Assessment of the Capacity of Infill Development in Rural-Urban Deteriorated Fabric (case study: Naeemabad, Yazd, Iran)

Hamidreza Sheidabaghdadabad (corresponding author)[1], Pooyan Shahabian [2]

[1]-MA of urban planning, Urban Planning Department, Central Tehran Branch, Islamic Azad University, Tehran, Iran.
[2]-Assistant Professor, Urban Planning Department, Central Tehran Branch, Islamic Azad University, Tehran, Iran.

Abstract: Following the outer expansion of cities, rural habitats, which are in the course of this development, gradually take urban features and are considered as neighborhoods of cities. In this study, these villages are known as the "village-city". Examples of these rural-urban textures can be seen in the city of Yazd, whose number reaches. One of these villages is Naeem Abad which experienced transformations in its normal course of operations during its merge with Yazd. In addition, access and physical problems caused issues for this village-city such as wear-out. Like other rural-urban textures, this texture has significant levels of agricultural lands, gardens and arid, abandoned lands. For example, more than 30 percent of the lands of the Naeem Abad village-city is composed of arid lands. Given above, it can be said that the main goal of this study is to measure infill development of the Naeem Abad old texture. To this end, after reviewing relevant literature and selecting the infill development program as a theoretical approach and considering the lands in the Naeem Abad old texture as infill levels and identifying the study scope and its lands, using the study criteria and indicators, the development capacity of the said lands is analyzed using Analytical Hierarchy Process (AHP) in the GIS environment. The results of this study are: (1) Effective indicators in measuring infill development in the rural-urban old textures fall in functional, physical, social, economic and managerial criteria. By preparing the map for each effective indicator and criterion in assessing the development capacity of lands in the rural-urban old texture and overlaying them by applying the calculated weight with the AHP method according to expert opinions, we can obtain a map that is indicative of development priority in the lands of this texture. (2) The development of Naeem Abad village-city, with the infill development approach, makes a part of the urban texture sustainable, while preventing outer and dispersed extension of the city.
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Introduction

Due to the increase in population and lifestyle changes today than in the past, the central textures of cities have become empty and cities have developed towards their surrounding areas. This trend, if continued, will swallow the lands around cities. However, in a part of the lands around cities, settlements have already been formed as villages. The village-city integration has happened with all the positive and negative consequences for the city and village and now we are forced to accept these villages as a part of our urban texture. In this study, such villages are called "village-city". A large part of lands in these textures is unused or abandoned and underdeveloped, which worsened irregular and scattered urban development. The lack of development of lands in these textures led to intensified urban spread, the loss of agricultural lands and natural environment, increased cost of municipal services, environmental problems and related pollutions, conflicts in neighboring uses and a decline in security of residential textures. On the other hand, buildings within these textures have the minimum living quality due to structural problems, and it is not easy to modify and upgrade them in an ad-hoc basis because of physical and access problems.

The 1970 decade is the start of the civil society's reaction and criticism to the negative consequences of scattered urban development. In this context, new concepts and ideas were raised including sustainable urban development, compact city, new urbanism, smart growth and infill development. This is the beginning of change for urban development policies from exogenous to infill development (in response to the challenges of scattered development). Infill development is a practical way to prevent the city expansion into underdeveloped countryside lands and green rural areas and development of vacant and abandoned lands within urban areas. It somehow supports the city restoration and revitalization. Basically, infill urban development policy refers to improving productivity and optimizing land use and intra-city development.

Given above, it can be said that the main goal of this study is to examine urban development and measure the infill development capability in the rural-

urban old textures, and express the advantages of this type of development.

Research question

The research question is: How can we measure infill development capacity in lands and spaces in old textures of the Naeem Abad village-city of Yazd and their zoning and priority based on the infill development indicators?

Research method

This study is applied in terms of nature and its results can be used for decision-making and planning. The study strategy is ex post and the data analysis method is descriptive and case study. For data collection, the documentary and field methods are used. In this context, library information and tools, available documents and maps, especially GIS maps of Yazd as well as field harvests, observations, questionnaires and interviews are used.

Because of the need to prepare the GIS information layers from basic location indicators and obtain the final map for determining zones with high development priority, we should use a method that determines the weight and importance of criteria and indicators. In this regard, the analytic hierarchy process (AHP) method is used for weighing indicators. It should be noted that for weighing and determining the importance of criteria and indicators, a questionnaire is designed and provided to experts and then the weights of indicators and criteria are calculated by Expert Choice. The statistical population can include urban managers and urban planning experts.

Literature review

Rural-urban old texture

The village-cities are environments where the city-village-nature or rural-urban systems have met and combined (urban-rural action place) (Daneshpur, 2006: 7) and their land use has changed from rural to urban (Cowan, 2005: 428). In fact, some kind of urbanization process happens for a village. (Goli and Askari, 2006: 140) Thus village-cities in this article are former villages around cities that have joined the city today and are considered a neighborhood of the city (Akbari-Qaderyan, 2013: 99) and are different from village-city in its classical meaning (the common term in the world urban literature).

The rural area has remained physically rural only in the heart of the city, but the residents, their culture, jobs and livelihoods have changed from rural to urban (Nooshafarin, 2010: 20). Since the beginning of the emergence and formation, this type of rural textures have been deprived of many urban services and infrastructure (Utopia, phase II, Volume I, 2007: 15). Changes did not end here and unplanned changes caused many problems such as a lack of designing organic texture and passageways for large population and complexes, lack of proper land division and united construction pattern, native and exotic culture mismatch and its social problems (Nooshafarin, 2010: 20). With the passage of time and the effects of economic weakness of residents for texture modernization, old textures assumed large dimensions. (Utopia, phase II, Volume I, 2007: 15). Attention to rural-urban textures as an opportunity requires an approach in order to benefit from urban facilities and opportunities in addition to rural potentials and strengths; thus rural-urban textures must be considered as opportunities to create sustainable urban settlements (Akbari-Qaderyan, 2013: 90).

Infill development

The urban growth pattern in the years after World War II (1940) was urban dispersion which made cities to spread horizontally and caused many adverse consequences such as distributed development and the loss of agricultural lands and gardens, population evacuation for inner-city textures and their destruction, service delivery problems due to uncontrolled expansion of the city, environmental problems and pollution as well as an increase in the city scope and the destruction of natural centers (Rahnama-Abbaszadeh, 2008: 61). But the 1970 decade is the beginning of critics and reaction of urban planning society to negative consequences of scattered development (Mohammad Zadeh, 2007: 94). Thus this is the beginning of change for urban development from exogenous to infill development policies (in response to the challenges of scattered development) (Rahnama-Abbaszadeh, 2008: 61).

The infill development talk was first raised in Habitata Conference in Canada in 1976 (Ardjmand, 2008: 32). Three years later, the concept of infill development was officially defined for the first time in 1979 by the Real Estate Association of America and was used for economic purposes (Hudnut, 2001: 1). After combining with the concepts of sustainable development, it became ecologically important. Among the benefits of infill development, one can point to environmental, social, economic and physical benefits (APA, 2006: 456).

There is a wide range of definitions to describe infill development. But it should be noted that all these definitions focus on common concepts, some of which are noted below:

- Infill development is a usually residential development on a land remained among buildings (Saifodini, 1998, p. 230). In other words, development of vacant lands and non-usable buildings that are often found in developed areas is called infill development. (City parish planning commission, 2004, p.1)
- Infill urban development is a practical way to prevent the spread of city in underdeveloped

countryside lands and green urban areas and develop vacant and abandoned lands within urban areas. It somehow supports urban restoration and revitalization. (EPA, 1999: 2)

- Infill development fills the gaps in the city's neighborhoods and plays a vital role in the use of existing urban potentials, protecting unused lands and preventing urban dispersion. (Kienitz, 2001: 5)
- Infill development refers to the use of existing buildings and parts of vacant or unused lands in the center of a metropolis for directing the growth against the development of outdoor and farmlands on the periphery of the city. This type of development is a regional smart growth strategy. (Caves, 2007: 258).

Experience in the field of infill development

In developed countries, given the high importance of sustainable development, environmental protection and efficient use of various resources, issues such as smart growth, infill urban development were and still are considered. (MRSC, 1997: 56) In this section, due to extensive experiences in the field, Table 1 summarizes some works done in the field of infill development in different cities and states in 3 areas: demolishing old textures, arid and abandoned lands and spaces with ownership issues. Then examples of each type of infill development are presented.

Table 1: Summary of works done in the field of infill development

Classification	Development name/location	Scale/type of development	Use of the previous site
Demolishing old textures	Southern District of Greensboro, North Carolina	10 acres, mixed uses	Abandoned residential area near the historic main street of Greensboro
	Marston area, San Diego	1.2 hectares, 42 residential units	Demolishing commercial and residential buildings
	Franklin Square	3 acres, 105 residential units	Demolishing school
	Belmar, Lakewood, Colorado	3.5 million square feet, creating 22 urban blocks with mixed uses	Abandoned lands of the city's old market (NJDCA, 2006: 14)
	Boca Raton and Florida	Neighborhoods with mixed uses, pedestrian-oriented and transit-oriented	In the stagnant demolishing central and commercial parts (Northeast-Midwest Institute, 1999: 7)
	City of Portsmouth, Virginia	A mixed neighborhood unit including new and traditional homes, parks and open spaces	A 45-acre public housing project (Northeast-Midwest Institute, 1999: 8)
Arid and abandoned lands	Western Region, Fort Worth	11 acres, 350 residential units	14 aggregated empty parts
	Greenwich Park, Cincinnati	1.8 acres, 212 residential units, retail units at ground floor	Previously flat parking parts
	Jersey City, New Jersey	19 acres, 1,000 residential units	Arid lands near Roosevelt Stadium
	Asbury Park, New Jersey	56 acres, 3,200 residential units, 450,000 square feet of retail units and hotels	Arid and empty lands (NJDCA, 2006: 14)
Spaces with ownership problems	Kuala Lumpur, Malaysia	The plan includes residential users (504 units), commercial spaces (retail), recreational-cultural facilities and parking	Ground project around and along Mushi Abdullah Street with an inherited ownership (Yean, 2006: 138-140)

A review of the research question

How can we measure infill development capacity in lands and spaces in old textures of the Naeem Abad village-city and the zoning and their priority based on the infill development indicators?

In this study, the infill development program was selected as the theoretical research approach for capacity assessment of land development which was presented theoretically and its analytical and administrative models were introduced and explained.

To answer the question, the following steps must be performed:

- Understanding the general, physical, functional, social, economic and managerial characteristics related to the lands of rural-urban old textures: In order to identify the research areas, we identify the status quo in the scope. In this section, we identify the demographic, economic, social, physical and institutional-managerial characteristics and examine the research indicator in the studied area through the use of available documents, GIS maps of Yazd as well as field harvests and observations, interviews and questionnaires.
- Identifying effective indicators in the development of rural-urban old textures in different dimensions, with particular attention to the specific characteristics of the lands
- Determining the importance factor of effective criteria and indicators using Analytical Hierarchy Process (AHP)
- Preparing maps for each indicator and criterion and overlaying maps by applying the relevant weights
- Preparing the final map by combining maps for criteria, showing the land development capacity of the rural-urban old texture
- Prioritizing them in terms of development capability

After reviewing indicators, the information layers for basic location indicators are provided in the GIS environment. Then, for zoning and prioritizing lands in terms of development, the layers are overlaid by applying calculated weights for each indicator through AHP. The end result is the map for zoning and prioritizing lands In Naeem Abad, Yazd. Finally, a table provides characteristics of each zone.

Criteria and sub-criteria for the study in the AHP method

Some criteria are required to evaluate development capabilities of infill levels and their priority in relation to the physical, functional, economic, social, and managerial areas. Accordingly, based on the criteria and indicators used in the world experiences and of course, the subject of this study, terms and problems of the studied scope, and a special emphasis on the rural-urban old texture, the criteria and indicators of interest in this study will be introduced below.

The main criteria which have different dimensions include physical, functional, economic, social and managerial. For each of these criteria, indicators are considered which act as sub-criteria in the hierarchy structure of AHP, as shown in Figure 1:

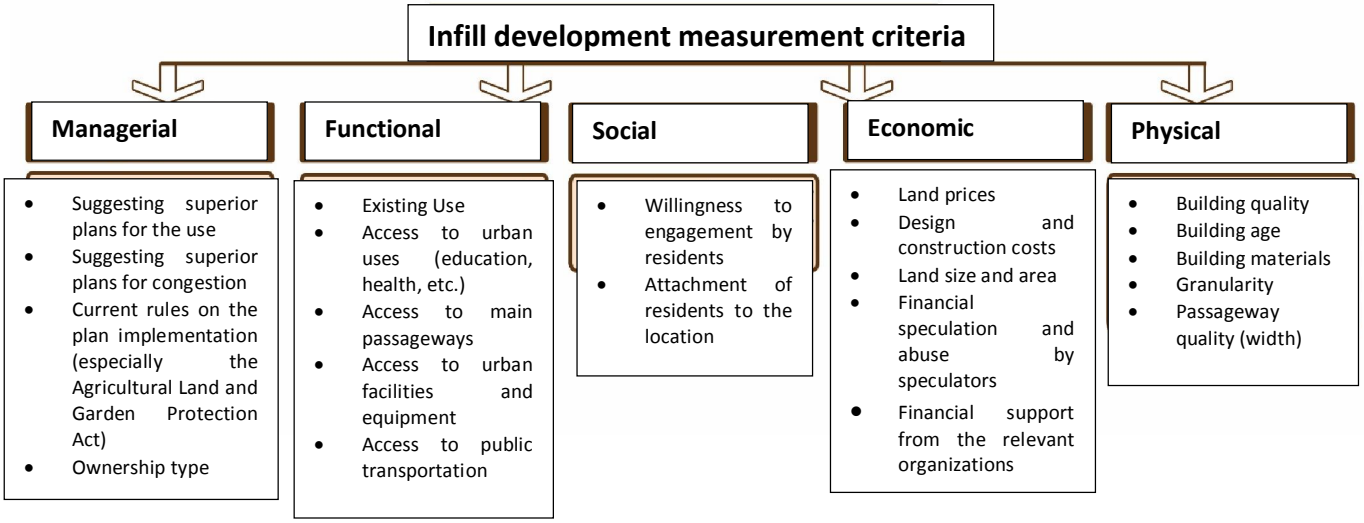


Figure 1: Measurement criteria and indicators for infill development

Research range and scope

Naeem Abad District of Yazd, which is also called Abshahi, is delimited by north to Akbar Abad neighborhood, by south to Daneshjoo Boulevard and Feyziyeh district, by east to Ayatollah Kashani Avenue and Mehdi Abad district and by west to Qasim Abad district. This district was constructed in the eighth century AH by Nusratoddin Shah Yahya (Khademzadeh, 2005: 201). Naeem Abad is currently considered as a neighborhood of Yazd in public opinion as well as in urban projects, including detailed plan and comprehensive plan prepared by the consulting engineers.

It can be said that Naeem Abad is worthy of study in two parts: old (rural) and new (urban). The first part is the old and rural area which includes gardens, farms and mainly rural homes, while the second part is composed of a series of new constructions mainly around the urban passageways of the village-city which is considerably different from the first part.

In terms of location, Naeem Abad has a good and valuable position in Yazd. It is located quite in the city and close to the downtown areas, and close to the old and new urban centers. In terms of access, it is located in the immediate vicinity of the arterial roads (Kashani Street and Daneshjoo Boulevard) which facilitates relations with other parts of the city, representing the high quality of the scope.

Data analysis for Naeem Abad in the field of development measurement criteria and indicators

The AHP method is used for data analysis. The AHP technique consists of three main steps:

a) A hierarchical structure is formed from the goal, criteria or indicators.

b) With pair comparisons between criteria and sub-criteria, the relative weight for each one is determined.

c) The judgment consistency is also determined for confirming the accuracy of calculations (Hadiani-Kazemi Rad, 2010, p. 105).

Then, after weighing criteria and indicators, in order to achieve the main objective of the study (i.e., measurement of land development capacity of the old texture of Naeem Abad), information layers (maps), which were provided in the previous step based on indicators for each criterion by applying the specified weight, are overlaid in the GIS environment in the Arc Map program. The result of overlaying sub-criteria maps is a map for the relevant criterion. Finally, the map for criteria are overlaid after applying the calculated weights with the AHP method and the final map is produced which shows the land development capacity and their development priority.

Hierarchy structure of goal, criteria and indicators

In order to assess the land development capacity in the studied area (Naeem Abad, Yazd), as previously mentioned, some criteria and indicators were determined in this field, whose hierarchical structure can be seen in Figure 1.

Determining the importance factor of indicators and creating the related maps in the GIS environment

In this section, based on pair comparisons between the indicators of each criterion extracted from the questionnaires completed by experts, their calculated weights in Expert Choice can be seen in the table below. Then, in order to assess the land development capacity of the studied area, maps for basic location sub-criteria associated with each criterion (provided in the previous section) are overlaid in the GIS environment by applying the calculated weights. The result is the map related to each criterion.

Table 2: The 9-quantiy comparison of Saati for evaluation of criteria and sub-criteria (Zebardast, 2001)

Preferences (oral judgment)	**Value**
Completely more important or quite more desirable	9
Very strong importance or desirability	7
Strong importance or desirability	5
A little better or a little more important	3
The same desirability or importance	1
Priorities between intervals	2, 4, 6 and 8

Functional criteria

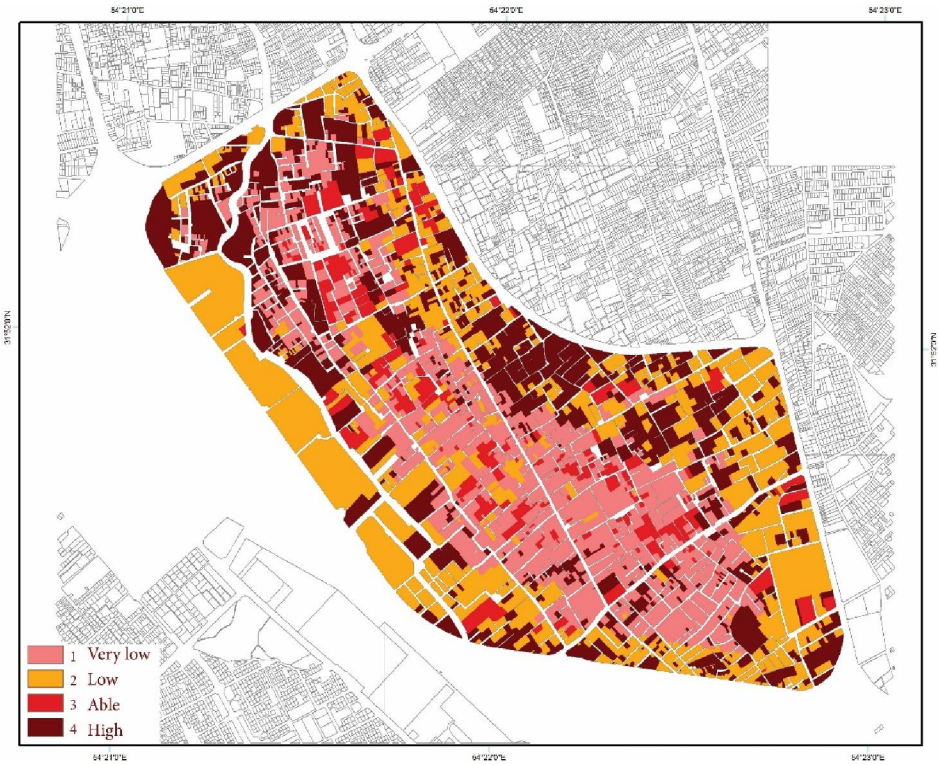
With regard to the pair comparison of functional indicators based on expert opinions extracted from questionnaires, the weight of each indicator was determined in Expert Choice.

Table 4-21: Pair comparison of functional indicators, (source: information extracted from questionnaires).

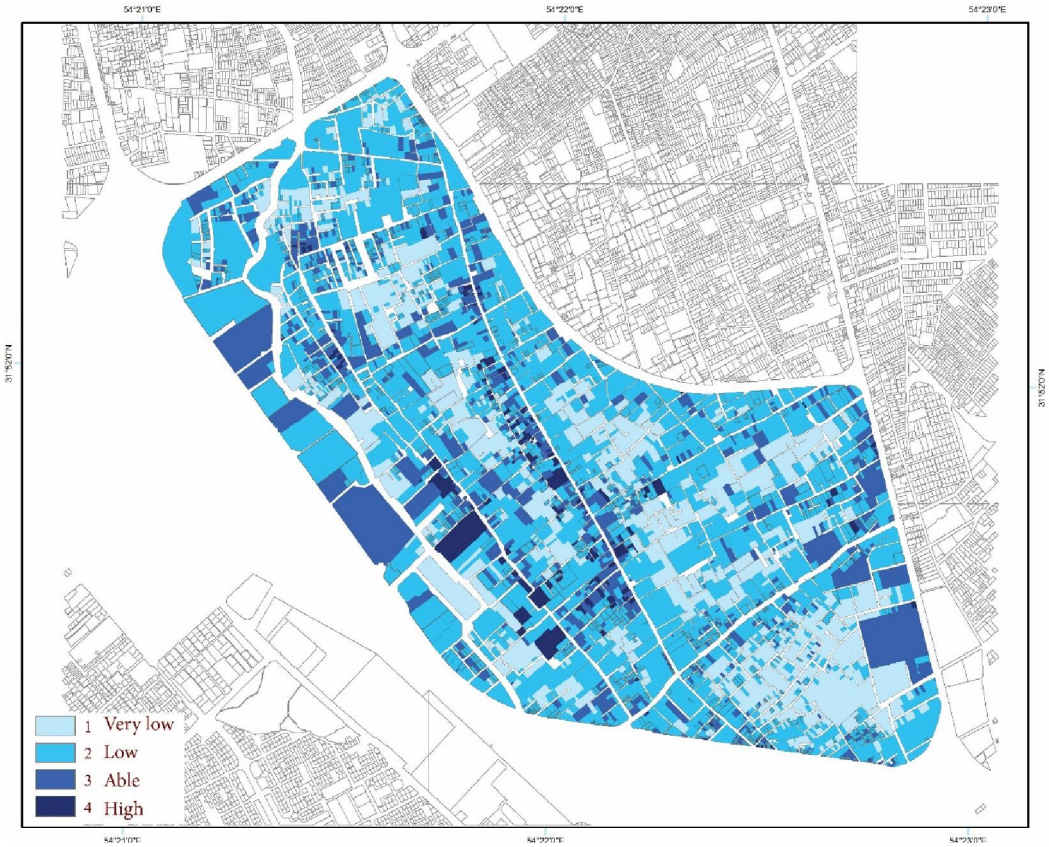
Table 3: Importance factor of functional indicators, source: information extracted from the AHP (Expert Choice)

NO	**Sub-criteria**	**Important factor**
1	Existing Use	0.420
2	Access to facilities and equipment	0.252
3	Access to main passageways	0.162
4	access to urban uses	0.099
5	Access to public transportation	0.066
Total		1
Inconsistency factor		0.02

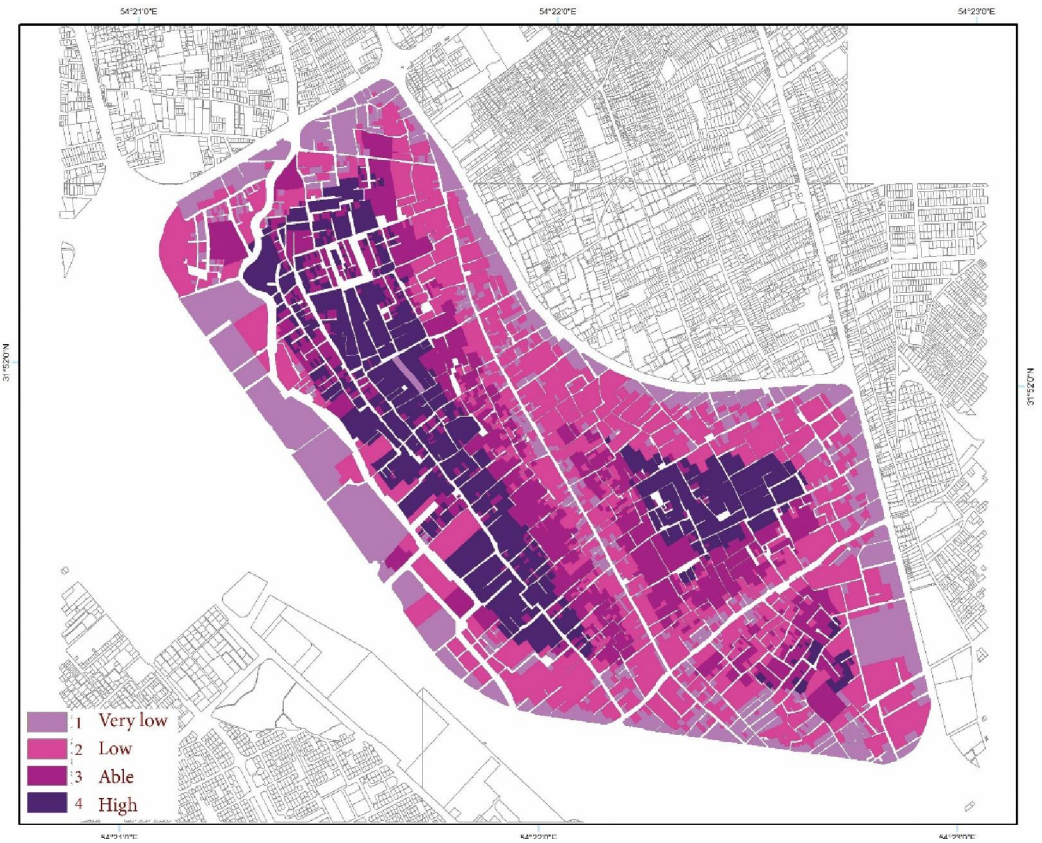
In this section, maps for functional sub-criteria provided in the previous section are overlaid in Arc Map by applying the related weights. The result is the functional criteria map that shows the land development priorities for this criterion. In Map 1 which is output of overlaying the related maps, lands are prioritized into four categories:



Map 1: Zoning of infill development priorities based on functional criteria, source: author



Map 2: Zoning of infill development priorities based on physical criteria, source: author



Map 1: Zoning of infill development priorities based on economic criteria, source: author

Physical criterion

With regard to the pair comparisons of physical indicators based on expert opinions extracted from questionnaires, the weight of each indicator was determined in Expert Choice.

Table 4: Importance factor of physical indicators, source: information extracted from questionnaires

NO	Sub-criteria	Important factor
1	Building quality	0.412
2	Passageway quality	0.259
3	Granularity	0.158
4	Building materials	0.116
5	Age	0.055
Total		1
Inconsistency factor		0.04

Table 4: Importance factor of physical indicators, source: information extracted from the AHP (Expert Choice)

In this section, maps for physical sub-criteria provided in the previous section are overlaid in Arc Map by applying the related weights. The result is the physical criteria map that shows the land development priorities for this criterion. In Map 2 which is output of overlaying the related maps, lands are prioritized into four categories:

Economic criterion

With regard to the pair comparison of economic indicators based on expert opinions extracted from questionnaires, the weight of each indicator was determined in Expert Choice.

Table 5: Importance factor of economic indicators, source: information extracted from the AHP (Expert Choice)

In this section, maps for economic sub-criteria provided in the previous section are overlaid in Arc Map by applying the related weights. The result is the economic criteria map (42-4) that shows the land development priorities for this criterion. In Map 3

which is output of overlaying the related maps, lands are prioritized into four categories:

Table 5: Importance factor of economic indicators, source: information extracted from questionnaires

NO	Sub-criteria	Important factor
1	Land prices	0.399
2	Financial supports	0.273
3	Land speculation	0.170
4	Land size and area	0.102
5	Design and construction costs	0.056
Total		1
Inconsistency factor		0.02

Social criterion

With regard to the pair comparison of social indicators based on expert opinions extracted from questionnaires, the weight of each indicator was determined in Expert Choice.

Table: Importance factor of social indicators, source: information extracted from the AHP (Expert Choice)

NO	Sub-criteria	Important factor
1	Participation of residents	0.750
2	Attachment of residents	0.250
Total		1
Inconsistency factor		0

Managerial criterion

With regard to the pair comparison of managerial indicators based on expert opinions extracted from questionnaires, the weight of each indicator was determined in Expert Choice.

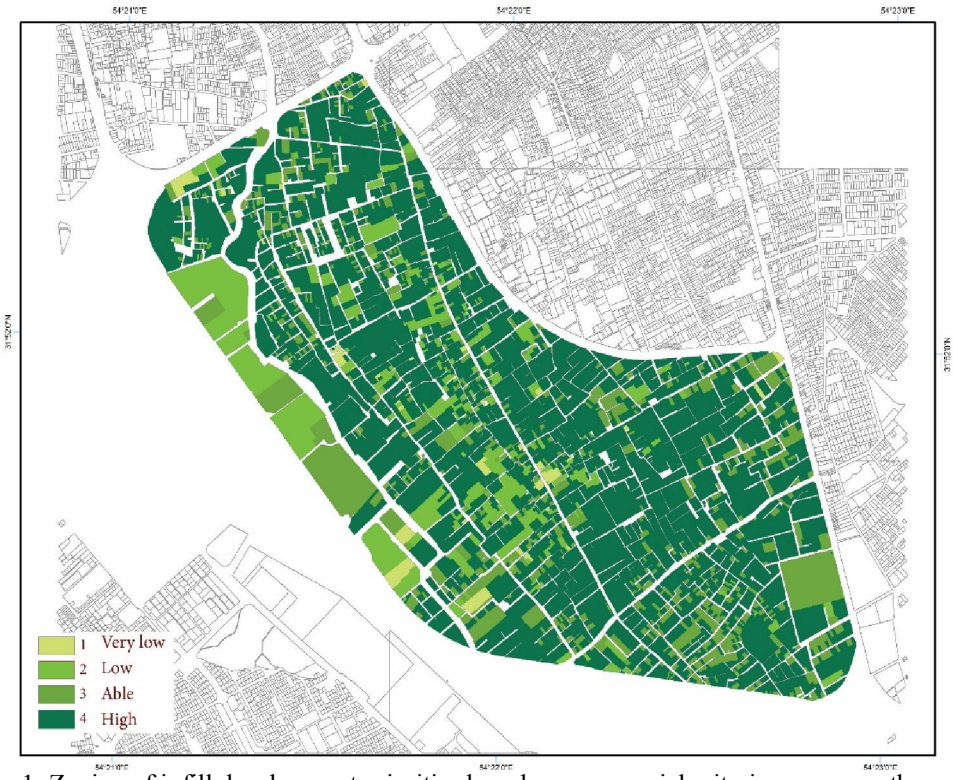
Table 6: Importance factor of managerial indicators, source: information extracted from the AHP (Expert Choice)

NO	Sub-criteria	Important factor
1	Ownership type	0.462
2	Suggesting plans for congestion	0.274
3	Suggesting plans for use	0.178
4	Existing law	0.086
Total		1
Inconsistency factor		0.03

In this section, maps for basic managerial sub-criteria (provided in the previous section) are overlaid in Arc Map by applying the related weights. The result is the managerial criteria map (43-4) that shows the land development priorities for this criterion. In this map, which is output of overlaying the related maps, lands are prioritized into two categories:

Table 7: Pair comparisons of the research criteria, source: information extracted from questionnaires According to the table in Expert Choice, the weight of each criterion was calculated.

Economic	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	Physical
Social	9	8	7	6	5	4	3	2	1	2	3	**4**	5	6	7	8	9	Physical
Managerial	9	8	7	6	5	4	3	**2**	1	2	3	4	5	6	7	8	9	Physical
Social	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	Economic
Managerial	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	Economic
Managerial	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	Social
Managerial	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	Functional
Social	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	0	8	9	Functional
Economic	9	8	7	6	5	4	3	2	1	2	3	**4**	5	6	7	8	9	Functional
Physical	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	Functional



Map 1: Zoning of infill development priorities based on managerial criteria, source: author

Determining importance factor for criteria

The following table shows pair comparisons of criteria according to expert opinions extracted from questionnaires.

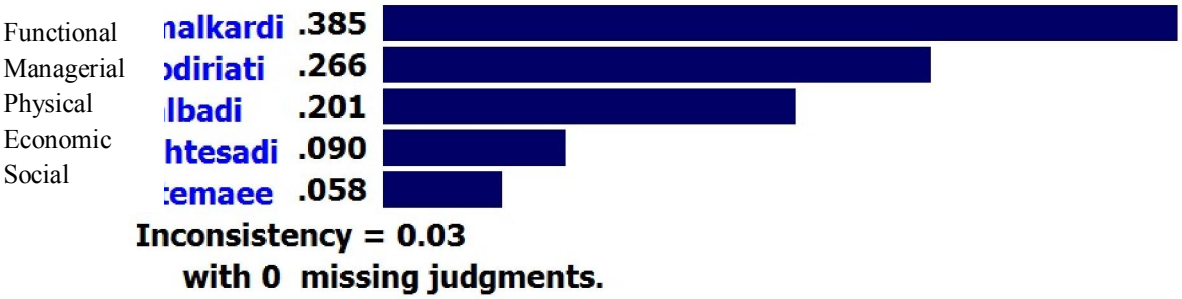


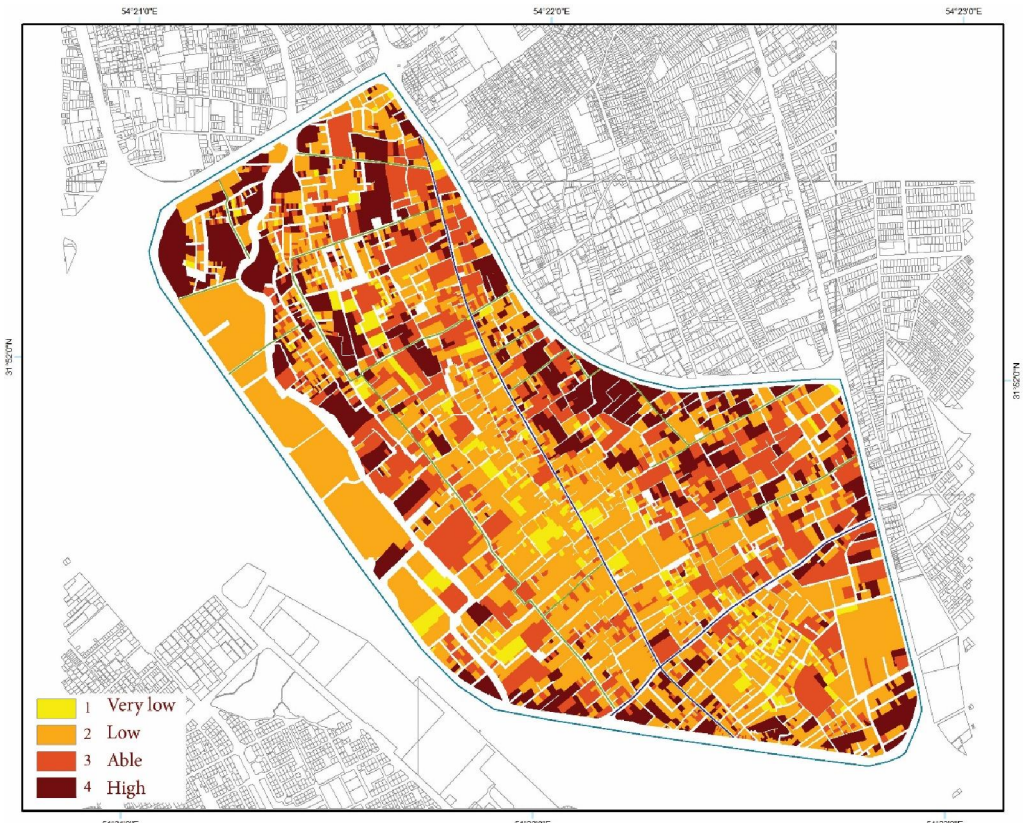
Chart 2: Importance factor for the research criteria, source: information extracted from the AHP (Expert Choice)

Assessing the land development capacity of the old texture of Naeem Abad, Yazd (prioritization in terms of development capability)

In order to determine land priority for the studied area in terms of development capability, the maps for physical, economic, social, functional and managerial criteria are overlaid after applying the corresponding weights and the final map is obtained which represents development capacity of lands in terms of priority.

Map 5 shows the lands of the studied area in terms of development capability. Lands are classified in 4 categories: high development capability, moderate development capability, low development capability, and very low development capability.

As is known, land distribution is as follows: high development capability (18.11%), moderate development capability (25.35%), low development capability (51.78%) and very low development capability (4.75%). Table 4-32 and Diagrams 4-29 and 4-30 show area and percentage of lands in each category. It is known that lands with low and very low development capability make up more than half of the scope. One of its most important reasons is coarse uses such as office and higher education uses in these areas.



Map 5: Zoning for infill development priorities, source: author

Table 8: Area and percentage of lands for each development category, source: information extracted from questionnaires

Land prices	**Frequency percentage**	**Frequency of parts**	**Area percentage**	**Area (ha)**
The first priority of development (high development capability)	12.32	692	18.12	54.1
The second priority of development (moderate development capability)	18.78	1055	25.35	75.1
The third priority of development (low development capability)	63.6	3574	51.78	154.64
The fourth priority of development (very low development capability)	5.3	298	4.75	14.17
Total	100	5619	100	298.63

Conclusion

The most important result of this study is the definition of an analytical model to assess the development capacity in the lands of a rural-urban old texture that was tested in the lands of Naeem Abad District, Yazd. According to this model, the land development capacity was measured and evaluated in the context of infill development program by a set of criteria indicators. To run the model for the lands of a scope, the following steps must be performed:

- Understanding the general, physical, social, economic and managerial characteristics related to the rural-urban old texture
- Identifying effective indicators in the land development of the rural-urban old texture in different dimensions, with particular attention to the specific characteristics of the lands
- Determining the importance factor for effective criteria and indicators
- Preparing maps for each indicator and criterion and overlaying maps by applying the relevant weights
- Preparing the final map by combining the maps of criteria, showing the land development capacity of the rural-urban old texture (prioritizing them in terms of development capability)

In this study, for assessing the land development capacity of the studied rural-urban old texture, the following factors are effective, respectively: **functional** (with a weight of 0.385 and indicators such as the existing use and access to passageways), **managerial** (with a weight of 0.266 and indicators such as type of ownership and suggesting superior plans), **physical** (with a weight of 0.201 and indicators such as building quality and building materials), **economic** (with a weight of 0.090 and indicators such as land prices, design and construction costs, and land size) and **social** factors (with a weight of 0.058 and indicators such as tendency to heavy participation and a sense of belonging).

In addition, by preparing the maps for each of the criteria and indicators in the GIS environment using Arc Map and then combining the maps by applying their calculated importance factors, a map is produced which shows the land development capacity of the rural-urban old texture. The result of this section is a map that prioritizes the studied rural-urban old texture into four categories based on development capability.

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