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REVIEW

The evolution of urban transport in Córdoba: sustainability and user experience

Evolución del transporte urbano en Córdoba: sustentabilidad y experiencia del usuario

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ABSTRACT

Introduction: mobility has always been an essential feature of human life, but in large cities it has become a social, economic, and environmental challenge. In the city of Córdoba, population and vehicle growth has led to congestion, pollution, and a deterioration in the quality of urban life. Faced with this situation, there was a need to rethink the public transport system as a sustainable alternative to private vehicle use.
Development: the research was based on an analysis of population growth and its impact on mobility, showing that the number of vehicles on the road increased steadily between 2015 and 2020. This, combined with the city's topography, intensified the accumulation of pollutants. Urban public transport was studied from the perspective of sustainability, understood as the ability to meet current needs without compromising those of future generations. Alternative propulsion technologies, such as Compressed Natural Gas (CNG), were also evaluated, and the transition to electric mobility was considered a viable option. Finally, the role of industrial design in creating accessible, efficient, and user-friendly transportation systems was analyzed, with the aim of promoting a cultural shift toward collective modes of mobility.
Conclusion: the study concluded that urban mobility in Córdoba required profound transformations towards sustainable and accessible public transport. These transformations should be aimed not only at reducing emissions, but also at improving the user experience, ensuring an inclusive and effective system that contributes to sustainable urban development.

Keywords: Mobility; Public Transportation; Sustainability; Accessibility; Córdoba.

RESUMEN

Introducción: la movilidad constituyó un rasgo esencial de la vida humana, pero en las grandes ciudades se convirtió en un desafío social, económico y ambiental. En la ciudad de Córdoba, el incremento poblacional y vehicular provocó congestiones, contaminación y un deterioro en la calidad de vida urbana. Ante esta situación, se planteó la necesidad de repensar el sistema de transporte público como alternativa sostenible frente al uso del vehículo particular.
Desarrollo: la investigación se basó en el análisis del crecimiento demográfico y su impacto en la movilidad, evidenciando que el parque automotor aumentó de manera sostenida entre 2015 y 2020. Esto, sumado a la topografía de la ciudad, intensificó la acumulación de contaminantes. Se estudió el transporte público urbano desde la perspectiva de la sustentabilidad, entendida como la capacidad de satisfacer necesidades actuales sin comprometer las de las generaciones futuras. Asimismo, se evaluaron tecnologías de propulsión alternativas, como el Gas Natural Comprimido (GNC), y se consideró la transición hacia la movilidad eléctrica como un horizonte viable. Finalmente, se analizó el papel del diseño industrial en la creación de sistemas de transporte accesibles, eficientes y atractivos para el usuario, con el objetivo de promover un cambio cultural hacia modos colectivos de movilidad.
Conclusión: el estudio concluyó que la movilidad urbana en Córdoba requería transformaciones profundas

hacia un transporte público sustentable y accesible. Dichas transformaciones debían orientarse no solo a la reducción de emisiones, sino también a la mejora de la experiencia del usuario, garantizando un sistema inclusivo y eficaz que contribuyera al desarrollo urbano sostenible.

Palabras clave: Movilidad; Transporte Público; Sustentabilidad; Accesibilidad; Córdoba.

INTRODUCTION

Mobility is inherent to human beings from the moment of conception. From walking to crossing continents by land and sea, it is an activity that distinguishes living beings, and us humans in particular. In the world's large cities, the need for transportation is a problem that afflicts society, the economy, and politics.

Focusing on the city of Córdoba, excessive population growth causes marked inefficiencies in transportation daily. The Argentine Association of Component Manufacturers (AFAC) reported that the circulating vehicle fleet or "active" fleet increased by nearly 21 % between 2015 and 2020, reaching 14 564 842 active vehicles by the end of 2020. This suggests that an increasing number of people are opting for private cars in the absence of an attractive public transportation system or urban routes for alternative mobility. As a result, there are not only major traffic jams, but also an increase in polluting emissions into the environment.

Measurements taken by UNC researchers identified nitrogen dioxide (NO2) values above internationally recommended maximum limits. The city's topography does not help either: Córdoba is located in a depression, which means that air circulation and removal are much slower.[1]

The orographic configuration of the city of Córdoba indicates that it is located in a depression surrounded by mountains, which intensifies environmental problems and the stagnation of particles that are harmful to the environment and people, such as smog.

For this reason, it is essential to review and rethink the composition of the city's urban public transport system and, consequently, to design an evolution of the system that uses zero-emission propulsion systems and is attractive to users. A proposal will be developed for the urban public transport system vehicle, with a view to adapting the space to the particular needs of users, emphasizing their experience, and taking into account future advances in technology and connectivity.

The aim is to attract more users, who currently travel in private vehicles, to the urban public transport system, to reduce the number of cars in the city center and its surroundings, and thus reduce the environmental impact they generate.

DEVELOPMENT

The following areas will be taken as a starting point for the research:

Figure 1. Areas for the development of the theoretical framework

When we talk about the basic notion of transport, we refer to the "system of means for transporting people and things from one place to another".[1] For this project, we will focus on urban public transport, which is defined as a system of means, i.e., infrastructure and vehicles, developed to take people from one place to another in the city. It is characterized by motorization and collectivity.

The work is based on the public transport system in the city of Córdoba, which, although similar to other cities in the region, has its own particularities due to its demographic and growth characteristics.

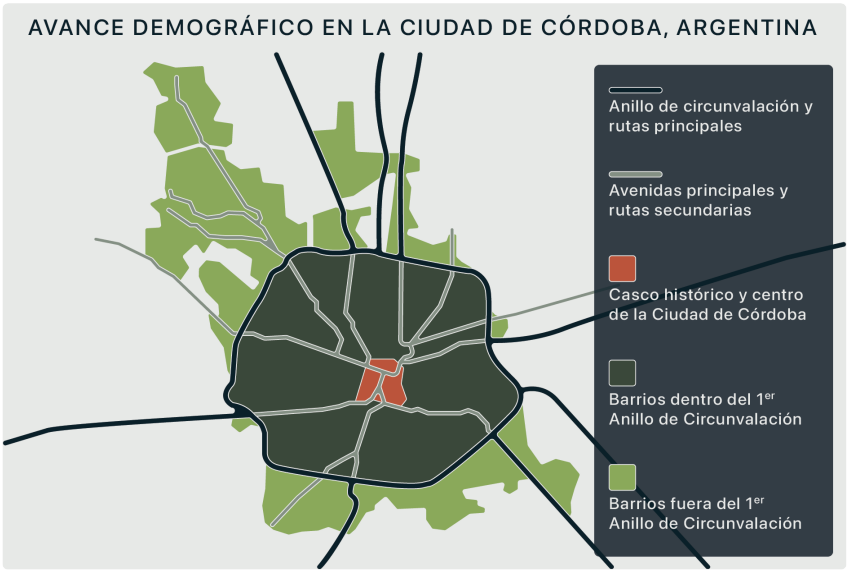

Figure 2. Demographic development of the city of Córdoba

Despite the strong influence of the Hispanic model, which is still recognizable in the city of Córdoba, the city's growth over the last century has overwhelmed the organizational and political-administrative capacity of those grids, spreading over a road system of highways, access roads, and connecting axes. Córdoba is characterized by a congested center, centered around the old colonial center, and a multiplicity of neighborhoods, gated communities, centers, and suburbs that are interspersed in an urban conglomerate characterized by its unstable articulation and the production of significant dysfunctions between the urban structure and the transportation systems offered.[3]

This situation leads to two problems: neighborhoods far from the center that require long daily commutes by vehicle, and traffic jams within the urban area due to the density of private cars converging there. As a result, we can see the inefficiency and unsustainability of transportation as we know it.

To develop a sustainable urban public transportation system, we must understand what sustainability is. In recent decades, this term has become vitally important due to the significant environmental impact generated by humanity, and vehicles in particular. «Sustainable development refers to the capacity that the human system has developed to meet the needs of current generations without compromising the resources and opportunities for growth and development of future generations.»[4] This definition, although classic, has evolved in recent years towards a modern notion of sustainability, which helps to understand the balance between economic progress and the environment: what sustainability essentially seeks is to move towards a different relationship between the economy, the environment, and society. It does not seek to slow down progress or return to primitive states—quite the contrary.

It seeks precisely to promote progress, but from a different and broader perspective, and that is where the real challenge lies.[4] And this raises the question of how the public transport system relates to the notion of sustainability in a city.

There is no doubt that transportation is a fundamental factor in the development and well-being of any society. However, this sector is responsible for 22 % of global energy emissions and 16 % of total emissions, and 26 % and 14 % respectively in Argentina. Furthermore, transportation not only generates global emissions, which are responsible for global warming, but also local pollutant emissions: microscopic particles, toxic gases, etc., which cause numerous illnesses and deaths, mainly in urban centers. On the other hand, the vehicle fleet is growing significantly, and this growth is expected to continue in the coming decades. If the current trend continues, the number of light vehicles in 2050 could triple that of 2010.[5]

The public transport system in Argentina, and in the city of Córdoba in particular, is basically composed of internal combustion engines powered by diesel or gasoline.

Developing a sustainable public transport system that is accessible to the masses becomes vitally important when looking at the emissions data produced by the fleet of vehicles that circulate daily in large cities; the more people are attracted to public transport, the more the fleet of private cars is reduced and, therefore, the environmental impact they generate.

The country's current energy matrix would allow for the immediate implementation of public transport fleets powered by less polluting energies such as CNG, which, although of fossil origin, has much lower emission levels.

Natural gas plays a crucial role in this country. Not only is it the most essential fuel in the national energy matrix, but the available transport and distribution network is one of the most extensive in the world. Of the approximately 23 million vehicles powered by compressed natural gas (CNG) that existed worldwide in 2017, more than 1,9 million were in Argentina, (...) This makes us one of the countries with the most developed technology in this area. We also have a significant infrastructure, numerous filling stations distributed throughout most of the country, and a developed industry for CNG vehicle equipment.[5]

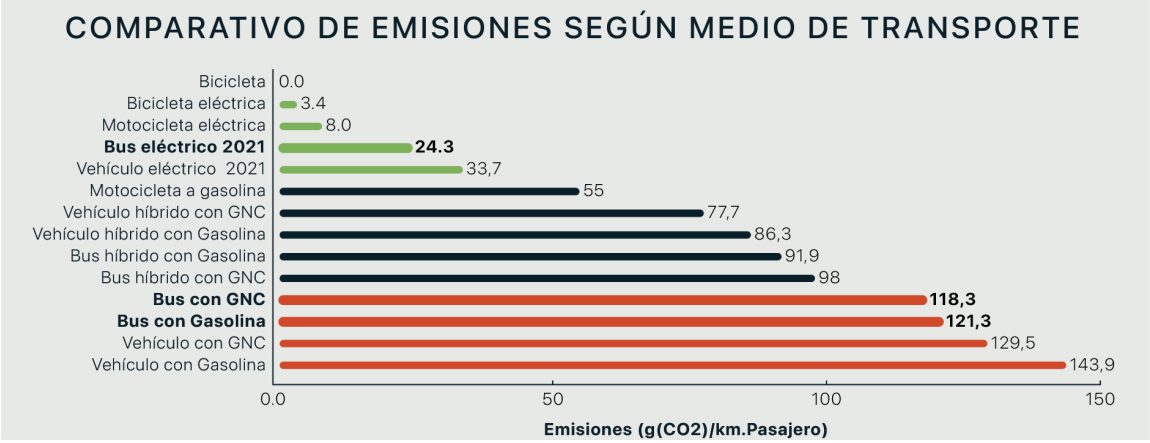

Figure 3. Comparative table of annual emissions per passenger in (g(CO2)/km.passenger) for different means of transport
Source: Own elaboration, based on Figure 36[5]

As shown in figure 3, the transition from fuels such as diesel to CNG would already represent a significant advance at a lower cost. However, as industrial designers, our role is to think ahead and anticipate the future.

To find a possible future for civilization, industrial design will have to redefine and promote elements that slow down degradation and the consumption of materials and objects, and reorient the values of beauty, status, luxury, and comfort based on criteria that put the planet's biodiversity at risk. In addition, it will have to take on the role of educator and a profile with a vocation to help.

With this in mind, considering the evolution towards an electricity-based matrix is a viable path, and even more so when analyzing some of the most advanced countries in terms of renewable energy. The world is moving towards electric, and so much so that many car companies are planning to stop offering combustion engines by 2030/35.

In the long term, Ford envisions the City of the Future with large concentrations of autonomous vehicles, most of them electric, as well as the integration of drones, advanced transportation operating systems that seamlessly and fluidly integrate data from all aspects of the ecosystem, and the large-scale implementation of advanced technologies for flexible traffic management, eliminating congestion, reducing emissions, and accidents.[6]

In 2021, the European Commission launched the "Fit for 55" program, which calls for a 55 % reduction in emissions by 2030 and zero emissions by 2035.[7] This represents a significant challenge for the industry, which, although lagging behind the European Union in terms of environmental regulations in our region, is a trend that will inevitably catch up with us and for which we must be prepared.

To understand the real impact our mobility has on the world, it is interesting to understand the concept of carbon footprint.

The carbon footprint is defined as the set of greenhouse gas emissions produced, directly or indirectly, by people, organizations, products, events, or geographic regions, in terms of CO2 equivalents. It serves as a helpful management tool for understanding the behaviors or actions that are contributing to increasing our emissions, how we can improve them, and make more efficient use of resources.

Fuel is part of the direct emissions that make up a person's carbon footprint. If a person travels alone in their private vehicle, which has been designed for five people, the impact on the calculation of their personal carbon footprint is exponential.

However, although propulsion energy is the spearhead for sustainable mobility, it is not enough to reach the user with the project; therefore, we must work on designing a public transport system that adapts to the needs, aspirations, and requirements of modern society, which is permeated by technology and connectivity. This is where a keyword comes into play: accessibility. «Accessible. Adjective applied to a person or thing that can be accessed or reached without difficulty».[8] Advances in technology are the order of the day and affect the way we relate to objects and the world.

As mobility increasingly becomes a factor in people's daily lives, the times and places of mobility become

more critical; transportation needs to be more convenient, economical, and enjoyable. Moreover, transportation is no longer simply a means of getting from A to B: it is a part of life in its own right, and deserves to be valued as such. Movement should also be a pleasure.[9]

Understanding accessibility from a personal perspective, linked to the user's experience and their environment, together with the object itself, is crucial if we want to encourage the use of public transport. In the words of François Ascher, this is where the main challenge of the project as a designer lies: to achieve a public transport system that users enjoy using; to assimilate it as an essential part of our daily lives, where we spend a lot of time, and where many things can happen.[9]

For all the reasons outlined above, this design project aims to develop a proposal for the evolution of the current urban public transport system in the city of Córdoba, focusing on user accessibility and their particular experience of use, and based on sustainable propulsion systems. All this is aimed at promoting its use over private internal combustion vehicles, thereby improving the efficiency of urban layouts and reducing the carbon footprint generated by people.[10]

CONCLUSIONS

Mobility in the city of Córdoba is currently facing a critical situation due to rapid population growth, dependence on private transportation, and a lack of attractive and sustainable public transportation alternatives. The adverse effects of this model extend not only to urban congestion but also to environmental deterioration, which compromises the health of the population and the quality of life in the city.

The evidence presented suggests that urban public transport needs to be transformed into a more efficient, accessible, and sustainable system, supported by lower-emission propulsion technologies and designs that prioritize the user experience. This evolution will not only reduce the environmental impact associated with the excessive use of private vehicles but also ensure more inclusive mobility that is adapted to the current needs of society.

In this context, the incorporation of alternative energies such as CNG and, in the future, the transition to electric mobility, are emerging as fundamental steps towards sustainable urban transport. However, the real challenge lies in designing a system that appeals to citizens, integrating sustainability with accessibility and quality of use. Only in this way can public transport consolidate its position as the driving force behind more equitable, efficient, and environmentally friendly urban mobility, contributing to the construction of a possible future for Córdoba and its inhabitants.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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