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ORIGINAL

Project Habit: Smart Transportation

Proyecto Habit: Transporte Inteligente

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ABSTRACT

Urban mobility is a problem that afflicts society in general. The mobility matrix, together with the existing horizontal urban growth path in Cordoba's City, promotes the acquisition of private vehicles over the public transport system for daily routine. This excessive growth towards the outskirts of the downtown, causes a greater extension of routes and the, increasingly, notorious influx of vehicles on the streets. As a consequence, the exponential increase in emissions of polluting gases into the environment and the excess of traffic jams in crowded areas of the city can be observed. This project is aimed at the development of a new urban public transport service system focused on the user's personal experience, inserted in a future prospective projection of multidisciplinary restructuring of regional urban mobility patterns, and of Cordoba's city in particular. From Industrial Design, a proposal is presented for a cabin for the urban public transport system that places accessibility and travel experience at the level of a private vehicle, thus promoting their daily use, in pursuit of reducing the environmental impact and footprint of personal carbon, towards an increasingly efficient and sustainable urban development system.

Keywords: Industrial Design; Urban bus; User experience; Cabin; Service; Sustainability.

RESUMEN

La movilidad urbana es una problemática que aqueja a la sociedad en general. La matriz de movilidad, junto con el trazado de crecimiento urbano horizontal existente en la Ciudad de Córdoba promueve la adquisición de vehículos particulares por sobre el sistema de transporte público para la rutina diaria. Dicho crecimiento desmedido hacia las afueras del centro, provoca una mayor extensión de trayectos y la, cada vez más, notoria afluencia de vehículos en las calles. Como consecuencia, se puede observar el aumento exponencial de las emisiones de gases contaminantes al ambiente y el exceso de embotellamientos en áreas concurridas de la ciudad. El presente proyecto se orienta al desarrollo de un nuevo sistema de servicio de transporte público urbano centrado en la experiencia personal del usuario, insertado en una proyección de prospectiva a futuro de reestructuración multidisciplinar de los patrones de movilidad urbana regional, y de la Ciudad de Córdoba en particular. Desde el Diseño Industrial, se presenta una propuesta de habitáculo para el sistema de transporte público urbano que coloque la accesibilidad y experiencia de viaje al nivel de un vehículo particular, fomentando así su uso diario, en pos de la disminución del impacto ambiental y la huella de carbono personal, hacia un sistema de desarrollo urbano cada vez más eficiente y sustentable.

Palabras clave: Diseño Industrial; Bus Urbano; Experiencia de Usuario; Habitáculo; Servicio; Sustentabilidad.

INTRODUCTION

This project will seek to revalue the urban public transport system in the city of Córdoba, with a focus on the personal relationship of the user and their accessibility to it.[1,2,3,4,5] It will be developed based on alternative propulsion systems to reduce emissions of pollutants.[6,7,8,9]

The aim is to encourage the use of public transport to reduce the number of private vehicles and the environmental impact they generate.[10,11,12]

Although it is initially planned for the city of Córdoba, it is expected to be scaled up to other cities in Argentina and around the world.[13,14,15]

General Objective

To develop a proposal for the urban public transport system in the city of Córdoba, focused on personal accessibility for users and based on sustainability, to promote its use to reduce private vehicle traffic and the carbon footprint.

Specific Objectives

- Analyze the composition of public transport in the city of Córdoba.
- Investigate the problems faced by current users.
- Investigate the reasons given by private vehicle users for not using public transport.
- Understand the advantages and disadvantages of public transport compared to private vehicles.
- Analyze sustainable material and propulsion options for the design proposal.
- Elucidate the future of sustainable mobility from the perspective of industrial design.
- Understand the evolution of technology and the user requirements that it entails.
- Establish improvements in the user experience.
- Verify the feasibility of the proposals in the urban public transportation system.

Developing a proposal for the urban public transport system, focused on the individual user as the fundamental axis and powered by a sustainable energy matrix, could generate an increase in the number of active users and also create a positive environmental impact in the city of Córdoba.

METHOD

ALCANCE	Descriptivo
ENFOQUE	Mixto (cualitativo y cuantitativo)
DISEÑO	No experimental, transversal
POBLACIÓN	Personas mayores a 17 años que utilicen algún medio de transporte (sea público o particular) residentes en la Ciudad de Córdoba.
MUESTRA REPRESENTATIVA	Personas que optan por utilizar vehículos particulares y personas que utilizan actualmente el sistema de transporte público urbano de la Ciudad de Córdoba
MUESTREO	Probabilístico
RECOLECCIÓN DE DATOS	Virtual y presencial
TÉCNICA	Encuesta
INSTRUMENTOS	Cuestionario
ANÁLISIS DE DATOS	Gráficos

Figure 1. Research Methodology

This work is part of a descriptive research study with a mixed approach (qualitative and quantitative). The research design will be non-experimental and cross-sectional.

The population to be considered in the research consists of people over the age of 17 who frequently use some form of transportation in Argentina. The representative sample will be divided into two groups. On the one hand, those who are current and frequent users of the Urban Public Transportation Service, and on

the other hand, people who use private vehicles as their daily means of transportation. The sampling type is probabilistic.

For data collection, two survey questionnaires will be administered, distinguishing between public transport users and users of private vehicles or private services.

The subsequent analysis will be reflected in graphs that clarify the information and facilitate its understanding.

Research Tools

Survey questionnaire. Segmentation of the questionnaire according to:

- Potential users of the Urban Public Transport System
- Current users of the Urban Public Transport System

Although the project focuses on the city of Córdoba, the survey has a broader scope (clarifying the origin of the respondent) to identify problems and/or success stories in other cities in the country.

The survey is conducted through the Google Forms virtual platform, allowing for the tracking of a larger number of people.

The survey is transcribed below.

SECTION 1

Research on urban mobility patterns in society.

Hello, my name is Tiziano. I am conducting research for my final project in industrial design.

The following survey seeks to understand the user's particular experience with urban transport in the city of Córdoba and the country, whether by public transport or private vehicles.

It will take no more than 10 minutes, and your participation is anonymous; your experiences will be beneficial for the development of my design project.

Thank you very much!

1- Age
2- Gender
3- Usual place of residence
4- What means of transportation do you use most often?
   - Mainly urban public transport (buses, trains, and trolleybuses) (SKIP TO SECTION 2)
   - Mostly private vehicles (cars, motorcycles, bicycles, etc.) or private services (e.g., Uber, taxis, etc.) (SKIP TO SECTION 3)

SECTION 2

User Experience in the Public Transportation System.

It is essential to understand urban mobility as a milestone in our daily lives. This study seeks to generate a proposal for urban mobility focused on the individual user's experience with public transportation, understanding its details.

1- What type of public transportation do you use most often?
2- How often do you use it?
3- How much time do you spend on it per trip?
4- What is its primary use?
5- How satisfied are you with the current urban public transportation system?

Now we will delve deeper into your personal experience as a user.

We will cover areas such as safety, comfort, livability, connectivity, aesthetics, among others...

6- Safety. Do you feel safe inside the vehicle when interacting with other people? (Situations involving theft, harassment, disturbances, etc.)
7- Safety. Do you feel safe in the event of a traffic accident?
8- Comfort. Do you prefer to make the journey...
9- Comfort. During the trip, do you usually...
10- Comfort. Which of the following statements do you most identify with? (choose up to 7 options)
11- Waiting. Waiting time is...
12- Journey. The time taken per section is...
13- Do you consider yourself a person concerned about sustainability and environmental impact?
14- Would you be willing to pay more for a service that guarantees zero emissions?

We're almost done!

One last effort on your part would be beneficial to us.

If you could share your experience as a user, it would be beneficial for the project's development, allowing us to identify advantages and disadvantages compared to other means of transport, as well as concerns and questions. Everything is valid... (JUMP TO SECTION 6)

SECTION 3

User experience of private vehicles/private services.

It is essential to understand urban mobility as a crucial factor in the environmental impact we generate as human beings. Vehicles are responsible for 26 % of total emissions in Argentina. On the other hand, the increase in the number of private vehicles has led to inefficiencies in urban planning, causing major traffic jams at key points in the city.

This paper aims to develop a design proposal that appeals to private vehicle users, encouraging them to utilize urban public transportation services.

1- What means of transportation do you use most often?
2- How often do you use it?
3- How much time do you spend on it per trip?
4- What is its primary use?
5- Do you usually make the trip...
6- Although it is not your usual means of transportation... How attractive do you find the current urban public transportation system (buses, trains, trolleybuses)?
7- Would you be willing to include the urban public transport system among your usual means of transport if you received a satisfactory offer?

- Yes (GO TO SECTION 5)
- No (GO TO SECTION 4)
- Maybe (GO TO SECTION 5)

SECTION 4

If you are not willing to use urban public transport, even if it has improved in various areas (routes, time, comfort, materials, safety, aesthetics, connectivity, hygiene, etc.)

If you have changed your mind and consider that improvements in any of the above areas could make it attractive, return to the previous section.

1- Can you briefly explain why? (...) (SKIP TO SECTION 6)

SECTION 5

Proposed improvements to the current urban public transport service.

From here on, we will focus on the areas that you feel should be improved in the proposal to make it more attractive to you as a user.

1- How satisfied are you with the current urban public transport system?
2- Now we will delve deeper into the proposed improvements
3- We will cover areas such as safety, comfort, livability, connectivity, aesthetics, routes, and travel times, among others...
4- Safety. Are you concerned about your safety around other people? (Situations involving theft, harassment, disturbances, etc.)
5- Safety. How safe do you feel in terms of traffic accidents?
6- Comfort. How would you prefer to travel?
7- Comfort. During the trip, what activities should you be able to do comfortably? (Select up to 4 options)
8- Comfort. Which of the following statements do you most identify with? (Select up to 6 options)
9- Waiting time. To your knowledge, what is the waiting time?
10- Journey. The travel time per section is...
11- Do you consider yourself a person concerned about sustainability and environmental impact?
12- Would you be willing to pay more for a service that guarantees zero emissions?
13- We're almost done!
14- We would greatly appreciate one last effort on your part.
15- If you could tell us why you choose a private vehicle over public transportation, and what would need to change for you to choose public transportation, it would be beneficial for the development of the project... Anything goes. (...) (SKIP TO SECTION 6)

SECTION 6

Thank you very much!

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Your contributions are crucial to the project's development.
Link to complete survey: https://forms.gle/y75wvCW4B9DVZdL39

Work plan

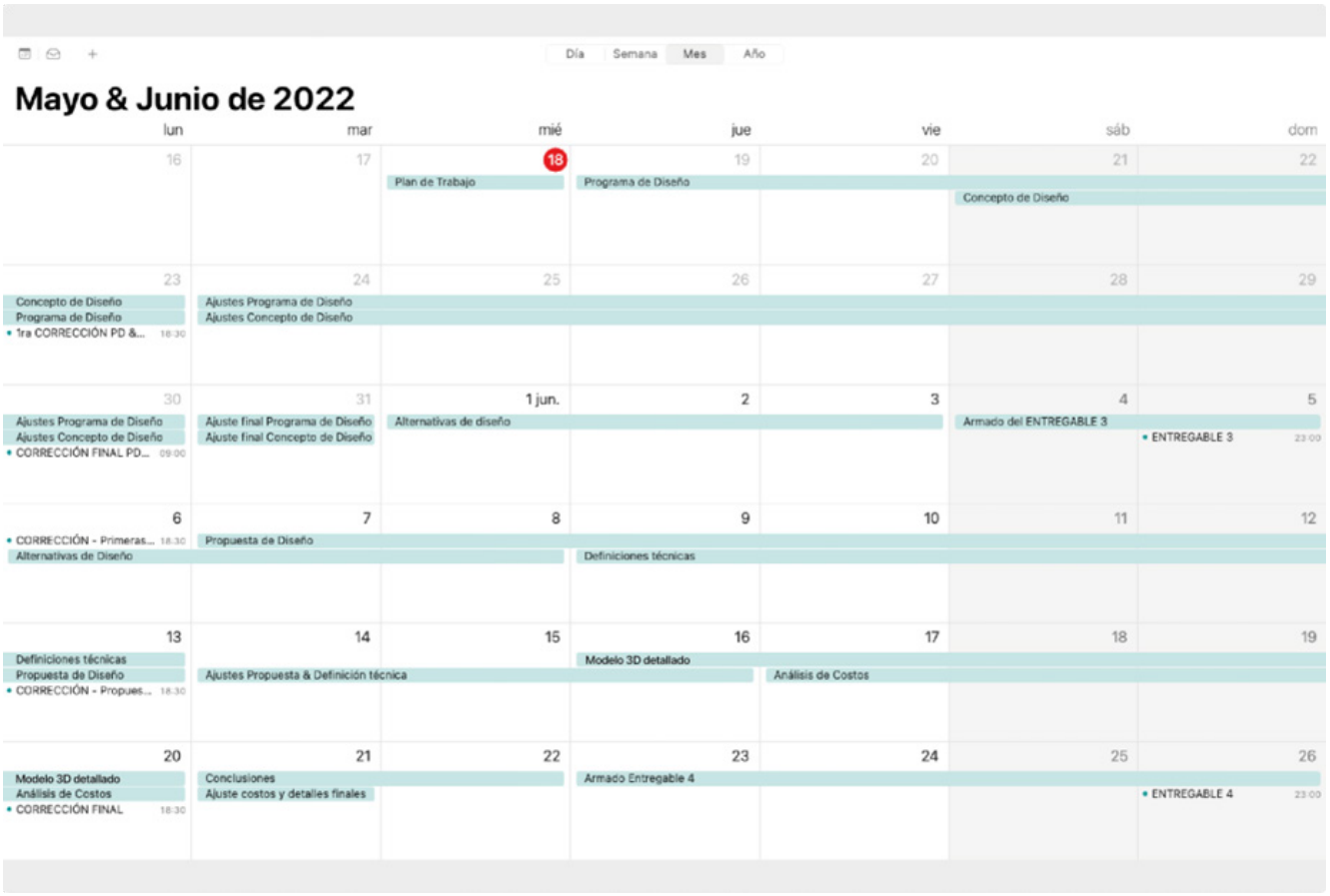

Figure 2. Work Plan Calendar

Design Program

The following Design Program is developed based on the conclusions drawn from the research, with the aim of obtaining a practical document for the development of a solution to the problem detected. The Constraints (C), Requirements (R), and Premises (P) that will govern the basic guidelines of the Design Proposal are detailed.

usuario **objetivo**

C

Elusuario objetivo utiliza actualmente vehfculos particulares o servicios privados

Se trata de una persona de nivel socioecon6mico medio - alto

Rango etario comprendido entre los 18 y 65 anos de edad

La persona resideen la Ciudad de Cordoba, Argentina

R

Disenar una propuesta lo suficientemente atractiva para competir con un vehfculo particular en la Ciudad de C6rdoba

Que el producto tenga un nivel de calidad comparablea un vehfculo particular

p

Se desarrollara un servicio como modelo de negocio para fomentar el uso del mismo por sobre los vehfculos particulares

Se hara enfasis en el diseno del habitaculo para mejorar la experiencia personal de usuario

funcionalidad

C

Frecuencia de uso generalque tiene el usuario

El tiempo de uso del vehfculo por tramo

La higiene de los espacios del habitaculo

La seguridad del servicio

La habitabilidad del vehfculo

El confort brindado hacia el usuario

Las facilidades de conectividad

Elmodo de uso por parte del usuario

Elementos con los que viajael usuario

La finalidad del traslado

La eficiencia del servicio

La comunicaci6n del vehfculo con el usuario

La accesibilidad del usuario personal

Elritmo de uso previsto

R

Contemplar su uso entre semana con trayectos promedio de 40 minutos por tramo

Debe redisenarse lahabitabilidad del vehiculo

Debe contemplarse la higiene y el mantenimiento del mismo

Potenciar la eficiencia del tiempo del usuario dentro del vehfculo

Disenar un espacio seguro para utilizar dispositivos m6viles

Incluir funciones de conectividad que requierelaactualidad

Debe permitirla mayor cantidad de personas sentadas o con un nivel de comodidad superiora ir parado

Se debe adaptar a losdistintos ritmos de uso segun dfa y horarios para lograr un trazado eficiente

Que laspersonas se sientan seguras entre si

p

Se propondran superficies de apoyo mullidas y de buen tacto para el contort durante el trayecto

Se redisenara el layout del vehfculo para mejorar la habitabilidad

Se disenara un sistema de rapida adaptaci6n del layout segunel ritmo de uso

Se implementaran acabados faciles de limpiar

Se implementaran funciones de higienizado para el ingresoy egreso los usuarios

Se propondran sistemas de nanotecnolo- gfa para mejorar la calidad del aire en e interior delvehfculo

Se incluiranespacios de carga para dispositivos m6viles en elhabitaculo

Se disenaran espaciospara apoyo de objetos personales

El servicio llevara registro de quien entra y sale del vehfculo

Se incluiraun sistema de camaras que monitoreen el interior y exterior

El vehfculo comunicara intuitivamente d6nde se encuentra y hacia d6nde se dirige

Figure 3. Design Program (03/01)

aspectos legales

C

La legislaci6n vigente en la Ciudad de C6rdoba

Implementaci6n en la Ciudad de C6rdoba

Adaptabilidad a otras urbes de laregi6n

R

Que el habitaculo se adapte a lo dispuesto enlaresoluci6n 139/97 del Ministerio de Transporte

Que el servicio se adapte a las necesida- des del usuario en la Ciudad de C6rdoba

Que el diseno contemple la adaptaci6n a otras urbes

p

El servicio se disenara en base a los recorridosprincipales de los usuariosy se ira adaptando almismo con el paso del tiempo

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morfologfa

C
La coherencia formal de la propuesta
Funcionalidad del diseno
Las sensacionestransmitidas alusuario
Eltacto general de los acabados
El concepto de diseno rector
Experiencia del usuario 6ptima

R
Replantear la estetica generaldel vehiculo
Mejorarla materialidad del vehiculo teniendo en cuenta la calidad y sustentabilidad
Desarrollar el diseno en base a un Concepto estimulantepara el usuario

p
Se desarrollara un concepto de diseno basado en la emocionalidad del transporte
Se propondran materiales nobles y acogedores para detalles,como acabados en tacto madera; textiles tejidos en base a pet reciclado; rellenos blandos de pet reciclado e inyecci6n de plastico reciclado/reciclable.

ergonomfa

C
Antropometria y biomecanica de los espacios adaptada al usuario
Posiciones, medidas y alcance de los mandos para el usuario
Terminaciones del habitaculo
Modo de uso previsto por elusuario
La seguridad de los mandos

R
Adaptarlos puntos maximos y minimos crlticos de las tablas antropometricas para elusuario
Tener en cuentalos movimientos biomecanicos,alturas,pesos y posicio-nes delusuario
Omitir acabados filosos / susceptibles de golpes
Indicar uso y destinatario / limitantes

p
Se utilizaran acabados suaves y redondeados que brinden seguridad frente a incidentes
Se disenara en base a la libertad de movimiento delusuario,en un espacio seguro y confortable
Se comunicara el fin de cada espacio y quien puede usarlo

tecnico/productivo

C
Procesos productivos ymateriales utilizados

R
Restringiruso de materiales no sustentables

p
Se crearan superlicies vistaslibres de uniones ffsicas y componentes extraibles

Figure 4. Design Program (02/03)

tecnico/productivo

C
Componentes utilizados en la construccion
Mantenimiento y reemplazo de piezas descompuestas
Fundamentos de la Economfa Circular
El Impacto ambiental ocasionado
El clima en la Ciudad de Cordoba
El ciclo de vida del producto

R
Minimizar componentes
Utilizar materiales resistentes al paso del tiempo y de facil mantenimiento
Disenar el habitaculo en base a una plataforma de vehfculo electrico
Implementar materiales y acabados sustentables
Contemplar el ciclo de vida de los componentes y su impacto

p
Se utilizaran materiales innovadores de bases sustentables, reciclados / reciclables y/o de origen natural

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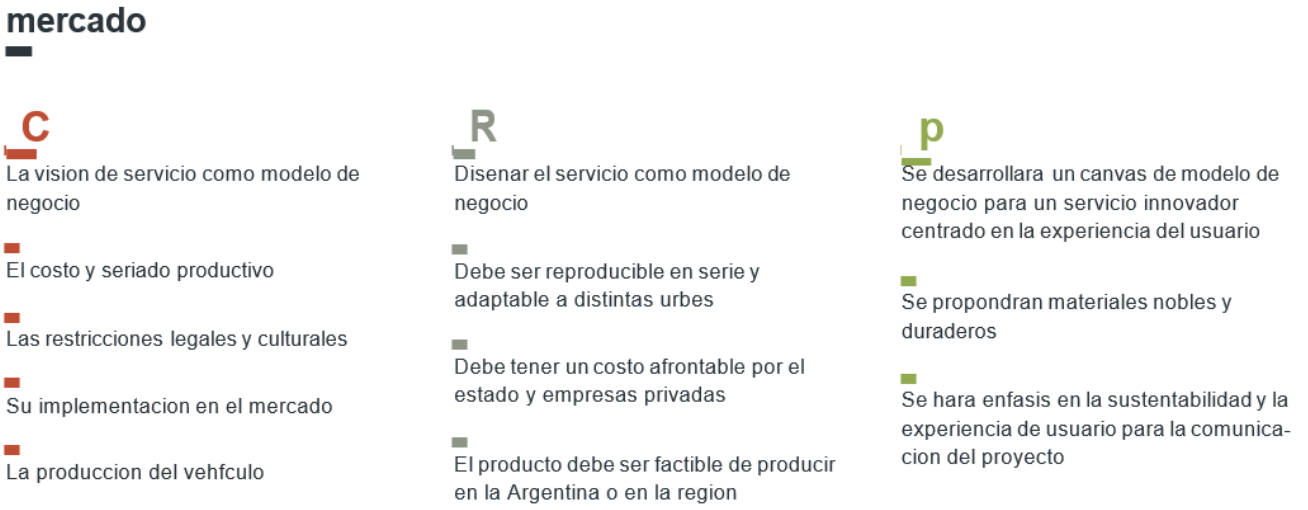

Figure 5. Design Program (03/03)

RESULTS

For the analysis of the data obtained, both the information collected from the survey and the research and comparison with different authors of expertise and trends developed in the area of action were taken into account.

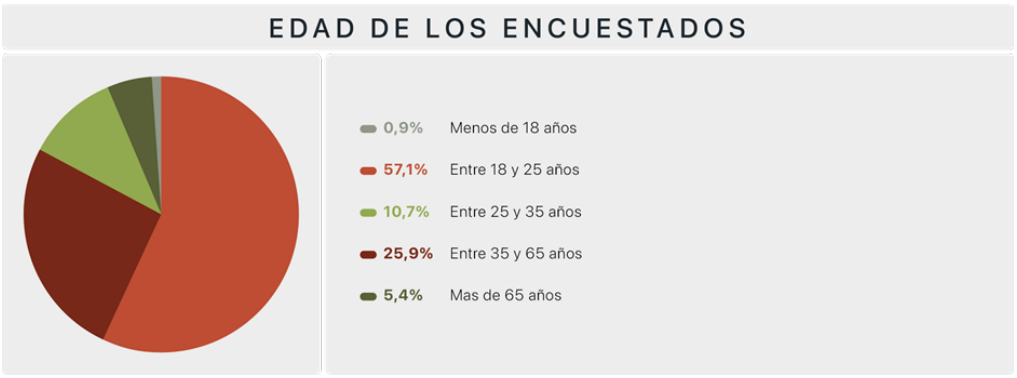

Figure 6. Question about the age of respondents

A sample of 112 people was taken, half men and half women, mostly between the ages of 18 and 25, accounting for 57,1 % of the total number of respondents. This indicates that the conclusions of the project will focus on the needs of a predominantly young society, responsible for future development.

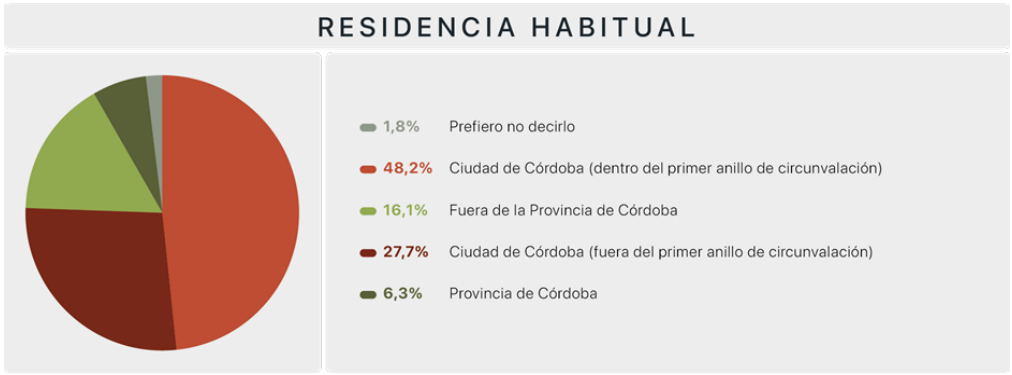

Figure 7. Question about the usual residence of respondents

Of those surveyed, 75,9 % live in the city of Córdoba, with 48,2 % usually residing within the first ring road and 27,7 % outside the first ring road. The analysis will focus on these portions that represent the basis of the project, but it is interesting to take into account experiences in other cities.

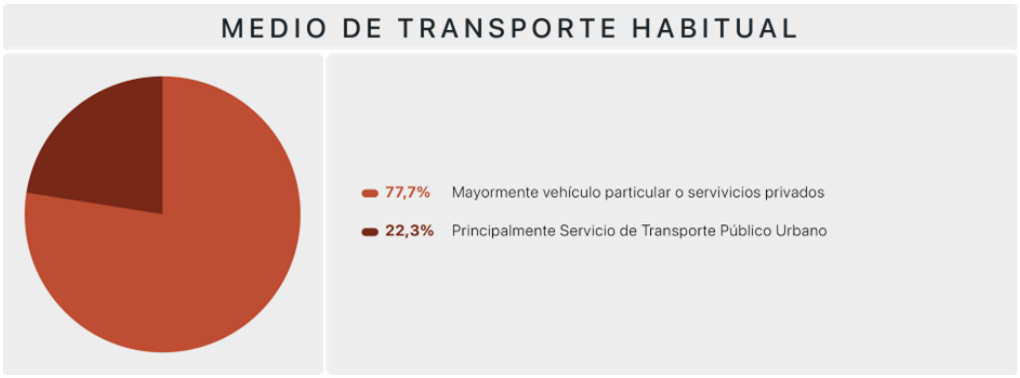

Figure 8. Question about the usual means of transportation of respondents

Here, the survey branches off into the two mobility patterns to be taken into account for the analysis. 22,3 % of people use the current urban public transport system as their usual means of transportation. The vast majority of respondents (77,7 %) use private vehicles or private services as their primary means of transport. Still, it is interesting to note that 93,1 % of them were open to the possibility of including the Urban Public Transport System if they received an improved proposal for it.

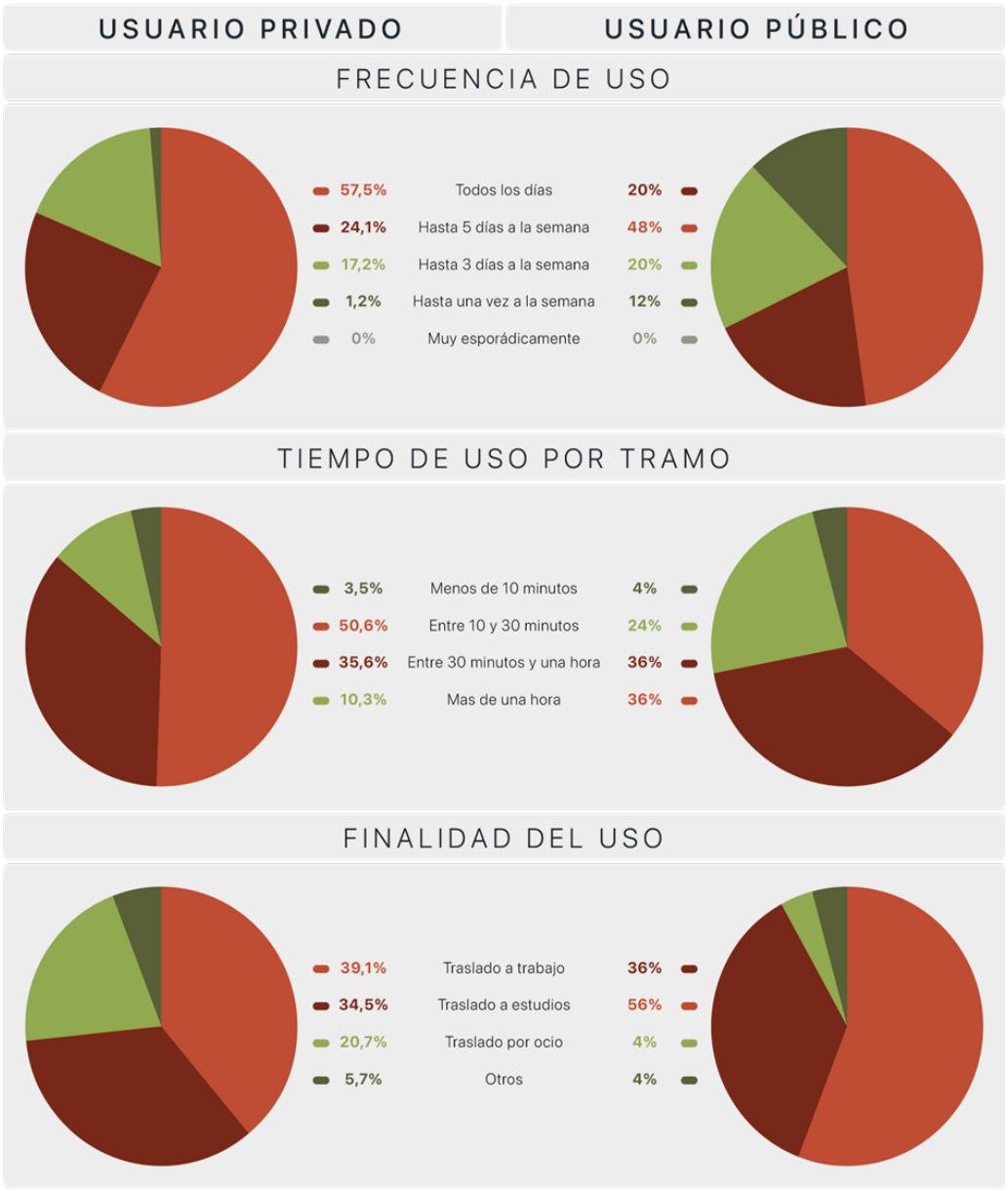

Figure 9. Questions about respondents' use of transportation

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To provide a dynamic reading of the Analysis of Research Results, from this point onwards, individuals who use private vehicles or private services as their primary means of transportation will be referred to as "Private Users." On the other hand, those who use the Urban Public Transport System as their usual means of transport will be referred to as "Public Users."

Below is an in-depth analysis of the data to understand and compare the reality and experience perceived by Private Users versus Public Users.

It should be noted that respondents who use the urban public transport system were asked to describe their current experiences. In contrast, Private Users were asked to respond based on their initial impressions of the current public system compared to their personal means of transport.

If we analyze the frequency, we can see that the "freedom" offered by the private system encourages people to use it more often (57,5 % say they use it every day), mixing its use for work or study with more social or leisure purposes in fairly similar proportions. In contrast, public transport users, only 20 % of whom said they use it every day, and 48 % of whom said they use it up to 5 days a week, also indicate that their use is almost exclusively for academic or work-related purposes, at 92 %.

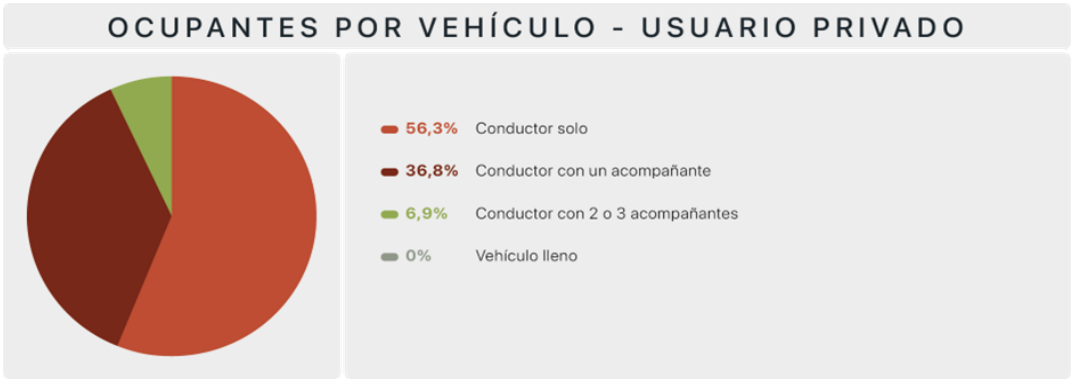

Figure 10. Question about the number of occupants in the vehicles of the Private Users surveyed

It is worth noting an alarming fact: the majority of Private Users surveyed usually travel with less than half of their vehicle's capacity, with 56,3 % of them having only one occupant. The impact on personal carbon footprints increases exponentially as a result, which in turn partly explains the increase in traffic and congestion in the city.

This demonstrates how a good urban public transport system could be attractive in reducing the academic and work-related use of private vehicles by private users, who would then leave their private vehicles for social and leisure occasions.

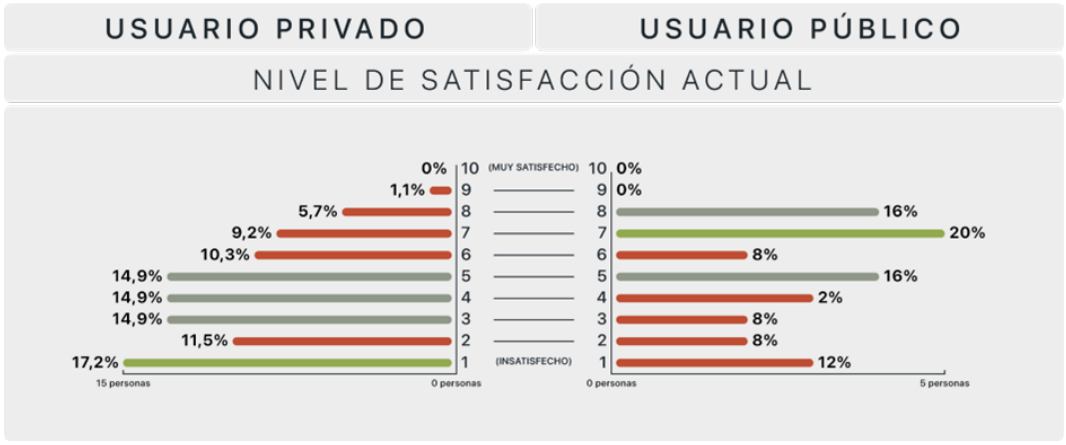

Figure 11. Question about the satisfaction of respondents

Continuing with the satisfaction of respondents with the current Urban Public Transport System, it can be seen that Private Users tend to have a more pessimistic overall view of the current proposal, with average satisfaction ratings of 1/10 to 5/10, compared to public users, who tend to indicate a better impression, with average responses between 5/10 and 8/10 in satisfaction. However, in both cases, it can be seen that there is clear room for improvement in the current proposal.

Below, we will analyze the main factors that affect the personal experience as a user. We will take into

account factors such as safety, comfort, waiting time, route, pollution, among others... It should be noted that the responses may be more realistic among Public Users due to the fact that they are active users of the system; however, Private Users are in the majority and tip the balance in favor of a new attractive proposal.

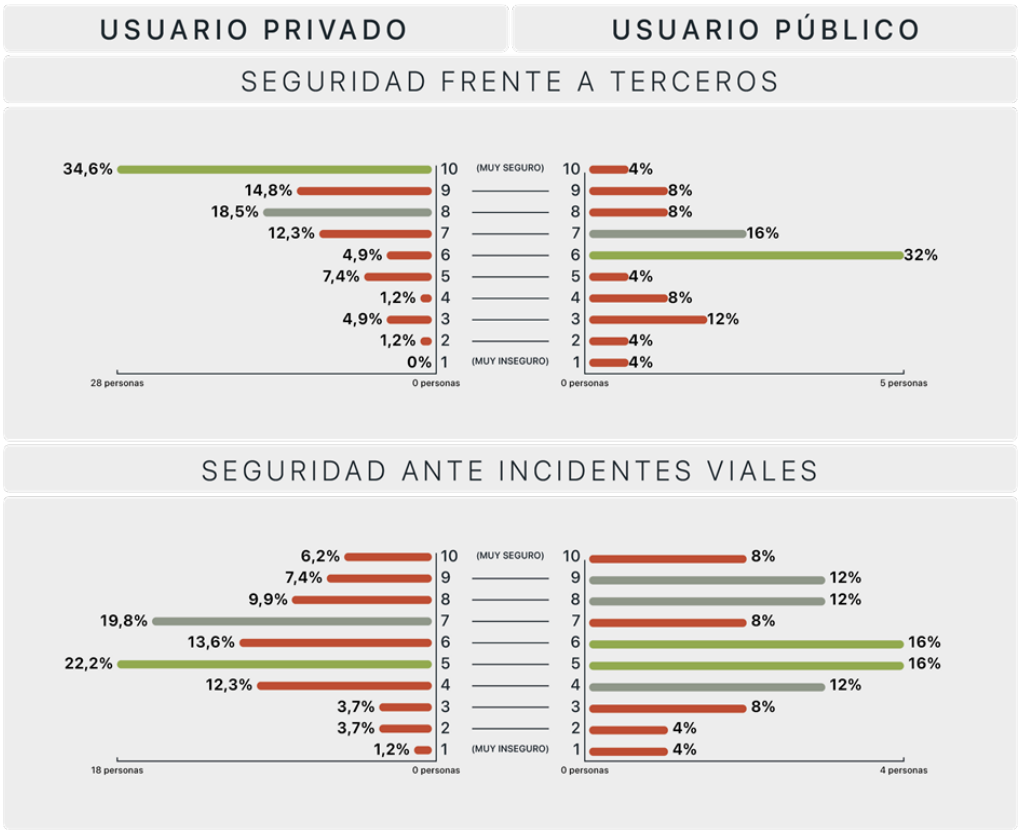

Figure 12. Questions about the safety of respondents

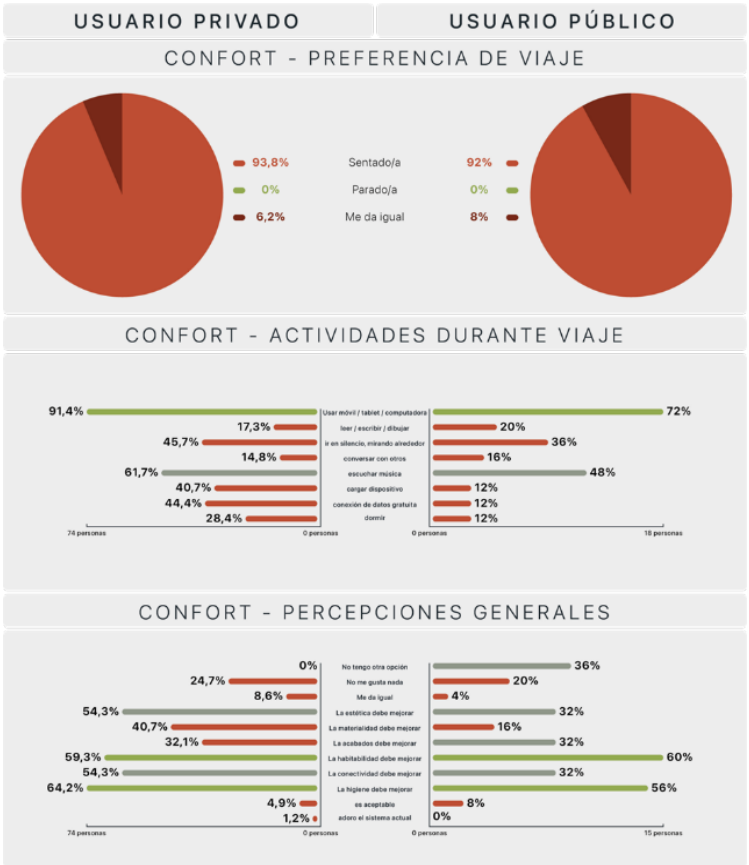

Figure 13. Questions about respondents' comfort levels

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Addressing the safety provided, we can highlight as a real concern for Private Users the insecurity faced by third parties (due to theft, harassment, etc.), with 34,6 % at the top of the table (10/10) of concern. Public Users are less concerned, but it is still relevant, with average peaks between 6/10 and 7/10 on the concern scale. In the case of safety from traffic accidents, respondents were more evenly distributed on the concern scale (1-10).

Moving on to the topic of comfort, understood as a fundamental aspect of the optimal user experience, we can see that both private and public users prefer to travel seated, or with a certain level of comfort superior to standing, with over 90 % of the responses collected. Understanding what a person does or would like to do during the journey is essential to developing a usage dynamic that adapts to those needs. Among the activities, what stands out most for both users, by far, is the possibility of using their mobile phone/tablet/computer without worries and in comfort. From this general activity, several vital sub-activities emerge, such as listening to music, charging the device, and maintaining a data connection. Comparing the responses between Public Users and Private Users, we can observe a certain degree of similarity in these responses, which suggests that the proposal should respond to general problems not solved by current mobility, regardless of the means used. Let's examine the primitive perceptions of Public Users in terms of comfort. They strongly emphasize habitability, which could be better designed, and poor hygiene, taking into account the pandemic context we are experiencing as a society. On the other hand, Private Users were more uniform in their perceptions of current deficiencies.

They also highlighted hygiene first, followed by habitability, but also added aesthetics, connectivity, materiality, and vehicle finishes as items of similar importance. This differentiation in perceptions is interesting because it demonstrates an acceptance, and perhaps resignation, that is more ingrained in public users than in private users.

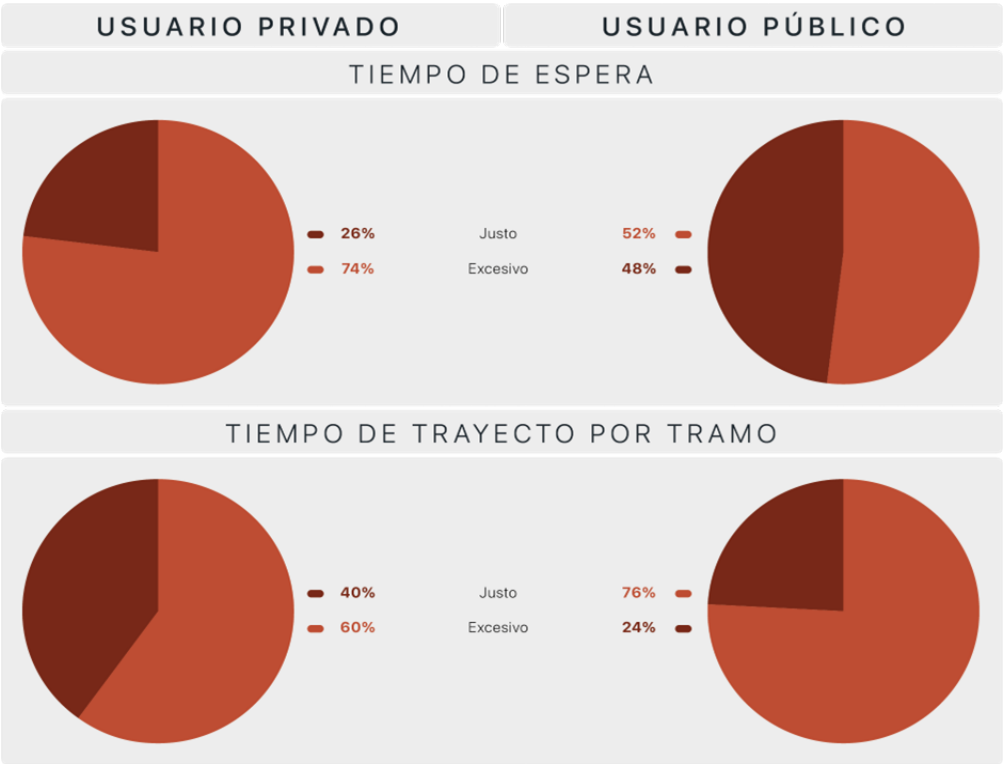


Figure 14. Questions about times among respondents

If we focus on the trip itself, the realistic response provided by public users placed the waiting time for buses at almost 50/50, and 75 % rated the travel time as fair. According to the comments they left in the open-ended section of the survey, they understand that the system itself, in terms of routes and itineraries, does not seem problematic to them, and they know that delays are due more to the general transport matrix than to the organization of the service. It should be noted that most individuals who claim the waiting time is excessive typically reside outside the first ring road, where routes and frequency are more limited. On the other hand, if we examine the responses from private users, they tend to reveal a more pessimistic view of waiting times and journey times. However, in response to the open-ended question, many agreed with the statement "it is not unrelated to what happens with my vehicle," referring to the fact that the overall mobility matrix is what affects the performance of the current Urban Public Transport System.

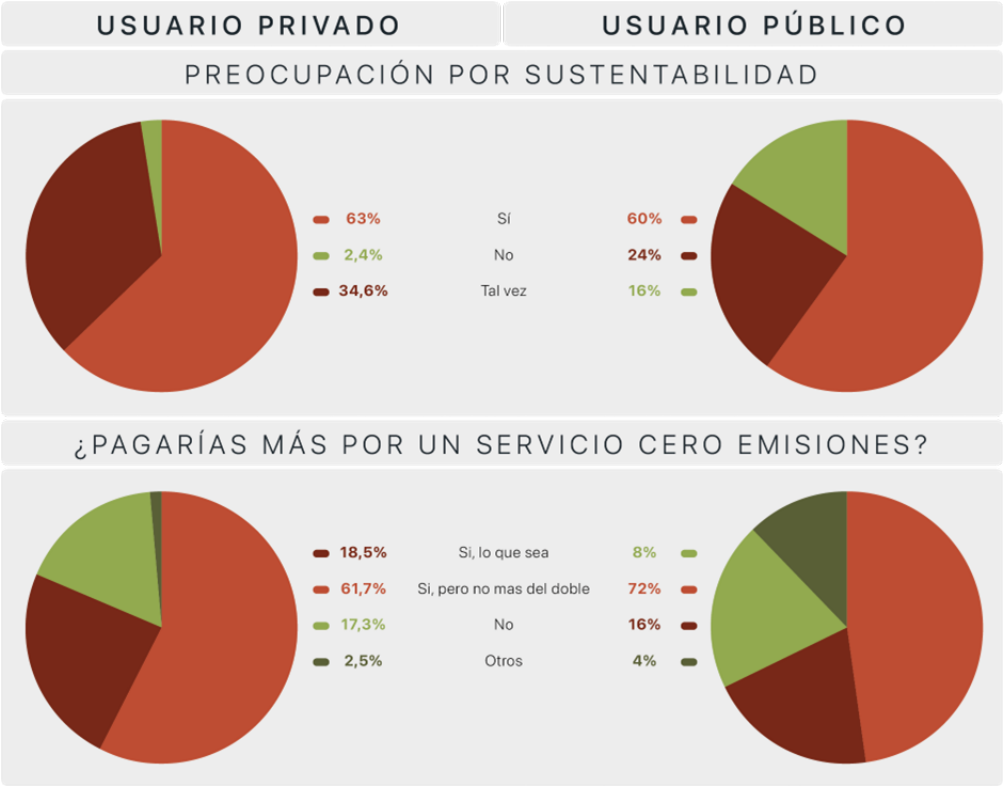


Figure 15. Questions about sustainability among respondents

In pursuit of a sustainable proposal, we inquired about the real concerns of users to understand how vital this argument is to them in purchasing an alternative propulsion matrix service. The results are very similar for both private and public users; approximately 60 % of respondents are genuinely concerned about pollution, although those who do not care are more numerous among public users, accounting for 24 % of them, compared to 2,5 % of private users. To implement such a service, between 61,7 % (private) and 72 % (public) of users were willing to pay a premium for the service, but no more than double the cost of a conventional ticket. This information suggests that people are eager to contribute to environmental improvement, but that a plan of this magnitude requires a reevaluation of the state's environmental policies, in addition to state aid, to establish the project's viability.

Finally, summarizing the space in the survey that was provided for people to describe in their own words the issues that the design proposal should address, the following stand out:

- The overall user experience inside the vehicle.
- Habitability dynamics during peak hours.
- Hygiene/ventilation/pandemic context.
- Journeys to the outskirts of the city / route.
- Valuables, heavy loads.
- Security against theft.
- Frequency/fleet.

It is worth noting that of the 87 private users who responded to the survey, only six stated that they would refuse to include an improved urban public transport system in their daily routine, citing the independence that private vehicles give them, along with emotional reasons, such as the pleasure of driving a car.

In conclusion, the research clearly demonstrates that the future of mobility must shift towards sustainable modes of transport that rethink how society moves from one place to another. For all these reasons, the design proposal must be based on the user's individual experience. The project will focus on developing a proposal that is so attractive that it motivates private users to incorporate urban public transport into their daily routines. Although the information provided by public users is fascinating (and will be used), it is private users who will tip the balance towards a city with more sustainable mobility, prioritizing the reduction of pollution and traffic in the city.

For practical purposes, given the limited development time available, the proposal will focus specifically on the interior dynamics of the vehicle, concentrating the design proposal on the most salient issues identified in the research, such as habitability, hygiene, and connectivity; that is, the experience itself as a personal user.

The aim is to provide a mobility solution that motivates people to take action, enabling, accompanying, and facilitating the daily lives of the population from a personal perspective.

Background Analysis

To begin the background analysis, we will start with a review of the current urban public transport system in the City of Córdoba, which consists of city buses and trolleybuses. Based on this, existing mobility proposals from around the world will be presented and compared, highlighting the advantages and disadvantages of each proposal in its respective background. Finally, an indirect background will be given, but as a reference point for the optimal User Experience and the future of services as such.

Background No. 1. Current bus and trolleybus system in Córdoba

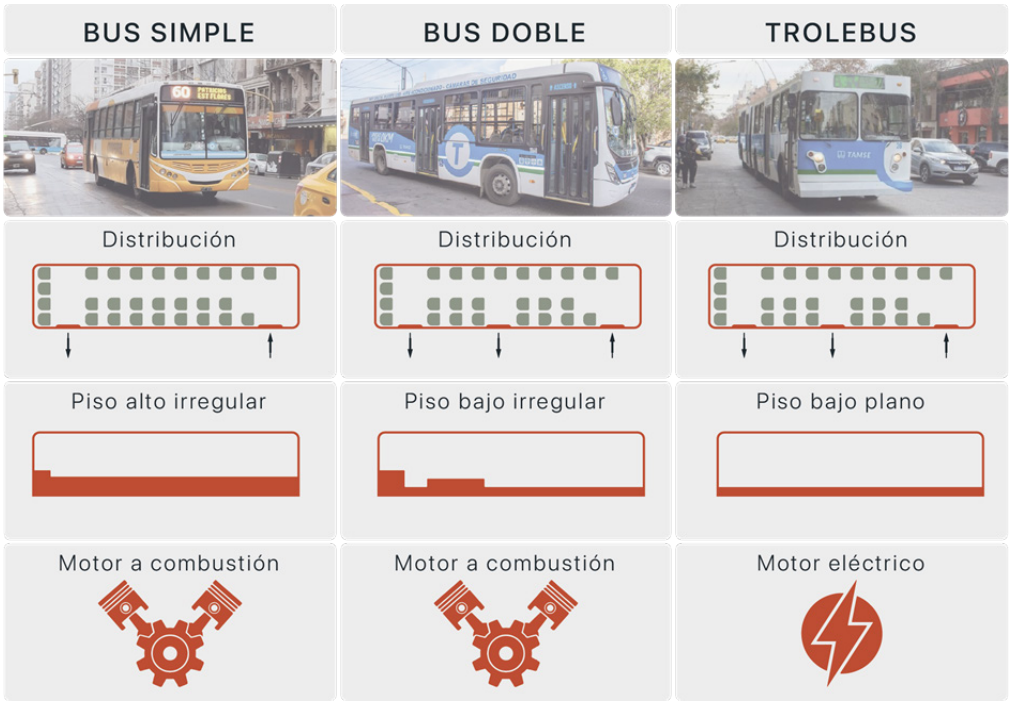


Figure 16. Table on the Urban Public Transport Service in the City of Córdoba

Image 1: Coniferal bus. Source: Coniferal, 2020, /

Image 2: TAMSE bus. Source: TAMSE, 2022, timetables

Image 3: TAMSE trolleybus. Source: TAMSE, 2022, timetables

The current urban public transport system in the city of Córdoba consists mainly of these three types of vehicles. The single-exit bus, operated by the companies Coniferal and Ersa, is smaller and has a single exit door at the rear. They use internal combustion engines (gasoline and diesel) and have a double seat layout on the left and a single seat on the right, with a central aisle for standing passengers. Some have a layout adapted for people with disabilities, with a graphic indicator on the front windshield. The Double Exit Bus operated by Tamse is longer than the previous model, allowing for a second exit door, which facilitates boarding and alighting. Like the single exit buses, these buses use internal combustion engines and have a double seat layout on the left and a single seat on the right, with a space in front of the central door for disabled passengers. Finally, the trolleybus system, also operated by Tamse, stands out for its electric propulsion system, but with the limitation of being connected to a cable network that limits its route and range. The design and layout are similar to those of the double-departure bus operated by the same company. However, it is characterized by a flat floor that allows for the electrical matrix to be installed. These buses are estimated to have a capacity of between 60 and 75 passengers, but in reality, this number is higher during peak hours.

In accordance with Argentine law, Resolution 139/97 of the Ministry of Transportation 1 stipulates that an urban bus must have a minimum of 24 seats or a maximum weight of more than 10 000 kg to operate as such in the country. The length of the bus cannot exceed 12 meters, and the minimum width of the aisle is 45 centimeters. This Resolution details all the regulations that the vehicle must comply with in terms of space, measurements, distribution, among other things. It is a fundamental document for developing an approved design.

1 Art. 1 and 2, Resolution 139/1997. Department of Transportation.

Background No. 2. Cable car system in San Francisco, California, USA.

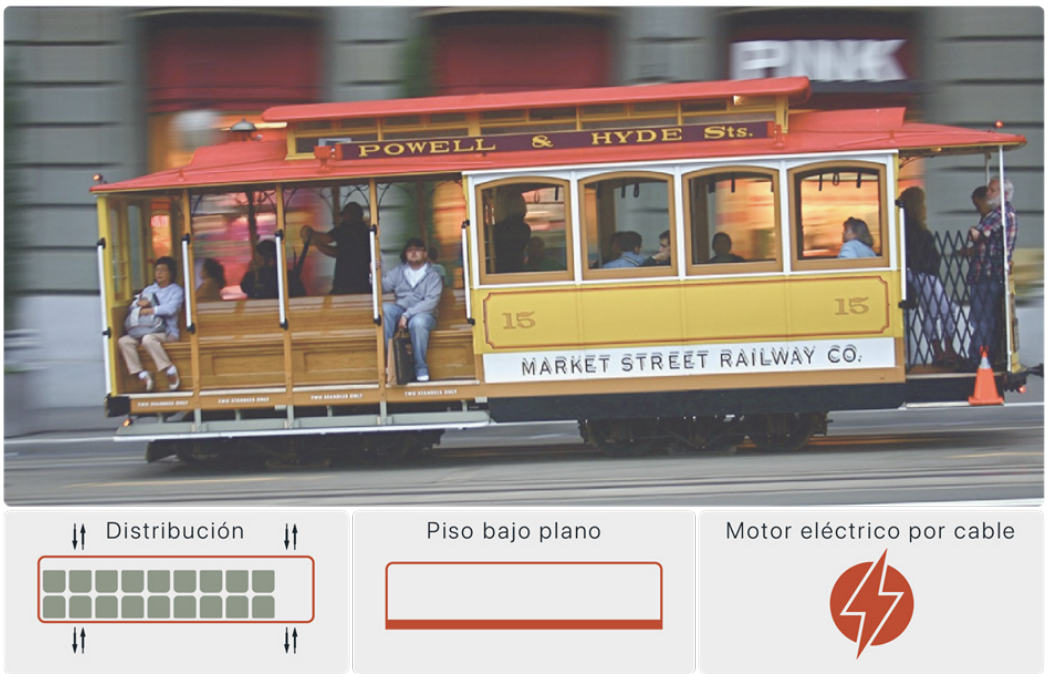


Figure 17. Table on the cable car system in San Francisco, California, USA

We will conduct a brief analysis of the cable car system in the city of San Francisco, California, in the United States, as it serves as a symbol of transport that was an innovative proposal for a town with a very particular orographic configuration, since until its introduction in 1873, horse-drawn carriages were the only form of mass transport, but it was not suited to a city with large and steep hills. Although it is no longer the primary means of transportation, it remains a symbol of success in terms of user experience, attracting thousands of tourists daily with its unique image, which not only complements but also defines the city's image.

Figure 18. Table on the London Routemaster

The London bus system is a global icon due to the vehicle's distinctive design and double-decker layout. The most modern design was developed in the context of a competition, won by the renowned architectural firm Foster & Partners. It is an example of how a city's mass transit system can be a globally recognized icon,

providing a much more enjoyable user experience. The vehicle has three doors, a staircase, and double seating on both sides. It uses hybrid engines that are 40 % more efficient than their diesel equivalents.

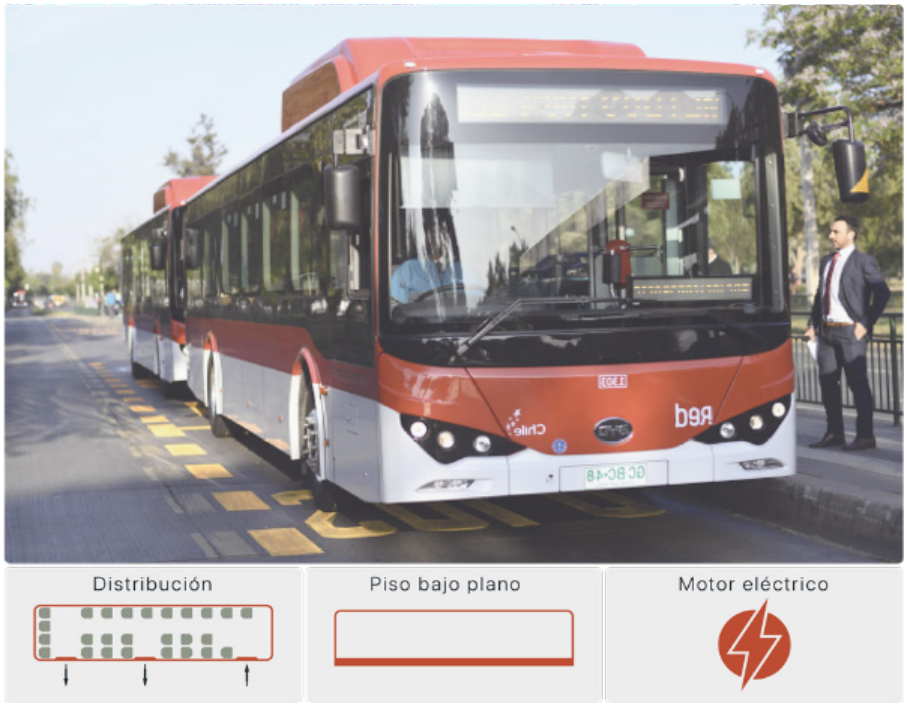


Figure 19. Table on the Electric Bus System in Santiago, Chile

Santiago, Chile, is positioning itself as a pioneer in the region, moving toward total electromobility in the urban public transportation system. Behind China, Chile has positioned itself as the second country worldwide in terms of electric bus circulation, with 500 e-buses and 245 charging stations. The electric matrix gives the vehicle the advantage of a completely flat floor, which optimizes the layout of the passenger compartment. It has a double seat/single seat layout with a central aisle and three doors.

Source: Amazon, 2022
Figure 20. Amazon Go

Finally, it is interesting to mention a precedent that, although it may seem very indirect at first glance, and indeed it is, represents the future of essential services, and transportation services are no exception. Amazon proposes optimizing the user experience, much like when you're looking for things in your kitchen cupboard at home. To do this, it designed a network of markets that allows you to enter with your cell phone, grab a paper bag, fill it with the products you need, and leave; nothing more than that, no physical checkout lines or product scanning, then the summary appears and everything is automatically charged to your phone. And that is the evolution that different services should aim for: a natural proposal for the user that minimizes critical points and optimizes people's time.

Design Concept

Below is the Design Concept that will serve as the basis for the development of the vehicle's interior design.

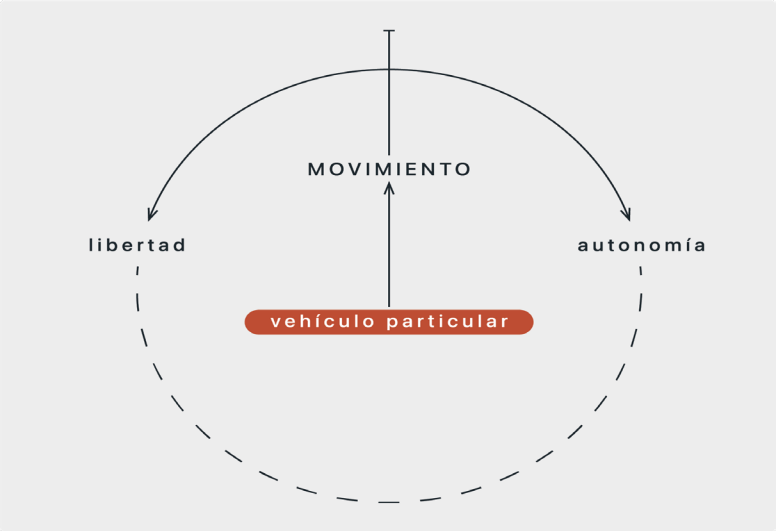


Figure 21. Generation of the Design Concept (01/02)

Starting from the basic concept of what owning a private vehicle represents in society, these three basic concepts emerge. The private vehicle as such is a successful mass-market product because of the ease of movement it allows and, a priori, the freedom and autonomy it provides to its owner.

MOVEMENT - FREEDOM - AUTONOMY

These terms are taken as the basis for the creation of the guiding Design Concept within the project, as they represent the original ideals that made the private vehicle a commercial success. However, if we think deeply about the subject, we realize that this initial notion is far from reality today. Today, owning a private vehicle in the city involves a series of factors that limit our sense of freedom (Where do I park the car? Is it safe? Is there space? How much do they charge, etc.) and autonomy of action, because although I can indeed choose where to go, the social and cultural system in which we live inserts us into a daily routine that alienates us from that symbolic autonomy. "The supposed freedom provided by the personal car (touted a thousand times in various advertisements) is directly linked to the democratic assumption that everyone goes where they want, how they want, and when they want, with the result that in the end we all go to the same place at the same time, but each on our own." (Tomé, 2017, 0041c5a6-82b2-11df-acc7-002185ce6064_2.html)

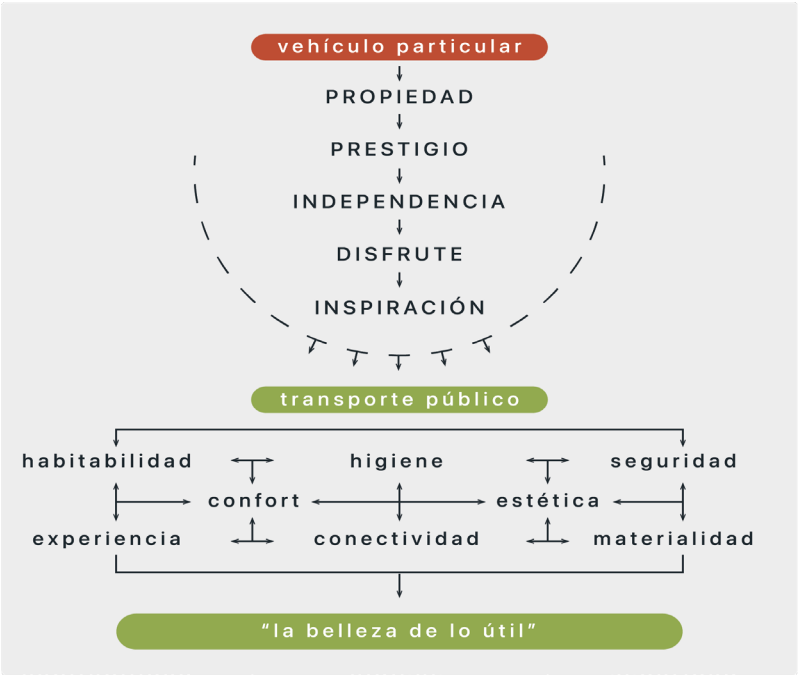


Figure 22. Generation of the Design Concept (02/02)

https://doi.org/10.56294/tms2024119 ISSN: 3072-8398

From this point on, the aim is to reevaluate the usefulness and efficiency of public transport, emulating the basic notions that made private vehicles a priori successful propositions. Owning a private car places the individual in a position of prestige, autonomy, enjoyment, inspiration, and freedom.

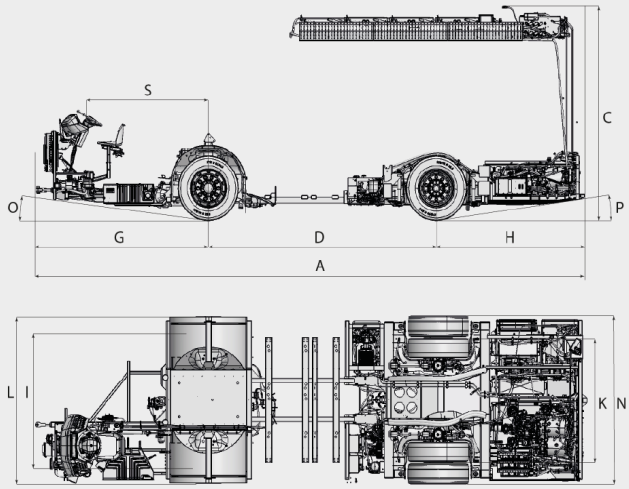
"THE BEAUTY OF THE USEFUL" MOVEMENT - FREEDOM - AUTONOMY

This phrase sums up the search for a change in the urban mobility paradigm, in pursuit of a revised idiosyncrasy that restores, as in its origins, the private vehicle as an item of enjoyment/leisure, and the new efficient and sustainable transport system for daily routines; a new approach to public transport that brings the emotionality of pride, prestige, and efficiency associated with private vehicles to the public transport environment. In short, a service tailored to and worthy of a demanding user demanding users seeking an optimal experience, always within a context of utility and sustainability.

Design Alternatives

At this stage, an initial exploration of design alternatives is carried out that responds to the Design Program and follows the Design Concept.

It should be noted that the Volvo BZL Electric platform will be used as the basis for the practical development of the proposal. This is a state-of-the-art production platform at the global level, presented in September 2021 in Sweden, but which will begin production in Mexico in the second half of 2022, providing proximity that would allow for the adoption of this platform in Argentina, thanks to the free trade agreements in force between both countries. This platform is characterized by its 100 % electric propulsion, flat floor, and great modularity (with variable lengths, number of floors, etc.), allowing it to be adapted to multiple transportation needs.



Model		BZL Electric
Overall dimensions		
A	Overall chassis length, depending on body, up to (mm)	11815
C	Frame height at rear structure (mm)	935
D	Transport wheelbase	3700
G	Front overhang (mm)	2500
H	Rear overhang (mm)	2315
S	Steering wheel position (mm)	1980
I	Track, front (mm)*	2107
K	Track, rear (mm)*	1885
L	Overall width front wheels or housing (mm)*	2500
N	Overall width rear wheels (mm)*	2500
O	Approach angle (°)	7
P	Departure angle (°)	7
	*) Overall height, approach and departure angles with tyres:	275/70 R22.5

Figure 23. Volvo BZL Electric Platform

Initially, a conceptual search was carried out for possible layouts based on the arrangement and use of seats and space in general.

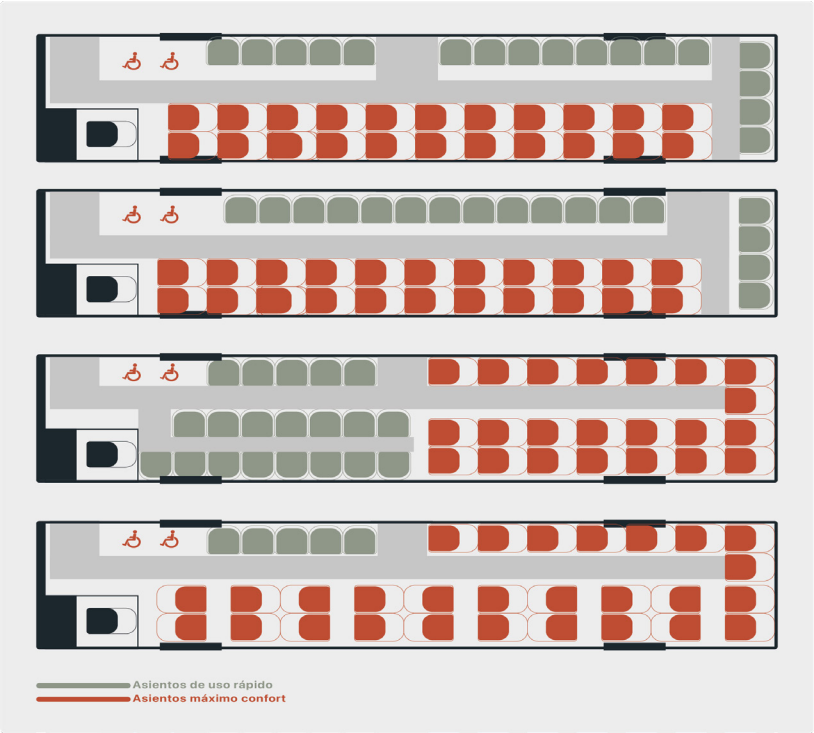


Figure 24. Possible LAYOUTS

Figure 25 shows different layouts that differentiate between spaces offering maximum comfort (larger proportion) and seats for quick use. Later on, we will work with alternatives that expand on these layouts and propose their adaptability to different rhythms and patterns of use.

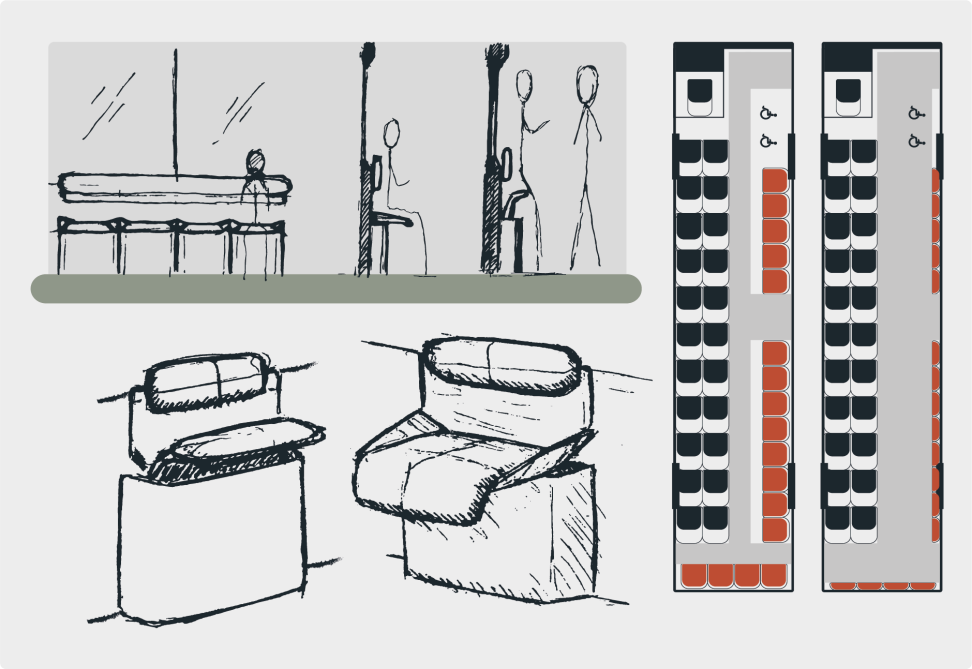


Figure 25. Design Alternatives I

Figure 26 shows a proposal for the quick-use seating area.

This allows the space between conventional seats for quiet use to be converted into benches for times of maximum capacity, as this arrangement takes up less space and, while still providing the same seating capacity, allows for extra standing room at peak times.

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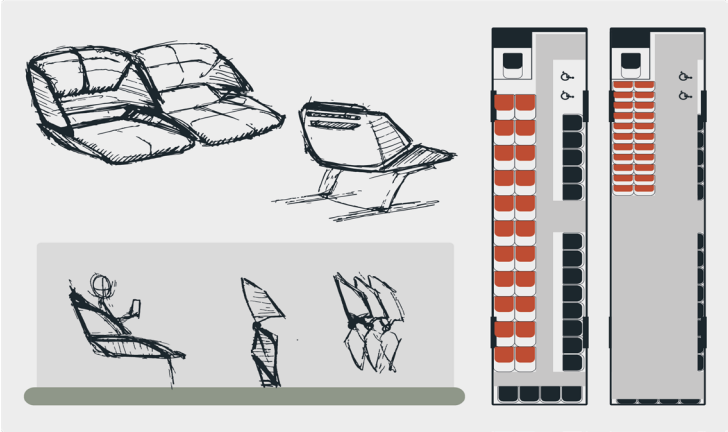

Figure 26. Design Alternatives II

Continuing with figure 27, a proposal for seats with maximum comfort is developed.

These are individual seats with an enveloping structure, which provides a feeling of security and privacy for the user. These seats are connected by a system of guides that allow them to be folded and moved to one end to increase the free capacity of the passenger compartment during times of extraordinary use, such as concerts, games, etc.

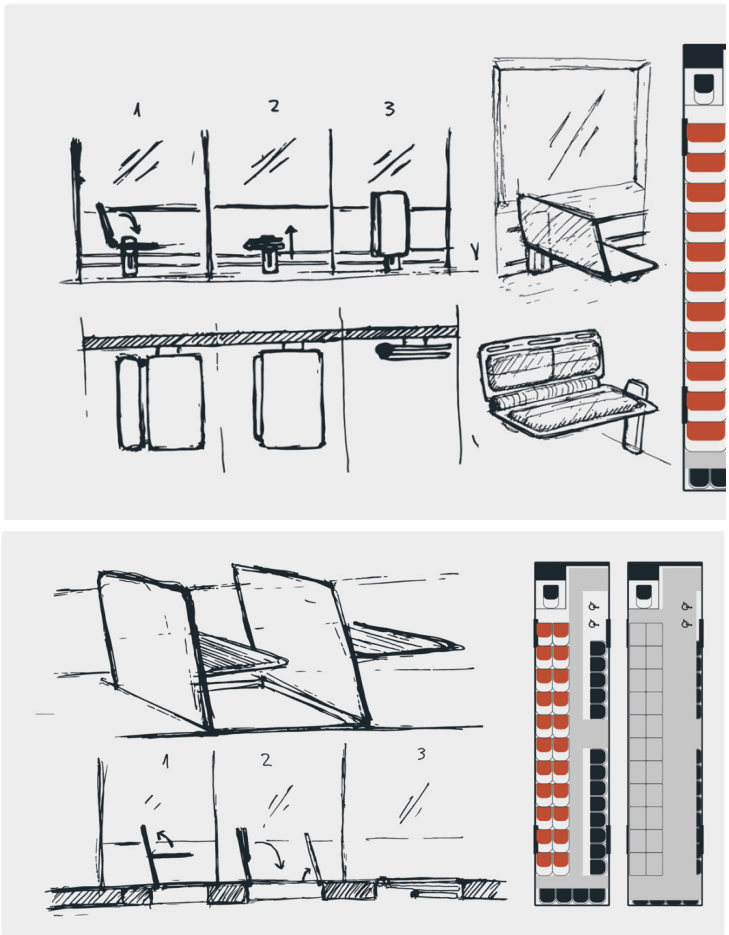

Figure 27. Design Alternatives III

In figure 28, we can see two other proposals focused on optimizing space during times of high demand for the service. In the upper alternative, we can see a continuous seat anchored to the sides of the bus, which can be folded and stored on the sides to leave a completely flat floor free of joints, facilitating general cleaning and maximizing space. On the other hand, the lower alternative presents the possibility of storing the seats on the floor, providing an option for the seats to disappear completely.

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Figure 28. Design proposal

Habit is an innovative public mobility service proposal based on the user's personal experience. It uses an artificial intelligence system that constantly learns users' daily mobility patterns to create an optimized, updated route. Habit seeks to resemble as closely as possible the offer of a private vehicle in the city, but maximizing the efficiency of the user's time inside the vehicle, in a safe, clean, comfortable, and sustainable environment.

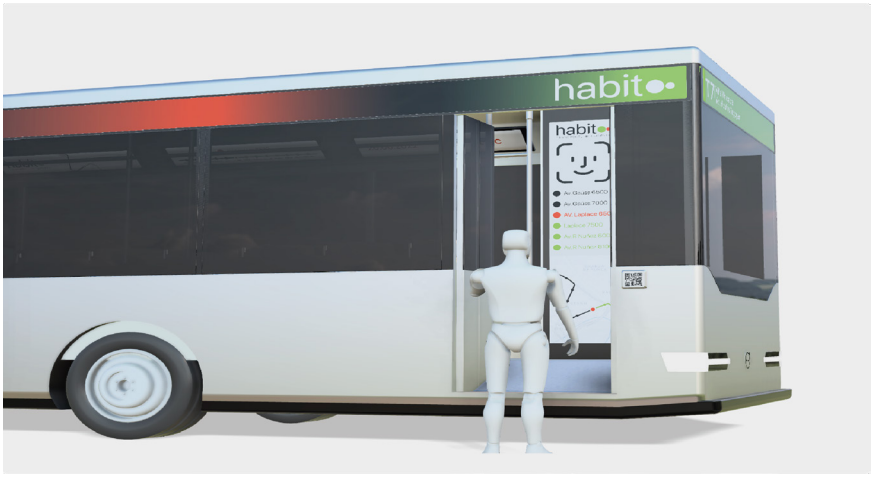

Figure 29. Habit Bus

Figure 30. Habit Bus detail

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The Bus

The vehicle is based on Volvo Buses' BZL Platform, a state-of-the-art product base characterized by 100 % electric propulsion with a long range, providing an optimal flat floor configuration for the modular design of the passenger compartment.

This platform will begin production in Mexico during the second half of 2022, which would make its implementation feasible in the region and in Córdoba, Argentina, in particular.

Interior design

After the initial proposal stage, where different design alternatives to the problem posed were explored, the final design proposal for the ongoing project is developed.

Research has led to the conclusion that we can differentiate between two types of travel. On the one hand, there is express travel, which is usually shorter in distance and time. On the other hand, there is comfort travel, which involves longer journeys where maximum comfort is required for an optimal user experience. For this reason, two different types of seats have been developed based on the same production matrix, as detailed below. It was decided to change the conventional configuration of forward-facing seats to modules rotated inwards. This arrangement optimizes the number of seats with greater comfort, allows for a more varied cabin layout than usual, and creates a more open interior dynamic towards the center.

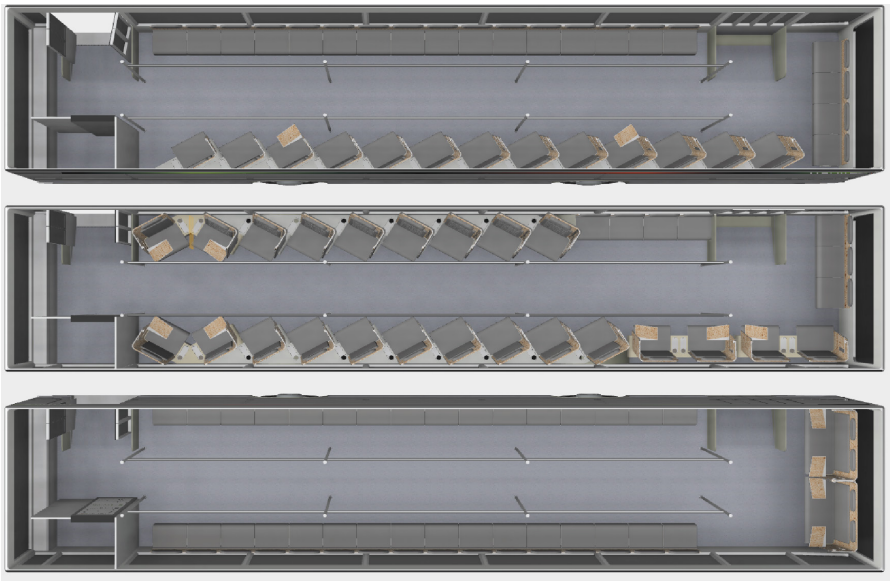


Figure 31. Examples of cabin configurations

Quick-use seat

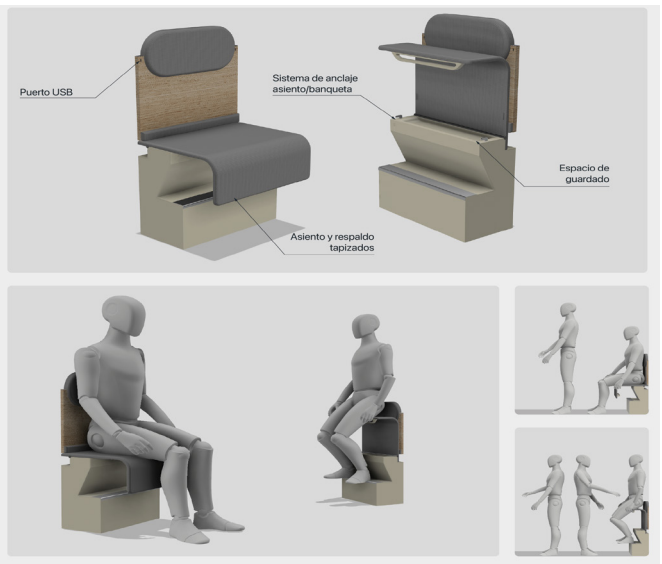


Figure 32. Detail of quick-use seat

The express seat is characterized by its versatility, as it can be converted from a conventional seat configuration for standard use (providing comfort to short-distance passengers while accommodating a large number of users) to a bench arrangement for special occasions, such as concerts, events, soccer games, etc. In this way, it occupies half of the interior space of the bus and accommodates the same number of people in a semi-seated position, plus twice as many standing, optimizing the safe space for these extraordinary occasions.

Extended-use seat

The maximum comfort seat is a space that seeks to provide the feeling of privacy and individuality offered by a private vehicle. It envelops you in a space that offers maximum comfort for an efficient journey. It has an upholstered seat and backrest, and the design includes a retractable table, independent focused lighting, cup holders, storage space, and charging ports with the possibility of wireless mobile phone charging.

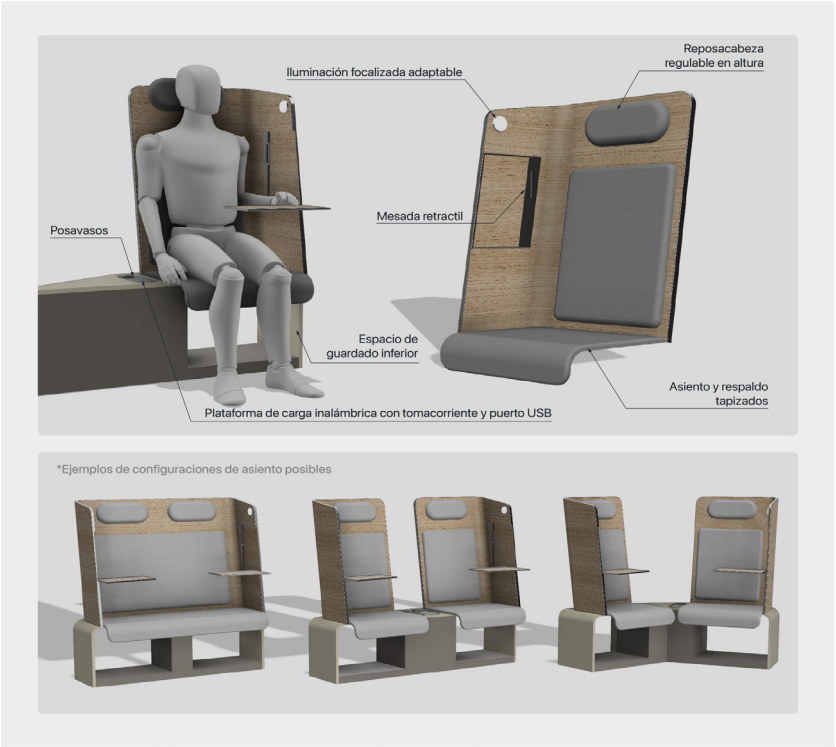
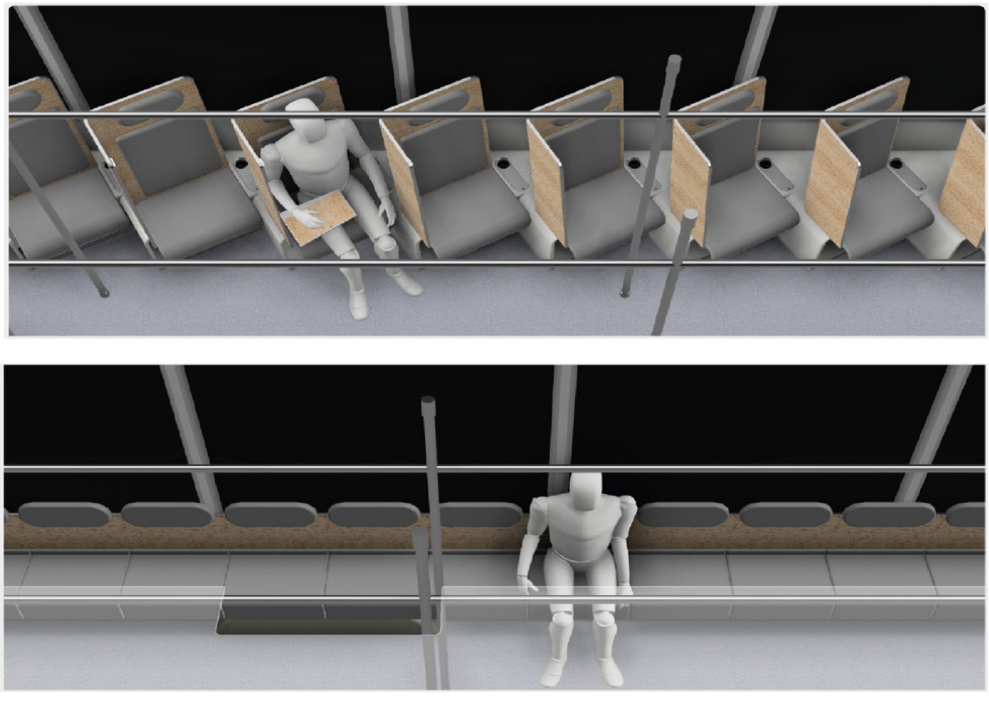


Figure 33. Detail of extended-use seats



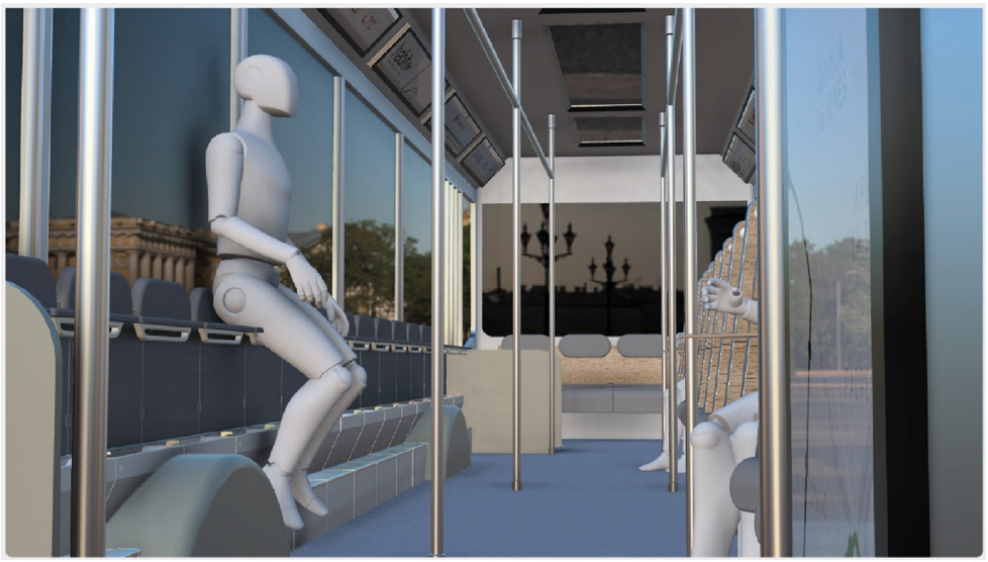


Figure 34. Habit details (1-2)

Technical definition

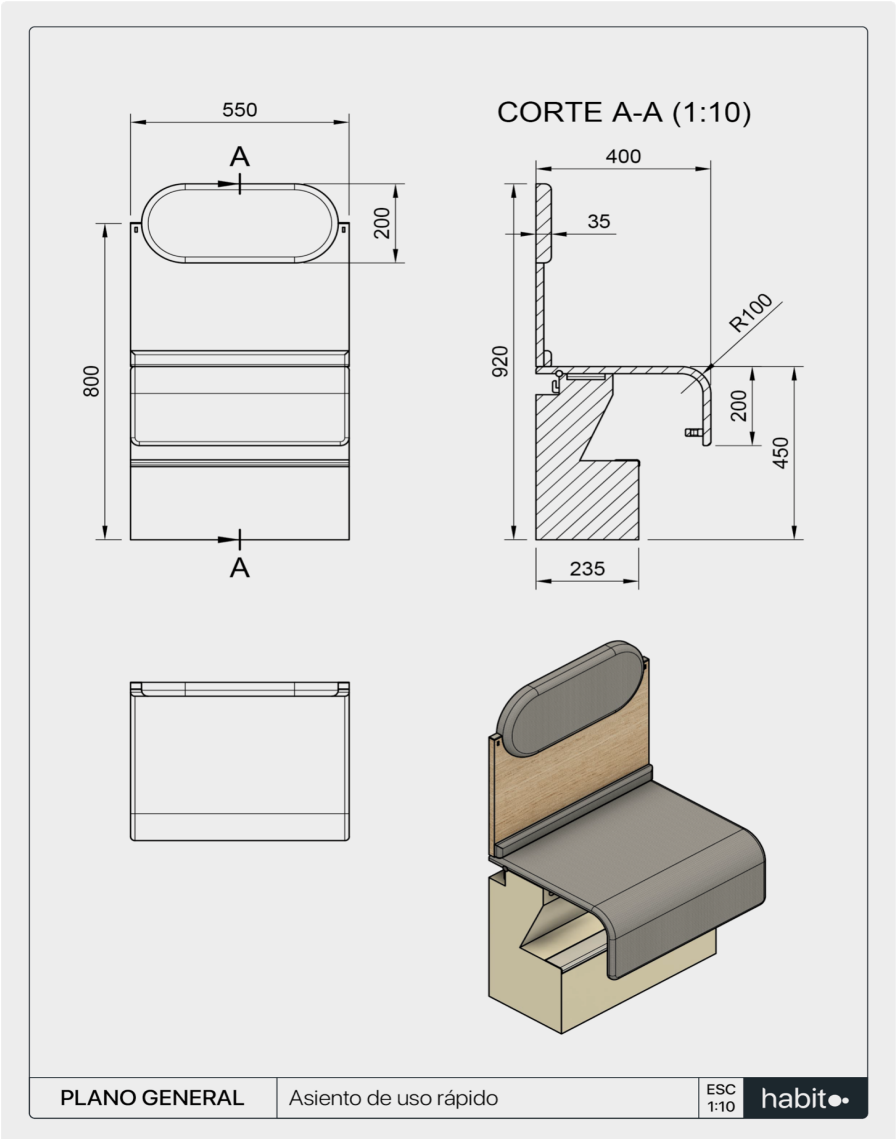


Figure 35. General plan of quick-use seat

To simplify production and minimize components, the main parts that make up the seats, backrests, and bases of both types of spaces (seats for quick use and seats for extended use) are produced based on the same one mm-thick wood plate bending matrix. The use of bio-adhesives and water-based surface treatments is planned. The result is natural pieces with an excellent feel, conveying a welcoming sensation and exceptional quality to the user.

The cushions that cover the surfaces and provide maximum comfort to users are intended to be manufactured with recycled PET fiber filling and upholstered with textiles made from recycled PET bottles.

Some extra ornamental details are manufactured using recycled plastic injection molding. It should be noted that the processes above are currently being developed at the School of Circular Economy of Ente Bío-Córdoba, a municipal entity in Córdoba, Argentina. This makes it feasible to produce the components for the vehicle›s interior in Córdoba.

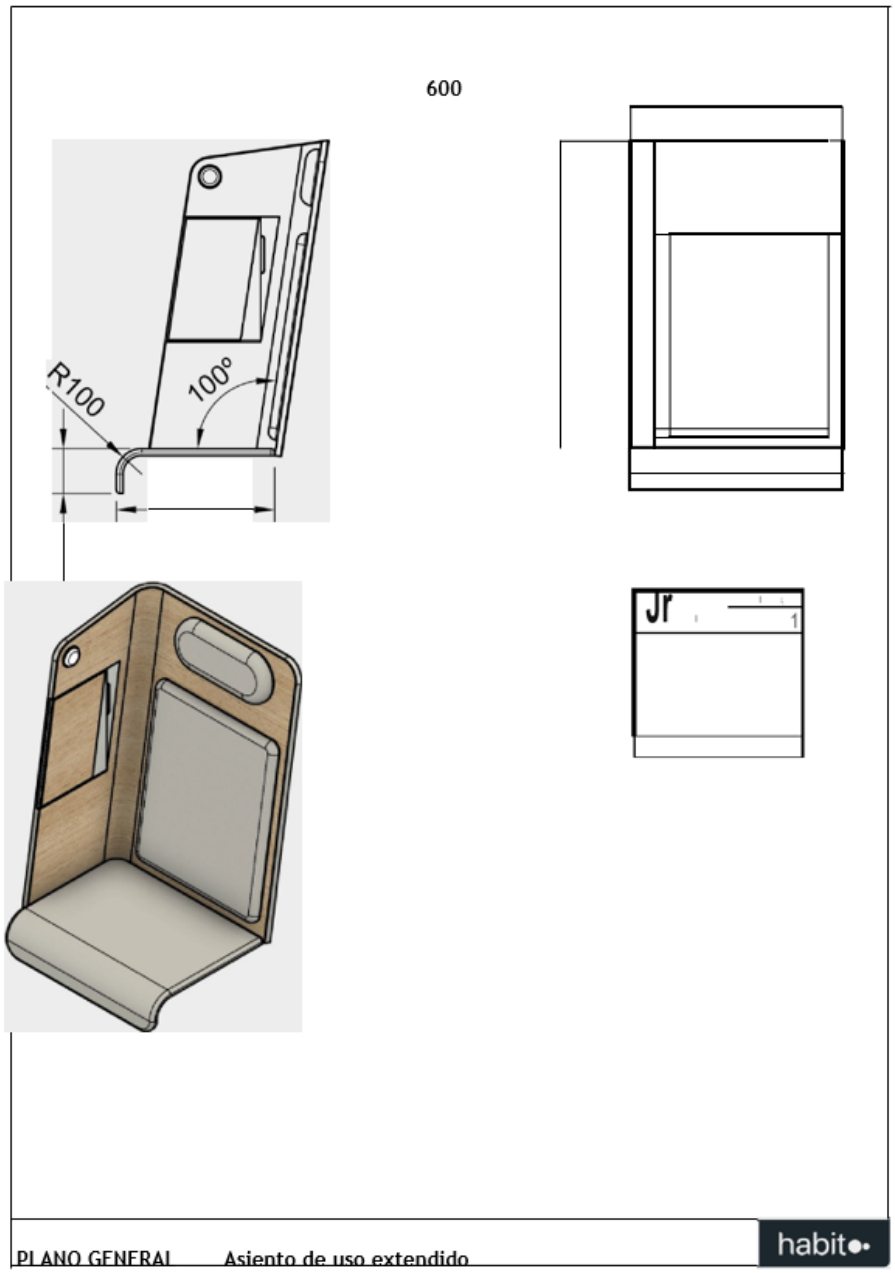


Figure 36. General plan of extended-use seat

Cost Analysis

Due to the scale and temporary nature of the project, the cost analysis is limited in this instance to the production of the passenger compartment seats.

The plan is to introduce the service to the market with a fleet of 15 buses to serve the main routes in the northern part of the city of Córdoba, and then gradually expand the network.

Each passenger compartment is estimated to have 32 seats, divided 50/50 between seats for quick use and seats for extended use. However, the configuration of each passenger compartment may vary and be adjusted to the specific needs of the network.

It should be noted that multilaminate panels will be used for the interior fittings of the passenger compartment.

The values indicated are expressed in US dollars, at the official exchange rate of the Banco Nación, due to the current economic instability in Argentina.

Quick-use seat

1) Through the nesting process, we can see that the utilization of boards for manufacturing is 2,5 seats per 1220 mm x 2440 mm board.

- 6,5 sheets are used for a 16-seat bus = US$ 292,50
- 97,5 sheets are used for the initial fleet of 15 buses = US$4387,50

2) The upholstery and padding pack for the seat, backrest, and headrest costs approximately US$7,08

- 16 packs are used per 16-seat bus = US$ 113,28
- 240 packs are used for the initial fleet of 15 buses = US$1699,20

3) Connectivity pack. Includes USB A and/or C port, with corresponding cabling. Approximate cost of US$7,50

- 16 packs are used per 16-seat bus = US$120
- 240 packs are used for the initial fleet of 15 buses = US$ 1800

Unit cost (per bus) = US$525,78
Total COST (x15 buses) = US$ 7886,70
Detailed costs do not include labor, fasteners, surface finishes, and tooling.

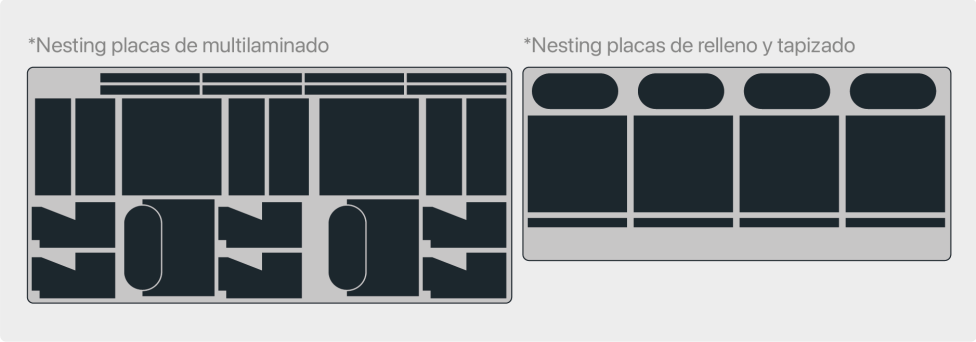


Figure 37. Nesting quick-use seat

Extended-use seat

1) After the nesting process, it can be seen that the utilization of plates in this case is 1 seat per 1220 mm x 2440 mm plate. This count includes the base structure of the seat in any of the configurations presented (the utilization of plates is almost identical).

- 16 panels are used for a 16-seat bus = US$720,00
- 240 panels are used for the initial fleet of 15 buses = US$ 10 800,00

2) The upholstery and padding pack for the seat, backrest, and headrest costs approximately US$10,00.

- Sixteen packs are used per 16-seat bus = US$160,00
- 240 packs are used for the initial fleet of 15 buses = US$ 2400

3) Connectivity pack. Includes power outlet, USB A and/or C port, and wireless charging platform with corresponding wiring. Approximate cost of US$20,00

- 16 packs are used per 16-seat bus = US$ 320,00
- 240 packs are used for the initial fleet of 15 buses = $4800,00

4) Lighting pack. Includes all the necessary mechanisms and wiring. Approximate cost of US$10,00.

- 16 packs are used per 16-seat bus = US$160,00

- 240 packs are used for the initial fleet of 15 buses = US$ 2400,00

5) Aluminum parts. Includes part finishing details, retractable table mechanisms, and loading platforms. Approximate cost of US$30,00

- 16 packs are used per 16-seat bus = US$ 480,00
- 240 packs are used for the initial fleet of 15 buses = US$7200,00

Unit cost (per bus) = $1840,00
Total COST (x15 buses) = US$ 27 600,00
Detailed costs do not include labor, fasteners, surface finishes, and tooling.

Figure 38. Nesting seat for extended use

Figure 39. Cost analysis

Total COST per bus = US$ 2365,78
Total cost x fleet of 15 buses = US$ 35 486,70

CONCLUSIONS

After conducting our research, we can conclude that although there are many examples worldwide of successful mass mobility with different approaches, such as propulsion, habitability, materiality, or experience, there is no proposal that reformulates the design of the passenger compartment as such, with the needs of a world that tends toward personalized service design, with the individual user experience as the fundamental axis.

This work aims to do just that. A design proposal for the current Urban Public Transport System of the City of Córdoba, which positions it as a pioneer, providing a service based on the personal user experience, motivating people who use private vehicles to include this system in their daily lives. To this end, a design proposal will be developed based on the information gathered during user surveys and the background information previously reviewed.

It should be noted that, due to the time frame and scope of the project, the design of this work will focus on the interior of the vehicle. However, the project is part of a proposal for a comprehensive reevaluation of the concept of urban mobility. For the proposal to be successful, a change in private and state policies must be developed to promote public transport, restrict the use of private vehicles in the city center, and rationalize land use distribution (in pursuit of proximity and accessibility).

The world is at a key moment to reformulate the way we move, as the transition to electric mobility planned for the coming years will inevitably affect the cost of vehicles. Electric technology is indeed more expensive than conventional internal combustion propulsion. For this reason, many automotive companies have plans to reduce sales but increase profit margins per unit. As a result, fewer people will have access to private vehicles

as we know them today. Still, the need for mobility will not disappear, and that is where the value of the design proposal developed in this thesis lies. A sustainable urban public transport system, designed for the optimal user experience, taking into account the demands of today's users.

Evaluation and conclusions

To conclude this phase of the project's development, it is appropriate to evaluate the process carried out.

This work was developed in response to the urban mobility problem that affects society at the regional level, particularly in the city of Córdoba.

Climate change is a fact that affects our development as a society on planet Earth. Following this problem, the hypothesis was generated that the development of a proposal for the urban public transport system, focused on the individual user as a fundamental axis and powered by a sustainable energy matrix, could generate an increase in the number of active users and thus create a positive environmental impact in the city of Córdoba.

Throughout the research, an exhaustive search and compilation of data were carried out based on papers, thesis work focused on design, engineering, economics, and political science, as well as other sources on the subject and its direct and indirect background, drawing on existing market success stories.

To understand the local issues and the experiences of people who use some form of transportation in the city of Córdoba, a detailed interview was conducted to elucidate patterns of behavior, identifying both users of private vehicles and current users of public transportation.

Based on the conclusions drawn, the decision was made to focus the design proposal on users who currently use private vehicles as their primary means of transportation, as this group of users is the one that would really tip the balance toward a sustainable mobility system, reducing the negative impact on the per capita carbon footprint of the city's inhabitants and improving traffic flow in urban spaces.

Continuing with the development of the work, a Program and Guiding Concept were formulated for the design proposals, focusing on what it ideally means to have a private vehicle and how to convey that essence and emotionality to a new urban public transport service that prioritizes accessibility and the user experience as an individual.

Continuing with the stage of proposing alternatives, an initial configurative search was carried out to understand the layout of the spaces in the bus interior and different viable layouts. Based on this research and the data obtained from the surveys, it was decided to divide the interior into spaces of maximum comfort for long journeys and spaces for quick use for shorter trips, thus achieving a balance between capacity and habitability. Based on this, work was carried out on the final design proposal that responds to the problem posed. Emphasis was placed on sustainable construction and the proposed morphology and materiality to create a high-quality living space for the individual user. Although the project initially focused on designing the passenger compartment, the aim is to lay the foundations for its implementation in a new subscription-based service system that focuses on the user and learns from them.

The result of the creative process is Habit, a brilliant mobility service. Its name alludes to the design concept, which seeks to change current mobility habits and foster a sense of pride and prestige in innovative and sustainable urban mobility. Habit uses a platform of vehicles designed as habitable modules so that people's journeys take place in a space of autonomy, safety, privacy, and comfort on a par with that of a private vehicle.

As for the viability of the project, it is essential to clarify that although

it is technically and productively feasible to implement, it is part of a forward-looking framework that requires a multidisciplinary macro-restructuring of the patterns of urban mobility. The public and private sectors must come together to create guidelines that chart the course we must take as a society in terms of sustainable mobility.

In an act of sincerity, I must admit that I am a lover of cars and their design in particular, so that the project could go against my passion. However, I also understand that the specific mobility pattern as we know it today is unviable both economically and environmentally in the long term. That is why I am developing my final degree project based on this issue.

Looking ahead to the future, there are various proposals for mobility solutions for the city of Córdoba, the region, and the world. As an example, it is interesting to cite Franco Gramaglia's Architecture Thesis, which focuses on developing a train system along the ring road instead of the fourth lane to connect the entire ring efficiently and slow down the horizontal development that the city has been undergoing. (La Voz del Interior, 2022 tren-por-la-circunvalacion--el-proyecto-para-rodear-la-ciudad-_a62a35e0683a0a177b2dd04 8d). Like this one, there are many attempts to rethink mobility in different professional areas, and they can be combined. Still, a clear vision for the future, designed by professionals and the state as a whole, is needed.

Finally, due to the project's scope and time frame, only the design of the furniture for the passenger compartment was developed. The proposal for a new service as a business model was investigated. Still, the door remains open for its continuation in the future, thus completing the project as a whole and integrating it into the broader restructuring of mobility patterns in the city of Córdoba, Argentina.

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