

Proposed Definition and Typology of Brownfield Sites in Iranian Cities

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ABSTRACT: The term of brownfield and its redevelopment has been considered extensively in the world urban planning literature. However, the nature of the brownfields and the differences between how they are created in countries have caused this term to be defined based on the contextual and typological conditions in each country, involving a wide range of lands. Meanwhile, despite the high importance of brownfield development in improving the quality of urban life, this issue is still neglected in the urban planning system of Iran. Therefore, this study is aimed to propose the definition of brownfield sites in Iranian cities and their typology as a policy to help reconsider them in urban development plans. After presenting the adaptive criteria extracted from the relevant literature, experts in this field were interviewed to determine the main categories of this concept in the country's cities using the grounded theory qualitative method. Then, the rules and regulations related to the categories were reviewed to finally define this concept and present its comparative typology. The findings show that in Iranian cities, the brownfield sites comprise abandoned sites or lands including activities that pollute the environment, being incompatible with authorized urban activities. According to this definition, twelve types of brownfield sites can be identified in Iranian cities, in which the activities are incompatible with urban activities and they require intervention for development, and one type includes lands with no function at present, in which development has occurred previously.

Keywords: *Brownfield Sites, Grounded theory, Typology, Iranian cities.*

INTRODUCTION

Under-utilized or abandoned properties, commonly referred to as brownfields, are mostly a result of rapid urbanization and de-industrialization (CEN, 2014; Chrysochoou et al., 2012). Brownfields are the result of changing patterns of industrial and urban development, and usually affect the devaluation of the surrounding lands (in the economic, environmental, and social terms), and city officials cannot revitalize them from their own resources (Frantál et al., 2013). Brownfields have mostly been defined as properties with hazardous substances, pollutants, or contaminants (Bartke, 2011; Schädler et al., 2012; Song et al., 2019) that may cause expansion, redevelopment, or reuse to be complicated. Meanwhile, brownfield sites as inner-city potentials for development challenge land and space management (Frantál et al., 2013) because of not only environmental pollution, but also functional incompatibility, social instability, and economic losses in the city (Song et al., 2019). However, the existence of these sites can be considered a serious opportunity at the same time, given the fact that redevelopment of these sites is generally productive and provides a very effective opportunity for texture integration, environmental balances, greater social sustainability, and

economic benefits (Carroll & Eger, 2006; Chen & Khumpaisal, 2009; Schädler et al., 2012; De Sousa, 2002a). That is why countries worldwide have concentrated on recognition, planning and reuse of these types of sites in an attempt to restore them into active urban land uses.

However, the process of recognition and redevelopment of these sites has been neglected or considered rarely in Iranian urban planning system, few traces of the redevelopment of brownfield sites just found in some rules and a handful of experiments. The related rules are scattered, are not subject to a single definition or organization, and have been formulated for special sectors (each based on the needs of the relevant administrative institutions). In fact, there is no specific rule and regulation defining the brownfield concept that not only legitimizes this concept in the urban planning system and city development plans but also being a guidance for urban planners or city authorities to recognize, plan or redevelop these sites. On the other side, the isolated practical experiments implemented in some sites such as Ghasr museum and House of Artists, nearly all have been recognized and redeveloped independently - as urban design projects - which is certain when there is no specific legal definition. Unfortunately, there have been simply limited

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scientific experimental studies conducted in this subject area, isolated surveys investigating and analyzing some cases reused (Afradi & Nourian, 2015; Izadi & Amiri, 2016). Consequently, in Iran there is no comprehensive rule or legal practical attempt about brownfield sites in which define it obviously, identify its types and introduce guidelines for how to redevelop and revive them to be a productive usable part of the city.

Under these circumstances, the first effort to restore these sites into urban planning system is to define and formulate its typology. It is needed a unique and also obvious definition with regards to which, these sites are legitimate, identified and also planned for redevelopment. Nevertheless, explaining the concept and typology of brownfield sites appears not to be straightforward. Firstly, real practices accomplished are limited and scattered as well, not allowing one to identify or formulate the concept. Secondly, the review of the experiences of other countries showed that the brownfield definitions and their orientations presented in European and American countries are not the same as those of the Iranian. In fact, the issue of brownfields in those countries is deeply linked to the history of de-industrialization - the transformations of the social division of labor in the industrial society and the movement of industries from the city center to the periphery-, however; causes of formation in Iran are mostly on the grounds of urbanization and urban growth.

Considering the above challenges, this paper should answer the question that according to the definitions and characteristics presented in the world literature for brownfields and the study of indigenous conditions, what definition of urban brownfields can be provided that is comprehensive and in accordance with the conditions of Iranian cities. The second question is how a typology can be achieved based on the provided definition and institutional context that allows urban planners in both academic and professional realms to identify these lands in different cities. Therefore, the purpose of this paper is first to define brownfields and second to formulate a typological

framework to identify them in cities and reconsider them in urban development plans.

This study describes brownfields, not in terms of the historical evolution of these lands and the reasons for their formation, but entirely in terms of what they are and in terms of their functions. Therefore, the purpose of this research is to present the adaptive definition of the brownfields in the Iranian cities, regarding the differences and contextual characteristics. To this end, after reviewing the theoretical literature and global experiences, the experts in this field are interviewed to determine the main categories of the definition of brownfields in Iranian cities using qualitative content analysis. In the next step, the relevant rules and regulations in the country are reviewed based on the main categories of brownfields. Finally, the definition and typology of these sites in Iranian cities are presented according to the results of the previous steps.

MATERIALS AND METHODS

In the present study, a qualitative research method and the grounded theory were used to provide an adaptive definition of brownfields in the country. The grounded theory is a qualitative method by which a theory is developed using a set of data. In this research, the grounded theory systematic approach, developed by Strauss and Corbin (1990), was applied to analyze data (Fig. 1). In the first step, to investigate the definitions and the characteristics of brownfields and how they were identified in different countries, theoretical resources and global experiences were studied. It was tried, in this step, to examine the same characteristics that exist in all definitions on the one hand and to investigate the reasons for different definitions in different countries on the other hand. These specified the points and the criteria that should be considered in the adaptive definition of brownfields in the country.

In the second step, given the criteria recognized in the previous section, in-depth interviews were conducted with experts in this field regarding the definition, characteristics, and instances

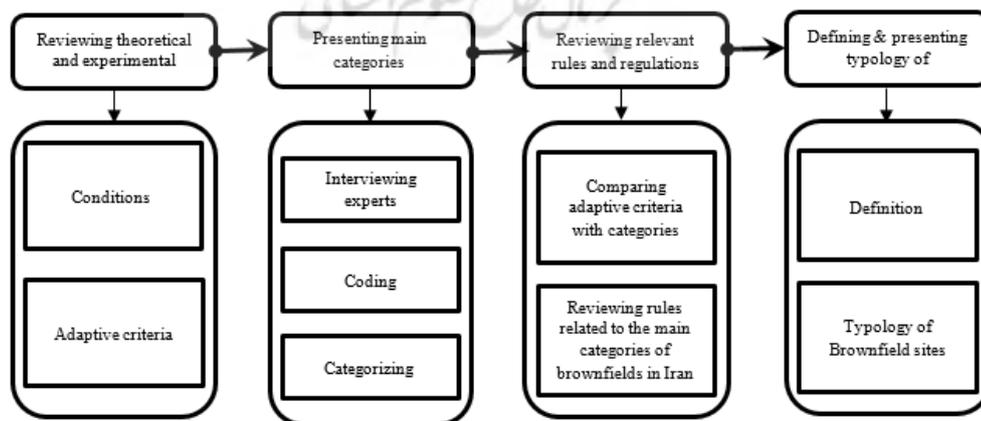


Fig. 1: Research methodology

of these lands in the cities of the country. Gradual strategy of sampling - theoretical sampling- was used for conducting the interviews. Theoretical sampling is the process of collecting data for generating a theory whereby the analysts simultaneously collect, encode, and analyze their data and decide what data to collect in the next step and where to find them to develop their theory as it emerges. The theory under development controls the data collection process (Flick, 2018). It is considered complete when the model of grounded theory construction reaches theoretical saturation, meaning that a grounded theory research reaches saturation when data collection no longer contributes to explaining the object of study (Allen & Davey, 2018). In this paper, theoretical saturation was achieved after interviewing 11 experts who were university professors and professionals. However, to ensure it, 13 experts were interviewed. Finally, the interviews were analyzed using the grounded theory systematic approach. The systematic approach includes three main steps, open coding, axial coding, and selective coding (Strauss & Corbin, 2017), which were used to identify the main categories of brownfields in the cities of the country.

In the third step, based on the results of the previous two steps and the categories extracted from the interviews, the rules and regulations related to these categories were reviewed. In addition to helping us to adapt the definition to the country's urban planning system, content analysis of rules and regulations contributed significantly to presenting the typology of these lands based on the capacities of the planning system. Finally, using the obtained results, the brownfields were first defined, and then the typology were presented with more precision.

Step 1: Theoretical and Experimental Brownfield's Research

The research on brownfields has gained attention in a number of disciplines, including environmental science (Zhu et al., 2015), geography, urban and regional planning (Raco & Henderson, 2006; USEPA, 2002, 2019; Yu-Ting, 2011), land economics (Schädler et al., 2013; Bartke et al., 2016; TIMBRE), and public policy (Han et al., 2019). Moreover, countries all around the world began to make strides to define, recognize and

redevelop brownfield sites. Some are of a legislative definition and the term of brownfield is seen in their legislation, a number of which have only institutional definition and this aim has simply been pursued by a certain organization, but others have yet to agree on a common definition of brownfields.

In the United States, the issue of brownfield redevelopment was pursued to reduce urban land pollution and it then became more serious with the efforts of the US Environmental Protection Agency (Heberle & Wernstedt, 2006). The agency has presented the following definition of brownfields in recent years: A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, reduces development pressures on undeveloped and open lands, and improves and protects the environment (U.S.EPA). In Canada, a brownfield is a commercial or industrial property which is, or possibly is, contaminated; is vacant, derelict or under-utilized; and is suitable for development or redevelopment for the general benefit of the municipality (De Sousa, 2002b).

The Parliamentary Office of Science and Technology (POST, 1998) in UK defines brownfields as buildings and lands that are vacant or could become suitable for development during a relevant planning period and presents the characteristics of these lands as follows (Alker et al., 2000): Brownfields include all derelict lands, not all brownfields are contaminated, but they may be contaminated, not all brownfields are located in urban areas, brownfields are lands that have previously been developed, sites with poor ground conditions that result from natural or human actions and cause physical difficulties that restrict structural development or lead to contamination are brownfields, and sites that are partially occupied but their full capacity is not used are also considered brownfields.

Various definitions of brown field sites have been presented in different European countries, (Table 1). The Concerted Action on Brownfield and Economic Regeneration Network

Table 1: Definitions, characteristics of brownfields in different countries (Alker et al., 2000, Cabernet Sauvignon, 2010, De Sousa, 2002 A and B, Potts & Cloete, 2012, POST, 1998, TIMBRE, 2015, Yu-Ting, 2011).

Definition	Key points	Countries and theorists
Brownfields and polluted lands are commonly used synonymously, as indicated in the following international definition: development and redevelopment of the lands and property, which may be complicated by the presence of .a hazardous substance or pollutant	Polluted lands	Belgium, Denmark, Poland, Romania, Bulgaria, Italy, Spain
Brownfields are synonymous with unused and neglected lands that may not be contaminated	Abandoned lands	Ireland, Slovenia, Netherlands, Scotland
Brownfields are lands that have previously been developed. This definition includes urban areas such as gardens and school playgrounds that are abandoned or contaminated	Lands that have previously used	United Kingdom, Germany, Belgium, Republic of Estonia, Sweden, Canada
Sites that have unfavorable conditions, but may not be abandoned and contaminated. In fact, re-development of these sites is difficult	Lands that require intervention	France, Austria, Czech Republic, Latvia, South of Africa

(CABERNET) defined brownfields as derelict and underused sites that are affected by the former uses of the site and surrounding lands, all or part of them are located in urban areas, may have contamination problems, and require intervention to bring them back to beneficial use. German brownfield definitions are based on the CABERNET project (2010), while in a report from the "City of the future" project, the Federal Office for Building and Regional Planning (BBR) defined urban brownfields as: "Formerly commercial, military, infrastructure used area that has not been used for at least one year and where from an urban planning point of view a re-use should follow" (TIMBRE Project in Germany). Italy is recognized to have a significant problem with contaminated sites: "Contaminated sites where the requalification and land use change can produce economic benefits equal or even higher than costs, considering in the costs both the work for new buildings/infrastructures and the work for remediation. These sites are usually located in urban or suburban areas and are already equipped with infrastructures and included in a logistic net. Although these areas have relevant impacts on the surrounding environment and socio-economical context, their characteristics permit their transformation and regeneration including financial and economic benefits and new opportunities of sustainable development for the community" (APAT, 2006). Despite being provided by the Italian Environmental Protection Agency (EPA), this definition cannot be considered a legislative definition, since it is not contained in any legislation (i.e. decree) (TIMBRE Project in Italy). Polish authorities have yet to agree on a common definition of brownfields. Land degradation is subject to a variety of legal frameworks. Neither the legislative framework nor the regulatory framework directly recognizes brownfields as post-industrial, post-military sites. The definitions of this aspect are developed by land management practitioners (TIMBER Project in Poland). In the Slovak republic, brownfields are not very commonly used. Brownfields are usually used at an academic or architectural level. It is similar to the CABERNET brownfield definition, but is not a law (TIMBER Project in the Slovak republic).

In other parts of world, such as Asia, the Japanese Ministry of the Environment described it in 2007 as "land that is underutilized or underutilized for its intrinsic value due to real or potential contamination" (Song et al., 2019) while, there is no official definition of brownfield in China. Given the studies and experiments carried out in China, "urban brownfield sites are industrial, commercial, storage, municipal facilities, transportation facilities and mining sites within the built-up areas of cities that are abandoned, idle or underutilized. These sites have a certain degree of contamination (real or potential) due to previous development and utilization, making them a certain obstacle in development and utilization" (Wang et al., 2022). In South Africa, brownfields are lands or premises where intervention is required before redevelopment. These lands may be uninhabited and have no specific use or may be

contaminated (Potts & Cloete, 2012).

It should be noted that the origin of the formation of brownfields has also affected their definitions. The United Kingdom, the United States, France, and West Germany have long-term experiences with the problems caused by these lands, most of which emerged as a result of declining mining, heavy industries, and textiles during the 1970s. However, in countries such as the Czech Republic, Slovakia, East Germany, Poland, and Romania, brownfields emerged during the last decade of the twentieth century due to the collapse of socialism and following global trends such as the return of a market economy (Frantál et al., 2013).

While there is no general agreement on the definition of brownfields, it is clear that countries share certain characteristics in their definitions, including: polluted lands, abandoned lands, lands that have previously used, lands that require intervention (Table 1).

Despite the importance of brownfield redevelopment to many countries and scientists around the world, there is still not a general understanding of what it means (Song et al., 2022). The absence of a universally accepted definition can be predicted because of these different interpretations of the term (Alker et al., 2000). Due to the reason for the formation of brownfields and the way of dealing with them in different countries, there are disagreements and even ambiguities about their definitions, which has led to contradictions among scientists. One of the most important differences among theorists arises from the discussion of the direct link between the definition of these lands and their contamination. Perhaps, the presence of pollutants in the brownfields is important due to the devaluation of these lands and the potential for their redevelopment (Loures et al., 2016). However, over-reliance on the link between contamination and the definition of these lands can lead to going the future development of the cities to extremes. For example, too much obsession with identifying contaminated urban lands can cause even clean plots of land, which are unlikely to be contaminated, to seem brown on the map (Ahmad et al., 2018). On the other hand, mere attention to pollution causes us to have a limited perspective on identifying or developing abandoned urban areas. Of course, it has been argued by many, such as the POST, that not all brownfields should be considered contaminated (POST, 1998) because, apart from contaminated lands, there are many sites in the cities whose redevelopment is complicated due to their surrounding areas, social or legal obstacles. For this reason, some researchers have tried to broaden their horizons and not link the definition of these lands solely to their contamination. For example, Alker et al. (2000) define brownfields as follows: "any land or premises which has previously been used or developed and is not currently fully in use, although it may be partially occupied or utilized. It may also be vacant, derelict, or contaminated. Therefore, a brownfield site is not necessarily available for immediate use without intervention". To sum up, it is clear that in every and

each country, providing a clear definition of brownfields plays an important role in identifying and classifying these lands and ultimately planning for their future development. Hence, the key points related to the definition of brownfields are extracted in an effort to achieve adaptive criteria for this research.

Adaptive Framework for The Typology of Brownfields in The Country

What can be deduced from the definitions provided by other countries is that brownfields and how they are identified and intervened are completely context-oriented and depend on how they are formed and the needs of society. However, the same characteristics can be found in the above definitions to describe brownfields: (1) they have been developed previously and can be redeveloped and rehabilitated, (2) they may be contaminated, abandoned, or derelict, (3) they require intervention and their redevelopment and rehabilitation is complex for various reasons, (4) the context and how these lands are formed affect the type and the definition of these lands in different regions, and (5) they are redeveloped to improve the quality of citizens' lives. Table 2 shows the same characteristics which can be found in the definitions presented for brownfields and the necessary conditions for developing an adaptive framework for the definition and the typology of the brownfields in the country.

Step 2: Presenting the Main Categories of Brownfields in Iranian Cities

Domestic Literature

In an attempt to define the term, Izadi and Amiri (2016) have considered renovation reserve lands as synonymous with brownfields and have included them in two categories: (1) abandoned lands, including inner-city barren lands and inner-city natural areas such as hills and riverbanks and (2) dysfunctional urban areas, including barracks, prisons, industrial lands, warehouses, factories, cemeteries, and brick kilns. In this study, abandoned areas such as schools, clubs, cinemas, transportation facilities such as parking lots, and gas stations, redevelopment of which can improve the quality

of life have not been included. In Mashhad, barren lands, military lands, abandoned lands, and industrial lands have been introduced as brownfields (Rahnama et al., 2015). In research, barren lands and inner-city natural areas have been considered brownfields while these areas have not been used so far and according to the international definition, cannot be classified as brownfields. Afradi and Nourian (2015) have also considered abandoned zones as equivalent to brownfields and have provided a set of qualitative considerations that can be used for the redevelopment of abandoned areas.

After all, there is an ambiguity in limited domestic studies for brownfield definition; a vast array of urban land and buildings, including dilapidated structures and valuable historic buildings, informal settlements, abandoned and unused buildings, industrial lands, warehouses and factories, inner-city wastelands, inner-city natural areas, barracks, prisons, airports, parking lots, and abandoned spaces have been introduced as potentials for internal development and in some cases named as brownfield. It can be said that the definition of brownfield in the domestic literature has not been clearly presented and most of the lands that have internal development potential have been considered synonymous with brownfields. Therefore, there is a lack of a comprehensive and distinct definition in the country's planning system that ultimately leads to the typology of these lands. To achieve this end, this research, in continue, first have interviewed with experts and then probed the related rules and regulations.

Interview with Experts and Thinkers

This step, which is the most important part of data collection and forms the core of the research, included 13 in-depth and semi-structured interviews with experts in the field of urban planning. According to the qualitative approach adopted in this step, the interviewees were selected purposefully to be experts in various environmental, urban, and economic fields in addition to being informed and active in the field of urban planning.

The grounded theory systematic approach was used for analysis. The systematic approach includes three main steps,

Table 2: Characteristics and conditions needed to develop an adaptive framework

Same characteristics of brownfields	Conditions
<ul style="list-style-type: none"> - have been developed previously - can be redeveloped and rehabilitated - may be contaminated, abandoned, or derelict lands - require intervention: their redevelopment and rehabilitation is complex for a variety of reasons - The context and how these lands are formed affect the type and the definition of these lands in different regions - They are redeveloped to improve the quality of life of citizens 	<ul style="list-style-type: none"> - The need for a definition at the national level and formulating it as a rule - Integration of relevant rules and regulations under the main rule - Giving priority to identifying these sites in the cities due to the high number of people affected by the disadvantages of remaining these sites and the advantages of their development and the high value of urban land - Paying attention to the main characteristics of these sites, especially having a history of development and the complexity of planning. - Separating these sites from other sites with the capability of internal development - Introducing the typology of a wide range of these sites in accordance with the rules and planning system of the country

open coding, axial coding, and selective coding (Strauss & Corbin, 2017). Open coding as the first step is done immediately after the first interview. In other words, after each interview, the researcher begins to find concepts, select appropriate labels for them, and combine related concepts (Strauss & Corbin, 2017). In fact, this step intends to convert the data into concepts (Flick, 2018). Axial coding involves the process of integrating subcategories and core categories. At this step, it is tried to create and discover categories based on a paradigm model (Strauss & Corbin, 1990). Selective coding, which is the third step of coding, continues axial coding at a more abstract level. In this step, the formation and the connection of each category with other categories are explained. Table 3 presents the units of meaning, categories, and core categories of qualitative analysis, which were obtained from interviews on the definition and characteristics of brownfields in the country.

According to the findings obtained from the grounded theory qualitative method and paradigm model of the research (Fig. 2), it can be said that brownfields in the cities of the country are areas with a history of development, and what distinguishes these lands from other active urban areas with a history of development is the abandonment and the incompatibility with authorized urban activities. These sites are more likely associated with environmental pollution and are very prone to redevelopment because they have a history of development. However, the existence of specific problems has caused these sites to be out of the cycle of authorized urban activities, making their redevelopment difficult and leading to the need for legal and financial interventions depending on the problem.

Step 3: Reviewing the Rules and Regulations Related to the Main Categories of Brownfields in the Country

In this step, upstream documents and rules related to urban development, especially internal development, were reviewed and evaluated to determine the position of these sites in the rules and regulations of the country. Among the rules and regulations related to cities, those related to the categories extracted from the interviews and the adaptive criteria include

the following five cases:

National Strategic Document for Rehabilitation, Improvement, and Renovation of Worn-out and Inefficient Urban Textures, approved by the Cabinet on 2014/9/30

The document defines internal development as a type of urban development that is carried out to achieve balanced and sustainable development and is based on identifying development capacities within the city limits, planning for their optimal use, providing healthy, safe, and standard living conditions, empowering residents, and improving the quality of life of citizens. In this document, the target areas that need urban revitalization, improvement, and renovation, the historical areas of cities, the middle unorganized (worn-out) zones, informal settlements, and urban zones with a rural background have been introduced. The textures with inefficient urban use and the textures which can be developed have been briefly explained in the National Document Support Studies, the volume "Study of Problem Dimensions and SWOT Analysis". Barren lands, barracks, and prisons have been identified as inefficient urban textures, according to the report. In fact, this support report only refers to the existence and necessity of identifying these textures and does not provide a definition or how to identify them.

Criteria for the Establishment of Industrial and Manufacturing Units and Activities, approved by the Cabinet on 2011/7/6, and the instructions of Article (3) of Criteria for the Establishment of Industries, approved by the Cabinet on 2011/7/6

Considering the instructions of Article (3) of the Criteria for the Establishment of Industrial and Manufacturing Units and Activities, industries are divided into 7 categories based on the severity of pollution and other environmental issues. According to the given decree (Appendix 3), except for Category 1 industries, other industrial units cannot be located within cities due to causing high pollution. Based on this decree, it is possible to identify the polluting industries that have settled

Table 3: presents the units of meaning, categories, and core categories of qualitative analysis

Core Categories	Categories	Original Statements of Interviewees/ The units of meaning
Prone to urban development/possibility of development	Defining a new activity	<ul style="list-style-type: none"> - It is possible to create a context for new events in the city by defining new activities. - Abandoned sites that may have a body and have lost their activity, and the city can intervene and inject urban land use. - Return to urban life by injecting a new activity and renovation. - All urban plots to which a land use can be assigned / whose use can be changed.
	Possibility of exploitation	<ul style="list-style-type: none"> - Abandoned railways and derelict lands that need to be exploited
	Possibility of development	<ul style="list-style-type: none"> - Urban lands that have the potential for redevelopment, but have not been considered during urban development. - have the potential for restoration and urban development

Continuie of Table 3: presents the units of meaning, categories, and core categories of qualitative analysis

Core Categories	Categories	Original Statements of Interviewees/ The units of meaning
Lands that were used previously and are now abandoned	Being used previously	<ul style="list-style-type: none"> - Brownfields were used previously - were already used - The areas that were used previously - Barren lands outside the cities - Inner-city agricultural lands converted into barren lands - have been developed previously, to some extent caused relative pollution
	Abandoned and inactive	<ul style="list-style-type: none"> - Any site whose body has remained but lacks soul and is abandoned - Out of service, abandoned, and unused - Abandoned due to a set of causes - Currently inactive or completely abandoned
	Underutilized	<ul style="list-style-type: none"> - Currently unused.
	Underutilized	<ul style="list-style-type: none"> - Generally unused.
	Inactive	<ul style="list-style-type: none"> - In front of active urban lands
	Abandoned in terms of any activity and not currently being used	<ul style="list-style-type: none"> - Abandoned railways and derelict lands that need to be exploited - Abandoned factory, caravanserai, and residential neighborhood.
	Abandoned	<ul style="list-style-type: none"> - Abandoned sports field
	Abandoned in terms of form	<ul style="list-style-type: none"> - Abandoned in form
	Abandoned in terms of form and activity	<ul style="list-style-type: none"> - Ruined buildings - A ruin where the building is being demolished or has been demolished. - As the form is abandoned, the activity is also abandoned.
	Abandoned in terms of activity	<ul style="list-style-type: none"> - can also include a building; can be newly built and abandoned at the same time.
	The body is not important	<ul style="list-style-type: none"> - can be newly built or not - - enclosed or unenclosed areas -
	Lack of activity is the needed condition	<ul style="list-style-type: none"> - It is not a brownfield if it is active (activity is not stopped)
	Current activity in them does not comply with the authorized urban activities	Security factors in relation to the incompatibility of the land use
Health and environmental factors		<ul style="list-style-type: none"> - According to the decree of the Environmental Organization, some activities should not be within the city limits
Contamination / the extent of damage caused by them		<ul style="list-style-type: none"> - There are different degrees of them/ they can be graded based on the degree of contamination and the damage caused by them.
Contamination / the relationship between brownfields and lands with incompatible activity		<ul style="list-style-type: none"> - If the incompatible activity has caused the contamination, the land can be considered a brownfield
Displacement due to incompatible activity		<ul style="list-style-type: none"> - Incompatible activities (urban nuisances) that don't comply with authorized urban activities for various reasons and can be displaced
Do not have enough efficiency	Inadequate use of activity can cause the lands to be abandoned or incompatible	<ul style="list-style-type: none"> - Activities that are not used enough
	Neglected in urban plans	<ul style="list-style-type: none"> - They are not used in urban development
	Insufficient efficiency in the form	<ul style="list-style-type: none"> - Inefficiency of form like ruined buildings
	Insufficient efficiency in the activity	<ul style="list-style-type: none"> - Inefficiency of activity for any reason
	Inefficiency in function for any reason	<ul style="list-style-type: none"> - A factory that is inside the city but has lost its function; it can be abandoned or lose its efficiency due to incompatibility with urban land uses

Continuation of Table 3: presents the units of meaning, categories, and core categories of qualitative analysis

Core Categories	Categories	Original Statements of Interviewees/ The units of meaning
They need intervention to adapt to urban development	Problems in redevelopment	- The redevelopment of these lands has a major impact on the city due to the problems caused by them.
	Difficulty in redevelopment	- Their redevelopment is not easy. Due to the existing difficulties such as land ownership, land acquisition, and defining a project and implementing it on the lands, the redevelopment of these lands is difficult.
	To be problematic	- These lands have special characteristics such as large areas and public ownership. A residential unit cannot be a brownfield because it is not problematic.
	Urban planning regulations cause problems in redevelopment	- Lack of urban planning regulations, their development or redevelopment is not possible.
	Difficulty in implementing redevelopment	- The law on the transfer of barracks was also intended to preserve their lands for the future. However, despite the importance of urban land and its added value, this goal is not achieved due to human and political factors and it is preferred that the barracks remain the same.

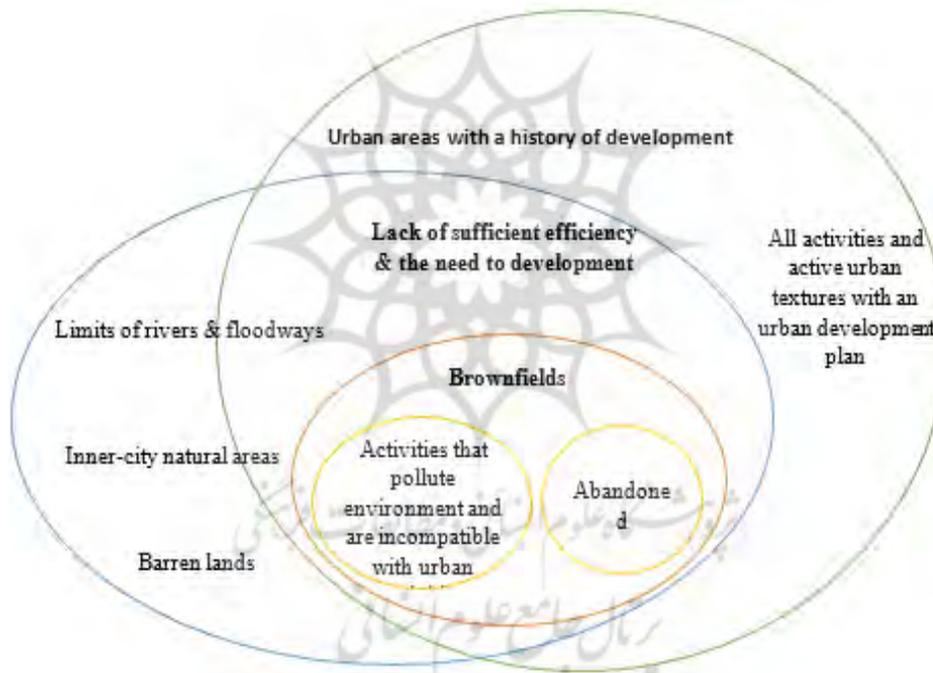


Fig 2: Paradigm model of defining brownfields in the country based on the grounded theory

inside the cities but have to be moved outside the urban areas.

Rules and Decrees Related to the Transfer of Some Activities from Inside the City to Outside It (Activities Incompatible with Urban Activities)

In this section, to identify the capacities of internal development, all the rules and regulations related to the transfer of some inefficient activities outside the cities and those related to the location of activities that should be outside the city limits for various reasons were reviewed. As these rules and regulations create new opportunities for redevelopment in

cities – which are mostly similar as the industries categorized based on the decree mentioned above-, they are important:

- The law on the sale and transfer of barracks and other places of the armed forces outside the cities, approved on 2009/9/2
- The law on transfer of existing prisons and centers of security and educational measures outside the cities, approved on 2001/12/6, executive regulations of the law on transfer of prisons and centers of security and educational measures outside the cities, approved in 2001, amendment of executive regulations of the law on transfer of prisons and centers of security and educational measures outside the cities, approved

in 2001.

- The decree on the transfer of livestock and poultry farms within the city limits to outside them, approved by the Cabinet on 1997/7/30.
- Waste Management Law, approved in 2004, Executive Regulations of the Waste Management Law, approved in 2005, and environmental criteria of ordinary waste disposal sites
- Regulations on construction, development, operation, and management of civilian airports, approved by the Cabinet on 2013/4/7.

The above rules and regulations indicate that barracks, prisons, animal shelters (livestock and poultry farms), airports, and landfills that were once located outside the cities, and they have been surrounded by urban lands as cities expanded over a time, must be again transferred out of the cities. With the transfer and relocation of these activities, suitable development opportunities are created.

The Decree on the Definitions and Concepts of Urban Uses and the Determination of Their Per Capita, Approved by Iran's Supreme Council for Planning and Architecture on 2010/5/31

According to the decree, the permitted functions are specified

in different scales of neighborhood, district, region, city, and out of the city. According to this decree, the uses and activities that should be located outside the city are as show in [Table 4](#). Definition of Urban Renovation Reserve lands in the Main Document of the Tehran Comprehensive plan, Approved by Iran's Supreme Council for Planning and Architecture on 2007/11/26.

"Urban renovation reserve" has been defined in the new urban development plans of Tehran which is defined "all large lands and properties with an area of one hectare and more", including large vacant lands and remaining open spaces in the city, or properties such as warehouses of goods and old factories. "To be used according to the circumstance after preparing the justification plans and approval in the Article (5) Commission".

To sum up, based on these 5 categories of rules and regulations, the potential brownfield sites in Iranian cities include a wide range of land uses and activities which are mostly incompatible with urban activities ([Table 5](#)). However, mentioned in rules, these sites are scattered, are not subject to a single definition or an organization, and have been formulated for special sectors (each based on the needs of the relevant administrative institutions). Thus, there is a need for a specific rule and regulation defining brownfield concept that not only

Table 4: Uses and activities located in the city that should be outside the city limits

Incompatible activities	Administrative and disciplinary	All prisons within the city limits
	Urban equipment	Slaughterhouse, cemetery, waste sanitary disposal center, central fruit and vegetable market, freight transport
	Transportation and warehousing	Main warehouses of goods, airports, silos, cold stores
	Military	Existing barracks and depots of the military forces
	Recreation-tourism	Zoo
	Industrial	All industries, except groups A, that are located within the city limits; the decree No. 64677, approved by the Board of Directors on 2000/3/16, and its subsequent amendments

Table 5: Land uses and activities can be regarded as brownfield sites based on rules and regulations

Rules and Regulations	Land Uses and Activities
National Strategic Document for Rehabilitation, Improvement, and Renovation of Worn-out and Inefficient Urban Textures	Barren lands
	barracks
	prisons
Criteria for the Establishment of Industrial and Manufacturing Units and Activities, and the instructions of Article (3) of Criteria for the Establishment of Industries	Industrial units which cannot be located within cities due to causing high pollution.
	barracks and other places of the armed forces inside the cities
	existing prisons and centers of security and educational measures
Rules and decrees related to the transfer of some activities from inside the city to outside it	livestock and poultry farms
	waste disposal sites
	airports inside the city

Continuie of Table 5: Land uses and activities can be regarded as brownfield sites based on rules and regulations

Rules and Regulations	Land Uses and Activities
The decree on the definitions and concepts of urban uses	All prisons within the city limits
	Slaughterhouse, cemetery, waste sanitary disposal center, central fruit and vegetable market, freight transport
	Main warehouses of goods, airports, silos, cold stores
	Existing barracks and depots of the military forces
	Zoo
Definition of urban renovation reserve lands in Tehran Comprehensive plan	All industries, except groups A, that are located within the city limits; the decree No. 64677, approved by the Board of Directors on 2000/3/16, and its subsequent amendments
	large vacant lands
	remaining open spaces
	properties such as warehouses of goods and old factories

legitimizes this concept in urban planning system and city development plans but also is able to collaborate and integrate many administrative sectors to redevelop these sites.

RESULTS AND DISCUSSION

Definition and typology of brownfields in the cities of Iran

In the three main steps of the research, the necessary criteria and conditions for developing an adaptive framework for brownfields in the cities of the country were first determined based on theoretical and experimental principles. Then, by interviewing the experts and using the grounded theory qualitative method for analysis, the main categories and the paradigm model were identified. In the third step, the rules and regulations related to the main categories and main criteria for the selection of brownfields were reviewed to finally define these lands and explain their typology. In this section, based on the previous three steps, these lands are first defined according to their key characteristics and their typology in the cities of Iran is then explained considering the rules and regulations.

Defining the Research Target Areas

Abandoned areas with incompatible urban activities are enclosed or unenclosed areas that are prone to urban development. They were used previously and are now abandoned or the current activities in them do not conform to authorized urban activities and require intervention to adapt to urban development.

The redevelopment of these areas, on the one hand, improves the quality of life of citizens and provides a suitable context to encourage new events through new urban activities and, on the other hand, creates new job opportunities, causes existing infrastructure to be utilized, and reduces development pressures on undeveloped and open spaces. These areas can be used and exploited based on the needs of the city and the vision established for it while priority is given to public services and housing.

Typology of the Research Target Areas

Based on the above definition, these areas can be distinguished from other urban lands in terms of activity, social consequences, and function.

-Activity

According to the definition provided, one of the characteristics that distinguish the research target areas from other urban areas is that there was previously an activity, which today is incompatible with the urban activities or has been completely lost, causing the lands to be left unused. Therefore, vacant or barren lands which included no activity in the past have not been among the target areas of this research. Accordingly, the research target areas are divided into two categories:

Areas with no activity: These areas were used previously and included an activity, but they are now abandoned. Therefore, the abandonment is the criterion for their identification. The duration of abandonment varies among these areas and it is recommended that the legal requirements set out in urban rules and regulations be used to identify them, or decisions about them should be made based on the time horizon of the urban development plan for example, the ten-year Comprehensive Plan. In this case, the areas that included no activity at the stage of recognition for the previous comprehensive plan and remained inactive at the time of preparing the new plan are included in this category of lands.

Areas with activities that are incompatible with urban activities: Some activities are driven out of the city limits in the early days of their formation due to incompatibility with urban activities. However, the horizontal expansion of cities causes them to be located within the cities. The areas including these types of activities fall into this category. Today, the continuation of some of these activities has environmental consequences and leads to pollution that affects citizens. Others, in conjunction with other urban functions, contribute to physical-spatial, economic-social, traffic, and visual inconsistencies in the city's landscape and must be relocated outside the city limits. These

activities cover a wide range of functions and can be identified based on their function.

-Social

The research target areas can be divided into two categories in terms of social aspects and functions:

In abandoned lands, social harms are more likely to develop than in any other place due to the lack of urban life and activity. In fact, the abandonment makes these areas vulnerable, deserted, and prone to crime. Therefore, redevelopment of these areas can be effective in promoting safety and security in the first step and defining and prescribing meaningful social activities in the next steps. Redevelopment causes lost and unidentified areas to become areas with a clear social identity.

In areas with incompatible activities, negative and destructive social consequences are more likely to occur than in any other place due to functional incompatibilities and the presence of inappropriate and harmful activities. The incompatibility of the activities of these areas with the authorized and appropriate urban activities causes their social meaning and function to be disrupted. In other words, the social added value resulting from the presence of activities incompatible with the civic spirit and identity of a city, if not negative and does not lead to the loss of existing social values, is at best zero. The redevelopment of these areas can certainly lead to the creation of meaning, function, and social added value in them.

-Functional

According to the characteristics of the research target areas,

a clear typology can be provided according to the type of function of these areas. In terms of function, these areas can be divided into two general categories:

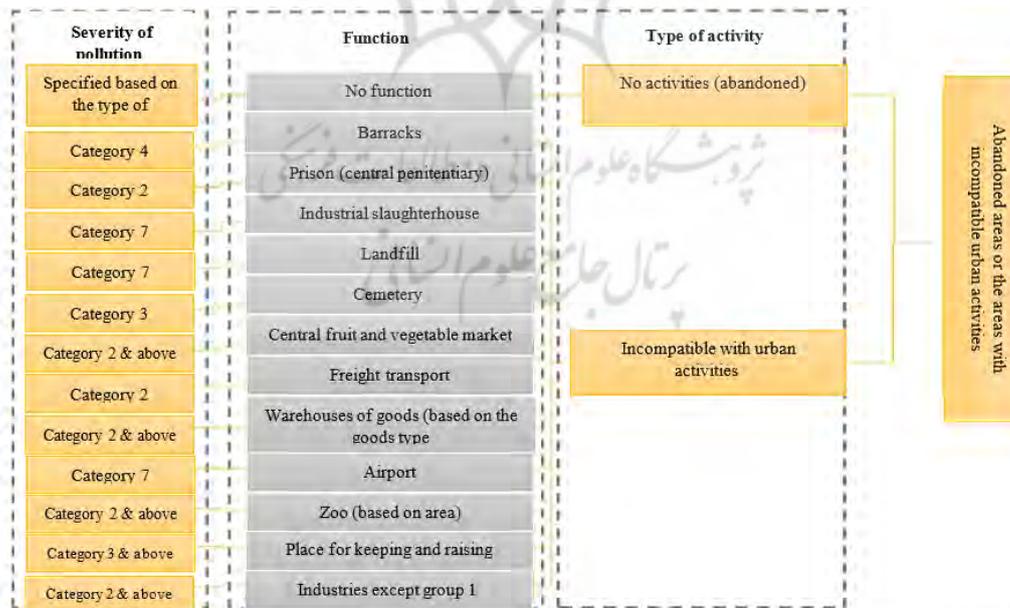
Areas with no function (abandoned): Normally abandoned areas with no activity lack a function and can be identified easily.

Functions whose activities are incompatible with urban activities: According to the definition of incompatible activities, the decision of Iran's Supreme Council of Planning and Architecture in 2010 on the definitions and concepts related to urban land uses and their per capita, and the instructions of Article (3) of the Criteria for the Establishment of Industrial and Manufacturing Units and Activities, based on which industries are classified in different categories considering the severity of pollution and other environmental issues, functions that are in the second category of pollution and above and must be outside the city fall into this category. These functions also require different development proposals based on their categories, the amount of contamination, the need for cleaning, and the method of cleaning.

Based on the above-mentioned, the typology of the research target areas has been presented in Fig. 3.

Discussion, Interpretation of the Findings, and Comparing Them with the General Theoretical Framework

If all the inner-city areas that have the potential for development are divided in terms of the history of activity, three categories



* According to the decree on the definitions and concepts of urban uses and the determination of their per capita, approved by Iran's Supreme Council for Planning and Architecture on 2010/5/31, the functions that should be out of the city were specified.
 * Based on the Criteria for the Establishment of Industrial and Manufacturing Units and Activities, approved by the Cabinet on 2011/7/6 and the instructions of Article (3) of Criteria for the Establishment of Industries, approved by the Cabinet on 2011/7/6, the severity of pollution was determined.

Fig. 3: Typology of abandoned areas and the areas with incompatible urban activities

with no history of activity	<ul style="list-style-type: none"> • vacant lands • green and natural spaces
under development	<ul style="list-style-type: none"> • areas with temporary activities • lands ready for development
with a history of development	<ul style="list-style-type: none"> • All urban activities and active textures that have an urban development plan • Abandoned or ruined • Activities incompatible with urban activities

Fig. 4: Categorization of urban areas based on the history of activity

can be achieved: 1. with no history of activity, including vacant lands and green and natural spaces; 2. under development, including areas with temporary activities or lands ready for development; and 3. with a history of development (Fig.4).

As the target areas of this research have been developed previously and included activities in the past, they fall into only the third category of this division and are distinguished from other urban lands prone to development. Of course, the developed lands of the third category are themselves divided into three categories in terms of activity, including 1- all urban activities and active textures with a development plan, 2- abandoned lands without activity, and 3- activities incompatible with urban activities. According to this categorization, only abandoned lands and activities incompatible with urban activities, which cannot be intervened easily and may not be resolved using development plans, can be considered as the research target areas. The characteristics of these areas, which are consistent with the definition of brownfields in other countries (Alker et al., 2000; De Sousa, 2002b; Potts & Cloete, 2012; Song et al., 2019; TIMBRE; U.S.EPA; Wang et al., 2022), are as follows:

- They have been developed previously and can be redeveloped and rehabilitated.
- They require intervention: their redevelopment and rehabilitation are complex for various reasons and are not possible within the framework of urban development plans.
- Most of them are located within the city limits.
- They include no activity or are abandoned.
- They have activities that are incompatible with urban activities.
- They can be contaminated.
- Their redevelopment improves the quality of life of citizens and reduces the negative social, economic, and environmental consequences.

Based on these characteristics, the areas defined in this study are different in terms of the history of activity, type of function, and the amount of pollution from other sites and areas with potential for internal development in the cities. These differences, as the experience of other countries have shown,

indicate the need for special attention to identify and redevelop these areas and first of all, the need for providing a national definition of them. On the other hand, the characteristics of these areas, in addition to compliance with the context of the formation of these areas and the legal context of the country, are consistent with the definitions and characteristics presented in other countries (Table. 1 & 2).

CONCLUSION

In this paper, the definition and typology of urban areas namely brownfields that have been neglected by the Iranian urban planning system were explained and identified. According to the characteristics of these areas, similarities could be found between these lands and their western examples. However, this concept and how it was formed in our country is linked to the history of urban development, and this makes it unique. Therefore, by looking at the concept of brownfields as a theoretical basis, adapting the concept to the conditions and characteristics of Iranian cities, considering how they are formed, interviewing with experts and professionals to find out the core categories of brownfield sites in Iran and reviewing the rules and regulations of the country's urban planning system, we presented the definition and typology of the areas that can be used in the future development of cities. This research provides new insights into how systematically brownfield site can be identified in the Iranian cities which not only integrates scattered definitions, rules and regulations related to brownfields but also by offering main characteristics of these sites, rules out some land uses like barren sites which were considered in some cases as brownfields previously.

To do this, in the present study, using qualitative content analysis, the same characteristics of brownfields were first extracted from the definitions presented in other countries and relevant literature. At the same time, the necessary conditions for the development of a comparative framework of brownfields in the cities of the country were presented. The interviews with experts were analyzed using the grounded theory qualitative method to present the core categories of brownfields in the country, and the relevant rules and regulations were reviewed

to provide a typology in accordance with the legal conditions of the country. Results show that two categories of abandoned areas or the areas with incompatible activities (based on their contamination and the type of their function) can be termed as the brownfields in Iranian cities, which were used previously and are now abandoned or the current activity in them does not comply with authorized urban activities and need intervention to adapt urban development. According to this definition, 12 types of enclosed or unenclosed areas prone to urban development with incompatible activities and one type with no function were identified.

The results of this research can help professionals in addition to academics to identify these areas and redevelop them. These areas can be used to achieve the goals of sustainable urban development. Therefore, by considering these lands in the urban development plans, their potential can be used to promote vitality and urban life and expand public services. However, it should be noted that the present study only deals with the definition and typology of these lands and it can be considered a beginning to address these issues in the universities and professional circles. Due to the characteristics of these lands and as the experiences of other countries indicate, their redevelopment is associated with many complexities that are caused by the abundance of these lands in cities, their diversity in terms of size, pollution, and ownership, their surrounding textures, how they are managed, and the impact of stakeholders and influencers on their redevelopment. These issues in turn require special attention. Additionally, how to prevent the emergence of these lands in the future development of cities requires further studies that can be done in academic and professional environments. At the same time, the identification and redevelopment of brownfield sites in the city as a whole need to be carried out by the government's professional forces in order to obtain more effective and scientific conclusions. Therefore, this research is the beginning of other relevant developmental and applied research in this subject area.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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