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Research Article

THE ROLE OF PEDESTRIAN-BASED REGIONS IN DEVELOPMENT OF SOCIAL INTERACTIONS (CASE STUDY: ANCIENT CONTEXT OF GORGAN CITY)

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ABSTRACT
Since the Second World War, cities have attached more importance to pedestrian regions, attempting to both improve stability of cities and resolve transportation problems via vehicles and to facilitate social interactions through pedestrian flows. This has been neglected in our country's cities. Moreover, timeworn contexts are experiencing no good conditions due to place extenuations. Therefore, in order to investigate the current conditions and present solutions, two methods of place-time and hydraulic-like were used to study the ancient context of Gorgan City by means of survey and library studies. On this side, the present research makes use of, and is categorized based on, practical approach. Since pedestrian movements are of A-Z service level in Iran, results of the paths ending to ancient context of Gorgan City are illustrative of the fact that Panj-Azar St. possesses the best conditions and Imam Khomeini St., especially its southern margin, has the worst conditions respecting pedestrian status. In addition, there was no significant difference between place-time and hydraulic-like methods, with results gained by one were verified by the other one.

Keywords: *Pedestrian Level of Service, Ancient Context, Place-time Method*

INTRODUCTION
Utilization of vehicles has strongly influenced urban areas and caused streets of old contexts and main avenues of the cities to lose many of their functions. Absence of areas for collective activities in the cities has, moreover, provoked people to use vehicles, resulting in removal of human beings from pedestrian areas and formation of dead locations in the cities. Therefore, paying attention to pedestrian areas in ancient contexts is, due to lessening of human capitals, felt more than ever. As pedestrian areas developed and social capital increased, inclination to taking part in political activities and local communities surged and making relations with friends and relatives grew (Williams, 2005).
On the other hand, research on effects of transportation on physical health and social welfare has recently increased and the concerns on the need to a stable transportation system and further demands are aggravated. In response, many traffic engineers and urban planners have begun to use plans and strategies to encourage non-motor transportations such as biking and walking (Kim *et al.*, 2013). Therefore, recent years have confronted a reemphasis on improvement of pedestrian facilities and presentation of functional characteristics in order to help dilute traffic, improve safety, and enhance life quality in crowded points of the globe (Lawlor *et al.*, 2003; Lo, 2009; Elias and Shiftan, 2012). According to the statistics, 50 and 75 percent of journeys inside large and small-to-average cities of Iran are made on foot, respectively. Therefore, passengers, as the main element of intra-city transportation systems, should be given attention in making policies and designs. Pedestrian areas are thus scientific and practical solutions to many major problems of cities that can fight against elimination of economic opportunities, lessening of life quality, pollution, congestion, and migration of the middleclass from the city center (Pakzad, 2009). In contrast to global functionality of pedestrians, engineers make use of traditional measurement methods to offer quantitative evaluations on pedestrian environments in terms of convenience and movement density (Kang *et al.*, 2013).
Pedestrian-based movements increase the likelihood of participation in communal places whereby social interactions and collaborations expand. Therefore, vehicles are instruments of decline of social

interactions and capitals. However, whenever time is ripe for pedestrian-based movements, social visits surge and social capitals intensify. As social capital increases, tendency to take part in political activities and communal societies raises high and relations with friends and relatives rush forward. Social relationships pave the way for residents of a local society to get acquaintance with one another and shape a common reliance; social networks contribute to development of social capital (Williams, 2005). In recent years, urban planners have failed to address Gorgan City's ancient contexts, the fact which has resulted in many passengers to give up the idea of walking thereupon due to a famine of powerful attractions offered by city environments. There are issues that have made pedestrian areas of ancient contexts of Gorgan City to be less used by the passengers, among which one may refer to incongruent usages, interference of on-board and on-foot people, short width of sidewalks, insufficient infrastructures, congestion of contexts, and non-coverage of areas to receive services.

Literature Review

Prior to the Industrial Revolution, size and relationships among the elements forming the cities were based on human scales. Relocation patters had, in addition, their roots in movements of an on-foot person (Gharib, 2004). This type of relocation comes with a thousand-age history: movement of passengers has shaped the structure of habitations the fact which is approved by the most beautiful city-centers of civilized cities**.** Paying attention to this after the WWII on the verge of reconstruction of European cities found a more specific mood. Success of such plans caused large-scale actions to be taken in next decades, so that many central and historical areas of European cities were, by the 1980s, banned for the vehicles to enter (Habibi, 1999).

During the last forty years, many attempts were made in European cities to regenerate the ancient core of the cities, like those made in the Italian and English cities, in the latter of which actions like increasing congestion of old contexts, removing obtruding and crowded usages into outskirts, strengthening sidewalks, and constructing passenger-specific pedestals were carried out. In Italy, measures were taken including the construction of a business center in the vicinity of the old context, creation of efficient transportation, creation of tourist walk routes, improvement of living standards, and full protection of old parts in order to strengthen walk routes, all of which have offered valuable results in improving quality of walk routes and ancient textures.

In recent years, modeling, simulation, and optimization of the flow of passengers have attracted the attention of many transportation researchers. The focus of such attentions has been directed mainly to the following:

1) Resolution of tangible, everyday problems concerning crowded public spaces such as busy traffic centers, shopping centers, and the like;

2) Optimization of the techniques aimed at evacuating crowded centers and buildings;

The latter case can come in hand for traffic architects and engineers to solve traffic- and safety-related problems (Sahaleh *et al.*, 2012).

Sidewalks

Sidewalks are passageways with the highest social role, in which passengers have the complete dominance. Motor vehicles are used to provide services for the current life in passageways (Pakzad, 2006). These passageways may be formed as lanes, markets, marketplaces, and a road in the square, park, or spaces of a complex. Eliminating the traffic of the on-board, sidewalks are made in a part of the city for architectural, historical, or commercial reasons. Passenger-based sidewalks are individual, segmented streets, whose car traffic has been removed. In other words, non-motorized traffic has the absolute priority. However, certain vehicles such as fire extinguisher, emergency, and police cars would have full access to such paths in emergency conditions; service and freight vehicles are, also permitted to enter during certain times (Brambilla and Longo, 1997). Urban road design regulations define passenger-specific streets as the ones which ban entrance of passenger cars and other motorized vehicles in order to prioritize the atmosphere (Housing and Urban Designing Department, 1995). Pedestrians are places where people are allowed, or encouraged, to cross the street on their feet. Thus, such axes should have no vehicle traffic thereupon (Cowan, 2008). In this regard, potential of a place to be used by passengers,

desirability of the environment for peoples' presence, life, purchasing, visits, and enjoying themselves are on one spectrum (Nosal, 2009). Moreover, the potential of being passenger-oriented is possession of desirable conditions which permit people to have trouble-free excursion thereon. This includes different aspects like connection, legibility, safety, and accessibility to services (Waldock, 2012). Therefore, scope of pedestrian is a place whose passengers at any age and ability can feel safety, convenience, and attraction upon their walking not only in their leisure, but also when using traffic facilities (American Urban Association, 2008).

Passenger-based Region

Passenger-based region is rooted in the concept of neighborhood units in which the emphasis is on commixture of usages, interconnected occupations, residential houses, shops, malls, and kindergartens that are located near transportation systems (Caves, 2005). In addition, a set of streets which have been changed into sidewalks and created a region dominated by the on foot are called passenger-based region (Brambilla and Longo, 1997). Passenger-specific region is a place into which the entry of other motor vehicles is prohibited and regulated in order to prioritize the environment. Permeability index is one of the crucial factors in marking a region as passenger-based. If permeability of urban fabrics is high, users will have a wider range of selection; thus, their passenger-based ability grows higher. In contrast, less permeable contexts come with lower ability to become a passenger-based region as the context's continuity is less and an individual's freedom to choose a route is more limited.

In the following graph, acceptable walking distances for a given passenger-based region are illustrated, in which part "A" relates to parking and children's playing area, part "B" to daily shopping centers and bus stations, part "C" to primary schools and kindergartens, and part "D" to commercial and administrative centers.

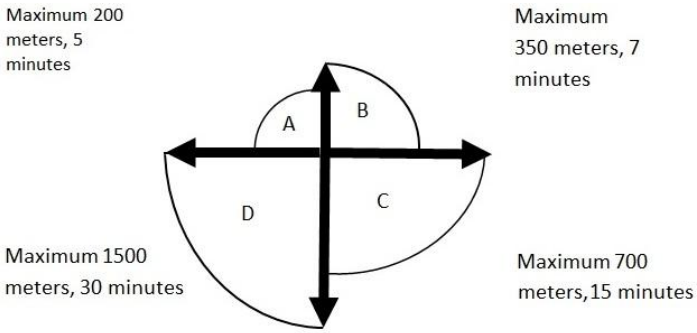

Figure 1: Diagram of acceptable walking distances (Technical Research and Criteria Bureau, 1996)

Throughout the centuries, traditional parts of the cities have been formed as a market and a gathering place with multiple applications. Such centers were originally reserved for the pedestrians, who could move thereupon in full freedom and safety. Gradual adaptation of vehicle-specific networks with the old contexts has left behind adverse effects, among which one may refer to destruction of historical contexts and monuments of these centers.

Sidewalk's Level of Service

The quality of passengers' movement in sidewalks is different when they walk with desired speed and free movements or when they are tightly pressed by each other through the routes the concept which is expressed in terms of level of service. According to HCM, level of service is a suitable model to describe and categorize traffic flows, especially pedestrian traffics. It was first introduced in the field of traffic engineering in order to provide planned congestion. This index is based on freedom in movement speed, ease of walking by passengers, and slow movement of the passengers (Watson, 2001).

A, B, C, D, E, and F criteria are used for classification of the concept of level of service, whose standards are expressed in terms of the capacity occupied by the passengers. Conditions of waiting places such as

those in public transportation stations and passenger queuing at the corner of intersections with traffic lights are also expressed in terms of the level of service. Most waiting sites require enough space to stand and an extra space for peoples' limited mobility. For example, in the spaces of less than 0.3 square meters per person, involuntary body contacts occur. In distances less than 0.2 square meters per person, congestion appears to grow dangerous. In addition, it should be noted that local and specific conditions governing the pedestrian environment should be taken into account and required adjustments considered upon determining quantitative and qualitative criteria related to level of service. Changes to pertinent levels of service for Iran's circumstances are given in the table below.

Table 1: Suggested criteria for levels of service of pedestrians for Iran's circumstances

Level of service	Movement space (square meter per person)	Expected velocity and flow		
		Average velocity (meter per minute)	Rate of passengers' passage (person per minute per meter)	Volume-to-capacity ratio
A	≥6	≥76	≤13	≤0.18
B	≥4	≥74	≤19	≤0.27
C	≥2.6	≥71	≤27	≤0.4
D	≥1.6	≥65	≤41	≤0.6
E	≥0.6	≥40	≤68	≤1
F	<0.6	<40	Variable	

(Technical Research and Criteria Bureau, 1996)

MATERIALS AND METHODS

Methodology

Models are simple representation of the reality. In fact, we need to find a simple model that reflects the actual behavior. Modeling of pedestrian motion is accomplished in two microscopic and macroscopic scales. In microscopic models, each pedestrian is considered as an individual and independent factor on behalf of the whole collection; while, in macroscopic traffic models in group and population levels, flow density and average velocity of mass is considered (Schadschnider *et al.*, 2009). This study uses the latter methodology to conduct its research.

Application of level of service criteria for analytical purposes is very simple if the volume of passenger passage is apparent. For instance, when we wish to determine effective width of a sidewalk in terms of its apparent volume of passenger passage, firstly we find its level of service. Then, the related volume is divided into the passage in each meter of the sidewalk's width to gain its effective width. Afterwards, additional width is added to the related side distance and street equipment and barriers are adjusted. Moreover, in case determination of sidewalk's level of service for an apparent passage volume and passage width is desired, effective width of the sidewalk is divided into passage volume in order to obtain average area available for each passenger in traffic flow. Then, related level of service id specified as per the above table.

There are two types of models for analyzing flow of passenger traffic:

A: Hydraulic-like model, in which criteria of presented level of service are based on the hypothesis of monotony and continuity of passages and purposeful movement of the passengers. In this method, volume of passages are identified and then divided into the effective width of the sidewalk.

B: Place-time model, which is based on latitudinal and indirect movement as well as non-uniformed and disjointed, flows. In this method, place-time presentation is obtained from multiplication of the area under study in terms of square meters by observation time in terms of minutes or seconds. Place-time demand is gained by multiplication of the number of passing persons over each segment during the time period they occupy that segment. By dividing place-time presentation into its demands, average of the area available

for each passenger is gained. If the width of the passage is unknown, a level of service and a per capita area should be selected to obtain place-time presentation (Technical Research and Criteria Bureau, 1996).
To calculate the passages' level of service, we need a series of statistics and information about streets, passage axes, on-board traffic volume, and the on-foot volume thereon. A part of the statistics has been provided by Gorgan Municipality Traffic Control Center and consulting companies and another part of information (such as volume of passengers per minute and effective width of the sidewalk) by field calculations. To do so, some points of the context were firstly selected and volume of passage traffic in Imam Khomeini, Shohada, Pasdaran, Sar-e Khaje, and Golshan were, secondly, calculated in Mordad (15^{th} and 20^{th}), Shahrivar (19^{th} and 24^{th}), and Mehr (16^{th} and 21^{st}) at morning and noon hours.

Research Scope

In northern Iran, the only historical context which is remained and recognized is located at the current Gorgan City. This context is an interconnected series of ancient houses, passages, public places, and different biological elements at urban space with an area of more than 150 hectares that were enclosed by gates and towers since around one century ago. Primary growth of the old context happened at its towers and battlements. Although, it found its way through southern and eastern sides of the city since 1911 and again eastern and south-eastern sides since 1938. In 1970s and 1980s, however, trend of city growth changed and the city expanded in a scattered manner in all fronts, the expansion which was along the streets (Design and Architecture Consulting Engineers, 1995).
The collection known as the Gorgan City's ancient context is the product of a continuous, organic, and ingrown formation during the centuries in the Islamic period. This collection indicates continuity among its elements including inclusive mosque, residential areas, and town centers, which were considered as the main gates. Primary congestion of three localities named Nalbandan, Sabs Mashhad, and Meidan were the birthplace of this context.

Main Access Points to the Ancient Context

- Imam St. (Shahrdari St.):

The oldest street of the Gorgan City is Imam St., which divides the ancient context into two southern and northern parts. Heavy traffic of motor vehicles, traffic conglomeration of heavy- and light-weight vehicles, commixture of on-foot and on-board persons in many points (especially in areas near market), and passage traffic are among the most important problems.

- Shohada St.:

This street is located along north-western/south-eastern path between Shahrdari Sq. and Shohada Sq. Being of first-class arterial type, this axis provides access to the old context and city-center from the northern parts.

Table 2: Physical properties of main streets located at old context

Street name	On-board	Effective width of sidewalk	Length	Total width	Gradient
5^{th}Azar St.	12.8	2	985	24.5	1.31
Imam Khomeini St.	19.1	1.5	753	29.7	3.38
Shohada St.	11	1.7	773	22.5	1.35
Pasdaran St.	18	1.9	463	23.5	1.52
Sar-e Khaje (Shariati) St.	17.5	1.1	536	21.7	1.20
Mir Karim St.	11.2	1.4	290	18	-0.24
Golshan (Mojahedin) St.	18	1.2	394	24.8	1.15

- Sar-e Khaje (Shariati) St.:

This street is of second-class arterial type and provides access to southern parts of the city.

- 5^{th}Azar St.:

This street, along with Namjoo St., Bahonar St., Imam Khomeini St.., and its axes nearby, are located the southern part of the ancient context. This street is of first-class arterial type.

- Mojahedi (Golshan) St.:

This vertical street crosses Imam Khomeini St. and is located between Shahrdari Sq. and Mazandaran Sq. Being of first-class arterial type, this street is the main point to get access to the old context from the northern side.

Discussion and Analysis

There are different factors which cause problems in sidewalks, disabling them to provide proper answers to users' demands. To resolve such problems, width of the sidewalks should be adjusted, which is carried out through determination of level of service for on-foot and on-board passages. Statistics and information are illustrative of the fact that some of the streets located at the old context confront terrible traffic problems for both on-foot and on-board passages. In order to analyze levels of service for on-foot passages, streets which are of direct influence upon central context of Gorgan are selected and their levels of service are analyzed using related methods. Such streets are Imam Khomeini, Shohada, Pasdaran, Golshan (Mojahedin), Sar-e Khaje, and 5thAzar streets.

Determination of Levels of Service for On-Foot Passages using Place-Time Method

Firstly, level determination stages are conducted for Shohada Street's available sidewalk. Then, levels of Service related to other passages are calculated and mentioned in the table.

Length of sidewalk segment: 773 meters

Effective width: 1.7 meters

Observation period: 1 minute

Place-time presentation: 773×1.7×1=1314.1 square meters per minute

On-foot passengers: 37 passengers per minute

Each user's occupation time: 10.6 minutes

Place-time demand: 37×10.6=392.2 person per minute

Average area per each passenger: 1314.1/392.2=3.35 square meters per passenger

In above method, average area occupied by each passenger is first specified and afterwards its level of service is calculated. Then, required adjustments are done to improve quality of the sidewalk.

Table 3: Levels of service for on-foot passages in morning rush hours (7:30-8:30 a.m.)

Street name		Effective width of sidewalk (m)	Sidewalk's length (m)	Volume of on-foot passage (per minute)	Average time for each passenger's occupation (m)	Place-time presentation (X)	Place-time demand (Y)	Average area per passenger (X/Y)	Level of service (LOS)
Imam Khomeini St.	Northern edge	1.5	753	56	10.4	1129.5	582.4	1.93	D
	Southern edge	1.3	753	51	10.4	978.9	530.4	1.84	D
Shohada St.		1.7	773	37	10.6	1314.1	392.2	3.35	C
5thAzar St.		2	985	12	13.3	1970	159.6	12.34	A
Pasdaran St.		1.9	463	43	6.7	879.7	288.1	3.05	C
Sar-e Khaje (Shariati) St.		1.1	536	21	7.7	589.6	161.7	3.64	C
Golshan (Mojahedin) St.		1.2	394	13	5.9	472.8	76.7	6.16	A

Table 4: Levels of service for on-foot passages in noon rush hours (16:30-17:30)

Street name		Effective width of sidewalk (m)	Sidewalk's length (m)	Volume of on-foot passage (per minute)	Average time for each passenger's occupation (m)	Place-time presentation (X)	Place-time demand (Y)	Average area per passenger (X/Y)	Level of service (LOS)
Imam Khomeini St.	Northern edge	1.5	753	62	10.4	1129.5	644.8	1.75	D
	Southern edge	1.3	753	57	10.4	978.9	592.8	1.65	D
Shohada St.		1.7	773	34	10.6	1314.1	254.4	15.16	B
5th Azar St.		2	985	24	13.3	1970	319.2	6.17	A
Pasdaran St.		1.9	463	40	6.7	879.7	268	3.28	C
Sar-e Khaje (Shariati) St.		1.	536	18	7.7	589.6	138.6	4.25	B
Golshan (Mojahedin) St.		1.2	394	16	5.9	472.8	94.4	5.00	B

Total width of the sidewalk is of paramount importance in inclusive and in-depth urban plans regarding on-foot passages.

Table 5: Suggested level of service and minimum width of sidewalk (m) in place-time method

Main characteristics		Required average width per each factor influencing on on-foot passengers				Total width (application of 0.3)
Street name	**Suggested level of service**	**Street facilities**	**Green area**	**Corbelling onto the sidewalk**	**Suggested level of service**	
Imam Khomeini St. Northern edge	A	1	1	1.2	2.5	6
Imam Khomeini St. Southern edge	A	1.5	1	1.2	2	6
Shohada St.	B	1.5	1.2	0.7	1.5	5.2
5th Azar St.	A	1.5	1.2	1	1.2	5.2
Pasdaran St.	B	1.5	1.5	1	1.5	5.8
Sar-e Khaje (Shariati) St.	B	1	1.5	0.8	1.5	5.1
Golshan (Mojahedin) St.	B	1	1	1	1.5	4.8

Therefore, effective width is firstly determined in designing and planning on-foot passages and then adjustment are made therein. Generally speaking, effective width of the sidewalk should not be less than 2 meters. Moreover, each person walks with an approximate distance of 0.3 from the wall, the distance which is not included in the effective width of the sidewalk, i.e. it is a dead space. Sidewalks beside the

commercial centers should allocate a distance of 0.5 meter to those looking through the showcase. Sidewalk barriers like trees, parking meters, fire hydrants, trashes, etc., would occupy about 0.6 meter from the effective width of the sidewalk. Based on desired levels of service and number of passengers, effective width of the sidewalk is specified. In addition, effective width of the sidewalk in standard volume is identified regardless the levels of service of passengers' movements.

As table 4 shows, Imam Khomeini St. experience severe problems in both northern and southern edges at morning rush hour (level of service "D"). But Shohada, Pasdaran, and Sar-e Khaje passages face fewer problems. Also, sidewalks in fifth Azar and Golshan streets display good performance in supporting passenger passages.

Due to existence of several commercial and administrative centers along Imam St., this axis can be regarded as central part of the city that attracts a huge number of people from all social classes. Therefore, evening rush hours experience many problems. For this reason, this condition should be approached to the level of service "A." a space of at least six square meters is required to enable passengers to have convenient traffic over the sidewalk with no contacts to one another (level of service "A").

To do so, effective width of this street should be taken three meters. Also, a width of two meters and one meter should, respectively, be added to enable the passengers to have contactless movements across the sidewalks and to create enough space for constructing newspaper malls.

Table 6: Suggested level of service and maximum width of the sidewalk (m) in place-time method

Main characteristics		**Required average width per each factor influencing on on-foot passengers**				**Total width (application of 0.3)**
Street name	**Suggested level of service**	**Street facilities**	**Green area**	**Corbelling onto the sidewalk**	**Suggested level of service**	
Imam Khomeini St. Northern edge	A	1.5	1	1.5	2.5	6.8
Imam Khomeini St. Southern edge	A	1.5	1	1.5	2	6.3
Shohada St.	B	1.5	1.5	1	1.5	5.8
5th Azar St.	A	1.5	1	1.5	1.5	5.8
Pasdaran St.	B	2	1.5	1.5	1.5	6.8
Sar-e Khaje (Shariati) St.	B	1.5	1.5	1	1.5	5.8
Golshan (Mojahedin) St.	B	1.5	1	1.5	1.5	5.8

Determination of Level of Service for Passengers Using Hydraulic-Like Method In order to reach at more accurate results with higher confidence coefficient, above general stages are once more completed to obtain total width of the sidewalks using hydraulic-like method. Stages for determination and calculation of level of service in hydraulic-like and place-time methods are different (following table).

Table 7: Calculation of level of service for on-foot passages using hydraulic-like method

Passage name		Passengers' traffic (V)		Effective width of sidewalk (m)	Rate of traffic of on-foot traffic (V/C)		L.O.S	
		morning	noon		morning	noon	morning	noon
Imam Khomeini St.	Northern edge	56	62	1.5	37.33	17.33	D	B
	Southern edge	51	57	1.3	39.23	43.84	D	E
Shohada St.		37	34	1.7	21.76	20	C	C
5th Azar St.		12	24	2	6	12	A	A
Pasdaran St.		43	40	1.9	22.63	21.05	C	C
Sar-e Khaje (Shariati) St.		21	18	1.1	19.09	16.36	C	B
Golshan (Mojahedin) St.		13	16	1.2	10.83	13.33	A	B

Table 8: Suggested level of service and maximum width of sidewalk (m) using hydraulic-like method

Main characteristics			Required average width per each factor influencing on on-foot passengers				Total width (application of 0.3)
Street name		Suggested level of service	Street facilities	Green area	Corbelling onto the sidewalk	Suggested level of service	
Imam Khomeini St.	Northern edge	B	1.5	1	1.8	2.2	6.8
	Southern edge	B	1.5	1	1.5	2	6.3
Shohada St.		B	1.5	1.5	1	1.5	5.8
5th Azar St.		A	1.5	1	1.5	1.5	5.8
Pasdaran St.		B	2	1.5	1.5	1.5	6.8
Sar-e Khaje (Shariati) St.		B	1.5	1.5	1	1.5	5.8
Golshan (Mojahedin) St.		A	1.5	1	1.5	1.5	5.8

Conclusion

Investigations showed that two place-time and hydraulic-like methods present generally similar results in all places, as in Iranian cities. Therefore, one of them can be used in studies to save time and money. After present conditions were specified, it was recognized that the best condition relates to 5th Azar St. Moreover, Imam Khomeini St., especially in its southern edge, has the most unsuitable condition (Level "E" in place-time method and "D" in hydraulic-like method). To improve this condition, an effective width of three meters is suggested, which, with regard to existent widths of the sidewalks, it would be doubled to be six meters. Due to this, a widening suggestion is given to the inclusive plan. Of course,

since Gorgan's ancient context uses a separated organization plan entitled "Aftab," results of the present research are also suggested to be used in that plan. Other paths ending in the ancient context are in suitable conditions and do not need ample constructions for neither present nor future developments.

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