The Mechanical Permeability of the Urban Perimeter of the City of Havre and the City of Bejaia

"Study, Analysis and Comparison"

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Abstract

As part of the field of reflection on interurban mobility, this paper aims to identify the concept of mechanical permeability at the entrance to and within the urban perimeter of the city of Bejaia. In order to identify the essential parameters that would allow the city of Bejaia to enjoy good mechanical permeability, and sustainable interurban mobility, it was discussed in this investigation, to compare the quality of the mechanical permeability of the urban perimeter of the city of Bejaia, with that of the city of Le Havre in France, which enjoys excellent mechanical permeability in addition to the similarities noted between the two cities in terms of demographics, natural physical context, and the size of the urban area.

The comparison between the two case studies will be completed by highlighting the essential quantitative and qualitative parameters for good mechanical permeability. This will allow us to make an objective assessment of the state of mechanical permeability in the city of Bejaia, and to take a critical look at the solutions recommended to ensure fluid, qualitative and sustainable mechanical permeability between the city of Bejaia and its urban area.

Keyword: Mechanical permeability ; Urban perimeters ; Road network ; The displacement ; Interurban mobility ; The city of Bejaia ; The city of Le Havre.

1. Introduction

Considering the city as a living organism (Rocío Penalta Catalan, 2011), called to develop itself in a healthy way, this organism must breathe easily, having as a barometer a sustainable mobility through a good physical permeability. The concept of mobility has always been part of the principles of urban planning and organization of cities, which were designed and structured along the main roads. These made it possible to ensure the proper functioning, safety and management of the city. Despite the inventions and technologies put in place to meet human needs, man remains overwhelmed by his activities and the travel they generate. Hence the need to satisfy the supply and demand side, which

is at the origin of the formation of traffic jams. Supply being the capacity of the road (or the number of cars it can accommodate) meets demand, i.e. the trips that users want to make at a specific time and place (Cécile Dehesdin, 2010).

The city of Bejaia was the subject of a study in the transport sector, with a household survey carried out in 2006 concretized by the adoption of the new traffic plan in 2012 drawn up by BETUR (BETUR, 2014). However, the quality of its mechanical urban and interurban mobility remains problematic, and the capacity of its road network is systematically outdated by the increase in travel demand.

Through this present investigation, we will attempt to study and understand the phenomenon of mechanical permeability at the entrance to and within the urban perimeter of the city of Bejaia, to see to what extent we can aspire to a better sustainable interurban mobility, and to a high quality urban mechanical permeability.

2. Concepts and semantic fields

The concept of permeability in urban planning, according to Bentley and his collaborators, is defined as the ease and facility with which an urban fabric can be crossed. It also refers to an urban fabric that ensures accessibility (Bentley et al, 1985). "It is a quality conferred on a site, it is reflected by the number of alternatives offered to the user to move from one point to another, it is concretized by the diversity of access and travel, it can be visual as it can be physical" (Bentley et al, 1985). In other words, having good permeability is a process, according to which a space, under all its urban scales, is made open to passengers to move from one point to another. At the scale of a city, good mechanical physical permeability implies easy and varied travel choices.

Addressing the issue of mechanical permeability in a city systematically refers to the concept of mobility, which contains an idea of movement. Controlling travel means efficiently managing the various trips generated by users in urban areas. In addition to Radial, central or tangential displacements (Françoise Choay, 2009), we will focus in this present research on urban and interurban travel. Professor Baouni defines mobility as a concept that poses the urban dimension of transport, Addressing the question of mechanical permeability also refers to analyzing the configuration of the urban grid, the number of alternatives offered by the latter to satisfy the different mechanical displacements, is decisive for the fluidity of mechanical displacements within the urban perimeter. It is in this sense that many reflections on the urban island have been carried out, considered as a portion of the urban territory "isolated" from the neighbors by streets (Philippe panerai et al, 2001), the islet is a constituent unit of the urban fabric, a unit of division and production of the urban fabric (Philippe panerai et al, 2001), and it is on its structure that we must reflect while keeping continuously in mind the street/built relationship which orders it (David Mangin and al, 2009). To obtain LEED

(Leadership in Energy and Environmental Design) certification, it is recommended to favour a permeable street grid, and small islets, this certification requires that a neighborhood include at least one crossing street and 55 intersections per km2, an intersection every 135 meters on average. A permeable grid means that streets allow varied and continuous routes within and outside the neighborhood (Vivre en Ville, 2010). Conversely, the dead ends and curvilinear streets reduce travel options and, therefore, the potential activities that a site can offer (Carmona et al, 2003). Non-permeable street patterns called growth barriers (Philippe pannerai et al, 1999) that enclave neighborhoods are to be avoided.

3. Methodology

In order to conduct our research well and consider appropriate solutions to road congestion problems, it would be appropriate to first choose a city with good mechanical permeability; a city that should have similarities with the city of Bejaia, according to predefined criteria, namely: the number of population, the extent of the urban perimeter, the shape of the city and its natural relief. We chose the city of Le Havre in France, which meets the above-mentioned criteria and enjoys excellent mobility, as evidenced by the 7.1/10 rating obtained by its traffic network in 2013 (CODAH, 2013). It is therefore necessary to first analyze the mechanical permeability between the urban perimeter of the city and its urban area and then to analyze the mechanical permeability within the urban perimeter.

With regard to the mechanical permeability at the entrance to the urban perimeter, we will begin our investigation by highlighting the road network that connects the city with all the municipalities in its urban area. To do this, we will first have to define and set the boundaries of the current urban perimeter of the city of Le Havre, through which all cars enter and exit. We will then list all the roads connected to the urban perimeter, while specifying the status of each lane (departmental road, national road, secondary roads, etc.), the roads identified will be superimposed on a summary map. We will then assess the importance of each road, by noting the number of municipalities it links to the perimeter of the Le Havre urban area, i.e. the number of municipalities grafted to the same road with the number of inhabitants of each municipality, the number of lanes in each road and its quality and condition. The resulting map would allow us to decide on the hierarchical distribution of the road network around the urban perimeter of Le Havre.

As the interurban mechanical permeability of Le Havre has been revealed, we will proceed with the analysis of the mechanical permeability within the urban perimeter of the city. An analysis that will go through;

- The calculation of the number, size and shape of the islets constituting the urban perimeter, in order to determine the properties of the average islet of this city.

- Identify the variety and balance between the islets, in terms of size.
- Calculate the number of intersections in the city by ranking them according to their importance, the number of urban interchanges, to reveal the number of intersections per square kilometer.
- Calculate the number of impasses within the city.
- Identify any growth barriers.
- The condition and quality of roads within the urban perimeter.
- Assess the condition and consistency of road signs and signals.

The entire analysis will be based on maps that we will produce from the "OpenStreetMap" support. We will proceed in the same way for the analysis of the mechanical permeability at the entrance and inside the urban perimeter of the city of Bejaia, before comparing it with that of Le Havre. The outcome of the comparison between the permeability of the two cities would shed light on the measures to be taken to improve the quality of the mechanical permeability of the city of Bejaia.

4. The mechanical permeability of the urban perimeter of the city of le Havre

Located on the right bank of the Seine estuary, Le Havre is a port city in northwestern France. Its inhabitants are called the Le Havre people. Administratively, this commune, located in the Haute-Normandie region (Figure 01), is one of the two sub-prefectures of the Seine-Maritime department, along with Dieppe. It is the most populated commune in Normandy with 172,074 inhabitants in the last census of 2013. It is connected to the capital, located 200 km to the east, by rail and highway (Official website of the city of Le Havre, 2016).

4.1 The Mechanical permeability at the entrance of the urban perimeter of the city of le Havre

A zoom on the Le Havre urban spot allowed us to draw an accessibility perimeter according to the diversity of the natural relief, then we identified all the roads connected to the Le Havre urban spot. (Figure 02).

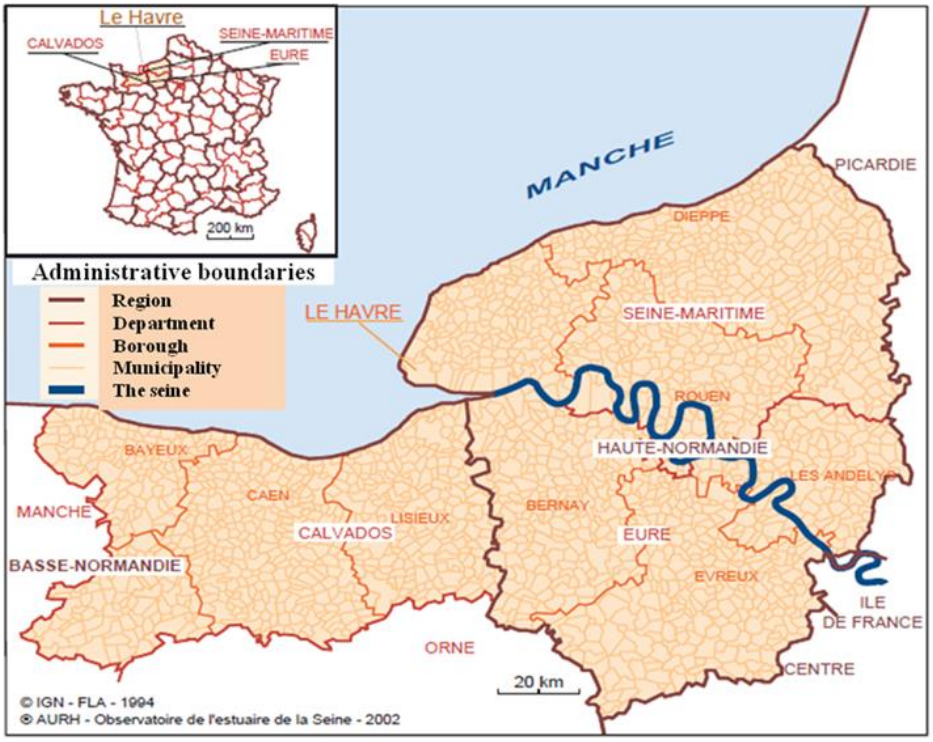


Figure 1. Geographical position of Le Havre. (Local urban planning plan - City of Le Havre – 2011. Developed by Authors)

We note that all the urban fabrics of the city of Le Havre form an urban spot relatively clustered around the maritime perimeter of the Channel and its estuary, the natural relief consisting of a lower part to the south and an upper part to the north and northeast separated by a dead cliff has also played an influential role in the urban evolution and spatial configuration of the city of Le Havre, the resulting urban spot area is around 50 Km2, or 5000 Hectares with a perimeter measuring 23 linear Km. Along this permeability perimeter, a road network distributed in a balanced way is connected to the urban task of Le Havre, a network consisting of a National Road linking Le Havre to Rouen and Paris on the East Side, eleven departmental roads linking all the municipalities of the urban area of Le Havre from the East to the North of Le Havre, this road network is reinforced by eight secondary roads which alleviate the main road network. This good distribution of the road network allows a good distribution of mechanical flows from the various municipalities located in the Le Havre urban area.

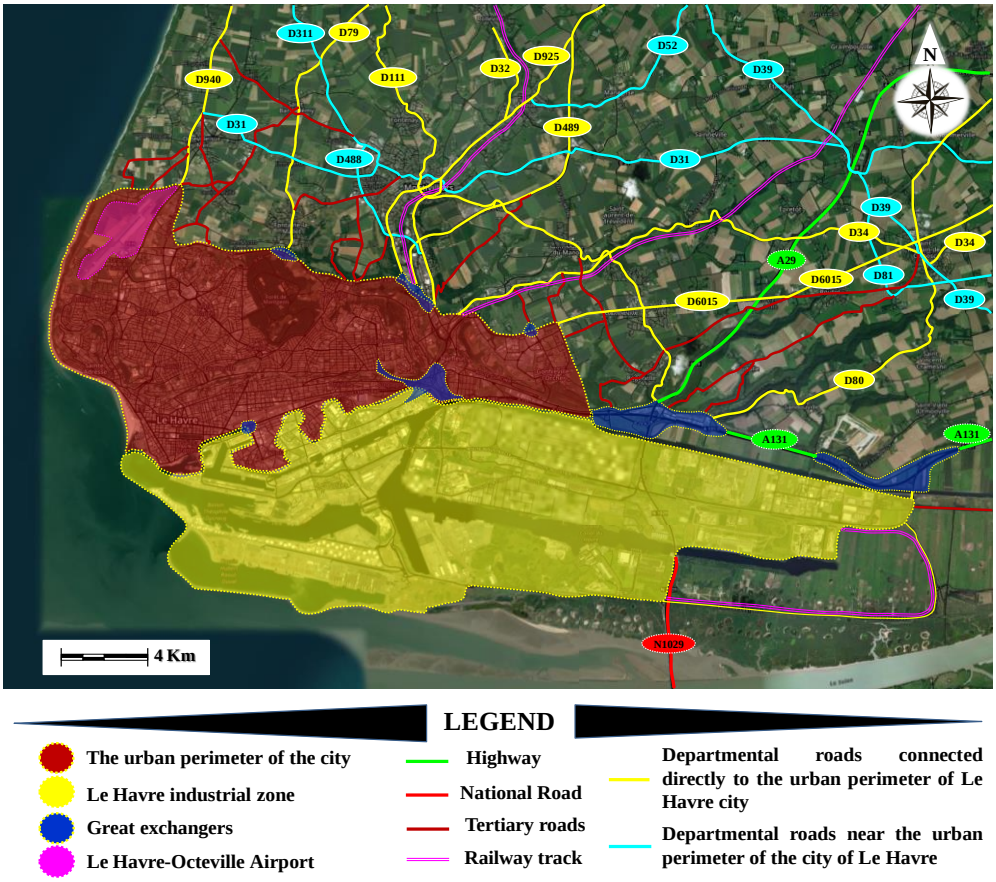
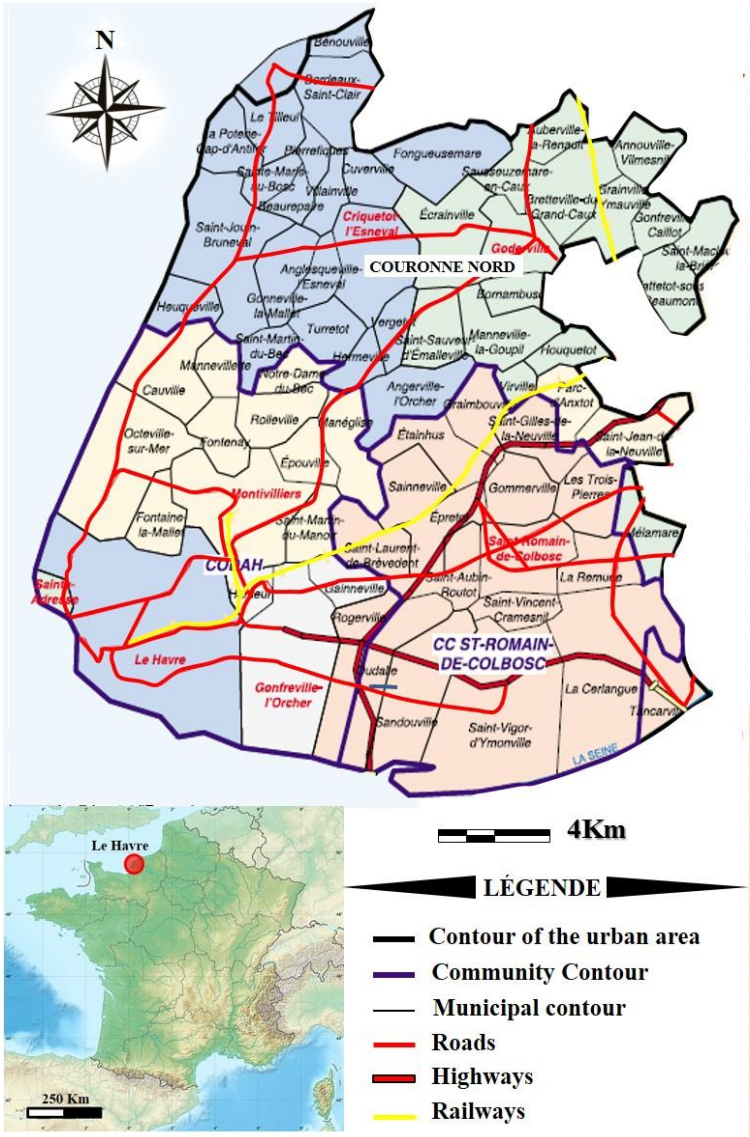


Figure 2. Distribution of the road network around the urban perimeter of the city of Le Havre (OpenStreetMap, Developed by Authors, 2019)

However, a balanced distribution of the road network around the urban spot of a city alone is not sufficient to ensure good mechanical permeability since it only acts as a connector between two distinct locations, Figure 03 and Figure 04, clearly show the distribution of the existing road network over the municipalities in the urban area of Le Havre. According to the definition given by INSEE, the urban area of Le Havre is composed of 72 municipalities located in the Seine-Maritime region (INSEE, 2001), municipalities whose population numbers are close to each other, while the number of municipalities appearing in the distribution of the figure is 96, which means that 24 municipalities are served by two roads from the main road network. The distribution is relatively balanced.



Canton Gonfreville-l'Orcher	
Municipalities	Hab
Angerville-l'Orcher	1 222
Anglesqueville-l'Esneval	473
Beaurepaire	393
Bénouville	128
Bordeaux-Saint-Clair	566
Criquetot-l'Esneval	2 149
Cuverville	292
Étretat	1 615
Fongueusemare	170
Gonneville-la-Mallet	1 139
Hermeville	372
Heuqueville	585
Pierrefiques	106
La Poterie-Cap-d'Antifer	316
Saint-Jouin-Bruneval	1 576
Saint-Martin-du-Bec	619
Sainte-Marie-au-Bosc	213
Le Tilleul	582
Turretot	1 315
Vergetot	349
Villainville	288

Canton Gonfreville-l'Orcher	
Municipalities	N-Hab
Gainneville	2 370
Gonfreville-l'Orcher	9 938
Harfleur	8 517

Canton Saint-Romain-de-Colbosc	
La Cerlangue	1 106
Epretot	644
Etainhus	1 007
Gommerville	648
Graimbouville	496
Oudalle	368
La Remuée	1 176
Rogerville	1 257
Sainneville	826
Saint-Aubin-Routot	1 118
Saint-Gilles-de-la-Neuville	562
Saint-Laurent-de-Brèvedent	1 489
Saint-Romain-de-Colbosc	3 937
Saint-Vigor-d'Ymonville	859
Saint-Vincent-Cramesnil	501
Sandouville	754
Tancarville	1 234
Les Trois-Pierres	723

Canton Montivilliers	
Municipalities	Hab
Saint-Martin-du-Manoir	1542
Rolleville	1 131
Octeville-sur-Mer	4 834
Notre-Dame-du-Bec	379
Montivilliers	16 556
Mannevillette	690
Manèglise	1 190
Fontenay	1 143
Fontaine-la-Mallet	2 544
Épouville	2 960
Cauville-sur-Mer	1 243

Canton Goderville	
Municipalities	Hab
Angerville-Bailleul	203
Annouville-Vilmesnil	385
Auberville-la-Renault	347
Bec-de-Mortagne	615
Bénarville	193
Bornambusc	241
Bréauté	1 102
Bretteville-du-Grand-Caux	1 134
Daubeuf-Serville	322
Ecrainville	1 031
Goderville	2 281
Gonfreville-Caillot	262
Grainville-Yamauville	392
Houquetot	289
Manneville-la-Goupil	932
Mentheville	158
Saint-Maclou-la-Brière	417
Saint-Sauveur-d'Émalleville	968
Saussezemare-en-Caux	360
Tocqueville-les-Murs	209
Vattetot-sous-Beaumont	490
Virville	260

Canton de Bolbec	
Municipalities	Hab
Saint-Jean-de-la-Neuville	557
Parc-d'Anxtot	578

Canton de Lillebonne	
Municipalities	Hab
Mélamare	751

Canton du Havre-6	
Municipalities	Hab
Sainte-Adresse	7 368

Figure 3. Distribution of municipalities and road network in the urban area of Le Havre (INSEE, 2001. Processed and developed by Authors, 2019)

With regard to the condition of the road network, the illustrations in Table 01 show that the road network as a whole is in very good condition, it has been distributed in a well thought-out, very balanced way around the urban perimeter of Le Havre, ensuring a good road connection with a fluid and varied choice of mechanical accessibility, which gives the city of Le Havre a good mechanical permeability.

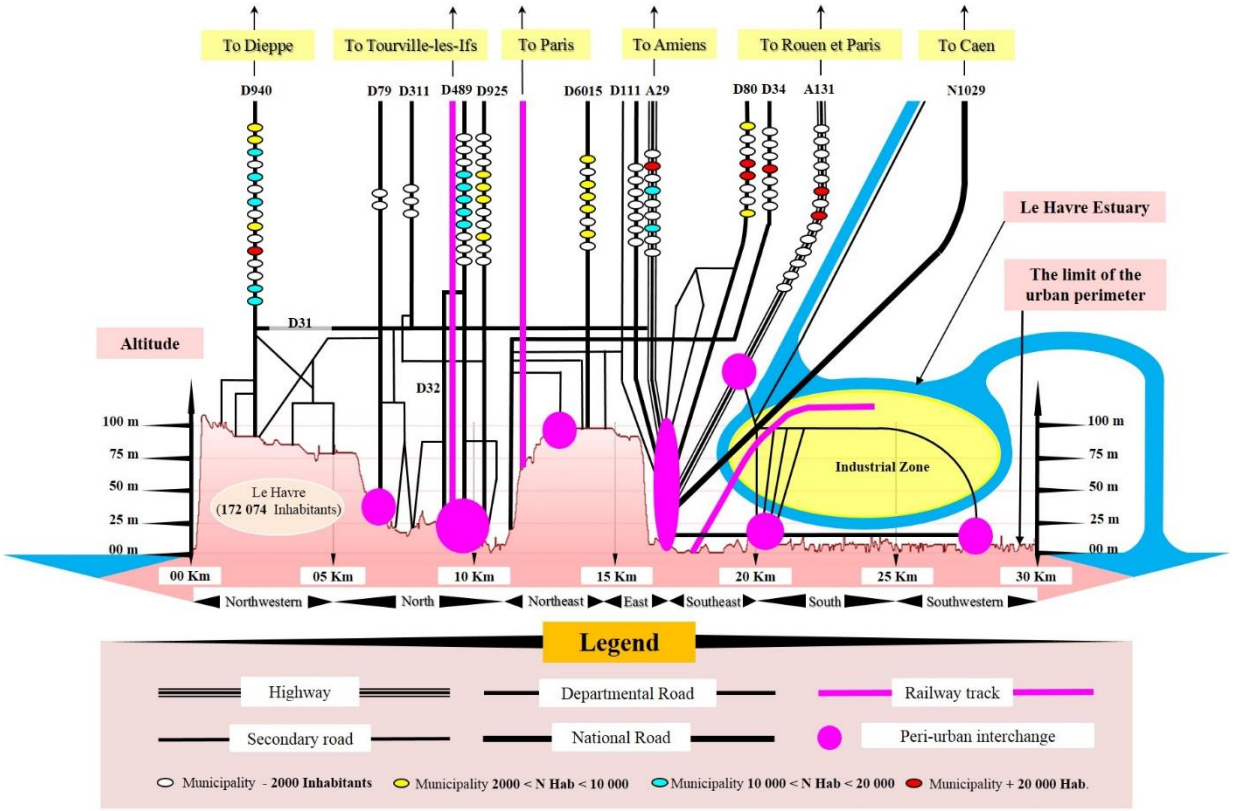


Figure 4. Representation of the mechanical permeability at the entrance of the urban perimeter of the city of Le Havre (Authors, 2019).

Table 1. Typology and condition of the road network serving the Havre urban area

PPM: Perimeter of mechanical permeability to the city (Flat / RF; relatively Flat /H; Accidental) / RS: Road Status / RL: Road width / NLR: Number of lanes per road / NMR: Number of municipalities served by the road.						
PPM	RS	Illustrative photos	RL	NLR	NMR	Road conditions
Flat	D940 Departmental road		8m	2	15	Very Good Condition
RF	D79 Departmental road		6m	2	2	Very Good Condition
RF	D311 Departmental road		6m	2	3	Very Good Condition

RF	D489 Departmental road		12m	4	11	Very Good Condition
RF	D925 Departmental road		8m	2	9	Very Good Condition
Flat	D6015 Departmental road		16m	4	9	Very Good Condition
Flat	D111 Departmental road		5m	2	7	Very Good Condition
Flat	A29 Highway		21m	7	9	Very Good Condition
RF	D80 Departmental road		6m	2	8	Very Good Condition
Flat	D34 Departmental road		9m	3	7	Very Good Condition
Flat	A131 Highway		18m	6	14	Very Good Condition
Flat	N1029 National Road		12m	4	/	Very Good Condition
RF	D32 Departmental road		6m	2	11	Good Condition
Flat	D147		6m	2	1	Very Good Condition

	Departmental road					
Flat	Way of the valley bottoms		5m	1	/	Good Condition
Flat	Way of Feveretot		6m	2	/	Very Good Condition
RF	D52 Departmental road		6m	2	2	Very Good Condition
RF	D231 Departmental road		6m	2	3	Very Good Condition
RF	Street of the Old Castle		5m	1	/	Average condition
Flat	Street of fleurville		5m	1	/	Very Good Condition
Flat	D982 Departmental road		6m	2	7	Good Condition
Flat	N282 National Road		9m	2	14	Very Good Condition
Flat	D483 Departmental road		6m	4	7	Very Good Condition

4.2 The mechanical permeability inside the urban perimeter of the city of the Havre

By observing Figure 5, we can detect data on the quality of mechanical permeability as follows:

Concepts inherent in the permeability of the urban perimeter	Parameters relating to the quality of mechanical permeability inside the urban perimeter of the city	Characteristics and figures
The urban perimeter	Surface area	50 Km^2
Islets	Total number of islets	1445 islets
	Number of islets per Km^2	36 islets / Km^2
	Average islets size	27681 m^2 = 166m *166m
	The Form of the dominant islet	A rectangular shape
	The Variety	Good
	the balance	Good
Mechanical exchangers	Number and distribution of mechanical exchangers in the urban perimeter of the city	13 mechanical exchangers well distributed around the urban perimeter of the city
The intersections	First-order intersections	46
	Second-order intersections	71
	Third order intersections	231
	Fourth-order intersections	1837
	Total number of intersections	2185
	Number of intersections per Km^2	54,62 intersections/Km^2
The dead ends	Number of dead ends	178
Road network	Hierarchy	Good
	Condition of the road network	Very good condition
	Presence and quality of road signs and signals	A good presence of road signs

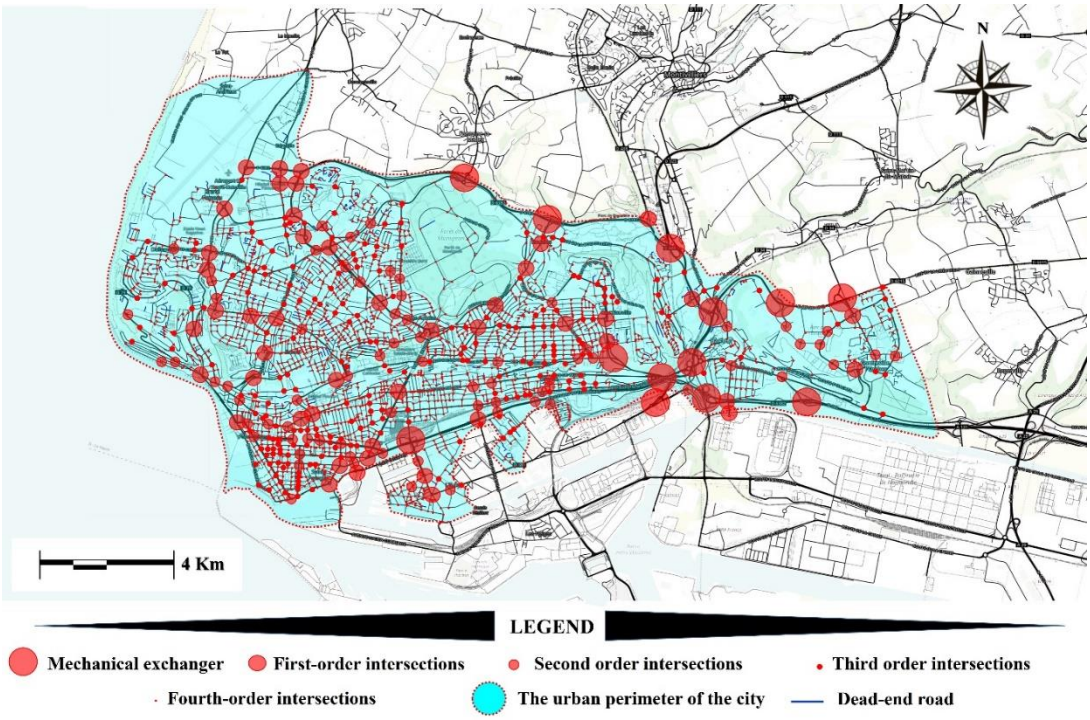


Figure 5. Islets, intersections and the urban perimeter of Le Havre (OpenStreetMap. Developed by Authors, 2019)

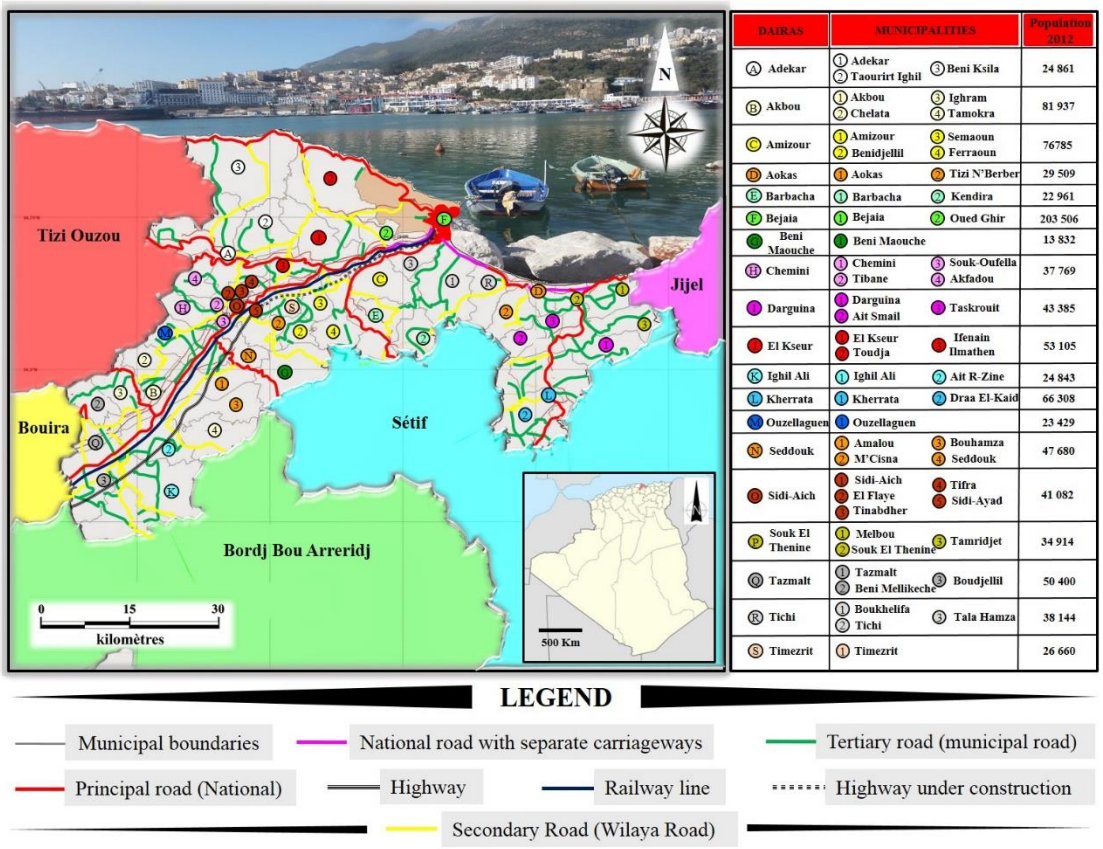
5. The mechanical permeability of the urban perimeter of the city of Bejaia

Bejaia, formerly Bougie, is an Algerian municipality located on the shores of the Mediterranean Sea, 181 km east of the capital Algiers. The Wilaya of Bejaia, which emerged from the 1974 administrative division, is organized in 19 Daïras, 6 of which are coastal (Souk El Tenine - Aokas - Tichy - Béjaia - Adekar - Akfadou) and 52 municipalities. It is located in the north of the country, overlooking the southern shore of the Mediterranean. With 177,988 inhabitants at the last census in 2008, Bejaia is the largest city in Kabylia in terms of population. It has an extensive road network consisting of 4 national roads that serve it. (Figure 06).

5.1 The Mechanical permeability at the entrance of the urban perimeter of the city of Bejaia

The intermunicipal PDAU of the city of Bejaia recommends a set of solutions to open up the city and make its interurban mobility more fluid. This analysis will allow us to evaluate its relevance. Figure 07 clearly shows the grouped and segmented shape of the urban spot of the city of Bejaia, arranged like an amphitheatre overlooking the sea, following its existing natural relief, consisting of a tiny flat part in the east and a steep relief from the south to the north of the city. Covering an area of 30 km^2, or 3000 hectares of land for a population of 177988 inhabitants according to the latest 2008 census. The connection of the road network to the urban perimeter of the city is clearly shown in figures 07 and 08, which started off very badly with a concentration of accessibility at the level of the plain.

We note from Figure 08 and Table 02 that the difficulty of the terrain, the overexploitation of the road infrastructure, which is in very poor condition, its high concentration in the southern part of the plain, the use of the same road network by all types of transport, are all parameters that considerably reduce the quality of the mechanical permeability at the entrance to the city of Bejaia. Of the 52 municipalities in the wilaya, we note that only 34 municipalities are directly connected to the road network serving the urban area of Bejaia, including 18 municipalities served by National Road No. 12, and 10 municipalities served by National Road No. 9

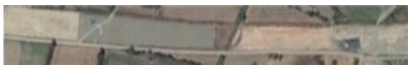


DAIRAS	MUNICIPALITIES		Population 2012
A Adekar	1 Adekar 2 Taourirt Ighil	3 Beni Ksila	24 861
B Akbou	1 Akbou 2 Chelata	3 Ighram 4 Tamokra	81 937
C Amizour	1 Amizour 2 Benidjellil	3 Semaoun 4 Ferraoun	76785
D Aokas	1 Aokas	2 Tizi N'Berber	29 509
E Barbacha	1 Barbacha	2 Kendira	22 961
F Bejaia	1 Bejaia	2 Oued Ghir	203 506
G Beni Maouche	1 Beni Maouche		13 832
H Chemini	1 Chemini 2 Tibane	3 Souk-Oufella 4 Akfadou	37 769
Darguina	Darguina Ait Smail	Taskrouit	43 385
El Kseur	El Kseur Toudja	Ifenain Ilmathen	53 105
K Ighil Ali	1 Ighil Ali	2 Ait R-Zine	24 843
L Kherrata	1 Kherrata	2 Draa El-Kaid	66 308
M Ouzellaguen	1 Ouzellaguen		23 429
N Seddouk	1 Amalou 2 M'Cisna	3 Bouhamza 4 Seddouk	47 680
O Sidi-Aich	1 Sidi-Aich 2 El Flaye 3 Tinabdher	4 Tifra 5 Sidi-Ayad	41 082
P Souk El Thenine	1 Melbou 2 Souk El Thenine	3 Tamridjet	34 914
Q Tazmalt	1 Tazmalt 2 Beni Mellikeche	3 Boudjellil	50 400
R Tichi	1 Boukhelifa 2 Tichi	3 Tala Hamza	38 144
S Timezrit	1 Timezrit		26 660

Figure 6. Geographical situation and administrative division of the city of Bejaia. (Authors, 2019)

Table 2. Typology and condition of the road network serving the urban perimeter of Bejaia (Author, 2016)

PPM: Perimeter of mechanical permeability to the city (Flat / RF; relatively Flat /H; Accidental) / RS: Road Status / RL: Road width / NLR: Number of lanes per road / NMR: Number of municipalities served by the road.						
PPM	PPM	PPM	PPM	PPM	PPM	PPM
RF	N24 National Road		9m	2	2	Average condition

RF	CW34 Wilaya Way		6m	2	/	Average condition
Flat	N12 National Road		12m	4	18	Average condition
Flat	highway (under construction)		24m	6	16	In progress (70%)
Flat	N75 National Road		9m	2	4	Average condition
RF	CW2 Wilaya Way		6m	2	/	Average condition
Flat	N9 National Road		12m	4	10	Good condition
RF	N43 National Road		12m	4	/	Good condition

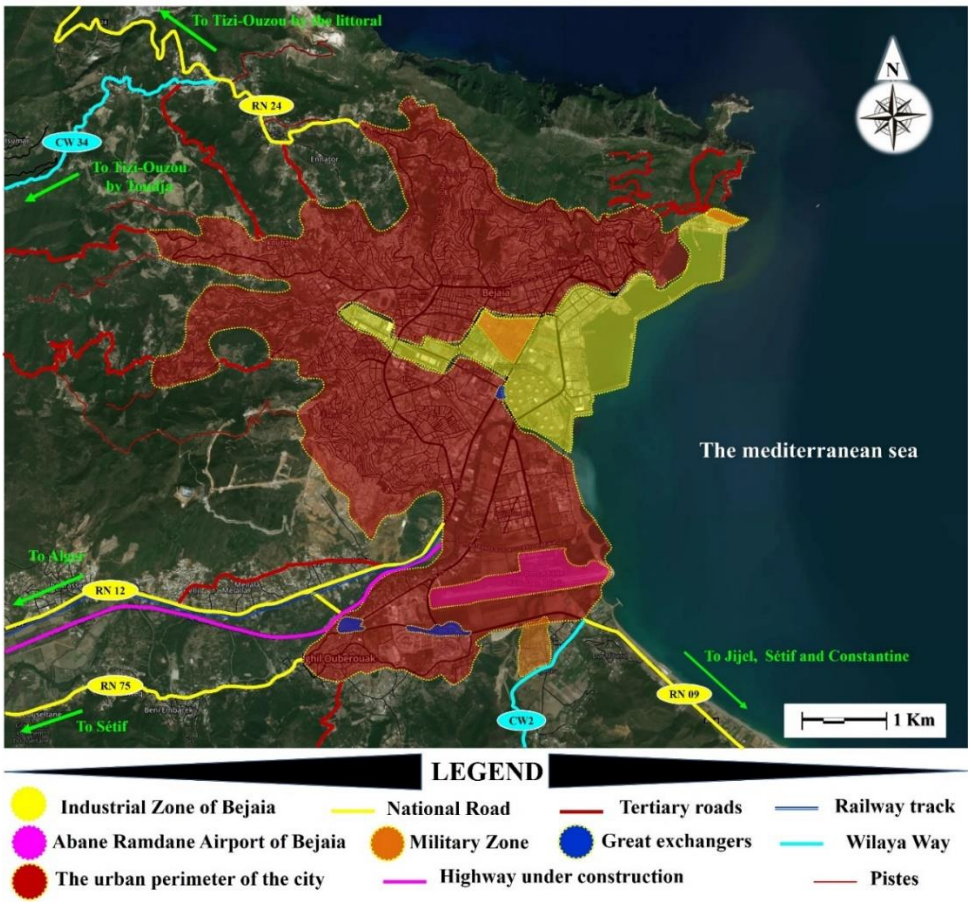


Figure 7. The distribution of the road network serving the urban perimeter of Bejaia City (Authors, 2019)

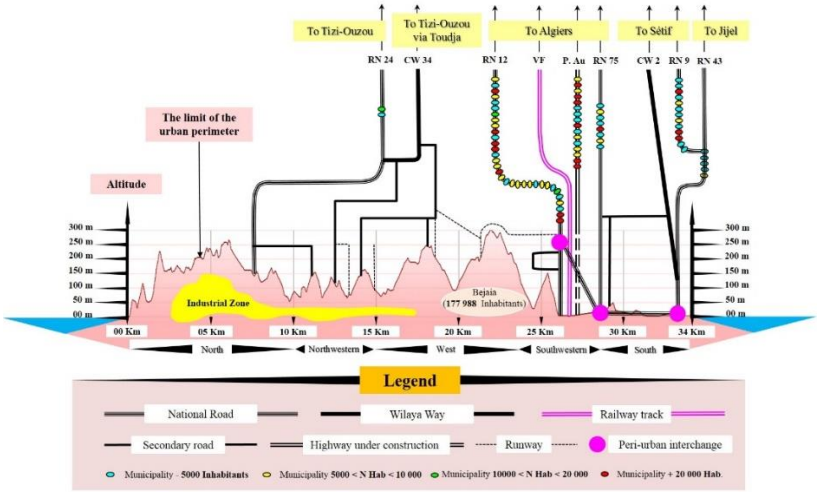


Figure 8. Representation of mechanical permeability as a function of accessibility perimeter, road network and distribution of Bejaia municipalities (Authors, 2019).

5.2 The mechanical permeability inside the urban perimeter of the city of Bejaia

The observation of Figure 9 allows us to highlight the information relating to the quality of the mechanical permeability of the city of Bejaia as follows:

Concepts inherent in the permeability of the urban perimeter	Parameters relating to the quality of mechanical permeability inside the urban perimeter of the city	Characteristics and figures
The urban perimeter	Surface area	30 Km^2
Islets	Total number of islets	394 islets
	Number of islets per Km^2	30,8 islets / Km^2
	Average islets size	63452 m^2 = 252m *252m
	The Form of the dominant islet	Organic shape that tends towards the rectangle
	The Variety	Wide variety
	the balance	A significant imbalance between the size of the islets
Mechanical exchangers	Number and distribution of mechanical exchangers in the urban perimeter of the city	4 mechanical exchangers located in the southern part of the city
The intersections	First-order intersections	20
	Second-order intersections	143
	Third order intersections	761
	Total number of intersections	924
	Number of intersections per Km^2	30,8 intersections/Km^2
The dead ends	Number of dead ends	248
Road network	Hierarchy	Medium
	Condition of the road network	Bad
	Presence and quality of road signs and signals	An average presence and Poor quality

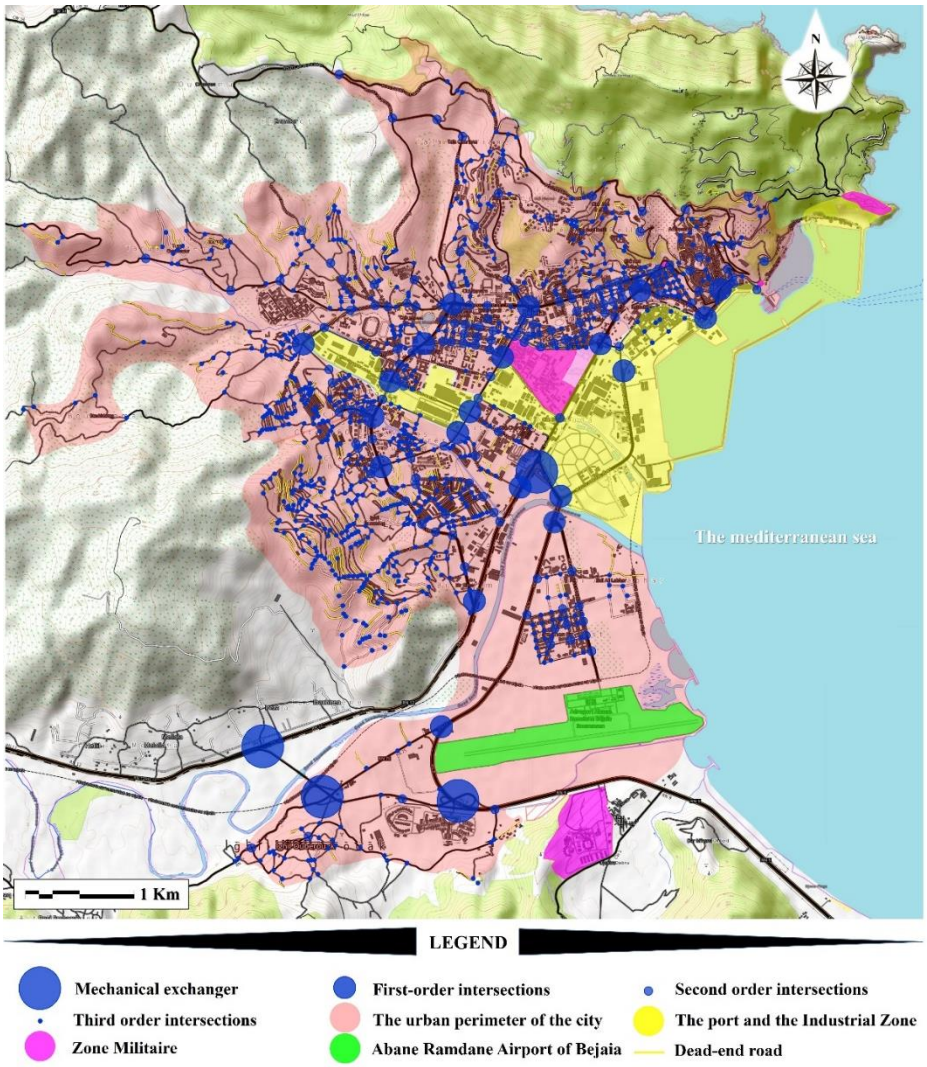


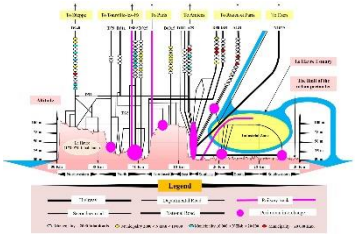
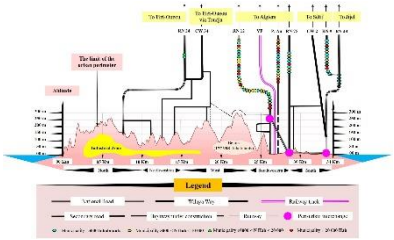
Figure 9. Islets, intersections and the urban perimeter of De Bejaia (OpenStreetMap. Developed by Authors, 2019)

6. Comparative synthesis

Table 03 shows the results and the difference between the mechanical permeability of the urban perimeter, between the city of Le Havre and the city of Bejaia.

Table 3. Comparison between the parameters relating to the quality of mechanical permeability between the city of Le Havre and the city of Bejaia (Authors, 2019)

		Le Havre	**Bejaia**
Mechanical permeability at the entrance to the city's urban perimeter	Geographical location	French Port Municipality, located in the North-West in the Haute-Normandie region, is with Dieppe one of the two sub-prefectures of the Seine-Maritime department. Located on the right bank of the Seine estuary.	Algerian municipality, located in the north of Algeria, overlooking the southern shore of the Mediterranean. 181 km east of the capital Algiers, It is the eponymous capital of the Wilaya of Bejaïa, an Algerian port city.
	Population	172 074 inhabitants	177 988 *inhabitants*
	Area of the urban perimeter	5000 Hectares	3000 Hectares
	Number of municipalities (M) in the urban area	The arrondissement of Le Havre is organized into 176 municipalities. the urban area is composed of 96 M	The Wilaya of Bejaia is organized into 52 municipalities
	Vocation of the city	Economic, industrial, tourist and university	Economic, industrial, tourist and university
	Relief and natural setting	Composed of two natural areas separated by a dead cliff or "coast", one high part to the north and one low part to the south overlooking the sea.	A plain surrounded by a curtain of steep mountains, Bejaia is crossed by the Soummam River, all overlooking the Mediterranean.
	Length of the Urban Perimeter (UP)	23 Km Linear	30 Km Linear
	Accessibility infrastructures	One port: Ranked second in France for total traffic, and the 1st French port for containers	A port: dedicated to commercial activities classified as the second largest port in Algeria
		An international airport: "Le Havre-Octeville Airport"	An international airport: "ABBANE Ramdane Airport"
		A bus station	A bus station
		A railway station	A railway station
		A maritime Station	A maritime Station
	Road network	National Roads: 1	National Roads: 4
		Departmental road: 12	Departmental road: 0
		Secondary road: 8	Secondary road: 7
		Highway: 2	Motorway: 1 under construction
	Distribution of the road network around the urban perimeter	A homogeneous, hierarchical and balanced distribution around the urban perimeter.	An unbalanced distribution, with the concentration of 80% of the main road network on the south side, on a reduced perimeter.
	Number of municipalities connected directly to the city by the main road network	96 municipalities out of 72, including 24 municipalities served by two different roads.	34 municipalities out of 52.
	The number of lanes serving the city	24 from the various municipalities in the urban area.	11 from the various municipalities in the urban area.
	The state of the road network	Very good	An advanced state of degradation
	Urban transport	Bus network consisting of 16 regular urban lines/2 tramway lines/	Taxis and passenger cars Bus network.

		Tramway on rails/ Taxis and private cars.	
	Representation of mechanical permeability as a function of the accessibility perimeter, the road network and the distribution of municipalities (Figure 04 and 08)		
Mechanical permeability inside the urban perimeter	Total number of islets	1445 islets	394 islets
	Number of islets per Km^2	36 islets / Km^2	30,8 islets / Km^2
	Average islets size	27681 m^2 = 166m *166m	63452 m^2 = 252m *252m
	The Form of the dominant islet	A rectangular shape of 110m * 250m	Organic shape that tends towards the rectangle
	The Variety	Good variety	Wide variety
	the balance	A good balance between the islets in terms of shape and size	A significant imbalance between the size of the islets
	Number and distribution of mechanical exchangers in the urban perimeter of the city	13 mechanical exchangers well distributed around the urban perimeter of the city	4 mechanical exchangers located in the southern part of the city
	Intersections inside the urban perimeter	46 of first order 71 of second order 231 third-order 1837 of the fourth order — Total : **2185**	20 of first order 143 of second order 761 third-order — Total : **924**
	Number of intersections per Km2	54,62 intersections/Km^2	30,8 intersections/Km^2
	Number of dead ends	178	248
	Route prioritization	Good	Medium
	State of the road network	Very good condition	Bad

	Presence and quality of road signs and signals	A good presence of road signs	An average presence and Poor quality
Quality of mechanical permeability at the entrance and inside the urban perimeter (MPUP)		• Very good distribution of the road network around the UP, • Consistent and very good road network with intelligent flow management. • A very good connection between the city of Le Havre and the municipalities of its urban area • A diversity of urban and interurban transport modes. • Homogeneity and balance between the islets in terms of size, involving a variety of urban sequences. • No growth barrier implying ease of mechanical movement. • 54.62 intersections/km^2, an excellent average allowing a multiplication in the choice of mechanical travel routes. • Reduced number of dead ends. **Very good quality of the (MPUP)**	• Poor distribution of the road network around the PU, • Inadequate and poor road network, with obsolete management of mechanical flows. • A poor connection between the city of Bejaia and the municipalities in its urban area. • Limited choice of urban and interurban transport modes. • A very large imbalance between the sizes of the islets making some parts of the city completely sealed. This imbalance is due to the presence of several military rights-of-way and the industrial zone in the middle of the city's urban perimeter, thus constituting a growth barrier with very large islets inside the city. This considerably reduces the quality of the mechanical permeability of the urban perimeter. • Excessive number of dead ends. **Very poor quality of the (MPUP)**

7. Conclusion

Nowadays, the city is considered as a complex ecosystem, which must obey organizational principles strongly linked to transport and road networks, or travel within the city has become a focus of general interest. The development of a city, its impact and its positive economic influence on its urban area, depends primarily on its degree of accessibility. As confirmed by our present analysis, the latter depends on a set of parameters essential for efficient mechanical permeability of quality. Starting with the consistency of the road network and its good distribution around and inside the urban perimeter, relieving road congestion requires the quality, distribution and number of alternatives that the road network offers to access inside the urban perimeter.

With regard to the case of the city of Bejaia, it seems essential to strengthen the road network that serves it and to improve the existing road network, to this end, we believe that the project of the highway that will link the city of Bejaia to the East-West highway, will have a positive impact on the mechanical permeability of the urban area of Bejaia, it will be considered as an additional lung, which will allow the city to breathe more. We share with the intermunicipal PDAU of Bejaia the need to carry out operations relating to the improvement of the road network and urban transport for

sustainable mobility. This comparative investigation shows that good mechanical permeability is dependent on the definition of a travel strategy based on the complementarity of the modes of transport according to the efficiency of each mode. It is also mentioned that a good mechanical permeability of the urban perimeter depends on a good permeability within its urban perimeter. Until an alternative to the car is found, many measures must be taken by public authorities and society to improve daily life, travel practices and sustainable mobility.

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