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RESEARCH ARTICLE

Estimation of the minimum demand for tires in public passenger motor transport

Estimación de la demanda mínima de neumáticos en el transporte público automotor de pasajeros

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Abstract

A study prepared by the JST's National Directorate for Motor Vehicle Accident Investigation (DNISAU) carried out an exercise calculated for urban, inter-urban and tourist public passenger transport.

The study estimates the minimum demand according to the characteristics identified as dominant in the companies' fleet, both in terms of the technical category of the vehicles and the axle configuration for a two-year cycle. The specific cutback of these services responds to the interests and scope of the JST. This article deals with the main aspects of the study published on the official JST website.

Resumen

Un estudio elaborado por la Dirección Nacional de Investigación de Sucesos Automotores (DNISAU) de la JST realizó un ejercicio calculado para el transporte público urbano, interurbano y de turismo de pasajeros. El estudio realiza un ejercicio de estimación de la demanda mínima según las características identificadas como dominantes en el parque móvil de las empresas, tanto en lo relativo a la categoría técnica de los vehículos como a la configuración de ejes para un ciclo de dos años. El recorte específico de estos servicios responde especialmente a los intereses y alcances de la JST. El presente artículo aborda los principales aspectos del estudio publicado en la página oficial de la JST.

Given the mission of the JST to promote actions that guarantee safety in operations, the relationship with the different actors in the sector is one of the fundamental resources to set the guidelines for the organization's activities.

In light of this, the DNISAU started a line of work that led to the creation of a safety study that examines the tire market for all public passenger transport services under National Jurisdiction. The provincial and municipal levels are included in the analysis when it comes to urban areas.

The study carries out an exercise of estimation of the minimum demand calculated for the case of public urban, interurban and tourist passenger transport, according to the characteristics identified as prevalent in the mobile fleet, both in terms of the technical category of the vehicles and the configuration of axles for a two-year cycle. The selection of these services specifically reflect the objectives and focus of the JST.

This article addresses the main aspects of the study published on the JST's official website. Among them, the conclusions regarding the functionality of the tires for the operation of the vehicles; the main characteristics of the activity segments; the method of estimating the minimum demand; the assumptions used for the estimation; and the results obtained for urban public passenger transport of municipal, provincial, and national jurisdiction, as well as interurban and for tourism under the national administration will be presented.

Segments Under Analysis

Urban public passenger transport

The data extracted from the Single Electronic Ticket System (SUBE, Spanish acronym) for the year 2019, when observing the set of administrative levels adhered to this system, show that urban public passenger transport is concentrated in the Metropolitan Region of Buenos Aires (RMBA, Spanish acronym).

Figure 1. Axle configuration, low-floor urban bus (national jurisdiction), 2021

Source: illustration extracted from the internet, 2021

Within the RMBA, those services operating in the national jurisdiction represent 44 % of the vehicle population in this area in relation to the other administrative levels (provincial and municipal). This level also includes services that operate outside this urban area, which are 2 % of the vehicle population. Regarding the services of provincial jurisdiction in the districts of the RMBA, these represent 32 % of the vehicles, while the municipal reaches 24 %.

The data provided by SUBE allows obtaining information corresponding to the vehicle fleets of businesses operating under provincial and municipal jurisdiction, at the federal level of those jurisdictions adhered to this system for the analyzed period, outside of the RMBA and the national jurisdiction. Together, these make up a population of 5.503 units.

Data from the National Commission for Transport Regulation (CNRT, Spanish acronyms) (2021) allow us to establish the characteristics of the vehicles that correspond to urban transport of national jurisdiction, a section on which this document deepens, given its importance in the service provision. In roadworthy vehicles, the prevalent coachwork type is the urban low floor, of reduced mobility with air-conditioning (AC), which reaches 44 % of the units. In the actual distribution, it is followed by the common urban and urban with AC that, as a whole, reach 50 % of the total units.

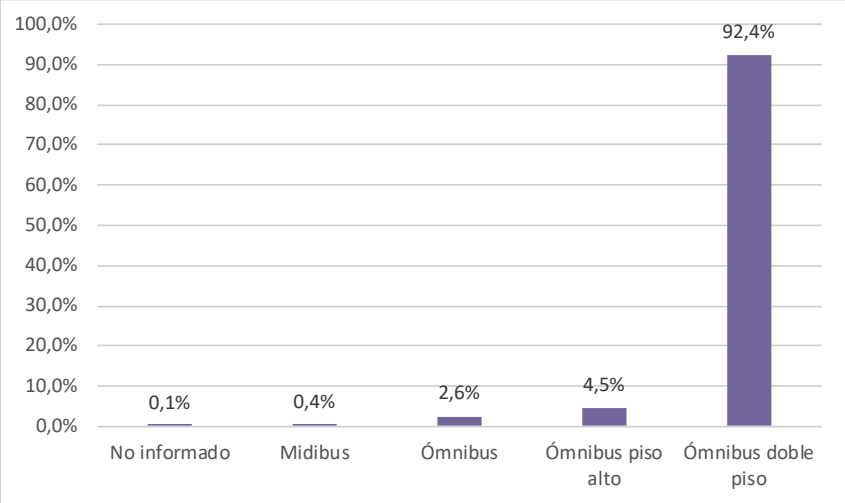
According to the studied information, demand estimation is made on the type of vehicles indicated as dominating. In these, the majority axle-configuration is the 1S-1D, which reaches practically the entire population. The 1S-2D and 1S-1D-1D-1D configurations are sporadic in the distribution (CNRT, 2021).

Interurban passenger road transport

Public services and tourism transportation make up the universe of mass passenger transportation services at the national jurisdiction level (Parodi and Sánchez, 2021). According to the analyzed statistics from the CNRT 2021, each of the units can exclusively conduct public services (21 %), exclusively provide tourism services (45 %), or provide a service-mix impacted by both activity groups (34 %).

In accordance with the regulatory framework that affects this subsector of activity, the pub-

Figure 2. Distribution of the type of coachwork corresponding to the mobile fleet of interurban public services of national jurisdiction, 2021



Source: own elaboration based on CNRT data, 2021.

lic transport service is one that attempts to satisfy the service provision with continuity, regularity, generality, binding force, and uniformity under equal conditions for users. Tourism service include all those who according to their programs are involved in this commercial activity (art. 13, art. 15, Decree 958/92).

In accordance with the observed data, the estimation of demand is made on double-decker vehicles (figure 3). The reason for this specific scope is determined by the weight of this type of coachwork, whose dominating axle-configuration is the 1S-1D-1S (CNRT, 2021), which obligatorily requires super wide directional tires on the front axle (SSTA Provision 294/11, art. 3).

The tourism service presents a more dissimilar distribution of fleet characteristics, locating vehicles with varying coachwork types in the technical categories M1, M2, and M3. Buses falling under the technical category M3 double-decker were chosen for the investigation. They feature a predominate 1S-1D-1S axle arrangement, are widely distributed (76.5 %), and demand super wide directional tires for the front axle (Documento Universal de Transporte, 2019).

As previously mentioned, this structural configuration requires a specific type of tire with unique properties and functions for each of the axles that make it up.

Directional tires

These are utilized in the tractive unit's front axle. They are specifically designed to provide the traction or grip needed to take the curves and counter-curves that arise along the way. In the case of urban transport, conventional-tire sizes are used, such as 295 mm. In the case of interurban, 385 mm (super wide).

Figure 3. Directional tires

Source: image extracted from the internet, 2021.

Traction tires

They are used only for the front axle by which the power and torque of the engine is applied to the road. They are recognized by the characteristic pattern of deep grooves, interspersed across the width of the tread that reduce the possibility of the vehicle skidding on slippery surfaces. In the case of urban and interurban vehicles, conventional-tire measures are used, such as 295 mm and 315 mm, respectively. Although equal in size to the directional ones for the first case, for both types of service the structural characteristics of the tire vary according to the required function in the vehicle.

Figure 4. Traction tires

Source: image extracted from the internet, 2021.

Free-axle tires

Both lateral braking forces and fluctuating loads must be withstood by them. They are designed to roll without torsional effort while withstanding centrifugal and compressive stresses. Sidewalls that have been reinforced aid in preventing housing damage when braking. These axles also use 385 mm (extra wide) tires for interurban transit.

Figure 5. Free-axle tires

Source: image extracted from the internet, 2021.

Minimum Demand Estimation Method

Standard model description

This estimate takes into account the entire two-year tire demand cycle in the examined industry sectors. The logic of this model recognizes that in all circumstances, after the directional axle's corresponding tires have served their purpose, they must be replaced by a new pair of tires for this axle. Note that the directional tires that reach their maximum mileage can be recapped twice and continue to be utilized on the traction- and/or free-axles according to the observed type of bodywork and service. Two one-year cycles of tire consumption are produced by this movement, which, depending on the circumstance, may result in a stock that lessens the requirement for new tires. Because it is assumed that there are no retread failures and that it is possible to achieve a total of two tread changes for each cover, we consider this estimating model determines the minimal number of new tires needed. According to the appropriate parameters for each activity segment, this standard description obtains particular content.

Urban Public Passenger Transport

Mobile fleet and kilometers traveled

Data for the number of vehicles and the number of kilometers traveled by urban lines operating at the national, provincial, and municipal levels and providing service inside and outside the RMBA for the year 2019 were taken from SUBE. The selection criteria for that year were thought to be the most reflective of typical operating conditions since they addressed the changes that the COVID-19 pandemic caused in transport's many sectors of business. All the industries included in this article are evaluated using the same criterion.

Axle configuration

According to information provided by the CNRT, the types of tires utilized correspond to the prevalent axle arrangement (1S-1D) (2019). There are six tires in total per vehicle.

Tire durability

A vehicle can travel 60.000 km before the first tire needs to be replaced, and it can run up to two retreads with an additional durability of 30.000 km each, according to the spare value of tires indicated in the cost structure calculated for a model company for the payment of subsidies (Resolution 422/2012).

Public Transport and Tourism with Interurban Passenger Vehicles

Population of public and tourism service vehicles

Data for the vehicle population of the nation's public and tourism services, broken down by domain and company for the year 2019, were submitted to the DNISAU by the CNRT. In accordance with the criteria established in the previous section, the population corresponding to the technical category M3 and double-decker configuration was selected.

Kilometers traveled, public services

The travel distance of each service corresponding to the various companies is taken into consideration as a reference, along with the weekly frequencies of summer and winter, which are discernible from the seasonality with which they are provided, according to the characteristics of the data provided by CNRT. In accordance with the frequencies set up for this time period, based on this information, the annual mileage of each service is projected (12 summer weeks for the period from December 15 to March 15 and the rest of the year, for a total of 40 weeks). The average number of kilometers traveled for each unit is then calculated.

Kilometers traveled, tourism services

Data on the origin and destination of tourism firms was submitted by the CNRT to DNISAU from the Documento Universal de Transporte (DUT). To determine the routes taken by each of the units in this calculation, the destinations of the places concerned must be homogenized. The services routes were identified in order to calculate the miles traveled by each vehicle after the geographic points were determined. The total mileage made per unit was added in the case of businesses that offer tourism-related services and public services.

Axle configuration

The predominant axle-configuration of technical category M3 (1S-1D-1S) is used as the reference to determine the types of tires utilized. The number of tires per vehicle is eight.

Tire durability

A unit's tires can be recapped twice and must go 110.000 kilometers before needing to be replaced, according to an estimate done by Casari and Baldini (2015). A maximum of 55.000 kilometers can be driven on each set of recapped tires. As stated in the estimate's assumptions, a strategy resembling that of urban services was used to determine that the retread has a 50% lower durability than its initial use.

Estimate Assumptions

Applied description of the model (Urban public transport)

To accommodate demand for this axle, the directional tires are replaced when they have traveled 60-000 km in total (Resolution 422/2012). Recaps of the set that reached its maximum mileage on the directional axle are now used for traction. The service life of these last treads is 30.000 km, with a maximum of two retreads.

Applied description of the model (Public and interurban tourism transport)

To meet the demand for this axle, the directional tires are replaced when they have gone 110.000 km overall (Casari and Baldini, 2015). The set is recapped to be utilized in the free for a total of 110.000 km after it has reached its maximum mileage on the directional axle (2 retreads). The drive axle has an initial performance of 110.000 km and is recapped twice. The service life of these last tire sheathings is 55.000 km per recap in all cases.

The outcome of the model used during the two years covered by this estimate may change according to a variety of factors. Depending on the level of stock availability and tire usage for the drive axle or free axle, according to the relevant activity sub-segment (urban or interurban). There are three possible scenarios based on their combination:

- The number of directional-recapped tires is insufficient to fulfill the drive- or free-axle replacement requirements. To account for the discrepancy, new tires are required.
- The quantity of directional-recapped tires covers the demand of the traction- or free-axle and are consumed in full. It is not required to purchase new tires in this instance to make up the difference.
- Although there is a surplus in its consumption that serves as stock for the second year of the estimate, the amount of supply of directional-recapped-tires is equal to the demand of the traction- or free-axle.

The tires can be entirely recapped twice and travel the maximum distance predicted for them in every situation. Because of the variability in this condition based on the type of use, tire quality, and carcass characteristics, an estimate must be made in this manner. As a result, this estimate establishes the absolute minimum values of tires that must be used without considering any potential reduction in performance or kind of wear.

Results

The Provincial fleet totals 10.918 vehicles, the Municipal fleet 10.791, and the National Jurisdiction's urban service 12.115.

The following table illustrates the total number of tires required on the market annually for the steering- and traction-axles in both years. The total number of directional tires that are readily available for use in a full cycle estimation on the drive-axle is also displayed in the stock column. In this case, availability is not discriminated by company.

"The directional tires that reach their maximum mileage can be recapped twice and continue to be utilized on the traction -and/or free-axles according to the observed type of bodywork and service."

Table 1. Absolute estimate of the tire demand for urban passenger public transport by jurisdiction and prevalent axle-configuration for the first estimation cycle, 2019

YEAR 1			
MUNICIPAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Within RMBA districts	9.942	195	9.548
Outside RMBA districts	3.494	101	3.264
MUNICIPAL TOTAL	**13.436**	**296**	**12.812**
PROVINCIAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Between RMBA districts	12.592	511	11.486
Outside RMBA districts	2.132	191	1.746
PROVINCIAL TOTAL	**14.724**	**702**	**13.232**
NATIONAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Inside the RMBA	13.316	551	12.090
Outside RMBA	504	154	180
NATIONAL TOTAL	**13.820**	**705**	**12.270**
COUNTRY YEAR 1 TOTAL	**41.980**	**1703**	**38.314**

Source: DNISAU-JST, own elaboration, 2021.

Table 2. Absolute estimate of the tire demand for urban passenger public transport by jurisdiction and prevalent axle-configuration for the second estimation cycle, 2019

YEAR 2			
MUNICIPAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Within RMBA matches	15.162	9.192	4.110
Outside RMBA matches	5.932	3.151	1.954
MUNICIPAL TOTAL	**21.094**	**12.343**	**6.064**
PROVINCIAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Between RMBA districts	18.592	11.186	4.210
Outside RMBA districts	3.254	1.682	604
PROVINCIAL TOTAL	**21.846**	**12.868**	**4.814**
NATIONAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Inside the RMBA	24.478	11.862	9.356
Outside RMBA	710	277	60
NATIONAL TOTAL	**25.188**	**12.139**	**9.416**
COUNTRY YEAR 2 TOTAL	**68.128**	**37.350**	**20.294**

Source: DNISAU-JST, own elaboration, 2021.

The results of the estimate for interurban services under national control are shown in Table 3 and are broken down by the type of service they offer, the year of the estimating cycle, and the most common axle configuration. The entire number of directional, free, and traction-axle tires that the market is expected to buy in the year of estimation is shown in this Table, as in the situations before. The number of directionals recaps that will be employed on the free axle as a whole is represented by the stock. Once more, stock availability is not company specific.

According to the most common axle design, operational sub-segment, and estimation cycle, Table 3 shows the absolute estimate of the tire demand for interurban passenger transport in the relevant national jurisdiction in 2019.

The importance of tires as an essential component of vehicles has been shown throughout this text. The concessionaire businesses carry out maintenance during the useful life and renewal at the end of it, which raises the operating safety margins for road transport services. The DNISAU-JST tire demand estimation model establishes the bare minimum requirement for public and private urban and interurban road transport businesses so that the tire demand cycle can function in accordance with the intensity of their consumption under optimal performance parameters. For this to occur, it is required to provide the conditions that enable operators to buy a sufficient number of various tire types to ensure the continuity of services, particularly those of a public nature that play a strategic and essential role in the transportation of people.

Table 3. Absolute estimate of the tire demand for interurban passenger transport of national jurisdiction according to prevalent axle-configuration, operating sub-segment, and estimation cycle, 2019

	1S (385)	1D (295-315)	1S (385) Free axle	STOCK
PUBLIC SERVICE				
Year 1	1.876	1.096	0	390
Year 2	3.084	2.656	264	604
TOURISM				
Year 1	80	0	0	40
Year 2	582	160	28	251
MIXED				
Year 1	2.348	1.276	0	536
Year 2	4.306	3.420	429	979
TOTAL				
Year 1	4.304	2.372	0	966
Year 2	7.972	6.236	721	1.834

Source: DNISAU-JST, own elaboration, 2021.

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