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Evaluation of deteriorated urban fabric pathways in detailed plans based on physical indicators using space syntax technique, (case study: Masjed Yeri Paein neighborhood, Zanjan)

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Abstract

Following the failure of urban plans throughout the 20th century, a shift towards participatory urban planning, influenced by community-based planning theories, emerged in the late 20th century. Although this approach has been discussed for several decades, it has yet to be fully adopted in Iran. More than a decade after the approval and implementation of the detailed plan in Zanjan, many plots along the streets and facades remain undeveloped, **Research Objective:** This study aims to evaluate the physical permeability based on the approved detailed plan and compare it with the findings derived from the Space Syntax technique and citizen perspectives, a decade after its implementation in the Masjed Yeri Paein neighborhood of Zanjan**.** This research is applied and employs a descriptive-analytical approach. It analyzes the street network structure of the Masjed Yeri Paein neighborhood using a combination of quantitative Space Syntax techniques and qualitative field observations.The study focuses on the street networks and accessibility patterns in the eastern semi-region of Zanjan, with an emphasis on the Masjed Yeri Paein neighborhood**.** The analysis of the results and field observations shows that the roads in the area of the Lower Yari Mosque of Zanjan do not conform to the approved detailed plan in some key indicators (such as spatial integrity and connectivity) and this can be due to the inefficiency of the detailed plan in predicting the real needs Some streets have limitations in width, inconsistencies in pathway quality, and weaknesses in connectivity with main roads.New street expansions have been proposed to enhance physical permeability in both north-south and east-west directions

Keywords: Physical Permeability; Deteriorated Urban Fabric; Space Syntax; Masjed Yeri Paein; Neighborhood, Zanjan

1. Introduction

Since the second half of the eighteenth century, historical and deteriorated urban fabrics have received increased attention. The initial steps in this regard were taken in Western Europe, particularly in the United Kingdom and France. One of the most notable actions in this field was Haussmann's urban renewal project for central Paris in the 1850s. However, with the advent of the twentieth century and the rise of modernist ideologies in its early decades, a more eclectic view of the past emerged, often leading to more aggressive demolition of urban fabrics. This trend reached a new phase with Le Corbusier's "Radiant City" proposal in the 1920s. Conversely, in the final decades of the twentieth century, a paradigm shift occurred across various domains, particularly concerning cities and their inhabitants. Approaches rooted in participatory urban planning theories emerged, emphasizing public involvement in urban interventions and recognizing citizens and local residents as the primary stakeholders in any form of urban transformation.

Cities, as dynamic and living entities, continuously interact with their inhabitants and the surrounding environment. In this context, the quality and physical structure of urban fabrics play a fundamental role in meeting citizens' daily needs and ensuring environmental sustainability. Physical permeability, as a key feature in urban design, determines the extent of accessibility and free movement for people and vehicles within a city. Appropriate permeability enhances spatial connectivity, prevents unnecessary congestion, and fosters a sense of security and satisfaction among residents. This issue is particularly critical in inefficient urban areas, where physical decay, high density, or inadequate infrastructure led to multiple challenges.

Furthermore, improving the quality of the urban environment, addressing deficiencies, enhancing regulatory oversight, strengthening urban management mechanisms, and organizing neighborhoods are fundamental objectives of urban development plans. Each of these goals holds significant importance. Detailed urban plans, as planning tools guiding urban development, have consistently aimed to optimize spatial efficiency and improve accessibility. However, in practice, the implementation of these plans often faces numerous challenges and constraints, sometimes failing to achieve their intended objectives, thereby necessitating further scrutiny and refinement.

The current model of urban development planning in the country dates back to the beginning of the Third National Development Plan (1961–1966). During the early years of this program, contracts for comprehensive urban planning were signed between the Planning and Budget Organization and various consulting firms. In 1964, the

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This article is a mockery of the Ph.D. thesis of the first author entitled " Analyzing the Concept of Land Regulation and Readjustment in Inefficient Urban Textures with the Approach of Harmonious Physical Development (A Case Study of the Inefficient Texture of the Eastern Half of Zanjan) under the guidance of Dr. Daryoush Ardalan and the consultation of Dr. Seyyed Mohammadreza Khatibi in the Department of Urban Planning of Qazvin Branch.

Ministry of Housing and Urban Development was established, followed by the formation of the Supreme Council of Urban Planning and Architecture, which was tasked with overseeing the preparation of comprehensive urban plans. Over time, the responsibility for managing new urban planning contracts was transferred to this council's secretariat. The first comprehensive urban plan approved by the Supreme Council was for Bandar Lengeh in 1966.

Despite over five decades of urban planning efforts in Iran, and despite the wealth of experience accumulated by urban planners and administrators, these plans have largely failed to effectively guide urban development in a structured and identity-driven manner. One of the key approaches to rectifying this issue is the critical evaluation of urban development plans. By adopting a critical perspective on the formulation, implementation, and content of these plans, underlying challenges can be identified, and strategies can be devised to prevent recurring problems (Niyazmand et al., 2022: 2)

A successful urban design process ultimately results in an improved quality of life for residents. To achieve this goal, urban design must be purpose-driven, facilitating long-term developmental processes that reinforce the social identity of residents. It should function as an enabler, supporting local communities while being rooted in the core human values, cultural heritage, and traditions of the society. Consequently, urban design is a continuous process, producing an aesthetically crafted built environment comprising open spaces, urban blocks, streets, and neighborhoods that offer safety, tranquility, and environmental sustainability. The failure of an urban plan often stems from neglecting the underlying processes shaping urban projects. These processes generate activity and imbue urban forms with meaning. The process of place formation unfolds over specific timeframes within a spectrum of potential form-function-meaning interactions, with varying degrees of likelihood. This highlights the necessity for flexible design approaches and cautious decision-making in urban interventions. Some scholars even extend beyond the conventional notion of urban design as a set of actions leading to a finalized plan and instead define urban design itself as an ongoing process. In this perspective, urban design is inherently complex, requiring not just the conception of a fixed final form and function but also the ability to envision and anticipate diverse combinations of forms and functions (Niyazmand et al., 2022: 4).

The Masjed Yeri Paein neighborhood in Zanjan, as one of the city's historic and deteriorated areas, has been subject to the implementation of a detailed urban plan over the past decade. Analyzing the outcomes of this plan concerning the neighborhood's physical permeability and its effects on residents' daily lives can provide new insights into the effectiveness of such planning initiatives. This study conducts a comparative analysis of physical permeability within the approved detailed plan, incorporating a spatial layout analysis (Space Syntax) alongside field evaluations. The research aims to assess the extent to which the detailed plan has successfully enhanced permeability and to identify its broader impact on urban life quality. Additionally, considering the conceptualization of the city as a living entity, this study seeks to determine the extent to which the implemented modifications have contributed to reinforcing urban vitality and dynamism.

2. Theoretical Framework

Today, many cities around the world face numerous challenges due to various reasons such as poor geographical location, inefficient physical expansion, and non-standard constructions (Ziari et al., 2023:1). These issues are closely tied to inefficient and deteriorated urban fabrics, which have created problems in multiple dimensions—physical, environmental, economic, social, and managerial (Subhani et al., 2023:115). The absence of clear and documented strategies for managing and planning these deteriorated areas has exacerbated the problems. Low financial capacity among residents hinders reconstruction efforts, indicating a strong correlation between income levels and urban fabric decay (Ahmadiyani & Almohammedawi, 2022:1) .

Serious initial actions aimed at revitalizing historical urban districts date back to the early 20th century (1300s in the Iranian calendar), coinciding with the beginning of the first Pahlavi era. During this period, modernization and transformation in urban structures were initiated through the construction of straight and intersecting roads that connected different quadrants of the city. This marked the first systematic attempt to transform the physical structure of cities, aiming to create urban environments symbolizing progress and development in the new era while distancing themselves from the past (Ardelan et al., 2021:91-92). However, the purely physical approach to urban transformation proved difficult to implement due to the lack of necessary infrastructures in management, legal frameworks, and other domains. Consequently, the initiatives launched in the 1920s took several decades to fully materialize.

Today, there are numerous terms related to urban fabrics, each prescribing specific interventions based on their underlying concepts. Familiarity with these specialized terms is essential (Davoodpour et al., 2022:1-2). Urban decay refers to areas within the legal boundaries of cities that suffer from physical deterioration, inadequate vehicular access, insufficient infrastructure, services, and urban facilities, resulting in low place value, environmental quality, and economic potential. Due to the poverty of residents and property owners, these areas lack the ability to renovate themselves. Additionally, investors have little incentive to invest in such areas (Habibi & Mashkini, 2007:66). Alternatively, "inefficient urban fabric" refers to urban areas where the presence of various factors reduces environmental quality, leading to declines in ecological, economic, and social values, halting renovation processes and increasing migration tendencies among residents (Jahanshahi, 2003).

Understanding fundamental and theoretical concepts about inefficient urban fabrics, physical permeability, spatial configuration, and urban fabrics as living entities forms the basis for more precise analysis in this research. The theoretical framework of this study rests on four main pillars: (a) inefficient urban fabric, (b) physical

permeability, (c) spatial configuration, and (d) the concept of the city as a living organism.

2.1. Inefficient urban fabric

In its broadest sense, inefficient urban fabric varies physically and spatially and stems from different roots and formation factors. These cannot be categorized under a single classification, as they often differ significantly. Economic destruction and the low financial capacity of residents often hinder reconstruction efforts (Khairi, 2019). It refers to areas that are physically, economically, and sometimes socially deteriorated, failing to meet the needs of their inhabitants (Rezvani & Khatibi, 2015). Deterioration is one of the most critical issues affecting urban spaces, causing disorganization, imbalance, inconsistency, and degradation. It contributes to the erasure of collective memories, the decline of urban life, and the formation of diminished daily urban lifestyles. This factor accelerates the obsolescence of structures, gradually moving them toward their ultimate demise (Habibi, 2002:15).

Decayed and inefficient urban fabrics exhibit characteristics such as physical deterioration, weak infrastructure, and a lack of public spaces, distinguishing them from other urban areas (Lynch, 1981). The decline in public space quality in these areas is typically due to insufficient services and poor accessibility, which diminishes urban identity and lowers the quality of life (Marshall, 2005). These areas usually consist of dilapidated buildings, narrow streets, and inefficient public spaces. Carmona et al. (2010) noted that these spaces lose their value over time due to poor design quality and inadequate facilities, leading to social and economic problems. Revitalizing these areas can be improved by optimizing permeability principles and strengthening communication networks. Among the features and consequences of decayed urban fabrics are physical deterioration, poor internal access, lack of appropriate infrastructure, environmental problems and high pollution levels, insufficient recreational facilities, poverty and deprivation, vulnerability to earthquakes, low service provision, excessive population density, temporary and unsafe building structures, insecurity, and social issues (Jahanshahi, 2003:34).

Table 1
Theories on the Worn and Dysfunctional Texture

Row	Researcher	Years	Nationality	Article/Book	Summary
1	Leila Aghamoradi Dolatabad	1400	Iranian	Book: Urban Fabric	Examining the history of each of the concepts and the explanation of the existing theories and views and the existing experiences related to each of them abroad and inside the country Understanding the study sample of Marand city and its characteristics in terms of demographic, physical, geographical, social, economic and political
2	Ali Madanipour	1395	Iranian	Book: Urban Management and the Reconstruction of Deteriorated Textures	Investigating the Role of Urban Management in the Reconstruction of Deteriorated Textures with Emphasis on Participatory Planning, Sustainable Development and Coordination between Different Institutions Also, analyzing the challenges and opportunities of this process in the form of domestic and international policies and experiences
3	Seyed Mohsen Habibi	2013	Iranian	Book: Deteriorated Textures and New Strategies for Urban Regeneration	Comprehensive Analysis of Deteriorated Urban Textures and Presenting New Regeneration Strategies with Emphasis on Local Community Participation, Sustainability, and Multidimensional Approaches (Physical, Social, Economic and Cultural) Challenges, successful domestic and international experiences, and operational solutions for urban regeneration are proposed
4	Zhen Wang, Xuan Bao and Associates	2024	Foreign	Article: Identifying and Redeveloping Inefficient Use of Urban Residential Land: A Case Study of the Harbin Ring Highway Area in China"	Urban central areas, especially those with outdated infrastructure or inadequate public facilities, have the highest concentration of inefficient land and offer suggestions to address these problems.

5	Sidney Brown	2014	Foreign	Book: Renewing Cities	Investigating innovative solutions for regeneration and revitalization of cities with an emphasis on sustainable development, improvement of infrastructure, and participation of local communities Analyzing global experiences in renovating urban areas and creating better living spaces
6	Peter Roberts Hugh Skinner	2000	Foreign	Book: Urban Regeneration in Europe	A Study of Urban Regeneration Processes, Policies and Strategies in Europe with a Focus on Sustainability, Community Participation and Social Integration Analysis of successful case studies and providing theoretical and practical frameworks for the improvement and revitalization of urban textures

2.2. Physical permeability

High permeability increases pedestrian movement, promotes sustainable urban design, and reduces dependency on vehicles (Droin et al., 2024). One of the main challenges today is the deterioration of urban fabrics due to lack of accessibility and impermeability. Physical permeability refers to the ease of access and movement within urban spaces. This concept highlights the continuity and connectivity between different parts of an urban environment and plays a crucial role in urban economic, social, and security dynamics (Carmona, 2010). Appropriate permeability can enhance social interactions, improve space quality, and increase the use of public spaces (Gehl, 2011). Physical permeability refers to the accessibility and traversability of urban environments, meaning the provision of barrier-free access to various urban areas. It is associated with factors such as visual transparency, the number of entrances and exits, and the structure of the road network (Carmona, 2010). Suitable permeability in urban environments not only enhances security but also strengthens social interactions and economic attractions (Lynch, 1981). Furthermore, the road network plays a significant role in spatial and social connections. Marshall believes that the continuity of roads and easy access to different spaces increases permeability and improves the quality of public spaces (Marshall, 2005). Studies conducted on deteriorated urban fabrics indicate that the primary cause of decay, based on the permeability criterion, is often due to the weak spatial structure of the road network (Aliabadi & Ahmadi, 2019:77-86). Recognizing the communication system in deteriorated fabrics is essential as one of the most important elements of urban spatial structure. The road network, as a key component of urban spatial structure, holds particular importance because it is both a fundamental element in city construction and a factor in creating spatial relationships between all urban components (Baharini, 2004:5).

Permeability, as a key concept in urban planning and design, refers to the level of accessibility and ease of movement within urban spaces. From the perspective of Kevin Lynch and other urban theorists, permeability is a fundamental feature for ensuring urban vitality, public access, and enabling smooth movement across different urban networks. Within this framework, permeability is important not only at larger scales such as roads and main pathways but also at smaller scales, including access to public spaces, courtyards, and gathering places.

The transportation network is considered one of the structural elements that determine the form and lifestyle of cities, significantly influencing other urban components. "The transportation network in cities has two primary functions: facilitating movement (mobility) and providing access. These two functions highlight the critical importance of the transportation network at the urban level" (Arman Shahr, 2010). The primary criterion for understanding the basic structure of a city is spatial relationships, where urban elements are connected through linear systems. These lines take shape through pedestrian paths, linear open spaces, and other connecting elements, linking different parts of the city physically (Barzegar, 2003:91).

Detailed plans are typically developed with the aim of improving accessibility and increasing physical permeability based on urban structure and citizens' daily needs. In contrast, inefficient urban fabrics often have low permeability due to issues such as high density, inadequate infrastructure, and inapropriate design. Researchers like Lynch emphasize that permeable urban fabrics should have connected and flexible networks to facilitate smooth citizen movement .

This theoretical framework underscores the significance of physical permeability in addressing the challenges of urban fabric deterioration and enhancing the overall quality and functionality of urban environments.Detailed plans are usually based on the aim of improving accessibility and increasing physical permeability according to the urban structure and daily needs.

are provided bycitizens. In contrast, inefficient urban textures usually have low permeability due to problems such as high density, inefficient infrastructure, and inappropriate design. Researchers such as Lynch also emphasize that permeable urban fabrics should have connected and flexible networks for the smooth flow of citizens.

Table 2
Theories about physical permeability in cities

Row	Researcher	Years	Nationality	Article/Book	Summary
1	Homa Sharifi	1400	Iranian	Book: Introduction to Urban Permeability	Permeability in urban design includes the pattern of the effect of streets and access in motion and routing between urban environments, spaces and cases of providing criteria for measuring the opportunity of access and movement.
2	Morteza Mafi Mohammadreza Hatamipour	2015	Iranian	Article: Investigating the Role of Permeability in Improving the Quality of Urban Spaces	The Role of Permeability in Improving Access Selection of Voting Method on the Quality of Urban Environment Investigating and proposing criteria and solutions and the impact of permeability in creating efficient and sustainable urban spaces
3	Kamaloddin Shariati Mohammad Masoumifar	1393	Iranian	Article: The Role of Permeability in Increasing Security and Access in Urban Spaces	Analyzing the Impact of Permeability on Security and Access in Urban Public Spaces The results show that high permeability can improve security and ease of access to urban services
4	John Takara et al	2023	Foreign	Paper : Readability and Permeability of Cities: Investigating the Role of Spatial Data and Criteria	With the help of data modeling and geographical data, these dimensions are provided to the reader. It also evaluates a system of readability and permeability on the level of understanding and absorption of the inhabitants and the prevalence of its effect on them
5	Raisa Machado	2022	Foreign	Article: Inclusive Spaces for a Permeable City	Research in the field of urban planning that creates movement and accessibility in more permeable and accessible environments. An Integrated Revision of Current Planning Practices and the Integration of Classical Structures with More Permeable Examples
6	Bill Hillier Julian Hanson	1984	Foreign	Book: Socio-Social Space: A Theory for Urban Design	Bill Hillier and Julian Hanson pointed to physical permeability as an effective factor in the formation of social life and local aesthetics. They believe that the design of the space should help in carrying out physical movements, because permeability is practically effective in promoting maximum interactions for shared use

2.3. The city as a living organism

The concept of the city as a living organism originates from the theories of Nikos Salingaros and Jane Jacobs, referring to the dynamism, continuous interactions, and natural changes that cities undergo over time. As an integrated, dynamic, and living entity, the city is a product of profound revolutions in human culture. Urbanization and urban-centric development have experienced rapid growth in developing countries during recent decades (Resuli et al., 2023:52). Like living organisms, cities grow, transform, and require constant care and regeneration under the influence of internal and external factors. It should also be noted that, "while cities change shape and expand over their lifetimes due to various factors, a good city is one whose physical structure meets the needs of its residents in response to changing times" (Davoodpour & Ardalan, 2008). From this perspective, a living city must be designed and managed in a way that remains flexible and responsive to the evolving needs of its inhabitants. Within this framework, detailed urban plans should not only focus on improving infrastructure and efficiency but also address social and cultural dynamics. This implies that physical permeability is only part of the equation; how citizens interact with spaces and the socio-cultural impacts of these interactions must also be considered. In this regard, the city of Zanjan and its Yeri Mosque neighborhood are evolving as living organisms, and the success of detailed planning in engaging residents and fostering active urban life is a key aspect of this research analysis.

In the early 20th century, humans viewed cities primarily through the lens of automobile use. However, the rapid expansion of cities, the proliferation of urban and intercity roads, and the widespread adoption of cars—along with their adverse effects—led to the perception of automobiles as one of the primary causes of urban problems and failures in urban planning. Yet, the destructive impacts of cars are more indicative of insufficient urban design than the root cause itself. While planners have struggled to reconcile automobiles with urban environments, they remain uncertain about how to design functional and vibrant cities either with or without cars (Jacobs, 1961:6). On the other hand, it is essential to recognize that streets are themselves urban spaces, not merely connectors between two points. Therefore, careful attention must be given to the selection of street beginnings, endings, and widths. Furthermore, while high permeability may benefit areas with commercial or administrative uses, it can negatively affect residential fabrics by reducing privacy. Additionally, the broader goal of urban design is to create

accessible opportunities (both behavioral and aesthetic) for all citizens and visitors of a city or its parts (John Lang, 2005:34). Finally, it is important to remember that interventions in accessibility—or, more broadly, physical permeability—are not aimed at creating transportation networks solely for the rapid and easy movement of vehicles between different urban areas. In the late 20th century, participatory urban planning theories influenced people-oriented interventions, which recognize residents as the primary stakeholders in any urban intervention (Habibi, 2010:173).

Table 3
Theories about the city as a living being

Row	Researcher	Years	Nationality	Article/Book	Summary
1	Parsa Ahmadi Dehrshid	1400	Iranian	Article: Smart City: Environmental Protector in the Era of Accelerated Urban Development	He examines the vital system, and in particular points out that urban systemscan play an important role in reducing the amount of environmental destruction caused by urbanization. Using sensors and GIS , he makes it possible to monitor human activities and protect the environment.
2	Seyed Amir Mansouri	1388	Iranian	Book: Fundamentals of Environmental Design	It looks at the city as a living and dynamic environment that has been created by the cultural and economic relations of citizens He believes that the city should be designed in such a way that not only the physical needs of those people but also their psychological, psychological and social needs are met
3	Mostafa Behzadfar	1380	Iranian	Numerous articles in the field of urban design and the sustainability of urban spaces	He sees the city as a living and dynamic environment that is influenced by human interaction, ongoing social and cultural change. He emphasizes how urban design should facilitate interaction and create sustainable and resilient spaces for residents. Revitalization of this process through the environment, economy, and local infrastructure note
4	John Takara	2024	Foreign	The City as a Living System: A Design Research Agenda	Urban and rural systems in order to provide social and technological structures that enable the evolution of cities to be flexible ecosystems and benefit from human and ecosystem support
5	Eric Fritters David Duge and Associates	2023	Foreign	The City as a System – Metabolic Design for New Urban Forms & Functions	It emphasizes the redesign of cities with a focus on infrastructure. It offers solutions for the sustainable management of resources such as energy, waste, and food, and recommends the use of modern technologies such as artificial intelligence to create dynamic and sustainable cities
6	Richard Florida	2002	Foreign	Book: The Rise of the Creative Class	He sees the city as a living and dynamic environment that is formed based on social, economic, and cultural relations and interactions. He believes that cities should provide a space for attracting and nurturing creativity, because it is creativity that contributes to the development and innovation of the urban environment.

2.4. Spatial configuration methodology

The spatial configuration approach contributes to the modeling of user flows in both open and enclosed environments, supporting sustainable urban development in line with the United Nations' Sustainable Development Goal 11 (Leite et al., 2024). As demonstrated in the case study of Porto, it facilitates the design of coherent urban housing settlements (Fernandes, 2023). The need for a comprehensive method capable of explicitly explaining the direct relationship between the physical structure of the city and human behavior led to the development of the Space Syntax methodology in the late 1970s by Professors Bill Hillier and Julienne Hanson at the University of London. Space Syntax is based on the spatial structuring of the built environment and its impact on human experience, discovery, and understanding of space. Consequently, this method helps designers better understand the role of spatial structure in shaping human behavioral patterns and analyzing their social impacts (Hillier & Hanson, 1984).
The analytical approach of Space Syntax allows designers to observe behaviors and usage patterns before finalizing plans, enabling them to anticipate the potential consequences of their interventions in urban and architectural spaces and make necessary adjustments accordingly (Abbaszadegan, 2002). In essence, Space Syntax is an advanced approach for analyzing the spatial structure of human-made environments, aiming to describe spatial models and present them in graphical and numerical formats for scientific analysis of the target spaces (Mostofi & Hassan, 2009). One fundamental principle of this theory posits that, compared to physical attributes of space, the

spatial structuring has a more direct influence on shaping human activities (Vaughan, 2007:208). Additionally, the relative distribution of populations is always correlated with the degree of integration within a spatial system (Hamedani Golshan, 2014).

Space Syntax serves as an analytical tool for evaluating the structure and organization of urban spaces using various indices such as integration, connectivity, and accessibility. Developed by Bill Hillier and his colleagues, this theory emphasizes that the design and arrangement of urban spaces can shape social interactions and human behavior in urban environments (Hillier & Hanson, 1984). In this method, all urban or architectural spaces are analyzed, and the results are presented through mathematical parameters and graphical representations. Mathematical parameters are useful for creating predictive models of human behavior in urban spaces, while graphical data serve as powerful tools in the architectural and urban design process, illustrating the impact of physical interventions on urban spaces and architectural fabrics. Therefore, designers can observe the effects of their choices throughout the design process and develop models that predict how design decisions will influence users' experiences of physical spaces (Abbaszadegan, 2002).

Key Concepts in Space Syntax: Mean Depth: Depth refers to the number of steps required to reach a particular space. In a spatial configuration, the higher the depth of a space, the greater its level of privacy (Mostofi & Hassan, 2013). High depth in residential settings can be desirable, enhancing privacy. However, excessive depth in public uses reduces accessibility and permeability (Heidari et al., 2017).

Integration: Integration is the primary concept in spatial configuration, referring to the average number of direction changes needed to access all spaces. In Space Syntax, integration is a relational rather than a distance-based concept (Abbaszadegan et al., 2012). Essentially, integration measures the continuity or isolation of a space relative to other spaces within the same configuration. A space with high integration is more interconnected with other spaces (Penn, 2003), and the distribution of integration values across the urban fabric correlates with pedestrian movement patterns.

Choice: This concept is synonymous with the number of options available. Specifically, a space has a high choice value if many of the shortest connecting paths pass through it (Kamali Pour et al., 2012). In architecture and collective use contexts, the more route choices available to access a space, the easier it becomes to manage gatherings and dispersals (Heidari et al., 2017). This enhances space utilization and improves surveillance and security.

Table 4
Theories about Space syntax in cities

Row	Researcher	Years	Nationality	Article/Book	Summary
1	Seyyed Mustafa Mir Mohammad Sadeghi	1402	Iranian	Article:Application of the Space Syntax Method in Analyzing the Urban Structure of the Historical Area of Isfahan	Using Space Syntax tools, this study analyzes the street network of Isfahan's historical area and demonstrates how spatial patterns have influenced the formation of socio-economic activities
2	Pedro Alfonso Fernández	2023	Foreign	Paper: Spatial Layout with Logical Programming: An Application in a Modern Residential Complex	Spatial layout can improve communication and coordination between public spaces and residential buildings, as well as address the benefits of circular structure and how to promote social cohesion through spatial layout design. Investigating a New Perspective for Space Layout Using Logical Programming and Especially Prolog Language
3	Bill Hillier	2022	Foreign	Paper:: : Space Syntax and the Social Logic of Cities	This study examines the relationship between the spatial structure of cities and demographic, economic, and cultural patterns , while analyzing the role of spatial configuration in predicting the behavior of urban residents
4	Bill Hillier Julian Hansen	1984	Foreign	Book: Socio-Social Space: A Theory for Urban Design	Hillier and Hanson believe that the syntax of space is very effective in producing the phenomena of social patterns and human behavior , and they propose that by using the theory of the syntax of space, spatial design and urban architecture can systematically control social interactions, access, and movement.
5	Raymond Lewis	1977	Foreign	Book:Space and Place: The Perspective of Experience	The layout of the space has psychological and empirical aspects and is not limited to the physical aspect. Lewis describes space in such a way that it must find meaning through human experience , and in the design of space, a sense of belonging and connection with place must be promoted in people

the discussion on deteriorated urban fabrics, challenges related to regeneration have been addressed, with multidimensional approaches encompassing physical, social, economic, and cultural perspectives. In the context

of physical permeability, emphasis has been placed on accessibility and its role in enhancing social interactions, security, and other related factors. The city, viewed as a living organism, highlights the importance of designing urban environments that foster increased social, economic, and cultural interactions among residents. In the discussion on spatial configuration, the focus is on movement flow and the quality of spatial experience, leading to the conclusion that the common thread across all these topics is the emphasis on enhancing social interactions.

Table 5
The Outcome of Theories in Four Areas of Worn Texture, Permeability, City as a living being and Space syntax Method

the Worn and Dysfunctional Texture	Physical permeability	City as a living being	Space syntax Method
- Presenting new regeneration strategies with an emphasis on local community participation, sustainability, and multidimensional approaches (physical, social, economic, and cultural). - The challenges of regeneration as well as strategies to improve the quality of life in these contexts are presented with regard to public participation and sustainability	- Permeability as one of the principles of urban design is to improve accessibility, social interaction and the quality of the urban environment The relationship between the permeability of urban networks and the strengthening of citizens' sense of belonging to public spaces	The city is shaped by the social, cultural, and economic interactions of its residents. The city must be designed to meet not only the physical needs but also the social and psychological needs of its citizens	The layout of space in Islamic and Iranian architecture reflects spiritual concepts and harmony with nature and strengthens the sense of continuity between man, space, and the unseen world.
Investigating the role of urban management in the reconstruction of worn-out textures, with an emphasis on participatory planning approaches, sustainable development and coordination between different institutions - Analyze the challenges and opportunities of the process in the form of domestic and international policies and experiences - Investigating and analyzing the development of mixed uses in cities and its role in the regeneration of urban areas, improving the quality of life and creating sustainable and vibrant urban spaces	The relationship between the permeability of urban networks and the strengthening of citizens' sense of belonging to public spaces - The Effect of Permeability of Urban Networks on Security - The design of the city should be such that it facilitates the free and convenient movement of citizens in the spaces and makes the ommunication between different parts of the city clear and understandable - Physical permeability is a key factor in shaping social interactions and the quality of urban spaces	The city must be constantly influenced by social, economic, and cultural interactions. Urban design must be such that it reflects this dynamism and diversity effectively in the urban structure and public spaces Urban design should create spaces that allow for diverse and natural interactions Cities should provide a space for attracting and nurturing creativity, because these creativity contribute to the development and innovation of the urban environment.	The arrangement of space is a factor that shapes social behaviors, the flow of movement, and the quality of spatial experience, and it must be in harmony with human needs and the cultural context. - The layout and syntax of the space has not only a physical aspect, but also a psychological and experimental dimension - Space design should pay attention to the cultural and psychological differences of humans in the perception and use of space - The layout and syntax of space play a decisive role in the formation of social patterns and human behavior

In this study, the roads introduced in the approved detailed plan for the Yeri Mosque neighborhood of Zanjan were examined in detail through field studies aimed at expansion and development. These findings were matched with results obtained from spatial configuration analysis techniques (integration, choice, and mean depth). Additionally, the reactions of citizens and residents to the implementation of the approved detailed plan in the area—more than a decade after its execution—were explored based on the concept of "the city as a living environment." The results across all three sections were aligned, and new roads were proposed to enhance physical permeability along two axes: north-south and west-east.

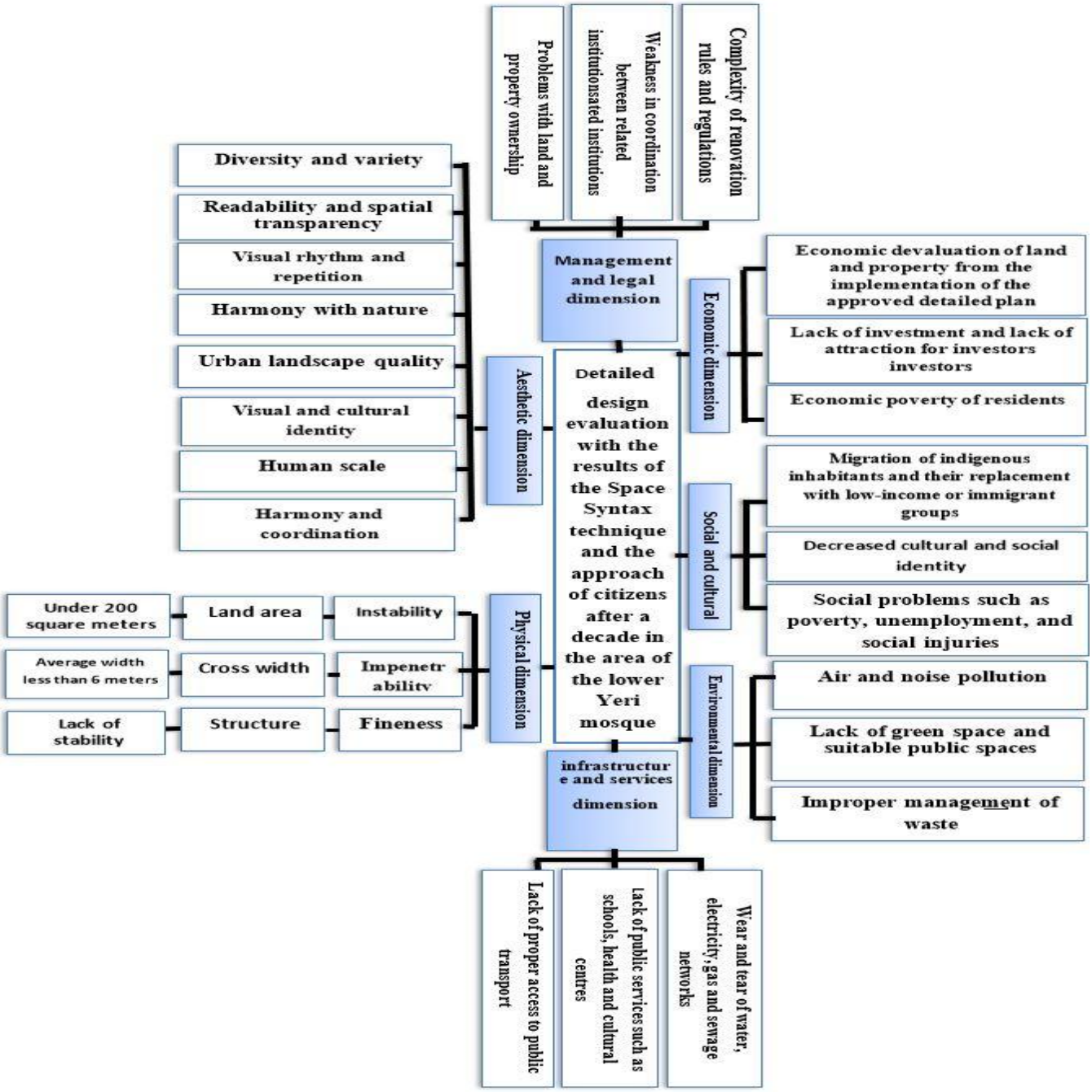

Figure 1. Conceptual Model of Research

3. Research Methodology

This research is of an applied and analytical-descriptive nature, focusing on the analysis of the road network structure in the Yeri Mosque Lower neighborhood of Zanjan. A combination of quantitative tools using Space Syntax techniques and qualitative observational measures through field visits has been employed. The stages of the research are as follows:

Preliminary Studies and Data Collection:1

- Document studies: Reviewing approved detailed plans for the city of Zanjan.
- Gathering information from available documents and records regarding the physical characteristics and functional performance of the Yeri Mosque Lower neighborhood.

Preparation of maps (extracting road network maps using Geographic Information Systems(GIS).

Field Visits:2

Conducting field visits to the study area and recording objective data, including:

- Road quality (width, materials, facilities).
- Usage levels of roads and traffic patterns (pedestrians and vehicles).
- Identification of existing barriers and opportunities within the road network.
- Taking photographs, videos, and field notes for better analysis.

Structural Analysis Using Space Syntax Techniques:3
Utilizing spatial analysis tools to model the road network and calculate key indices such as integration, connectivity, and mean depth.
Comparative Analysis:4
Comparing the indices obtained from the Space Syntax technique with the approved detailed plan. This involves analyzing discrepancies and alignment between the actual performance of the road network and the objectives of the detailed plan.
Final Analysis and Recommendations:5
Combining the results of field visits and quantitative analyses to propose recommendations for improving the road network and enhancing the alignment of the detailed plan with the actual needs of the area.
Tools and Techniques:
The tools used include GIS and Space Syntax software for spatial analysis and modeling of the road network, field visits for collecting observational data and assessing the qualitative condition of roads, and comparative analysis for evaluating the compatibility of the detailed plan with existing realities .
The statistical population in this research consists of the road network in the Yeri Mosque Lower neighborhood of Zanjan. The sampling method includes comprehensive and targeted visits to primary and secondary roads in the area, with a focus on key and high-traffic locations.

Outputs of the Research:
The outcomes aim to identify deficiencies and contradictions between the detailed plan and the current situation, providing recommendations to enhance the efficiency of roads, increase safety, and improve citizen satisfaction. These findings contribute to evidence-based urban planning and design, ensuring that interventions align with the real needs of the community

The area studied and its location:
In the city of Zanjan, the current Imam Street (formerly Pahlavi Street) serves as the primary communication artery. It was shaped by modern urban planning concepts and the integration of biological and organic patterns into the old urban fabric. This street was constructed in 1934 by German engineers to connect the eastern and western entrances of the city. With the intensification of land-based trade with the west and before the construction of major highways outside the city, Imam Street also functioned as a transit route. Another significant road built during the first Pahlavi era is Saadi Street, which runs perpendicular to Imam Street. Today, Saadi Street, particularly its central section, has a more prominent commercial role than its transportation function and serves as the north-south arterial road of the city.

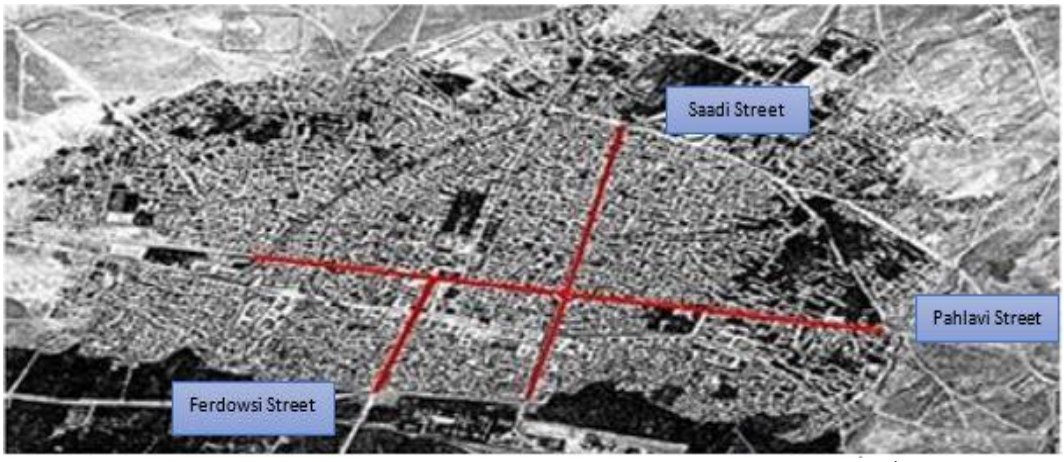

Fig. 2. Streets built in the first Pahlavi period (red lines), aerial photo, 1956[1]

The study area is located in the southeastern part of Zanjan, east of Saadi Street. To the north, it is bordered by Tawhid Street, to the east by Sadr-e-Jahan Street, to the south by Khayyam Street, and to the west by Saadi South Street. According to the detailed urban plan, this area falls within the deteriorated urban fabric zone. Based on GIS mapping results for the city of Zanjan, most plots in this area have an area of less than 200 square meters. Field studies indicate that the majority of residential units in this area remain unreconstructed and lack the necessary structural integrity to withstand lateral forces and earthquakes. Additionally, approximately 50% of the roads in this area still have a width of less than six meters despite the implementation of the detailed plan over the past fifteen years. Consequently, according to the criteria and indicators established by the Ministry of Housing and Urban Development in 2006, this area has been classified as a deteriorated urban fabric and is recognized as such in the detailed urban plan.

[1] Archive of the Cultural Heritage, Tourism and Handicrafts Office of Zanjan Province

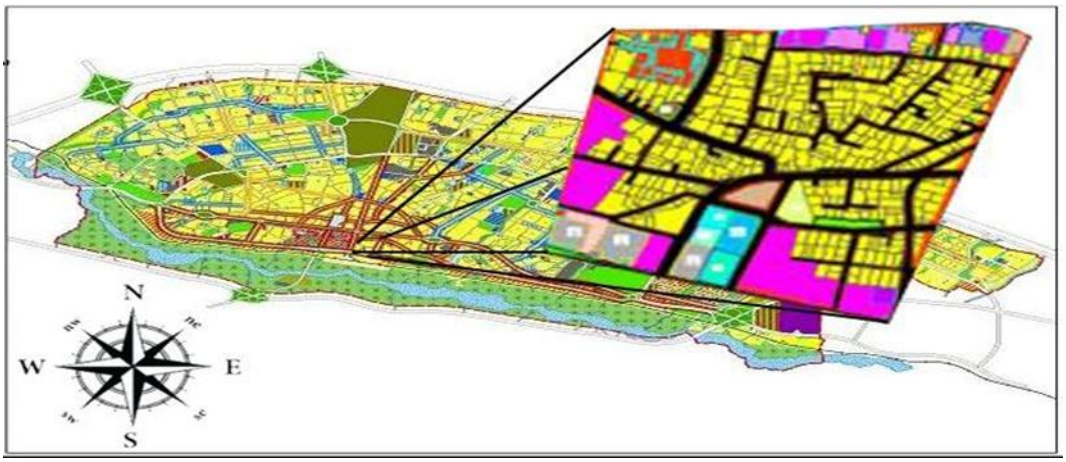

Fig. 3. The status and location of the study area on the detailed plan map of zanjan city
(Archive of Zanjan Municipality Urban Planning Unit)

Table 6
Passage information in the study period

Investigation of the Latest Physical Permeability Status of the Lower Yerry Mosque Area of Zanjan City Based on Paragraph 2 of the Definition of the Worn Texture											
Row	Alley Name	Geographical Directions	Length of the alley	Number of cross-sectional changes	Minimum width	Minimum width length	Largest Width	Largest Width Length	Medium width of the alley	Number of deadlocks	Total length of deadlocks
1	Chavoshi	North-South	175	12	3/10	11/74	10	19/46	6/02	4	65/16
2	lecturer	North-South	49/40	5	3	9/80	4/31	4/73	3/60	---	---
3	Etesami	North-South	167/50	2	6	53/30	7/80	114/20	7/20	1	53/30
4	Aqueduct	North-South	103	15	5	4/30	8/85	7/70	6/75	---	---
5	Najaf Sultan	West - East	32/60	3	4	20/31	7/15	21/50	5/29	1	28/50
6	Taghi Ezzati	West – East	224	22	3/10	9	10/94	27/70	6/42	5	60/4
7	Hamid Moslemyoun	West-East	227	18	4	7/71	10/80	66/14	7/38	3	63/30
8	Reza Hosseini	West – East	215/85	23	2/90	0/8	8/14	18/33	5/52	3	65/93
9	Morteza Molaei	West – East	528/40	25	3/31	1/50	12/80	73	9/25	2	114/7
10	Parvin	North-South	195	23	2/62	25	7/15	15/17	4/76	3	45/24
11	Lower Yeri Mosque	North-South	135/65	12	2/71	3/04	6/69	13/70	3/50	2	10/12
12	Hossein Hatami	North-South	308	25	3/70	7/50	12/12	12	5/01	5	100/09

4. Data Analysis

As previously mentioned, one of the main challenges of inefficient urban fabrics is their impermeability. Given the importance
of physical permeability prior to any intervention—especially since the primary cause of deterioration based on permeability
criteria often stems from weaknesses in the spatial structure of the road network—an overall assessment of all roads in the area has been conducted. This evaluation considers geographical orientation, road length, minimum and maximum existing widths, total lengths, number of cul-de-sacs, and the total length of these cul-de-sacs. The aggregate information for these roads is presented in Table 6

A- Assessment of Average Width of Alleys to Determine the Current Status of the Area Based on Deterioration Indices

According to the findings mentioned earlier, 49.77% of the alleys in the study area have an average width of less than six meters. Based on this criterion, the Yeri Mosque neighborhood is classified as a deteriorated and inefficient urban fabric.

Table 7
Summary of the study of the passages of the Lower Yerry Mosque based on the Worn Texture Index

The total length of the passages in the alleys of the Lower Yerry Mosque (meters)	The total length of the alleys with an average width of less than six meters	The total length of the alleys whose average width is equal to or greater than six meters
2391/10 m	1190/20m	1200/90m
Percentage	49.77%	50.22%
The number of deadlocks in the area of the Lower Yerry Mosque	29 Deadlock	Length 543/47 meters

B- Analysis of Results from DEPTH MAPS Software in Space Syntax Technique

To determine the priority of residents' preferences in selecting streets for movement and to identify which streets should be widened in the north-south and west-east directions, the integration graph results indicate that Sadr-e-Jahan Street has the highest level of integration. Additionally, Chavoshi Alley has higher integration compared to the Lower Yeri Mosque Alley.

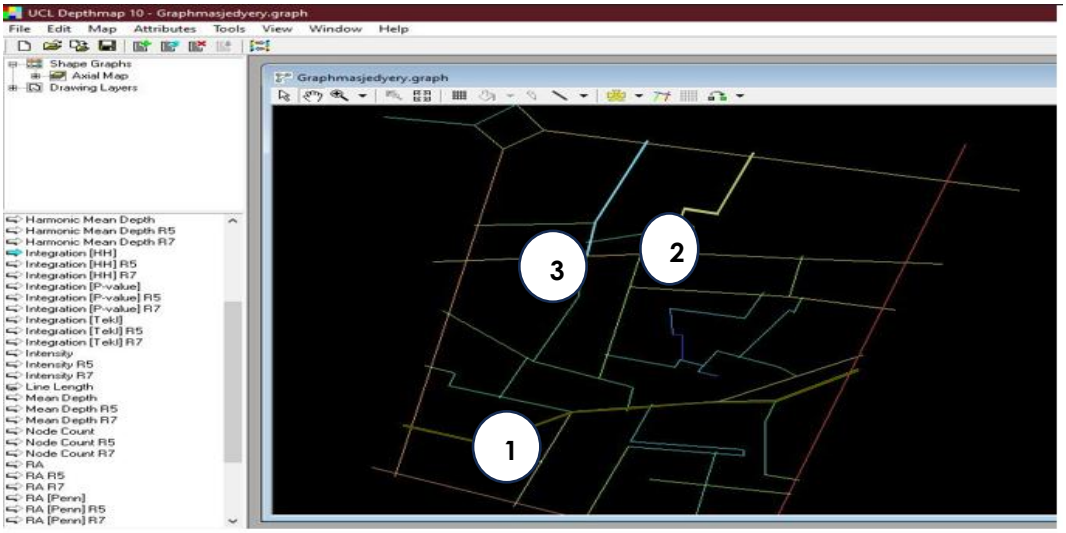

Fig. 4. Convergence graph

According to the integration graph, Sadr-e-Jahan Street has the highest integration level, while Chavoshi Alley has greater integration compared to the Lower Yeri Mosque Alley.

Table 8
The results of the correlation graph in the north-south and west-east directions

Row	INTREGRATION	Alley or street name	Software Number	Color	Axis
1	INTREGRATION MAX	Shahid Molaei Alley	1/36	Bright Yellow	West-East
2	INTREGRATION	Chavoshi Alley	1/298	Yellow	North - South
3	INTREGRATION	Yeri Mosque Alley	1/06	Turquoise	North-South

According to the spatial depth graph, Sadr-e-Jahan Street has the lowest spatial depth, and Chavoshi Alley has less spatial depth compared to the Lower Yeri Mosque Alley.

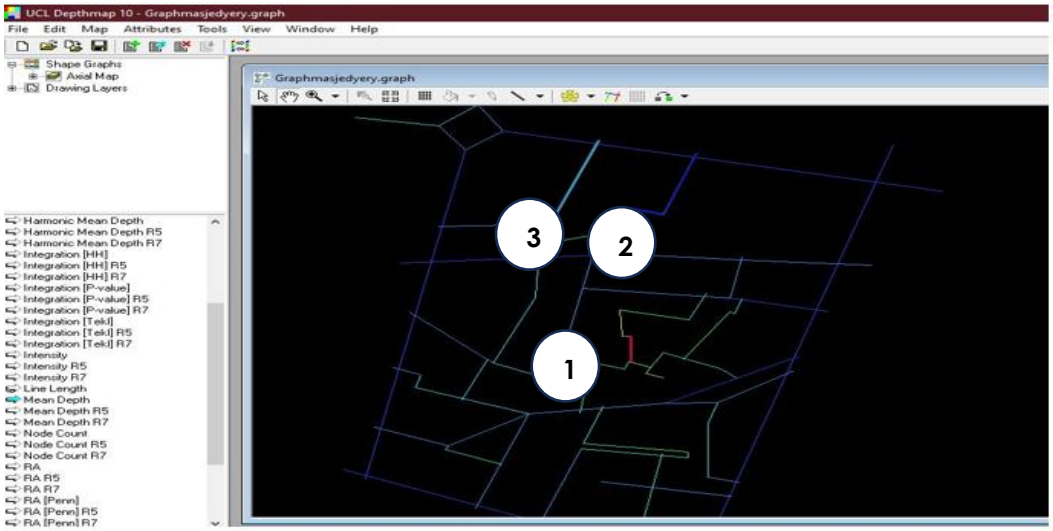

Fig. 5. Spatial depth graph

Based on the obtained spatial depth graph, Sadr-e-Jahan Street has the lowest spatial depth, and Chavoshi Alley has less spatial depth compared to the Lower Yeri Mosque Alley.

Table 9
The results of the mean depth graph [2] in two directions of north-south and west-east

Row	MEAN DEPTH	Alley or street name	Software Number	Color	Axis
1	MEAN DEPTH MAX	End of Parvin Alley	258	Red	North-South
2	MEAN DEPTH	Chavoshi Alley	306	Blue	North-South
3	MEAN DEPTH	Yeri Mosque Alley	263	Turquoise	North-South

According to the choice graph, Sadr-e-Jahan Street has the highest choice value, and Chavoshi Alley has a higher choice value compared to the Lower Yeri Mosque Alley.

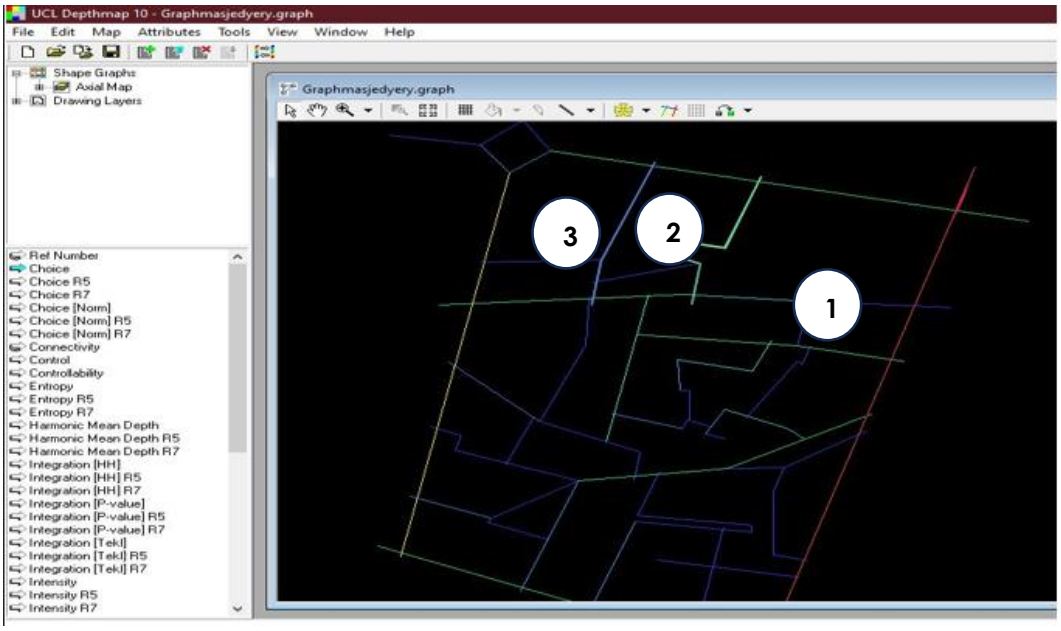

Fig. 6. Selection Graph

Based on the choice graph results in two directions (north-south and west-east), Sadr-e-Jahan Street has the highest choice value, and Chavoshi Alley has a higher choice value compared to the Lower Yeri Mosque Alley.

Table 10
Results of the Choice Graph in Two Directions (North-South and West-East)

Row	CHOISE	Alley or street name	Number	Color	Axis
1	CHOISE MAX	Sadr Jahan Street	1722	Red	North-South
2	CHOISE	Chavoshi Alley	580	Light Green	North-South
3	CHOISE	Yeri Mosque Alley	57	Blue	North-South

C. Comparison of Approved Detailed Plan and Space Syntax Technique Results

Upon reviewing the approved detailed plan and the results from the DEPTH MAPS software using space syntax techniques, it is evident that the results from the space syntax analysis do not align with the approved detailed plan in the north-south axis. While the software recommends widening Chavoshi Alley to enhance permeability, the approved detailed plan focuses on widening the Lower Yeri Mosque Alley.

Table 10
Omparative Comparison of Passages in the Approved Detailed Plan and Space Layout Technique in Two North-South and West-East Axes

Row	INTREGRATION	Alley or street name	Software Number	Matching	Color	Axis
1	INTREGRATION MAX	Shahid Molaei Alley	1/36	Detailed plan approved and layout of the space	Bright Yellow	West-East
2	INTREGRATION	Chavoshi Alley	1/298	Space Layout	Yellow	North - South
3	INTREGRATION	Yeri Mosque Alley	1/06	Approved detailed plan	Turquoise	North-South

D. Reaction of the City as a Living Organism to Physical Interventions Over the Past Decade (Lower Yeri Mosque Area)

Cities are living entities that exhibit vitality and continuously change their appearance. Urban planners and designers influence cities through their decisions, and cities respond accordingly. When faced with expert interventions, cities thrive, but inappropriate interventions can lead to decline. Unfortunately, in most cases involving deteriorated urban fabrics, there is widespread agreement on government intervention to facilitate the revitalization of these areas. In countries like ours, where most investments come from the public sector rather than private entities, plans often stall due to changes in laws, government priorities, or economic challenges.

By examining the latest status of Mosaddeghi Alley (Figure 7, left) and Chavoshi Alley (Figure 7, right), it is evident that Mosaddeghi Alley, which was planned for the most widening according to the detailed plan, has faced less public acceptance compared to Chavoshi Alley for reconstruction. As a result, it has experienced regression in terms of widening and physical penetration.

5. Conclusion

Analysis of the results shows that the existing passages in the lower Masjed-e-Yeri area of Zanjan do not fully align with the approved detailed plan in some key indicators such as spatial integration and connectivity. This could be due to the inefficiency of the detailed plan in predicting real needs. In some areas, the passages suffer from limitations in width, inconsistency in the quality of routes, and weak connectivity with main roads, leading to reduced accessibility and safety for citizens. However, in certain areas, the spatial structure of the passages, with high control and connectivity indices, provides opportunities to improve accessibility and social interaction. These cases can serve as a basis for planning to expand urban functions. Thus, the research highlights the importance of space syntax in analyzing spatial structures, showing that major passages play a crucial role in the access network of the area. High-frequency routes are mainly concentrated along specific axes. This emphasizes the need for revisiting the detailed plan to strengthen the role of these passages. Field visits confirm that operational issues such as material inconsistency, lack of proper signage, and physical barriers like illegal parking have limited the functionality of the passage network. These findings justify the need for improvement from both human and objective perspectives. A city is a living entity that responds to decisions made by officials; it thrives with well-thought-out interventions but deteriorates under poor planning

A review of the approved detailed plan by Zanjan Municipality in 2009 for the lower Masjed-e-Yeri area, as well as the latest reconstructions and setbacks in the Chavoshi and Mosaddeghi alleys, clearly indicates that residents of the lower Masjed-e-Yeri area have chosen to develop Chavoshi Alley rather than following the approved plan's emphasis on widening Mosaddeghi Alley. This aligns with the findings of the space syntax technique used in this study .

The transportation infrastructure of a city, in terms of quality, passages, scale, and accessibility via public transport, defines the ease of people's access to buildings, spaces, and places within an urban area. This creates a network of transport-related accessibility in the area, which can be considered in terms of travel distance, time, and cost. Therefore, designing streets prioritizing vehicle traffic in two north-south axes (Chavoshi Alley) and one west-east axis (Molaei Alley) facilitates public transport accessibility. Due to population density and geographical location, these routes are economically justified for creating public transport stations. Overall, while increasing physical penetration, they also contribute to the sustainability of the area. In other routes, spatial justice and centralization within the area should be considered by encouraging citizens to use public transport and reducing personal car usage, thereby decreasing greenhouse gas emissions and promoting urban sustainability. Additionally, these routes should prioritize pedestrian traffic to prevent further fragmentation of the area's texture.

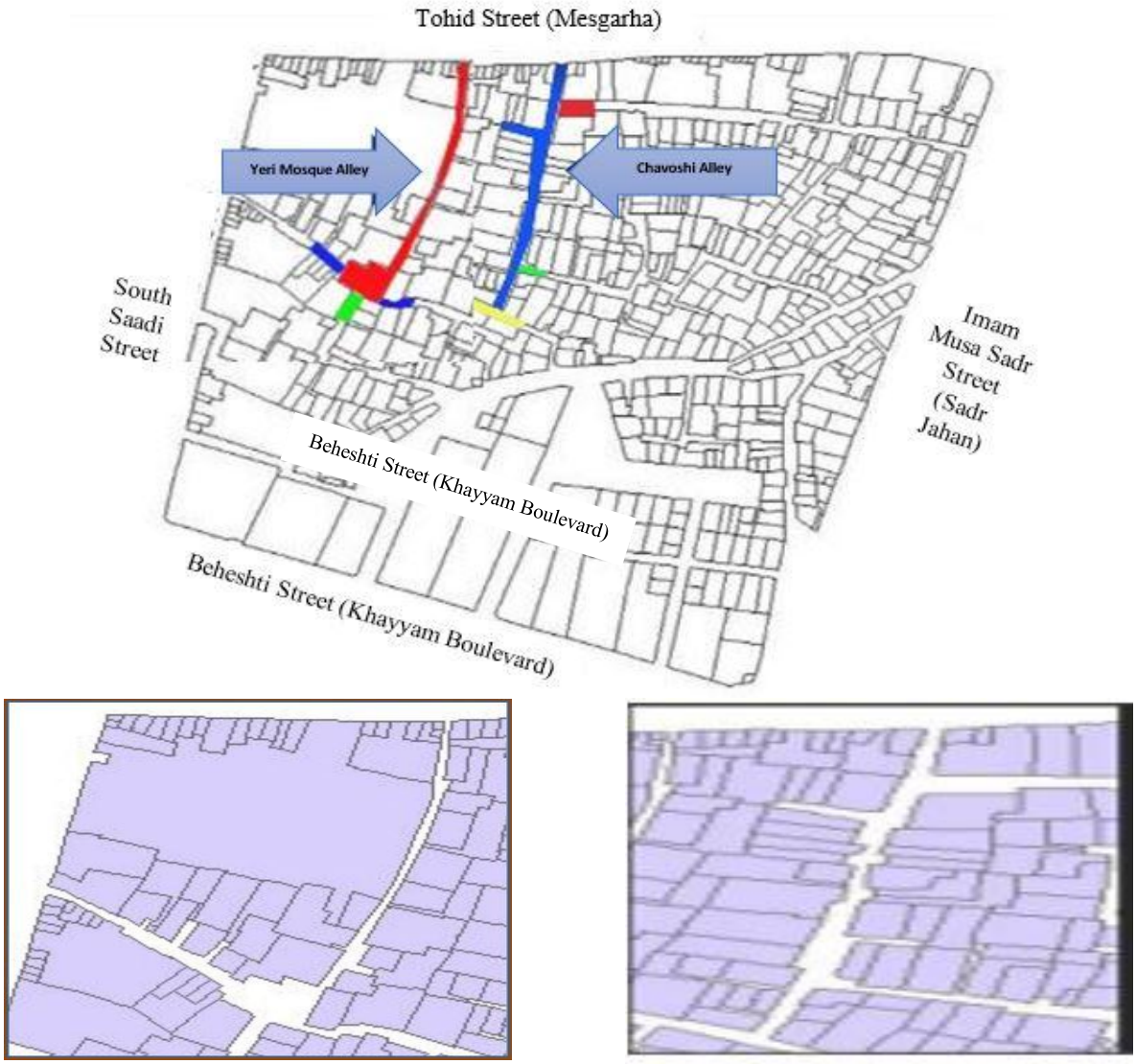

Fig. 7. The latest situation of masjidi alley (left) and chavoshi alley (right) in gis of zanjan city

6. Recommendations

Based on the findings of this study, urban planners must decide, during any intervention, how many routes should be placed on a site, how they should connect with each other, and where they lead. Prior to any intervention plan, it is advisable to conduct comprehensive surveys among residents through consulting firms or facilitation offices, as they are the actual beneficiaries of any urban intervention. The success of any plan depends on gaining the trust and input of residents, keeping in mind that a city is a living entity. Each urban fabric should be evaluated independently and then harmonized within the overall urban framework, avoiding generic plans even for similar textures, as no two fabrics are entirely alike. Revisiting the detailed plan of this area, particularly in improving the road network with an emphasis on alignment with real indicators such as integration and connectivity, is necessary. Overall, improving the quality of passages includes reconstructing them with standard materials, adding appropriate signage, and installing necessary safety equipment. Attention to the

needs of a living environment—planning for improved accessibility, safety, and visual appeal—should be prioritized so that citizens have a better experience of the space. Maintaining coherence and unity in the area through local passage design (prioritizing pedestrian over vehicle traffic) is essential in such interventions and measures. Defining new criteria for evaluating passage widening and expanding physical penetration in detailed plans, such as:

a) Access to streets (evaluating the connectivity of surrounding zones with the designed area, which refers to integration in Space Syntax and is the primary criterion for analysis).

b) Evaluating penetration length and alley position relative to the centrality of the designed area for equitable access.

c) Number of connected alleys (connectivity capability).

d) Selecting alleys with the least number of turns (visual penetration reduction).

e) Evaluating the possibility of opening and continuity of alleys to increase access and integration.

f) The impact of passage extension and openness on physical penetration is essential for establishing unified procedures and systematic, comprehensive actions based on citizen needs when preparing such urban plans.

g) Widening and opening passages with priority for vehicle traffic on two north-south axes (Chavoshi Alley) and one west-east axis (Molaei Alley) to facilitate public transport accessibility

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