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EVALUATION OF THE EFFICIENCY AND QUALITY OF THE TRAM ROUTE OF SETIF CITY, ALGERIA: COMBINING AHP AND GIS APPROACHES

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Abstract: The study aims to evaluate the efficiency of the tram track in the urban transport system of the Algerian city of Setif by combining Analytical Hierarchy Process (AHP) and Geographic Information System (GIS) approach. In this research, a set of multiple pre-determined criteria applicable in the field of urban transport were selected for decision-making. They were collected from recent research literature and expert opinions in this discipline, and then were arranged and evaluated in the AHP to extract the main weights for each criterion. In the end, they were processed spatially by using GIS. The study showed that the selection of the tramway track in the city of Setif was not successful in terms of the chosen location, and its selection was not studied according to the efficiency and quality criteria applicable in the field of urban transport. In addition, the study concluded that there is a significant shortfall in the first tram track, especially the one linking the tram route to the northern and southern parts of the city, which affected the efficiency and quality of the tram route. As the results have shown, the percentage of good spaces near the tram route does not exceed 0.34%. It is followed by the percentage of the average and acceptable areas (13.48%) and then the percentage of the marginalized areas and the areas far from the tram track (86.18% of the total area of the city). The study also demonstrated the importance of using AHP and GIS in evaluating a completed tram track according to a comprehensive and widely studied scientific methodology.

Keywords: urban transport; transport decision-making; AHP; GIS; tramway Setif

1. Introduction

In 2016, the United Nations held the first global conference on sustainable transport in Turkmenistan, which focused on reducing the impacts of transport on the environment, and focusing on the use of clean energy "Electric trains are clean. It depends if the electricity is clean at the origin" (Loubinoux, 2016, para. 10), and specialists believe that the development of solar energy to produce electricity is the best solution for its use in electric transport. Jean-Pierre Loubinoux from the International Union of Railways explained it to Euronews in the following

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way: "Marrakesh has the biggest solar field in the world, and this would be dedicated to train electricity. But there are other examples in the world, and I'm sure that Turkmenistan with the radiation you have here in your country can also develop solar energy that can be used for train driving" (Loubinoux, 2016, para. 10).

Many studies have applied different methods for evaluating the efficiency and quality of the tramway. There are also several previous studies that relied mainly on the Analytical Hierarchy Process (AHP) or Geographic Information System (GIS) in the field of urban transport and mobility, some of which being: Ahmed and Asmael (2015), Bubalo et al. (2021), Ghorbanzadeh et al. (2019), Ghorbanzadeh et al. (2020), Giuffrida et al. (2019), Han et al. (2020), Krmac and Djordjević (2017), Pogarčić et al. (2008), Sameer et al. (2021), and Żak and Kurek (2020). AHP and GIS are of great interest to researchers and engineers in the field of urban planning and urban transport in particular. The GIS program provides several special features. By using the model feature, the program collects information for all the selected criteria to extract the final map as a result of the studied phenomenon. The previous two systems were also relied on in several other disciplines, such as determining the quality-of-life field (Dehimi, 2021; Dehimi & Hadjab, 2019), choosing the best waste collection area (Redjem et al., 2021), or for mapping flood vulnerability (Loumi & Redjem, 2021). All these studies concluded the importance and efficacy of the AHP and GIS in determining the priority of an area, track, road, railway, and other urban issues.

In the 1980s, the lack of investments in realizing urban development projects and transportation, especially public transportation, was due to the financial difficulties that Algeria had to face. The financial improvement at the end of the 1990s, thanks to high oil prices, led to a disproportionate explosion in the number of cars. This explosion is the cause of urban traffic congestion known as "traffic jams" that all large cities and towns experience (Madani, 2017). Setif is considered one of the most important urban cities at the regional and national levels in terms of its important strategic location. It contains an important road network as a transit point for the different flows between East and West and between North and South. It is characterized by economic and commercial recovery. The construction of important development projects has strengthened its position as a major city, making its structure and regional elements in the face of the inevitability of adapting to new characteristics. Among them, the most important is the tramway project, the first part of which was completed in 2014. The Setif tramway was activated on May 8, 2018, and after several years, we wanted to evaluate the route of the tramway in order to see the extent to which it managed to achieve its objective of connecting most of the city areas. To verify this, we followed a scientific methodology that could enable us to identify and address errors, improve the efficiency and quality of these projects and bring them to the level of successful projects by reducing deficits, adhering to quality criteria, and providing solutions for the future. This scientific research deals with the problem of choosing the best sites or the best paths, especially in the field of urban transport. Its aim is to evaluate the efficiency and quality of the Setif tramway by using AHP and GIS. In this research, six criteria for the efficiency and quality of the tram route were chosen based on two previous studies (Alexander, 2007; Alkubaisi, 2014) and the opinions of experts in the field of transportation planning. For the experts, we interviewed engineers at the Tramway Operating Company of Algeria (SETRAM) where the AHP system was relied upon using pre-set criteria to select the best tram route. Krmac and Djordjević (2017) studied Intelligent Transportation Systems (ITS). This plays an important role in improving and developing high-efficiency transport performance with the aim to meet the needs of passengers.

Żak and Kurek (2020) used Multiple Criteria Analysis (MCA) for trams based on customer specifications and open bid lists in different countries, and then compared them to select the best and most appropriate specifications for the transportation system in their case study. Giuffrida et al. (2019) provided an overview based on a structured literature review of the use of Volunteered Geographic Information (VGI) and development of Public Participatory GIS (PPGIS) in transport studies, identified the areas in which GIS can be implemented, and highlighted the role of public participation in decision-making to increase its success rate. Sameer et al. (2021) integrated a set of evaluation criteria using the Analytical Hierarchy Process (AHP) and a spatial multicriteria model to choose a highway in the case of their studies. Alexander (2007), Madani (2017), Alkubaisi (2014), and Han et al. (2020) used a combination of AHP with GIS and field analysis for finding the best road networks.

2. Study area

The city of Setif is located in northern Algeria, in the region of the highlands, and it is 300 km far from the capital Algiers, and at the height of 1,100 m a.s.l. (Algerian Ministry of the Interior, Local Authorities, and Territory Planning [MICLAT], 2016; Figure 1). It is located in the central part of the state of Setif boarded to the north by the city of Ouricia, to the east by the city of Ouled Saber, to the west by the cities of Mezloug and Ain Arnet, and to the south by the city of Guedjel. It occupies a predominant position among the cities of the Eastern highlands, which makes it their capital. The city of Setif covers an estimated area of 127.3 km^2 (MICLAT, 2016). It is also a crossing point of great importance because it is crossed by the National Road No. 5, and recently by the East West Highway, and by the National Road No. 9 that connects Bejaia with Setif. In addition, it serves as a transit point for the convoys of goods coming from the south and heading towards the ports of Bejaia and Jijel, and it has an airport open for both the national and international network (MICLAT, 2016).

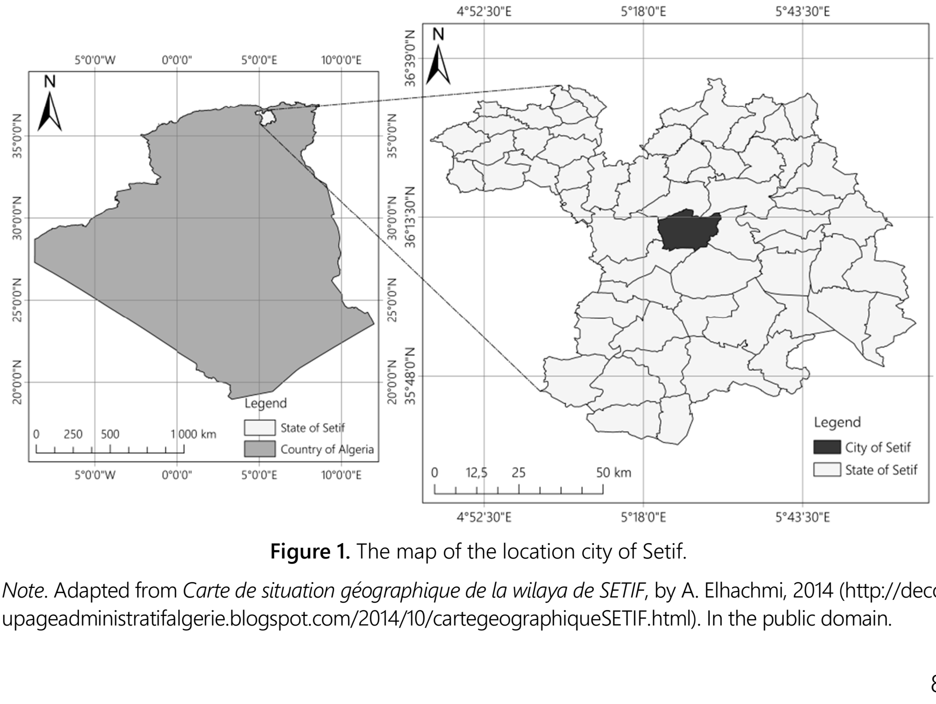

Figure 1. The map of the location city of Setif.

Note. Adapted from *Carte de situation géographique de la wilaya de SETIF*, by A. Elhachmi, 2014 (http://decoupageadministratifalgerie.blogspot.com/2014/10/cartegeographiqueSETIF.html). In the public domain.

The population of the state of Setif, according to the last official population and housing census in Algeria in the year 2008 was about 1,489,979 people, while the population of the city of Setif and its environs was 288,461 (Algerian National Office of Statistics, 2008). Setif's long history has been instrumental in its economic and social features and has contributed to the emergence of the city today throughout the national territory. The changing lifestyles and location of people, businesses, and urban utilities have contributed to the redistribution of urban jobs on the city's land, promising a prosperous economic future for the city (Abderrahmane et al., 2017).

After the realization of tramway projects in the capital Algiers, and in the cities of Oran, Constantine, Sidi Bel Abbes, and Ouargla, Setif is the sixth city in Algeria to have its tram line (Madani, 2017). The Setif tram project is an integral part of the ongoing dwelling and major public installations (stadium, multimedia station, etc.). The tram track is a spine formed on the central axis that connects the east and the west. In addition to its primary role of responding to the demand for internal travel within the city of Setif, it is also a planning and development tool for the neighborhoods it passes through. Setif tram route consists of two tracks. The first part was completed and put to use in 2018, while in the second part an itinerary was set. However, it was not completed and is currently suspended for financial reasons, including the global economic collapse due to the COVID-19 pandemic, in addition to the austerity policy applied after the decline in oil prices. Therefore, this study focused on the first track only. On May 8, 2018, as part of the historic commemoration, the Minister of the Interior and Local Authorities, accompanied by the Minister of Transport and Public Works, inaugurated the Setif city tramway. According to SETRAM Company (2020), the length of the first route of the Setif tramway was 15.2 km, including 26 stations, which were named after historical names, and it also passes several important places such as Ferhat Abbas University, Central University, stadium 08 Mai 1945, passenger transport station in the city center.

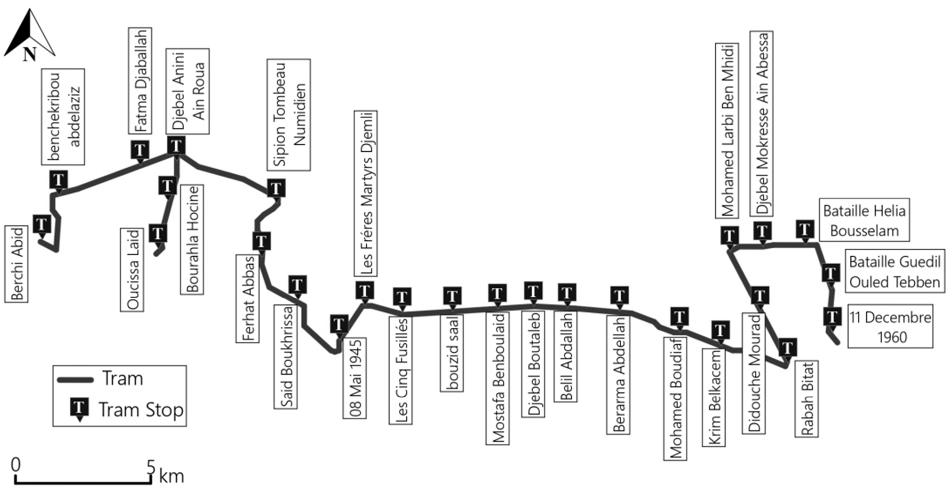

Figure 2. The map with the names of the tram stops of the city of Setif.

Note. Adapted from *SETIF*, by R. Schwandl, 2019 (https://www.urbanrail.net/af/setif/setif.htm). In the public domain.

3. Materials and methods

Information about the Setif tram was collected by conducting an oral interview with the public works engineers and the transportation technicians at the headquarters of the SETRAM Company on October 2020. Questions were raised about the criteria and characteristics of the Setif tramway.

The spatial evaluation of the tram route requires the use of a GIS program so that we can translate the weights of the criteria obtained from the AHP system into maps. The ModelBuilder feature of the GIS program allows us to create, modify, and manage geoprocessing models that automate these tools. Models are the processes of compiling a series of geoprocessing tools and injecting the output of one tool an as input to another tool. In this study, the outputs are the criteria used, which using ModelBuilder become inputs to extract the final work map.

3.1. Using the AHP

For the AHP, we used Excel programme with a matrix of binary comparisons and arithmetic equations for the AHP system. The problem of choosing locations and comparing between them can be described as a multi-criteria decision-making problem. This is the result of its holistic view and taking into account all the criteria that may be contradictory between preference and importance, as well as the views of decision-makers at the level of institutions and bodies (opinions), thanks to the invention of the analysis process. The AHP system, created by Saaty (1980), supports decision-making by involving several variables, identifying alternatives, and then choosing the best among them through binary comparison to form a hierarchical series with several levels where the top represents the desired goal. It also allows prioritizing criteria and alternatives to achieve the main objective (Pogarčić et al., 2008). The AHP is among the best-known and most widely used techniques for multi-criteria decision-making in recent years (Krmac & Djordjević, 2017). Basically, it is a hierarchical structure located at the top of the target hierarchy, then at the first level there are basic criteria, then the next level includes the sub-criteria, and so on until we reach the last level of the hierarchical structure where the alternatives are. The AHP method is based on comparing the advantages and disadvantages of alternatives, ranking them in order of importance by giving them weights. The weights of each criterion are determined by the binary comparison of criteria in pairs to determine the preference between them, thus forming a binary comparison matrix through which the alternatives are arranged (Bubalo et al., 2021). The AHP procedure is based on three basic steps (Harker & Vargas, 1987): (1) establishing the hierarchical structure, (2) judgments of comparison, and (3) collecting priorities.

In the first step, analysis includes or may refer to the establishment of a hierarchy. Establishing the hierarchical structure includes defining the problem, the criteria affecting it, and the sub-criteria. Table 1 shows the criteria that were chosen based on previous studies in the field of transportation, Alexander (2007) and Alkubaisi (2014), as well as on the opinions of tramway experts represented by SETRAM Company (2020).

Table 1. The criteria selected by previous studies and the opinions of specialists

The criteria selected	Previous studies and the opinions of specialists
Traffic safety	Alexander (2007), Alkubaisi (2014), SETRAM Company (2020)
Security	Alkubaisi (2014), SETRAM Company (2020)
Accessibility	Alexander (2007), Alkubaisi (2014), SETRAM Company (2020)
Economic feasibility	Alexander (2007), Alkubaisi (2014), SETRAM Company (2020)
Exploitation by citizens	Alkubaisi (2014), SETRAM Company (2020)
Preserving the environment	Alexander (2007), Alkubaisi (2014), SETRAM Company (2020)

After comparing the previous two studies (Alexander, 2007; Alkubaisi, 2014) and the opinions of experts in the tram field (SETRAM Company, 2020), we chose six criteria to be used in evaluating the efficiency and quality of the tram route in terms of location in the city of Setif, which are illustrated in the following Figure 3.

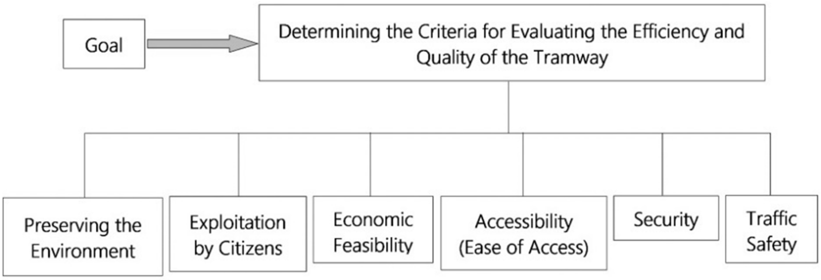

Figure 3. The criteria selected in the study.

The second step includes the judgments of comparison, or the identification and implementation of data collection to obtain binary comparison data about the elements of the hierarchical structure, as well as the binary comparison of criteria with each other. The weighting is done on a numerical scale where each number represents a degree of importance according to Saaty's rating (Saaty, 1980). Table 2 shows the relative importance of the classification:

Table 2. The AHP verbal scale ranges 1 to 9

The fundamental scale for pairwise comparisons		
Intensity of importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
2	Equal to moderate importance	/
3	Moderate importance	Experience and judgment slightly favor one element over another
4	Moderate to strong importance	/
5	Strong importance	Experience and judgment strongly favor one element over another
6	Strong to very strong importance	/
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
8	Very strong to extreme importance	/
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation

Note. Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3 (at sublayer level) can be used for elements that are very close in importance. Adapted from “Application of AHP Method in Traffic Planning”, by Pogarčić et al., in B. Hernavs and P. Meše (Eds.), *Proceedings of ITS - A Condidition for Sustainable Development and Prosperitiy of A Modern and Safe Transport* (p. 5), 2008, Borut Verhovec. Copyright 2008 by Borut Verhovec. Adapted with permission.

The percentage of the agreement required for the success of the two-way comparison needs to be calculated in order to ensure that there is no contradiction in opinions. To verify the percentage of agreement required, Equation 1 (Dehimi, 2021) was used:

$$M = \begin{bmatrix} 1 & A_{12} & \dots & A_{1n} \\ A_{21} & 1 & \dots & A_{2n} \\ \dots & \dots & 1 & \dots \end{bmatrix} \quad (1)$$

where M is a matrix, $A_{12}...A_{1n}$ is a binary comparison between criteria, n is the number of criteria.

If there are n factors, the first step is to establish an $n \times n$ pair-wise comparison. In this matrix $A_{12} = 1/ A_{21}$. When the array is made using binary comparisons between the chosen criteria, a value is generated for each cell in the array. If the criteria in the horizontal row and the vertical row are equal, then the cell between them takes number 1. The value of the cell is divided by the sum of the values in each column to get the arithmetic mean of each row from which the weights of the criteria are drawn.

To ensure consistency within the pairwise comparison matrix, we use the consistency index CI, to check the consistency of the judgments. The CI is determined by Equation 2 (Dehimi & Hadjab, 2019):

$$CI = \frac{\lambda \max - N}{N - 1} \quad (2)$$

where CI is the consistency index, λmax is the largest eigenvalue, N is the number of criteria selected. In this research $N = 6$.

The third step is the process of collecting priorities or building a comprehensive classification of priorities using the weights of the criteria to prioritize them after ensuring the integrity of the compatibility. This is done by utilizing a matrix for binary comparisons. To verify the value of consistency ratio, Equation 3 (Krmac & Djordjević, 2017) was used:

$$CR = \frac{CI}{RI} \quad (3)$$

where CR is the consistency ratio, CI is the consistency index, RI is the random index.

Saaty (1980) laid the foundations for determining its value based on the number of criteria chosen for decision-making. The random index helps us to check the value of CR according to Equation 3. RI can be identified in the following Table 3.

Table 3. Random consistency index for different values of *N*

N	1	2	3	4	5	**6**	7	8	9
RI	0	0	0.58	0.9	1.12	**1.24**	1.32	1.41	1.45

Note. Bold text represents the used number of criteria and the random consistency index. Adapted from "The analytic hierarchy process—what it is and how it is used," by R. W. Saaty, 1987, *Mathematical Modelling, 9*(3–5), p. 171 (https://doi.org/10.1016/0270-0255(87)90473-8). Copyright 1987 Pergamon Journals Ltd.

3.2. Using A Geographic Information System by a QGIS program

QGIS is an open-source geographic information system. The program aims to facilitate the use of GIS system. QGIS program provides easy access for students and researchers to use it to display, process, and output data. It has been in a state of continuous development since its inception in 2002 to the present day, as it is in line with the development of scientific research related to geographical information (Oasis Hub, 2019).

The following Figure 4 summarizes the research methodology where the research aims to evaluate the tram path spatially. We used the AHP system to determine the weights of the selected criteria based on a review of previous literature as well as expert opinions in the field of transport, and checking the *CR* is less than or equal to 10%. Then GIS program is used. Initially, we prepared a map of the tram coverage area spatially, in order to compare it with the final map later. Then we used GIS software to translate the weight of the criteria of the AHP system into spatial data. Using the ModelBuilder feature, the final map was extracted, which represents the evaluation of the efficiency and quality of the tramway.

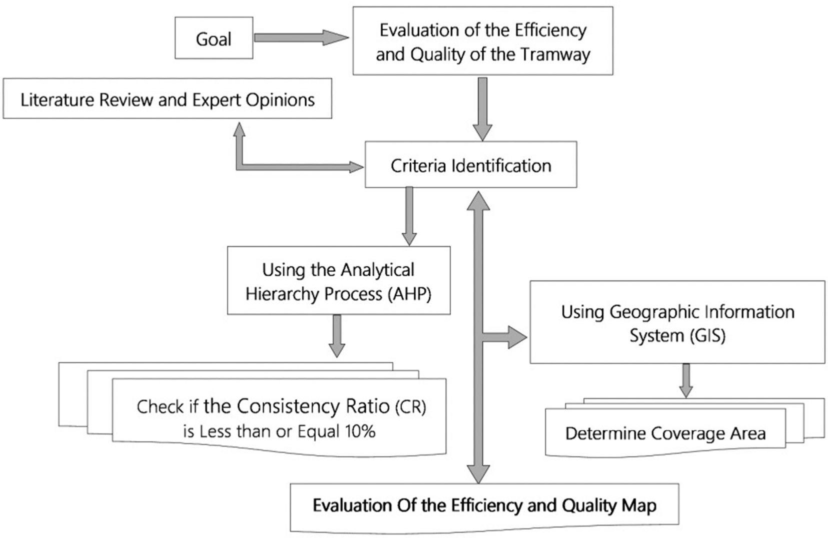

Figure 4. Research methodology used.

4. Results

4.1. Result of using the AHP method

According to Saaty (2008), if the consistency ratio *CR* exceeds 0.1, the set of judgments might not be consistent and cannot be reliable. Therefore, a *CR* under 0.1 or 10% is acceptable, but the procedure is repeated if the *CR* evaluation is inconsistent. If $CR \leq 10\%$, the inconsistency is acceptable and if $CR > 10\%$, the preference needs to be revised.

In Table 4, the criteria are arranged according to weight and importance. The traffic safety criterion is ranked first, as it represents the most important criterion for the tramway with 29.33%, followed by economic feasibility (21.44%), security (16.30%), exploitation by citizens (13.85%), then accessibility (13.09%), and finally environmental preservation with 6%.

Table 4. Results of the binary comparison criteria

Criteria	Traffic safety	Security	Accessibility	Economic feasibility	Exploitation by citizens	Preserving the environment	Weight (%)	Rank
Traffic safety	1	2	3	2	1	5	29.33	1
Security	1/2	1	2	1	1	2	16.30	3
Accessibility	1/3	1/2	1	1/3	2	3	13.09	5
Economic feasibility	1/2	1	3	1	2	3	21.44	2
Exploitation by citizens	1	1	1/2	1/2	1	2	13.85	4
Preserving the environment	1/5	1/2	1/3	1/3	1/2	1	6.00	6

Note. As a general rule, for the matrix to be consistent we should have a value of *CR* ≤ 10%. For this study, *RI* = 1.24 for *N* = 6 (Table 3), and the calculated λmax = 6.4074, producing a value of Consistency Index (*CI* = 0.0815). The consistency ratio *CR* was 6.57% (< 10%), which means that the weight distribution among the factors is acceptable and shows good consistency in judgment.

Percentages and order of criteria are used as spatial areas in extracting the final map of the study. In order to obtain more accurate results, we had to use the sub-criteria, in which the selected criteria were divided into three areas, according to the coverage area of each criterion. They were also arranged according to weight and importance. This is shown in Table 5. When entering the spatial data for each criterion in the GIS program, and using the ModelBuilder feature, the program analyzes and collects them in one map, so that in the end it produces a map consisting of three areas according to importance and proximity to the tramway.

Table 5. Using the weights criteria and sub-criteria to prioritize and order them obtained in the AHP process

Criteria	Weights of criteria (%)	Sub-criteria (m)	Weights of sub-criteria (%)		Rank
Traffic safety	29.33	< 100	3/6	14.67	1
		100–500	2/6	9.78	3
		> 500	1/6	4.88	9
Security	16.30	< 500	3/6	8.15	4
		500–1,000	2/6	5.43	8
		> 1,000	1/6	2.72	14
Accessibility	13.09	< 100	3/6	6.55	7
		100–500	2/6	4.36	11
		> 500	1/6	2.18	16
Economic feasibility	21.44	< 100	3/6	10.72	2
		100–500	2/6	7.15	5
		> 500	1/6	3.57	12
Exploitation by citizens	13.85	< 1000	3/6	6.93	6
		1,000–2,000	2/6	4.62	10
		> 2,000	1/6	2.30	15
Preserving the environment	6	< 20	3/6	3	13
		20–100	2/6	2	17
		> 100	1/6	1	18
Total	100%	/	100%		/

4.2. Result of using the QGIS program

Initially, the coverage area of the Setif tram line was extracted by using QGIS software and without using the weights of the criteria of the AHP method. This was done in order to compare the coverage area map and the efficiency and quality map of the tram at the end of the research. In this map (Figure 5), we have identified the areas around the tram and arranged them according to the walkability distance needed to get to the tram.

The first area of the tramway extends to 500 m, and its area is estimated at 11.26% of the total city area, representing the good region, followed by the second area that extends from the end of the first area to 1,000 m, its area is estimated at 9.86% of the total city area, and it represents the acceptable region partially. The third area extends from the end of the second area to the borders of the city of Setif, and its area is estimated at 78.88% of the city area, representing the bad and the weak region. We notice from the map that the good area surrounding the tram track is located in the center of the city of Setif, and the importance of the tram location becomes less important as we move away from the city center and head north and south of the city.

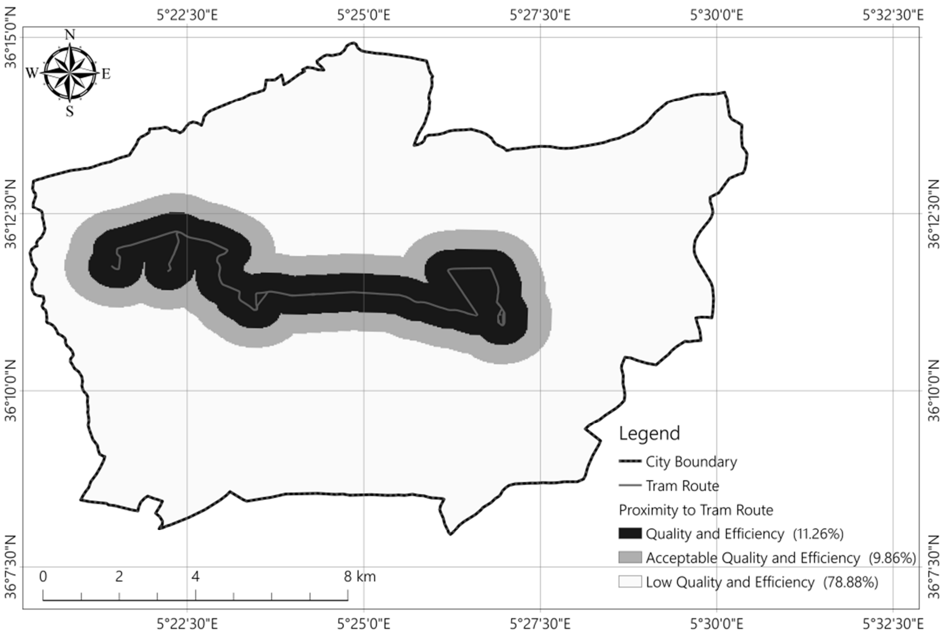

Figure 5. The map of the coverage area by tramway.

4.2.1. Criteria's maps

At this stage, we used the criteria obtained by the AHP system and processed them spatially using QGIS to obtain the final map of efficiency and quality for the tram:

- *Traffic safety criterion, map* (Figure 6): Dangerous turns of the tram route were identified to find out the degree of safety of passengers during trips.

- *Economic feasibility criterion, map* (Figure 7): We have identified the economic places in the city, such as tourist resorts, commercial centers, sports and entertainment centers, as well as the industrial area, and then extracted the spatial link between them and the tramway.
- *Security criterion, map* (Figure 8): The security services in the city were identified and the distance between them and the tramway were determined. This enabled to find out the degree of security, during the occurrence of abuses such as theft, violence, harassment, and others in the tramway.
- *Exploitation by citizens criterion, map* (Figure 9): The buildings near the tramway range are determined in order to find out the ability of the residents to use the tram in their daily lives.
- *Accessibility criterion, map* (Figure 10): According to the tram stops, the accessibility at a range of 100 m and 500 m are determined in order to find out the ease of accessing to the tramway.
- *Preserving the environment criterion, map* (Figure 11): It determined the tramway with a range of 20 m and then 100 m, which represents the path that preserves the environment.

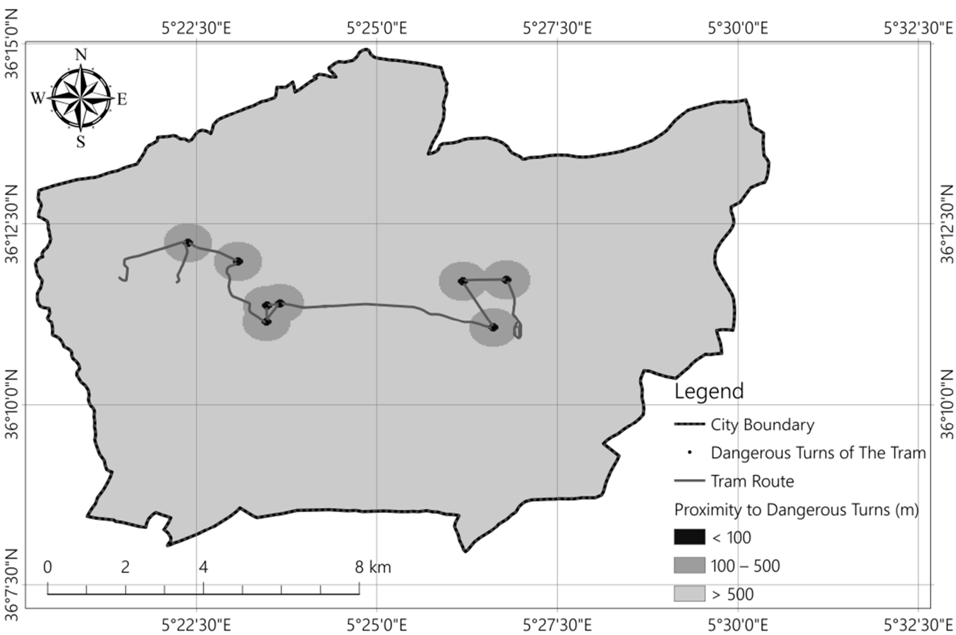

Figure 6. The map of the traffic safety criterion.

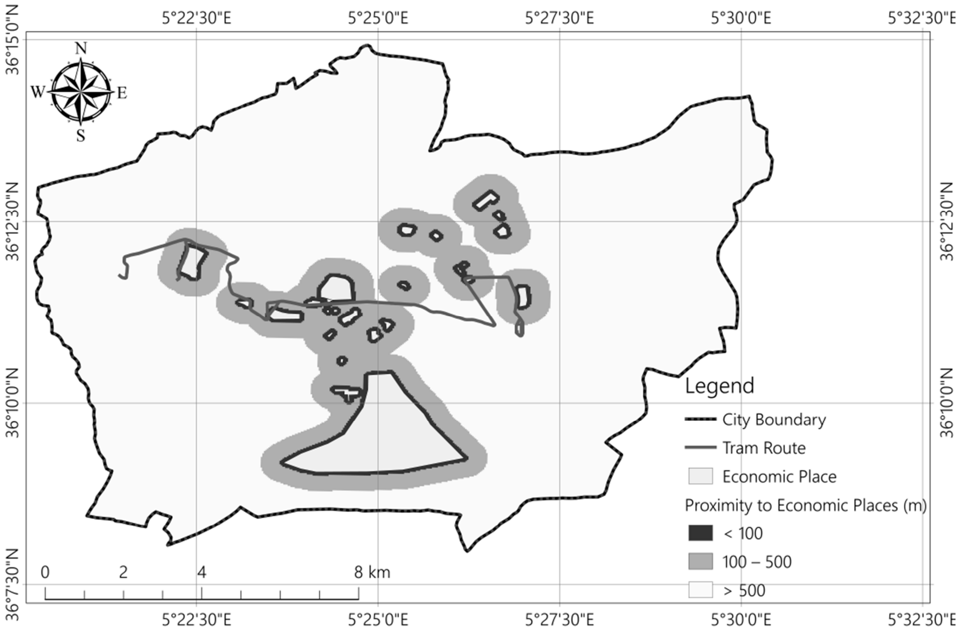

Figure 7. The map of the economic feasibility criterion.

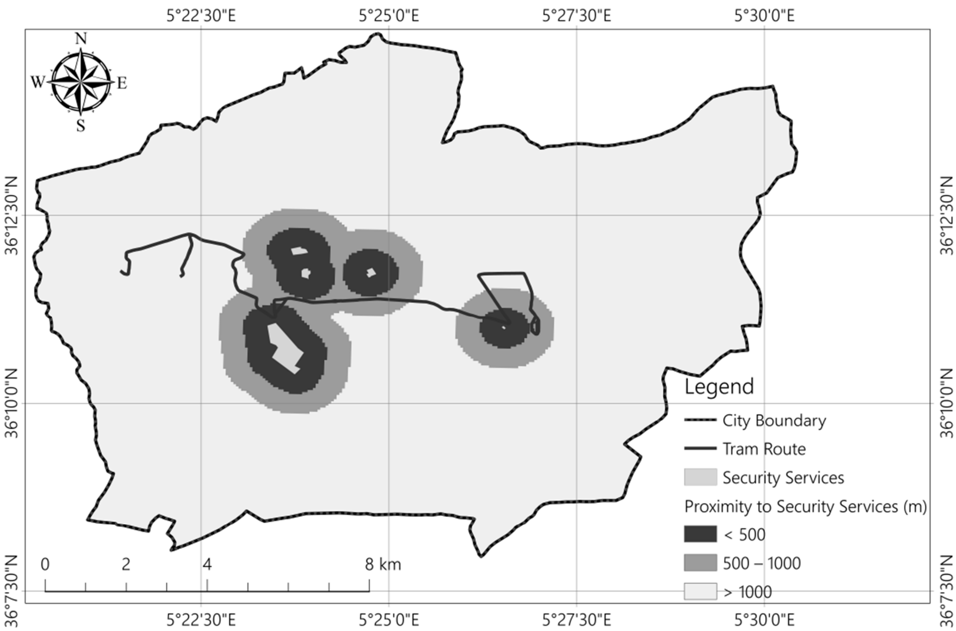

Figure 8. The map of the security criterion.

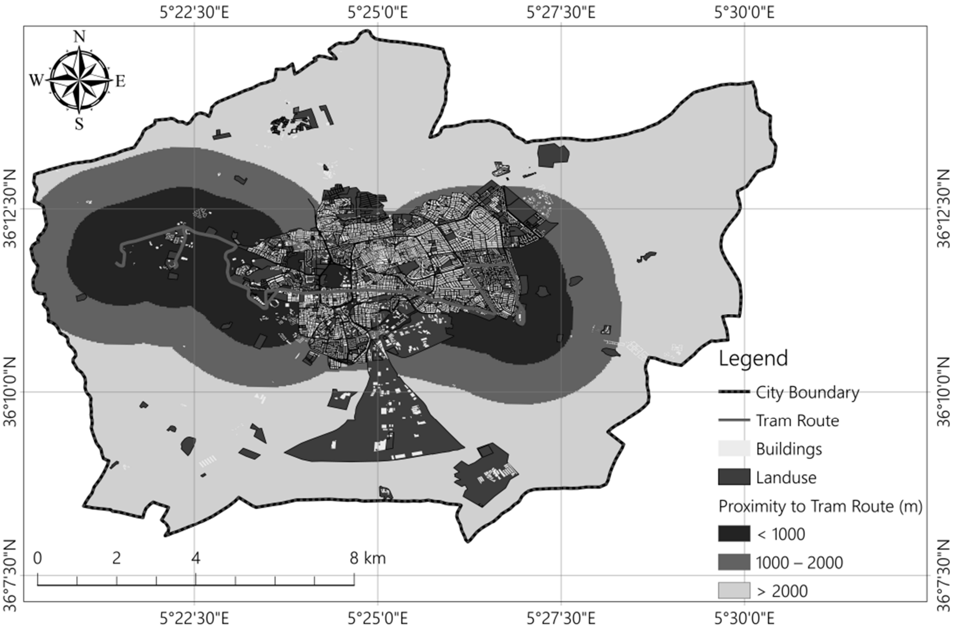

Figure 9. The map of the exploitation by citizens criterion.

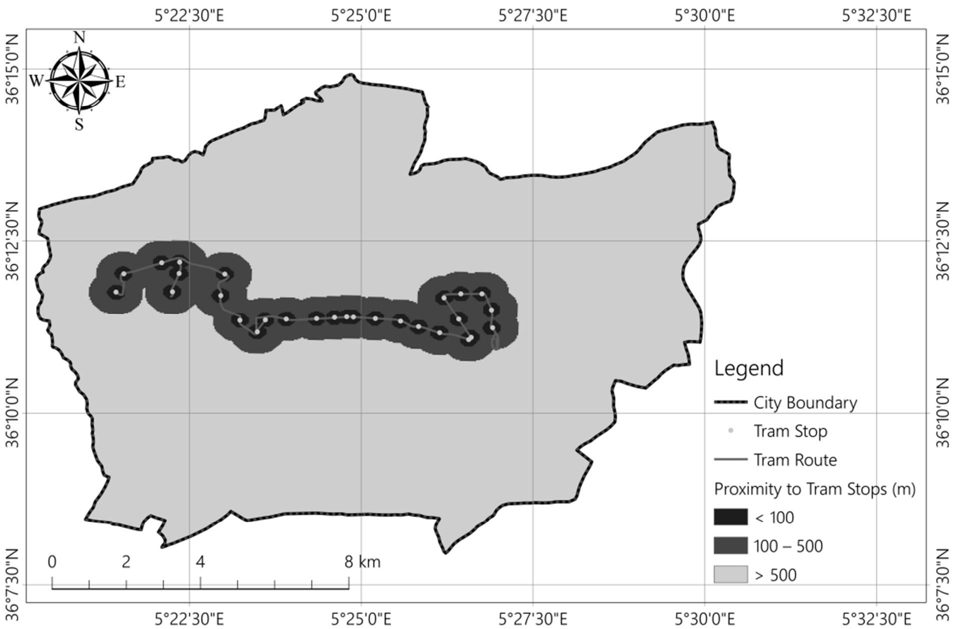

Figure 10. The map of the accessibility criterion.

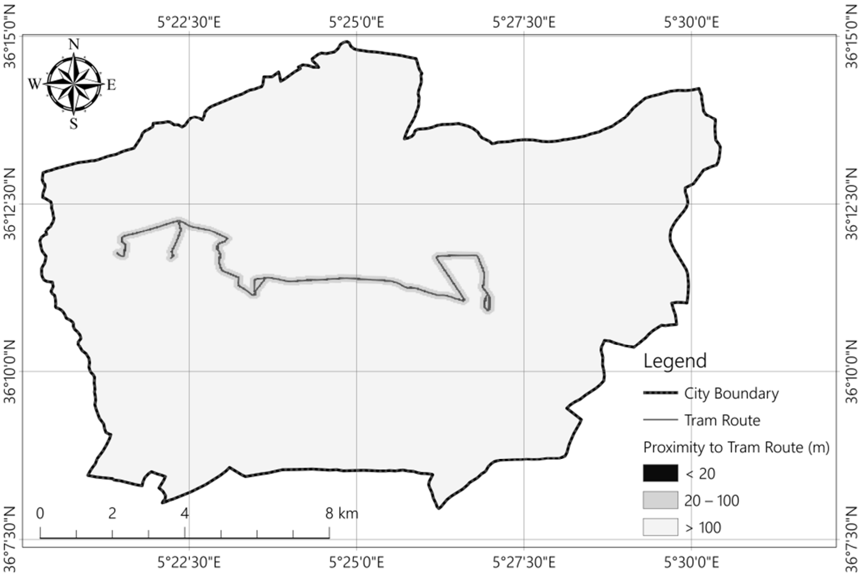

Figure 11. The map of the preserving the environment criterion.

5. Discussion

The results extracted from the map of tramway efficiency and quality for the city of Setif show that the choice of the tramway path was not successful, as the area with high efficiency and quality is very small, limited to several stopping points. It is estimated at 0.34% of the total area of the city, which is not sufficient for the length of the path and the coverage area. The second area with average or acceptable quality and efficiency, surrounding the track on a range between 500 m and 1,000 m is estimated at 13.48% of the total area of the city. In the latter, the area of low quality and efficiency, which represents the largest area, is estimated at 86.18% of the total area of the city. These results reflect the efficiency and quality of the services provided by the tramway, which suffers from a lack of connectivity between the outskirts of the city, and accessibility is limited to the city center on the main road that connects the east to the west of the city, while accessibility decreases when heading towards the north and south.

By comparing the percentage of good area in the coverage area map (Figure 5), which represents 11.26%, with the percentage of good area in the efficiency and quality map (Figure 12), which represents 0.34%, it turns out that the selected good area is much smaller. Where the tramway is based in the center of the city of Setif, it has a negative impact on all parts of the city. This area is very small and not enough to cover the entire city. The choice of location for the tram route was not successful, as it contains many shortcomings and spatial deficits, parts of the city are isolated from it, especially the north and south ones. The completion of the second tram track was discontinued for the reasons mentioned above. It would reduce the deficit ratio for the southern region. According to SETRAM Company (2020), the second line connects the city center with the industrial zone in the south, and also connects with the first track line, as shown in Figure 13. Completing the second line will reduce the deficit in the southern region. But this is not enough to plug the deficit in the entire city. Especially the northern part, which is not connected to the tram track, and this makes the movement of residents from the north of the city to other destinations difficult, so they use taxis in their daily commute, and this affects their financial situation, not to mention the impact on the environment.

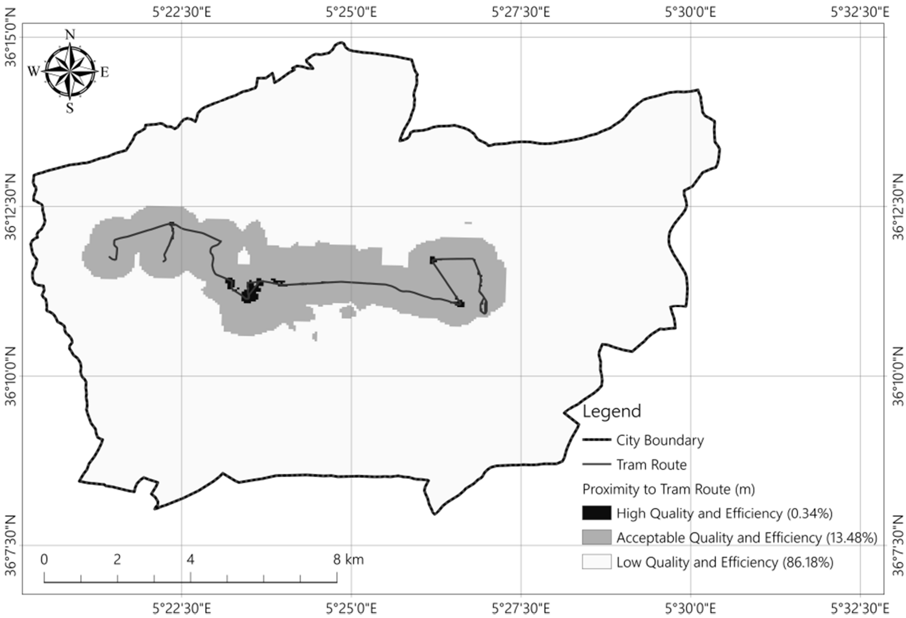

Figure 12. The map of the evaluating the quality and efficiency of the tram.

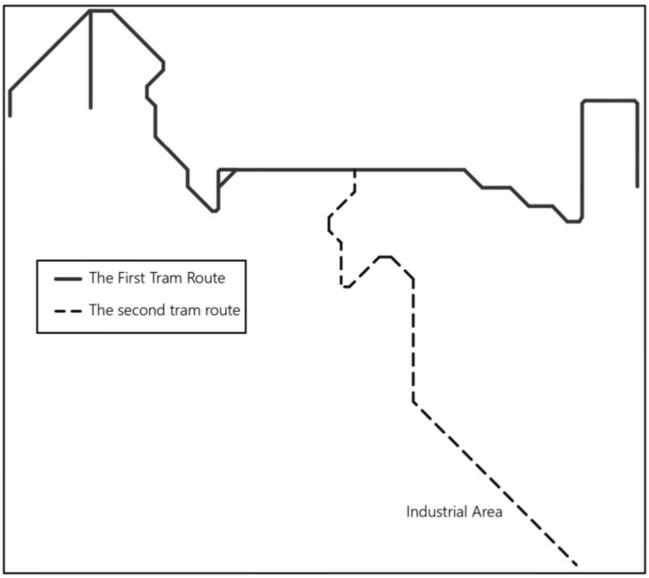

Figure 13. The second tram route of the city of Setif programmed.

Note. Adapted from *SETIF*, by R. Schwandl, 2019 (https://www.urbanrail.net/af/setif/setif.htm). In the public domain.

The purpose of comparing the final map with the tram coverage area map was to find out the benefits of using the AHP theory in route selection. The results were impressive as the use of the AHP theory gave the work high quality and accuracy in the results, which enabled us to study the phenomenon well and use several predefined criteria to reach the final results. The application of AHP theory with GIS is of great importance in geographical and urban studies, as it allows studying several criteria and variables to choose the best decisions.

6. Conclusion

In this paper, the AHP analytical hierarchy theory was applied to determine the efficiency and quality criteria for the completed Setif tramway line. The criteria were determined based on previous studies and the opinion of experts in the field of urban transport, especially the tramway. The previously selected criteria were classified in the matrix of binary comparisons between criteria, where the value of the consistency ratio CR = 6.57% is less than 10% of the values, which means the weight distribution between the factors is acceptable and shows good consistency in the judgment, and the criteria were arranged according to priority within the matrix.

Then the GIS program was used to translate the weights of the criteria into spatial data, as special maps were produced for each criterion, which reflects the link between the tramway and the selected criteria. Using the ModelBuilder feature provided by the GIS software, we entered the spatial data of the criteria to extract the final map of the efficiency and quality of the tramway in the city of Setif. Based on the analysis of the final map represented by the efficiency and quality map for the tramway, it was found that the good places in the tramway are very scarce, as they were represented in 7 well-selected tram stops out of the total of 26 stops of the tramway.

This study showed that the selection of the Setif tram line was not successful, as it suffers from not covering most parts of the city. In choosing the tram route, the governing bodies and those responsible for the project relied on the tourist attractions in the city center of Setif, such as the presence of the historic Ain El Fouara fountain and the statue of the woman, in addition to the historical area adjacent to the mall, the ancient mosque, and other historical monuments. Therefore, the function of the Setif tram is more touristic than service-providing.

The commercial character of the city center was also changed after the establishment of the tram line, which became an obstacle to shops and customers. Citizens living in the city need a tram line connecting the parts of the city from north to south and from east to west so that they can satisfy their needs and move freely in the city, taking advantage of the tram services. The second track, if the country's financial and economic conditions improved to allow its completion, was specifically programmed to link the city to the industrial zone in the south. But it would not be enough to cover the entire city because the northern region still does not benefit from tram services.

However, despite these shortcomings, there is still the possibility to correct the project and upgrade it to reach efficiency and high quality, through the establishment of major commercial equipment, and the restoration of the commercial character of the city, as well as linking the tramway with urban mass transport lines to connect the outskirts of the city that the tram does not reach. In light of the state’s endeavor to expand the Setif tram project by increasing the length of the route of the first track to reach the far west of the city, in addition to completing the second track that will connect the city center with its south, we believe that the next future step is to think of providing the northern side with a new tram line, connecting the north of the city with its other parts.

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