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Research Article

The Impact of Road Infrastructure on the Economic and Industrial Activities of Cities: Case of the East-West Highway in the Constantine Region of Influence, Algeria

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ABSTRACT

In most countries, transport infrastructure makes a major contribution to socio-economic development. Given these factors, a growing number of studies have focused on the impact of road infrastructure on urban activities. However, a systematic review of the literature revealed no bibliometric studies dedicated to an in-depth examination of the impact of road infrastructure on the economy and business of cities. The main objective of this study is to analyze the state of global research on the impact of transport infrastructure on the economy and business, and to identify future trends in this research area. We will focus this analysis on a specific case: the East-West Highway of Algeria, the subject of our research thesis.

The main steps in a systematic literature review are 1. Design of the research study, 2. Preparation of bibliometric results, and 3. Analysis and interpretation of the results. The total sample of publications analyzed was 257 documents, retrieved from the Scopus database (up to November 10, 2024). The VOS viewer was then used to map and visualize the bibliometric networks. The results include the most significant publications in the field, as well as the most frequently cited international contributors in these studies, the leading authors in the field, and the most frequently used keywords.

Keywords: Road infrastructure, economy, business, bibliometric analysis, East-West Highway, Constantine region, Algeria

INTRODUCTION

Efficient and effective transport infrastructure is essential for the proper functioning of businesses and society.

The explicit objective of an effective and efficient transport infrastructure is to strengthen economic activity and development. A robust transport infrastructure can promote the international competitiveness of businesses and economic growth.

This question is more relevant to Algeria than to many other countries, as it is a small, open economy, highly integrated into the global economy, with potentially significant impacts from global economic activities and the environment.

Given that both passengers use transport infrastructure and transport infrastructure, this study focuses specifically on road transport. The opening of the only East-West highway has impacted the radius of influence of the planned route. However, these impacts have not been highlighted in an academic study to make them known.

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Globally, the benefits and importance of transport infrastructure as a public service have been extensively studied. Furthermore, the extent of a transport network's impact on the national or regional economy depends on the level of economic development and varies from country to country, as well as from rural to urban areas.

Furthermore, there could be an incompatibility between the benefits of immediate action and sustainable growth in some cases.

Economic development can be affected by transport infrastructure primarily in two ways: direct and indirect ((US) & (US), 2014; Goetz, 2011; Lakshmanan, 2007) and input-output analyses (C et al., 2006).

The first channel – direct effects – strengthens the contribution of the road freight transport sector by improving access to inputs and/or reducing purchasing costs. The second channel – indirect effects – results in additional contributions to other sectors.

Due to certain typical aspects of investment in transport infrastructure, such as economic sustainability and environmental issues, as well as the activity of cities, the long-term impact of these investments is still the subject of considerable debate.

With this in mind, the Chinese government has chosen to develop infrastructure, with the aim of creating municipal and district road networks (Fujiwara & Zhang, 2013).

(Kamps, 2006) used 1960-2001 panel data for 22 OECD countries and calculated a median elasticity of 0.22 for all panel countries, with a UK estimate of 0.18 for the respective governments.

In 1985, two instruments for assessing environmental impact were introduced in the EU: strategic environmental assessment (SEA) of policies, strategies, plans and programmes, and environmental impact assessment (EIA).(Magazzino & Mele, 2021).

This article examines the role and development of Vietnam Expressway Corporations (VEC) as a state-owned enterprise for 5 highway construction projects in the first phase of Vietnamese network development between 2004 and 2016. (Mai & Casady, 2023)

This study uses a systematic literature review (bibliometric analysis) to demonstrate the impact of road infrastructure on the economy and business in cities. This is an appropriate strategy when a research topic needs to be refined without duplicating existing research. The research will help establish a holistic framework for this research theme and provide a foundation for future studies.

The structure of the document is described below. The introduction is in Section 1, Section 2 contains a literature review, Section 3 discusses the methodology used, Section 3 details the results of this bibliometric analysis using the Scopus database, and finally, Section 4 concludes the study by highlighting future research directions and emphasizing the case study. As academic studies on road infrastructure in Algeria are almost entirely lacking, we introduce our research case study by outlining observations made on the East-West Highway within the Constantine area.

1. LITERATURE REVIEW

1.1. Research development

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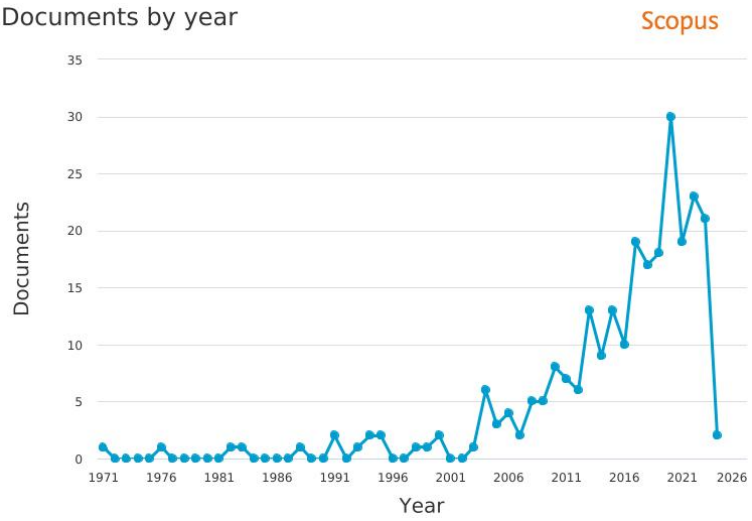

Fig. 1: Growth of research

Figure 1 shows the number of citations per year that these studies received. It can be seen that the number of studies published on the impact of transport infrastructure on the economy and business of cities increased from 1971 to 2024.

This shows that there are two phases in the publication. The first phase represents the period between 1971 and 2020, with a peak in publication in 2020 with 30 studies.

The second phase includes the period between 2021 and 2024, where the average annual number of studies for this period is estimated to be between 2 and 22. Figure 1 shows the total number of publications (cumulative) of citations on TRANSPORT INFRASTRUCTURE ON THE ECONOMY AND BUSINESS OF CITIES between 1971 and 2024.

2. METHODOLOGY

Our goal is to find publications that describe the impact of transport infrastructure on the economy and business of cities.

To do this, we used Tranfield's systematic review technique [22], which explored the advantages and disadvantages of expanding the synthesis for evidence-based research. The main steps of a systematic literature review are 1. Study design, 2. Preparation of bibliometric results, 3. Analysis and interpretation of results. The figure 2 summarizes all the steps.

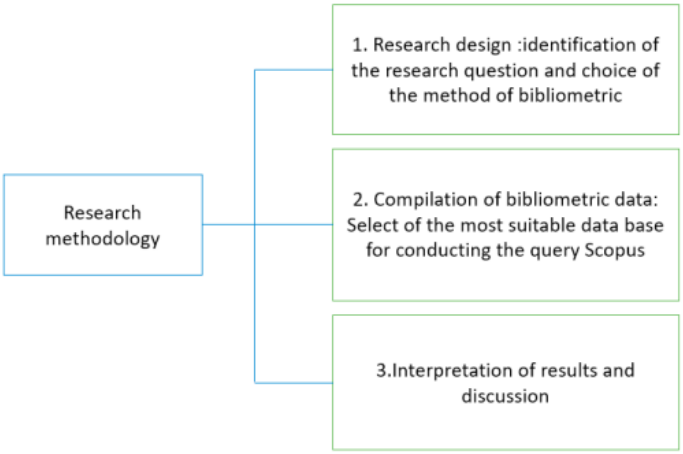

Fig. 2 research methodology

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3. RESULTS

3.1. Scope of transport infrastructure on the economy and business of cities.

This study presents a list of articles published in the Scopus database, from various disciplines such as computer science, engineering, social sciences, management, etc., covering the topic of the impact of transport infrastructure, particularly roads, on urban activities and the economy, as summarized in Figure 3. Overall, the distribution indicates that research on this topic is emerging in the following fields: engineering, environmental science, social management, business economics, decision science, energy, etc. According to the articles examined, publications on this research topic are best represented from the perspectives of environmental science (20.2%), engineering (17.7%), and social sciences (16%). As the articles examined indicate, scientific articles relating to the impact of road infrastructure on the economy and business are best represented from an engineering perspective, as they are linked to the fields of architecture and urban planning. We can see that there is a certain symmetry between the environment and the social sciences, meaning that they should focus on people-centered solutions, both socially and environmentally.

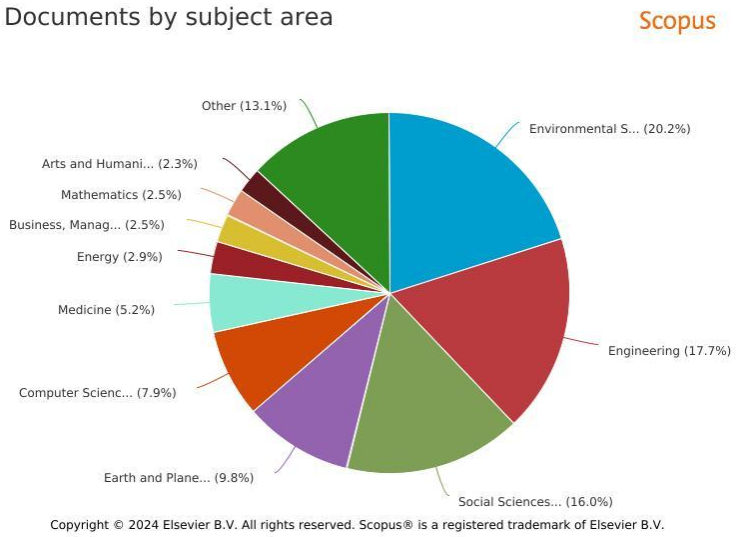

Fig. 3: Documents by domain

3.2. Geographical distribution of road infrastructure in economic and commercial cities

Table 1: Geographical distribution of road infrastructure on the economy and business of cities

Country	Documents	Citations
brazil	9	276
canada	17	146
china	42	462
france	8	90
germany	12	198
india	18	110
indonesia	7	12
iran	7	73
italy	8	46
japan	7	31
netherlands	5	53
poland	5	49
russian federation	8	40
united kingdom	17	142
united states	45	1050

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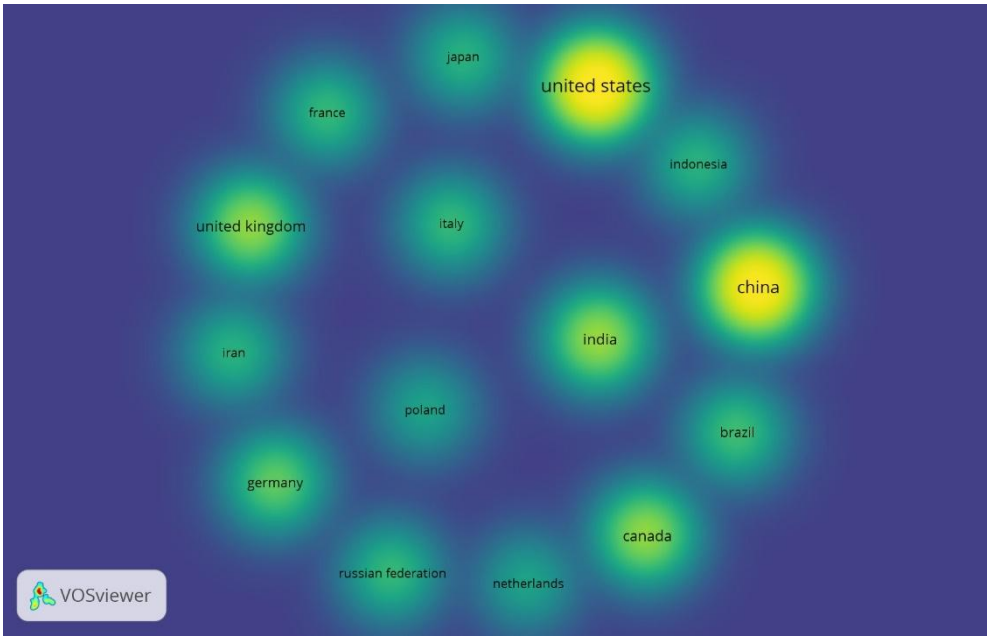

Fig. 4 Geographical distribution of the impact of road infrastructure on the economy and business of cities.

We have observed that the distribution of publications on the impact of highways on the economic and commercial activities of cities is uneven around the world.

Highways play a crucial role in the American transportation system, enabling the movement of goods and people over long distances. They support economic growth, connect cities, and serve a wide range of industries, including commerce, tourism, and logistics. Highways are particularly essential for emergency operations, as they improve accessibility and connectivity across the country. The United States leads the world with 45 highways, followed by China with 42, and then the United Kingdom with 18.

3.3. Citation network analysis (can)

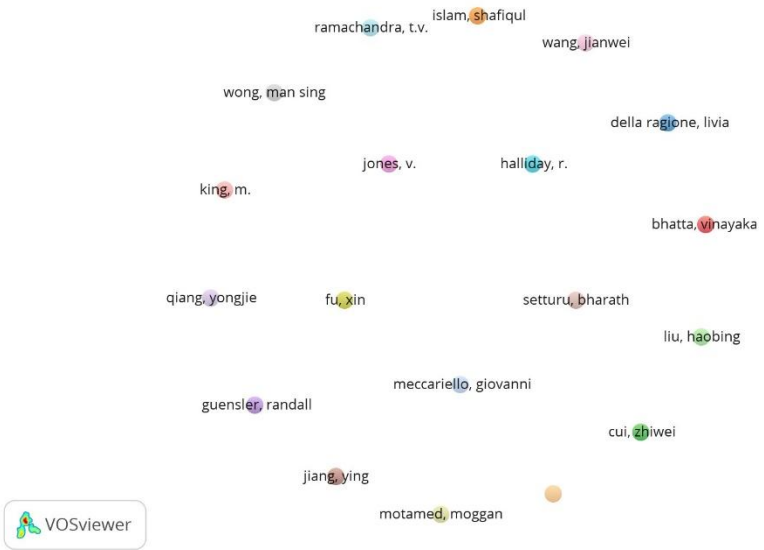

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Table 2 Analysis of author quotations

Author	Documents	Citations
bhatta, vinayaka	2	0
cui, zhiwei	2	22
della ragione, livia	2	5
fu, xin	2	22
guensler, randall	2	40
halliday, r.	2	1
islam, shafiqul	2	1
jiang, ying	2	22
jones, v.	2	1
king, m.	2	1
liu, haobing	2	40
meccariello, giovanni	2	5
motamed, moggan	2	0
qiang, yongjie	2	22
ramachandra, t.v.	2	0
rodgers, michael o.	2	40
setturu, bharath	2	0
wang, jianwei	2	22
wong, man sing	2	13

A citation network analysis was conducted to uncover connections and research topics referenced in the 257 articles reviewed, in accordance with Scopus data and analysis. The authors used the VOS visualization program to map keywords associated with each article for the RCA analysis. The authors' citations are shown in **Figure 5**. The most influential authors are Guensler et al. (Passmore et al., 2023) and Liu et al. (Shen et al., 2020), with 40 citations each.

3.4. Citation network analysis (can)

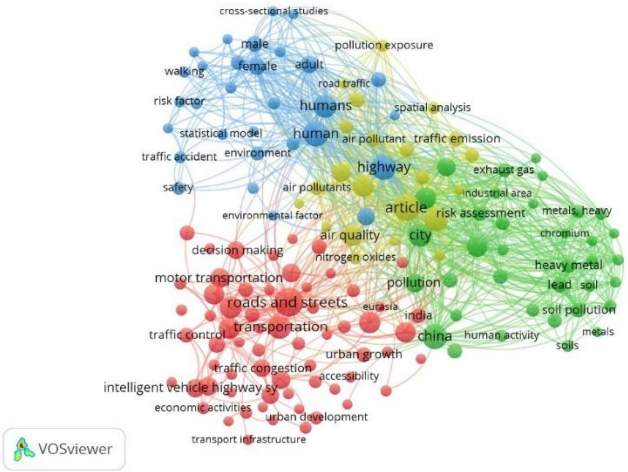

Fig. 5 Analysis of keyword co-occurrence

Keywords extracted from the 257 articles studied were used to create a map using the VOS viewer. The keywords are represented by different colored spheres and are listed separately, but are often closely related to each other.

The results presented in Figure 5 show 3 main rankings:

The first classification brings together words related to transport infrastructure: highway, transport, urban development, roads and streets, motorized transport, chrome and accessibility..., etc.

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The second classification groups together words relating to the city and polluting materials such as: heavy, metal, soils, soil pollution...etc.

The third classification includes words related to the themes studied, such as statistics, gender, man, woman, traffic risk, adult, human, environmental factor, etc.

Infrastructure, transportation, cities, environmental pollution, business, and the economy are all interdependent elements of urban systems. Efficient transportation infrastructure enhances interconnectivity and fosters business growth by facilitating operations. However, poorly planned infrastructure can also contribute to congestion and pollution, impacting both environmental and economic dimensions. Urban areas with efficient public transportation systems tend to reduce traffic congestion and pollution, positively affecting quality of life. The environmental impact is further mitigated by sustainable urban development, including green spaces and effective waste management.

Uncontrolled pollution can harm public health and hinder economic productivity.

3.5. THE CASE STUDY/ The radius of influence of Constantine.

The case study of our research is the route of the East-West highway and particularly the radius of influence of Constantine.

East-West Highway Corridor Development Plan.

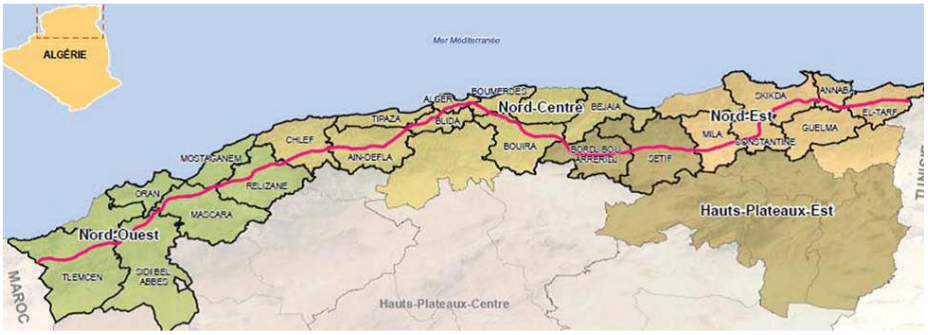

Fig 6 General presentation of the East-West motorway route.

The main objective is to anticipate and channel the socio-economic effects generated by the passage of the East-West motorway by creating new industrial, economic and residential activity zones around interchanges and intermodal transport hubs.

The map is at the global level. Our subject is at the regional and local level: the sphere of influence of Constantine.

We note that the East-West highway passes through the city's urban area and crosses it via a slip road, leaving impacts behind it.

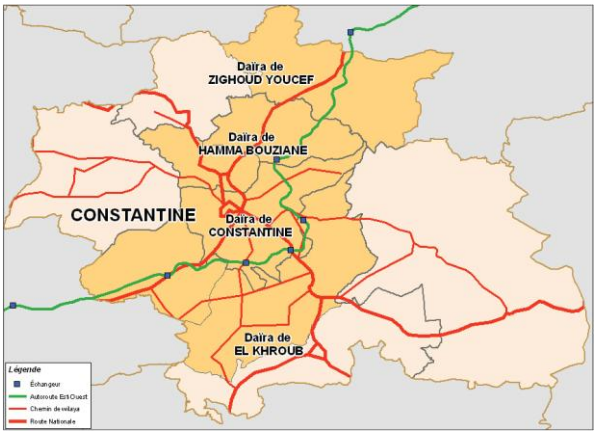

Fig 7: Crossing the East-West highway in the urban area of Constantine.

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3.5.1. Socio-economic profile/ Positioning and geographical components

• The wilaya of Constantine covers a total area of 2,297 km².

• It is bordered by the wilayas (departments) of Skikda (north), Guelma (east), Mila (west), Oum El Bouaghi (south).

• An integral part of the Tell Atlas and characterized by three major distinct relief zones:

-- The mountainous area located in the north of the wilaya. It has a mountainous and rugged terrain. This area is mainly dedicated to agropastoral and forestry activities.

-- the inland zone consisting of a series of depressions and basins framing almost all natural environments. It is in this zone that the largest urban areas are found.

-- the southern zone, characterized by the regularity of the relief. Large agricultural areas are found in the southeast while in the southwest the pre-steppe areas begin.

Located in the heart of eastern Algeria, Constantine has always held a significant position.

Influence on this region due to its geographical location and demographic weight.

The entire eastern region of the country identifies with the metropolis of Constantine.

3.5.2. Transport networks and infrastructure

• Presence of a road network, a railway line and an international airport.

• Road network distributed across the entire territory, from the metropolis of Constantine. Composed of approximately 258 km of national roads, 416 km of wilaya roads and 632 km of communal roads.

• Main routes: East-West motorway, RN5, RN3, RN27 and RN20. (RN: national road)

• The East-West Highway crosses the Constantine province from the west-central region to the northeast. Its route follows the RN5 and then the RN3 as far as the Skikda border. The construction of this important highway was intended to strengthen the province's road network capacity and consolidate its position as a regional hub.

• The RN5 also connects Constantine to the capital Algiers and to all the important urban areas: Setif, Bordj Bou Arreridj and Brouira.

• The RN20 provides the link with the east of the country, up to the Tunisian border.

• National Routes RN3 and RN27 provide access from the wilaya to the coast, particularly to the ports of Jijel, Skikda, and Annaba. RN3 also connects to the south, towards the wilayas of Oum El Bouaghi and Batna.

• Presence of a railway line which crosses the wilaya from west to northeast for 97 km.

• Presence of an international airport (Aïn El Bey) and road access to the two seaports of Skikda and Annaba.

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Fig 8: The network and infrastructure passing through the urban area of Constantine

3.5.3. Summary of strengths and constraints/ Observed impacts.

- **Strengths**

The Constantine conurbation, an inland metropolis in the East, a road and rail crossroads, supplies a set of localities that depend on it economically and administratively.

• Accelerated urbanization of satellite cities

• Large availability of useful substances

• Numerous local, regional and even national companies in the construction and public works sector

• Availability of a skilled workforce – universities and 20 specialized programs, numerous training centers

• Large urban land potential in Greater Constantine, particularly in the new city of Ali Mendjelli (in Aïn El Bey) located near the highway and Mohamed Boudiaf International Airport.

• Availability of land in industrial and business parks

• Existence of regional-level commercial networks

• Cereal-dominated agriculture, the current areas of which must be preserved (loss of nearly 500 hectares during the construction of the highway)

• The highway project opens up the urban area of Constantine. From now on, the port of Skikda and the Annaba conurbation will be only 45 minutes and 1 hour from Constantine respectively.

• Presence of a core group of mechanical engineering companies in Aïn Smara and El Khroub. Creation of workshops or units around two major hubs of the mechanical industry in the municipalities of Aïn Smara and Oued Hamimine: industrial maintenance, subcontracting (manufacturing of accessories and spare parts, and service activities).

• Major cement plant in Hamma Bouziane

• The largest livestock market in eastern Algeria is located in El Khroub

• Very high rates of household connection to gas and electricity.

- **Contraints**

Demographic slowdown and shift of growth in the Constantine metropolitan area to the periphery

• Large influx of rural population

• Overconsumption of land suitable for urbanization at the expense of agricultural land

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• Significant landslides in rural areas resulting in the loss of agricultural soil and

Damage to infrastructure (roads and pipelines). In urban areas, it is estimated that one-third of the Constantine metropolitan area is threatened by landslides.

•Urban sprawl and peri-urbanization leading to significant commuting in the Constantine region

• Constantine railway station is not equipped for freight transport. Goods from Annaba (steel products, phosphates, and fertilizers) only pass through Constantine. El Khroub and Hamma Bouziane stations, on the other hand, are equipped.

• The Constantine industrial zone is at full capacity.

Population base

• Segment with nearly 640,000 inhabitants.

• Metropolis (Constantine) located at the center of a major urban network. Agglomeration at the heart of the urban framework of the northeastern region. Most of the region's roads converge there.

• Framework formed of two layers:

-- First tier: the metropolitan areas of Constantine and Annaba, fulfilling the functions of regional hubs that balance the country's urban structure and facilitate connections and links between these cities and smaller and medium-sized towns. Annaba (230,000 inhabitants) and Constantine (440,000 inhabitants) complement each other and function as a pair in eastern Algeria. (These figures are not up-to-date as the 2022 census has not yet been published.)

-- Second layer: cities with regional influence: Batna, Sétif, Skikda and Tébessa.

• Other agglomerations also contributing to the urban structuring of the two regions: Jijel, Guelma, Oum El Bouaghi and Souk El Ahras.

• Population of 2.5 million people within a radius of 50 kilometers and 6 million people within a radius of 100 kilometers.

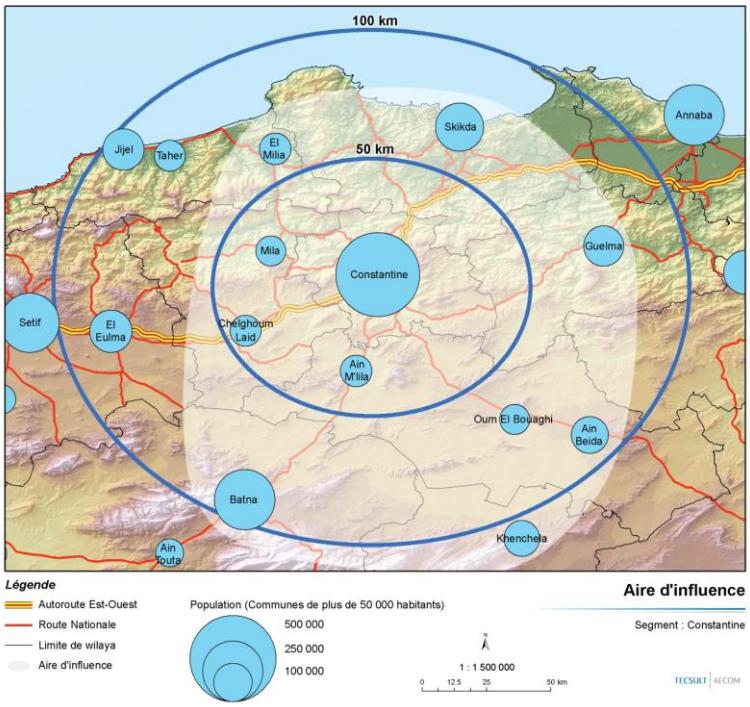

Fig 9: Area of influence of Constantine and its urban area.

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3.5.4. Socio-economic development potential

• High potential given the presence of:

-- Numerous private companies in several sectors of activity.

-- A large, trained and diverse workforce.

-- Large higher education and research institutions, which offer numerous programs and include several research laboratories in diverse fields.

- **Planning guidelines/Impacts of the East-West infrastructure.**

• Thanks to the passage of the East-West highway, the Guidelines are inscribed, aiming for significant economic development in the metropolis of Constantine while highlighting the need to channel this development into appropriate areas, given the limited territory, the terrain and the imperative of preserving agricultural land.

• Enhancement and protection of agricultural heritage.

• For Constantine, the SNAT (National Scheme for Territorial Development) indicates: located at the head of the urban system in the north-east programme region (on the same basis as the Annaba agglomeration), the metropolis of Constantine drives the overall dynamic by being a place of concentration of people, technical and financial capital, centers of higher services and hubs of technological innovation.

• Constantine serves as a relay point towards the High Plateaus.

• This urban area has been identified as one of the international logistics platforms, along with Algiers and Oran. It could host a dry port, serving as a link to the ports of Skikda and Annaba.

• Constantine is defined as a center of competitiveness and excellence (POC) for the biotechnology sector (pharmaceuticals and agri-food).

• The Vieux Rocher sector is identified as a heritage economy hub (PEP).

• Constantine is identified for the development of a tourism hub of excellence centered around business and cultural tourism.

• Availability of a 100 ha industrial development zone in Aïn Smara.

- **Physical development potential**

• A total of 4,751 hectares are planned in urban expansion areas.

• Urban expansion areas located mainly south of Constantine, northwest of Constantine, in the new city of Ali Mendjelli as well as in El Khroub (new city of Massinissa and Ain NAHAS)).

- **Environmental factors**

• Important and extensive, to be considered in the planning of the segment.

• Wooded and scrubland areas covering 5,800 hectares.

• Preservation of agricultural land.

The existence of the East-West highway in the Constantine region produces diverse and varied impacts. If we consider the studies on road infrastructure discussed at the beginning of the article, we can affirm that the presence of such an important and vital road axis as this highway can, within a few years, develop several dimensions and influence the creation of assets as important as urban dynamics: a powerful lever for development and the creation of an economic hub for labor and activities, not only industrial but also service and quaternary sectors, with the introduction of new technologies in connected management.

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CONCLUSION

This article examines the impact of highways on the economies and businesses of cities. The methodology used is a bibliometric technique that allowed us to identify the evolution of this topic and its structures, with 257 publications indexed in the Scopus database for the period from 1971 to 2024. This methodology is recognized as an effective tool for analyzing this topic. In this type of bibliometrics, the unit of analysis consists of the keywords that appear in the subject matter, encompassing the title, keywords, abstract, and the full article in some form within each document. The United States, the United Kingdom, and China are the most productive countries in the field of the impact of road infrastructure on the economies of cities and businesses. The most influential authors are Guensler and others, and Liu and others, with 40 citations each. Publications on this research topic are best presented from the perspectives of environmental science (20.2%), engineering (17.7%), and social science (16%). The most frequently cited keywords were divided into three groups: cities, transport infrastructure, and statistical studies. This finding can be used to demonstrate the comparative novelty of the impact of transport infrastructure on the economy and the need for empirical studies. Other databases, such as IEEE and Web of Science, can also be used for further research. To compare what is available in the literature, a bibliometric review of other databases will be essential.

In Algeria, the lack of academic studies on road infrastructure and its impact on the various dimensions of cities led our study to focus solely on the East-West Highway, particularly within the case study area of Constantine. We have attempted to document our observations, hoping to continue monitoring the direct and indirect impacts this infrastructure has had on the geographical fabric of the Constantine region..

THANKS

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Thesis: Impact study of the East-West Highway on the sphere of influence of the Constantine Metropolis. Algeria. Methods: segmented regressions, time series, GIS/Arc GIS.
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PhD Researcher (2020-present)
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Preparation of academic presentations.
Teaching Assistant/Research Assistant (dates) [University Constantine 3]. Courses in quantitative methods and urban planning. Public procurement courses, quantity-surveying courses. Supervision of Master 2 students in urban planning.

Technical skills

Data analysis: R, SPSS, regressions. • Tools: ArcGIS, Excel/Google Sheets, • others: Scientific writing, visualization (PowerPoint), geospatial modeling. Projects and distinctions • Thesis project: Study of the impact of the East-West highway on the influence radius of the Constantine Metropolis. Algeria

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Areas of interest include urban projects, heritage conservation, management, the impact of urban infrastructure on the environment in general, territorial marketing, projects with structuring effects, urban business models, and ICT strategies in urban planning

Innovation patent in urban planning (LABEL STARTUP INAPI in 2024).

Several articles published. 28 master's degrees defended in Urban Planning after the HDR,

9 doctorates supervised, including 3 defended. Several theoretical courses taught, including an educational handout. Two books published in European editions. Chapters in edited books.

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