Transport, Mobility & Society. 2023; 2:72
doi: 10.56294/tms202372

ORIGINAL

Analysis of public transport fares in Guadalajara, Mexico

Análisis de la tarifa técnica del transporte público en Guadalajara, México

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Cite as: Estrada Meza RU. Analysis of public transport fares in Guadalajara, Mexico. Transport, Mobility & Society. 2023; 2:72. https://doi.org/10.56294/tms202372

Submitted: 08-01-2023 **Revised:** 21-04-2023 **Accepted:** 11-07-2023 **Published:** 12-07-2023

Editor: Prof. Emanuel Maldonado

ABSTRACT

The study analysed public transport fares in the Guadalajara Metropolitan Area (AMG), with an emphasis on their economic and social dimensions. It started from the fact that, until 2018, there was no formal methodology for calculating this fare, and the only ruling issued by the then Jalisco Institute of Mobility and Transport (IMTJ) focused solely on Trunk Line 05 of the General Transport Programme. Based on this context, the work explored international references such as the IDB, ECLAC and UITP, which offered conceptual frameworks on how to structure fares that were efficient, sustainable and fair.The research incorporated social justice theories, such as those of Rawls, Sen and Veblen, to argue that public transport should be understood as a right and not just as an economic good. It also addressed the economics of transport, considering concepts such as demand elasticity, joint costs, diminishing returns and marginal pricing. The technical fare was conceived as one that reflected actual operating costs, while the social fare should be adjusted to the population's ability to pay. The study proposed a replicable methodology for calculating the technical fare, considering variables such as travel speed, cost per kilometre and demand elasticity. Finally, it concluded that a fair fare system should balance operational efficiency and social equity, and that the state had a responsibility to guarantee universal access to public transport as part of its social function.

Keywords: Technical Tariff; Social Justice; Public Transport; Elasticity; Equity.

RESUMEN

El estudio analizó la tarifa técnica del transporte público en el Área Metropolitana de Guadalajara (AMG), con énfasis en su dimensión económica y social. Partió del hecho de que, hasta 2018, no existió una metodología formal para calcular dicha tarifa, y el único dictamen emitido por el entonces Instituto de Movilidad y Transporte de Jalisco (IMTJ) se enfocó únicamente en la Troncal 05 del Programa General de Transporte. A partir de ese contexto, el trabajo exploró referentes internacionales como el BID, la CEPAL y la UITP, los cuales ofrecieron marcos conceptuales sobre cómo estructurar tarifas que fuesen eficientes, sostenibles y justas. La investigación incorporó teorías de justicia social, como las de Rawls, Sen y Veblen, para argumentar que el transporte público debía entenderse como un derecho y no solo como un bien económico. También abordó la economía del transporte, considerando conceptos como elasticidad de la demanda, costos conjuntos, rendimientos decrecientes y tarificación marginal. La tarifa técnica fue concebida como aquella que reflejaba los costos operativos reales, mientras que la tarifa social debía adecuarse a la capacidad de pago de la población. El estudio propuso una metodología replicable para calcular la tarifa técnica, considerando variables como la velocidad de recorrido, el costo por kilómetro y la elasticidad de la demanda. Finalmente, concluyó que un sistema tarifario justo debía equilibrar eficiencia operativa y equidad social, y que el Estado tenía la responsabilidad de garantizar el acceso universal al transporte público como parte de su función social.

Palabras clave: Tarifa Técnica; Justicia Social; Transporte Público; Elasticidad; Equidad.

INTRODUCTION

In the AMG, there is no formal technical study determining the public transport fare system. What does exist is a report issued in 2018 by the now-defunct Jalisco State Institute of Mobility and Transport (IMTJ), which outlines the costs of the main inputs necessary for the operation of public transport. Therefore, the scope of this study is to characterize the technical fare for one of the 18 trunk lines outlined in the Jalisco State PGT and is limited to describing the different types of fares related to the technical fare.[1,2,3,4,5,6,7]

However, the technical, social, and sustainable aspects of public transportation are a topic of interest to governments, transportation operators, and users. Around the world, various studies have been conducted to analyze and determine the appropriate technical fare for public transportation. Some of the primary studies are:[8,9,10,11]

- Study on public transport fares in Latin America and the Caribbean: This study was conducted by the Inter-American Development Bank (IDB) in 2017 and analyzes fare policies in 26 cities in the region. The study highlights the importance of technical fares in the financial sustainability of public transport.
- Study by the International Association of Public Transport (UITP) on technical fares: This study, published in 2019, analyzes the different methodologies used around the world to calculate technical fares. The study also provides recommendations on how to improve transparency and understanding of technical fares.
- Study by the Economic Commission for Latin America and the Caribbean (ECLAC) on public transport fares: This study, published in 2018, analyzes fare policies in seven cities in the region. The study emphasizes the significance of technical fares in enhancing the efficiency and quality of public transport services.
- Study by the Institute for Transportation and Development Policy (ITDP) on technical fares in Latin American cities: This study, published in 2017, analyzes the methodologies used to calculate the technical fare in 14 cities in the region. The study emphasizes the need for an integrated fare policy that considers demand and supply.

Additionally, technical, social, and sustainable public transport fares are a topic of interest to many transport researchers and experts worldwide. Some of the primary studies on this topic are:[12,13,14,15]

"Technical public transport fares: Analysis and international perspectives," prepared by the European Commission in 2017. This study examines the different methodologies used by European Union countries to calculate technical public transport fares.

"Technical public transport fares: The case of Santiago, Chile," a study conducted by the University of Chile in 2018. This paper examines the methodology employed by the public transportation system in Santiago, Chile, to determine its technical fares.

- "Technical fares and operating costs of urban public transport in Latin America and the Caribbean" (IDB, 2012): This study analyzes technical fares and operating costs of public transport in 24 cities in Latin America and the Caribbean.
- "Technical fares and financing of urban public transport in developing countries" (World Bank, 2010): This study examines the factors that affect technical fares for public transport in developing countries and how the operating costs of the system can be financed.

In 2013, the Mobility and Transportation Law of the state of Jalisco was created. Article 3, section II, regulates that public transportation services must be provided under the principles of punctuality, hygiene, order, safety, universality, accessibility, uniformity, continuity, adaptability, permanence, timeliness, effectiveness, efficiency, and environmental and economic sustainability. Similarly, Article 5, section XIX, describes the integrated public transportation system as a public transportation service in a city with a highly efficient, effective, and sustainable organization, resulting from the systemic integration of infrastructure, operations, and fares for the different modes of public transportation and non-motorized transportation.[16,17,18,19,20,21,22,23,24]

Additionally, the General Technical Standard for the Quality of Mass and Collective Public Transportation Services in the State of Jalisco aims to establish standards for the components of the public passenger transportation system in terms of service quality, as well as to establish indicators for its evaluation.[25,26,27,28,29,30,31,32]

Likewise, in section I, subsection c), 3 section I, 14 section II, 15 section I subsection g), 18, section I, subsection c), 19, sections XIII, XXII, XXIII, XXIV, XXV, XXXI, XXXV, XXXVI, article 99, sections I and II of the Mobility and Transportation Law, articles 51, 56, 57, 58, and 59 of the Regulations for the Regulation of Collective Public Transportation, Mass, Taxi, and Radiotaxi in the State of Jalisco, the "Declaration of the need for 18 trunk mobility routes and 86 complementary routes from the section of the second General Transportation Program for the Integrated Public Transportation System in the Guadalajara Metropolitan Area, Jalisco" is issued.[33,34]

Currently, Mexico has the General Law on Mobility and Road Safety. The State of Jalisco must harmonize and publish its New Law on Mobility and Road Safety by 2023.

In 2014, the IMTJ proposed Trunk Route 05 for the General Transportation Program (PGT), integrating six routes for the main corridor and seven feeder routes, as shown in figures 1 to 10.[35,36,37]

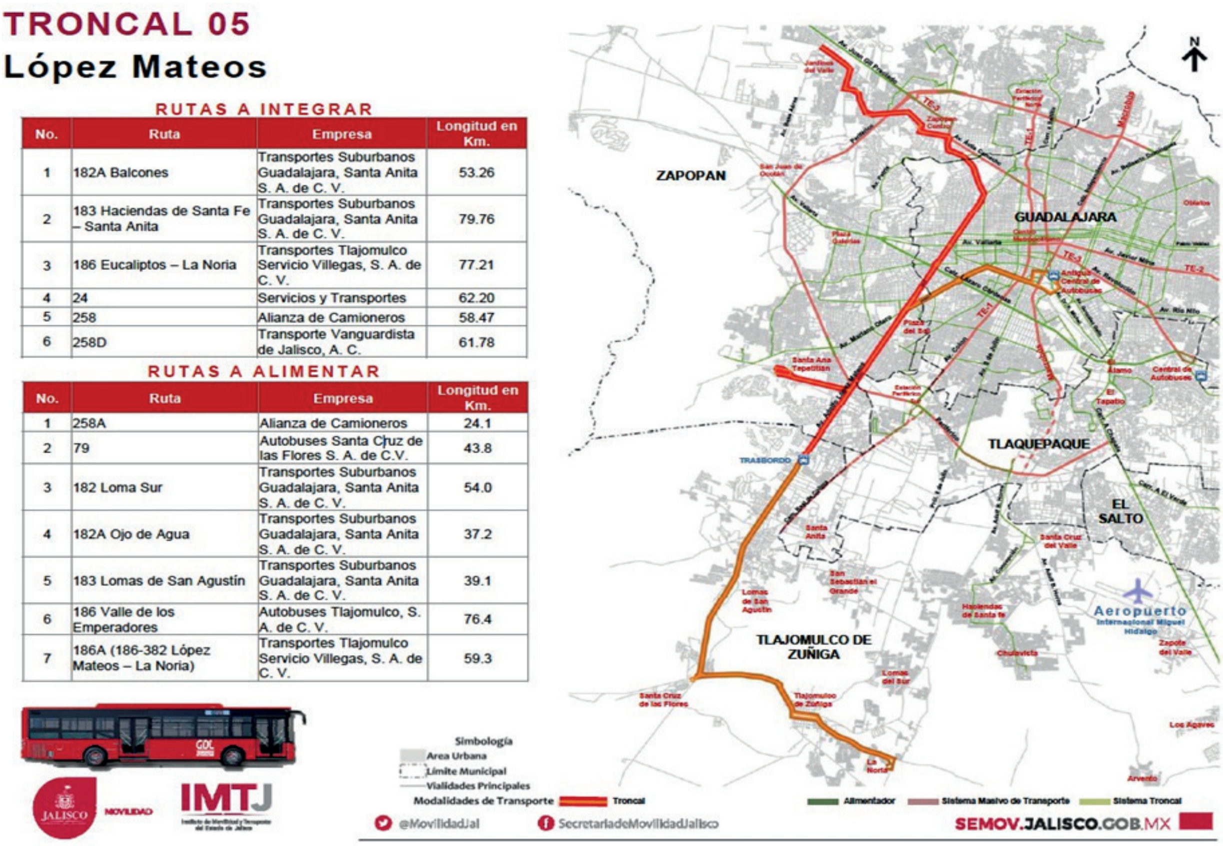

Figure 1. Integrating and complementary routes of Trunk Route 05. López Mateos

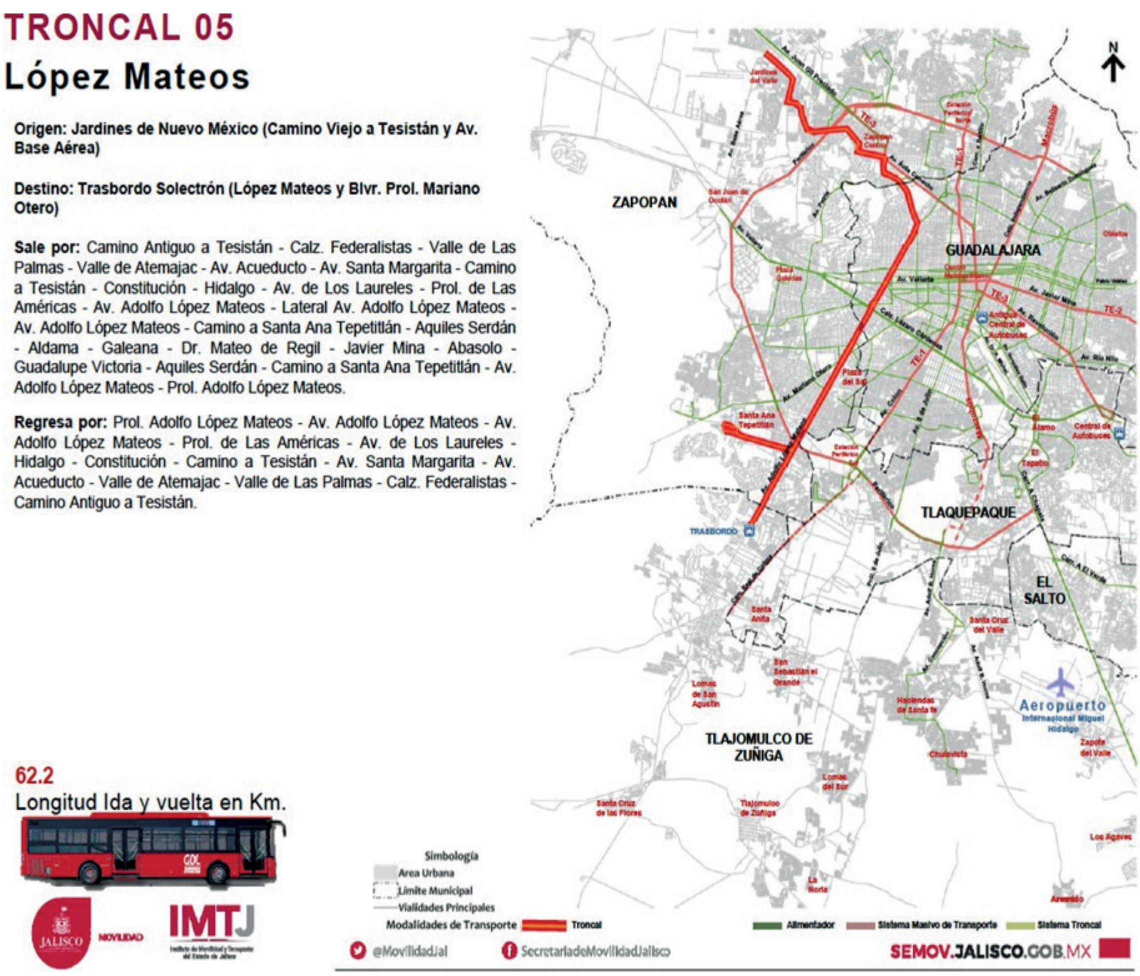

Figure 2. Origin, destination, and route of Trunk Route 05. López Mateos

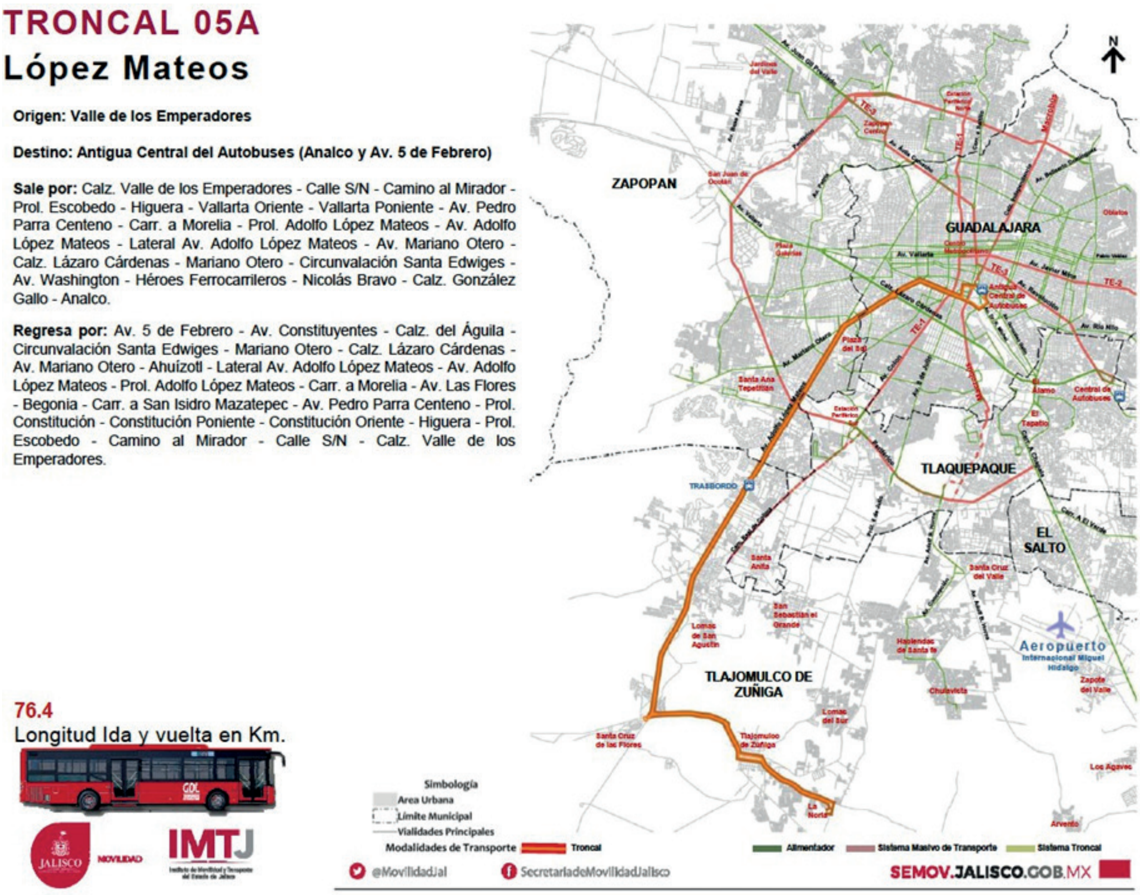

Figure 3. Origin, destination, and route of Trunk Line 05A. López Mateos

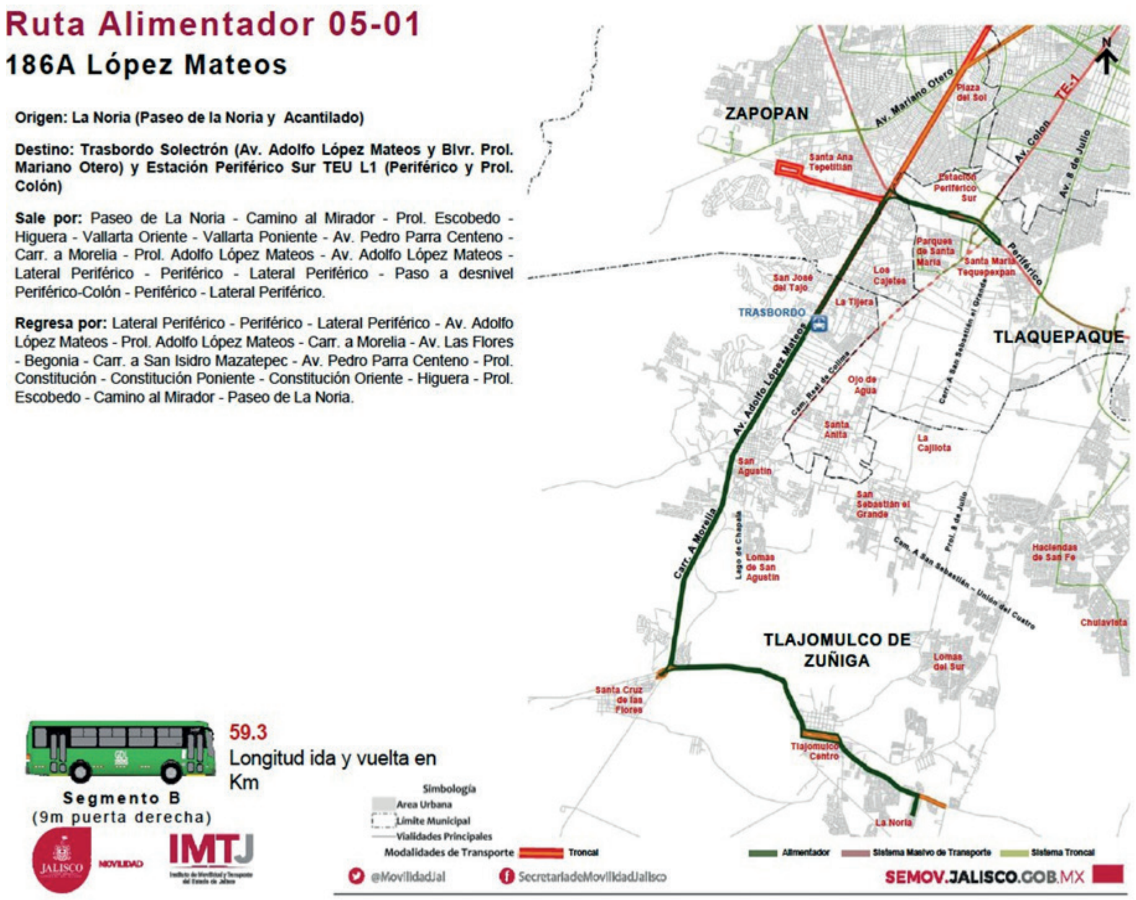

Figure 4. Origin, destination, and route of Feeder Route 05-01. 186A López Mateos, from Trunk Route 05. López Mateos

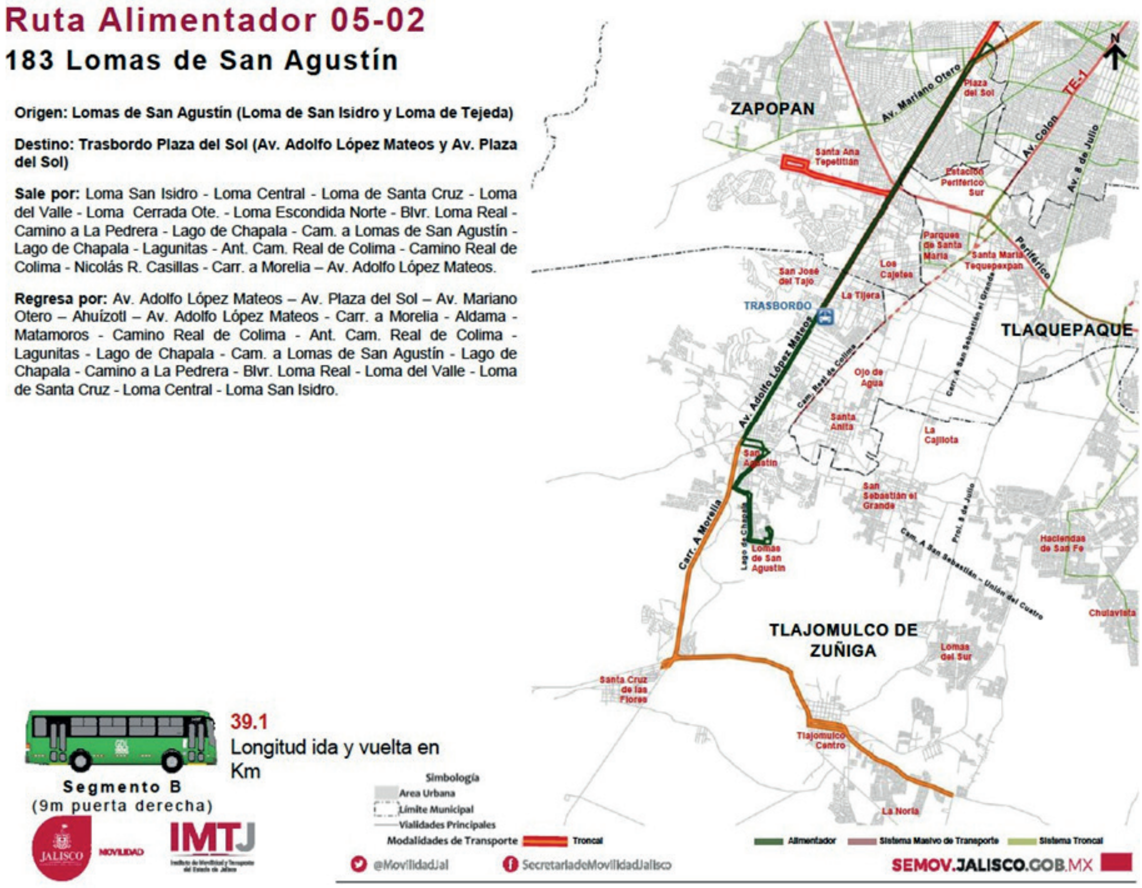

Figure 5. Origin, destination, and route of Feeder Route 05-02. 183 Lomas de San Agustín, from Trunk Route 05. López Mateos

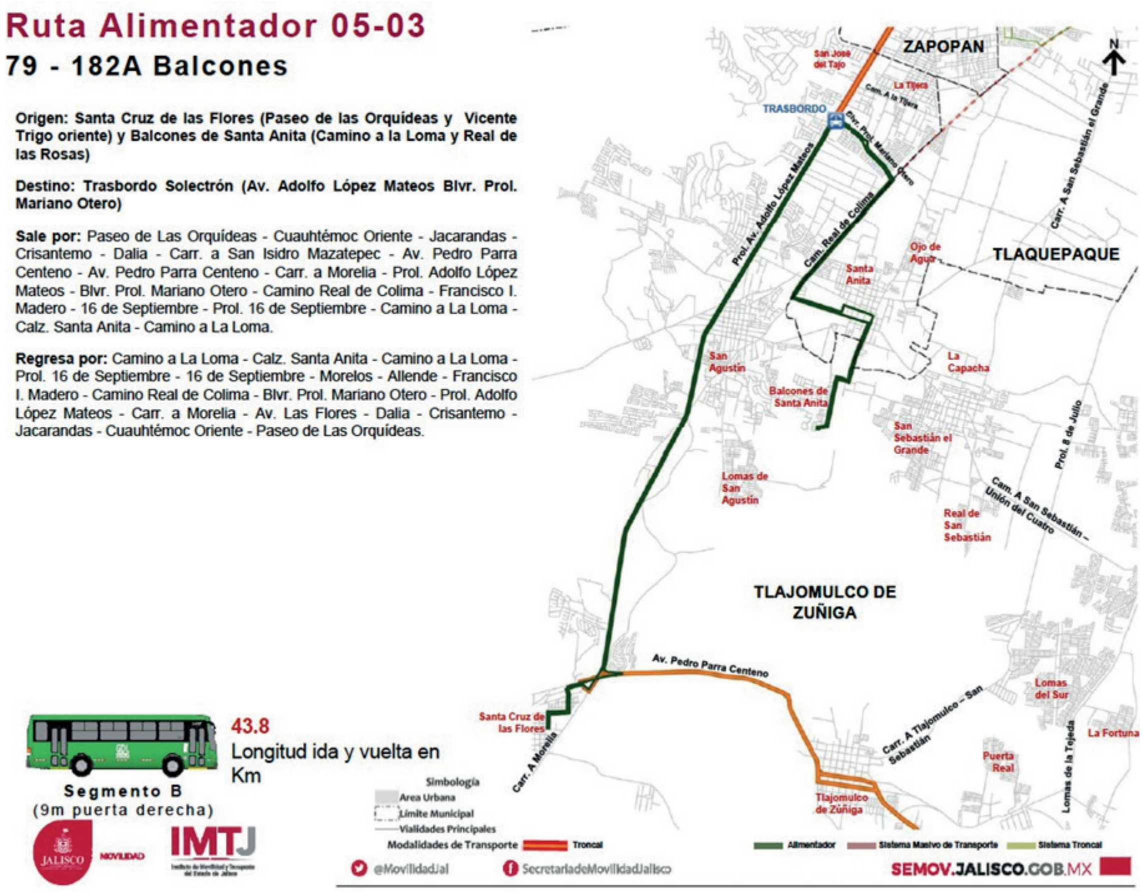

Figure 6. Origin, destination, and route of feeder route 05-03. 79 – 182A Balcones, from Troncal 05. López Mateos

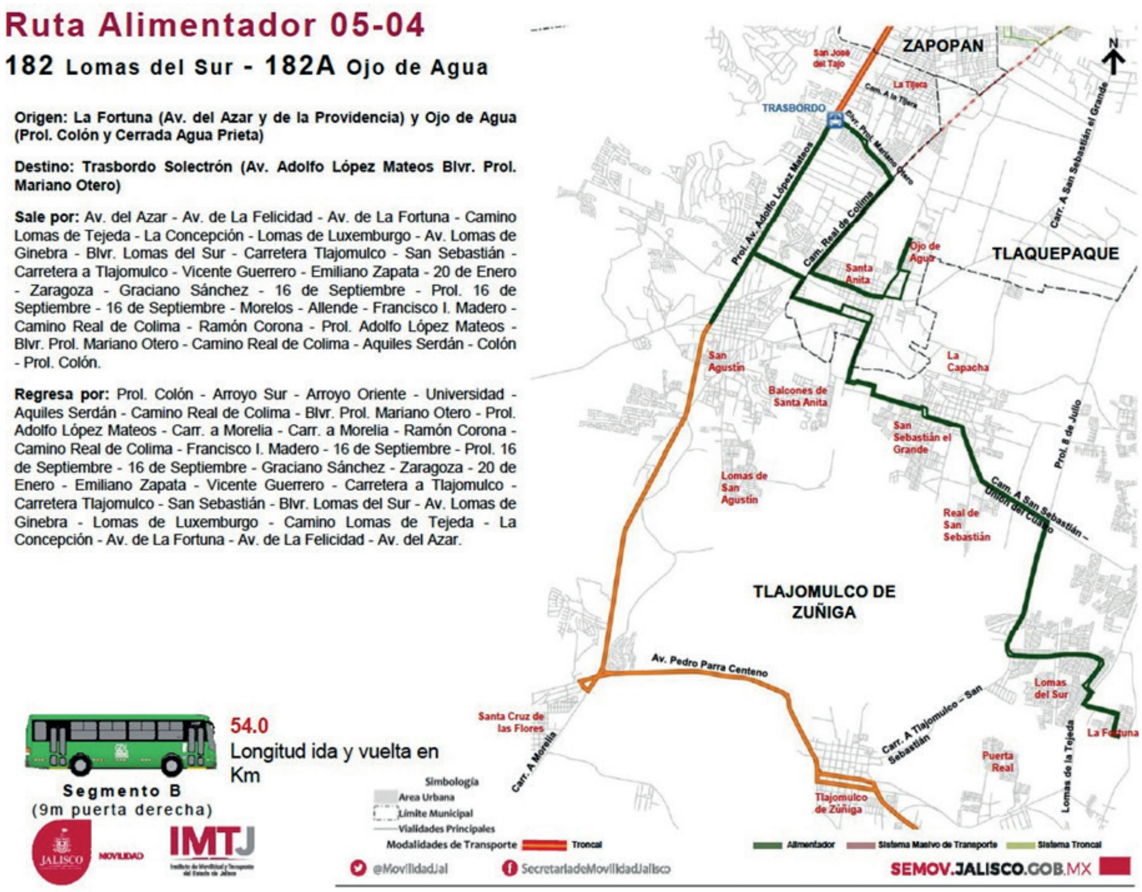

Figure 7. Origin, destination, and route of feeder route 05-04. 182 Lomas del Sur – 182A Ojo de Agua, from Troncal 05. López Mateos

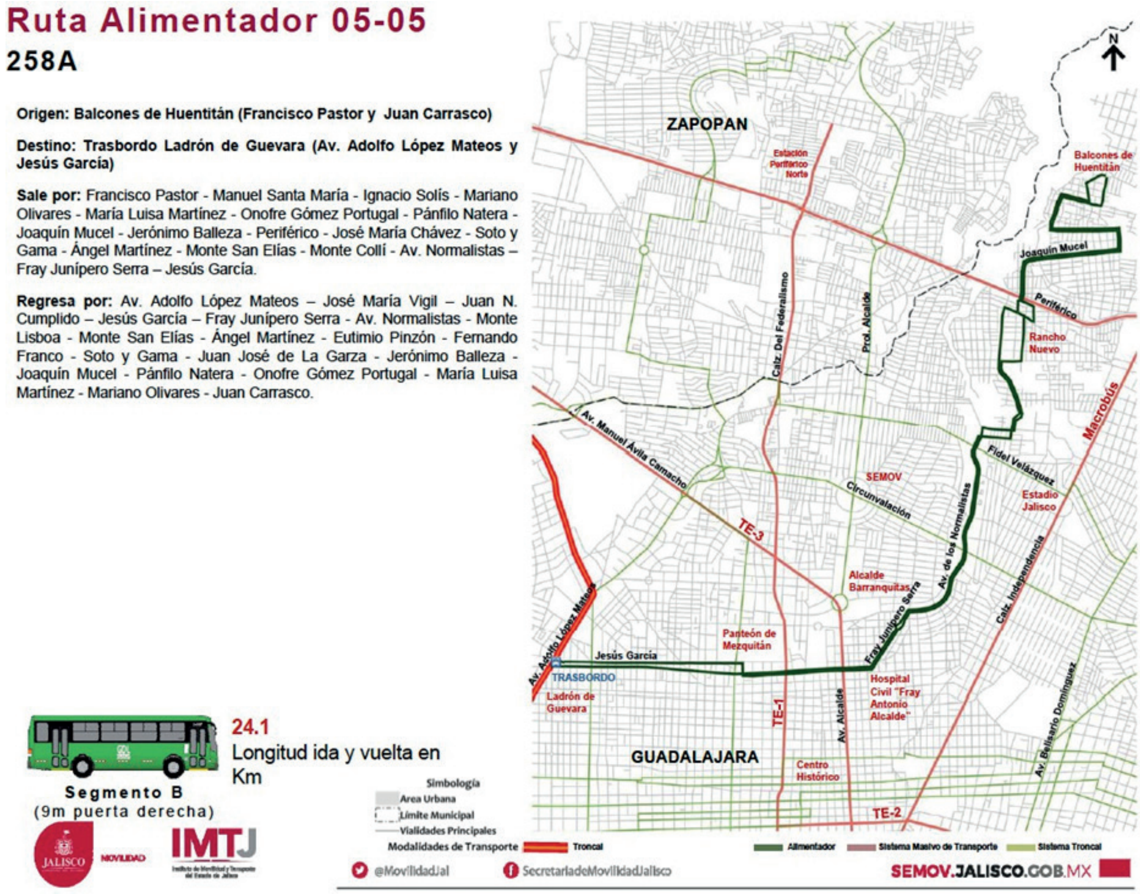

Figure 8. Origin, destination, and route of feeder route 05-05. 258A, from Troncal 05. López Mateos

Figure 9. High demand for transportation on complementary routes

In the case of Guadalajara, the first Origin-Destination Study (ODS) of the 21st century was conducted in 2002 by the company USTRAN, titled “Origin and Destination Study of the Guadalajara Metropolitan Area.” Five years later, in 2007, the second ODS was carried out by AU Consultores, which the Jalisco state government had contracted. The expectation was to have created a monitoring and updating system to carry out this study every five years. However, this was not the case, as in 2012, due to the election period, the rhythm was disrupted. In 2014, the Jalisco State Institute of Mobility and Transportation (IMTJ), now defunct, conducted a study to update the results of the 2007 EOD. In 2019, the Guadalajara Metropolitan Area Development Planning and Management Institute (IMEPLAN) initiated work on the Comprehensive Sustainable Urban Mobility Plan (PIMUS), aiming to update travel patterns in the city. In 2021, the latest study was conducted under the name of the Emerging Metropolitan Mobility Strategy (EMME) for the Guadalajara Metropolitan Area (AMG).[38,39,40,41,42,43,44,45]

Although the EODs in the AMG have not been as consistent as desired, urban mobility projects within the AMG have been, as justified by data collected in previous studies. Among the most notable projects are: Line 1 of the PRETREN (currently SiTren), which began operations in 2007; Macrobús, inaugurated in 2009 (now Mi Macro Calzada); Line 3 MiTren (formerly Tren Ligero, now Tren Eléctrico Urbano de Guadalajara), with the project launched in 2014 and inaugurated in 2020; MiBici in 2014; Line 2 SiTren inaugurated in 2015; Line 3 of the SiTren in 2016 with trolleybus-type units towards the east of the city; in 2018, the Andador Alcalde; Line 1-b in 2018, reaching the University Center for Biological and Agricultural Sciences (CUCBA); Mi Macro Periférico began construction in 2019 and was inaugurated last January, including side bike lanes; Route C98 of Mi Transporte Eléctrico in 2021; Bus-Bici 2022; the bike lane on Avenida Javier Mina.[46,47,48,49,50,51,52,53,54]

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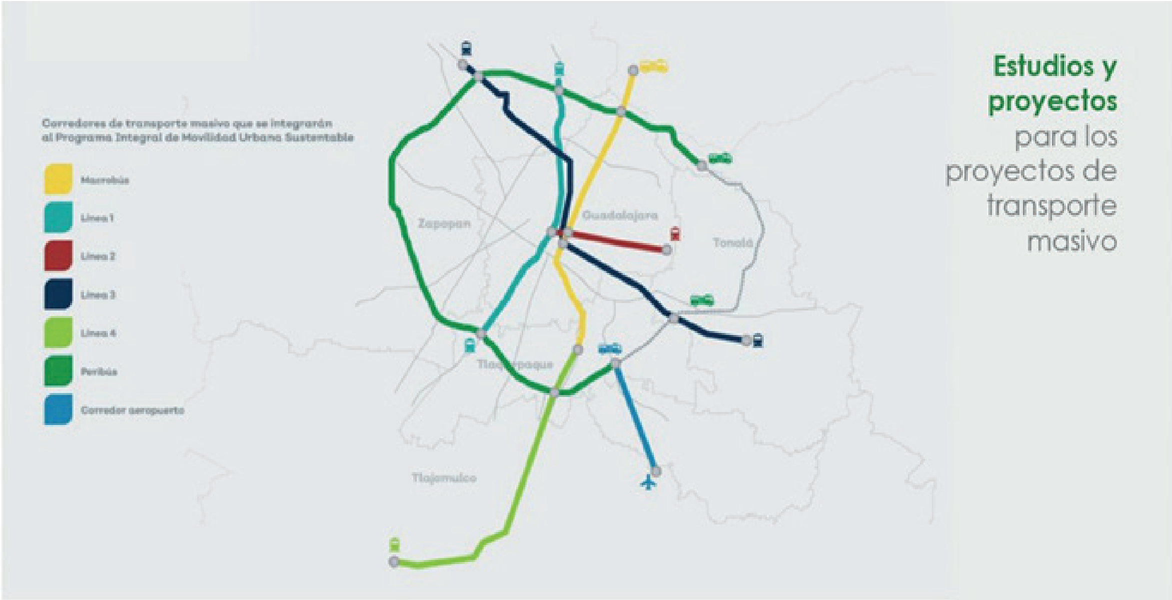

Figure 10. Metropolitan Mobility and Transportation Planning

The importance of this research lies in six fundamental aspects. First, it has a significant impact on the Sustainable Development Goals established by the United Nations Development Program (UNDP, 2016), addressing issues such as poverty reduction, hunger, health, education, innovation, infrastructure, reduction of inequalities, sustainable cities, responsible consumption, and climate action.[55,56,57,58,59,60,61]

Second, it proposes a methodological-instrumental approach, specifically a valuable model for characterizing fair and sustainable technical fares for public transportation. This is achieved through a detailed study of the Integrated Transportation Model “Mi Transporte” under the route-company scheme in the Guadalajara metropolitan area, focusing on Troncal 05. López Mateos. It also seeks to identify whether elasticity affects demand for the service. A fair and sustainable technical fare can reduce gaps and inequalities between the productive and social sectors, since the right to social integration through mobility is a principle of accessibility that an inadequate fare should not obstruct.[61,62,63,64,65,66]

Thirdly, the study contributes to the Lines of Knowledge Generation and Application (LGAC) of this postgraduate program, specifically in the areas of transport planning, management, and public policies, including urban mobility public policies, urban mobility and land use planning, and transport economics, operation, and management. Therefore, the research work has significant relevance in the generation and application of knowledge in the field of public transport and urban mobility.[67,68,69,70,71,72]

Fourth, this study offers a crucial opportunity to assess the environmental impact of public transportation in the Guadalajara metropolitan area. The implementation of a fair and sustainable technical fare model not only influences social equity but can also have significant effects on reducing pollutant emissions. By establishing fares that encourage the use of public transportation over individual means of transportation, it would be possible to reduce the carbon footprint and alleviate traffic congestion, thereby promoting a healthier and more sustainable urban environment from an environmental perspective.[73,74,75,76]

Fifth, the research contributes to the development of performance and evaluation indicators in the public transport sector. The methodological proposal for determining a fair technical fare could serve as a basis for creating metrics that measure the efficiency, quality, and accessibility of the public transportation system on Troncal 05 in Guadalajara. These indicators are crucial for assessing service performance, pinpointing areas for improvement, and making informed decisions to enhance urban mobility in terms of effectiveness, efficiency, and quality.[77,78,79,80,81]

Sixth, the study contributes to academic and professional training in the field of urban mobility and transportation. By presenting a specific methodology for characterizing the fair and sustainable technical fare, this work becomes a valuable resource for students, academics, urban planners, and transportation professionals. It provides a theoretical and practical framework for understanding the complexities of fare design in public transportation, fostering the development of analytical and strategic skills necessary to address contemporary challenges in urban mobility management.[82,83,84,85,86,87]

Figure 11. Complementary route with high demand

DEVELOPMENT

Social justice theory

According to John Rawls, social justice theory outlines fundamental principles for structuring an equitable society. It focuses on the regulation of freedoms, obligations, and income distribution, addressing the direct distribution of taxes, transfers, income from productive resources, and personal property.

Rawls questions utilitarianism, which links goodness with the maximization of good, and proposes two principles for a just society:[88,89]

- Principle of fundamental freedoms: Every person is entitled to a comprehensive system of compatible liberties for all.
- Difference principle: Economic inequalities must benefit the least advantaged and be linked to positions accessible to all on equal opportunity terms.

However, he prioritizes the first over the second: fundamental liberties cannot be sacrificed for economic gain. Equal opportunity prevails over income; economic inequalities are allowed only if they benefit the least advantaged.[90,91,92,93]

This theory can be applied to public transport: it is argued that fares should be fair and take into account the situation of the less privileged. This could involve progressive fares, citizen participation in their definition, and transparency in their application, ensuring their compatibility with Rawls' principles of social justice.

In addition to John Rawls[2], other authors have also addressed the theory of social justice and its application to public transport. Some of the most prominent authors in this field are: Amartya Sen[3], Martha Nussbaum[4], and Robert Nozick.[5]

Indian economist and philosopher Amartya Sen[3] has developed a theory of social justice based on human capabilities. According to his approach, social justice is achieved when people can function fully and participate in society. In the context of public transport, Sen argues that it is essential to ensure that all people can access transport services and participate in the social and economic life of the community. However, this argument has no implications for calculating the technical fare.[94,95,96]

Martha Nussbaum[4] is a philosopher and human development theorist who has proposed the theory of human capabilities as the basis for social justice. Her approach focuses on the capabilities that people need to have to lead a whole and dignified life. In the context of public transport, Nussbaum argues that it is necessary to ensure that all people can access the transport services required for their well-being and development.

Robert Nozick[5], in contrast to Rawls[2] and other social justice theorists such as Sen[3] and Nussbaum[4], holds a libertarian position that questions state intervention in the redistribution of resources. According to Nozick's theory of justice, justice is achieved through the initial just defense of resources and the protection of property rights, without state intervention to redistribute wealth. In this approach, public transportation can be considered a form of state intervention in the economy, as it often involves government subsidies or regulation for its operation.

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

From Nozick's perspective, the application of social justice theory to public transportation raises questions. Nozick would argue that state intervention in setting fares or providing public transportation services could be unjust, as it would involve the forced redistribution of resources from some individuals to others, which would be incompatible with his conception of justice based on private property and non-interference by the state.[97,98,99,100,101]

However, it is worth noting that Nozick's position[5] has been the subject of criticism and debate in the academic literature. Other social justice theorists argue that Nozick's conception of justice is insufficient to address socioeconomic inequalities and the needs of the less privileged in society. Therefore, the application of Nozick's theory of justice to public transportation may generate debate and controversy regarding its compatibility with the principles of social justice in this context.

In summary, Nozick[5] approached social justice theory from a libertarian perspective, questioning state intervention in the redistribution of resources, which may have implications for how this theory is applied to public transportation, particularly in terms of government subsidies. However, his approach has been subject to criticism and debate in academic literature.

The theory of expensive tastes

The theory of expensive tastes, proposed by Thorstein Veblen[6], offers an interesting conceptual framework for analyzing issues related to public transportation fares from an economic perspective. This theory, which is based on the idea that people's socioeconomic status influences individual preferences, may have implications for how fares are set and how they are adapted to different segments of the population.

From the perspective of the theory of expensive tastes, it could be argued that public transport fares may be perceived differently by different groups of people depending on their socioeconomic status. For example, for people with higher incomes, fares could be considered "cheap tastes," that is, a relatively low cost compared to their ability to pay. However, for people with lower incomes, fares could be perceived as "expensive tastes," i.e., a significant cost relative to their available economic resources.

This perspective could have implications for how public transportation fares are set. For example, it could be argued that fares should be set to be more affordable for those facing greater economic challenges, such as low-income groups. This could involve implementing progressive fares or applying subsidies or discounts for those with lower incomes, to make them more accessible and equitable for all segments of the population.[102,103,104,105,106]

In addition, the theory of expensive tastes could also have implications for how the issue of public transportation fares is addressed in terms of social justice. Considering that people's preferences and perceptions of fares are influenced by their socioeconomic status, it could be argued that it is necessary to take into account existing inequalities and seek public policies that mitigate disparities in access to and affordability of public transport. This could include the implementation of redistributive policies that benefit those who face greater economic difficulties in paying fares.[107,108,109,110]

Figure 12. Electric units. My electric transport

In this sense, Thorstein Veblen[6] theory of expensive tastes can be applied to the analysis of issues related to public transport fares, highlighting the importance of considering the preferences and perceptions of different groups of people based on their socioeconomic position. This may have implications for how fares are set and how social justice is addressed in the context of public transport.

Furthermore, Veblen[6], in his theory of conspicuous consumption, as outlined in his work "The Theory of the Leisure Class," argues that people use conspicuous consumption to demonstrate their social status and their membership in a particular social class. According to Veblen, people consume expensive goods and services not so much for their intrinsic utility, but as a way of signaling their social position and standing out in society. Veblen argues that this consumer behavior is especially prevalent among the wealthy and idle classes, who seek to display their status and distinction through conspicuous goods and services, such as mansions, luxury cars, or extravagant jewelry.

This theory posits that consumption is not solely based on utility or necessity, but is also a socially motivated behavior. Veblen argues that people acquire expensive goods and services as a means of imitating or competing with the consumption behaviors of the upper classes, thereby seeking recognition and acceptance in certain social circles. Veblen's theory of conspicuous consumption, not expensive tastes, has influenced the fields of economics and sociology and has been studied and analyzed in the context of consumer preference formation, social inequality, and class dynamics in modern society.[111,112,113]

On the other hand, Thorstein Veblen's theory of expensive tastes, proposed in his work "The Theory of the Leisure Class" in 1899, can be applied to public transportation in such a way that people use their choice of transportation to demonstrate their social status and membership in a particular class. According to Veblen[6], some people may choose to use expensive or exclusive means of transportation, such as luxury cars or private transportation services, not only because of their need or convenience, but as a way to show their status and distinction in society.

This theory suggests that people may use their choice of public transportation as a way to express their social position or stand out in their social environment. For example, some individuals may prefer to use exclusive public transportation services, such as luxury taxis or high-end ride-sharing services, as a means to showcase their social status or demonstrate their membership in the upper class. On the other hand, some people may choose to use more affordable or public means of transportation, such as buses or trains, as a way to demonstrate their commitment to sustainability or their affiliation with the middle or lower classes. Veblen's theory of conspicuous consumption, not expensive tastes, can help us understand how public transportation choices can be influenced by social and cultural motivations.

Economic laws of transportation, demand elasticities

Economist Duque[7] assumes that, in addition to government regulation, the transportation industry is subject to specific economic laws.

- The law of increasing returns states that expenses do not increase in the same proportion as income when the volume of business does.
- The law of diminishing returns states that after a certain threshold, adding a new factor decreases productivity.
- Once a transportation system is established with fixed capital, an expansion in the volume of shipments causes an increase in operating expenses or variable expenses. Still, it has a limited effect on fixed or constant expenses, which is reflected in a decreasing total average cost per unit. However, there will be a ceiling for expansion.
- Joint costs are those incurred by a company when it obtains more than one product simultaneously or when it acquires raw materials of different qualities through the same purchase transaction.
- The savings obtained by the company in joint production processes are called "economies of scope." It is essential to strengthen the coordination between small and medium-sized entrepreneurs to make their access to input and consumer markets economically viable.
- Common costs occur in production scenarios where individual products use common resources or where particular services are provided to two or more users.[8]

In this sense, this thesis addresses the concept of demand elasticities, given that, in the event of a possible increase in fares and impacts on different groups of households based on income and spending on public transportation, elasticity, according to Marshall[9], serves to quantify the positive or negative variation experienced by one variable when another changes.

In the specific context of the public transport market in the Guadalajara Metropolitan Area (AMG), the price elasticity of demand reflects the sensitivity of the quantity demanded of the service (i.e., trips per user) to changes in the fare price. It is defined as elastic when the percentage change in the quantity demanded is greater than the percentage change in price; this implies that users are susceptible to fare changes. In

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

contrast, it is considered inelastic if the quantity demanded experiences a relatively minor percentage change in response to changes in price, indicating low sensitivity to fare variations. To illustrate the concept of demand elasticity in the context of public transportation, consider the following hypothetical example:

Suppose that in the Guadalajara Metropolitan Area (AMG), the current price of a public transport trip is MXN 10,00. At that price, data shows that approximately 100,000 visits per user are made per day. The transport authority decides to increase the fare by 10 %, bringing the cost of the journey to MXN 11,00.

Case of elastic demand

After the fare increase, the number of trips decreases by 15 %, to 85 000 visits per user per day. The quantity demanded has changed by a greater proportion (15 %) than the price change (10 %). This indicates elastic demand; users are sensitive to the price increase, and some have stopped using the service or use it less frequently.

Calculation of elasticity in this case

$$Elasticidad = \frac{\% \ /0\ '123,4\ 05\ 61\ '15\#./1/\ /0215/1/1}{\% \ /0\ '123,4\ 05\ 06\ +70',4} = \frac{89:\%}{9:\%} = 1.5$$

The absolute value of elasticity is greater than 1, confirming that demand is elastic.

Case of inelastic demand

In an alternative scenario, the 10 % fare increase results in a 5 % decrease in the number of trips, to 95 000 visits per user per day. Here, the quantity demanded varies by a smaller proportion (5 %) than the price change (10 %). This indicates inelastic demand; price changes have a relatively small impact on the quantity demanded, suggesting that users do not have many alternatives to public transportation and continue to use it despite the fare increase.

Calculation of elasticity in this case

$$Elasticidad = \frac{\%\ de\ cambio\ en\ la\ cantidad\ demandada}{\%\ de\ cambio\ en\ el\ precio} = \frac{-5\%}{10\%} = -0.5 \quad (2.2)$$

The absolute value of elasticity is less than 1, confirming that demand is inelastic

Based on the above, the price effect generated by a decrease in the fare causes a drop in the carrier's total revenue. However, there is also a quantity effect; that is, an increase in the fare causes a decrease in the quantity demanded. This means that revenue comes from fewer tickets sold. Therefore, the quantity effect generated by an increase in the fare causes a decrease in total revenue.

In this context, the effect of the elasticity of public transport demand on the AMG fare suggests that if the fare increases and the carrier's total revenue decreases, the elasticity of demand is elastic. Conversely, if the fare decreases and the carrier's total revenue increases, the elasticity of demand is also stretchy. Likewise, if the fare increases and the carrier's total revenue increases, the elasticity of demand is inelastic. In this vein, if the fare decreases and the carrier's total revenue decreases, the elasticity of demand is inelastic. However, why does demand vary, even when the fare aligns with economic levels? The answer is that several factors determine whether the demand for transportation is elastic or inelastic within a specific price range. For example, services that represent a significant portion of users' budgets tend to have elastic demand because any change in the fare has a greater impact on users' overall spending. On the other hand, those that constitute a small part of their budget tend to have inelastic demand, since the impact of a change in the price of this service has a lesser effect on their overall spending.

It is important to note that services with a wide range of substitutes tend to have elastic demand. This is because, when faced with a price increase, users can easily opt for alternatives such as walking, using taxis, Uber, and light rail, among others. Conversely, services with limited substitution options tend to show inelastic demand; consumers, faced with a shortage of alternatives, maintain their level of use despite price increases. Additional factors, such as service quality, comfort, the integration of advanced technology, and motorization rates, directly affect the elasticity of demand. It is important to note that elasticity varies over time. Users, referred to as customers in the new transportation model, need time to adjust to fare changes, which means that demand response intensifies in the long term, becoming more elastic than in the short term.

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

The concept of elasticity of demand is intrinsically linked to that of opportunity cost in the economic analysis of public transport. When transport services are subject to elastic demand due to the presence of numerous substitute goods, the opportunity cost of choosing an alternative service in the event of a fare increase is relatively low. This is because users can switch to the substitute mode of transport with minimal economic impact, reflecting high price sensitivity to the original service. In contrast, in the case of inelastic demand, where there are few substitutes, the opportunity cost of not using the service increases, since the alternatives are not convenient or readily available. This cost may not only be economic but also in terms of time, comfort, and efficiency. Therefore, users may be willing to absorb the fare increase rather than incur a higher opportunity cost by choosing a less favorable alternative. Similarly, the time elasticity of demand highlights that the opportunity cost may vary over time; in the short term, users have less ability to adapt to tariff changes, while in the long term, the ability to adjust increases, allowing for a more elastic response to tariff changes and, therefore, an adjustment in the opportunity cost associated with choosing different modes of transport.

Figure 13. Interior of electric vehicles

Technical fare vs. social fare

Technical fare

The fare is the price that a transportation company sets for its services. The concept of fare does not apply to self-employed transportation. Like all prices, the fare is measured in monetary units per unit of transport provided, and can be $/ton-kilometer, or $/ton, or

$/passenger-kilometer, or $/passenger. Tariffs can be public, i.e., established by the transport company and applicable to any service request, regardless of the requester's identity. Alternatively, they can be private or agreed upon, only valid between the carrier and the shipper, and established through bilateral negotiation. Transport companies that provide services under public tariffs are referred to as public transporters. In contrast, those that do so under agreed-upon tariffs or freight rates are typically referred to as contract carriers.

The concept of "technical fare" in the context of public transport was first proposed by William Vickrey, an American economist who received the Nobel Prize in Economics in 1996. Vickrey is known for his contributions to the field of transportation economics, including second-degree pricing theory and the implementation of pricing schemes for congested roads. His concept of technical fare has been widely studied in the field of public transportation.

Technical fare refers to the fare that should be charged to public transport users to cover the operating and maintenance costs of the service, without generating profits for the transport company. Vickrey[10] argued that setting an appropriate technical fare was essential to ensure the efficient and sustainable operation of public transportation, as it would cover the real costs of the service without relying on subsidies or external financing.

Vickrey[10] proposal to establish technical fares for public transport has been the subject of debate and analysis in academic literature and urban transport planning and management practice. It has been argued that the application of technical fares can help achieve greater equity in the distribution of public transport costs

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among users and ensure sustainable financing of the service. However, concerns have also been raised about the feasibility and social acceptability of technical fares, as well as issues with implementing and calculating the actual costs of public transport.

In short, William Vickrey's approach seeks to establish a fare that covers the operating and maintenance costs of the service without generating profits for the transport company. Vickrey's proposal has been extensively analyzed and debated in the academic literature, as well as in the practice of public transportation planning and management. It has been argued that it can contribute to greater equity in the distribution of public transportation costs and to sustainable service financing.

The technical fare is based on costs and demand and constitutes an extreme criterion among those that can be used. However, both ingredients are taken into consideration in the AMG. The cost-based technical fare consists of determining the average cost per unit of traffic for a given service. Several economic principles or criteria can be used to set prices over which the public sector has some degree of control; one of these is economic efficiency.

However, it should be noted that, in certain circumstances, companies may opt to set their tariffs based on marginal costs rather than average costs. When market situations arise that are far from perfect competition, companies tend to prefer setting rates based on marginal cost rather than average cost. When there is idle transport capacity on specific routes and at certain times, rates are reduced to values below average costs. In contrast, when peaks in demand put pressure on transport capacity, rates exceed average costs. A typical case of marginal pricing occurs on return trips, when the most significant demand pressure occurs in only one direction of travel, being much lower than traffic requirements in the opposite direction. In this case, carriers usually cover their fixed costs on the outward journey and only charge enough to cover their marginal costs on the return journey. This situation often leads to conflicts between modes of transport and between companies, prompting government intervention in fare regulation.

Figure 14. Complementary route units on Trunk Road 05. López Mateos

The ideas presented by Muñoz et al.[11] propose urban road pricing as an effective instrument within the framework of public transport policies for enhancing sustainability in large cities and their surrounding areas. One of the main problems for its implementation is low social acceptance. In their research, the authors employed a population survey to analyze the social acceptability of implementing an urban fare in the city of Madrid, aiming to identify the effectiveness of this measure on mobility patterns and the advantages and disadvantages reported by citizens as indicators of the degree of social acceptance. The results of this study revealed several significant implications for public transport policy, serving as a basis for strategic decision-making and ensuring an adequate level of social acceptability of fares.

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For their part, Muñoz et al.[11] state in their conclusions that social acceptance of the hypothetical fare system proposed for the city of Madrid was supported a priori as a result of two determining factors: first, the high social perception of congestion as a priority problem to be solved through the implementation of effective measures; and second, the adequate level of availability of the transport system in general as a competitive alternative to cars when paying the fare, i.e., the fare has high social acceptance because citizens are aware that the greater the use of public transport, the lower the pollution from private car use.

Social fare

In his 1999 work, the award-winning Indian thinker Amartya Sen conceived a doctrine of social justice focused on human potential and talents. From his perspective, social equity is achieved when individuals have the opportunity to reach their full potential and actively participate in their community. Applied to the field of public transport, Sen argues that it is crucial to ensure that all citizens have effective access to transportation, which is essential for their participation in the social and economic dynamics of their environment.

Vickrey[12] introduced the concept of "Transit Fare Equity" to create a fare system that is fair and equitable for all public transport users. In his approach, Vickrey[12] argued that public transport fares should be based on users' ability to pay and their access to alternative means of transport. He proposed that individuals with lower incomes or those who do not have access to private vehicles should pay lower fares or receive subsidies to ensure equitable access to public transportation. In addition, Vickrey[13] advocated for the implementation of a progressive fare system that takes into account distance traveled, travel time, and users' ability to pay.

Vickrey[13] contributions are relevant to understanding his approach to equity in public transport fares and his proposal to implement a progressive fare system based on users' ability to pay.

According to Vickrey[14], the price of public transportation should be based on users' ability to pay, rather than simply covering operating costs. In this way, public transit can be more accessible to low-income individuals, helping to reduce the mobility gap and improve social equity.

Additionally, the use of public transportation can also help reduce traffic congestion and air pollution in cities.

Vickrey advocates for a pricing system that reflects users' ability to pay, offering discounts to those with low incomes or living in disadvantaged areas. He also suggested implementing peak-time fares to discourage the use of public transport during times of high demand and encourage use during off-peak hours.

The concept of Transit Fare Equity has been adopted in many public transportation systems worldwide. It has been a key contributor to ensuring the accessibility of public transportation for all citizens, particularly those with low incomes or residing in disadvantaged areas. In addition, this idea has also contributed to the fight against climate change and the reduction of traffic congestion in cities.

According to De Rus et al.[15], a social fare guarantees access to public transport for people with low socioeconomic status. However, in several cities across the country, this fare lags due to factors that extend beyond social aspects alone. Thus, it was possible to identify a wide variety of reduced fares, such as:

a) Work fare: this is a fare designed for those who use public transport regularly. It is lower than the base fare. The primary reasons for its use are to support captive and regular users, promote uniform usage, and stabilize demand.

b) Peak hour fares: many systems use a higher fare during peak hours to distribute demand evenly over a more extended period of the day. These users dictate the capacity that must be offered, the size of the vehicle fleet, and labor costs. In short, a higher price per trip is justified for this segment of the population.

c) Student and child fares: it is common practice to charge children and students less for social and equity reasons. Both groups have no income or low incomes and typically lack other means of transportation. It is essential to note that the carrier benefits in the long term as it develops a habit of using public transportation. For this reason, many systems allow free travel for children of a certain age (5 years old, for example) and a reduced fare for schoolchildren, which can be as much as 50 % of the base fare.

d) Fares for senior citizens:fare reductions are often given to people over 65, usually during off-peak hours, due to the social implications involved.

e) Fares for shoppers: some transportation systems that require a strong marketing effort to attract users from other modes of transportation (cars) offer reduced fares to users who are going shopping, for example, to the city center or the central market after the morning rush hour or on Saturdays.

f) Night or "tecolote" fares: these are charged for trips made at night, after 11 p.m., for example. In public transportation, these should be higher than daytime fares, as they must reflect the high costs per passenger involved in providing this service due to low demand.

g) Special fares. there is a wide range of fare types, including family fares, convention fares, weekend fares, and special event fares.

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

According to Jaramillo et al.[16], defining a socially fair fare for public transportation services is an important issue that concerns the authorities regulating mobility in cities.

This study analyzes the relationship between vehicle travel speed and the fare required to achieve a balance between income and expenses. The research method employed involves analyzing several operating scenarios. For the analysis of each scenario, ITP (Itineraries for Public Transport Routes) software is used as a computer tool, which generates information that allows the fare to be calculated using the methodology defined by the National Transit Authority.

The procedures used to conduct the research can be replicated, ultimately concluding that higher travel speeds reduce route operating costs, which translates into lower fares.[16]

According to Jaramillo et al.[16], a relationship exists between the speed of urban transport buses and the fare required to maintain a balance between the system's costs and revenues. The higher the speed, the lower the fare to be paid by the user.

Likewise, Jaramillo et al.[16] conclude in their study that for the scenarios considered in this study, it can be seen that when the travel speed is reduced from 24 to 14 km/h, the operating and maintenance costs of the route increase, resulting in a fare increase of up to 23,99 %.

Defining different dispatch intervals according to existing demand during peak and off-peak hours allows for the optimization of route operating and maintenance costs, as it reduces the number of kilometers traveled by each vehicle. In the case of this study, this reduction is 18,58 %. References are needed to support these improvements.

Therefore, reducing the number of kilometers traveled by each vehicle without affecting service levels related to vehicle passenger capacity generates a fare reduction ranging from 6,9 % to 8,18 % for the different analysis scenarios. References are needed to support these improvements.

The procedures applied in this study contribute to the search for a socially fair public transport fare, which can be replicated to define fares on routes in any city worldwide.

Figure 15. Public transport users during the pandemic

Transportation economics

Transportation economics is an interdisciplinary field that examines transportation systems from an economic perspective. Some of the most prominent authors in this field and their main works include John R. Meyer 17), author of "The Economics of Transportation Systems," which provides an overview of transportation systems from an economic perspective, analyzing the efficiency and financial challenges associated with these systems. Meyer[17] himself, in his work "Transportation Planning and Analysis," focuses on strategic planning and transportation policy analysis, addressing methods and approaches for effective transportation planning.

Likewise, Meyer[17] in his work "The Economics of Competition in the Transportation Industries" examines the dynamics of competition in transportation industries and their economic implications. Button[18] explores the fundamentals of transportation economics, addressing demand, supply, costs, and transportation-related policies. In addition, Button[18] analyzed the intersection between economics and transportation policy, exploring regulatory and public policy issues. Finally, Button[18] in his work "Transport Economics: Selected Readings," compiled a selection of relevant readings on transportation economics.

Furthermore, in his works "Urban Travel Demand: A Behavioral Analysis" and "The Measurement of Urban Travel Demand" addressed the analysis of human behavior in urban travel demand and methods for measuring such demand, respectively. In 1994, he explored econometric techniques for studying transportation systems.

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In 2001, Hensher[19] examined models and methodologies for travel choice analysis, with a particular focus on user preferences. Hensher[20] himself, in his work “Transport Economics,” offers a broad view of transport economics, addressing economic concepts applied to the transport sector. In 2011, Hensher provided an extensive compendium of current ideas, methods, and debates in transport economics, entitled “Handbook of Transport Economics.”

De Palma[21,22,23] in “The Economics of Urban Transport” and “Fundamentals of Transport Economics,” respectively, explored transport systems in urban environments and the fundamental principles that underpin them. De Palma[22] conducted a study titled “Demand Analysis for Transportation Planning,” which examined methods and techniques for analyzing transportation demand within the context of transportation planning.

These authors and their works have made significant contributions to the development of transportation economics as a field of study.

Transportation economics is a branch of economics that examines the production, distribution, and consumption of transportation goods and services. Transportation is a fundamental part of the global economy, as it is used in commerce, industry, and the movement of people. Transportation economics focuses on optimizing transportation systems to maximize efficiency and minimize costs.

One of the main topics of research in transportation economics is the analysis of transportation demand and supply. Transportation economists study how individuals and businesses choose which modes of transportation to use and how transportation operators respond to these decisions. Several factors, including income, fuel prices, geographic location, and technological advancements, influence transportation demand.

Another important topic in transportation economics is the analysis of transportation infrastructure and its effect on the economy. Investments in transportation infrastructure, including roads, railways, airports, and ports, can have a substantial impact on productivity and economic efficiency. Transportation economists also investigate how public policies, such as taxes and subsidies, can affect transportation demand and supply.

Transportation economics also concerns itself with the analysis of transportation costs. Costs can vary depending on the mode of transportation and the distance traveled. Transportation economists study how transportation costs influence the choice of transportation mode and how transportation operators can reduce costs to remain competitive in the market.

In summary, transportation economics is a vital field of study that addresses various issues related to the production, distribution, and consumption of transportation goods and services. Transportation economists focus on optimizing transportation systems to maximize efficiency and minimize costs, as well as how public policy influences transportation demand, supply, and infrastructure.

Public service theory

Public service theory is a legal construct that gained prominence during the 1930s, in a context of systematic state organization of services. Leon Duguit, a French jurist, is recognized as the pioneer of this theory, whose influence was significant in the internal politics of states, particularly in countries such as Colombia during the first half of the 20th century.

According to Navarro, in the classical conception, public service was structured around notions of solidarity and equity, with universal and constant provision. It was considered a pillar of the common good, regulated by legal principles and characterized by its monopolistic nature and low-cost pricing. However, the wave of privatization and emerging regulations has called these economic foundations into question, leading to a transformation of the public service paradigm.

In this sense, the concept of public service, deeply rooted in the foundations of modern public administration, finds its cornerstone in the theory of León Duguit. This theory, which redefines the nature and purpose of the state through its function of providing services to society, is particularly relevant in the field of public transportation.

León Duguit, with his progressive vision, argued that the state is a set of services owed to citizens. His theory of public service is based on the principle of social solidarity, where the state acts as a guarantor of general welfare, providing essential services equitably and efficiently. In this framework, public transportation services become a reflection of democratic values and social justice, which are fundamental to Duguit’s thinking.

Public transportation, as an essential public service, fulfills the principle of solidarity by facilitating mobility and access to opportunities for all sectors of the population. From Duguit’s perspective, the management of these services should be geared toward meeting collective needs rather than pursuing economic benefits. Thus, the focus is on the quality, accessibility, and sustainability of the service.

Urban growth and current environmental challenges require a reinterpretation of Duguit’s theory. Public transport services must adapt to the demands of sustainable urban mobility and the transport economy, incorporating clean technologies and innovative management models that prioritize sustainability and inclusion.

In short, León Duguit’s public service theory, when applied to public transport, provides a valuable framework for reflecting on the state’s responsibility for providing essential services. As cities evolve, adapting this theory

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

to the current context is crucial to ensuring that public transport services continue to serve the common good, promoting equity and efficiency in an increasingly urban and environmentally conscious world.

CONCLUSIONS

This study provided an understanding of the complexity involved in establishing a fair, technical, and sustainable fare system for public transportation in the Guadalajara Metropolitan Area (AMG). It showed that, despite a ruling issued by the now-defunct IMTJ in 2018, there is still no formal technical methodology to regulate and justify fares based on economic, social, and operational criteria. Through the analysis of international and national benchmarks, it was identified that the technical fare should cover operating costs without relying on excessive subsidies. In contrast, the social fare should guarantee equitable access to mobility for all sectors of the population, especially the most vulnerable.

The social justice approach, based on theories such as those of Rawls, Sen, and Veblen, made it possible to assess the need to integrate criteria of equity, accessibility, and progressivity into fare design. Likewise, the study of demand elasticity and its impact on transport operators' revenues showed that fare decisions must consider user behavior and their ability to adapt. Transportation economics and public service theory reinforce the idea that mobility should be conceived as a social right, not simply a commercial good.

In short, the implementation of a technically sound and socially just fare model would not only contribute to the operational efficiency of the system but also enhance its social justice. Still, it would also strengthen equity, environmental sustainability, and inclusive urban development.

BIBLIOGRAPHIC REFERENCES

1. Banco Mundial. Tarifas técnicas y financiamiento del transporte público urbano en países en desarrollo. Washington D.C.: Banco Mundial; 2010. https://openknowledge.worldbank.org/handle/10986/2412

2. Rawls J. Teoría de la Justicia. 4a reimp. México: Fondo de Cultura Económica; 1995.

3. Sen A. Development as Freedom. New York: Alfred A. Knopf; 1999.

4. Nussbaum M. Creating Capabilities. The Human Development Approach. Cambridge, MA: Harvard University Press; 2011.

5. Nozick R. Anarchy, State, and Utopia. New York: Basic Books; 1974.

6. Veblen T. La teoría de la clase ociosa: un estudio económico de las instituciones. New York: Macmillan; 1899.

7. Duque Escobar G. El transporte en la vida cotidiana. Introducción a la Economía del Transporte. Colombia: Universidad Nacional de Colombia sede Manizales; 2007.

8. Duque Escobar G. Leyes económicas del transporte. Introducción a la Economía del Transporte. Colombia: Universidad Nacional de Colombia sede Manizales; 2007.

9. Marshall A. Principios de Economía. México: El Consultor Bibliográfico; 1890. Principios de Economía. España: Aguilar; 1957.

10. Vickrey W. Tarificación en el transporte urbano y suburbano. Económica. 1992;59(233):457–73. http://www.jstor.org/stable/1823886

11. Muñoz Miguel JP, Anguita Rodríguez F. La tarificación vial en el marco de las políticas de transporte urbano. Un estudio empírico sobre su aceptabilidad social y eficacia en la ciudad de Madrid. Gestión y Política Pública. 2019;28(1):175–206.

12. Vickrey W. Principios de precios eficientes. Política de Transporte. 1994;1(3):186–9.

13. Vickrey W. Subsidios al transporte público: una crítica. Rev Econ Polít Transp. 1994;28(2):139–54.

14. Vickrey W. Quince falacias fatales de la política de tránsito urbano. Política de Transporte. 1995;2(3):161–83.

15. De Rus G, Campos J, Nombela G. Economía del transporte. Barcelona: Antoni Bosch; 2003.

16. Jaramillo W, Jacome L. Tarifa socialmente justa para el servicio de transporte público urbano y su relación con los tiempos de recorrido e intervalos de despacho. INNOVA Res J. 2017;2(12):89–98.

17. Meyer J. La economía de los sistemas de transporte: una referencia para los profesionales. Cambridge, MA: Harvard University Press; 1979.

18. Botón K. Economía del transporte. Edward Elgar; 1985.

19. Hensher D. Modelado de elección de viaje aplicado. Oxford: Pergamon Press; 2001.

20. Hensher D. Economía del transporte. Cheltenham: Edward Elgar; 2007.

21. De Palma A. La economía del transporte urbano. Madrid: Instituto de Estudios Fiscales; 1990.

22. De Palma A, Ben-Akiva M. Análisis de la demanda para la planificación del transporte. Barcelona: Universidad Politécnica de Cataluña; 1991.

23. De Palma A, Lindsey R, Quinet E. Fundamentos de la economía del transporte. Barcelona: Antonio Bosch Editor; 2018.

24. Alvizo C. El transporte público en Guadalajara: alianzas, actores y mecanismos, 1925-1953. Guadalajara: El Colegio de Jalisco; 2010.

25. AU Consultores. Estudio de Demanda Multimodal de Desplazamientos de la Zona Metropolitana de Guadalajara. Guadalajara: Gobierno del Estado de Jalisco; 2007.

26. Axhausen K. Smartcard data use in public transit: A literature review. Transp Rev. 2012;32(3):263–83. https://doi.org/10.1080/01441647.2012.656417

27. Banco de México (BANXICO). Encuestas sobre las Expectativas de los Especialistas en Economía del Sector Privado. Noviembre 2018. http://www.banxico.org.mx/publicaciones-y-prensa/encuestas-sobre-las-expectativas-de-los-especialis/%7B8084E026-4B5E-5D05-08D1-69F8005AC602%7D.pdf

28. Baranda B, et al. Hacia una Estrategia Nacional Integral de Movilidad Urbana. Movilidad Urbana Sustentable. México: Instituto de Políticas para el Transporte y el Desarrollo (ITDP); 2014. http://www.itdp.org

29. Baumol W, Baer K. Decisiones de hacer o comprar y la protección de activos de propiedad pública: el caso del transporte urbano en autobús. Diario de Negocios. 1960;33(2):219–39.

30. Betancor O, et al. Evaluación Económica de Proyectos de Transporte. Estimación de los costes del productor y del usuario en la evaluación de proyectos de transporte. España: Centro de Estudios y de Experimentación de Obras Públicas (CEDEX), Ministerio de Fomento; 2009.

31. Bielich Salazar C. La guerra del Centavo. Una mirada actual al transporte público en Lima Metropolitana. Lima: CIES, IEP; 2009.

32. Bondorevsky D, Estupiñán N. Quién, qué y cómo se financia el sistema de transporte público en la Región Metropolitana de Buenos Aires. Caracas; 2018. http://www.scioteca.caf.com

33. Botón K. Economía y política del transporte. Brookfield; 1992.

34. Botón K, editor. Economía del transporte: Lecturas seleccionadas. Edward Elgar; 2005.

35. Burgueño O, Pittaluga L. El enfoque neo-schumpeteriano de la tecnología. Quantum. 1994;1(3):5–32.

36. Breitenbücher S, Geurs K, Bertolini L. Análisis de costo-beneficio para la evaluación del transporte en Europa: una revisión de la literatura. Transp Res Part A Policy Pract. 2020;133:1–16.

37. Camelo M. Sobre el desarrollo de la teoría de los bienes públicos locales. Finanzas y Política Económica. 2009;1(2):jul-dic.

38. Cárdenas J. El Sistema de Transporte Colectivo de Guadalajara: Movilidad pública y crisis económica. 1970-1982. Guadalajara: Universidad de Guadalajara; 2019. https://www.academia.edu/43427793

39. Cascajo R. Metodología de evaluación de efectos económicos, sociales y ambientales de proyectos de transporte guiado en ciudades. Madrid: Universidad Politécnica de Madrid, Departamento de Ingeniería Civil: Transporte; 2004.

40. Castells M. La cuestión urbana. 4a ed. México: Siglo XXI; 1974.

41. Castells M. La sociedad red: una visión global. Madrid: Alianza Editorial; 2006.

42. CEIT. Una visión estratégica en la Zona Metropolitana de Guadalajara. Guadalajara: CEIT/ITESO; 2002.

43. Comisión Europea. Tarifas técnicas del transporte público: Análisis y perspectivas internacionales. 2017. https://ec.europa.eu/transport/sites/default/files/tariff-technical-notebook-2017_es.pdf

44. Cook WD, Seiford LM. Data envelopment analysis (DEA) – Thirty years on. Eur J Oper Res. 2009;192:1–17.

45. Comisión Reguladora de Energía (CRE). Portal de la CRE. 2019. https://www.gob.mx/cre

46. CTS México. Macrobús, movilidad sustentable en Guadalajara. Movilidad Amable. 2008;(5):84–95.

47. Dan L. An empirical analysis of household choices on housing and travel mode in Boston. Berlin: Springer-Verlag; 2009.

48. Daamen W, Van Oort N. Integrating smart card data for public transport and travel behaviour research. In: Currie G, Delbosc A, editors. Public transport planning with smart card data. CRC Press/Balkema; 2016.

49. Dextre JC. Ciudades en movimiento: Innovación y sostenibilidad en el transporte urbano. Barcelona: Editorial Gustavo Gili; 2020.

50. De Rus G, et al. Manual de Evaluación Económica de Proyectos de Transporte. Washington, D.C.: Banco Interamericano de Desarrollo; 2006.

51. DINA Camiones S.A. de C.V. Ficha Técnica Linner. 2019. https://dina.com.mx/

52. Ding C, Bradley M. Economías de escala y alcance en el transporte público: una revisión de la literatura. Transp Res Part A Policy Pract. 2000;34(7):515–45.

53. Eliasson J. The Value of Time in Public Transport: Time, Money, and the Importance of Travel Time Variability. Transp Res Part A Policy Pract. 2016;91:65–76.

54. Elster J. Justicia Local. Barcelona: Editorial Gedisa; 1994.

55. Falavigna C. Metodología para cuantificar accesibilidad y conveniencia de un sistema de transporte público masivo de pasajeros: aplicación al caso de la ciudad de Córdoba. Córdoba: Universidad Nacional de Córdoba; 2009.

56. Ferri M, et al. Estudio sobre Políticas Tarifarias para Usuarios Habituales del Transporte Público. Propuesta de nuevos títulos de transporte público. España; 2009.

57. Fielding GJ, Babitsky TL, Brenner ME. Performance Evaluation for Fixed-Routed Transit: the Key to Quick, Efficient and Inexpensive Analysis. Irvine: Institute of Transportation Studies, University of California; 1983.

58. Gas Natural El Salto S.A. de C.V. Planta Distribuidora de Gas Natural "El Salto". México; 2019. https://gas-natura-el-salto.negocio.site/

59. Gehl J. Cities for People. Washington D.C.: Island Press; 2010.

60. Gihring T, Hirsch G. Revisión de estudios recientes sobre funciones de costos de tránsito. Transp Res Rec. 1980;775:1–6.

61. Gonzáles E. The Social Value of Time in Public Transit Systems. Transp Res Part A Policy Pract. 2014;69:267–78.

62. Guzmán S, Hernández L. Sistemas de transporte público, los motores para el desarrollo sustentable. Revista Expansión. 2021 Aug 9. https://expansion.mx/opinion/2021/08/09/sistemas-transporte-publico-motores-desarrollo-sustentable

63. H. Ayuntamiento de Guadalajara. Metro-Tran: Hacia un sistema de transporte colectivo en Guadalajara. Comisión de Planeación Urbana; 1973.

64. Hensher D. Estructuras de costos de operadores de autobuses: algunas pruebas australianas recientes. Transporte. 1990;17(1):33–55.

65. Hensher D. Valuing Travel Time Savings in Public Transport. Transp Res Part A Policy Pract. 2008;42(1):55–67.

66. Hensher D, Button K, editors. Handbook of Transport Strategy, Policy and Institutions. Vol. 6. Oxford: Elsevier; 2004.

67. Hensher D, Button K. Manual de economía del transporte. Cheltenham: Edward Elgar; 2011.

68. Hunt J. Value of Time in Public Transport. Transp Res Rec. 2000;(1735):14–9.

69. IMSS. Patrones y empresas. México: Instituto Mexicano del Seguro Social; 2019. http://www.imss.gob.mx/patrones

70. INEGI. Encuesta Intercensal 2015. México: Instituto Nacional de Estadística y Geografía; 2015. https://www.inegi.org.mx/programas/intercensal/2015/

71. INEGI. Censo de Población y Vivienda 2010. México: Instituto Nacional de Estadística y Geografía; 2010.

72. INFONAVIT. Reglamento de Inscripción Pago de Aportaciones y Entero de Descuentos. México: Instituto del Fondo Nacional de la Vivienda para los Trabajadores; 2017.

73. Instituto de Movilidad y Transporte del Estado de Jalisco (IMTJ). Dictamen final para la aprobación de las tarifas técnicas del servicio de transporte de pasajeros colectivo para las Rutas-Empresa del Área Metropolitana de Guadalajara y del Sistema Integrado de la Ciudad de Puerto Vallarta. Guadalajara: Gobierno de Jalisco; 2018.

74. Instituto de Movilidad y Transporte del Estado de Jalisco (IMTJ). Encuesta de Satisfacción del Usuario para el Área Metropolitana de Guadalajara 2016. Guadalajara: Gobierno de Jalisco; 2016.

75. Islas V, García S, Zaragoza M, Osorno J, Martínez J. Caracterización de la movilidad (urbana e interurbana) y el transporte de pasajeros en México. Sanfandila: Instituto Mexicano del Transporte, Secretaría de Comunicaciones y Transportes; 2012. https://imt.mx/archivos/Publicaciones/PublicacionTecnica/pt377.pdf

76. ITDP. La tarifa técnica en el transporte público de América Latina: Experiencias de 14 ciudades. México: Instituto de Políticas para el Transporte y el Desarrollo; 2017. https://www.itdp.org/wp-content/uploads/2017/04/La-Tarifa-Tecnica-en-el-Transporte-Publico-de-America-Latina_ITDP_Spanish.pdf

77. Jalisco Cómo Vamos. Moverse en GDL. Informe de resultados de la Encuesta de Percepción Ciudadana sobre Calidad de Vida. Guadalajara: Jalisco Cómo Vamos; 2019. https://jaliscocomovamos.org/

78. Jasman Llantas. Los mejores precios en llantas. 2019. https://tienda.grupoloyga.mx

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

79. Kamargianni M, Givoni M. Smart card ticketing systems: Functionality, benefits, and implementation challenges. Transp Rev. 2014;34(3):319–37.

80. Kenworthy J. An International Sourcebook of Automobile Dependence in Cities, 1960-1990. Boulder, CO: University Press of Colorado; 2011.

81. Cámara de Diputados. Ley del Impuesto sobre la Renta (LISR). México: H. Congreso de la Unión; 2013. https://www.diputados.gob.mx/LeyesBiblio/pdf/LISR.pdf

82. Poder Legislativo del Estado de Jalisco. Ley de Movilidad y Transporte del Estado de Jalisco (LMTEJ). 2013. https://congresoweb.congresojal.gob.mx/bibliotecavirtual/leyesestatales.cfm

83. LubTrac. Empresa proveedora de lubricantes. 2019. http://www.lubtrac.com.mx

84. Luján X. Estudio sobre políticas tarifarias para usuarios habituales del transporte público. Madrid: Centro de Referencia en Movilidad de ISTAS; 2009. http://istas.net/descargas/Estudio%20de%20sobre%20pol%c3%adticas%20tarifarias%20para%20usuarios%20habituales%20del%20transporte%20p%c3%bablico.pdf

85. Manheim ML. Fundamentals of Transportation Systems Analysis. Volume 1: Basic Concepts. Cambridge, MA: MIT Press; 1979.

86. Martens K. Transport Justice: Designing Fair Transportation Systems. New York: Routledge; 2017.

87. Mees P. Transport for Suburbia: Beyond the Automobile Age. London: Earthscan; 2009.

88. Meyer J, Kain J, Wohl M. The Urban Transportation Problem. Cambridge, MA: Harvard University Press; 1977.

89. Meyer J. Planificación y análisis del transporte. Englewood Cliffs, NJ: Prentice Hall; 1984.

90. Meyer J. La economía de la competencia en las industrias del transporte. Dordrecht: Kluwer Academic Publishers; 1991.

91. Ministerio de Fomento. Encuesta de Movilidad de las personas residentes en España, Movilia 2006/2007. Madrid: Ministerio de Fomento; 2008.

92. Oliva C, Cantillo V. Costos de operación en sistemas de transporte público: una revisión. Cuad Econ (Latinoam). 2010;29(52):31–58.

93. Organización de las Naciones Unidas (ONU). Nuestro Futuro Común. Ginebra: Comisión Mundial sobre el Medio Ambiente y el Desarrollo; 1987.

94. UN-HABITAT. Planning and Design for Sustainable Urban Mobility. Global Report on Human Settlements. New York: Routledge; 2013.

95. Pasajero7. Revista especializada en vehículos comerciales para transporte de pasajeros y Movilidad Urbana. México; 2019. http://www.pasajero7.com/

96. Pazos A. Desarrollo Sostenible y Economía: una mirada hacia el futuro. Macroecon Appl. 2007. http://campus.usal.es/~ehe/anisi/MA/Laura/trabajos/Desarrollo_sostenible_y_economia.pdf

97. Peñalosa E, Hidalgo D. Ciudades para todos: Propuestas para disfrutar el espacio público. Washington D.C.: Banco Interamericano de Desarrollo; 2008.

98. Plataforma Metropolitana para la Sustentabilidad. Declaración de Guadalajara por una Movilidad Sustentable. México; 2012. http://www.plataformametropolitana.org/

99. IMEPLAN. Plan de Ordenamiento Territorial Metropolitano del AMG (POTmet). Guadalajara: Instituto Metropolitano de Planeación; 2016. http://www.imeplan.mx

https://doi.org/10.56294/tms202372 ISSN: XXXX-XXXX

100. Puccia M. Metodología: Riesgo de la industria. Criterios generales. Nueva York: Standard & Poor's Global Rating; 2018. http://www.standarandpoors.com

101. Sacristán J, Casorrán S. La revolución de la movilidad en bicicleta: Modelos y experiencias internacionales. Barcelona: Ediciones Octaedro; 2017.

102. Sadik-Khan J, Solomonow S. Streetfight: Handbook for an Urban Revolution. New York: Penguin; 2015.

103. Sangurima WE, Jacome Galarza LR. Tarifa Socialmente Justa para el Servicio de Transporte Público Urbano y su Relación con los Tiempos de Recorrido e Intervalos de Despacho. INNOVA Res J. 2017;2(12):89–98.

104. SEMOV. Norma General de Carácter Técnico de la Calidad del Servicio de Transporte Público Masivo y Colectivo del Estado de Jalisco. Guadalajara: Secretaría de Movilidad; 2016. https://periodicooficial.jalisco.gob.mx/

105. Shoup D. The High Cost of Free Parking. Chicago: APA Planners Press; 2005.

106. Spieler C. Trains, Buses, People: An Opinionated Atlas of US Transit. Washington D.C.: Island Press; 2018.

107. Universidad de Chile. Tarifas técnicas de transporte público: El caso de Santiago de Chile. Santiago: Universidad de Chile; 2018. http://www.facso.uchile.cl/publicaciones/memoria/2018/II-2018/FS_Memoria_II_2018.pdf#page=191

108. Valdés C, López-Lambas ME. Del BRT al BHLS: un enfoque europeo de los sistemas de transporte masivo en autobús. In: Actas del IX Congreso de Ingeniería del Transporte; 2010; Madrid.

109. Verhoef ET, Bliemer MCJ. The economics of smart cards in transport: Theoretical framework and cost-benefit analysis. Transportmetrica. 2010;6(5):341–62.

110. Vuchic V. Urban Public Transportation Systems and Technology. Englewood Cliffs, NJ: Prentice Hall; 1998.

111. Vuchic V. Urban Transit Systems and Technology. Hoboken, NJ: John Wiley & Sons; 2007.

112. Walker J. Human Transit: How Clearer Thinking About Public Transit Can Enrich Our Communities and Our Lives. Washington D.C.: Island Press; 2012.

113. Zamorano C. Financiación de sistemas ferroviarios urbanos y metropolitanos. Ing Territ. 2006;(76):24-31.

FINANCING
The authors did not receive funding for the development of this research.

CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

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