patterns of recreation both within and across different places. These include the popularity, use and aesthetic value of parks. Overall, the content of photographs captured within parks also provide an indication of park usage and enjoyment. [Cerrone et al. \(2021\)](#) utilized a Russian social media data platform known as a VKontakte. They analyzed publicly shared images from 32 Russian monotowns and implemented the Gehls methodology into the quantifiable set of measures using images taken by dwellers. They utilized the timestamp of VK posts to characterize indoor and outdoor spaces based on how long they are used through the day, days of the weeks, and seasons of the year, studying the temporal distribution of social media photos throughout. Multiple design interventions were then proposed.

[Martí et al. \(2019\)](#) used data from overlapping four LBSN; Foursquare (to analyze venue quantity and types of demand), Twitter (to analyze the spatio-temporal patterns of human activity), Google Places (to find out the quantity and types of economic activities) and Airbnb (to shed light on potential areas of alternative tourist accommodation in the city). They considered citizens as volunteer sensors to analyze the city. They ultimately proposed three scenarios for urban regeneration depending on the density and spatial distribution of LBSN data.

[Cheng et al. \(2022\)](#) analyzed social media texts and compared the evaluation outcomes of the 50 most popular urban parks in Beijing from different viewpoints, such as the characteristics of various groups of people, park types, and the spatial and temporal distribution characteristics of recreational activities. They (1) compiled information achieved from users' comments on each park in each time period on social media; (2) used text analysis to obtain the results of differences in park evaluation texts by gender, geographic population, category, time, and district and their reasons; and (3) explored the primary factors influencing satisfaction with the recreation offered by the parks and sensory perceptual satisfaction using the importance–performance analysis (IPA) method.

[Kong et al. \(2022\)](#) quantified the positive emotions of visitors to urban parks and public spaces using social media data and sentiment analysis. They assessed the differences in visitors' positive emotions among different types of parks and used Random Forest Regression to identify urban park attributes that were associated with positive emotions. They understood that visitors to various types of urban parks had different levels of positive emotions. [Zabelskyte et al. \(2022\)](#) conducted a systematic literature review, analyzing 22 papers that utilized social media data to assess urban park visitors' needs and preferences. They focused on identifying key park attributes, popular activities, and the interplay of spatial, social, and ecological elements between visitors and parks. This study stands out for its comprehensive approach to understanding park usage through digital footprints.

[Bernabeu-Bautista et al. \(2023\)](#) utilized user-generated data from Google Places, Foursquare, Twitter, and Instagram to evaluate public spaces in the historical centers of four cities in Spain. Their approach aimed to derive insights on economic and urban activity, the spatiotemporal distribution of people, and the collective urban image of plazas and their surrounding areas. This study offers a novel

perspective on public space usage and perception through diverse digital lenses. [Zhang et al. \(2023\)](#) employed social media data in a post-occupancy evaluation of large public spaces. They used methods such as data automation, descriptive statistics, and SNA to identify and quantify park activities, scenes, and sentiments. This study contributes valuable insights into park usage and user perceptions, aiding in the optimization of park design and management.

[Fan et al. \(2023\)](#) analyzed social media text data from Sina Weibo to understand activities in 100 Urban Green Spaces (UGSs) in Xiamen, China. They inferred the number of daily activities, the intensities of optional and social activities, and the overall daily touring experience. Their study highlights differences in daytime and nighttime activities, offering a nuanced view of urban space utilization. [Su et al. \(2023\)](#) used Weibo review data to analyze city images, employing Kevin Lynch's cognitive method. They categorized urban images into landmark buildings, natural landscapes, public spaces, and cultural life. Techniques like Image Semantic Segmentation and word frequency analysis were used to perceive and analyze the city image. This study provides a unique method of understanding urban spaces through the lens of digital user reviews.

Previous sections have delineated the inherent limitations of conventional methodologies (such as on-site observations and interviews) in analyzing urban public spaces. These methods are often time-intensive and lack cost-effectiveness. Additionally, they may not effectively capture citizens' genuine needs, preferences, and opinions about these spaces. Consequently, traditional approaches may fail to identify not only the existing issues but also the potential opportunities within these spaces. In contrast, social media networks offer an avenue for individuals to freely and candidly express their views, emotions, experiences, and perceptions of these spaces. The data derived from social media provide novel conceptual and analytical avenues for designers, planners, and policymakers. This rich dataset aids in comprehending the SWOT as perceived by the actual users of the space. Therefore, it is increasingly evident that social media insights are invaluable and irreplaceable by other data sources ([Cerrone et al., 2021](#)).

A comprehensive review of the literature, as summarized in [Table 3](#), indicates that significant urban public spaces have been extensively analyzed using diverse social media sources. These studies have elucidated key characteristics, including the activities, spatial, and temporal patterns of user behavior. However, there remains a gap in the literature concerning the analysis of opportunities and weaknesses of urban public spaces, as well as in proposing necessary regenerative interventions to enhance their quality. Addressing this gap, the present research aims to analyze the quality of public space in Tehran's Bazaar, using social media data. This study will focus on three primary indicators: comfort, vitality and diversity, and safety. The goal is to develop strategic design interventions that regenerate the space in a manner that is both inclusive and sustainable.

3. Materials and methods

The Bazaar, Tehran's historic marketplace, was once the vibrant epicenter of the city during the Qajar dynasty.

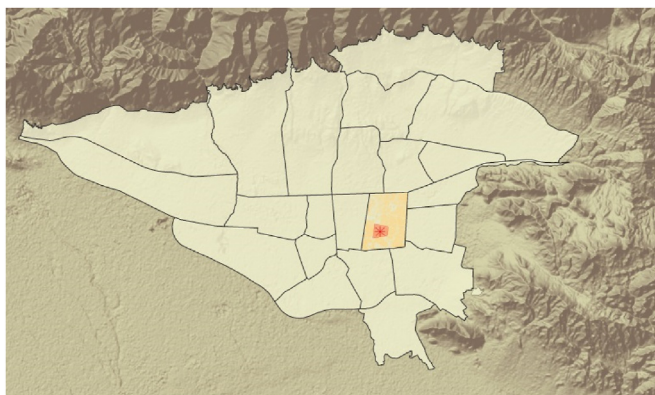


Fig. 1 Position of Bazaar in Tehran.

Despite undergoing various transformations in its structure and functions over recent decades, it continues to hold a prominent place as a key commercial hub in Tehran. Moreover, it is renowned as one of the city’s most iconic locations, playing a crucial role as a dynamic urban public space and a major attraction for tourists. Geographically, the Bazaar is situated in Tehran’s 12th district. It is bounded by Panzdah Khordad Street to the north, Molavi Street to the south, Mustafa Khomeini Street to the east, and Khayyam Street to the west, as depicted in Fig. 1. This strategic location contributes to its enduring significance in the urban landscape of Tehran.

The authors (1) conducted a literature review on the quality of urban spaces, (2) identified the related categories and keywords to assess the quality, (3) applied SNA to

quantify the importance of each keyword and associated category regarding the quality of urban space and (4) identified and applied several design intervention strategies applied to promote the walkability, comfort, safety and diversity of Tehran’s Bazaar. The research methodology stages are explained in detail in the following subsections. As seen in Fig. 2, the study follows a comprehensive methodological procedure, comprised of several integrated phases in order to achieve the objectives of this research.

3.1. Data acquisition

The literature review conducted for this study identified the utility of various social media platforms in researching urban public spaces. Key platforms such as Twitter,

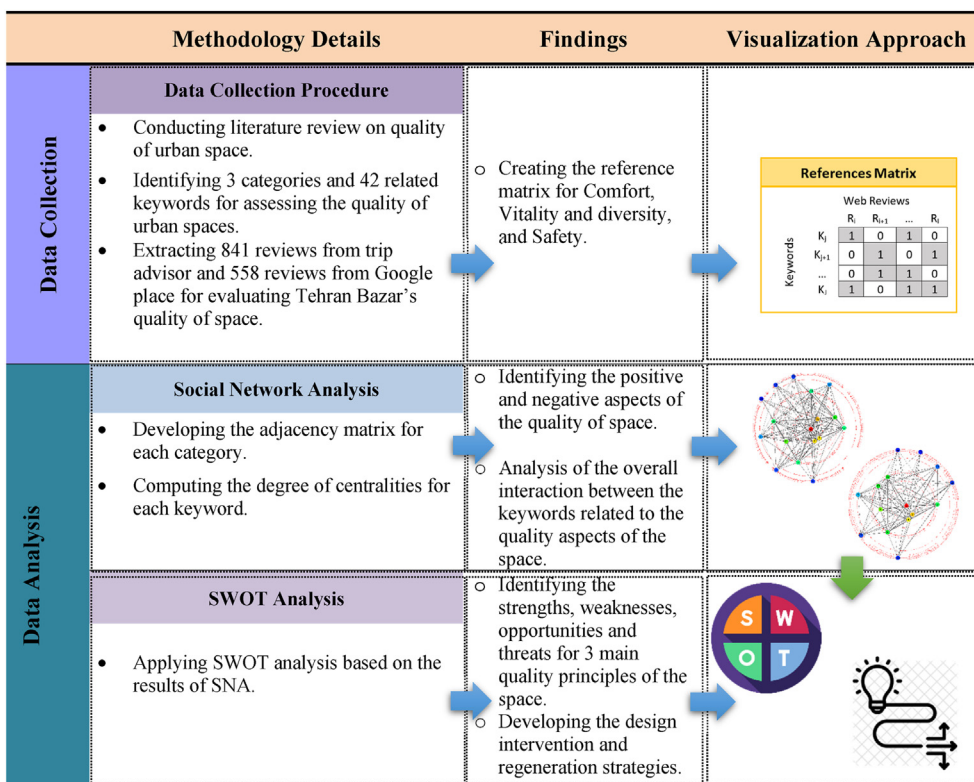


Fig. 2 Adopted research methodology.

Foursquare, Airbnb, Google Places, TripAdvisor, Sina Weibo, Dianping, Flickr, and Instagram were found to be instrumental in providing insights into user interactions and perceptions within these spaces. It is noteworthy that platforms like Sina Weibo and Dianping are primarily utilized in China, reflecting regional social media preferences. However, such platforms have not seen widespread adoption in Iran, indicating distinct regional disparities in social media usage. Furthermore, Airbnb, which offers valuable insights into traveller experiences, is not operational in Iran. In the Iranian context, while platforms like Instagram and Twitter are popular, there is a noticeable trend of users sharing limited detailed experiences or evaluations of urban public spaces. This trend indicates a potential gap in leveraging these platforms for urban space analysis within Iran.

For this research, two social media networks—TripAdvisor and Google Place—were selected for data mining to gauge public perception of urban public spaces in Iran. These networks were chosen due to their user-centered nature, where individuals actively share their activities, opinions, and perceptions about the qualities and features of various spaces. A Web scraping tool was employed to gather data from these networks. A Python script, utilizing the Selenium library, was developed to extract content and access elements within the HTML code of these sites. The data were compiled in CSV format. In total, 1399 user reviews were collected, comprising 841 reviews from TripAdvisor and 558 from Google Place.

3.2. Data preprocessing

Subsequent to web mining, the collected reviews were thoroughly examined. In this phase, reviews that did not contain the target keywords were excluded from each dataset. Consequently, 891 reviews related to vitality-diversity, 299 to safety, and 925 to comfort were retained for further analysis.

3.3. Quantitative analysis

The collected web-based user reviews facilitated the identification of key terms pertinent to assessing the quality of urban spaces. A reference matrix was constructed, with identified keywords represented in rows and extracted reviews in columns. In this matrix, a keyword's presence in a review is denoted by a value of 1, and its absence by 0. Figure 3 graphically depicts this reference matrix concept. In the matrix, K_j represents an identified keyword, and R_i denotes an extracted review associated with urban space quality. This reference matrix was then utilized for quantitative analysis through SNA. Further details on SNA and its application in this study are provided in subsequent subsections.

3.4. SNA

In this study, SNA is employed to examine keywords pertaining to the quality of urban spaces. A pivotal aspect of this analysis involves developing a metric to quantify the significance of keywords, based on their co-occurrence in

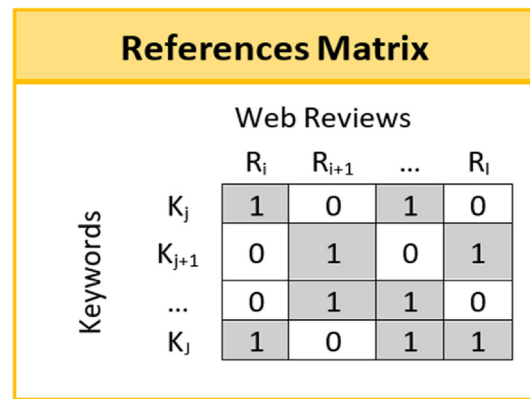


Fig. 3 Concept of the reference matrix.

user reviews. For this purpose, the Degree of Centrality (DC) metric is utilized, which is indicative of the frequency with which a keyword appears alongside other keywords within the same review. The DC for nodes within the SNA is calculated by constructing a weighted adjacency matrix for the network being analyzed. To construct the weighted adjacency matrix, networks corresponding to the three thematic categories—comfort, vitality-diversity, and safety—were established based on keyword analysis. This matrix was generated by multiplying the reference matrix with its transpose, followed by modifying the resultant matrix. Specifically, the diagonal cells, which originally represent the frequency of each keyword with itself, were replaced with zeros. It should be highlighted that the transposed matrix is multiplied by the original matrix to conduct a mathematical operation that aggregates and combines the information about connections between keywords (Sheikhkhoshkar et al., 2023). This process reveals connectivity patterns and the strength of relationships between keywords. Each value in the resulting matrix represents the cumulative strength of connections between pairs of keywords. This can be interpreted as the overall influence or importance of one keyword on another within the network (Sheikhkhoshkar et al., 2024).

The weighted adjacency matrix, thus formed, serves as a network representation where (1) the matrix's columns and rows correspond to the "n" nodes, representing the keywords associated with each thematic category, and (2) the entries within the matrix indicate the edge weights, denoting the strength of connections between the keywords. The computation of this matrix is governed by Eq. (1). Figure 4 presents a visual representation of constructing a weighted adjacency matrix, which includes depictions of the references and an adjacency matrix. As shown in the reference matrix, it becomes apparent that specific keywords, such as K2 and K4, are addressed within web review 4 (R4), thus establishing a connection between them when represented in a diagram of this web review, Fig. 4(b). The adjacency matrix, employed to illustrate a unified network for the reference matrix rather than individual networks for each keyword, reveals the interrelations among the keywords. Specifically, it indicates that K1 is referenced with K3 twice and K2 concurrently with K3 once. The calculated values within the adjacency matrix, commonly referred to as link strengths, indicate how directly the keywords are

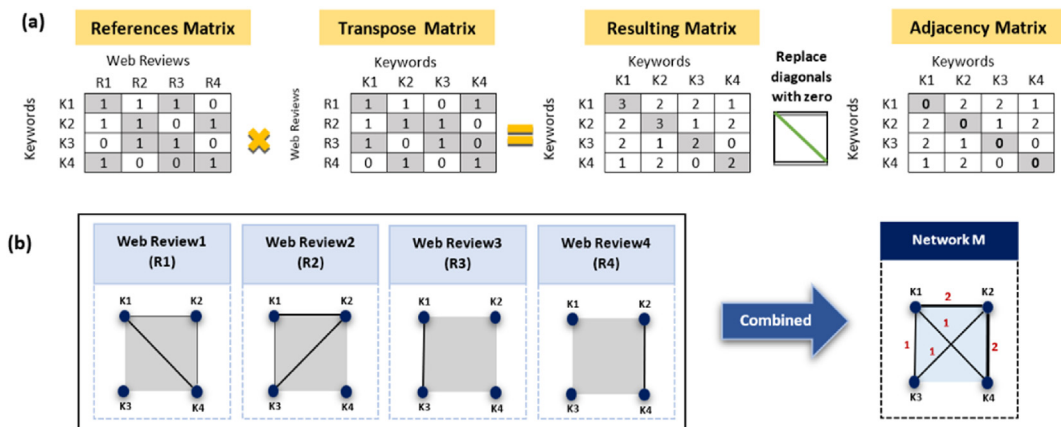


Fig. 4 The process of creating an adjacency matrix.

connected. As depicted, K_j symbolizes the keywords, while R_i signifies the reviews.

$$A_{k \times k} = \begin{cases} M_{k \times r} \times M_{k \times r}^T & \text{for } i \neq j \\ 0 & \text{for } i = j \end{cases} \quad (1)$$

where $A_{k \times k}$ = weighted adjacency matrix; $M_{k \times r}$ = reference matrix; $M_{k \times r}^T$ = transpose of the reference matrix; k = number of identified keywords, and r = number of reviewed.

After constructing the weighted adjacency matrix, the DC for each keyword was computed based on Eq. (2).

$$DC_k = \sum_{i,j \neq i} V_{i,j} \quad (2)$$

DC_k refers to the degree of centrality of keyword k , and $V_{i,j}$ represents the value of the cell in row j and column i of the studied adjacency matrix. Furthermore, since the accuracy of the DC is dependent on the size of the relevant network, it was decided to be normalized. The normalized DC for a keyword k in a network can be calculated by dividing the DC of the evaluated keyword by the highest DC in the network under study.

$$\text{Normalized } DC_k = \frac{DC_k}{\max \{DC_k\}} \quad (3)$$

Thus, the normalized DC_k range from 0 to 1 for all keywords.

Following calculating the weighted adjacency matrices, the outcomes were visually represented through network graphs and color-coded matrices. In these representations, the nodes of the networks correspond to individual keywords, while the edges denote the connections or co-occurrences between each pair of keywords. The positioning of nodes within the network graph is determined by their normalized DC, with nodes closer to the centre, indicating higher normalized DC values compared to those positioned further away. The color differentiation of nodes within the network graph is directly proportional to their calculated normalized DC values, indicating each keyword's relative significance. Specifically, nodes colored in red, orange, and yellow represent keywords with higher DC values, signifying greater prominence within the network.

Furthermore, color-coded matrices were employed to represent the connectivity levels between keywords. Each matrix comprises rows and columns corresponding to the keywords under examination, with the cells color-coded based on the intensity of the connection between any given pair of keywords. White cells denote the absence of co-occurrence between keywords in the analyzed web reviews. Conversely, darker-colored cells signify stronger connections and a higher frequency of co-occurrence between the respective keywords.

3.5. SWOT analysis

SWOT analysis emanates from the businesses management field, and it has been used in various disciplines because of its simple operation and easy to understand process (Hill and Westbrook 1997). The SWOT analysis is a ubiquitous and strategic planning analytic tool used to evaluate strengths (S), weaknesses (W), opportunities (O), and threats (T) of an urban context, in order to figure out the points on which to base the regeneration strategy. This informs in decision making and enables the analysis of internal and external factors of a special environment. The structure of the SWOT analysis is a 4-quadrants matrix that allows decision makers to divide a given problem according to existing factors in the current situation (i.e., strengths and weaknesses) and possible future factors that could occur (i.e., opportunities and threats) (Pazzini et al., 2022; Yi et al., 2017).

As to the literature applications of this tool, Jayaprakash and Swamy (2021) applied spatial SWOT Analysis as a technique for a comprehensive understanding of the study area (Hassan City, India) for enhancing the quality of the urban environment and urban regeneration intervention. They found out that SWOT as an evaluation tool is increasingly efficient in the evaluation process of urban regeneration projects. They used Spatial SWOT mapping which offers the opportunity to make the process contextual and specific to the area in consideration and identified the design strategies for urban regeneration intervention. Mirzakhani et al. (2023) assessed the existing situation of historical city centers of Iran in order to offer prioritized appropriate regeneration strategies for their sustainable

development. Applying SWOT technique, a set of appropriate strategies for the sustainable regeneration of these valuable fabrics were proposed. In fact, the SWOT technique was used to identify the most leading features and deficiencies in historical urban fabrics of Iran and as a background to formulate proper sustainable regeneration strategies.

This study applies SWOT analysis to develop the design intervention and regeneration strategies of the case study using the SNA analysis outcomes.

4. Results and findings

4.1. Comfort

Main factors which considered for evaluating the comfort of urban space (Table 2) can be analyzed based on SNA graphs.

Physical condition and physiological level of comfort

- Physical Features Impacting Comfort. Literature suggests that the physical condition significantly influences the comfort level in urban public spaces (Van Hecke et al., 2018). For instance, the scale and magnitude of a space (Keyword 16) play a crucial role, as evidenced in Fig. 5, where this feature prominently figures in reviews, implying its importance in enhancing physical comfort.
- Correlation with Crowding and Satisfaction. However, Fig. 6 reveals a strong correlation between space size (Keyword 16) and crowding (Keyword 4), with a weaker relationship with satisfaction and enjoyment (Keywords 17, 6). This indicates that while larger spaces attract more visitors, they also lead to overcrowding, thus negatively impacting the psychological comfort.

Accessibility

- Perception of Accessibility. Accessibility is identified as a subjective element of comfort (AL-Fadala 2020). The SNA analysis (Fig. 5) shows that public transportation modes like subways, taxis, and buses are primary means of access to the Bazaar.
- Preference for Underground Transport. Importantly, access via the underground (Keyword 14) is preferred over other transport modes (Keywords 15), as shown in Fig. 6. This preference, however, contributes to crowding issues, affecting user satisfaction. Hence, improving the quality and capacity of subway systems is imperative for enhancing space accessibility.

Possibility of doing various activities

- Dominance of Shopping Activities. According to Gehl (2010), diverse activity options are crucial for comfort in urban spaces. Our SNA (Fig. 5) indicates that shopping (Keyword 2) is a primary activity in the Bazaar. Although this attracts visitors (Keywords 3, 6), it leads to space overcrowding (Keyword 4), as per the keyword correlation matrix (Fig. 6).
- Limited Activity Diversity. This overcrowding restricts the feasibility of other activities, corroborated by a lesser inclination towards walking and leisure activities. Eating out (Keywords 8, 10) is another significant activity, but like shopping, contributes to crowding. The SNA suggests a need for design strategies to diversify activities and improve comfort.

Walking convenience

- Walking as an Essential Activity. Gehl (2010) categorizes activities into essential, optional, and social. In

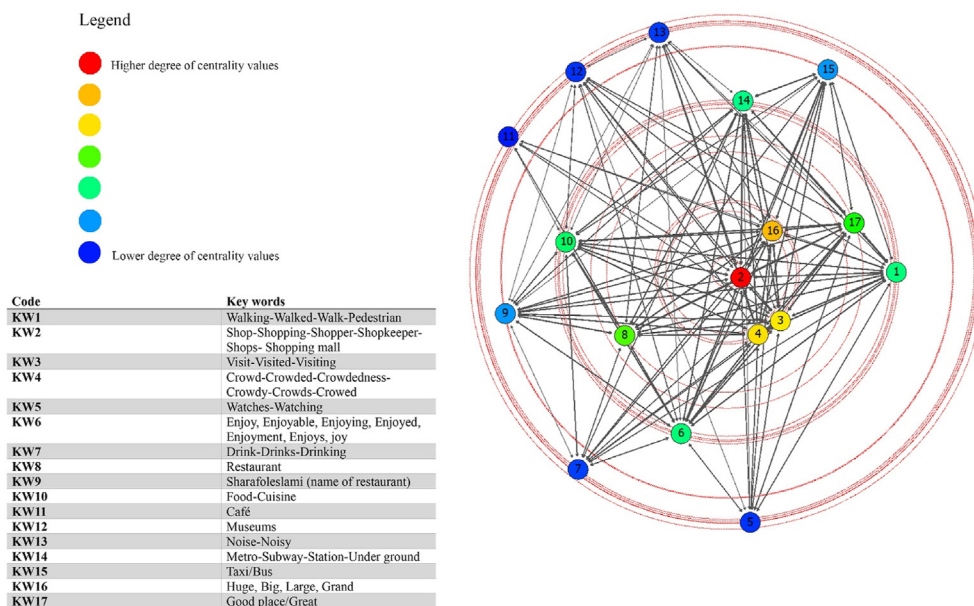


Fig. 5 Keywords network for comfort.

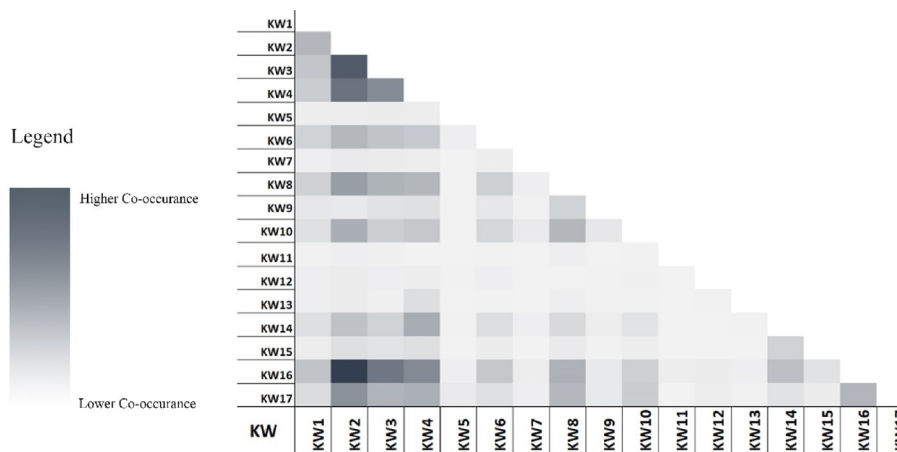


Fig. 6 Color-coded matrix of keywords for comfort.

this context, walking, primarily linked to shopping (Fig. 6), is more of an essential than an optional activity. This highlights the need to enhance walkability, making it an appealing and optional activity for visitors.

Thus, the SNA graphs provide vital insights into the factors influencing the comfort of urban public spaces. While certain physical attributes like space size enhance comfort, they also lead to crowding, affecting psychological well-being. Accessibility, particularly through underground transportation, is a key factor, as is the diversity of activities, which currently skews heavily towards shopping. Addressing these issues requires thoughtful urban design strategies to balance physical features with the need for diverse, enjoyable activities, and improved accessibility.

4.2. Vitality

Variety of activities as a vitality indicator

- Jan Gehl and Jane Jacobs' Perspective. Both Gehl and Jacobs highlight the importance of diverse activities in creating urban vitality. Jacobs particularly emphasizes functional mixing as a key factor (Jacobs 1962).
- SNA Findings. Figure 7 shows a concentration of activities such as visiting historical centers (Keyword 11), dining (Keywords 8, 10), and shopping (Keyword 2), which contribute to space vitality. However, to truly enhance vitality, a more balanced mix of activities (e.g., walking (Keyword 1), watching (Keyword 5), café culture (Keyword 12)) should be encouraged, ensuring inclusivity for all user groups.

Presence of people in public spaces

- Number of Users as a Vitality Measure. Consistent with literature (AL-Fadala 2020), the presence of people is a primary indicator of vitality. Figure 7 demonstrates that

shopping (Keyword 2) attracts a significant number of visitors, thereby increasing space vitality.

- Balancing Crowding and Vitality. While a crowded space indicates high vitality, it's important to balance this with the comfort and experience of users. Diverse activities can help distribute crowds more evenly, enhancing overall experience.

Walkability and urban vitality

- Importance of Walkability. Jacobs underscores the significance of pedestrian-friendly environments for maintaining urban vitality (Jayaprakash and Swamy 2021; Lu et al., 2019).
- SNA Insights on Walkability. Figure 7 suggests that walking (Keyword 1) is primarily linked to shopping (Keyword 2). To boost vitality, walking should be promoted not just as a means to an end but as an enjoyable activity in itself. The color-coded matrix in Fig. 8 indicates that enhancing walkability can diversify activities and improve the overall vitality of the space.

Hence, the SNA graphs provide valuable insights into the factors influencing urban vitality and diversity. While activities like shopping currently dominate, there is a clear need for a more varied mix of activities to cater to different demographics and interests. Ensuring inclusivity and enhancing walkability are key strategies for improving the vitality of urban public spaces. This balanced approach to urban design will not only attract more people but also enrich their experience in these spaces.

4.3. Safety

Interplay of safety and criminality

- Safety and Crime Context. Urban public space safety is intrinsically linked to its criminality context. Modern societies face challenges in managing public space

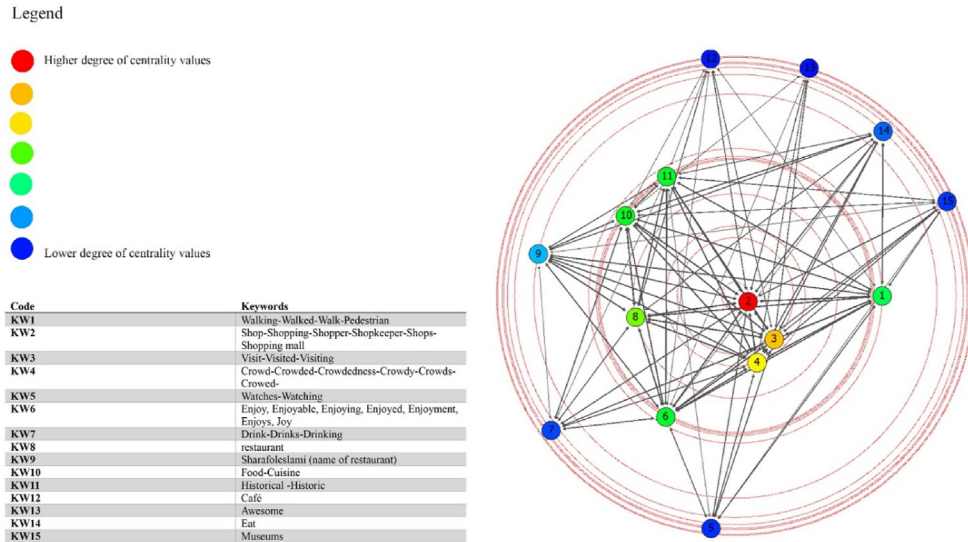


Fig. 7 Keywords network for vitality.

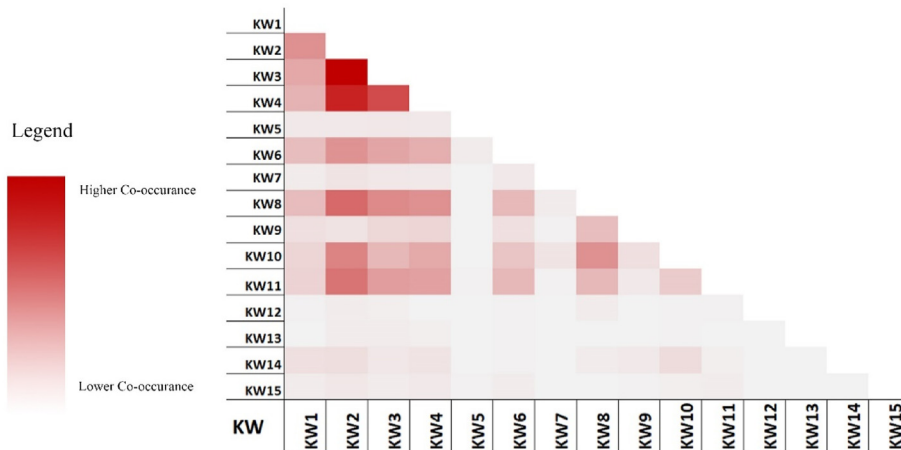


Fig. 8 Color-coded matrix of keywords for vitality.

safety, with municipalities and police departments employing strategies like Crime Prevention Through Environmental Design (CPTED) (Mirzakhani et al., 2023).

- SNA Findings on Crime and Space Congestion. Figure 9 reveals a negligible correlation between crime rates, including thefts (Keyword 3), and space congestion. While thefts are mentioned in reviews, they do not emerge as a significant concern in this space, possibly due to effective CPTED strategies.

Traffic and urban space safety

- Impact of Traffic on Safety. The rate of accidents and traffic congestion can significantly affect urban public space safety. Figure 9 shows a moderate relationship between traffic (Keyword 4) and crowdedness, suggesting that traffic contributes to safety concerns.
- Design Interventions for Traffic Management: To enhance safety, it is imperative to implement design interventions aimed at easing traffic flow and reducing crowding.

Natural surveillance and the “eyes on the street”

- Importance of Natural Surveillance. Jane Jacobs’ concept of “eyes on the street” emphasizes the role of natural surveillance in enhancing safety (Zumelzu and Barrientos-Trinanes 2019). The continuous flow of people and the presence of attraction objects in public spaces strengthen social ties and increase vigilance.
- SNA Insights on Crowding and Safety. Figure 9 indicates that the space’s overcrowding (Keyword 1) potentially contributes to increased natural surveillance. Despite the high level of crowding, the space is deemed relatively safe, possibly due to the enhanced observation afforded by the large number of people present.

The applied SNA graph provides valuable insights into the complex interplay between safety, crime, traffic, and natural surveillance in urban public spaces. While the presence of crime is not significantly correlated with space congestion, traffic issues pose a safety challenge that requires targeted design solutions. The principle of natural

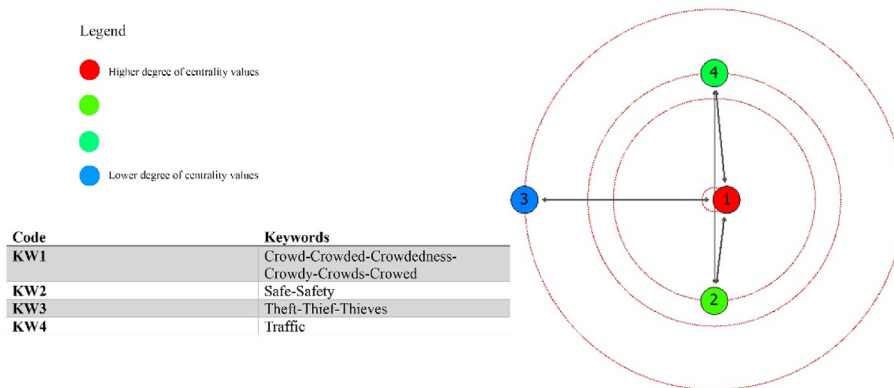


Fig. 9 Keywords network for safety.

surveillance, facilitated by high footfall, plays a crucial role in maintaining safety. These findings suggest that urban design strategies should focus on balancing crowd management with traffic control and leveraging the natural surveillance afforded by vibrant public spaces to enhance overall safety.

4.4. SWOT analysis

Following the detailed SNA, a SWOT analysis was conducted focusing on the three primary quality principles of comfort, vitality, and safety. This analysis was integral in developing a framework for regeneration and design interventions for Bazaar, the chosen case study of urban public space (refer to Fig. 10 for details). A synthesis of the SNA findings reveals several key insights.

1) **Congestion.** Identified through the keyword “crowd”, congestion emerged as a significant factor impacting the quality of comfort, safety, and vitality within the space. This aspect presents a dual nature, acting both as an

opportunity and a threat. The opportunity lies in leveraging the crowd to enhance vibrancy and activity, while the threat is in potential overcrowding leading to discomfort and safety concerns.

2) **Spatial Dimensions.** The keywords “large”, “huge”, and “big” were associated with the spatial dimensions of Bazaar. These terms are indicative of the area’s extensive space, which positively influences the quality of comfort and vitality. Hence, the spacious nature of Bazaar is regarded as both a strength and an opportunity, offering potential for diverse uses and activities.

3) **Shopping Activity.** The prominence of shopping as a key activity in Bazaar was highlighted. This aspect is seen as a strength, contributing significantly to the site’s vitality. However, it also poses a threat if the shopping activities lead to excessive commercialization or overcrowding, potentially detracting from other aspects of urban space quality.

These insights from the SWOT analysis underscore the complex interplay of various factors influencing the quality

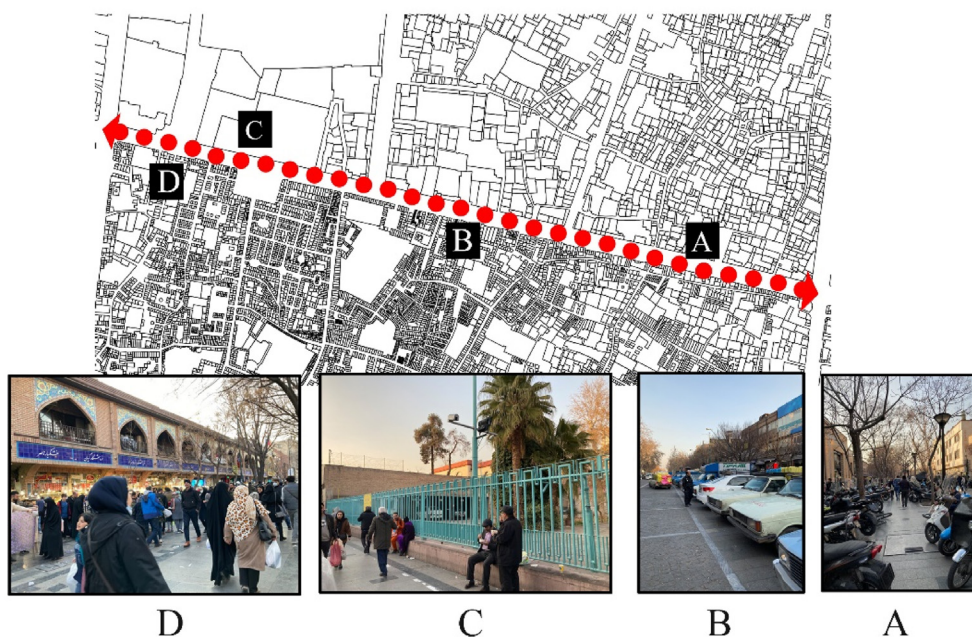


Fig. 10 The design interventions zone.

of urban public spaces. They provide a nuanced understanding of Bazaar's current state and serve as a foundation for informed design and regeneration strategies.

4.5. Design intervention and regeneration

Drawing on the insights gained from the SWOT and SNA, it has been deduced that the expansive area of the space offers a significant opportunity to enhance its overall quality. This "magnitude of space" can be strategically utilized to improve the user experience and functionality of the area. Conversely, the issue of congestion, encompassing both pedestrian and vehicular traffic, emerges as a primary weakness and threat. Addressing this challenge is crucial for augmenting the quality of the urban space across all three dimensions: safety, comfort, and vitality-diversity. The integration of on-site observations with the findings from the SWOT analysis has led to the formulation of targeted design principles and intervention strategies. These strategies are tailored to address the unique characteristics and needs of the designated design intervention zone (as detailed in Fig. 10). The proposed interventions aim to capitalize on the inherent strengths and opportunities of the space while mitigating its weaknesses and threats. Table 5 presents a comprehensive outline of these design principles and intervention strategies, providing a roadmap for enhancing the urban space qualities in a holistic and sustainable manner.

The SWOT analysis dedicated to comfort, as outlined in Table 4, reveals that while crowded spaces may impede comfortable walking as an optional activity (C-W4), the expansive nature of the area offers an opportunity to facilitate convenient walking (C-O4). Environmental attributes that promote and support walking activities significantly contribute to an individual's comfort level (Liang et al., 2022). Factors such as aesthetic appeal, presence of greenery (refer to Table 5(b)), human-scale architecture, well-designed spaces, quality materials, ample walking space, and well-maintained surfaces are crucial for pedestrian comfort (Zakaria and Ujang, 2015). Furthermore, the criteria bolstering walkability, and thereby comfort, include sufficient walkways, continuous sidewalks free from impediments, comfortable walking surfaces, seating, weather protection, maintenance of desired walking speeds, engaging pedestrian activities, and minimized noise and air pollution (see Table 5(f)) (Sarkar, 2003). Walkability not only enhances comfort but also plays a vital role in boosting urban vitality and safety (Table 5(c)), as it can reduce crime and increase the safety of the space (Jalaladdini and Oktay, 2012).

In contrast, the SWOT analysis for vitality, detailed in Table 4, highlights the space's magnitude as an opportunity to improve walkability, thereby augmenting vitality (V-O3). The congestion issues, depicted in Figs. 11 and 12 and involving both pedestrian and vehicular traffic, pose significant challenges to walkability. Consequently, the redesign of the space to restrict motor vehicles and alleviate car congestion is proposed. This intervention aims to enhance both the vitality and comfort quality of the space. In essence, the SWOT analyses for both comfort and vitality underscore the interlinked nature of these aspects, with walkability being a pivotal factor in their improvement.

As deduced from the SWOT analysis focusing on comfort (referenced in Table 4), a critical concern is that congestion within the space, caused by both vehicles and pedestrians, can escalate air and noise pollution. This environmental degradation potentially leads to a decrease in the number of visitors (C-T1). To mitigate these negative impacts, a strategic enhancement of vegetation and greenery in the area is recommended (as illustrated in Figs. 11 and 12). The introduction of green spaces can have a profoundly positive effect on the psychological well-being of visitors, fostering a sense of comfort and tranquility.

Moreover, the addition of greenery is not only beneficial for aesthetic and psychological reasons but also serves as a practical measure against environmental pollutants. Vegetation acts as a natural barrier, contributing to the reduction of noise and air pollution (as detailed in Table 5 (b)). Thus, the strategic implementation of green spaces is proposed as a dual-purpose solution: enhancing the overall aesthetic and psychological comfort of the space while simultaneously addressing environmental concerns (Vukmirovic et al., 2019).

The issue of overcrowding is identified as a principal weakness in the studied space, adversely affecting the level of comfort (C-W1). Urban morphology, specifically the spatial arrangement of buildings, plays a pivotal role in either hindering or facilitating the utilization of open spaces (refer to Table 5(g)) (Vukmirovic et al., 2019). Design interventions aimed at alleviating population density are crucial in this context. Figure 13 showcases a proposed redesign, where the transformation of semi-private spaces into more open designs is highlighted. Such restructuring is expected to not only elevate the comfort level and reduce congestion but also to enhance the vitality of the space.

The SWOT analysis for comfort and vitality further reveals that the expansive nature of the space presents opportunities for a variety of activities (C-O3, V-O1). Research underscores the importance of diverse urban activities in fostering vibrant urban spaces (see Table 5(a)) (Ou et al., 2021; Vukmirovic et al., 2019). In line with this, it is proposed to incorporate additional facilities and urban furniture to support a range of activities. This intervention, as depicted in Figs. 11 and 12, aims to accommodate various age groups, thereby enriching the experience of comfort, vitality, and safety within the space. The analysis confirms that the Bazaar has ample space available for such design interventions. Hence, this principle is reinforced by providing necessary urban amenities and sufficient space for diverse activities, including seating, dining, observing, and recreational activities, as visualized in Fig. 13.

These strategies, derived from the SWOT analysis and supported by literature, emphasize a multi-faceted approach to urban design. By addressing overcrowding and enhancing the capacity for diverse activities, the interventions aim to create a more comfortable, vibrant, and safe urban environment.

The SWOT analysis concerning safety (refer to Table 4) highlights that the space's congested nature potentially diminishes the sense of safety (S-T3). According to Jacobs (1962), to reduce crime rates and enhance the perception of safety, while also improving vitality, three key urban design features should be emphasized:

Table 4 SWOT analysis for safety, comfort and vitality.

Urban space quality	Factors	Strength	Weakness	Opportunity	Threat
Comfort	Physical condition and physiological level of comfort	Magnitude of space leads to physical comfort for the users (C–S1)	Magnitude of space leads to overcrowding the space (C–W1)	Magnitude of space can increase Psychological comfort for their users (C–O1)	Magnitude of space leads to crowded space which can reduce the number of visitors (C–T1)
	Accessibility	Accessibility of space through public transportation (C–S2)	Crowded subway leads to difficult access (C–W2)	The possibility of providing more and easier access to the space through the reinforcement of public transportation (C–O2)	The lack of convenient access to public transportation leads to a decline of number of visitors (C–T2)
	Possibility of doing various activity	Concentration of commercial activities (C–S3)	Lack of equal conditions to perform different activities (C–W3)	Magnitude of space provides opportunities to do various activities (walking, sitting, eating) conveniently(C–O3)	Concentration of shopping activities can lead to crowding the space and dissatisfaction of the users, decrease number of visitors (C–T3)
	Walking convenience	Possibility of do walking for shopping (C–S4)	Crowded space reduces the possibility of doing comfortable walking(C–W4)	Magnitude of space provide opportunity to do convenient walking (C–O4)	Crowded space decreases possibility of convenient walking as an optional activity (C–T4)
Vitality	Possibility of doing various activities and mix land use	Concentration of shopping activity leads to enhancing vitality (V–S1)	Concentration of commercial activity leads to decreasing the presence of different age group (V–W1)	The possibility of providing the opportunity to perform various activities (V–O1)	Commercial focus overtakes other activity in the space and reduces the variety of opportunities (V–T1)
	Presence of large number of people	Presence of a large number of people leads to more vital space (V–S2)	Presence of large number of people just for shopping activity (V–W1)	Possibility of creating vital space with enhancement of human attractions (V–O2)	Crowded space leads to decreasing safety and number of visitors (V–T2)
	Walkability	Possibility of do walking in this space (V–S3)	Walking activity as essential activity in this space not optional activity (V–W2)	Possibility of do walking as an optional activity due to magnitude of space (V–O3)	Crowded space may reduce the possibility of creating a comfortable space for walking (V–T3)
Safety	Crime	The low rate of crime in this space (S–S1)	Low rate of theft due to congestion of space (S–W1)	Possibility to Presence of large number of people due to safety of space (S–O1)	Crowded space may lead to increasing crime (S–T1)
	Traffic	Low rate of traffic in the space (S–S2)	Traffic is related to congestion of space (S–W2)	Possibility of creating safe space with removing traffic (S–O2)	Decreasing safety with increasing traffic in the space (S–T2)
	Natural surveillance-flow of people (eye street)	Presence of people increases safety of space (S–S3)	Flow of people leads to congestion of space and lead to occurrence of crime (S–W3)	Possibility of presence of more people due to safety of space (S–O3)	Decreasing safety of space due to congestion of space (S–T3)

Table 5 Design intervention strategies for Bazaar’s regeneration.




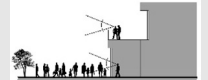


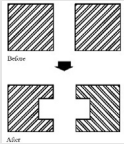
Urban space qualities	SWOT analysis	Urban space quality covered			Regenerative design principle	Proposed design sketches	Reference
		Fully covered	Partially covered	Not covered			
Comfort Vitality Safety	C–O3, C–W3, C-T3, V–T3, V–W1, V–O1		Comfort, Vitality	Safety	(a) Providing opportunities and facilities to make various activities conveniently (mixed used).		(Zumelzu and Barrientos-Trinanes 2019; Ou et al., 2021; AL-Fadala 2020; Montgomery 2007)
	C–O1, V–O2	–	Comfort-Vitality	Safety	(b) Enhancing greenery of space.		(AL-Fadala 2020; Mehta 2014; Vukmirovic et al., 2019; Zamanifard et al., 2019)
	C–S1, C-T4, C–O4, C–W4, V–S3, V–O3, V-T3, S–O3	Comfort	Vitality, Safety	–	(c) Enhancing walkability of the space.		(Almahmood et al., 2022; Liang et al., 2022; Zamanifard et al., 2019)
	V–T2, S-T1, S–W1, S–W3, S–O3, S-T3	Safety	Vitality	Comfort	(d) More focused monitoring of crowded spaces.		(AL-Fadala 2020; Jacobs 1962; Mehta 2014)
	C–T3, C–W3, C–O3, V–O1, V–W1, V–T1, S–W1, S–T1, S–T3, S–W3, S–O3	Safety	Vitality, Comfort	–	(e) Delivering 24-7 activities to monitor the space and active frontage.		(Jacobs 1962; Zamanifard et al., 2019)
	C–O3, C–W4, C–O4, C–T4, V–S3, V–W2, V–O3, V–T3	Comfort, Vitality	–	Safety	(f) Providing comfortable pathways.		Jacobs (1962)
	C–T1, C–O1, C–W1, C–T4, C–O4, C–W4, V–T2, V–T3, V–O3, S–T1, S–W3, S-T3	Comfort	Vitality, Safety	–	(g) Considering open spaces, designing porosity for better population dispersion and preventing population concentration (changing urban morphology to better use of urban public space).		Vukmirovic et al. (2019)



Fig. 11 Enhancing the walkability and greenery of the space.

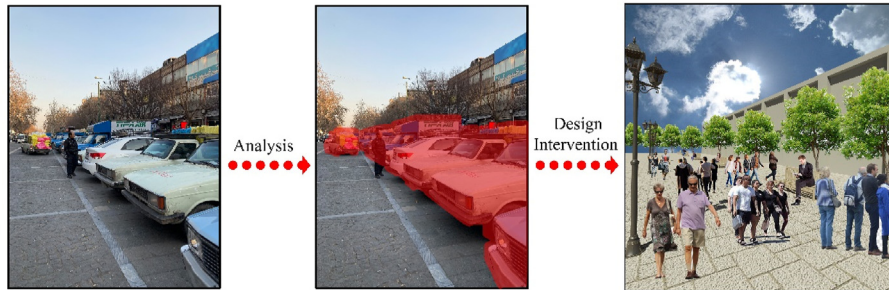


Fig. 12 Creating comfortable urban public space with the enhanced walkability.

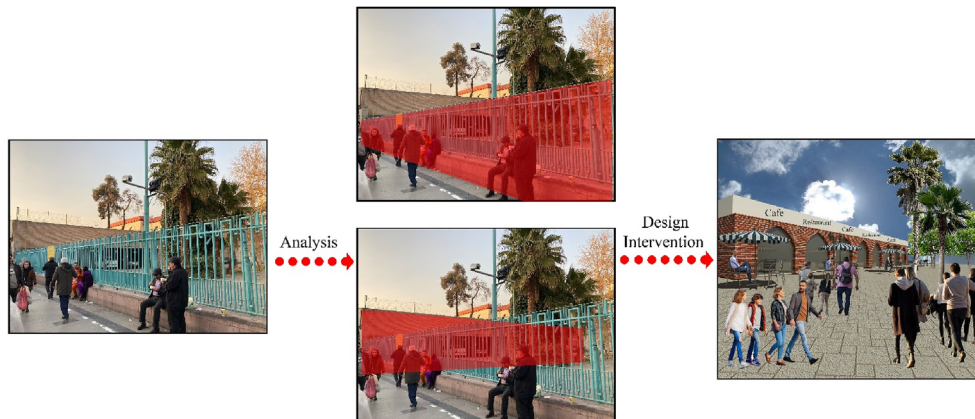


Fig. 13 Creating more comfortable and vital urban space.

- 1) A clear demarcation between public and private spaces along the street;
- 2) Social monitoring facilitated by the placement of buildings adjacent to the street (as detailed in Table 5(d));
- 3) The creation of lively and attractive sidewalks to increase “natural surveillance” or “eyes on the street” (refer to Table 5(e)).

In alignment with these principles, it is proposed that the buildings surrounding the space incorporate 24-h active uses, such as restaurants and cafés. These establishments can provide subtle yet effective surveillance over the area, contributing to a heightened sense of safety (as depicted in Figs. 13 and 14). This approach not only addresses safety concerns but also serves to enhance the overall vitality of

the space by promoting continuous activity and engagement. Implementing such design strategies is anticipated to create a more secure and vibrant urban environment. The integration of active ground-floor uses, coupled with clear spatial definitions and natural surveillance, aligns with Jacobs’ urban design principles and offers a practical approach to improving both safety and vitality in the urban context.

5. Discussion

This study marks a pioneering integration of SNA and SWOT analysis, utilizing social media data to elucidate and enrich the urban public space qualities of Tehran’s Grand Bazaar. This integrative discussion aims to delve deeply into the



Fig. 14 Enhancing the safety of space.

synthesized findings from the study, highlighting the methodological innovation, analytical depth, and practical implications.

5.1. Methodological innovation and analytical depth

The application of SNA to social media data represents a significant methodological leap in urban studies, enabling the quantification and visualization of public perceptions and interactions related to urban spaces. The study's use of a weighted adjacency matrix for analyzing keyword co-occurrences within social media reviews is particularly noteworthy. This approach not only identifies the salient themes of comfort, vitality, and safety but also quantifies the strength of relationships between these themes and associated keywords. For instance, the prominence of keywords such as "crowd" and "shopping" in relation to the Bazaar's vitality underscores the dual nature of crowdedness as both a driver of vibrancy and a potential detractor from comfort and safety.

The synthesis of SNA findings with SWOT analysis further enhances the analytical depth. This integration allows for a nuanced understanding of the Bazaar's current state, revealing that its spatial magnitude acts as both a strength (enabling diverse activities and improving comfort) and a weakness (leading to potential overcrowding and safety concerns). The detailed mapping of these dynamics provides a comprehensive picture of the urban space's qualities, informed directly by user-generated content.

5.2. Practical implications and urban design considerations

Drawing on the analytical insights, the research proposes targeted design interventions aimed at alleviating identified weaknesses and threats while capitalizing on strengths and opportunities. For example, the suggested redesign to alleviate pedestrian and vehicular congestion addresses the identified threat of overcrowding. This intervention is underpinned by a deep understanding of the Bazaar's spatial dynamics, highlighting the manuscript's practical relevance.

Moreover, the proposed enhancement of greenery and the emphasis on diverse activities within the Bazaar not only aim to improve the physical and psychological comfort of users but also reflect a sophisticated application of urban design principles aimed at enhancing vitality and safety. These interventions demonstrate an effective synthesis of data-driven insights with urban design considerations, showcasing a model for future urban regeneration projects.

6. Conclusion

The conclusions of this study are twofold, encompassing both methodological insights and substantive findings derived from a comprehensive analysis. Methodologically, this research employed a triangulated approach, integrating literature reviews, social media data analysis, and regenerative design principles. The literature review facilitated the extraction of essential qualities of urban public spaces, while the analysis of data from social media networks, specifically Tripadvisor and Google Place, provided insights into users' opinions and perceptions of these spaces. This approach offered a more straightforward and time-efficient alternative to traditional methods of analyzing urban public spaces. Furthermore, the data from these platforms serve as a readily accessible virtual layer of information, supplementing the physical aspects of urban spaces.

In this research, the Grand Bazaar in Tehran was selected for a detailed case study, utilizing social media data as a primary source of information. Subsequent analysis employed SNA to examine three key attributes of this area: comfort, vitality, and safety. A SWOT analysis was then conducted to formulate design and regeneration strategies for the space. The analysis revealed that the spatial magnitude serves dual roles as both a significant strength (opportunity) and a potential weakness (threat) concerning the quality of comfort. Similarly, the study identified that the area's focus on shopping activities and its resultant crowdedness could be perceived as both an advantage (opportunity) and a critical limitation (threat) in terms of vitality. Furthermore, the findings suggest that while population density (crowdedness) enhances the space's vibrancy, making it a strength (opportunity), it also leads to congestion, posing a significant challenge (threat) to safety. Ultimately, the study proposes comprehensive regenerative design principles and interventions aimed at bolstering the qualities of the space, thereby enhancing its overall utility and appeal.

Three significant findings emerged from this study:

- 1) Quantitative analysis of social media data can effectively inform qualitative analyses, providing a deeper understanding of urban space qualities.
- 2) Social media data serves as a valuable tool for investigating the qualities of urban spaces.
- 3) The SWOT analysis highlighted two critical aspects: the "magnitude of space" as a key opportunity and "crowdedness" as a prominent issue needing attention.

The contributions of this research are manifold, synthesizing quantitative data with qualitative analysis to

inform urban regeneration strategies in a novel and impactful manner. Firstly, the successful application of SNA to social media data exemplifies the study's innovative use of digital analytics to uncover qualitative insights within quantitative datasets. Secondly, the execution of a SWOT analysis, informed by the findings from SNA, further contributes to the study's depth. This strategic analysis integrates the complex array of qualitative indicators extracted from social media data, enabling a comprehensive assessment of the SWOT associated with the Bazaar's urban space qualities. Lastly, the development of a design intervention framework, predicated on the insights garnered from both SNA and SWOT analysis, showcases the practical application of the study's findings. This framework proposes specific, data-informed strategies for enhancing comfort, vitality, and safety within Tehran's urban public spaces, thereby directly contributing to the regeneration of these areas.

These findings suggest that the proposed methodological approach could be effectively replicated in other case studies. However, caution must be exercised in interpreting the results due to certain limitations. The study's analytical scope was confined to three factors—comfort, safety, and vitality—and their direct correlation with the quality of urban public spaces. Future research could expand this scope to encompass a broader array of quality criteria and explore the potential interrelationships among these factors.

AI ethics statement

During the preparation of this work, the authors used ChatGPT in order to improve the language and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

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

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