

Article

An Integrative and Sustainable Workplace Mobility Plan: The Case Study of Navantia-Cartagena (Spain)

Pilar Jiménez * , David María-Dolores and Stephany Beltrán

Department of Mining and Civil Engineering, Technical University of Cartagena, 30203 Cartagena, Spain; david.mespejo@edu.upct.es (D.M.-D.); stephany.beltran@edu.upct.es (S.B.)

* Correspondence: pilar.jimenez@upct.es

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Abstract: The United Nations Sustainable Development Goals have been the strategic aims of many interventions in society recently. Navantia has developed a Sustainable Workplace Mobility Plan motivated by Sustainable Development Goal 11, Sustainable cities. Navantia is a leading Spanish company in the design and construction of high technology military and civilian vessels. This project is focused on the Navantia facilities in Cartagena. A workplace mobility plan has been developed to encourage sustainable mobility, promoting access on foot, by bike, by scooter, and using public transport to travel to and from the company's facilities. The methodology used is based on the European Guidelines for developing and implementing a sustainable urban mobility plan. Thus, the current accesses and their mobility characteristics have been studied in detail, and surveys have been conducted among the company's employees. A diagnosis of the situation has been elaborated. To solve the identified problems, three sets of measures have been developed: (i) improved access measures; (ii) management of car park areas; and (iii) soft measures. The economic cost of all these measures has been estimated, as well as the related carbon savings. As a result, a complete sustainable workplace mobility plan has been designed from an integrated point of view to encourage sustainable mobility, not only for the company's employees but also for all the inhabitants of Cartagena, to transform the city into a place with good quality of life now and in the future. This practical case can serve as a reference for other companies that want to foster sustainable mobility among their employees, even when they are subject to urban constraints.

Keywords: Sustainable Workplace Mobility Plan; mobility management; urban sustainability; active modes; low emissions; commuter trips

1. Introduction

Work mobility is the main reason for daily commuter trips in urban and metropolitan areas [1,2]. Work mobility is defined as the set of movements, of people and goods, that occurs in a company and its surroundings. Cars are the mode of transport that is used in the greatest proportion, despite being an inefficient alternative due to energy and space consumption. Some of the well-known negative impacts of cars are an increased number of accidents, emissions, and expenses, and loss of time. Thus, it is necessary to consider other forms of transport, such as walking or using bicycles, scooters and public transport [1–3].

In recent years, the European Union has increasingly focused on the development of sustainable urban transport and has introduced directives, guidelines and numerous projects and initiatives [4–6]; for example, the Urban Mobility Observatory ELTIS website [7], where the essence of a Sustainable Urban Mobility Plan (SUMP) is explained in detail; or the CIVITAS SUMP project [8], which evaluates the implementation of measures in the economic, energy, environmental, social, and transport areas in

all the countries in Europe. This project elaborates a policy paper for national decision-makers on how to improve national frameworks for SUMP support as well as directing support to three countries.

A Sustainable Urban Mobility Plan (SUMP) is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation and evaluation principles. They include integrated sets of technical, infrastructural, policy-based, and soft measures [7,9,10]. According to [11], the main objectives of a SUMP are to reduce the need to travel or to travel long distances (a reasonable travel time is targeted in a SUMP), and to achieve a modal shift to public transport, cycling and walking.

Numerous documents have focused on the assessment of SUMP from different points of view. There are studies examining the business and health benefits of encouraging employees to adopt more sustainable travel [12,13]; studying the viewpoints of influential stakeholders active at a local or national level [14]; exploring the most appropriate strategy to adopt on the topic of transport models [15]; identifying the level of implementation of SUMP among 15 EU capital cities, including freight transport [16]; and how to incorporate climate change targets and social equity issues into the most adequate monitoring indicators for measuring policy progress in the next generation of SUMP [17].

A workplace mobility plan is a specific SUMP focused on commuting. It can be defined as a set of measures that an employer puts into place to encourage and enable staff to travel to work more sustainably [18]. Some governments are adopting guidelines for their countries and cities. For example, the United Kingdom, through the Department for Transport [19,20]; Spain with the Institute for Diversification and Energy Savings [2]; or Canada with the Victoria Transport Institute [21].

Among the specific studies about workplace mobility plan initiatives, the results of Ref. [18] are highlighted. They assessed what some workplace travel plan initiatives have achieved in the UK and examined the factors that determined whether these initiatives were successful. The need for an overall plan that addresses car parks, the improvement of alternative travel modes and a more comprehensive national strategy, together with the definition of mode-specific measures complemented by marketing initiatives and general working practices are some of the conclusions reached. From the employee's perspective, assessment of the effectiveness of mobility plan measures has been evaluated based on stated preference surveys [22]. The surveys were applied in different business sectors in Bogotá (Colombia) to employees of medium-to-large companies in the city. Implementation of company bus services, facilities for bicycles and parking policies are the strategies that could influence employees and foster a modal shift towards active and sustainable modes of transport according to the results.

The current tendency of travel plans is to link mobility objectives with internal motivation and business objectives [23]. Examples of this would be addressing accessibility problems but ensuring that congestion and car park shortages do not constrain the growth of the company, reducing carbon emissions or giving benefits packages to employees to integrate the travel plan personally. In fact, the perceived benefits of sustainable transport include a decrease in stress levels and staff wellbeing is improved. Consequently, awareness is raised among managers, who start believing that an increase in sustainable transport modes for commuting is beneficial for their companies, even if these benefits were indirect and difficult to quantify [24].

Navantia is a leading Spanish, state-owned company in the design and construction of high technology military and civilian vessels, located in the city of Cartagena (Spain). As a company, it is concerned with climate change; excessive emissions of CO₂ and the accessibility problems caused by local traffic congestion; and difficulties linked to poor public transport, bicycle and pedestrian access.

The aim of this study is to promote sustainable urban mobility in the surroundings of Navantia's installations. The Sustainable Workplace Mobility Plan (SWMP) is focused on the movement of people to promote and increase the use of sustainable modes of transport, such as walking, cycling, personal mobility vehicles (scooters) or an increased use of public transport. The main challenge to this is the location of the firm because Navantia is in a consolidated area in the city center, with little space

available to build new infrastructures. The objective of the plan is to reduce the use of cars to improve the quality of life, not only in the company environment but also in the city of Cartagena.

This study, and its future implementation, is aligned with the Sustainable Development Goals (SDG) that guide current interventions in countries. Specifically, it is motivated by SDG 11—Sustainable Cities and Communities, as it seeks to provide access to safe, affordable, accessible, and sustainable transport systems for all and to improve road safety. In addition, strengthening positive economic, social and environmental links between the different areas of the city of Cartagena and Navantia are among the expected results, thereby fostering local and regional development planning.

This SWMP is explained in the paper. In Section 2, the methodology used is briefly described. In Section 3, the current situation from a mobility point of view is characterized. Section 4 explains the main results of surveys given to the company's employees. In Section 5, the proposals for improved mobility are described, and conclusions are drawn in Section 6.

2. Methodology

A sustainability planning process must be comprehensive and integrated. It should consider all the significant objectives, impacts and options. Hence, this SWMP has followed the European Guidelines for SUMP [9] (Figure 1). The SUMP cycle consists of four phases, each of which is subdivided into three steps (for a total of twelve steps in the planning cycle). All four phases of the cycle start and end with a milestone. The milestones are linked to a decision or an outcome necessary for the next phase and which mark the completion of the previous phase.



Figure 1. The 12 Steps of Sustainable Urban Mobility Planning. Source: Guidelines for developing and implementing a sustainable urban mobility plan (2nd Edition). Rupprecht Consult (editor). 2019. [9].

In this paper, only the results of activities 3 and 7 are explained for brevity. Activity 3 (analyze mobility situation) is the final task of the first phase where the planning context is defined. Existing plans or legal requirements are identified; the mobility situation from the perspective of all transport modes are analyzed; and the participation of employees is considered to learn their opinions about the existing access and their views about the travel plan. Numerous meetings have been held among the managers of Navantia and the planning team to define the strategic direction of the SWMP. This fluid communication has allowed us to develop parts of phase three, specifically, activity 7 (select sets of measures), where sets of measures are chosen to achieve the agreed-on objectives and targets. At the time of writing this document, the measures were being presented to political stakeholders and the public.

Specifically, the methodology used consists of the following steps:

1. Creation of an inter-departmental core team and definition of the research goals. The workgroup is created with Navantia representatives and transport engineers. This group allows orienting and limiting the scope of the plan to be developed, since the general objectives to be pursued are defined.
2. Literature review. Documents on sustainable workplace mobility plans such as policy documents, academic papers, technical reports, and case studies are reviewed.
3. Definition of planning context and data collection. Factors that will have an impact on the planning process, such as existing plans or legal requirements, are identified. A detailed study of the company's accesses and their mobility characteristics has been carried out to determine the transport infrastructure. In addition, surveys to all the employees were conducted to find out the schedules and transport modes used to access the factory.
4. Diagnostic assessment. Data from the previous step has been analyzed to elaborate a diagnosis of the situation. Problems to solve and opportunities to take advantages related to mobility are identified. This stage is the starting point of the proposals described in the next step.
5. Measures planning. Strategies to achieve a sustainable workplace mobility plan are proposed. Different solutions to solve the identified problems are described with an approximate budget of their execution cost.

The objective of these proposals is to encourage sustainable urban mobility, promoting access on foot, by bike, by scooter, and using public transport to travel to and from the company's facilities. Intermodality and synergies among the different modes of transport, together with the management and regulation of parking lots to minimize conflicts among the different modes of transport, are the ultimate goals.

3. Characteristics of Study Area

Navantia is a leading Spanish, state-owned company in the design and construction of high technology military and civilian vessels with strategic facilities in the Spanish cities of Ferrol, Cádiz, Madrid and Cartagena. Navantia also maintains subsidiaries, offices and delegations abroad, which allows the company to work closely with clients and partners in strategic markets, such as the USA, Brazil, Norway, India, and Australia, among others.

This SWMP is focused on the facilities in Cartagena, which have a total of 2500 employees (including auxiliary industries). The main characteristic of this company is its location. Unlike other companies or industrial areas located outside of cities, an important conditioning aspect of this company is its physical limitations inside the city. Navantia-Cartagena's boundaries are established by the Cartagena Military Arsenal to the North, the Rambla of Benipila to the West (an intermittent river) and the Castle of Galeras to the South (Figure 2).

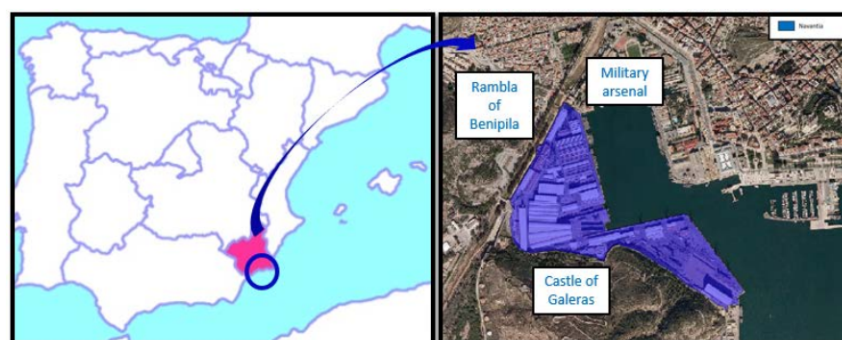


Figure 2. Geographic location of Navantia's Cartagena facilities and its urban boundaries. Source of background: Google Earth.

Several items have been studied in detail to characterize this area, in particular: an inventory of streets, accessibility, car parks, cycle-lanes, public transport, and urban planning conditions. Only the main conclusions of each issue are shown.

3.1. Access Routes

Navantia-Cartagena has two access routes, the Algameca road, for all types of vehicles and pedestrians, and the Elephant walkway, for pedestrians and non-motorized vehicles; that is, personal mobility vehicles like bicycles and scooters (Figure 3).

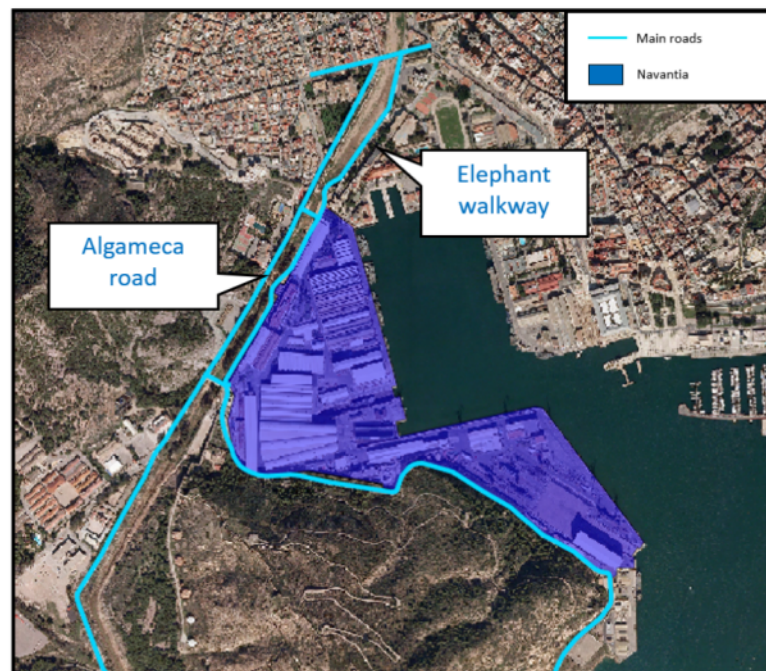


Figure 3. Access routes to Navantia-Cartagena. Source of background: Google Earth.

From the pedestrian point of view, the Algameca road is the only one with pavements, an acceptable road surface and enough lighting and signaling, although this infrastructure could be improved for intermodal mobility. In contrast, the Elephant walkway has a deteriorated surface, insufficient lighting and signage and poor maintenance (Figure 4).



Figure 4. (a) The Algameca Road and (b) The Elephant walkway. February 2020.

Although there are nearby bike lanes, none of the access roads to the company have bike lanes. Thus, it is difficult to access the factory using this mode of transport due to the lack of infrastructure facilitating direct connections (Figure 5).

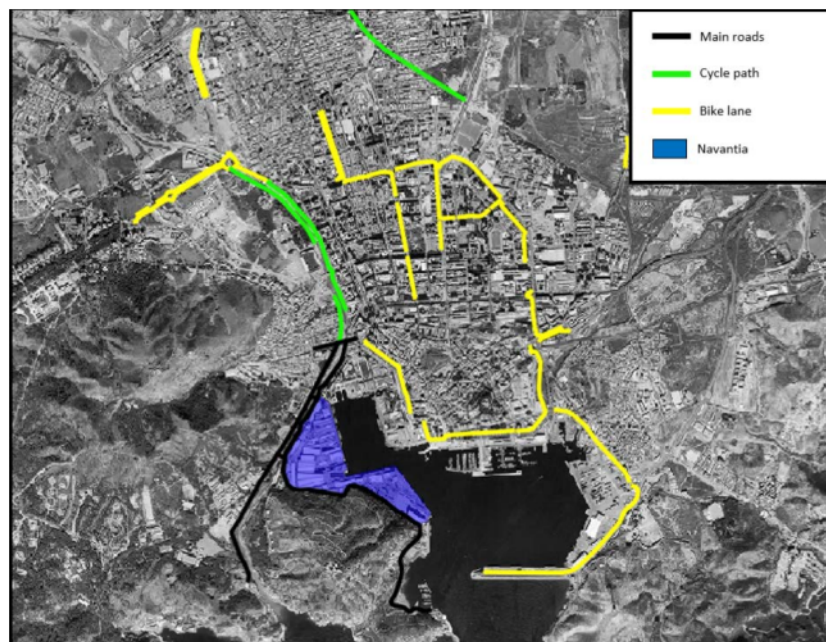


Figure 5. Bike lines and cycle paths in Cartagena (Spain).

3.2. Public Transport Stops

Regarding public transport, there are 10 bus lines stopping at an acceptable distance from the company (1500 m in the case of the farthest) (Figure 6). However, the schedules and frequencies make it difficult for employees to use. It is necessary to improve the operation of these lines.

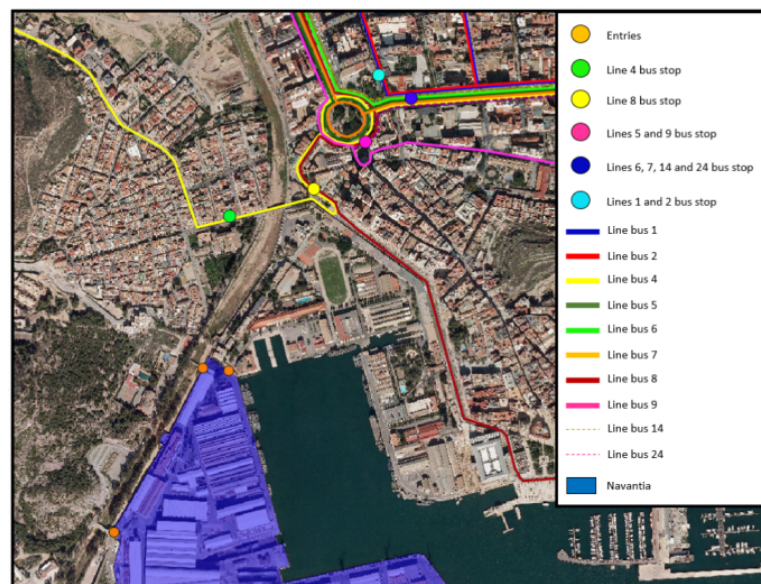


Figure 6. Public transport stops near Navantia.

From the point of view of intermodality, Cartagena has three stations (FEVE, RENFE and bus station) located approximately 2 km away from the closest access to Navantia. This distance is too far for pedestrians, considering that it takes between 25–30 min. to walk. However, it could be possible to travel by bicycle (6–8 min) or with a shuttle bus service.

3.3. Modal Split to Navantia Access

Navantia has six access points: Cortadura, Santa Rosalía, Carenas, Carenero, one reserved for heavy vehicles, and one from the Arsenal military facilities (limited to authorized personnel only). In relation to the Cortadura entrance, Figure 7 shows that 84% of the entries are produced on foot because of its proximity to the city center; 10% correspond to employees who use bicycles as their means of transport and the remaining 6% access using personal mobility vehicles like scooters. Santa Rosalía is the main entrance to the factory for employees and visitors, and it allows entrance to all modes of transport; that is, motor vehicles, pedestrians, cyclists, and scooter users. Considering that there are two large car parks nearby, 76.6% of the entries are on foot, while 19.6% correspond to workers who enter the factory in their own vehicles; 3.3% of employees choose to use bicycles to go to their jobs and only 0.5% use a personal mobility vehicle at this access (Figure 7). The Carenas and Carenero entrances are only for pedestrians and authorized employees.

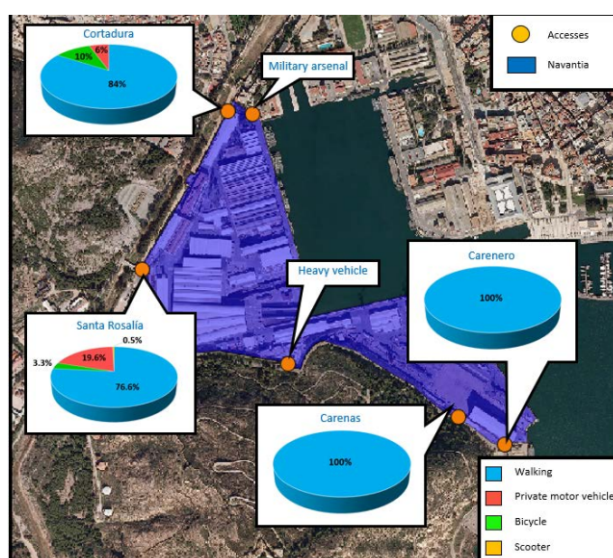


Figure 7. Distribution of modes of transport at the accesses to Navantia on an average working day.

In general, 78.1% of employees gain access on foot, 17.8% enter by car (only those who enter inside the factory by car are considered), 3.7% of employees use bicycles, and 0.4% of the staff members use a scooter or similar personal mobility device (Figure 8a). Moreover, Figure 8b shows that Santa Rosalía is the main entrance to the factory because 90.7% of workers use this access on an average day. The Cortadura access is used by 5.9% of employees, whereas the Carenas and Carenero entrances, both only for pedestrians and authorized employees, are used by 3.4% of workers.

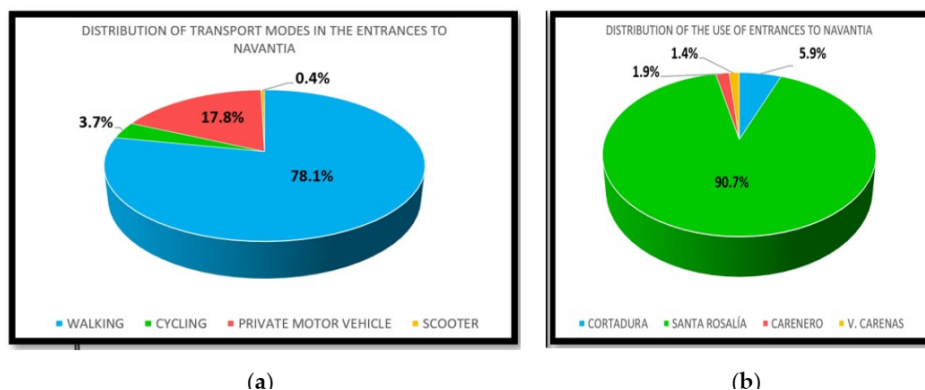


Figure 8. (a) Distribution of modes of transport at Navantia entrances and (b) usage percentage at each access for an average working day.

3.4. Car Parks

Navantia-Cartagena has a total of three conditioned car parks with 1002 parking spaces overall, of which 857 correspond to four-wheeled vehicles, 143 are for motorcycles, and 2 are exclusively for people with reduced mobility (Figure 9a). On the other hand, there are three other unconditioned parking areas with approximately 183 parking spaces (Figure 9b).

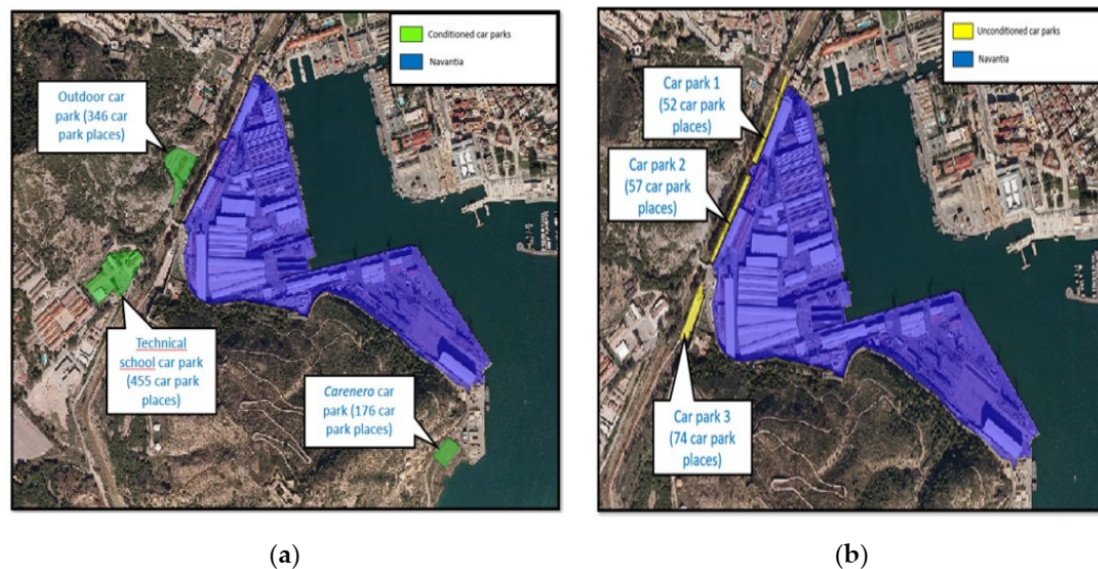


Figure 9. (a) Conditioned car parks near Navantia. (b) Unconditioned parking areas near Navantia.

3.5. Urban Planning Conditions

Because of the geographic location of the factory, there are several limitations due to the different conditions arising from protection to forest, hydraulic, maritime, and defense areas. This set of conditions is an obstacle to overcome in order to carry out the proposals described in the following sections. The most relevant one is that related to the Public Hydraulic Domain because all the roads are affected by rain with a return period (T) of 50 years (Figure 10), extreme events which are increasing due to climate change.

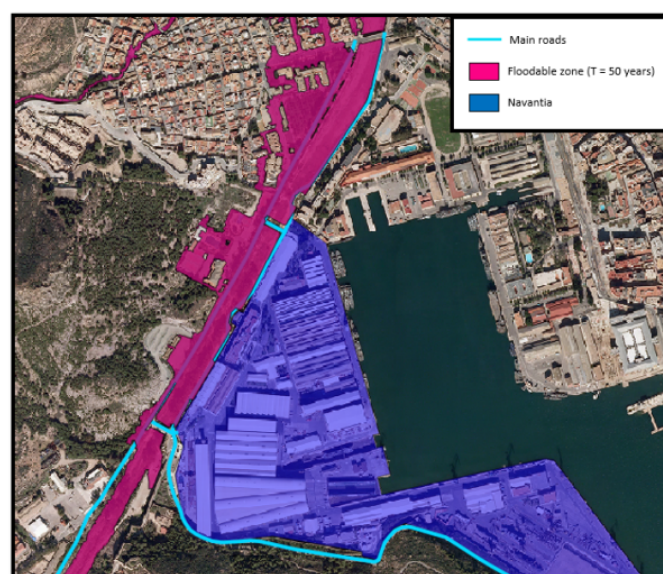


Figure 10. Floodable zone for a T = 50 years on the Rambla of Benipila. Source: Prepared by the authors from the database of the Segura River Hydrographic Confederation [25].

In short, Navantia has two access roads, the Algameca road and the Elephant walkway. The Algameca road does not have bike lanes and the width of its two pavements is insufficient for use by pedestrians with a minimum degree of safety; while the pedestrian path is in poor condition with faulty paved surfaces and insufficient signage and lighting.

Navantia has six access points. However, the fact that 90.7% of employees access the factory through the Santa Rosalía entrance causes traffic jams during peak hours (6.00–7.00 and 14.00–15.00). The rest of the accesses, Cortadura, Carenas and Carenero, are used by the remaining 8.3% of workers.

There are car parks outside the facilities, however, there are no bike lanes, and it is necessary to improve the characteristics of the public transport lines to provide a good enough service to make the use of buses a viable option.

4. Analysis of Mobility Survey Results

A survey was conducted to learn about employees' mobility patterns during the first 2 weeks of March 2020. That date has been decided for considering normal weeks, without holidays or extraordinary activities of the company. A total of 496 anonymous surveys were received from the company's 2500 employees, with a participation rate of 20%.

The survey is structured in five parts (see Appendix A):

- *Personal data.* This section provides an overview of the profile of the employees (anonymously), where they come from, and, therefore, the daily journey they make.
- *Work schedule.* This allows us to calculate the peak hours in the area based on the entrance and exit times of the employees.
- *Mode of transport to work.* The main mode of employee transport is identified, and we ask about their reasons for using that mode of transport.
- *Private motor vehicles.* For those who mostly use private vehicles as their means of transport, we ask a little more about the characteristics of their trip, such as the time it takes them to park and the use of car-sharing.
- *Sustainable mobility.* The purpose of this section is to find out about employees' willingness to use different sustainable modes of transport and what characteristics would promote their more frequent use. At the end of this section, an open question is left for each respondent to express their opinion and proposals for the improvements that they consider appropriate.

From the point of view of age, the results show a good representation of the employees' considerations towards sustainable mobility because all the main age groups have been represented in similar percentages (Figure 11). Twenty-six percent of the workers between 51–60 years old and those between 31–40 years old responded to the questionnaire. The intermediate group between 41–50 years old was the most highly represented with 30%. These three age groups represent 82% of the completed surveys. At the extremes, 16% of those surveyed are between 61–70 years old, while the youngest groups represent 2 and 0.2%.

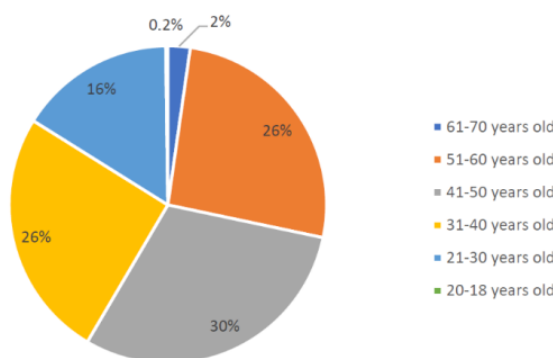


Figure 11. Age groups of survey respondents.

The factory's area of influence is regional, including 13 different towns (only 1% come from cities more than 100 km away); 87.7% of the workers come from Cartagena, of which 62% live in the central districts of the city.

The peak hours are 6: 00–7: 00 a.m., the time employees enter to work, and 2:00–3:00 p.m. for the departure period.

In relation to the modal split (Figure 12), according to the data extracted from the surveys, 67% of employees use cars as their means of transport to travel to work every day, 62% as drivers and only 5% as passengers. As the second and third most popular modes of transport, 14% of workers go on foot and 10% on bicycles, followed by motorcycles with 8%. Scooters are the option for 1% of employees. Therefore, 25% of the respondents use sustainable modes of transport. However, collective modes of public transport, such as buses and trains are not represented in daily use because of their poor operation in relation to the company. Comfort and speed are the main reasons for choosing cars and walking.

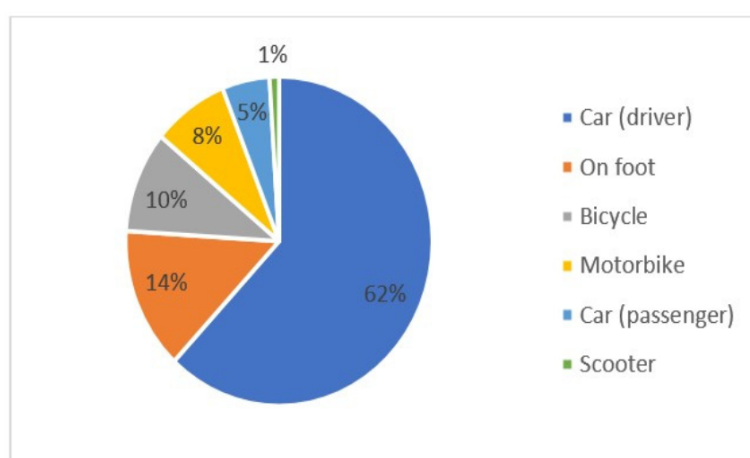


Figure 12. Modal split for an average working day.

For car users, increases in travel time are related to traffic jams at departure time (43%) and in the surroundings of Navantia (26%), together with finding a parking space (26%). The average time needed to find a parking space varies between 5 and 15 min.

In order to understand an employee's views about sustainable mobility, preference questions were asked to learn their willingness to use more sustainable modes of transport, considering that improvements are needed. From a pedestrian point of view, 76% of respondents agree that the urban environment is inadequate (Figure 13). Improvement of pavements, illumination, cleaning and bike lanes are the most frequently requested upgrades.

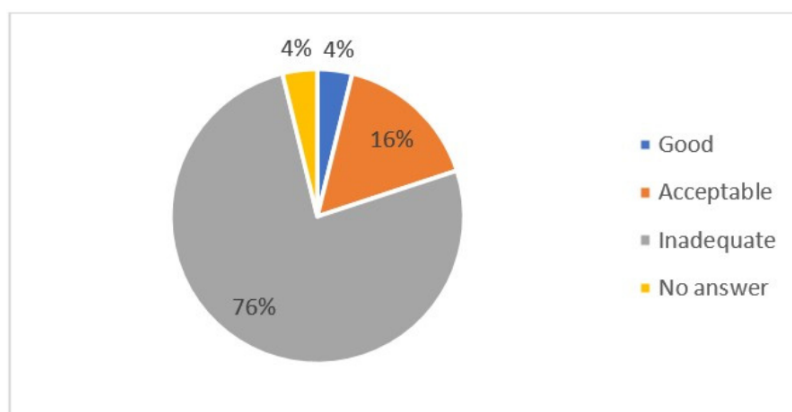


Figure 13. Value of the urban environment of Navantia.

Seventy-seven percent of the employees surveyed confirm the lack of adequate infrastructure for cycling. More bicycle parking spaces closer to the company are requested by 10%. Other options are the implementation of a flexible schedule and offering a bicycle rental service (Figure 14a). In a similar way, increasing the use of personal mobility devices such as scooters depends on having safe and comfortable roads (36%), appropriate legislation (25%) and minor measures, such as charging points, parking spaces, scooter rental services, and a flexible schedule (Figure 14b).

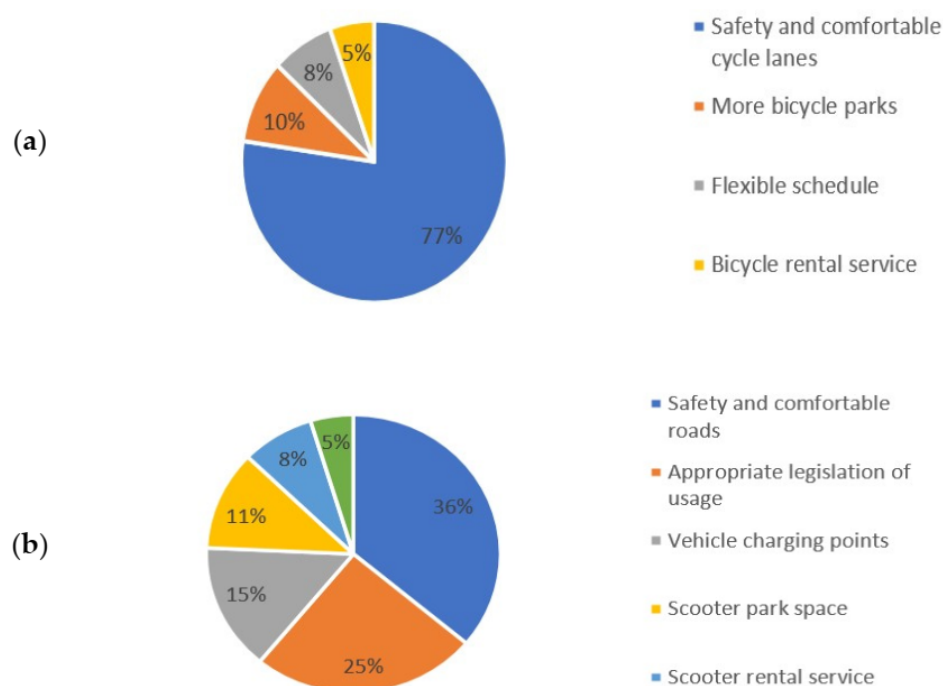


Figure 14. (a) Preferences to make cycling more attractive among employees; (b) preferences to make scooters more attractive among employees.

To make the public bus service competitive, almost half of the employees ask for better operation with more frequency, appropriate schedules or some improvements in the current routes. Twenty-nine percent approve of a bus service operated by Navantia; that is, a regular service adapted to company requirements. New bus routes and a monthly bus pass are other suggestions (Figure 15).

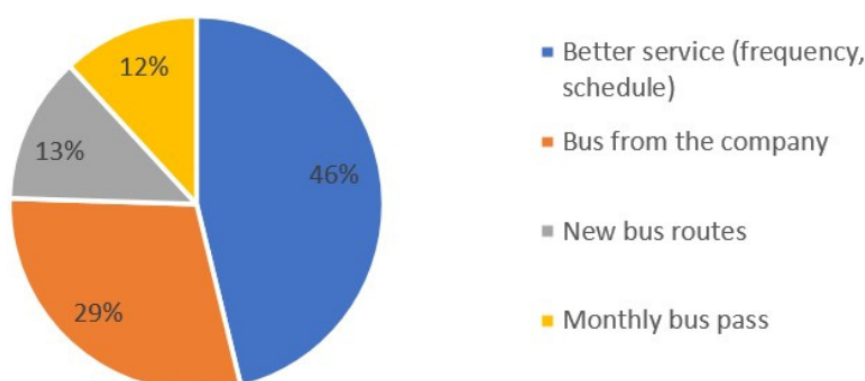


Figure 15. Suggestions to make public bus service more attractive among employees.

Therefore, although cars are the most frequently used mode of transport, the surveys show employees' willingness to change to sustainable modes of transport, provided that some improvements were carried out. To sum up, employees support (i) improvement of the infrastructures that provide

access to the factory; (ii) consciousness-raising to encourage usage of sustainable modes of transport; and (iii) incentive measures, such as flexible schedules, bus passes and bicycle/scooter rental services.

5. Proposals for Improvements in Sustainable Mobility

The SWMP should encourage sustainable mobility through the rational use of private cars and make intermodality easier among public transport, bicycles, scooters, and pedestrian areas.

Guidelines and examples of sustainable mobility plans have been studied as references for this project [2,7–10]. These references provide an overview of possible measures to promote sustainable mobility. Consequently, a wide variety of measures were identified (see first column of Table 1) and grouped in different policy types: demand management, infrastructure investments, pricing and financial incentives, and traffic management and control.

Table 1. The cross-matrix analysis of the measures and objectives to select those measures that best contribute to meeting the objectives.

MEASURES	STRATEGIC OBJECTIVES					
	Promoting Access on Foot	Promoting Bicycle Access	Promoting Scooter Access	Promoting Public Transport	Parking Areas Regulation	Reducing the Need of Travel
DEMAND MANAGEMENT						
Sustainable travel information	✓	✓	✓	✓		✓
Bike-sharing scheme		✓				
Carpooling						✓
Delivering and servicing plans			Not apply			
Land—use planning					✓	
INFRASTRUCTURE INVESTMENTS						
Bus network and facilities				✓		
Walking and cycling networks and facilities	✓	✓	✓			
Park and ride					✓	
Tram/metro networks and facilities			Not apply			
Urban delivery centers/city logistics facilities			Not apply			
PRICING AND FINANCIAL INCENTIVES						
Congestion and pollution charging					✓	✓
Parking regulation and pricing					✓	✓
Public transport integrated ticketing				✓		
TRAFFIC MANAGEMENT AND CONTROL						
Legal framework of urban freight transport			Not apply			
Prioritising Public Transport				✓		
Access regulation (road/parking reallocation)	✓	✓	✓		✓	
Traffic calming measures	✓	✓	✓	✓	✓	

A cross-matrix analysis of the measures and objectives was carried out to select those measures that best contribute to meeting the objectives (see Table 1).

The results of the cross-matrix were assessed by the workgroup to obtain a set of effective measures that realistically fit with the available resources and local circumstances. Accordingly, a shortlist with the most promising measures was obtained, classifying them into three groups:

- **Measures to improve accesses.** The designing of a safe, homogeneous and efficient network of bike lanes is proposed to encourage the use of bicycles and other personal mobility devices like scooters. Moreover, the improvement of pedestrian access by modifying pavements, road surfaces and lighting is proposed.
- **Management of car parks.** Management and regulation of the company's car parks, both the conditioned ones and the unconditioned parking areas.
- **Soft measures.** Set of suggestions whose implementation the company could evaluate, such as, the possibilities of implementing flexible schedules, teleworking, awareness campaigns, a new company bus line for employees or a possible ferry service within the Cartagena dock that would connect the city center with the factory.

Note that all the measures are required. That is, all of them must be put into practice at the same time to obtain successful results for the company and the city of Cartagena. Next, the main measures studied are explained briefly.

5.1. Measures to Improve Accesses

The first measure proposes improving the Elephant walkway. The actions to execute are the improvement of the paved surface (draining pavement), the installation of more streetlamps and the elimination of 109 parking spaces to give more space to pedestrians, bicycles and scooters. To this end, a green path is designed, whose circulation area is shared by the different sustainable modes of transport (Figure 16). Cars and motorcycles are banned. The estimated budget for this measure is 646,286.59 €.

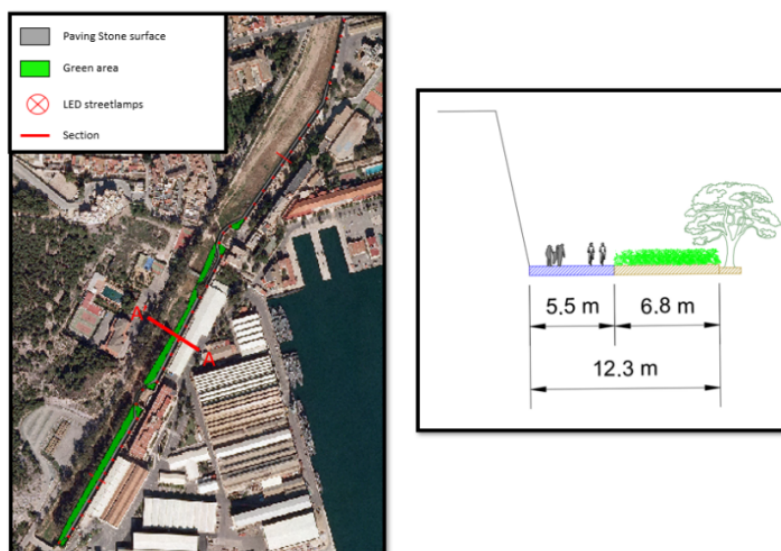


Figure 16. Proposed improvements to the Elephant walkway and cross-section.

The second measure proposes modifications to the Algameca road to transform it into a cycle-street. More streetlamps and wider pavements are also considered. Traffic diverters and speed humps are placed to reduce the speed of the road to 30 km/h, a safe environment for cyclists and scooter users. On the right side of the road, the embankment is eliminated to gain space for pedestrians and parking areas (84 parking spaces), with a total estimated budget of 505,932.94 € (Figure 17).

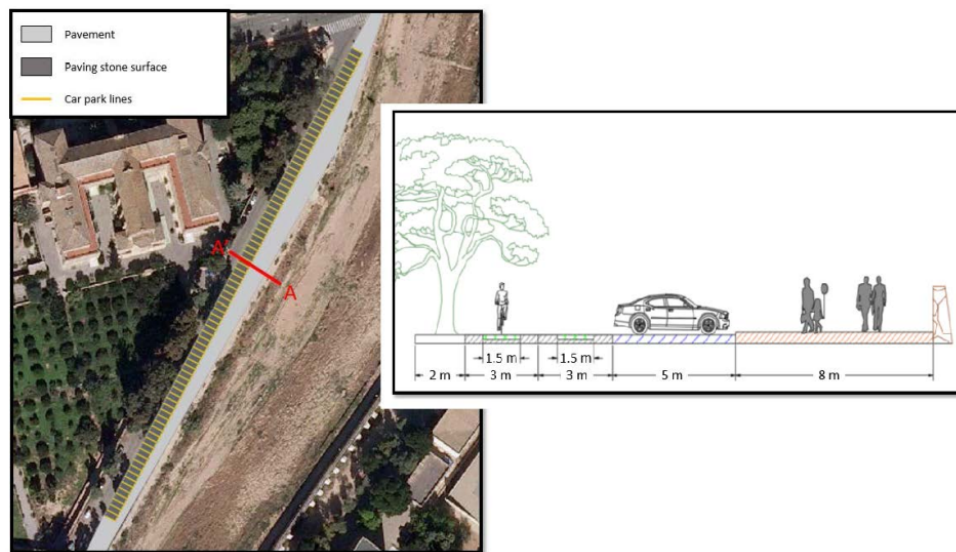


Figure 17. Proposed improvements to the Algameca road and cross-section.

5.2. Management of Car Park Areas

This set of measures is focused on improvements to the two car park areas (Figure 18). It is important to note that the measures have not only focused on the organization of the car parks to optimize space, but also on the improvement of the area. Permeable pavement to avoid the accumulation of the water that collects during heavy autumn rainfalls has also been proposed. Moreover, using green or brown pavement and wooden logs to separate the different parking lots provides a pleasant appearance (Figure 19).

A total of 183 parking places are improved with an estimated cost of 353,025.58 € in Car Park 3 (Figure 19). For the Outdoor Car Park area, 298 parking spaces are optimized together with the adaptation of the entrance and exit gates to facilitate access to emergency vehicles (Figure 20). The estimated budget for this measure is 179,939.14 €.

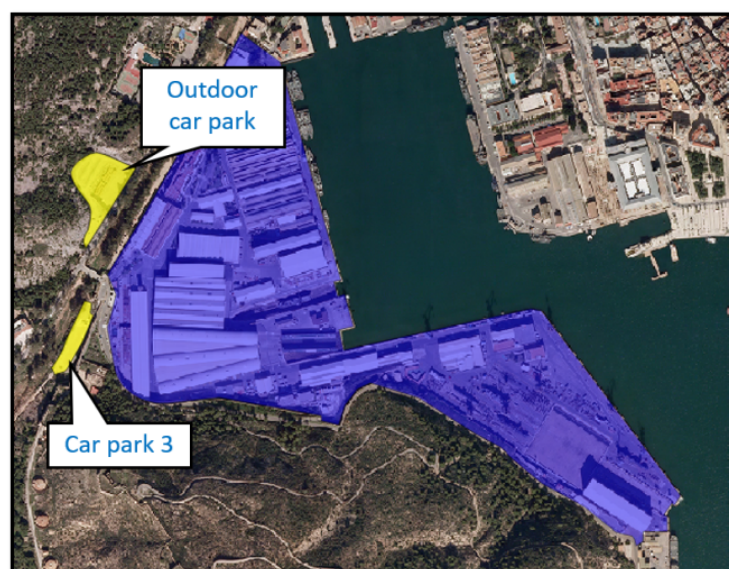


Figure 18. Car park areas to improve.

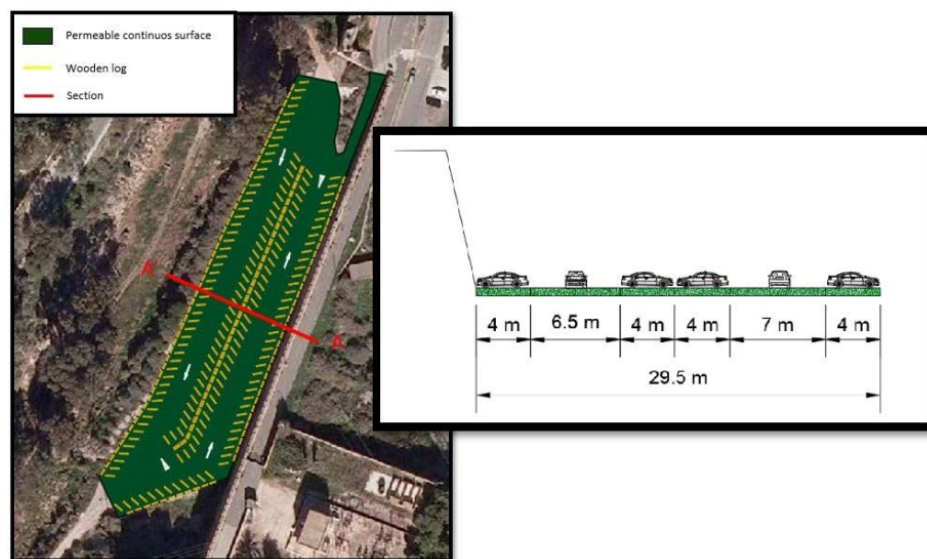


Figure 19. Proposed improvements to Car Park 3 and cross-section.

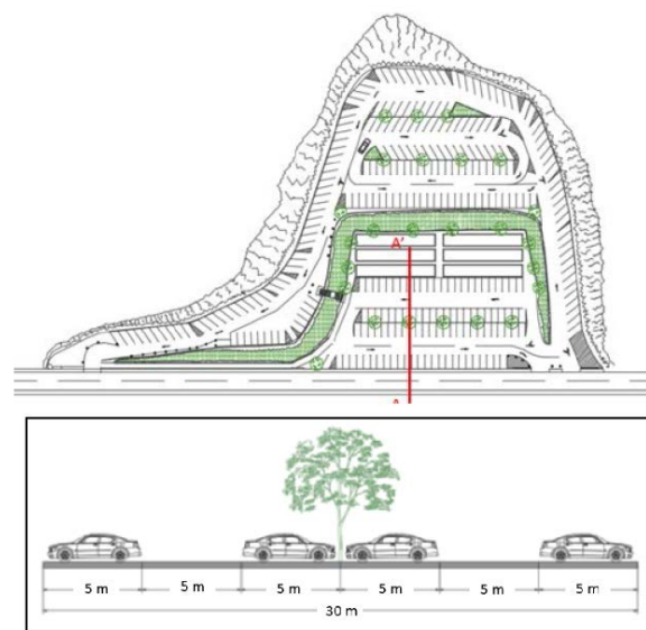


Figure 20. Proposed improvements to Outdoor Car Park and cross-section.

5.3. Soft Measures

A set of suggestions whose implementation the company could evaluate are presented. For example, 25 new parking spaces for people with reduced mobility inside the company are proposed to achieve the recommended accessibility ratio.

A sustainable option is to provide a bus pass for company employees to foster the use of public transport, in addition to schedule changes adapted to company timetables. Launching a new company bus line for employees could be a good option. Moreover, establishing covered parking lots for bicycles and scooters, or even rental services of these vehicles among employees, are other suggested measures.

Transport by ferry from the Alfonso X pier to Carenero pier, inside Navantia, would be another option, considering shared responsibility for its operation by the Cartagena City Council and the Cartagena Port Authority to expand the use of this service to the city (Figure 21).



Figure 21. Ferry line suggested between Navantia and Cartagena city center.

Different policies related to the reduction of trips to work have also been discussed, such as the implementation of teleworking in some divisions of the company and flexible timetables.

Table 2 provides the budgets of the assessed measures. The estimated budgets have been calculated based on an official pricing database, which is produced by an architecture, engineering and construction software every year [26]. The total estimated budget is 2,389,409.64 € (see Appendix B for more detail). It is important to note that, although the budgets of the first two sets of measures are adjusted to real values with a margin of error between 3% and 5%, the budget for the soft measures is indicative. They are estimates based on assumptions about the number of employees to be served. However, it would be necessary to contact specialized companies (depending on the measure) as well as define the scope that the measure would cover and/or the phases of implementation to obtain a more accurate value.

Table 2. Summary of the budget of all the suggested proposals.

	Proposals	Budget (€)
I	Elephant walkway improvement	646,286.59 €
	Algameca road improvement	505,932.94 €
II	Car park area 1: car park 3	353,025.58 €
	Car park area 2: outdoor car park	179,939.14 €
III	Policies related to private motor vehicles	286,483.36 €
	Policies related to sustainable modes of transport	417,742.03 €
		2,389,409.64 €

An estimated study has been carried out about how much CO₂ would not be emitted by implementing the proposed measures, according to the results of the survey and the preferences for change stated by the respondents. For this calculation, the decrease in kilometers travelled by Navantia employees and the decrease in vehicles that go daily to the company, estimated at 683 vehicles, have been considered. To calculate the savings of kilograms of CO₂ per passenger-km not emitted into the atmosphere, these average values are calculated: an emission of 0.069 kgCO₂/p-km for buses and an emission of 0.133 kgCO₂/p-km for cars. These multipliers define the amount of CO₂ emitted per passenger and per kilometer for a given mode of transport [27]. Table 3 provides the savings of kg CO₂ per day of each proposed measure. It is estimated that 805.03 kg of CO₂/day will not be emitted into the atmosphere.

Table 3. Summary of the savings of kg CO₂ per day of each proposed measure.

	Not Emitted Kg CO ₂ /Day
Improvements to the environment: bike lane, Elephant walkway	283.02
New company bus line	353.41
Improvement of urban bus lines schedules	−97.49
Car-sharing	225.77
Ferry implementation	39.90
Emissions not released into atmosphere	805.03 Kg CO₂ /day

Taking into account 253 working days, an amount of 203,672.04 kg of CO₂ not emitted into the atmosphere per year is obtained. This figure is based on the respondents' answers and considering a change in the mode of transport used by all those surveyed, with 100% exchange preferences (optimistic hypothesis).

6. Conclusions

The presented project has been motivated by the Navantia company, according to Sustainable Development Goal 11—Sustainable Cities and Communities. It seeks to provide access to safe, affordable, accessible, and sustainable transport systems for all and to improve road safety by means of a Sustainable Workplace Mobility Plan. The main challenge is the location of the company because Navantia is in a consolidated area of the city center with little space available to build new infrastructures. Strengthening positive economic, social and environmental links between the different areas of the city of Cartagena and Navantia are the expected results, thereby fostering local and regional development.

The measures presented in detail in this document reduce the use of private vehicles as the main mode of transport to and from Navantia, offering pleasant pedestrian areas and safety on cycling routes in order to achieve an adequate balance and coexistence among the different sustainable modes of transport. These measures, together with other soft measures that the company could implement, will facilitate the reduction of private vehicle traffic and increase the number of sustainable transport users. The estimated total cost is 2,389,409.64 € and a reduction of 203,672.04 kg of CO₂ emitted into the atmosphere per year has been calculated.

This practical case shows that workplace travel plans do not need to be very expensive, and positive results can be achieved relatively quickly. However, they do require a comprehensive strategic approach and well-designed measures that match the needs of the company and the city.

This manuscript increases the scientific knowledge about workplace mobility plans by applying the Spanish guidelines of the Institute for Diversification and Energy Savings [2]. The results showcase the potential of soft measures to promote sustainable mobility even in consolidated areas with little available space to build new infrastructures. Fostering sustainable mobility implies energy savings and less congestion, considering not only employees but also inhabitants will be benefited.

From this stage, it is essential to agree on clear responsibilities, implementation priorities and timelines for each action [9]. Communication and promotion to political stakeholders, employees and citizens are necessary. Finally, the application of an ex-post evaluation would be useful to compare the theory and practice of workplace mobility plans. Moreover, the reviewing process, evaluating successes and failures, helps to consider new challenges and solutions since mobility patterns change rapidly and the Sustainable Workplace Mobility Plan should be updated to adapt to future trends.

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Appendix A

Sustainable workplace mobility plan. Towards a sustainable urban mobility in Navantia accesses

A. PERSONAL DATA

1. Home municipality: _____

2. Home zip code: _____

3. Birth year: _____

4. Gender: ☐ Male ☐ Female

5. Do you have a driving license? ☐ Yes ☐ No

6. Do you have a private vehicle? ☐ Yes ☐ No

7. Workplace:

☐ Shipyard ☐ Engines ☐ Repairs ☐ Shared services

☐ Other: _____

8. Group:

☐ Navantia ☐ Aux. Company ☐ Temporary ☐ Other: _____

B. WORK SCHEDULE

9. Work schedule: Check-in Check-out

☐ Intensive timetable: _____

☐ Split timetable: _____

☐ Other: _____

10. Do you change your Schedule in summer?

☐ No

☐ Yes, indicate it: _____

C. MODE OF TRANSPORT TO WORK

11. Indicate the order in which you use the means of transport from the origin to the workplace:

MEAN OF TRANSPORT	Everyday	3-4 days	1-2 days	Sporadic use
Walking				
Bicycle				
Personal mobility device (Scooter)				
Motorcycle				
Bus (urban/interurban)				
Train				
Private car (driver)				
Private car (passenger)				

12. Indicate the reason for using the main mean of transport:

☐ Price ☐ Lack of bus stops

☐ Quickness ☐ Less pollution

☐ Comfort ☐ Without own vehicle

☐ Inappropriate public transport schedule ☐ Without driver license

☐ Difficulty to find a park space ☐ Other: _____

13. Approximately, How much time do you spend traveling from your home to the workplace? (minutes)

Outward journey: _____ Return journey: _____

14. What reason do you think delays the time you spend traveling to the workplace the most?

☐ Traffic delays at the entrance to Cartagena

☐ Traffic delays in the surroundings of Navantia

☐ To find a car park

☐ Urban/interurban transport bad performance (only users)

Figure A1. Survey—Page 1.

Sustainable workplace mobility plan. Towards a sustainable urban mobility in Navantia accesses

D. PRIVATE MOTOR VEHICLES

15. Vehicle type:

☐ Car ☐ Motorcycle ☐ Van/truck

16. Fuel type:

☐ Gasoline ☐ Diesel ☐ Electric ☐ Hybrid ☐ LPG/CNG

17. Usual car park place:

☐ Company ☐ T. school ☐ Outdoor car park ☐ Carenero ☐ Other: _____

18. Approximately, How much time do you spend looking for parking? _____ minutes

19. How often do you travel to work with other workers during the week?

☐ Daily ☐ Once a week ☐ Twice or more during the week

☐ Occasionally ☐ Never, indicate the reason: _____

*In case of sharing, indicate the total number of passengers: _____

E. SUSTAINABLE MOBILITY

20. How would you assess the urban environment to be used by pedestrians? (condition of pavements, road surface, illumination, etc.):

☐ Good ☐ Acceptable ☐ Inadequate

In case of inadequate, How could it be improved? _____

21. Have you ever taken a personal mobility vehicle to work?

☐ Yes. Why? _____

☐ No. Why? _____

22. What would make personal mobility vehicle riding a more attractive option?

☐ Appropriate normative regulation

☐ Appropriate roads

☐ Loan service

☐ Charging points in the workplace

☐ Exclusive parking for personal mobility vehicles

☐ Flexible schedule

☐ Other: _____

23. Have you ever taken a bicycle to work?

☐ Yes. Why? _____

☐ No. Why? _____

24. What would make cycling a more attractive option?

☐ A more comfortable bike lane

☐ Better condition of the bike lanes

☐ Flexible schedule

☐ More car parks close to the work area

☐ Loan service

☐ Other: _____

Figure A2. Survey—Page 2.

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Sustainable workplace mobility plan. Towards a sustainable urban mobility in Navantia accesses

E. SUSTAINABLE MOBILITY

24. What would make the bus a more attractive option?

☐ Increased frequency
☐ Best tour
☐ Extended hours
☐ More bus lines
☐ Help with the transport pass
☐ Bus arranged by the company
☐ Other: _____

25. Would you be willing to share your commute by car with other employees of the company?

☐ Yes, only as a driver
☐ Yes, only as a passenger
☐ Yes, indistinctly
☐ No. Why? _____

26. What would make car sharing a more attractive option?

☐ Reserved parking for shared car
☐ Fuel discount voucher
☐ Tools to facilitate contact with other users
☐ Alternative transport for the round trip
☐ Flexible schedule
☐ Other: _____

We would like to know your opinion. What other proposals would you make to improve sustainable mobility?

Thanks for your participation!

Figure A3. Survey—Page 3.

Appendix B

Table A1. Estimated budget for The Elephant Walkway works. Source of prices: Database of construction prices—CYPE [26].

The Elephant Walkway				
WORKS	Unit	Quantity	Unit Price (€)	Total Price (€)
Land-clearing	M2	1919.86	0.78	1497.49
Excavation	M3	6523.27	2.98	19,439.34
Demolition	M2	2031.7	7.93	16,111.38
Graded-aggregate base	M3	1105.2	20.02	22,126.00
Paving stone surface	M2	4420.78	68.76	303,972.83
Topsoil	M3	800.88	36.39	29,144.02
Vegetation cover	M2	4004.4	10.01	40,084.04
LED streetlamps	UNIT	41	381.15	15,627.15
Road signs	UNIT	4	138	552.00
Paint for road signs	M2	47.6	6.03	287.03
TOTAL (€)			448,841.30	
BME (€)			448,841.30	
GE (13%) + IB (6%) (€)			85,279.85	
VAT (€)			112,165.44	
TOTAL GENERAL BUDGET (€)			646,286.59	

Table A2. Estimated budget for The Algameca Road works. Source of prices: Database of construction prices—CYPE [26].

The Algameca Road				
WORKS	Unit	Quantity	Unit Price (€)	Total Price (€)
Land-clearing	M2	3480	0.78	2714.40
Road clearing	M3	229.8	2.03	466.49
Structural reinforcement	M3	422.94	76.52	32,361.50
Demolition of asphalt pavement	M2	585.00	7.93	4639.05
Graded-aggregate path	M3	332.67	20.02	6660.05
Road asphalt pavement	M2	1108.90	9.89	10,967.02
Pavement	M2	1757.00	20.43	35,895.51
Permeable continuous surface	M2	15.00	182.06	2730.92
Steep reducer surface	M2	192.60	25.75	4959.45
Steep reducer	UNIT	6.00	287.18	1723.08
Scuppers	UNIT	16.00	194.04	3104.67
Removal of handrail	M	527.00	13.19	6951.13
Stainless steel handrail	M	790.00	250.20	197,658.00
LED streetlamps	UNIT	43.00	675.78	29,058.54
Road signs	UNIT	44.00	64.10	2820.38
Paint for road signs	M	2321.00	3.73	8656.53
TOTAL (€)			351,366.72	
BME (€)			351,366.72	
GE (13%) + IB (6%) (€)			66,759.68	
VAT (€)			87,806.54	
TOTAL GENERAL BUDGET (€)			505,932.94	

Table A3. Estimated budget for Car park 3 works. Source of prices: Database of construction prices—CYPE [26].

Car Park 3				
WORKS	Unit	Quantity	Unit Price (€)	Total Price (€)
Road clearing	M3	1814.4	3.43	6223.39
Land-cleaning	M2	965.59	0.78	753.16
Graded-aggregate path	M3	1008	20.02	20,180.16
Permeable continuous surface	M2	4032	49.88	201,116.16
Wooden log	M	852	19.75	16,827.00
Paint for road signs	M2	12.24	6.03	73.81
TOTAL (€)			245,173.68	
BME (€)			245,173.68	
GE (13%) + IB (6%) (€)			46,583.00	
VAT (€)			61,268.90	
TOTAL GENERAL BUDGET (€)			353,025.58	

Table A4. Estimated budget for Outdoor car park works. Source of prices: Database of construction prices—CYPE [26].

Outdoor Car Park				
WORKS	Unit	Quantity	Unit Price (€)	Total Price (€)
Road-clearing	M3	150	3.43	514.50
Land-cleaning	M2	4500	0.78	3510.00
Graded-aggregate path	M3	1200	20.02	24,024.00
Asphalt pavement milling	M2	3500	6.03	21,105.00
Pavement demolition	M2	75	7.93	594.75
Asphalt pavement	M2	70.65	9.89	698.73
Prefabricated curb	M	739	23.76	17,558.64
Removal of metal mesh	M	104.6	24.11	2521.91
Fencing area	M2	271.96	11.89	3233.60
Removal of outdoor sliding door	UD	1	32.55	32.55
Removal of outdoor folding door	UD	1	25.57	25.57
Automatic sliding door assembly	UD	2	1,511.18	3,022.36
Tree plantation (celtis australis)	UD	25	64.62	1615.50
Aptenia Cordiflora plantation	M2	1000	10.01	10,010.00
Aromatic plants	M2	50	2.34	117.00
Drip irrigation system	M2	1125	10.35	11,643.75
Safety barrier	M	220	34.19	7521.80
Reflective beacons	UNIT	26	53.61	1393.86
Road markings	M	2970	1.47	4365.90
Paint for road signs	M2	1900	6.03	11,457.00
TOTAL (€)			124,966.42	
BME (€)			124,966.42	
GE (13%) + IB (6%) (€)			23,743.62	
VAT (€)			31,229.11	
TOTAL GENERAL BUDGET (€)			179,939.14	

Table A5. Estimated budget for policies related to private motor vehicle. Source of prices: Database of construction prices—CYPE [26].

Policies Related To Private Motor Vehicle	
	Total Price (€)
Parking spaces for disabled people	8983.36
Financing of private parking spaces	85,500.00
Financing of public transport fares	192,000.00
TOTAL GENERAL BUDGET (€)	286,483.36

Table A6. Estimated budget for policies related to sustainable modes of transport. Source of prices: Database of construction prices—CYPE [26].

Policies Related to Sustainable Modes of Transport	
	Total Price (€)
Bus service for employees	41,142.03
Ferry implementation	376,600.00
TOTAL GENERAL BUDGET (€)	417,742.03

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