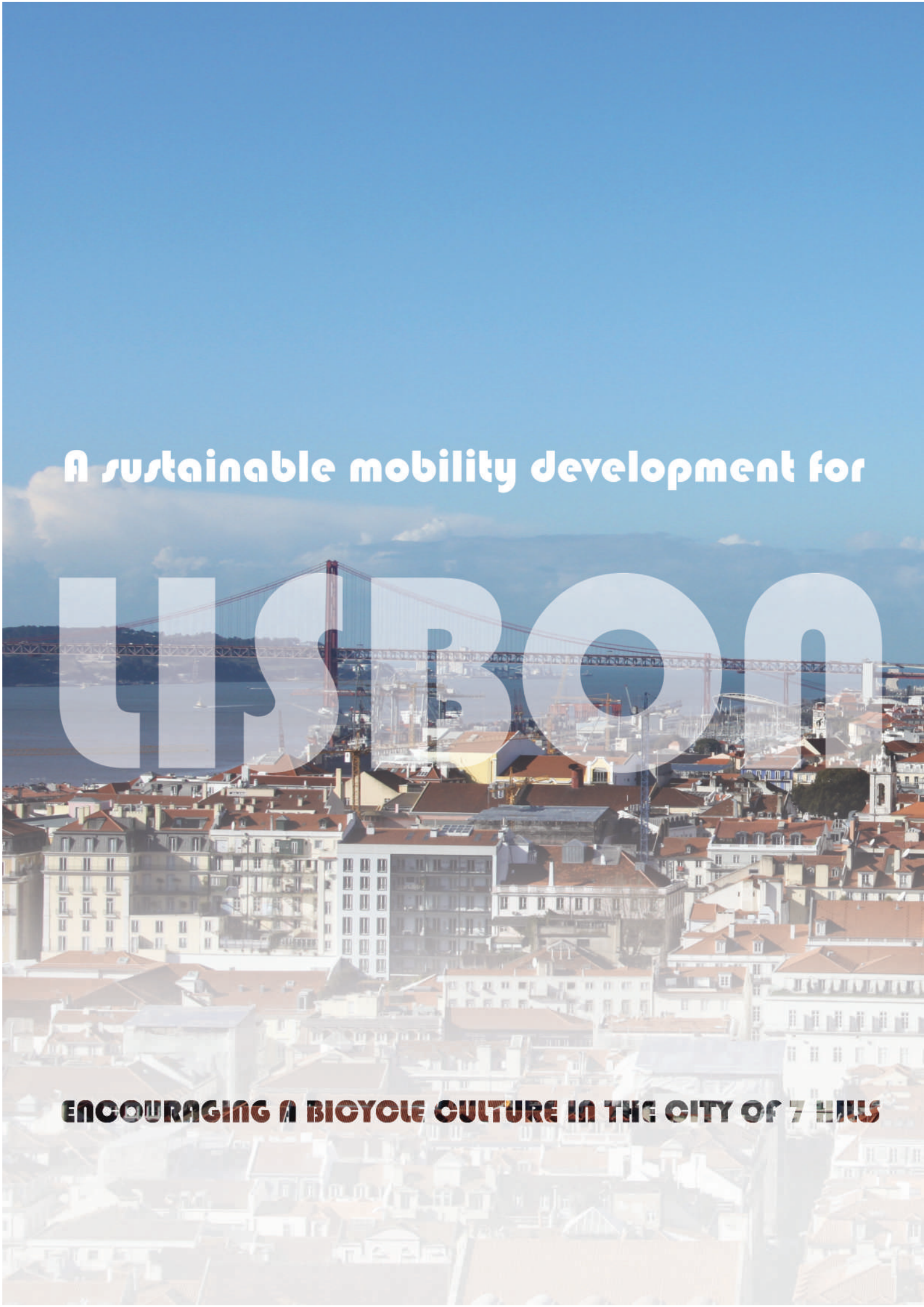
A sustainable mobility development for



LISBON

ENCOURAGING A BICYCLE CULTURE IN THE CITY OF 7 HILLS

Title description

Color. Trees. Flowers. Grass. Warmth. Air. Wood. Water.

These are some of the words that cross our minds when we think about nature.
Nature is also defined by its beautiful fauna, landscapes and wonders.

Over time, humans have created spaces that can increase their level of comfort. We can now travel all across the world in less than a day as a consequence of modern technology, something that was not possible not so long ago. But with comfort comes also concrete, asphalt, gravel and other urban and modern materials. Nowadays, given the high density and high demand for infrastructure, we come to explore nature outside the cities rather than in our own neighborhoods.

With a constantly increasing population and growing numbers in migration from rural to urban, cities are asking for adaptation. A rising density in cities can affect the comfort and health of locals and tourists, therefore a change in the cities lifestyle is a must.

By using tools such as technology, cities can create alternative solutions that can help improve the city lifestyle without changing people's comfort.

Promoting a sustainable life in urban areas is something that all cities should take into account when planning or designing for people.

Moving from home to work or school as fast as possible has become the most important factor in urban mobility nowadays thus, people forget to pay attention to their surroundings and the nearby landscapes. As a consequence, the landscape is treated today more as a background element and not as an important piece of the city as the streets.

This project is proposing to include nature as part of the urban tissue. The car culture is reversed, promoting the fact that a different approach is not necessarily slower, but sometimes can be even faster and probably most important, healthier. Therefore, a small intervention can be a simple method to bring a more sustainable lifestyle in cities.

Thus, A SUSTAINABLE MOBILITY DEVELOPMENT FOR LISBON.

title page

PROJECT TITLE
A SUSTAINABLE MOBILITY DEVELOPMENT FOR LISBON.
Encouraging a bicycle culture in the city of 7 hills.

Diana Cristina Binciu
Stud. Msc Urban Design

PROJECT PERIOD
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NUMBER OF REPORTS
3
NUMBER OF PAGES
91
APPENDIX
14 + PLANS

Diana Cristina Bînciu 

abstract

"In 2016, an estimated 54.5 per cent of the world's population lived in urban settlements. By 2030, urban areas are projected to house 60 per cent of people globally and one in every three people will live in cities with at least half a million inhabitants. " (UN 2016)
Regarding urban design and planning, cities are nowadays facing a challenge of how to cope with a rapidly increasing migration from rural to urban.
Furthermore, pollution and increasing temperature are caused by this phenomenon. As most cities have car oriented streets, the increasing of population is producing more CO_2 in the air each day. Thus, designers must focus on proving alternative solutions in order to reverse the increasing numbers of CO_2 and still respond to people needs. By using technology, engineering and social fields, designers can help prevent climate change and provide a healthier environment for people.

reading guide

The following booklet is divided into 7 chapters: introduction, design approach, design presentation, analysis, theory, study cases and evaluation.
The introduction presents the location of the project, the methodology used, time management and the challenges that will fallow.
In the design approach chapter, the vision, concept development, design parameters together with the strategy will be present in order to get a better understanding of what the project is about.
Design presentation consists of plans, renders and sections about the proposal.
Analysis chapter comes as a support for the proposal where the existent situation is shown in the chosen area and its neighborhoods.
Study cases are also presented in the booklet in order to provide actual examples of similar projects.
The last part of the booklet contains the conclusion and reflections and references.
The booklet is completed with the appendix consisting of 1:200 plans and other materials relevant to the project.

preface

This project represents the master thesis for Msc. in Urban Design and Urban Architecture at Aalborg University, Department of Architecture, Design and Media Technology, from 1st of February 2018 until 24th of May 2018, with the examination on 7th of June 2018.
The main scope of this project is to define a solution to a chosen challenge in order to meet the demands of the curriculum of one's specialization.
The following proposal is the result of combining different fields and tools from professions such as architecture, urban planning, spatial management, urban design, landscape design and civil engineering regarding traffic calculations.

table of content

introduction

Site
Methodology
Problem statement
Why should we rethink streets

Site

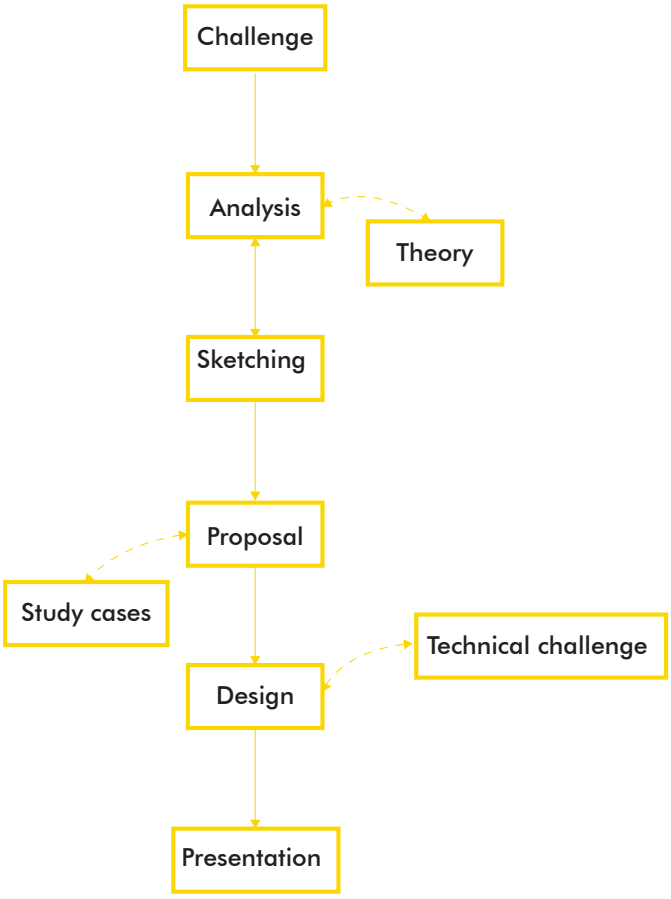
The location of the site is in Portugal, Lisbon. Both locals and tourists are biking through the city in between the cars and buildings, trams and buses. Thus, the need to implement a bike path infrastructure has grown in the past years. In the municipality's master plans there are shown projects and researches about bike paths of which some have already been implemented, some are only on the analysis phase.
Being known as the city with 7 hills, Lisbon represents a challenge for urban planners, architects, traffic planners and designers when it comes to proposing solutions throughout the city.
However, the project gives a precedent for the whole city by using an example: Rua da Palma/ Av.Alm.Reis.

Ill. 01 - location

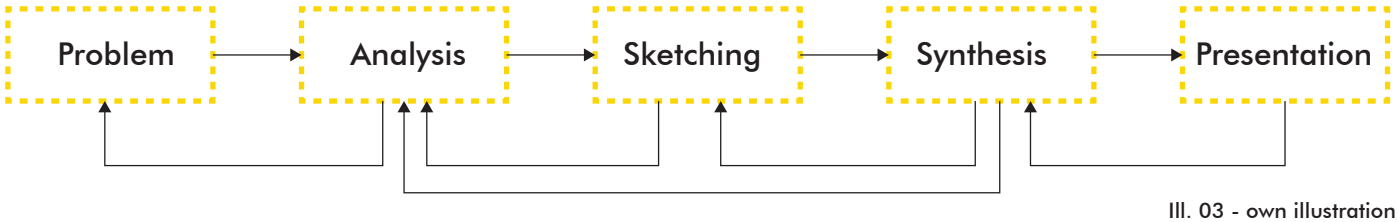
Methodology

This paper is based on PBL method, where the challenge consists in an authentic problem.
The paper is based on creating a connection between theory and practice and this is achived by using procedures,
professional knowledge and reflections. [Holgaard,
Ryberg, Stegeager, Stentoft, Thomassen, 2014]
The paper is also based on the IDP (integrated design process), where different fields of study interact in order to produce a good result and provide a solution.

The final solution is achieved by using this tool that creates links between the aesthetics, functional and technical aspects that help overcome challenges.
IDP has five phases (Problem phase,
analysis phase, sketching phase, synthesis phase and presentation phase) and it is considered to be an interactive process where different stages are approached and revised and continuously reassessed interaction with each other in order to produce the final design. [Knudstrup, 2005]
The paper begins with a problem phase, challenge description where the project goals are introduced. Acknowledging the challenge leads to the second step where the analysis and sketching phase are constantly influencing each other.



Ill. 02 - own illustration

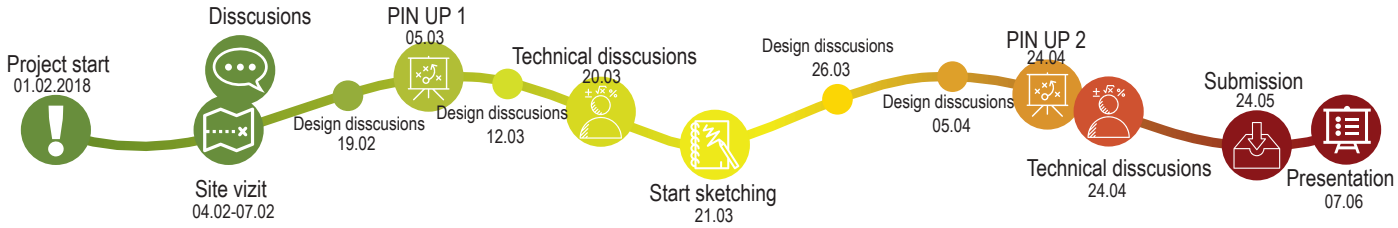


Ill. 03 - own illustration

The analysis part contains relevant studies about theories and the existent information. This step is helping in clarifying about the state of the recent situation and give an insight about the possible outcomes and urban strategies. This way design parameters are formed and give a kick start in the design process.
The sketching step is where the technical, aesthetics and functionality requirements give information from different fields such as architects, engineers or urban planners and in the synthesis phase are combined and compared in order to provide an optimal solution.
The final stage of the design process is the presentation part. At this point the final solution is given, taking into consideration previous information from the first phases.
The elements are presented in a detailed manner, through diagrams, texts, collages and drawings.

The time line presented below shows the entire design process with milestones and important dates.

After the start of the project, supervisions where scheduled in between pinups. At the site visit meetings with professionals such as municipality employees were conducted and a discussion with a professor from the department of architecture and design from University of Lisbon was scheduled. This part helped with gaining a better view of the existing situation and future plans for the city. Also, along the time frame for the project two technical supervision were scheduled in order to meet the technical requirements for the proposal.



Ill. 04 - time line

The challenge/problem statement

How can an urban intervention offer an alternative solution to increasing levels of CO_2, respond to aesthetically challenges and overcome the steep slopes that prevent people from biking on them?

Why should we rethink streets?

The climatic changes caused by CO_2

Emissions of CO_2 are causing a significant change in the climate, therefore a response to post-car future is necessary. (Dennis and Urry, 2009)

The amount of CO_2 a person should produce per year, in order to make a difference in the climate change, is 2.0 t CO_2. The amount of CO_2 that a EU citizen actually produces each year on average is 9.1 t CO_2.
Therefore, a significant change should occur in order to lower the number.

Rua da Palma/Av.Alm.Reis represents an experiment and can be taken as an example of how the increasing levels of CO_2 can change only by using bicycles instead of cars.
On a 3,2 km distance from north to south a car produces 0.001 t CO_2 in approximately 17-21 min, without taking into consideration the waiting time on stops and parking.
The experiment uses a program that calculates these amounts based on the type of car and fuel used. On the other hand, for the same distance a bicycle produces 0 t CO_2 in approximately 16-17 min.

Car culture

Urban development in the early 1970's created a barrier at a street level, therefore functional separation can be easily spotted around the cities in the present situation. Streets are more car than pedestrian oriented, therefore creating the impression of an urban jungle more than a friendly environment.

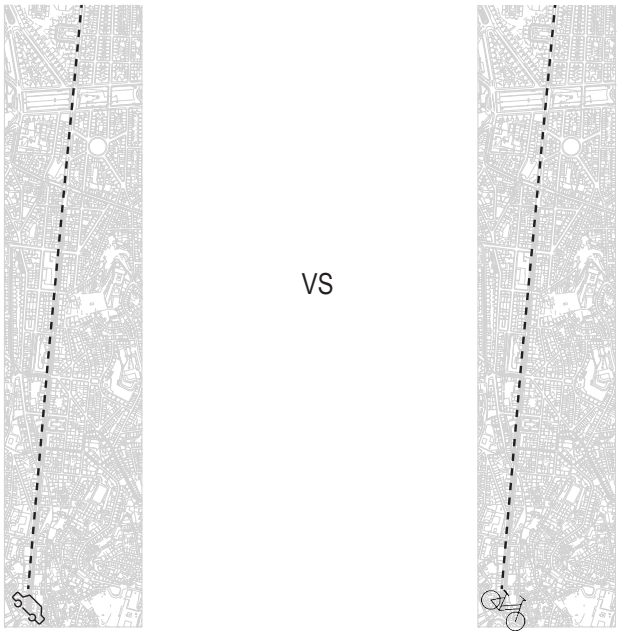
Due to present infrastructure, the car culture has thrived in cities, taking more and more from pedestrians.
Main streets that are forming the urban composition and main axes in the cities are usually speed oriented, thus taking away the feeling of safety for pedestrians.

Therefore, a slow speed oriented infrastructure can help lower the number of motorized vehicles in cities and create more space for pedestrians and urban activities, reduce stress and restore the feeling of safety on the streets.

Walkable/bike-able city

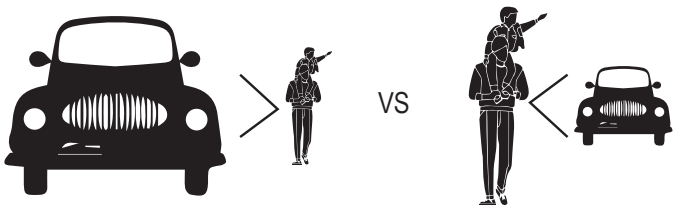
Designing mixed-use spaces, involving nature in the process and living close to the working place are the core principles of slow urbanism (Honore, 2015).
Planning at a human scale, promoting a walking and cycling culture and encouraging a healthier balance between work and leisure are images of a Slow City that can happen in 50 years (Honore, 2015)

The climatic changes caused by CO_2



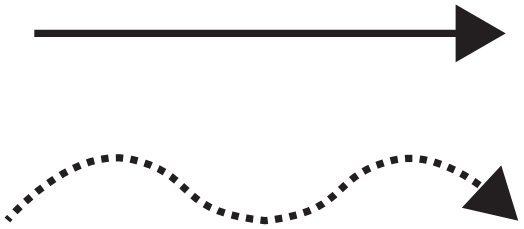
Ill. 05 - own illustration

Car culture



Ill. 06 - own illustration

Walkable/bike-able city



Ill. 07 - own illustration

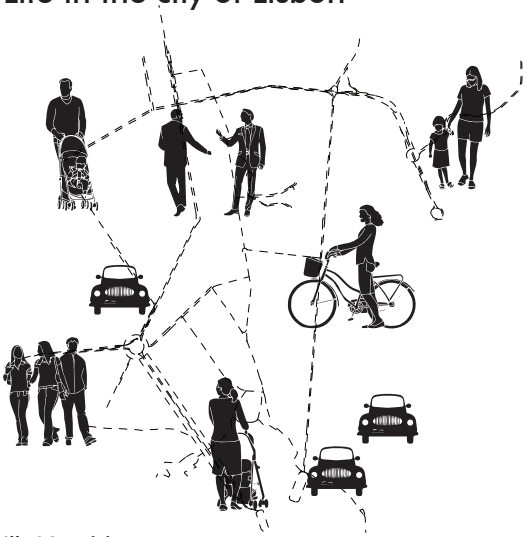
design approach

Vision
Concept development
Design parameters
Diagnosis
Mission
Strategy

Vision

Lisbon is a walkable city with bike paths to connect main points and intersections.
It has a breathable air due to the decrease of cars and increase of green spaces and it stands for a safe environment for its people. Technology helps residents and tourists bike across the city even on its high hills, thus giving the possibility of biking to work, school or just for leisure and enjoying a healthier and less stressful life.
The implementation of this proposal gives residents and tourists of Lisbon an overall better lifestyle.
By implementing smart mobility solutions and redesigning the streets, so that bike users can share the space as well and offer pedestrians the possibility to move through the city without having to avoid main axes, the "If NOT" situation described in the diagnosis(see page. 26) can be avoided.

Life in the city of Lisbon



Ill. 08 - vision

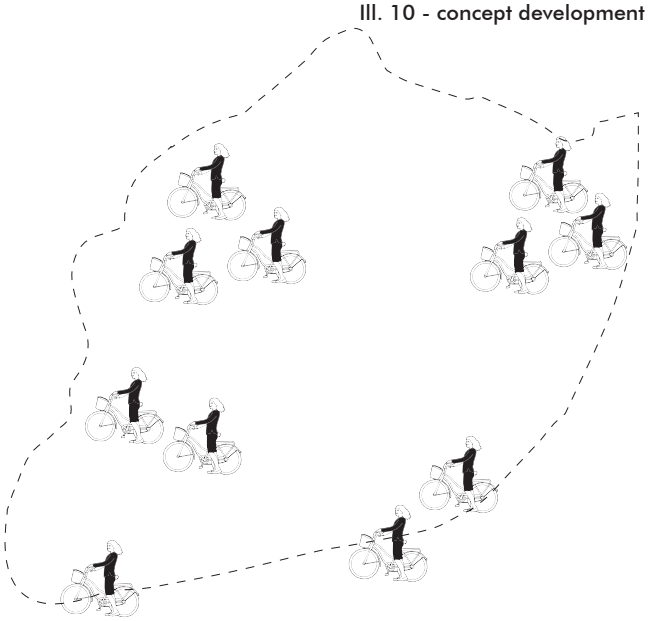
Space in the city of Lisbon

Ill. 09 - vision

Concept development

The concept of the proposal is about promoting a healthier lifestyle. In a city where personal car is the main use of transportation, the bicycle is forgotten.
Moreover, as buses and trams are overcrowded during rush hours, implementing a bicycle infrastructure on the main streets of Lisbon, that connects all networks, even on steep slopes, can help promote a healthier way of moving around the city.
In addition, a bicycle infrastructure can also decrease the level of stress and lower the time spent in traffic.

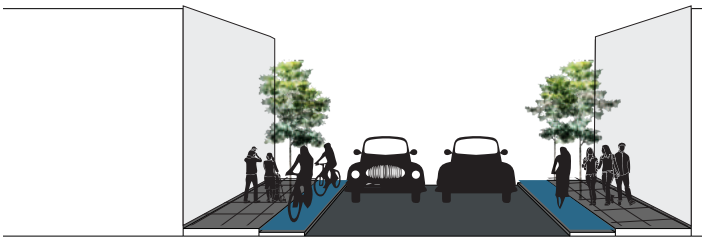
Ill. 10 - concept development



Creating special areas for parking your bicycle around the city is increasing the safety levels for bickers as well. In a city where locals are afraid to leave their bike outside, because of car accidents or theft prevent people from purchasing their own bike and using it on the streets.
Lastly, having a bicycle parking brings comfort to users and gives non-users an incentive to become bicycle owners.

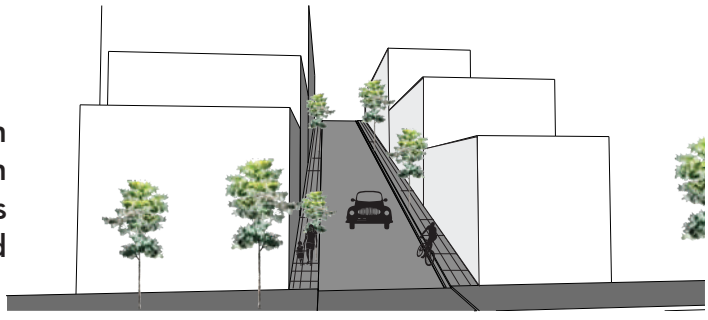
Ill. 11 - concept development

Including biking paths into the street infrastructure gives people the comfort and confidence to use them.



Ill. 12 - 3D-illustration

Lisbon is considered to be the 7 hills city. With slopes up to 73% in the city center, biking can be rather difficult. Therefore, smart solutions can help people bike on them rather the around them.



Ill. 13 - 3D illustration

Design parameters

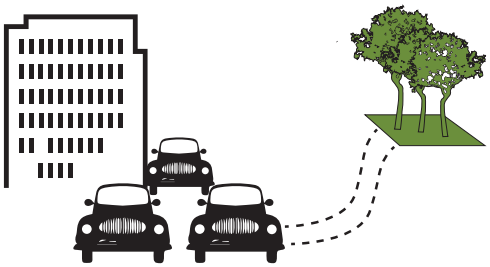
The existent infrastructure represents a car culture with speed oriented streets in Lisbon, where the green separation is visible and the landscape is treated as a background rather than part of the city life.
Pedestrians and tourists need to move around the urban tissue and usually try to avoid main streets.

The scenario aims to lower the speed on main axes and create a safe environment for people. The mixture of green areas and urban spaces helps include the nature in the city.

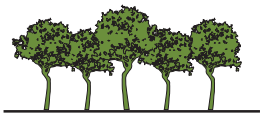
EXISTENT

car culture/speed oriented streets

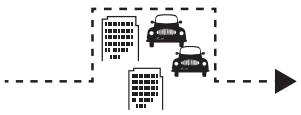
green separation



landscape as a background



moving around the urban tissue

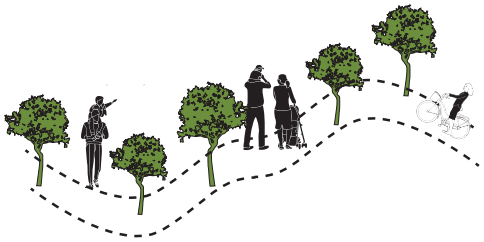


PROPOSAL

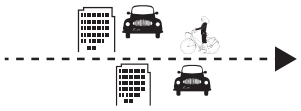
safe environment for people

mixture of green and urban

landscape as part of urban life



going through the urban tissue



Ill. 14 - parameters

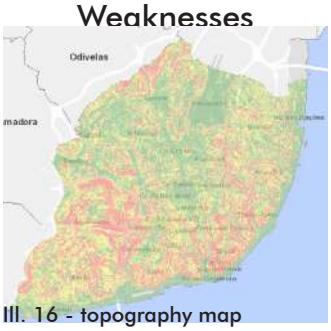
Diagnosis

Strengths

Ill. 15 - existing bike lanes

The locals of Lisbon wish for a biking network in their city, therefore the Municipality of Lisbon is conducting investigations for placing bike paths throughout the city for both locals and tourists alike.
As tourism increases, the use of rented and shared bikes to commute in the city between attractions also thrives.

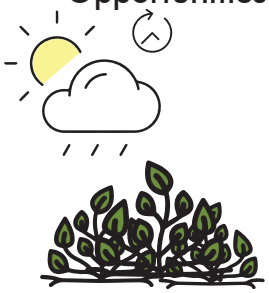
Weaknesses



Ill. 16 - topography map

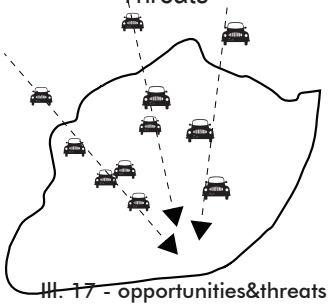
The city of Lisbon has 7 hills with steep slopes up to 73%.
The car oriented culture is creating a polluted and unsafe environment for people. Moreover, a citizen of the EU produces each year on average 9.1 t CO_2 .

Opportunities



Good weather, between 10° and 40° Celsius, all year round.
Green vegetation during all seasons.

Threats



Ill. 17 - opportunities&threats

Residents from outside Lisbon are contributing to traffic jams buildup in the city center.

Diagnosis

The car culture is deep inflicted in the heart of Lisbon, thus increasing the numbers of CO_2 in the air and building up stress to its locals.
Tourist are coming all year round, thus contributing to economy but also adding to stress among traffic.
Increased tourism creates a mental barrier between the city center and the outskirts.
High slopes are making biking very difficult for residents and tourists.

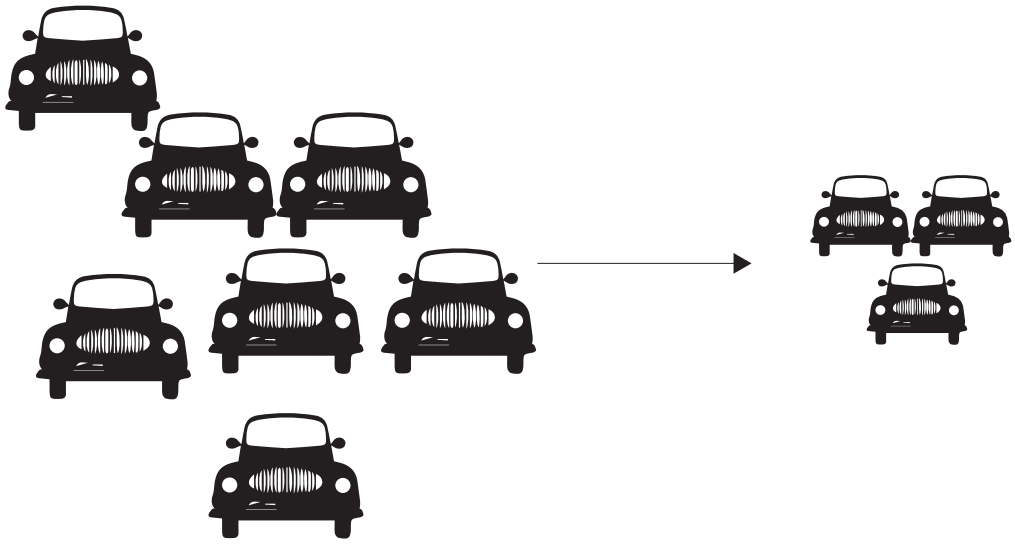
If NOT!

If these problems are not addressed, the city will continue to become more and more crowded and polluted. Car culture will create visual limits between spaces, separating green ones from city life, thus resulting in a gray urban jungle.

Mission

Reversing the car culture and addressing the topography challenge by creating possibilities for biking in the city in a safe manner can create a better environment for both residents and tourists.

Reverse car culture



Smart mobility solutions

Ill. 18 - mission

Strategy

Based on the diagnosis and IF NOT previously presented, the strategy concludes with a solution for the city of Lisbon.
By using the scale definition of Jan Gehl, where city plan scale is a bird-eye view, site plan scale is from a rooftop or a helicopter perspective and people scale is a 5hm/h view, the strategy is presenting a set of approaches.
After categorizing the streets of Lisbon at a city plan scale, the strategy proposes that the main axes should be redesigned so that they include a bike lane for cyclists, thus promoting a more sustainable way of transportation.
Connecting main squares and the city center with the outskirts by a bicycle network both tourists and residents can benefit from the network.
An analysis regarding the percentage of slopes in the city is added to the importance of using smart intervention on some streets which requires assistance for moving uphill and make possible links between main networks.
The strategy presents a catalog of streets that can be used for biking in the city. Using bicycles as a means of transportation in Lisbon can increase the health parameters among citizens, degrease stress and help fluidized the traffic.
At the same time, promoting cycle culture by organizing public workshops and events, creating safe inter-modality between public transportation and bicycles, offering parking spaces along side bike paths can help increase the use of bike in the city of Lisbon.
Cycle lanes should increase drivers' awareness of cyclists, encourage drivers to leave space for cyclists, encourage lane discipline by cyclists, help to confirm a route for cyclists
In order to allow comfortable use by cyclists, including those using trailers and cycles/tricycles used by disabled people. In what dimension is regarded, cycle lanes should normally be 1.5m wide and 2.0m wide where space permits. A wider width will also allow a cyclist to overtake another slower cyclist without entering the main flow of traffic.
The exception to this is in congested situations where a narrower lane may be useful to allow cyclists to pass slow or stationary motor vehicles, particularly on the approach to junctions. DFT advice is that a lane as narrow as 0.8 m is acceptable in these situations; however lanes not less than 1.2 m are recommended.

Ill. 19 - strategy

design presentation

Redefined streets
Intersection catalog
Plan intersection 1
Plan intersection 2
Smart mobility solution
Urban furniture
Materials

Ill. 20 - render

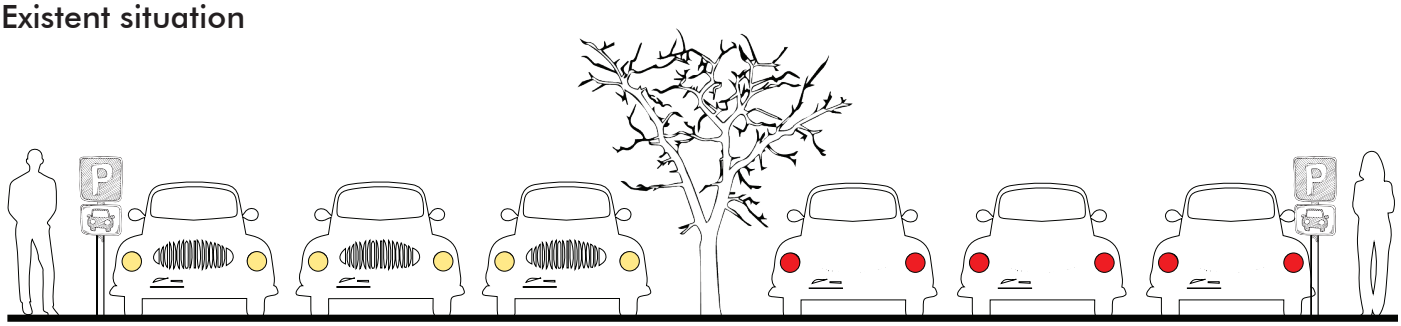
Redefined streets

In the present situation it can be observed that cars use most of the space in the street infrastructure. On Rua da Palma/Av.Alm.Reis there are two car lanes with a parking lane per way.
The simulation bellow shows that there is space enough for both parking and biking paths if the street is redesigned.

Small secondary streets with one way car lane, as well as the streets with two car lanes are crowded by parking spaces or trams, leaving the pedestrian path which has a small width for people to use and space for bicycles.

The proposal presents a redistribution of the space as well as a redesign of small intersections. The intersections between a secondary street and a main street are redesigned by implementing small shared spaces.

Existent situation

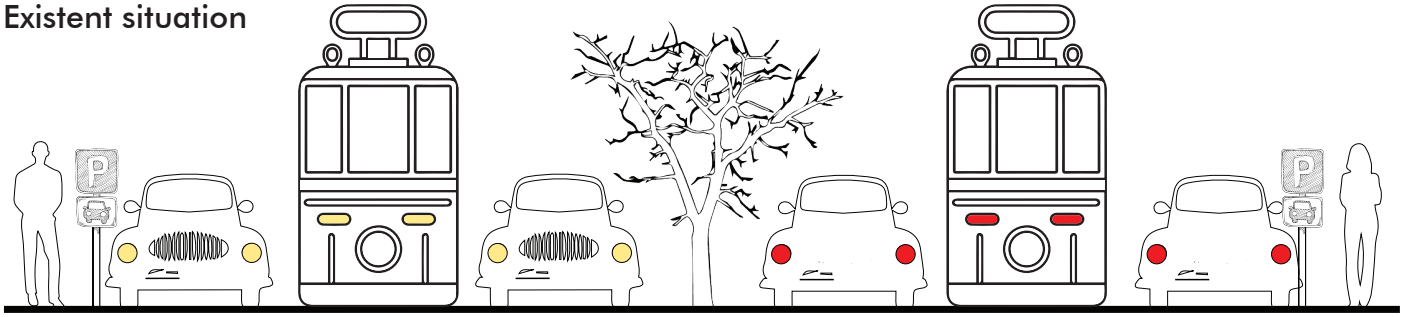


Ill. 21 - existent

Scenario

Ill. 22 - scenario

Existent situation

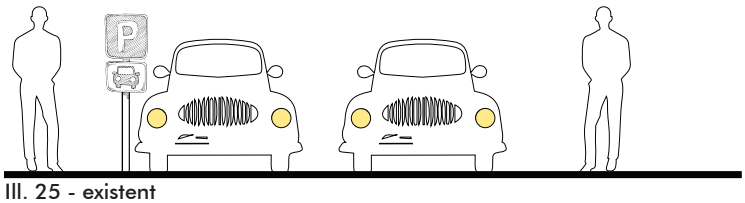


Ill. 23 - existent

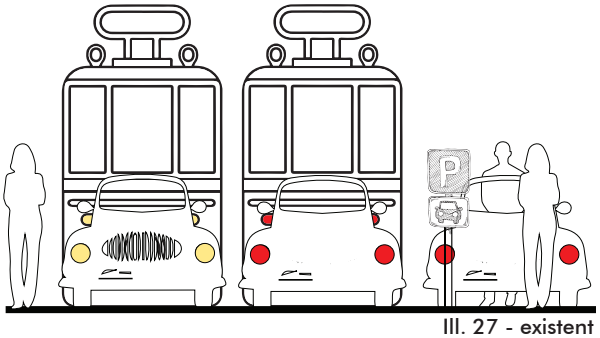
Scenario

Ill. 24 - scenario

Existent situation



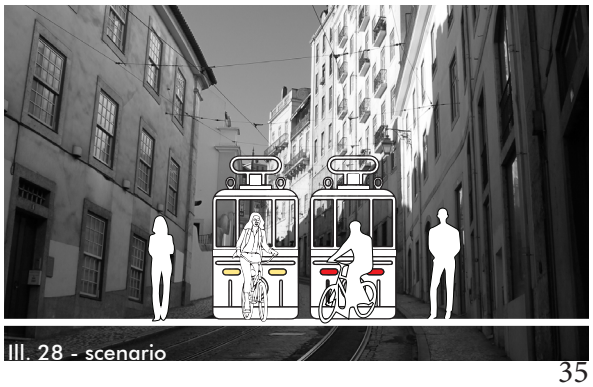
Ill. 25 - existent



Ill. 27 - existent

Scenario

Ill. 26 - scenario



Ill. 28 - scenario

Intersections catalog

This map is taking Rua da Palma/Av. Alm. Reis as an example of how these shared spaces can represent a precedent for the city of Lisbon. All the small intersections are handled the same in terms of design, while the bigger intersections are treated individually, since each present unique characteristics.

Ill. 29 - catalog map

Ill. 30 - render

Ill. 31- plan

Plan intersection 1

The design proposal presents an intervention on two crossings of secondary streets with Av. Alm. Reis, a street with heavy traffic, carrying tram lines, car lines and pedestrian paths.
The street is highly used by pedestrians for its bus, metro and tram links, as well as parking spots and shops along the side.
The plan represent the intersection of R. Antero de Quental with Av. Alm. Reis to the south and Tv. do Cidadao Joao Goncalves with Av. Alm. Reis to the north.
As both R. Antero de Quental and Tv. do Cidadao Joao Goncalves are one way street the flow generated from each of them into Av. Alm. Reis is not heavy, therefore the design is not affecting the flow in the area.
The proposal works on two fronts. First step is to redistribute the areas on the main street (Av. Alm. Reis). Therefore, as observed in the plan, parking lanes are moved from the side to the center of the street while being highlighted with different pavement. Enough space is thus obtained for people to access their cars. As a consequence the number of parked cars in the area is reduced by about 50%.
Local vegetation such as trees or spontaneous bushes are used in order to integrate nature in the urban tissue and fade the gray color of the concrete and asphalt.
Bicycle lanes are implemented on the ex-parking spaces, highlighted by a colored pavement or bicycle traffic signs situated every 200m.
Urban furniture and special lighting is inviting people to stop along the way and admire the historical buildings surrounding the street and the new improved Av. Alm. Reis.
The new pavement used in the design is an improvement, since every user, no matter the disabilities can walk on it and it provides a better noise distribution in the area.
The patterned pavement means to alert vehicles and pedestrians that something is about to change. A small shared space just before entering the main street is telling the drivers that they need to lower the speed and be aware of bicycles and pedestrians, not only the cars crossing.
Placing bike racks in the shared spaces is also providing good access from the main street for users, while at the same time they stand in a visible spot which brings down theft.

Ill. 32 - render

Plan intersection 2

The second design proposal present an intersection between Av. Alm. Reis and R. Jose Falcao, a one way street that enters and exists the main street.
This street is also highly used by pedestrians, buses and vehicles altogether creating the impression of an urban jungle.
The proposal is bringing more green elements in the area and it stands as an supplement of the first design proposal, with small shared spaces along the main street.
In this scenario the road has a two car line per way, therefore not changing the normal flow from the existing situation.
By moving the parking areas from the sides to the middle of the street, again reduces the parking spaces by 50%, on the other hand allowing biking paths to be implemented.

Ill. 33- plan

Scale 1:

Ill. 34 - render

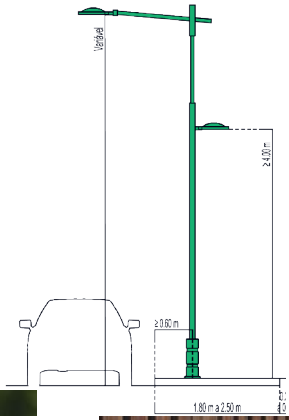
Smart mobility proposal

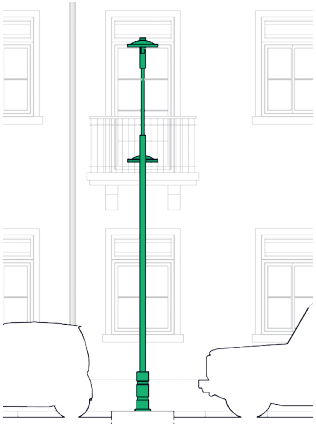
The third scenario proposal is about implementing technologies on streets that are impossible to bike uphill.
By using smart eco-friendly, smart, solutions that can help overcome the challenge of cycling uphill, people might be encouraged to climb them instead of fear the steep slope.
Therefore, as part of the strategy, a proposal for implementing such technology on steep slopes that connect points of interest is presented.
A system invented by a norwegian and that is now implemented in Trondheim, Norway, cyclists of Lisbon can also overcome the issue of steep slopes.
The system is based entirely on electricity, with no need for assistance. It involves a foot support that will transport the cyclist with about 2 m/s up which at the top of the hill retracts underneath the pavement, going back to base and ready to transport again.
Based on the information gathered from the analysis of slopes overlapped with the transportation map, a catalog of streets where the system could be implemented was generated.

Ill. 35 - proposal

Urban furniture

Ill. 36 - bench





Ill. 39 - public illumination

Ill. 37 - parking monitor

Ill. 38 - dumpster

Ill. 40 - bike racks

Ill. 41 - cap

In order to give an advantage for riding a bicycle in the city as means of transportation, parking spaces must be provided in the city, along main streets. A prominent place and a properly signaled way is good in order to minimize the risk of theft.

The location of biking areas can be in the pedestrian circulation area, without disturbing the normal flow of the traffic. In any given situation, the area must be associated with special bike racks that scan support the bicycles at any time.

The support of the bicycle must provide a frame for the bicycle to depend on, allow the bicycle to be attached to the holder with a D or U type of lock, ensure that the fixing situation is not causing the wheels to rotate and have a safety bar that can be identified by blind people.

Parking devices for cars, in order to control the parking on public roads, must be placed no further than 100 m from the subject.

In order to improve the quality of urban life, benches and public dumpsters must be placed along the streets. Preferably backrest seats should be used in order to respond to the need of being more comfortable.

One of the most unobserved piece of urban furniture is the sewer cap. Although unimportant for some people, they are actually very important, since they have the role to protect the gas, electricity or sewage system beneath the ground. It can come in different shapes, round, square, hexagonal. The sewage ones have the role of collecting the leaves and other natural waste from the streets, therefore, their placement is also very important. These are usually situated at the edge of the street, between the car lane and pedestrian path where the terrain is the lowest, while also depending on the position of the system beneath the ground. Lisbon Municipality, in this case, uses the rectangular ones. Although, the grid is placed horizontally and can create an agglomeration of leaves and waste, it is still better for biking on them, then placed vertically where the wheel of the bicycle can remain blocked.

The width of the road determines how often the lighting polls should be places as well as the their height.

Materials

Ill. 42 - material

Ill. 43 - material

Ill. 44 - material

Ill. 45 - material

Ill. 46 - material

Materials proposed for the solution are also approved by the municipality of Lisbon. The Municipality is trying to preserve the traditional way of paving, but with new, improved materials that can answer to all needs.

A bituminous mixture prepared in a cold, normal temperature by mixing bituminous emulsion and an aggregate is an eco-friendly option for bike paths. It reduces the energy consumption and toxic fumes and it is a flexible material that is strong enough to withstand temperature fluctuations. Even though it needs maintenance one a year, this mix is an easy fix and economically and environmentally friendly since it can be recycled.

Granite blocks have been and are still used in Lisbon pedestrian paths. The blocks can be cut manually or mechanically, generating irregular texture surfaces that can be adjusted.

The height is greater than a quarter of its length, always with parallel surfaces, thus easy to manage when joint, resulting in an increased resistance. These blocks are mainly used for pedestrian traffic and occasional access of vehicles and can also endure natural elements.

The downside of this material is that it is difficult to maintain, it discolors when exposed to sun rays and can be slippery in the presence of water.

Slabs of chalk and granite are also proposed by the municipality of Lisbon to cover pedestrian streets. Due to their endurance for pedestrian and occasionally vehicle traffic they represent a good option for the proposal. Even though the process of making them is not economically or environmentally friendly, Lisbon also tries to maintain its traditional way of paving the streets, in order to preserve the atmosphere in the city. Therefore, using the same pavement in the design is a good solution to maintain a constant flow and not create a mosaic view of the streets.

Granite slabs are usually used for transitions between walks and spaces, cycling, road and parking. They also have the property of being shaped, therefore are very good when connecting to spaces that need to meet special needs for people in wheelchairs or strollers.

The mixed sidewalks is something very often found in Lisbon. It helps highlight the pedestrian paths while also bringing awareness that something is happening in the area. Therefore, by employing this mixed sidewalks is part of the proposal since it helps lower the speed of the vehicles. As being composed of cubes of glazed limestone and cubes of granite also provides good adherence. With manageable sizes it becomes very easy to create different patterns in the sidewalks.

analysis

Existing master plan and projects
Terrain and slope analysis
Existing bike paths
Existing street typology
Vegetation
Traffic estimation
Transportation
Accessibility
Existing materials
Weather reports
Experiences

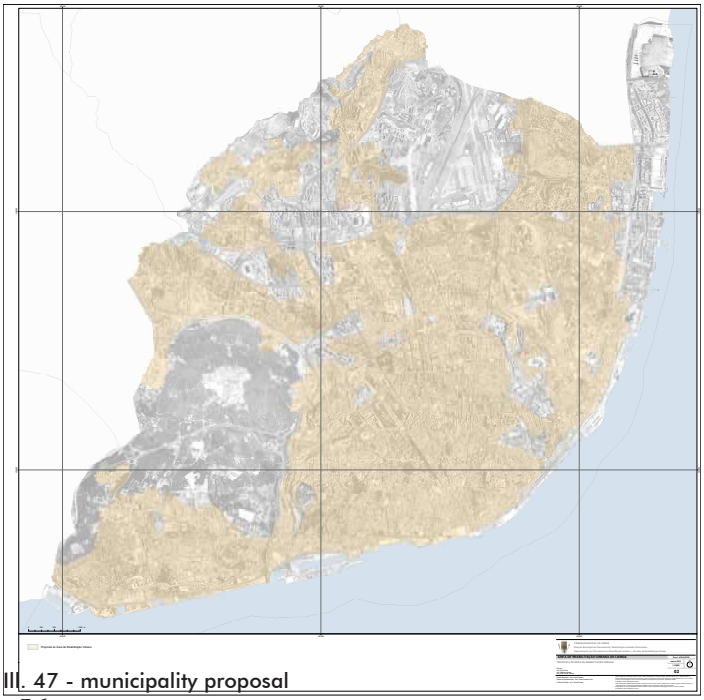
Existing master plan and projects

The Lisbon Strategic Charter approaches 6 questions for Lisbon current situation.

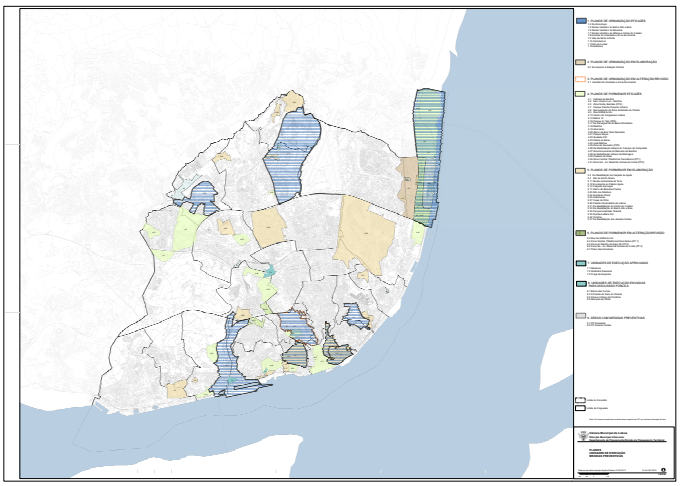
How to recover, rejuvenate and socially balance the population?
How to make Lisbon a friendly, safe and inclusive city for all?
How to make Lisbon an environmentally sustainable and energy-efficient city?
How to transform Lisbon into an innovative, creative city capable of competing in a global context, generating wealth and employment?
How to affirm the identity of Lisbon in a globalised world?
How to create an efficient, participatory and financially sustainable governance model?(Camara Municipal de Lisboa)

The current Municipal Master Plan (PDM) of Lisbon came into force on August 31, 2012 (Notice no. 11622/2012, published in the Diário da República, 2nd series, no. 168, of August 30). 1994. The territorial development strategy of the MDP 2012 is based also on 4 main priorities: develop Lisbon in global and national networks; regenerate the consolidated city; promoting urban skills; stimulate participation and improve governance model.
These priorities translate into 7 major goals that will guide the development of the city until 2024: attract more inhabitants; capture more companies and jobs; boost urban rehabilitation; improve quality of public space; return the riverside front to the people; promote sustainable mobility; encourage environmental efficiency.
In the design of the road network PDM breaks with the radio-concentric model, inherited from the 1948 Master Plan, and successively replicated in the subsequent master plans, to be based on a reticulated network, allowing to decongest the historic center and relieve the central axis of the city, to make feasible the re-qualification of the public space and the regeneration of the central areas of the city.
Urban mobility and urban policies are focused towards urban regeneration, and boost the public transport in urban districts, create soft modes and moderate speed streets. (Camara Municipal de Lisboa)

In the illustration bellow the affected areas by the proposed master plans and strategies are shown.

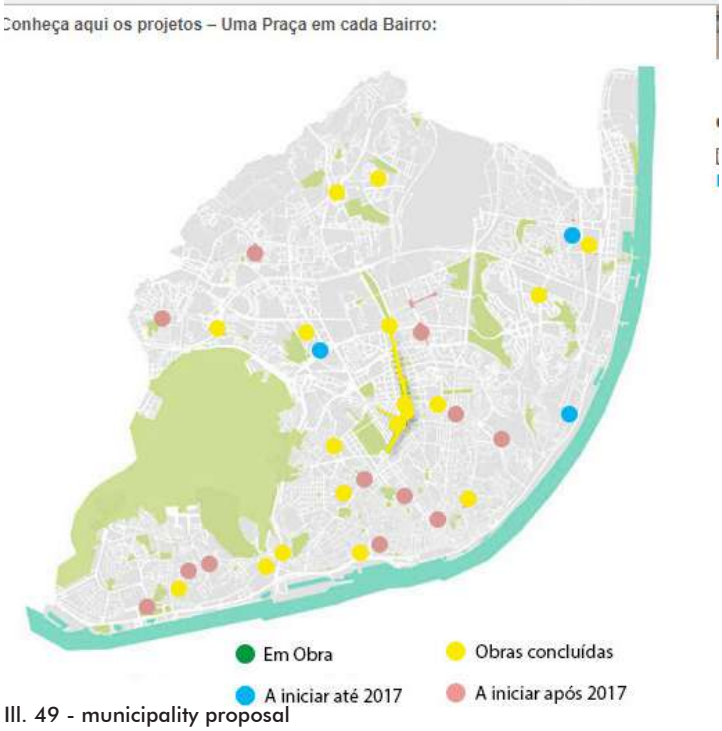


Ill. 47 - municipality proposal



Ill. 48 - municipality proposal

Illustration 49 shows the projects in course, finished and planned to start.
In illustration 50 is Plaza Do Chille and its intent to become more green and pedestrian friendly for locals with new urban furniture, pavements and green corridors.
The municipality of Lisbon has a catalog of squares that are being addressed in the main master plan that are fallowing the 6 questions addressed in the strategic charter.



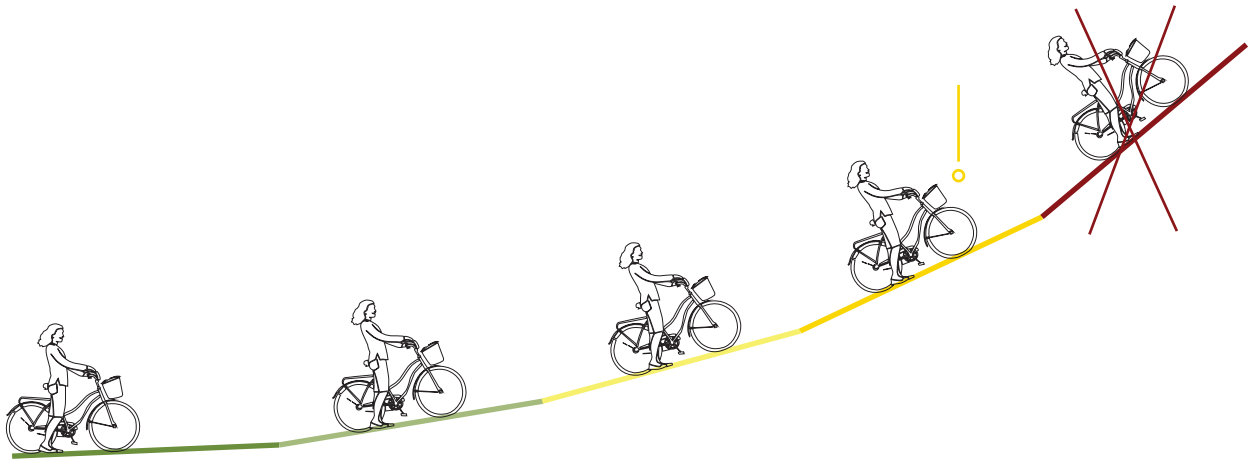
Ill. 49 - municipality proposal

Ill. 50 - municipality proposal

Terrain and slope analysis

Ill. 51 - slope

With the help of a MDT program, a map that shows the percentage of the slopes for the streets in the near vicinity of Rua Da Palma/ Av. Alm. Reis was generated. (Rosa Félix, page 57)
This map is used as a base for the intervention of the smart mobility solutions.
The Center for Studies and Landscape Architecture of Lisbon has made an analysis of the geomorphological suitability of a terrain for the cycling mode. From this analysis a conclusion is drawn that all the streets with a slope higher than 10% should be avoided or have an urban intervention that help the cyclist climb the street.



0-3% Flat Excellent for cycling	3-5% Low slope Satisfactory for cycling	5-8% Medium slope Acceptable for short distances	8-10% High slope Unacceptable for cycling	>10% Maximum slope Impossible for cycling

Ill. 52 - slope

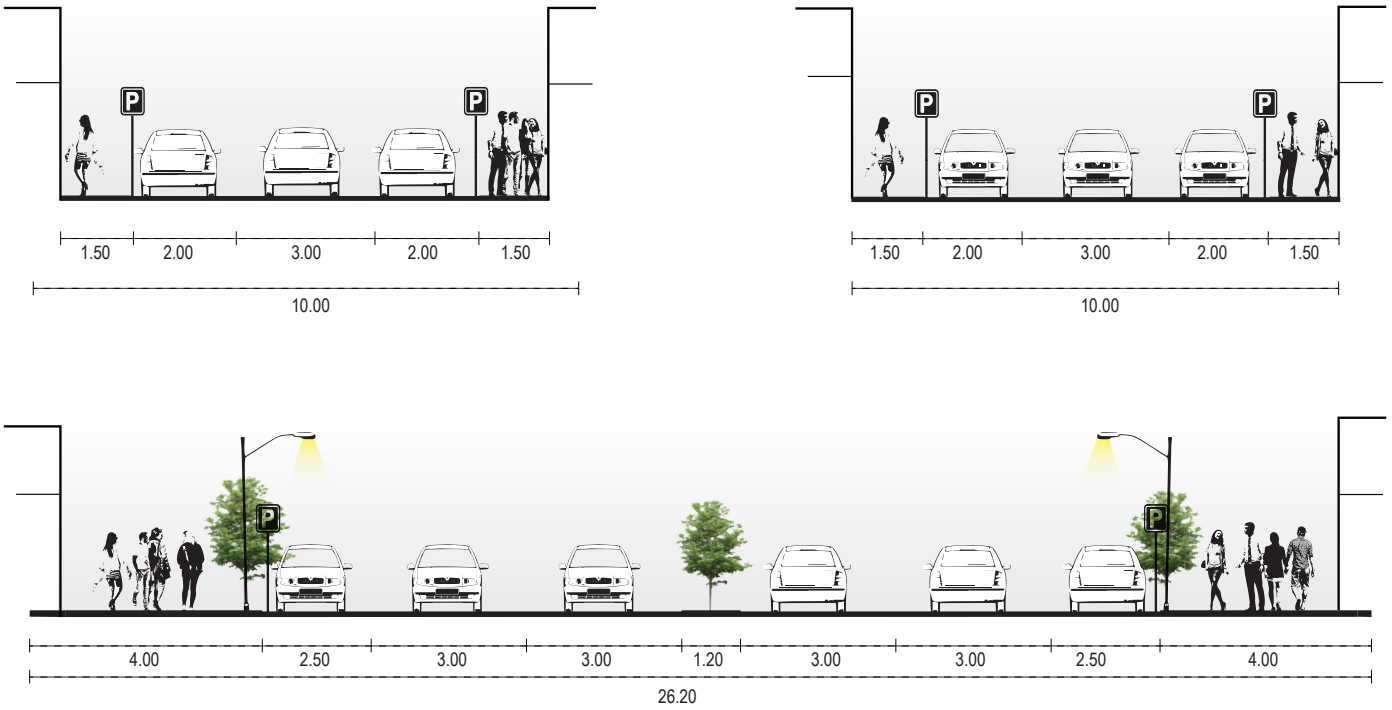
Existing bike paths

Mapping the existing bike lanes throughout Lisbon in offering an overview of the existing situation. Currently, these bike lanes are used primarily by tourists in order to commute between touristic attractions.
Most of the existing bike paths are not connected to each other, therefore making it very difficult for locals to use them in order to commute from home to work or school.

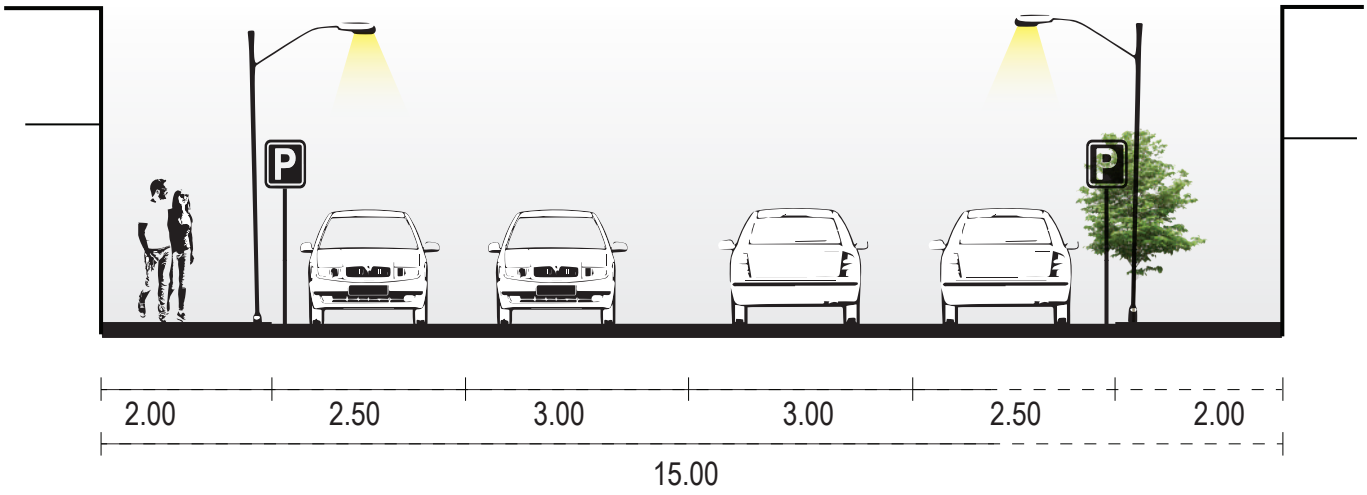
Ill. 53 - existing infrastructure

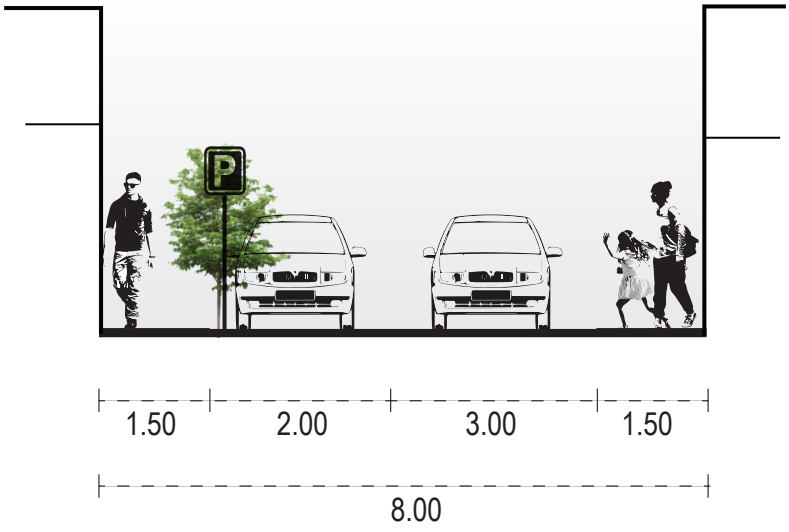
Existing street typology

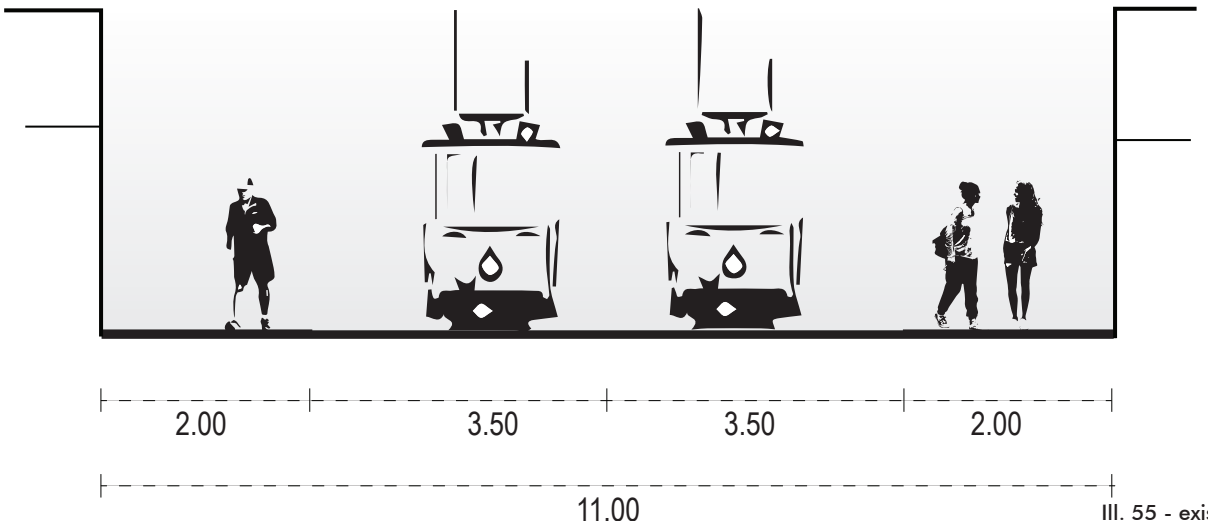
The existent street typology is clearly presenting a more car oriented infrastructure. Since more than 50% of the space is used by cars, parked or in transit in the indicated spaces, the pedestrian and the nature elements are forgotten. Thus, giving the feeling of an urban jungle where people have to mingle between motorized vehicles in order to find their way.



Ill. 54 - existing infrastructure



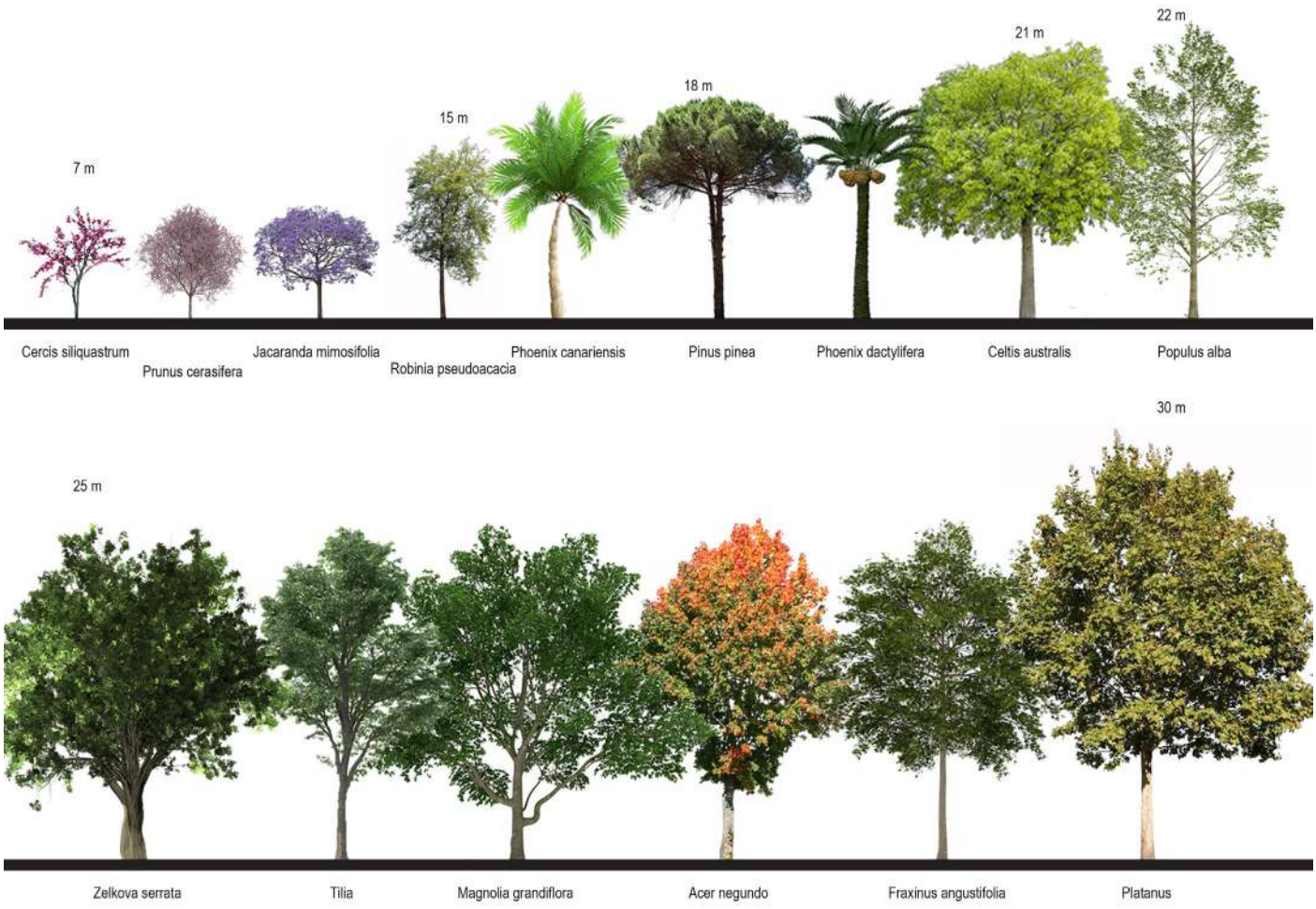




Ill. 55 - existing infrastructure

Vegetation

Portugal has a diverse fauna and flora. Most of the green is spontaneous vegetation with trees from 7 m to 30 m high, with different colors which give Lisbon a more colorful overview of the city and different flower scents.



Ill. 56 - existing vegetation

Traffic estimation

Taking a look at the present situation in Lisbon, Rua da Palma/Av. Alm. Reis is not going to be affected by the implementation of the shared spaces in small intersections. Considering the fact that a car is now waiting for an opportunity to enter the main street from a side street, implementing small shared spaces is not affecting the flow of the traffic in any way. Moreover, it brings awareness to the fact that pedestrians are crossing the street. However, due to changes in the parking spaces, fewer spaces will be provided for those who transit the area. As the intervention is reducing the parking spaces by 50%, fewer cars will be able to park in the area. Currently the traffic in the area is generated by buses, trams and metros that connect the city center with the outskirts of Lisbon.
Calculations performed by the Municipality of Lisbon allow them to implement bike paths on the area in discussion, as seen in the in the map bellow way.
According to the available statistical information from the Institute of Roads (IEP), during the year 2000, approximately 621 thousand vehicle movements on average crossed Lisbon city borders every day, typically entering in Lisbon in the morning and leaving it in the evening. Commuting movements are concentrated in ten major entrance points, two of them though bridges over the Tagus estuary.
The Lisbon city covers an area of 84 km^2 with a resident population of approximately 565 thousand inhabitants (according to the latest census, in 2001). It is however surrounded by a larger area at the northern and southern margins of the estuary of Tagus river, called the Great Lisbon Metropolitan Area. This area comprehends approximately 2.1 million inhabitants, i.e. 26 per cent of total Portuguese population over an area of 2 750 km^2 .
In order to provide a valid strategy for the streets of Lisbon, an estimation of the traffic flow was required.
The Lisbon Metropolitan Area has about 5 million person-trips each day, of which 55% are commuting trips to go to work or study. Car ownership rate is of 217 cars per 1000 locals and the parking in the city center is very difficult, fact that contributes to lower the car ownership. The low daily trip rate is related to the demographic profile of the city center population - in some traditional city boroughs, more than 50% of the population is aged 65 years or older.

More than 60 000 cars, 400 buses and 2 000 taxis circulate in Lisbon during rush hours, resulting in an average density of 60 vehicles per road kilometer (Martínez et al., 2014). This numbers are especially high when taking in consideration the narrow streets of Lisbon.
Considering that the chosen road has a length of 3,2 km, an average of 192 cars can be distributed on site.

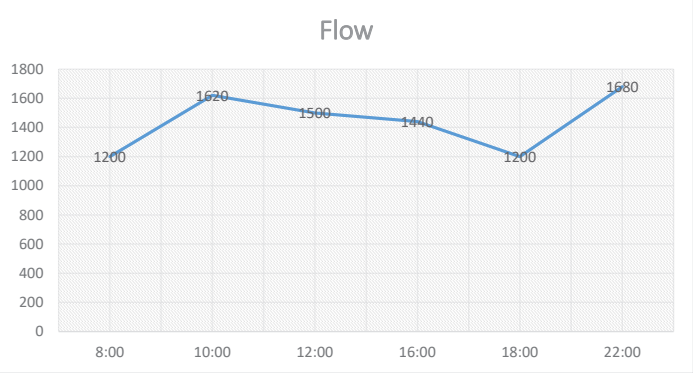
$$W_{avg} = TD/m$$

TD = total delay experienced by m vehicles

m = total number of delayed vehicles

$$q^1_i = u_i \times k_i$$

q^1_i = flow(vehicles/hr)
u_i = average circulation speed(km/h)
k_i = density of cars in circulation(vehicles/km)



Therefore, the flow was calculated at different hours of
a working day(see ill. 57) and as a conclusion the numbers prove that the design proposal is possible.

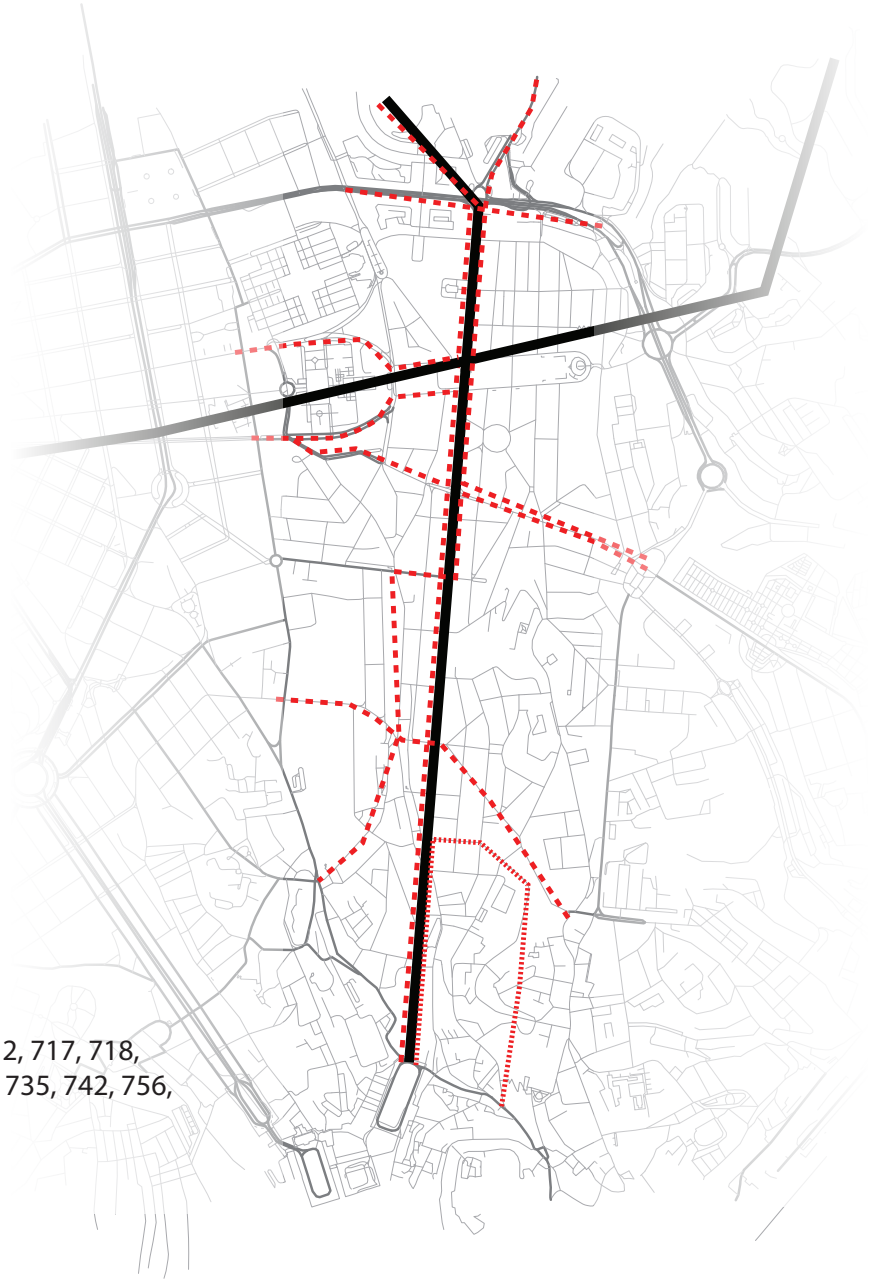
Ill. 57 - flow

Transportation

Ill. 58 - transportation

Lisbon has 3 main types of streets: highway, city level and district streets.
These roads are intensely used by cars, buses and pedestrians together.
As the main connectors between main intersections for locals and attraction points for tourists, the street infrastructure represents an important part in the urban tissue and is treated as such.
As a city on levels, Lisbon has many district level streets with stairs and elevators that help connect.

Accessibility



Buses: 705, 706, 708, 712, 717, 718, 720, 722, 726, 730, 734, 735, 742, 756, 797

Tram: 28E

Ill. 59 - accessibility

Rua da Palma/Av. Alm. Reis is a city level street with a limit of 50 km/h, that connects Praca Francisco Sa Carneiro with Martim Moniz. As a connecting axis to the city center, the street present heavy traffic for both public transportation and individual cars. Buses and trams are crossing these streets and an underground metro is going beneath the street facilitating the access in the area.

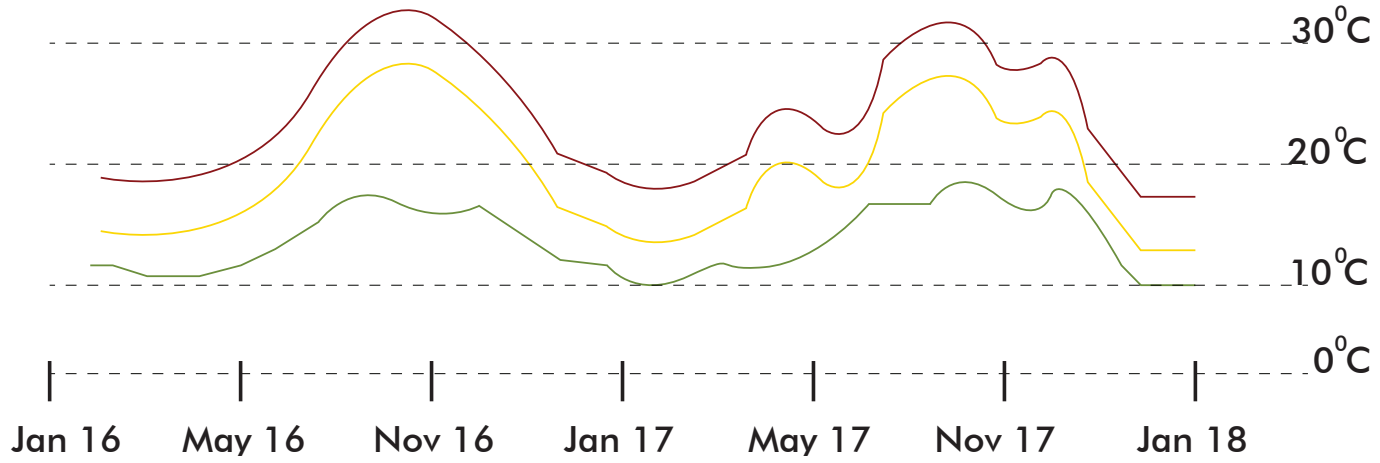
Existing materials

Lisbon has a history and tradition regarding the urban materials currently used. Pavement is treated rather different in the city of Lisbon compared to other capitals around the world. The city is known for its shaped and colored pavement across the pedestrian paths and main squares.
Although the materials are not very eco-friendly and comfortable to walk on, people are still very proud of their stylized pavements.

Ill. 60 - materials

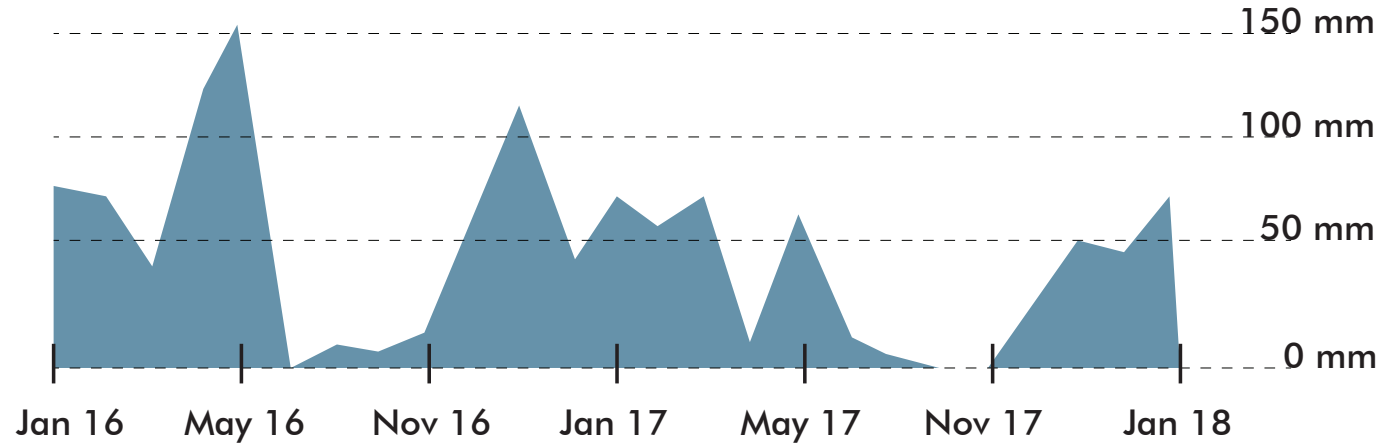
Weather reports

According to past weather reports it can be seen that during the year the average temperature during summer is +27 C and +13 C during winter. The maximum temperature being +32 C and the minimum of +8 C.



Ill. 61 - temperature

The rain falls are mainly during winter and spring. The registered amount of rain for years 2016 and 2017 is between 0 mm and 147.8 mm.



Ill. 62 - rain falls

Experiences

Ill. 63 - experiences

The beautiful site seeing spots and yellow trams are hidden behind the noise of the tires scratching on asphalt and honking of the cars.
In a highly dens city with a growing population of 2,943,000 in 2018 according to UN data, tourists and locals altogether are trying to make their way to different places. The historical sites can be spotted everywhere in the city, mixed together with the new buildings and technologies.
Creating the feeling that you are in a city built on levels, where stairs and elevators are the easy way up, between narrow streets and people's homes, Lisbon has an unique way of transporting you into its history.

The old pavement that embraces the streets of Lisbon is enhancing the hilly character of the city, giving it a more natural vibe.
Although the pavement is creating an interesting feeling, when walking on it, is not very comfortable, since people tend to trip, slip, or even fall down. Nonetheless, it is impossible for people with disabilities to walk.

One of the most used way of transportation is Tram 28. Since it has become an emblematic sign of the city, tourist are staying in line just to take the 20-30 minutes ride with the lovely old and yellow tram.

theory

MobilITY
SustainabilITY
BikeabilITY

During history, planners and designers have tried to respond and adapt to the constant change of people's needs. One of those needs refers to mobility that influences people in their everyday life.
Society focuses nowadays on easy access between points of interest and their comfort, at the cost of losing sight of consequences such as health and environmental issues. Thus, people tend to become self-centered which leads to a detrimental development of cities.
There is a difference between what society needs and what it desires. A driver will always prefer a speedway, a traveler will always prefer the plane ride and not the train ride, without considering the greater good.
Therefore, when designing and planning for a city, especially in urban planning and mobility issues, fitting solutions should emerge from a complex understanding of people's needs.
Mobility is a complex concept that can be found in both public and private aspects of human life, and can have different meanings. It can be linked to the use of different technologies (cars, bikes) or complex systems (public transport, air travel).
Specialized literature recognize the importance of mobility, as many theories and innovation tools address it. In urban planning, its importance is represented by the many guidelines and rules in city's legislation.
As the standards of the quality of life increase, it has become clearer that planning can provide good mobility solutions.
"A large majority of European citizens live in an urban environment, with over 60% living in urban areas of over 10 000 inhabitants. They live their daily lives in the same space, and for their mobility share the same infrastructure." (European Commission of Mobility and Transport)
"But more importantly, seen from an interaction perspective the claim that behavior affords behavior is crucial. From this discussion of affordance I should aim at clarifying and specifying notions of 'mobility affordances' created by the natural environment as well as the human-made infrastructures and transport technologies." (Jensen, 2013)
Mobility is more than infrastructure. This concept encloses opportunities of movement, time and routine responses as well as subjective optimized accessibility.
In 2013 the European Commission in the department of Sustainable Urban Mobility released a set of guidelines for the member countries to review and use for future projects. SUMP is a user-focused approach and it differs from the traditional planning where projects were oriented more on infrastructure, economy and traffic rather than people's mobility needs.
This approach is based on participatory planning and sustainable solutions provision for the users of daily urban mobility. (European Commission).
This way mobility in cities can be improved and create an inclusive design for everyone no matter age or physical limitations.

Good mobility can influence the quality of life by providing opportunities. Combined with sustainable and environmental movements, focused towards improving living quality and environmental health, it can provide suitable solutions in many spectrum of human activities.
On top of understanding the actual need of the community, participatory design provides a sense of belonging and attachment towards the plan. This phenomenon is proven motivating for communities, as the respect for the project can be seen in the level of maintenance of the space. (Stratigea, 2015, pp. 45)
"Participatory planning techniques are important tools for achieving success. As defined here, participatory planning involves the systematic effort to envision a community's desired future, plan for that future, and involve and harness the specific competencies and inputs of community residents, leaders, and stakeholders in the process. Participatory planning attempts to use a common goal for a community to bring together stakeholders in a constructive, consensus-building process to develop a plan to meet that goal." (Foth, 2008, pp. 58)
Often spaces are used in a different manner than originally thought by designers. In some cases, the user is making improvements on the space showing that the design quality can be improved. Therefore, this is a good example for why involving the user pro-actively in the process helps avoid these mistakes.
Co-designing brings together investors, users, professionals and institutions in order to come up with the optimal solution for the design of space.
By using methods such as workshops, with all the parties involved in the process, making the user aware of the importance of properly designing a space, leads to a significant improvement in the quality of the design and the quality of lifestyle in the neighborhood.
Size and space for approach use refers to the fact that the user should be able to fit, manipulate and feel comfortable regardless of his physical limits such as body size, posture, or mobility (Steinfeld and Maisel, 2012).
If looking at how communities evolve, the physical context is based on a standardized body and its abilities. In this case, a non-standardized body is automatically tagged as disabled as it is unable to fit the reality it is exposed to (Moser, 2009).

Urbanization is constantly altering the relationship between nature and humans while affecting the environment at alarming rates.
Sustainability is a discussed subject in many communities, thus becoming a key element when designing cities in order to create livable spaces and buildings. Moreover, the terms sustainability and resilience moved so fast that have created the need of educated specialists.
For most people, sustainability theory has its origins in biology and ecology, where it refers to the rates at which renewable resources can be used or polluted without affecting ecosystem structure and function. (Alberti 1996)
In urban planning, sustainability is seen as a topic in which the resources used and the waste produced by cities should not be a attacking or overuse the ecosystem locally or globally while at the same time ensuring a high quality for sustaining life and social activities. (Davidson 2010)
Being sustainable means to improve the quality of life and at the same time to assure that future generations will not suffer from today's acts.
Cities that implement sustainable solutions in urban mobility have a better public transportation system and reduce traffic stress.
In Europe we can find the highest average score of the six world continents, with an average of 49.8 points (51.5 points for Western Europe and 45.2 for (South)-Eastern Europe) and nine out of the 26 reviewed European cities scoring above 52 points. European urban mobility systems are the best developed ones while leading the way in mobility performance. Stockholm (57.4), Amsterdam (57.2) and Copenhagen (56.4 points) are head of the list, while Athens (40.0 points), Rome (40.9 points) and Lisbon (41.3) are the worst European cities in the sample.
Copenhagen has the safest urban mobility system in the world, with 4.1 traffic deaths per million citizens. It also has the lowest penetration rate of cars in Western Europe at 0.24 per capita while the use of individual transport is on the decrease. This, along with the fact that it has a very good cycle lane infrastructure, helps explain why CO_2 emissions are significantly lower than the European average at 812 kg per capita, compared to a Western European average of 1,330 kg. (Arthur D. Little, January 2014)
Sustainability represents a complex system with which people are getting acquainted. With technology and engineering solutions evolving rapidly and designers that bring people closer to nature, sustainability is gaining more popularity every day. Economy, politics, planning, engineering and technology are all trying to embrace and implement sustainability as fast as possible in order to reverse the process of degradation that started since the industrial period.
Nowadays anyone can have access to information, thus it is very easy to find definitions for sustainability. People are informing themselves how to be more sustainable and how they can contribute to improving quality of life for them and their future generations.
How can I be sustainable?

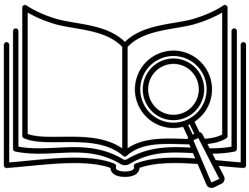
"... surveys have shown that a cyclist can travel 1,600 miles [2575 km] on the equivalent energy of one gallon [3.8 litres] of petrol" (Sharp, 1991)

A bicycle uses less space and offers better fluidity in urban mobility. Moreover, it is better for society in terms of health, considering the fact that it does not pollute the air and helps improve the human physical condition.
For most cities, the main concern is providing parking spaces for cars and enlarging the streets for a continuously increasing car traffic. This is a response to the increased number of population that migrates from rural to urban.(EEA 2005)
Six to ten bicycles parking use the same space as one vehicle (Beatley, 2000)
As today cities face a major problem such as climate change, it is time to reconsider the importance of the car in the city.
A bicycle is produced under eco-design principals by being recyclable, clean. In addition bicycles do not contribute to air and noise pollution.

As for 2003, there were 200 million bicycles in the EU, which adds up to about 500 bikes per 1000 EU inhabitants (ECF 2003).

In order to transform biking from a weekend activity into a mode of transportation used day by day by its citizens, there is need for planning and designing an entire system. Bike lanes are not enough for a person who is biking for more than 5 km. Therefore, intermodality can come as a response to this issue. Making connections between modes of transportation is very important for promoting a bicycle culture.
Public awareness on the environmental challenges today, caused in part by vehicles, make people look for more convenient and environmental friendly solutions. Even though bicycle is a viable mode of transportation for most people, some consider it unsafe, due to bike theft or have a problem with social acceptance. Northern countries consider biking a part of their culture while being very proud of it. Being able to bike in countries such as Denmark or Sweden, where the weather is harsh most of the year can stand an example of a good infrastructure and planning. Nonetheless, bicycle theft still occurs in northern cities, but initiatives throughout history have proven helpful in reducing the numbers in bicycle theft. As proven in Copenhagen, City Bikes reduce bicycle theft. In the five years that the Copenhagen City Bike program has been around, Copenhagen has experienced a 30% drop in bicycle thefts according to the Danish Statistics and Insurance Information Organization. This has occurred because the City Bikes provide the same service that a stolen bike would would. (DeMaio, 2009). Also, by using technology, nowadays bike thefts have lowered. Being able to track your bicycle through GPS systems or simply declaring it stolen to the local authorities with your unique bicycle number is an improvement brought by technology.

study cases



A lift for a hill!

Called the Cyclocable, the lift for biking uphill is located in Trondheim, Norway and has been installed in the early 1990 by Jarle Wanwik, also Norwegian inventor.

It is a system powered only by electric power and with no need of assistance to start it up. Pushed by a pedal, the cyclist is moved uphill with around 2 m/s. At the top, the pedal retracts underneath the pavement and travels back to the starting point.
This unique device is eco-friendly, cost-efficient while being an easily implementable way of transportation.

"Do you need a Bicycle Lift when you can buy an electric bike (E-bike)?
E-bikes always have to carry the load of an electric motor, even when the terrain is flat and downhill. E-bikes are quite expensive, and you have to bother with charging. The Bicycle Lift just give you a push when you really need it, e.g. in the steepest hill(s), and you can still enjoy the lightness and handiness of your bicycle."
(Jarle Wanvik, 2000)

The Municipality of Trondheim decided to build the new technology in order to improve life quality and health, reducing pollution and traffic congestion, noise and dust in Trondheim.

Ill. 64 - system

Ill. 65 - system

Ill. 66 - system

Moscow

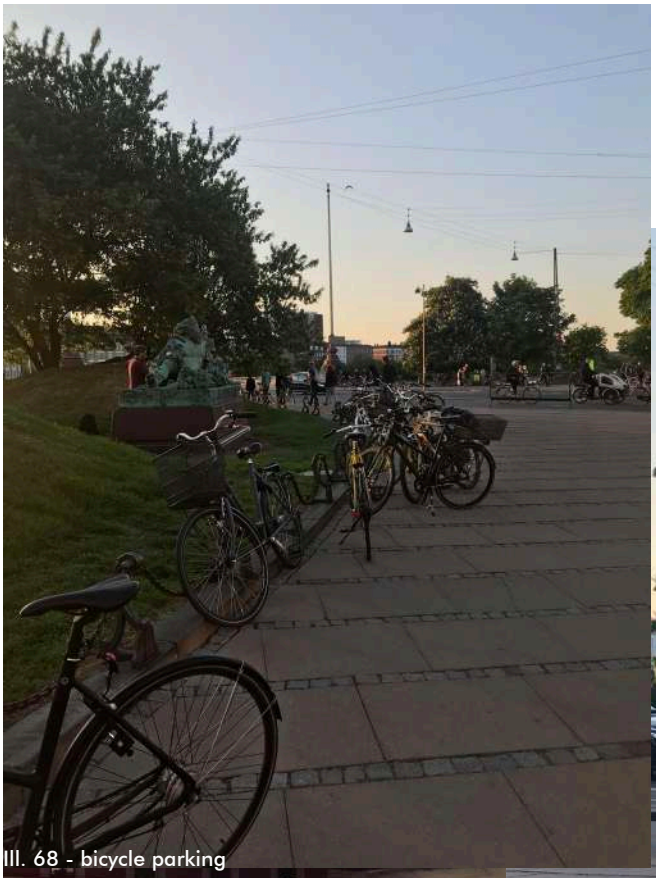
In Moscow it is "COOL" to bike right now. Taking advantage of this trend, Moscow desires to use this in order to change a car oriented culture. Event though the process is slow and compared to other cities such as Amsterdam, New York or London where the share of journeys is significantly bigger, the municipality has developed ways to increase these numbers. By organizing public events, such as parades and promoting them through social media, Moscow is slowing moving towards a more bicycle friendly city. Compared to most cities in Europe, the streets of Moscow have up to 10-12 lanes and are crossed only by bridges or underpasses,. Here, developing a biking network can be difficult. Nonetheless, Moscow stand as an example that even though it is a demanding and slow process, it is still

Ill. 67 - traffic jam

Bicycle city - Copenhagen

Danish people have a well established cycling culture in their lifestyle.
From the middle class working family to the CEO of an important company or a merchant transporting his deliveries across the city, more than 50% of Copenhagen population is biking everyday, even on rainy days.
In the early 1950 the vehicles started to crowd the cities of Denmark, therefore pushing the bicycles aside.
When the oil crisis hit Denmark the dream of a motorized city vanished and cars were replaced by the 2 wheeled man powered vehicles. At the time, many locals rooted for a clean, green city and chose bicycles instead of cars and mopeds.

This is how nowadays Denmark stands as an example for most countries presenting cycling as a good transportation alternative, a healthier and more sustainable option.



Ill. 68 - bicycle parking

Ill. 69 - bicycle lane

Ill. 70 - bicycle parking during night

conclusion

With a growing population and tourism, Lisbon is a wonderful city, located in the heart of Portugal near the Atlantic Ocean, being constantly exposed to a perfect weather.
As technology evolves every day and has become a part of our everyday lives, designers can use it in order to improve the quality of life. The steep slopes represented a challenge in urban mobility, a challenge that now can be surpassed with the help of technology. One answer to this challenge, present in Lisbon, is shown within this proposal which includes a vision that can be used in present planning.
In order to answer to this challenge a thorough investigation (analysis, sketches, mapping, simulations and conclusions) had to be made.
During the design process, theories and similar cases had to be analyzed in order to create design parameters.

Different scales had to be used in order to understand the need at both a city and district level. Starting with an urban strategy for the city of Lisbon, the project continued with a catalog of intersections and streets, and ended with a design proposal for intersections between district streets (one way or two way streets) and city streets, that can represent a precedent for all the similar intersections. The bigger intersections are not addressed in this project and have to be treated separately, since each one of them has a unique character. For this category the municipality of Lisbon is already implementing projects and proposals.

The idea of small shared spaces at the intersections aims to lower the speed when entering the heavy flow of the main streets and shows the fact that pedestrians and bicycles are also crossing that space.
The parking spaces distributed in the center of the street is meant to help reducing the usage of cars in the city center and give the extra space to pedestrians and bicycles.
This proposal has also the purpose to reintroduce the landscape and nature in the urban tissue. By implementing bike lanes across main streets, locals and tourists are encouraged to approach a healthier lifestyle. The changes in the pavement and materials, as well as urban furniture are meant to encourage people to stop and admire the beautiful colors of Lisbon as well as to help people with disabilities or parents with strollers to move around the city. This proposal can be taken as an example and used further for future developments as a practical method of dealing with more specific target groups, such as the ones mentioned above.

reflexion

The scope of this project was to overcome an urban mobility challenge that is present in the city of Lisbon.
In order to understand why this represented a challenge, existent data and tendencies on a global scale had to be taken into consideration. As for the proposal to be accurate, technical answers had to be addressed as well.
Due to lack of information in technical aspects such as numbers of cars or flow existent in the area, the results presented in traffic estimations represents just a scenario based on personal investigations on the site and other interpretations of articles.

After visiting the site, an overview of the existent situation became more clear. The need to reintroduce nature in the urban lifestyle, slowing down the pulse of the city and answering people's needs became part of the challenge as well.

As we can see today, the definition of car and transportation is starting to change. As cars become more environmentally friendly, the roads are also likely to change as well. By reversing the car culture into a bicycle culture, the proposed scenario is still meeting the requirements of mobility. Taking into consideration that such scenarios already exist across Europe, this proposal represents a suggestion that could work on a bigger scale and might be interesting to develop further on.
The world's needs are changing, technology is evolving and a sustainable lifestyle is being promoted across the globe, therefore a change in urban mobility is imperative for all cities in order to meet these conditions.
The location of the proposal has a great potential, since both the citizens and the municipality is showing desire for changing and becoming more environmental friendly.
This proposal is addressed to Lisbon city, but it might be used for other cities across the globe as well.

The motivation for this proposal and this particular case was the desire to form an answer and provide a scenario of how a simple intervention can have an impact on the city of Lisbon. A city with streets that are car oriented, but with an inclination of becoming more sustainable and environmental friendly for its inhabitants. Its 7 hills are creating the impression that Lisbon is a city build on levels, with stairs and public elevators to help people move from one level to another. Thus, the challenge is even bigger, considering the topographical restrictions and existent infrastructure.
This projects aims to stand as an example that reversing the car culture is possible in a city crowded with people, personal vehicles, trams and buses, elevators and metro stations.
Although the scenario is presented as a positive one, it does not mean that there are no consequences, such as reducing parking spaces for inhabitants or the need for investments in smart solutions. This project proposes interventions on a rather small area, therefore it is not established the fact that it could actually work on a city level scale.
Due to a small time line for the project and a lack of knowledge in GIS systems, important tools such as a thorough analysis of the topographical aspect was not possible.
A positive aspect was the fact that the Municipality is very responsive in terms of offering information about their plans and existing analysis and are open to initiatives.
At the end of the process a clearer overview of the entire designing process was drawn. In order to implement an intervention, while at the same time make it functional, more actors should be involved.

reference list

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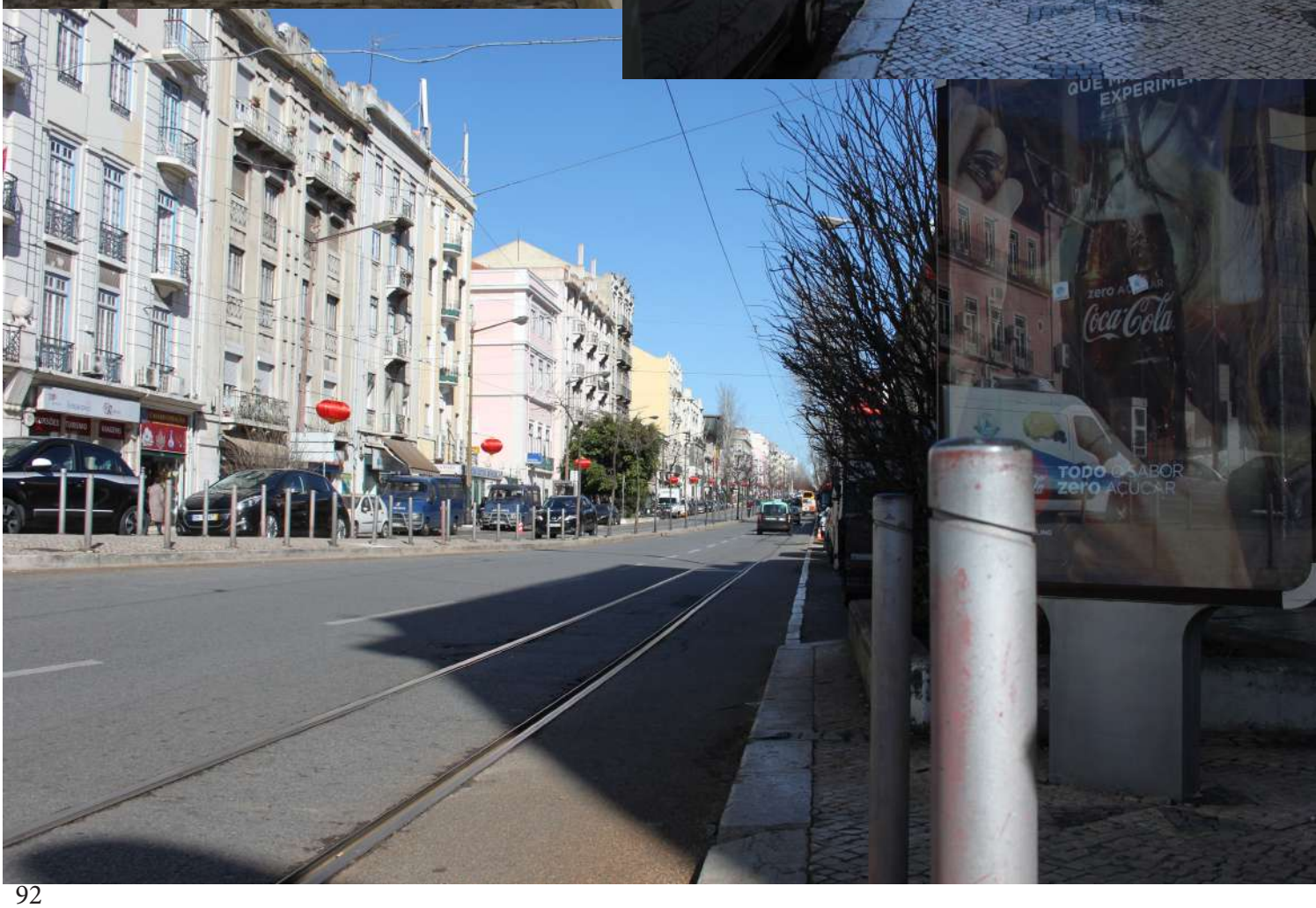
appendix

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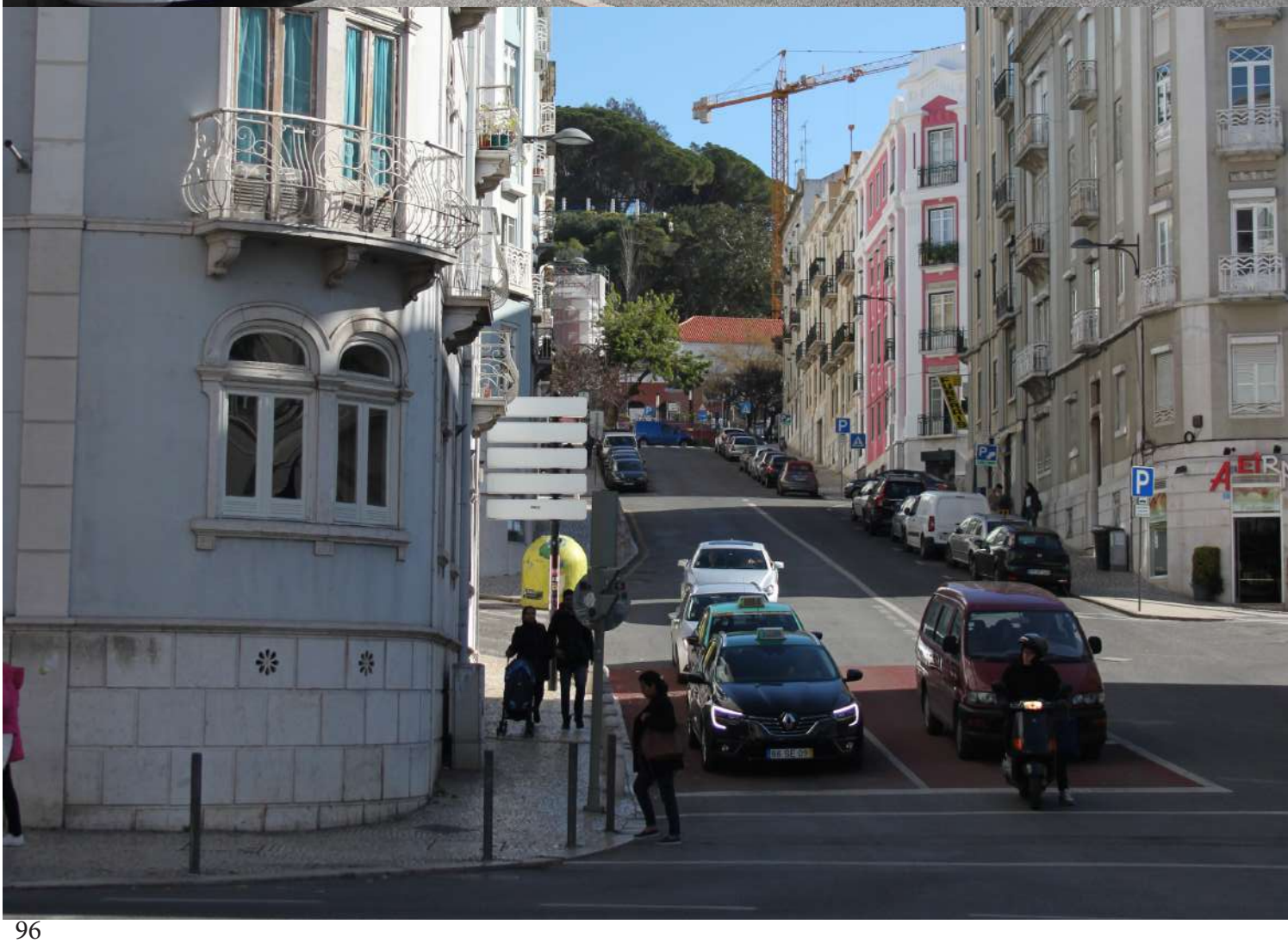

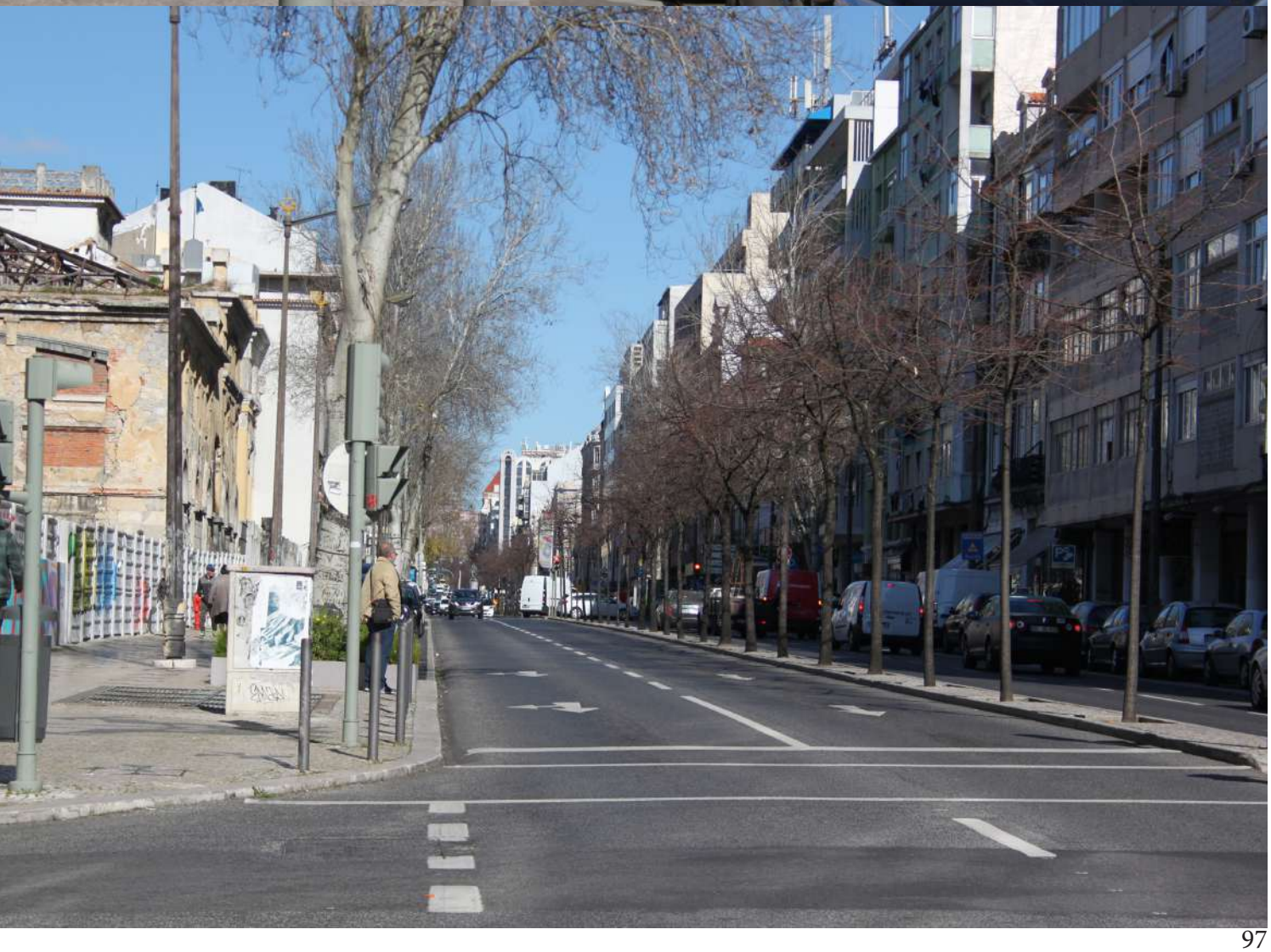


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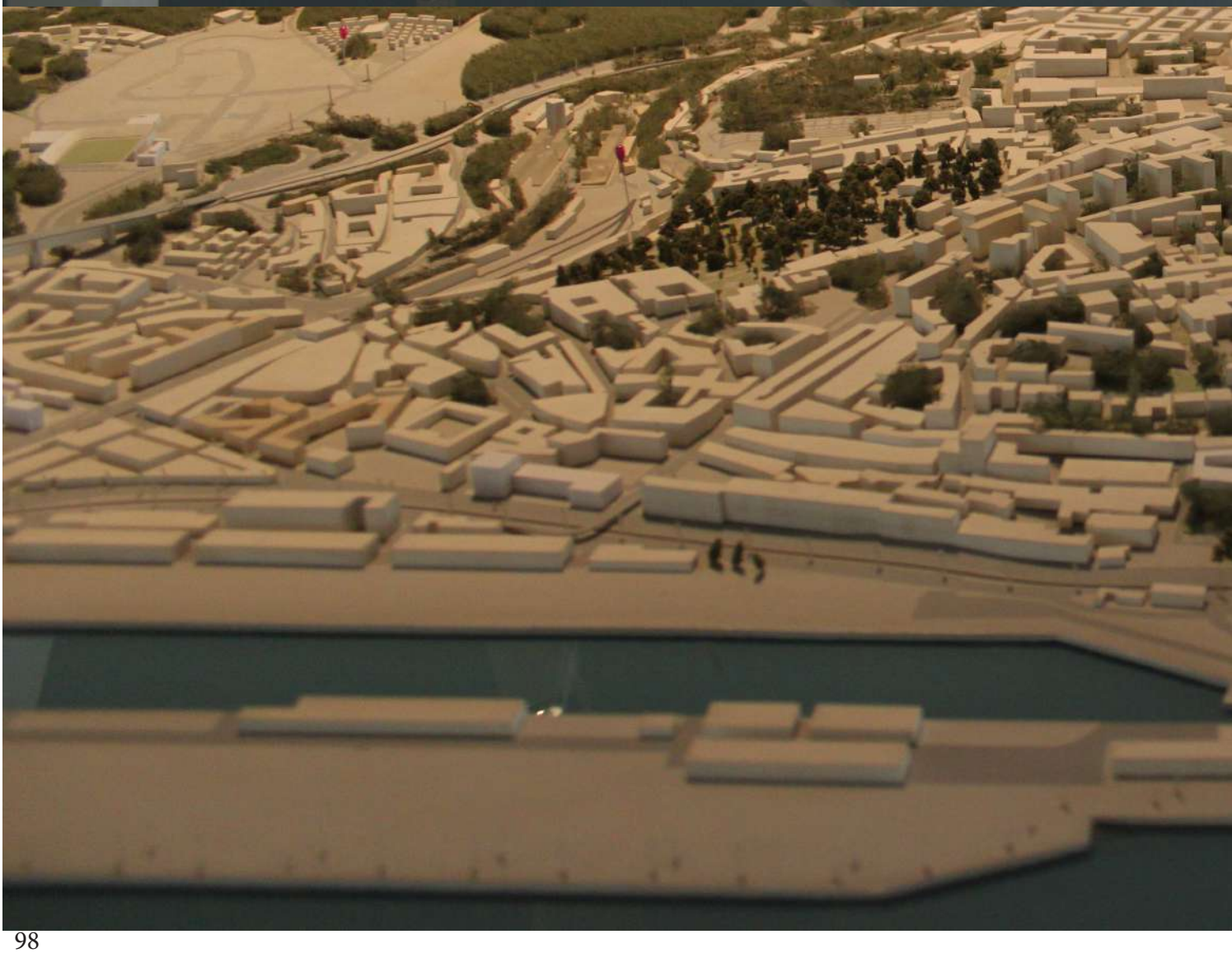


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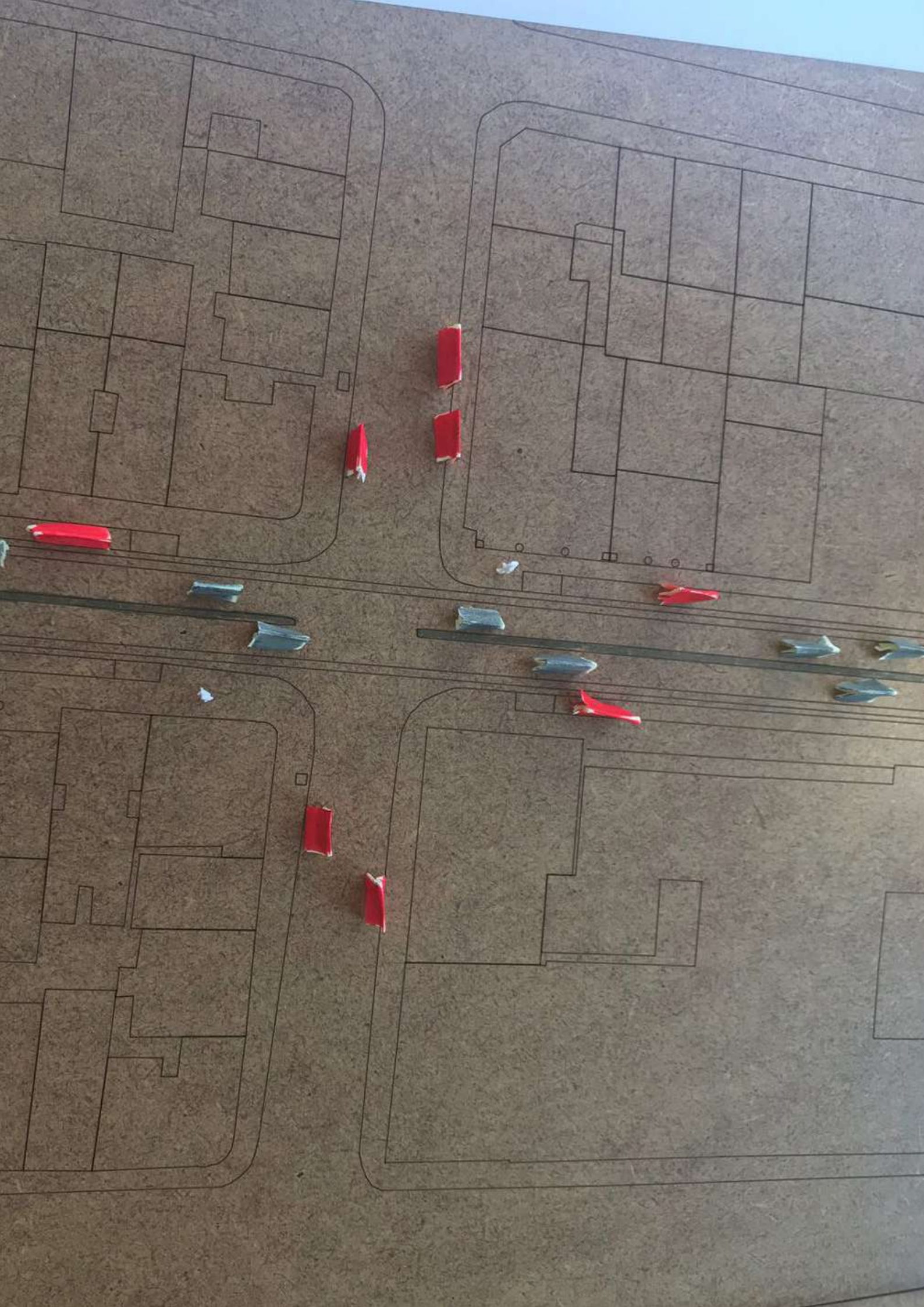

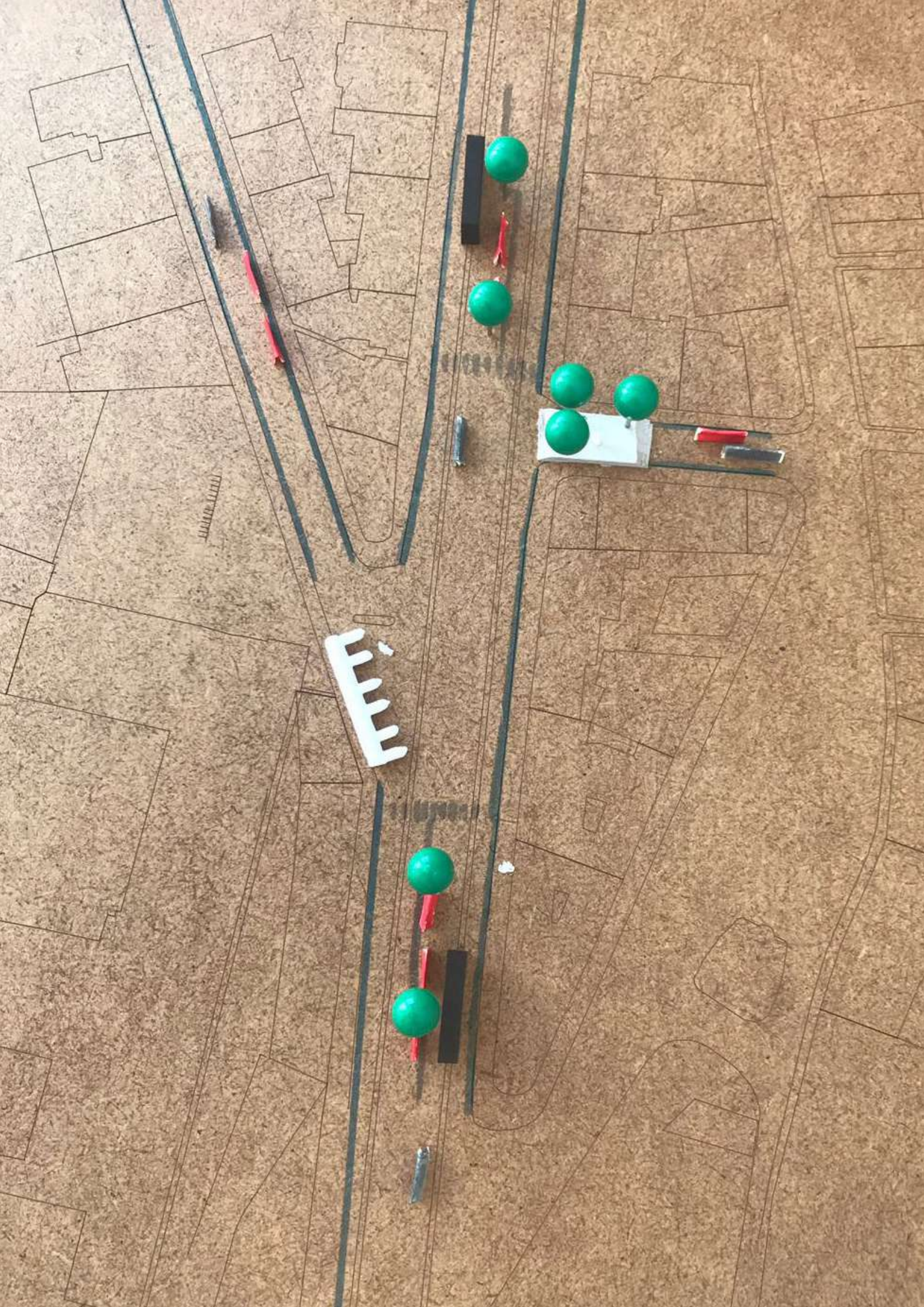

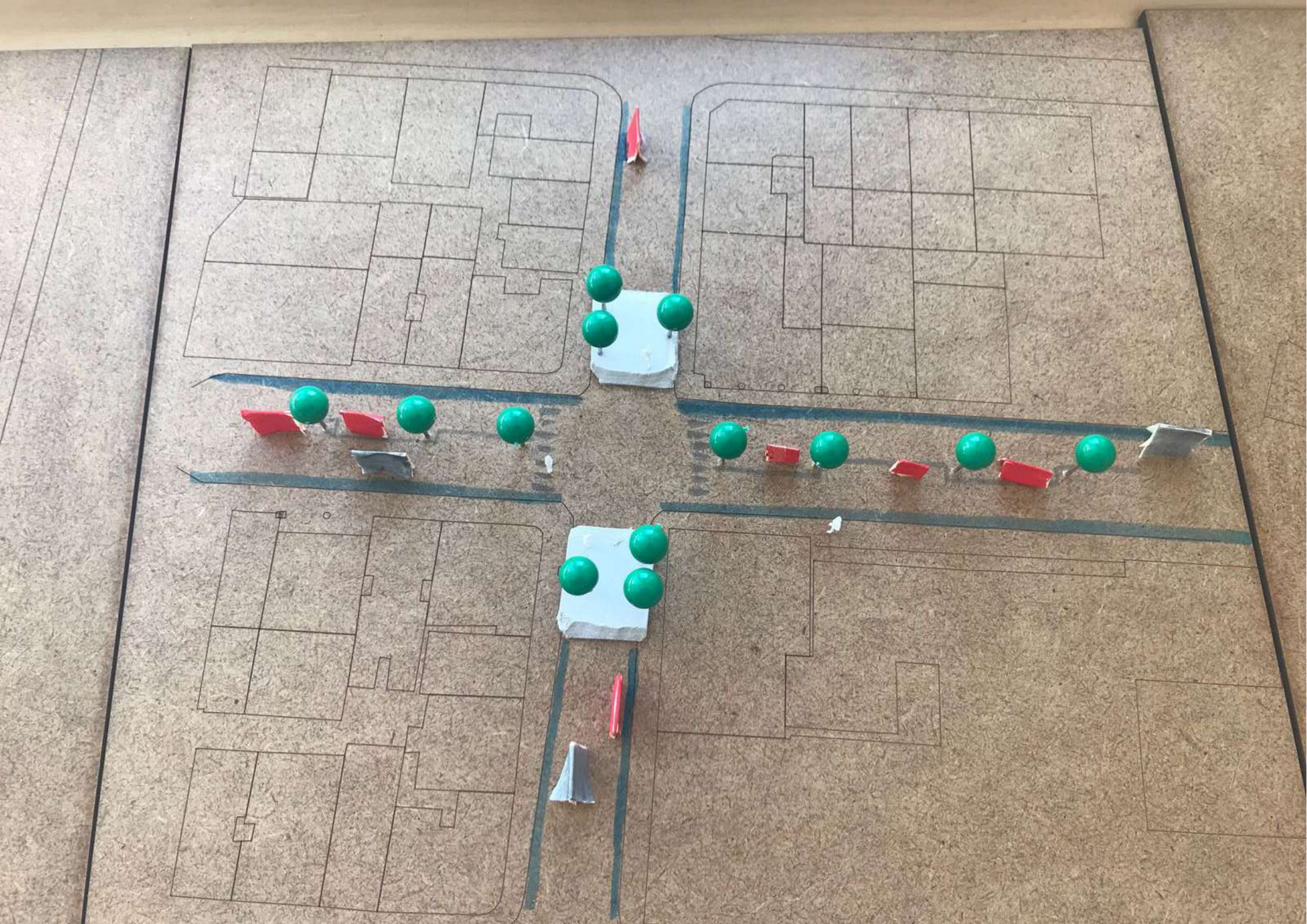

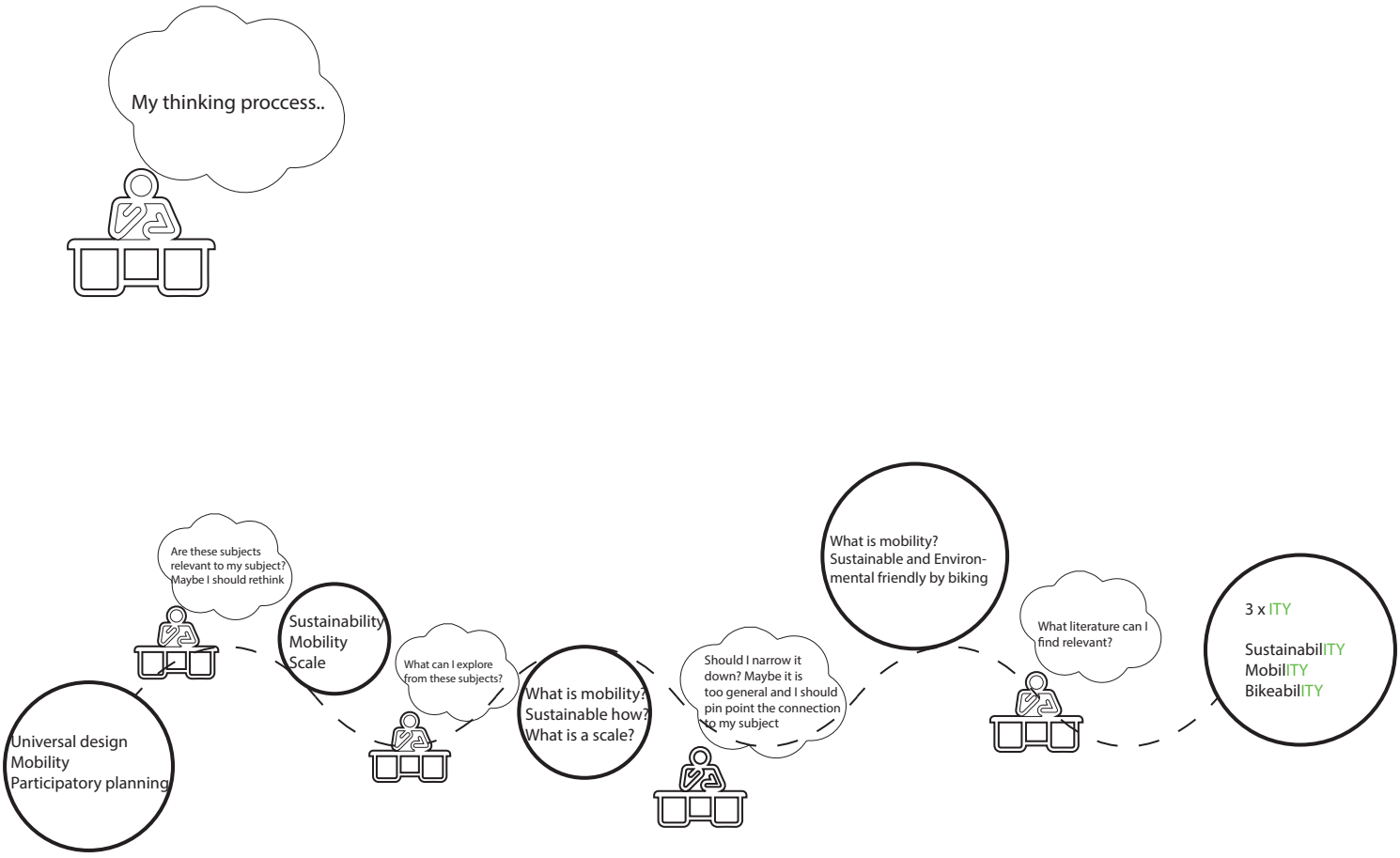
My thinking proccess..
Are these subjects relevant to my subject? Maybe I should rethink
Sustainability
Mobility
Scale
What can I explore from these subjects?
What is mobility? Sustainable how? What is a scale?
Should I narrow it down? Maybe it is too general and I should pin point the connection to my subject
What is mobility? Sustainable and Environ-mental friendly by biking
What literature can I find relevant?
3 x ITY
SustainabilITY
MobilITY
BikeabilITY
Universal design
Mobility
Participatory planning