

EVALUATING THE ATTRIBUTE OF INDUSTRIAL HERITAGE IN URBAN CONTEXT ON NATURAL MOVEMENT DISTRIBUTION. THE CASE STUDY OF DEZFUL CITY

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Abstract

Space configuration of industrial heritage sites, which have been adaptively reused, are modeled in the depth map. Simultaneously, by using in-situ observation the actual patterns of pedestrian movement in these sites are captured. Finally, the results of simulated patterns and actual patterns are compared and interpreted. Findings show a notable impact of built heritage on the natural movement's patterns. Consequently, the significance of determinative factors of natural movement in these sites differs from regular sites. Therefore, this exception could develop a tourism policy towards these sites. By acknowledging the fact that the functions of selected case studies are not the same, yet those are the only adaptive reuse practice of industrial heritage in that region. This paper aims to assess the possible impact of built heritage as an influential attraction on distribution patterns of natural movement and develop natural movement theory in these sites. The use of natural movement theory, which provides accurate data that proves the impact of industrial heritage scientifically, is the main indicator of this research. this theory has not been used as an exact tool to identify the behavioral-movement attributes of heritage and needs some consideration to be applied in cultural heritage sites.

Keywords: *Urban Heritage; Industrial Heritage; Natural Movemen; Dezful City*

Introduction

The possible future urban development may have a positive or adverse impact on the integrity of cultural heritage sites and as long as thorough studies have not been conducted to identify heritage values, it would not be possible to evaluate the impact of urban development on heritage sites. In this sense, scholars have tried to develop various methodologies to identify the values of cultural heritage to evaluate the impact of urban development projects on these sites. Understanding the applicability of heritage values, it can be found, that we can achieve the features that responders the needs of today's society [1]. In this case Heritage impact assessments (HIA) is a notion grounded in the requirements to perform environmental assessments at a project or more strategic levels [2]. Based on this method, it is possible to determine the values (which include historical, cultural, architectural, psychological, etc. value) of cultural heritage to proper planning in order to preserve and conserve them.

Heritage impact assessments (HIA) method seeks the holistic assessments of heritage sites [2]. That is to say, this method has been formed based on EIA (Environmental Impact

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Assessment) and SIA (Social Impact Assessment) and has tried to combine their merits in assessing different aspects of the built environment.

Industrial heritage, however, has some unique features that distinguish it from other cultural heritage. Possessing aesthetic values in terms of architecture and construction like other cultural heritage sites, Industrial heritage such as industrial values, or function-related values which are notably different than other kinds of cultural heritage. Serving as a common means to link people to their roots, a cultural heritage monument helps to develop and enrich the cultural identity of individuals as coherent groups within different locations, history, aesthetics, religious beliefs, etc. [3]. Therefore, industrial heritage as a historic sign of technology development, the industrial revolution, and knowledge transfer in some areas needs a very deep study to identify its values and attributes properly [4]. This research suggests that the psychological aspect of industrial heritage should be categorized as a separate aspect as it is too significant to be merged in other aspects.

Literature review

Heritage conservation has begun advocating the importance of district-wide approaches that not only focus on individual historic buildings but also on the urban fabric [5-8]. Industrial heritage appeared as both a material by-product and a social construction thanks to the gradual advent of post-productivism in the most-developed economies after World War II. When conceived as a material that remains with attached aesthetic values, it is linked to processes of territorial valorization resembling what has elsewhere been defined as the “becoming-rent of profit” [9-11]. Industrial heritage includes remained examples of industrial culture which enjoy historic, technological, architectural, and scientific values [12, 13]. Industrial heritage and the culture for using and encountering it then should be conserved as an intangible heritage alongside local people as an integrated system [14].

When related to memory, community, and the past it connects with place identity. Both aspects are always present in “heritage” of all kinds and are always intertwined to a certain extent [11]. Without such reference, industrial building transformations cannot be considered. Studies have included such teams and their functional transformations have become the basis to define their types [15]. Comprehensive knowledge of industrial heritage has been accurately described and classified in figure 1.

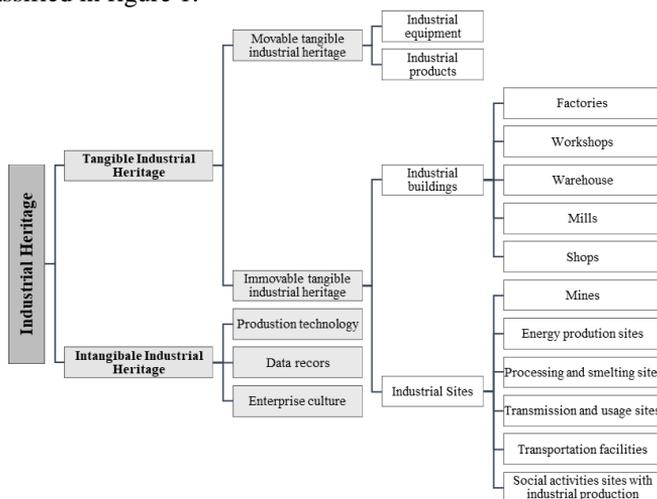


Fig. 1. Industrial heritage classification [16, 17]

Heritage Impact Assessment is a tool to identify and assess impacts of proposed development projects on cultural heritage; and therefore, it supports better protection and management of the heritage assets. HIA is needed in advance when the cultural heritage such as natural, cultural, and intangible heritage, would be affected by these kinds of threats [18]. Depending on the context, HIA may be performed either by governmental technical experts or by external consultants on behalf of government or project developers [2]. Some related research are shown in Table 1.

Based on the studies and available research, one of the aspects that were less considered or ignored in previous researches is the psychological aspects of industrial heritage. Therefore, this research investigates this issue through one method that is effective in the psychological dimensions of the environment, which is "natural movement theory".

The theory of natural movement is fundamental to space syntax: a set of theories and methods developed in the late 1970s that seeks, at a general level, to reveal the mutual effects of complex spatial systems on society and vice versa [16-30]. In urban systems configuration is the primary generator of pedestrian movement patterns, and, in general, attractors are either equal or work as multipliers on the basic pattern established by configuration. Predicting pedestrian movement can be performed based on space configuration features. Logically, the presence of attractors can influence the presence of people, but it cannot influence the fixed configurational parameters which describe its spatial location [31].

Table 1. Some researches about IH and HIA

Industrial Heritage (IH)	Sustainable development of industrial heritage tourism – A case study of the Industrial Monuments Route in Poland	[19]
	Industrial Heritage Assessment and Guidelines for the Architectural Conservation of Hydroelectric Plants	[20]
	Using Industrial Cultural Heritage to Transform and Develop Resource-Based Cities	[21]
	Good practice for industrial heritage sites: systematization, indicators, and case	[22]
	An approach to assess the value of industrial heritage based on Dempster-Shafer theory	[23]
	Industrial heritage as a catalyst for urban regeneration in post-conflict cities Case study: Mostar, Bosnia and Herzegovina	[24]
	Adaptive reuse of industrial heritage for cultural purposes in Beijing, Shanghai and Chongqing	[25]
	Industrial Heritage in Albania: An Assessment	[26]
	Industrial Heritage and Place Identity in Spain: From Monuments to Landscapes	[11]
	Heritage Impact Assessment (HIA)	Improving heritage impact assessment: an analytical critique of the ICOMOS guidelines
Applying Heritage Impact Assessment to urban development: World Heritage property of Masjed-e Jame of Isfahan in Iran		[18]
Social Impact Assessment: Guidance for Assessing and Managing the Social Impacts of Projects		[28]
Guidance on heritage impact assessments Learning from its application on World Heritage site management		[2]
Dealing with the cultural heritage aspect of environmental impact assessment in Europe		[29]

This theory demonstrates that in urban systems, the configuration is the primary generator of pedestrian movement patterns and the basic patterns established by this quality. The place satisfaction variable was chosen to measure this quality and considering the existence of industrial heritage in one of the trails. Place satisfaction, or a multidimensional summary judgment of the perceived quality of a setting [32, 33], is a structure that is strangely absent from the sense-of-place literature but common in community sociology. Although space configuration is applied in cultural heritage research projects this research assesses the spatial quality of the environment surrounding historic industrial structures which deteriorated or lost certain features of monuments, hence they only enjoy the intense natural imaginary historic industrial monuments.

Experimental

Methods

By studying the literature reviews and previous research, it is raised that the psychological dimension of industrial heritage is ignored and it is necessary to study. For this reason, the method of conducting this research consists of several parts (Figure 2).

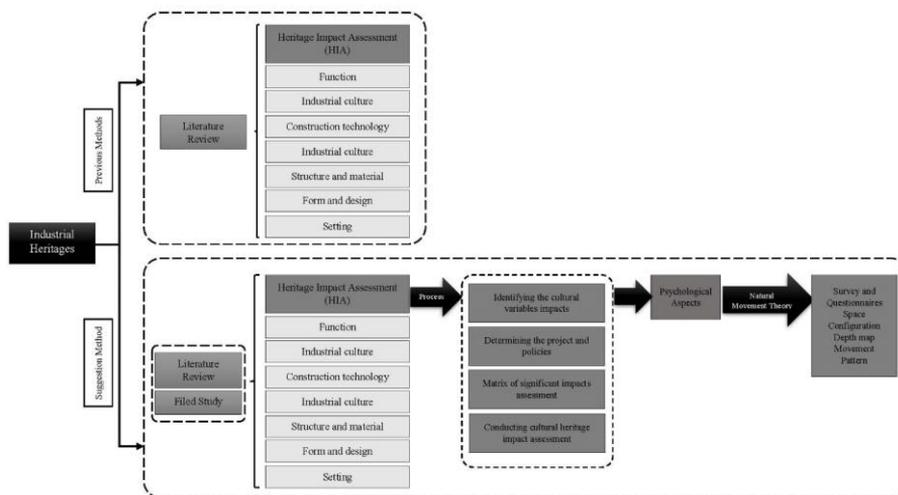


Fig. 2. Research flowchart

In the first part, due to the need to study aspects of industrial heritage, the HIA method has been used. In the second part syntactic analysis is performed as a first approach to predict and interpret the densities of pedestrian movement is used. This step is based on an urban street network and open street data were obtained by Open Street Map-OSM- (www.openstreetmap.org) Subsequently, the axis lines are imported to an open-source software platform- DEPTHMAP [34]. Integration measures are calculated and illustrated in graphs through DEPTHMAP. In the second step, the movement trails were observed and the cumulative movement traces in the study area was drawn based on pedestrian movement pattern for the interpretation of natural movement and analyzing the pedestrian behavior [35]. The sightseers who were observed for pedestrian movement patterns were asked to fill a questionnaire about this variable, simultaneously. The questionnaire used in this study is a modified scale from Stedman (2002) includes using a 4-point Likert-type scale ranging from ‘extremely dissatisfied’ to ‘extremely satisfied’ [36, 37]. In the next step, we expected to see a positive correlation between place satisfaction and integration which was measured in the trials. As UNESCO defines (2020), cultural heritage is the generator of natural and cultural attributes. Cultural heritage, indeed, represents key factors to reach livability, economic prosperity, and social cohesion [38, 39].

Research Area and Case Studies

Dezful is located in the southwest of Iran, at the east of the Dez river and has a history that back to the Sassanid period and even prior and has been counted as a part of Elamites and Achaemenian territories [40]. The last extension of the city, back to the Qajar era [41]. Dezful has been a center of governors’ attention for its climatic and agricultural potentials since Qajar and central government of Iran times and it was the time when other countries entered this region to create businesses and financial investments, hence, to create jobs workshops and ranches, and settlement houses were established. These activities made industrial culture popular amongst natives and as it was observed industrial workshops became common in

Dezful. The industrial city shows many fundamental differences between these cities and traditional and undeveloped cities which are shaped base on agriculture. Indeed, the idea of the industrial city of Dezful had been a topic of much thought and discussion before the Pahlavi period. A short glance at the historical map of Dezful in 1956, physical changes in urban fabric are noticeable (Fig. 3). These urban changes even got bigger in 1968 and gave a new look to the city. This comparison shows different characteristics and it is such a notable difference which is visible in Dezful urban fabric in 1968 (Fig. 4).



Fig. 3. The urban fabric of Dezful in 1956



Fig. 4. The urban fabric of Dezful in 1968

While these changes happened, Dezful prepares itself for a new identity. Due to the structural changes, industrial spaces change to respond to new conditions. These elements represent culture, historic positions, technology, processes, and distinct achievements of the area [42]. A large number of industrial sites were established between 1950 and 1965 which are shown in figure 5.

There are 9 industrial heritage structures located in both urban and historic districts of Dezful city which are represented in Table 3.

They are located in different parts of the city with considerable differences in terms of the urban fabric. Some of them are still functional and unfortunately, many of them are abandoned useless. Two case studies have been selected for this research. “Kooreh Milioni” The old brick furnace of Dezful, and “Makineh dast pache” flour workshop.

Table 3. Industrial heritage structures of Dezful

No.	Location	Name	Original Function	Construction date	Conversion	Date of Conversion
1	Urban District	Kooreh Milioni	Brick furnace	1981	Public Park	2015
3		Tanki gaz	Petroleum tanker	1973	—	—
4		Manba kashefie	Water tanker	1945	—	—
5		Tanki 1	Water tanker	1966	Neighborhood center	2005
6		Makineh yakhi Afshar	Ice workshop	1985	—	—
7		Historic Urban District	Makineh ardi dastpache	Flour workshop	1960	Public Market place
	Tanki 2		Water tanker	1968	Neighborhood Park	2002
8	Makineh yakhi Golchin		Ice workshop	1976	—	—
9		Pole jadid	Bridge	1972	—	—



Fig. 5. The industrial heritage of Dezful

Flour workshop (Mákinēh dástpāce)

This building is one of the industrial structures of Dezful, which in addition to its historical value, due to its different urban granulation, is separate from other parts of the urban fabric. On the other hand, since the buildings were built as traditional architecture, i.e., using brick construction and brick decorations, and also used traditional structural systems, another distinguishing feature of this building is the use of rough arch roof structural systems. This made this building the pioneer of other buildings and became a structural model for them. At some point in time, the building changed its use, spontaneously becoming a bazaar according to the needs of the people. And this change caused the presence of people in it. On the other hand, there were no similar stores before this change. This change of use led to a private building where only workers were able to move, becoming a public place with ordinary people moving around. This change and the good attraction of the people led to the building becoming a larger Bazaar that is influential not only around it but also to the main street leading to the building (Fig. 6).



Fig. 6. Space and entrance of Makineh dast pache

Brick Furnace (Kooreh Milioni)

Kooreh Milioni is one of the largest brick furnaces in Dezful, which has many decorations and is considered as one of the most important urban landmarks in the past and today. Due to people's jobs, and since it was outside of the city and the need of people to go there, that caused one of the reasons for the development of the city for that region. After its closure, the furnace's visual appeal, as well as its reputation as a landmark, and the surrounding plants, led to it becoming a meeting place for the people. And over time, it became the center of the neighborhood. This shows that despite the existing destruction, the building has retained its identity in a different appearance (Fig. 7).



Fig. 7. Space and entrance of Kooreh Milioni

Results and discussion

This research consists of different stages through different methods to achieve the results. In the following section, the current state of literature in values identification industrial heritage of Iran through HIA method is reviewed and the aspect that can be considered in this process separately will be pointed out. Then in the next stage to demonstrate the importance of the psychological aspect and to support that this aspect should be added to HIA process as a separate aspect.

Heritage Impact Assessment (HIA)

According to the Operational Guideline for World Heritage Conservation, the key attributes of industrial heritage sites of Iran have been determined, including decorative, structural, and functional aspects that truly convey the heritage value (Table 4). They have also determined whether the planned urban development may threaten the authenticity and the integrity of a given heritage site. The classification of the values of Iran's industrial heritage according to their work is as follow: A1. Function, A2. Industrial culture, A3. Construction technology, A4. Structure and material, A5. Form and design and A6. Setting.

According to the research's suggestion by adding the psychological aspect in the above list, not only one important aspect of industrial heritage will be covered but also due to the severity of the adverse impact of urban development on the integrity of industrial heritage, the majority of them would be tackled properly. The closest aspects that have been mentioned in this classification are function and industrial culture that despite having some similar features, neither can entirely cover the psychological aspect of industrial heritage. To show the significance of this hypothetical category in the previous classification the vulnerability of both function and industrial culture as the most relevant aspect is analyzed. To do so at first review the classification of urban development possible impact on industrial heritage and then discuss which aspects are the most critical ones.

Considering the severity of urban development impact on different attributes of industrial heritage in Iran based on Table 5.

According to the results, it is obvious that A1 and A2 which are the closest aspect to psychological character are very vulnerable. That means that the psychological aspect potentially has a similar condition. Therefore, to evaluate the significance of this aspect an

experiment based on natural movement theory has been designed and the results of this experiment are as follow.

Table 4. Classification of urban development possible impact on industrial heritage

Impact	Aspects
I ¹ : Causing cracks in all elements	A3, A4
I ² : Damaging masonry structure	A1
I ³ : Ambiguity of structural perception	A3, A5
I ⁴ : Negative impact on structural integrity	A4
I ⁵ : Interruption of the production process	A1
I ⁶ : Loss of aesthetic values	A4, A5
I ⁷ : Reduction of the authenticity of form and design	A4, A5
I ⁸ : Causing deterioration of the decorative finishing	A5
I ⁹ : Interruption of the possible knowledge transfer	A1, A2
I ¹⁰ : Potential loss of the genius loci of the place	A1, A2
I ¹¹ : Potential loss of industrial identity	A2
I ¹² : Making the construction technology incomprehensible	A3, A5
I ¹³ : Making the design, material, and form detached from the surroundings	A2, A6
I ¹⁴ : Adverse impact on the townscape and visual integrity	A6

Table 5. Matrix of impact severity adapted from ICOMOS [42]

Attributes of industrial heritage	Severity of impacts				
	Negligible	Minor	Moderate	Major	Severe
Very high values Setting/ function	Slight/ Minor	Minor/ Moderate	Moderate/ Large	Large/ Very large	Very large
High values/ construction tech	Slight (A3, A5)	Slight/ Minor (A1, A2 A3, A5, A6)	Minor/ Moderate (A1, A4, A5, A6)	Moderate/ Large (A2,A3, A4, A5)	Large/ very Lage (A1, A2)
Medium values/ form	Slight	Slight	Slight/ Minor	Minor/ Moderate	Moderate/ Large
Low values/ industrial culture	Slight	Slight	Slight	Slight/ Minor	Minor/ Moderate
Negligible	Slight	Slight	Slight	Slight	Slight/ Minor

Natural movement theory

We know that people simply follow the shortest distance paths between the origin and destination, that is why people who want to explore the market and move between two hypothetical points are expected to use the shortest path. Indeed, the blue path is expected to be more popular for movement between A and B. Observations were carried out for both sites to test our expectations. To make any claim about the reason why people are expected to choose a path, metric distance analysis should be performed accurately (Fig. 6).

Table 6. Metric distance analysis

Cases	Length of the blue path or short path	Length of the long path (or the average length of red paths)
Makineh ardi dastpache	198.92	310.30
Kooreh Milioni	92.92	165.16

Despite all these expectations, our observations were completely different. Figure 12 shows the process of observation.

By observing 30 people in each site in an average of one hour, Movement rates for each path are tabulated in Table 7. This controversy (Fig. 12) leads us to this concept that “these differences seem to correspond broadly to the difference between 'grid-integration' areas. For

testing two types of paths and proving what seemed to be right, natural movement theory is quite relevant.

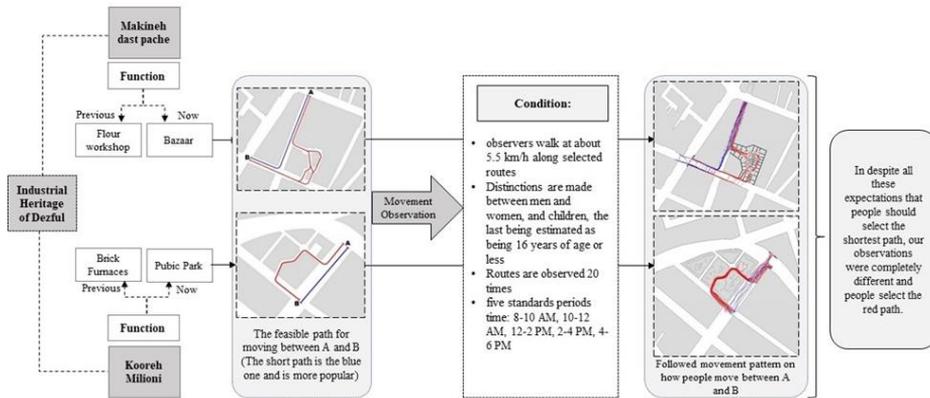


Fig. 12. The process of people’s movement observation

Table 7. Socio-demographic data of an accidental statistical sample of pedestrians

Individual-level variables		N	Percent	Mean	SD
Gender	Age	60		31.30	0.80
	Male	30	50.00	-	-
Marital Status	Female	30	50.00	-	-
	Married	23	38.30	-	-
Family	Single	35	58.30	-	-
	Divorced	02	03.40	-	-
Nationality	Number of family members	-	-	04.20	0.65
	Iranian	60	100	-	-
Race/ Ethnicity	Foreigner	00	0.00	-	-
	Local	60	100	-	-
Local experience	Residence of other cities	-	-	-	-
	Length of residence in the neighborhood	45		17.50	3.50
Education	illiterate	04	06.65	-	-
	Up to diploma	41	68.35	-	-
	Have a higher education degree	15	25.00	-	-
Annual household income	< \$1000	04	06.65	-	-
	\$1000 - \$1300	20	33.35	-	-
	\$1300 - \$1600	23	38.30	-	-
	\$1600 - \$2000	10	16.70	-	-
Homeowner	> \$2000	03	05.00	-	-
	Yes	19	31.60	-	-
	No	41	68.40	-	-

Integration is a variable that is very close to what this research looking for. Indeed, to reach integration analysis, the first axial map for the whole city is needed. The 'axial map' of an urban fabric encompasses the longest and fewest straight lines that can be drawn through the spaces of the grid so that the grid is covered. The axial map of the Dezful urban grid was drawn based on the “Open Street Map” (Fig. 13).

The simplest graph is the one that describes the local properties of a node in the graph: “Integration”. By interpreting the integration (R3) map it seems we must also acknowledge the existence of harmony between metric analysis and space configuration analysis, corresponding to the two case studies (Fig. 14).

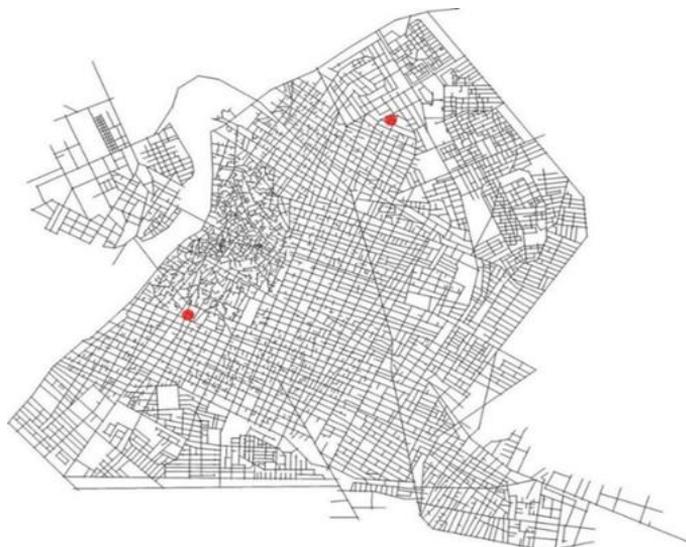


Fig. 13. Axial map of Dezful urban grid

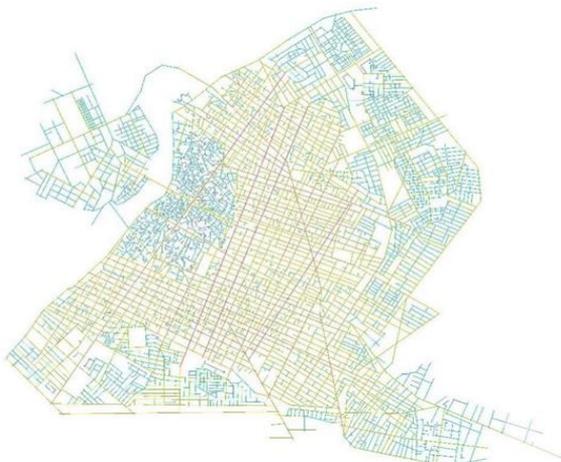


Fig. 14. Integration (R3) distribution of Dezful urban grid. The blue path enjoys better conditions regarding the space configuration and this means that this path should have been popular amongst sightseers

The difference is so high that no doubt that “something attracts people to the red paths, irrespective of what space configuration condition these paths have”. This is an obvious surprising point according to natural movement theory, as it says the most integrated path, simply enjoys the high rate of pedestrian movement (Fig. 15).

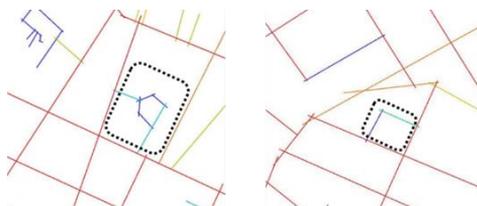


Fig. 15. Integration (R3) distribution map (Left: Makineh dast pache, Right: old brick furnace)

With considering the graphics export of depth map for each case, first, both cases are like a large circle in the urban fabric, and it is striking that movement rates in these specific sites are expected to be very low and the highly attractive path of each site must be the blue one (Table 8).

Table 8. Average integration (R3) for each path

Cases	Average Integration (R3) for the red path	Average Integration (R3) for the blue path
Makineh ardi dastpache	2.69	5.08
Kooreh Milioni	3.05	5.44

The research tries to say that industrial heritage values appear as super positive attractors in urban networks which can easily affect the average movement rates. The path where normally should be empty of movement because of this is full. But for proving this claim, we have to be sure that the quality of these spaces is the key that attracts people into them. To evaluate place satisfaction in case studies, a statistical test was done to investigate the source of differences. Sightseers who use red or blue paths are asked to fill the questionnaire. Each question is related to a specific value that can be imagined for industrial heritage.

Table 9 shows a clear difference between “place satisfaction” elements associated with the industrial heritage values in the two areas of study.

Table 9. Summary result of questionnaires

Elements	Evaluated value	The average answer of red path users in “Makineh dastpache”	The average answer of blue path users in “Makineh dastpache”	The average answer of red path users in “Kooreh Milioni”	The average answer of blue path users in “Kooreh Milioni”
Accessibility of roads	Space configuration	37.73%	65.54%	54.81%	64.27%
Cultural orientation	Cultural value	46.05%	25.49%	68.27%	12.40%
A good place to visit	Space quality	40.17%	52.31%	57.66%	30.08%
Social relations	Social values	59.28%	31.28%	58.64%	19.50%
Privacy and community	Respecting the privacy	38.42%	24.51%	37.48%	47.67%
Identity and values	Public identity	54.56%	21.71%	83.09%	15.61%
Having memories	Nostalgic values	50.50%	44.76%	42.80%	25.85%
Feeling about all	-	49.35%	42.15%	61.94%	51.50%
Industrial heritage values (average of all question except the first one)		48.33%	34.60%	58.55%	28.90%

In “Kooreh Milioni”, the question of identity and values the area of study has the highest positive answer by red path users (83.09%), followed by the question about the cultural orientation in the same case by the same responders as the second important aspect in this case (68.27%). While the results of “Makineh” in each path show a different order for the most positive answers, but on the whole, the red paths in both cases have higher positive answers. In general, considering this feature, as well as other attributes of a space by considering future uncertainties [42,43] and performance of a space [44] as well as adaptability [45] and authenticity [46] which can heavily affect the spatial quality.

Conclusions

This research focused on industrial heritage identifications of public spaces which investigate the effect of the mental and physiological dimensions of industrial heritage on the urban fabric and Natural Momentum theory has been used to verify the psychological dimensions of heritage attributes on individuals. Results show that cultural and memorial orientations of case studies have a rate of contradiction in space configuration features and pedestrian movement routes. This creates a distinct spatial integrated distribution that contradicts expected space configuration conditions. This can be determined that urban public spaces with a high rate of space configuration conditions, could be influenced by cultural, historical, and memorial values which are considered as high potential places for social and city branding features. The relationship between heritage and visitors to cultural heritage spaces is direct, in a way that this relationship originates from the effect of heritage on the individuals which causes individual behaviors. In different sites the combination or combination of built heritage in urban spaces or their special location, causes conscious or unconscious choice behaviors based on previous to reminisce of individuals, these can cause changes in movement choices, pauses, and interacting opportunities in such sites (Fig. 16).

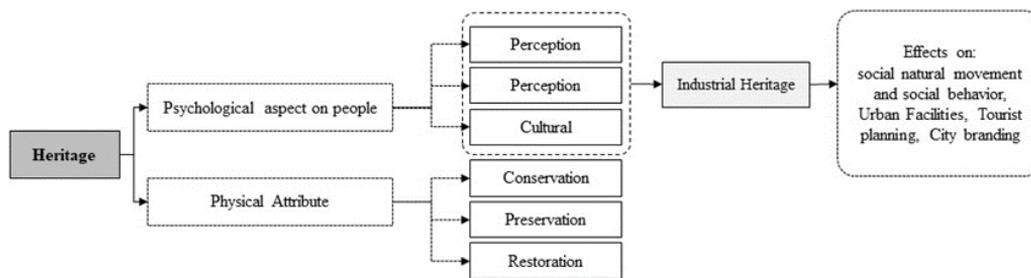


Fig. 16. Conceptual framework of results

In Natural Momentum theory, the psychological aspect of heritage in urban historical contexts can be used to orient and improve the quality of urban environments that enjoy industrial heritage. On occasions, combining or combining artificial heritage in urban spaces or locating their properties, causes conscious or unconscious choice behaviors that are based on people's precious memories. These can cause changes in movement choices to pause the interaction of visitors of the place. These changes resulting from conscious and unconscious choices derived from the intangible impact of heritage on human behavior.

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