How to Keep Cities Accessible and Liveable

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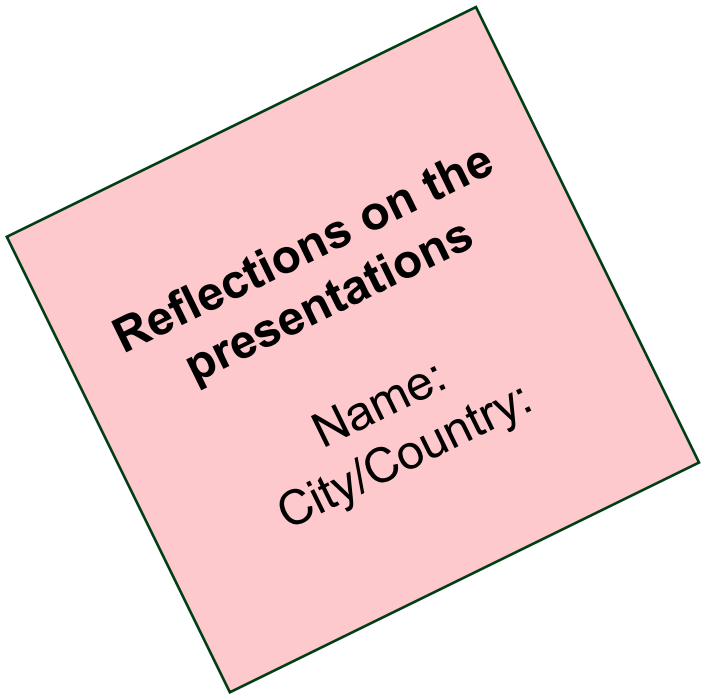
Duration	Topic
5 min	Introduction to the programme (Maaike Snelder - TNO + TU Delft)
15 min 10 min + 5 min Q&A	**MRDH** Identified Challenges (Vincent Joanknecht – Rotterdam Gemeente)
15 min 10 min + 5 min Q&A	**Reducing the number of cars in European** (Sean van der Lee - Master Research)
15 min 10 min + 5 min Q&A	**Active Mobility in Oaxaca: transforming urban dynamics from a car-centric model to a human scale city** (Luigi Barraza - Arcadis)
15 min 10 min + 5 min Q&A	**Assessing the impacts of creating low car areas within a city** (Jyotsna Singh - PhD XCARCITY)
15 min 10 min + 5 min Q&A	**Multi-objective Multimodal Network Design** (Tygo Nijsten - PhD Research)
10 min	**Plenary Discussion** Review challenges + general discussion

Question for the audience

What **challenges** do you have in your cities in making your areas car low?



MRDH Challenges

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MRDH Strategic Agenda

- Invest in accessibility to facilitate population growth in the region
- Stimulate a future-proof economy

- Renew work locations
- Stimulate active and collective forms of mobility
- Restoring the public transport system
- Strengthen the regional mobility network

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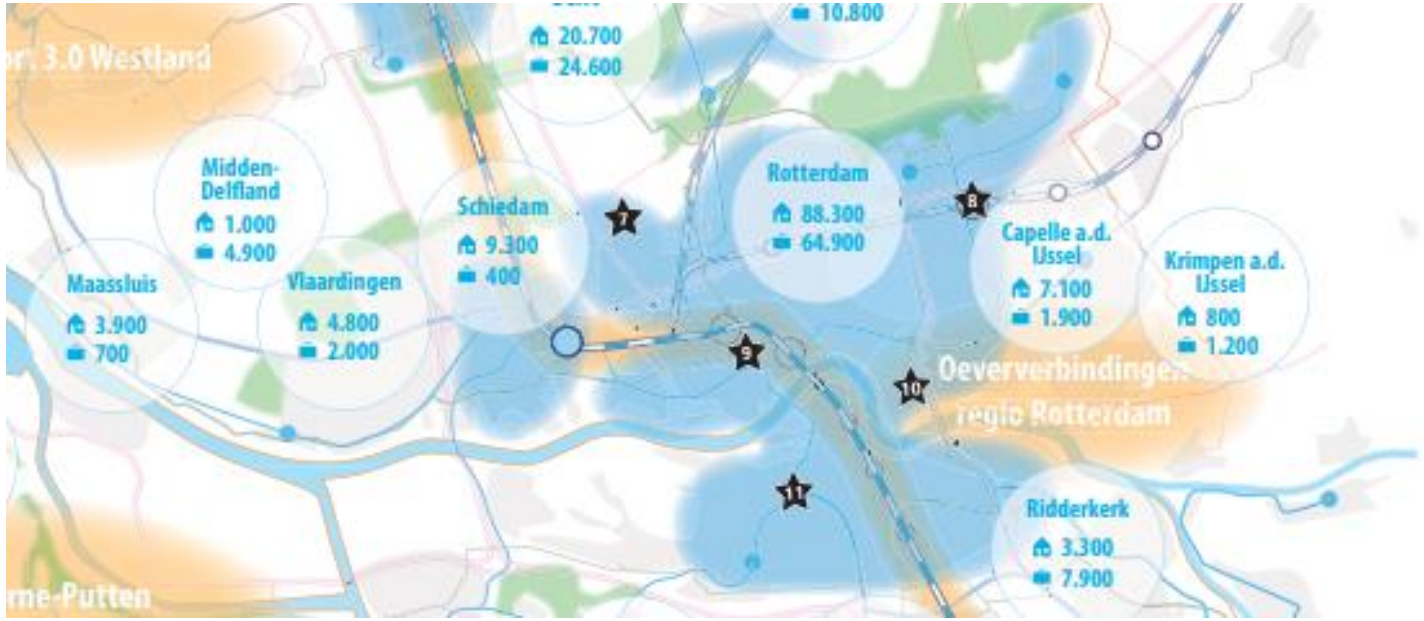
HOW TO REDUCE CAR TRAFFIC?

How do we make sure that **the motorist -** who has an alternative - leaves his car

but

The automobility that has to be there is affected as little as possible.

With only car restriction measures you hit both the first and the second group.



DILEMMAS IN EXISTING AREAS

- Where do you start in **existing environments: with the sour or with the sweet**?
- What do you want with **shared mobility**, how do governments see their role for this? How do we remove possible regulatory barriers to new forms of mobility?
- Is a private **car-free** city or district possible or do we focus on the **second car first**?
- How scalable is this concept, in **which neighborhoods and areas** will it succeed and which will not?
- Is it known what users want: public transport, bicycle, shared mobility (bicycle / scooter)?
- Which target groups are they?
- How do we do that without too much technology?

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ACTIVITIES IN THE REGION

- In the region, several municipalities are working to reduce car use / sometimes ownership. Such as in The Hague, Delft and Rotterdam.
- Examples are: The Hague Binckhorst and South West, Delft Spoorzone, Rotterdam Merwe4haven and the area around Rotterdam Central Station.
- Sometimes also smaller projects such as bicycle parkings and cooperative shared mobility.
- Both sweet and sour measures are taken.

- There is objective measurement, but relation with measures taken remains difficult.

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ROTTERDAM MERWE4HAVEN

Immersive VR research by design Urban Community Vehicle (with BMW)

Integration of Rotterdam Open Urban Platform, Digital Twin Federation, Vehicle data (with BMW)

Modeling and optimisation of sustainable mobilty

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Reducing the number of cars in European cities

What are the keys to success?

Ir. Sean van der Lee
10/10/2024

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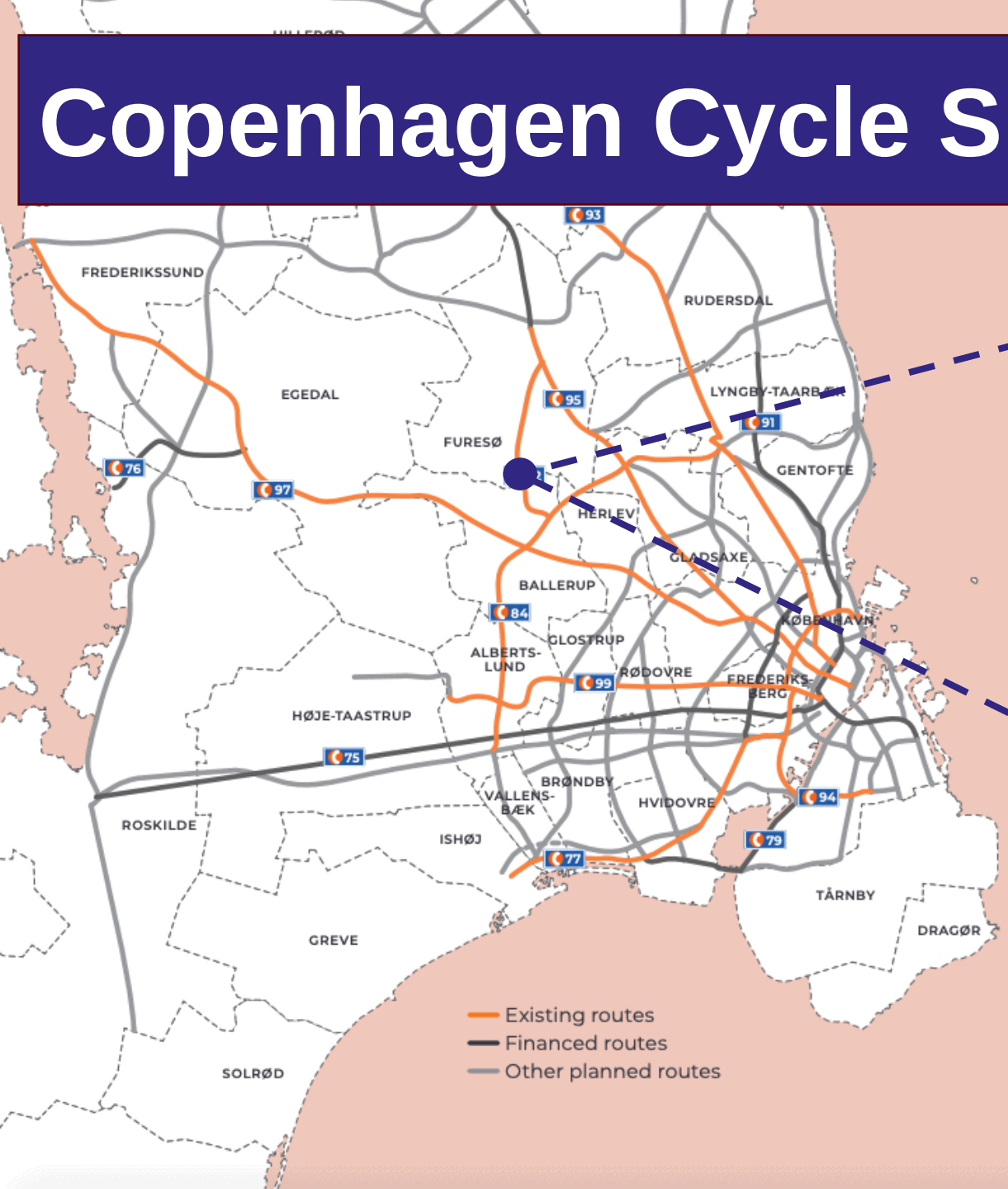
Copenhagen Cycle Superhighways



Success factors

Strategic communication

Organising responsibility

Showing openness and flexibility

Barriers

Resources

Policy & institutional

Bremen Shared Cars

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Success factors

Strategic communication

Showing openness and flexibility

Barriers

Path dependence

Legal

Barcelona Superblocks

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Success factors

Trials to create legitimacy

Organising responsibility

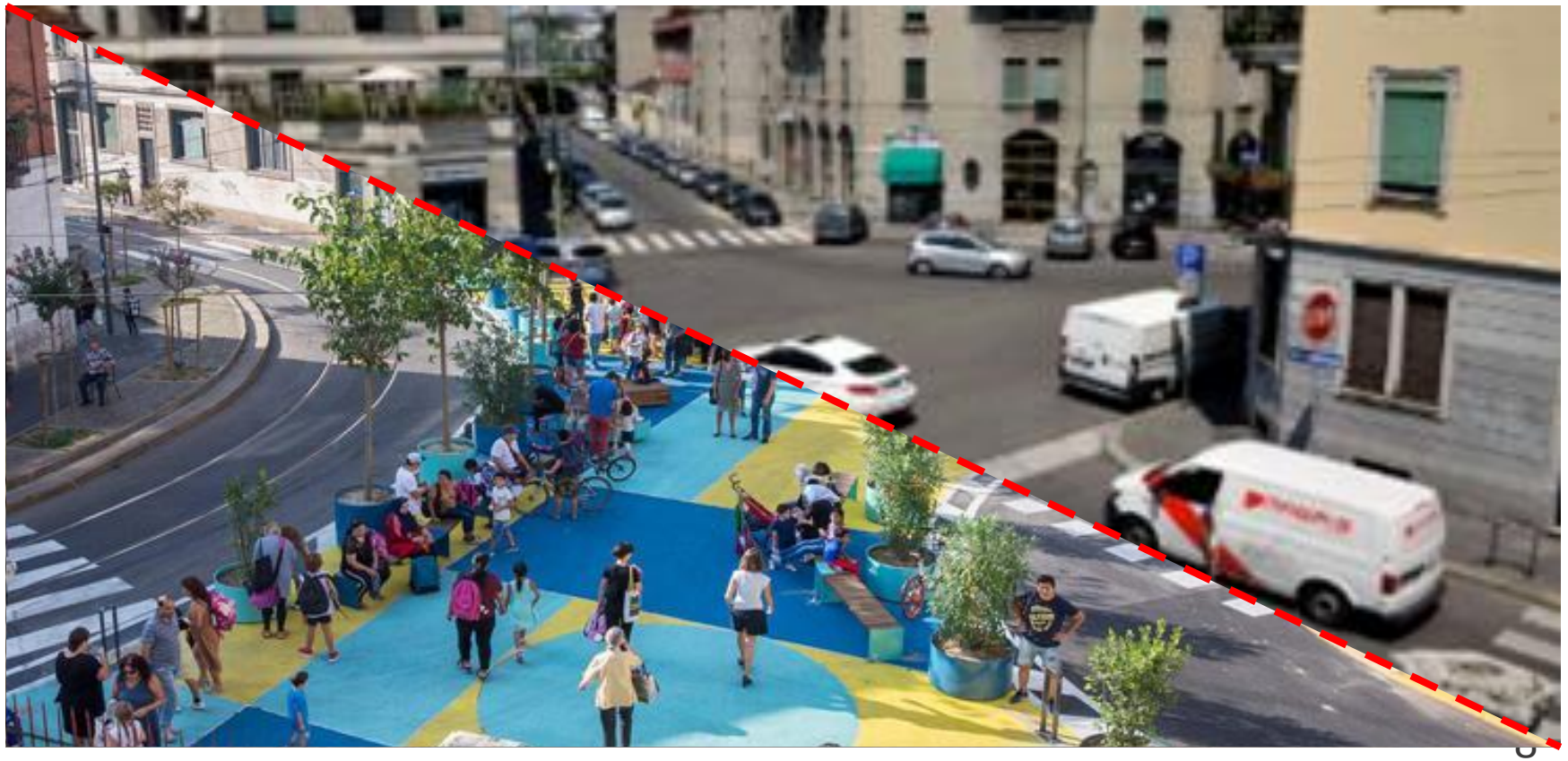
Timing and windows of opportunity

Barriers

Social

Policy & institutional

Milan Open Squares



Success factors

Barriers

Trials to create legitimacy

Showing openness and flexibility

Social

Path dependence

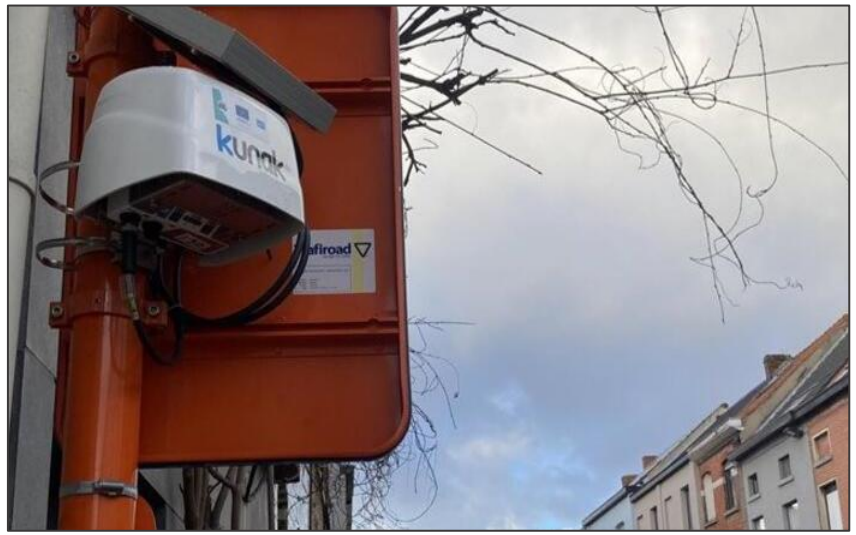
Success factors

- Trials to create legitimacy
- Organising responsibility
- Strategic communication
- Showing openness and flexibility
- Timing and windows of opportunity
- Combining sticks and carrots

Barriers

- Social
- Path dependence
- Policy & institutional
- Resources
- Legal

Additional success factors



The undeniability of hard evidence

The inarguability of schools

Success factors

- Trials to create legitimacy
- Organising responsibility
- Strategic communication
- Showing openness and flexibility
- Timing and windows of opportunity
- Combining sticks and carrots
- The undeniability of hard evidence
- The inarguability of schools

Barriers

- Social
- Path dependence
- Policy & institutional
- Resources
- Legal

General Lessons

1. **Continuously explore new possibilities**
2. Be aware of the context and stakeholders' needs
3. Create and identify windows of opportunity
4. Test new measures

Regulations
Pricing
Land-use Planning
Infrastructure
Information Campaigns

City	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Antwerp	X		X		X	-	X	X	X			X		-		X	X	X		X
Brussels	X	X	X	X	X	-	X	X	X		(X)			-	X	X	X	X		X
Ghent	X	X	X	X	X	-	X		X					-		X	X			X
Leuven			X	X	X	-	X	X	X					-		X	X			X
Copenhagen	X		X		X	-	X	X	X					-		X	X		X	
Helsinki	X		X		X	-	X		X					-		X	X	X		
Paris	X	(X)	X		X	-	X	X	X			X		-		X	X	X	X	
Strasbourg	X	X	X		X	-	X		X			X		-		X	X			
Berlin	X		X		X	-	X	X	X					-		X	X	X		
Bremen	X		X		X	-			X					-		X	X			
Hamburg			X		X	-	X		X					-		X	X			
Heidelberg	X		X			-			X					-		X	X			
Nuremberg			X			-			X					-		X	X			
Bologna	X	X	X		X	-	X		X			X	X	-		X	X	(X)		X
Milan	X	X	X		(X)	-	(X)		X			X		-		X	X	(X)	X	
Venice	X	X	X			-	X		X			X		-			X			
Valletta						-	(X)		X		X			-	X	X	X	X		
Amsterdam	X		X		X	-	X	X	X				(X)	-		X	X	X		
Groningen			X	X	X	-	X	X	X					-		X	X	(X)	X	
Houten				X	X	-		X	X					-			X			
Utrecht	X		X		X	-	X	X	X					-		X	X	(X)	X	
Bergen	X		X			-				X				-		X	X			
Oslo	X		X		X	-	X	X	X			X		-	(X)	X	X	(X)		
Barcelona	X	X	X		X	-			X			X		-	X	X	X	X	X	
Madrid	X		X		X	-	X		X			X		-	X	X	X	X	X	
Götheborg	X		X		X	-			X	X				-		X	X	X		
Stockhom	X		X		X	-	X		X	X				-		X	X	X		
Zurich			X		X	-	X	X	X			X		-		X	X	X		
Birmingham	X		(X)		X	-	X	X	X			X	X	-	X	X	X	(X)	(X)	
Glasgow	X		X		X	-	X		X					-	X	X	X		X	
London	X		X		X	-	X	X	X	X	(X)	X		-		X	X	(X)		X
Oxford	X		X	X	X	-	X	X	X			X		-	X	X	X		(X)	X

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General Lessons

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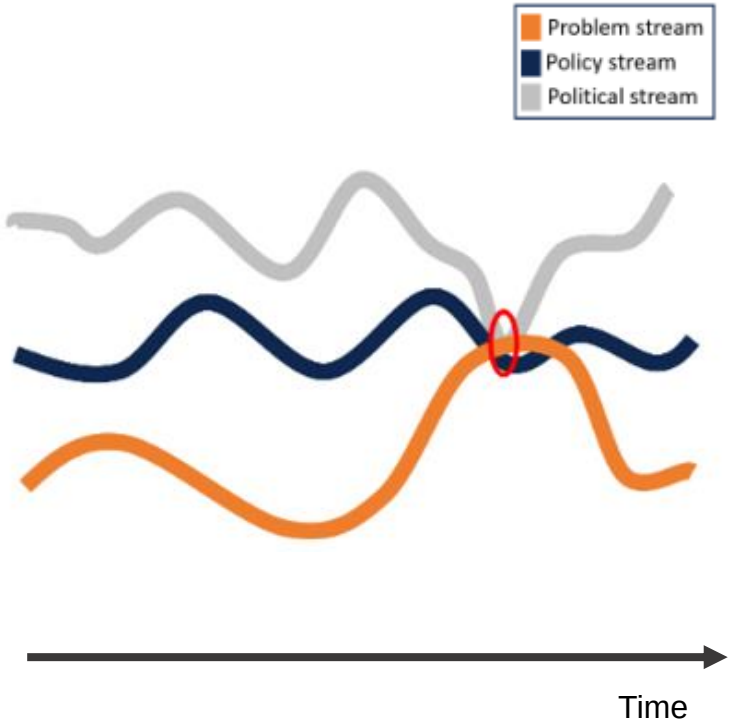

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General Lessons

1. Continuously explore new possibilities
2. Be aware of the context and stakeholders' needs
3. Create and identify windows of opportunity
4. **Test new measures**

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Additional Lessons for Amsterdam

1. Structured and swift interventions
2. Focusing on school communities
3. Benefiting from windows of opportunity

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Reducing the number of cars in European cities

What are the keys to success?

Ir. Sean van der Lee
10/10/2024

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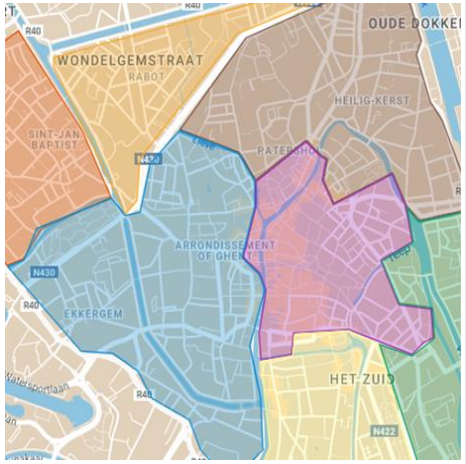
Categories of measures

Regulation

Infrastructure

Land-use



Information

Pricing

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City	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Antwerp	X		X		X	-	X	X	X			X		-		X	X	X		X
Brussels	X	X	X	X	X	-	X	X	X		(X)			-	X	X	X	X		X
Ghent	X	X	X	X	X	-	X		X					-		X	X			X
Leuven			X	X	X	-	X	X	X					-		X	X			X
Copenhagen	X		X		X	-	X	X	X					-		X	X		X	
Helsinki	X		X		X	-	X		X					-		X	X	X		
Paris	X	(X)	X		X	-	X	X	X			X		-		X	X	X	X	
Strasbourg	X	X	X		X	-	X		X			X		-		X	X			
Berlin	X		X		X	-	X	X	X					-		X	X	X		
Bremen	X		X		X	-			X					-		X	X			
Hamburg			X		X	-	X		X					-		X	X			
Heidelberg	X		X			-			X					-		X	X			
Nuremberg			X			-			X					-		X	X			
Bologna	X	X	X		X	-	X		X			X	X	-		X	X	(X)		X
Milan	X	X	X		(X)	-	(X)		X			X		-		X	X	(X)	X	
Venice	X	X	X			-	X		X			X		-			X			
Valletta						-	(X)		X		X			-	X	X	X	X		
Amsterdam	X		X		X	-	X	X	X				(X)	-		X	X	X		
Groningen			X	X	X	-	X	X	X					-		X	X	(X)	X	
Houten				X	X	-		X	X					-			X			
Utrecht	X		X		X	-	X	X	X					-		X	X	(X)	X	
Bergen	X		X			-				X				-		X	X			
Oslo	X		X		X	-	X	X	X			X		-	(X)	X	X	(X)		
Barcelona	X	X	X		X	-			X			X		-	X	X	X	X	X	
Madrid	X		X		X	-	X		X			X		-	X	X	X	X	X	
Götheborg	X		X		X	-			X	X				-		X	X	X		
Stockhom	X		X		X	-	X		X	X				-		X	X	X		
Zurich			X		X	-	X	X	X			X		-		X	X	X		
Birmingham	X		(X)		X	-	X	X	X			X	X	-	X	X	X	(X)	(X)	
Glasgow	X		X		X	-	X		X					-	X	X	X		X	
London	X		X		X	-	X	X	X	X	(X)	X		-		X	X	(X)		X
Oxford	X		X	X	X	-	X	X	X			X		-	X	X	X		(X)	X

Regulations
Pricing
Land-use Planning
Infrastructure
Information Campaigns

BID OAXACA GOBIERNO DEL ESTADO Oaxaca de Juárez Por una ciudad educadora 2022 - 2024 COPARMEX OAXACA ARCADIS

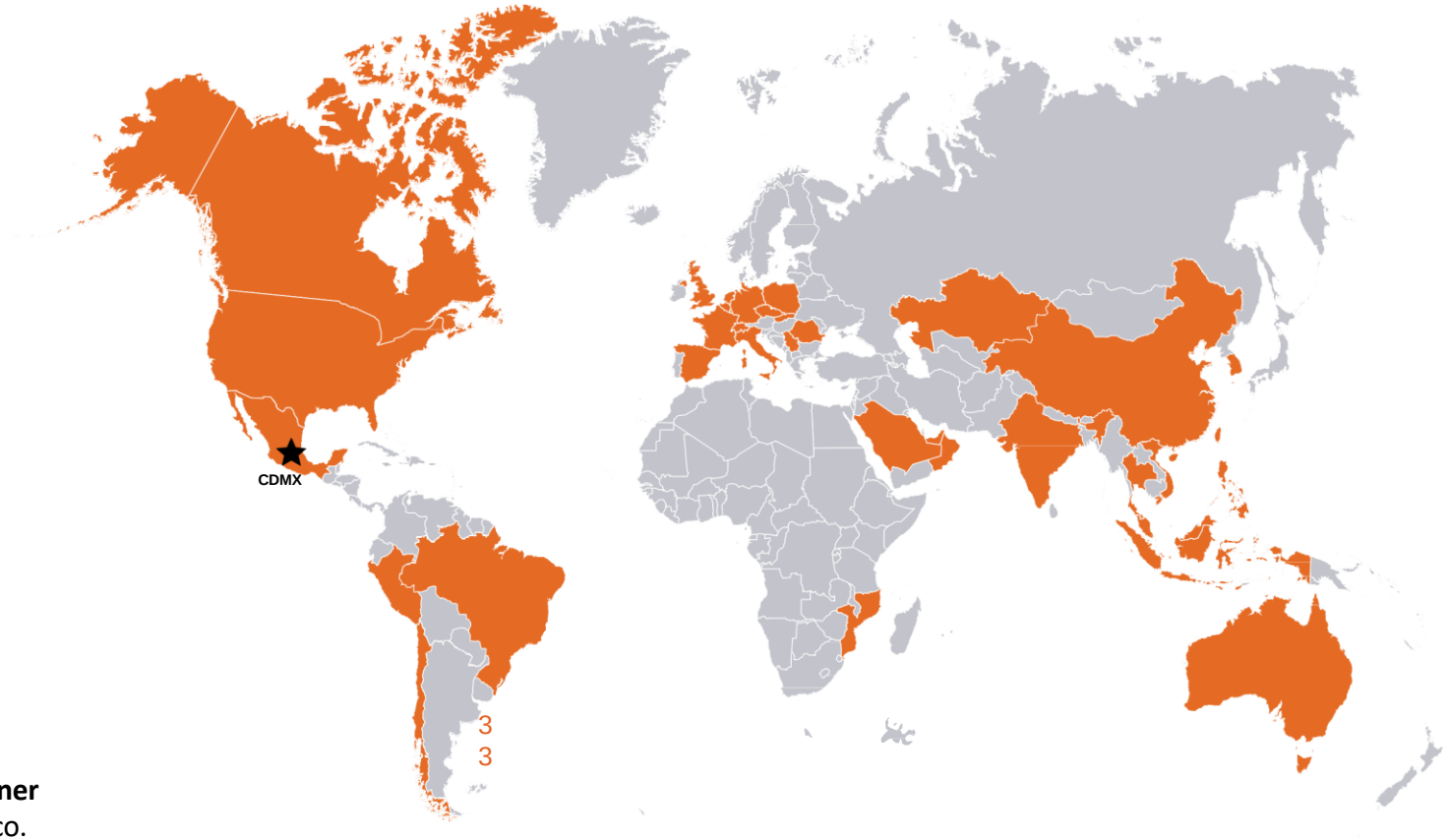
Active Mobility in Oaxaca:

Transforming urban dynamics from a car-centric model to a human scale city

Designing for Impact

Places

A new approach to architecture and urbanism



Urban Planner + Designer
Places - Arcadis | México.

Assistant Professor
Panamerican University | México.

MSc Sustainable Urbanism
University College London. 2021
Chevening Scholar*

Architect, BArch
Tec de Monterrey. 2014

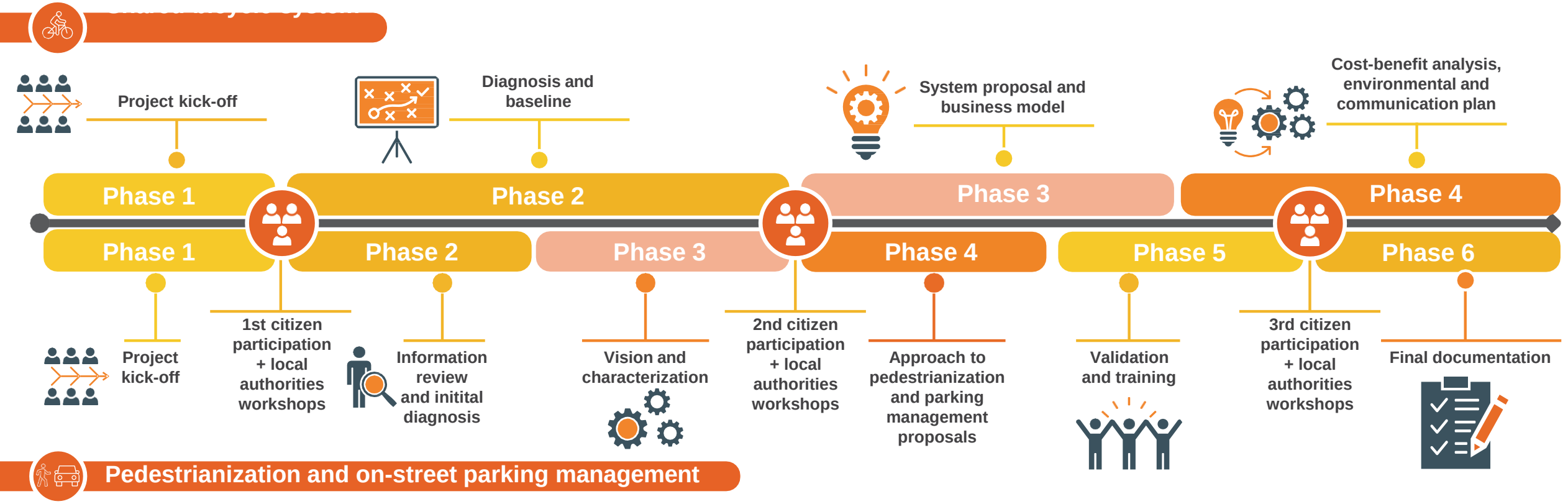
Two projects, one goal; a human-scale city.

SHARED BICYCLE SYSTEM

- Define needs and objectives that the service will address.
- Design a project compatible with the regulatory environment and its goals of sustainability, climate change, diversity, and gender equality.

PEDESTRIANZATION AND ON-STREET PARKING MANAGEMENT PROGRAM

- Propose pedestrianization alternatives considering their economic impact and the reduction of environmental pollution.
- Propose an on-street management program for the historical city center to reduce the amount of congestion.



Anyways, what is Oaxaca? *(waa-haa-kaa)*

Imagen: *Plano de la Ciudad de Oaxaca 1790.* ***Fuente:*** *Mapoteca Manuel Orozco y Berra. Autor: F. Arjona Mejía.*

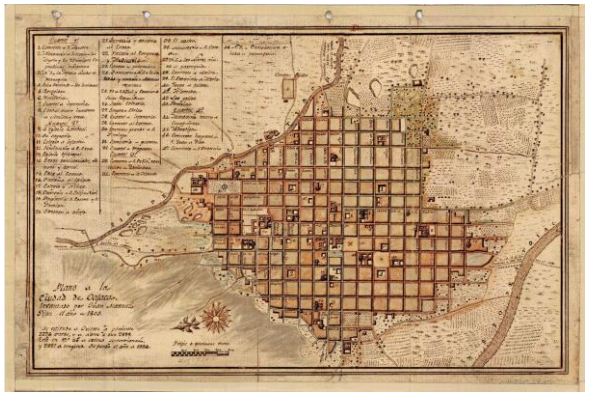


Imagen: *Plano de la Ciudad de Oaxaca 1803.* ***Fuente:*** *Mapoteca Manuel Orozco y Berra. Autor: Juan Manuel Gijón*

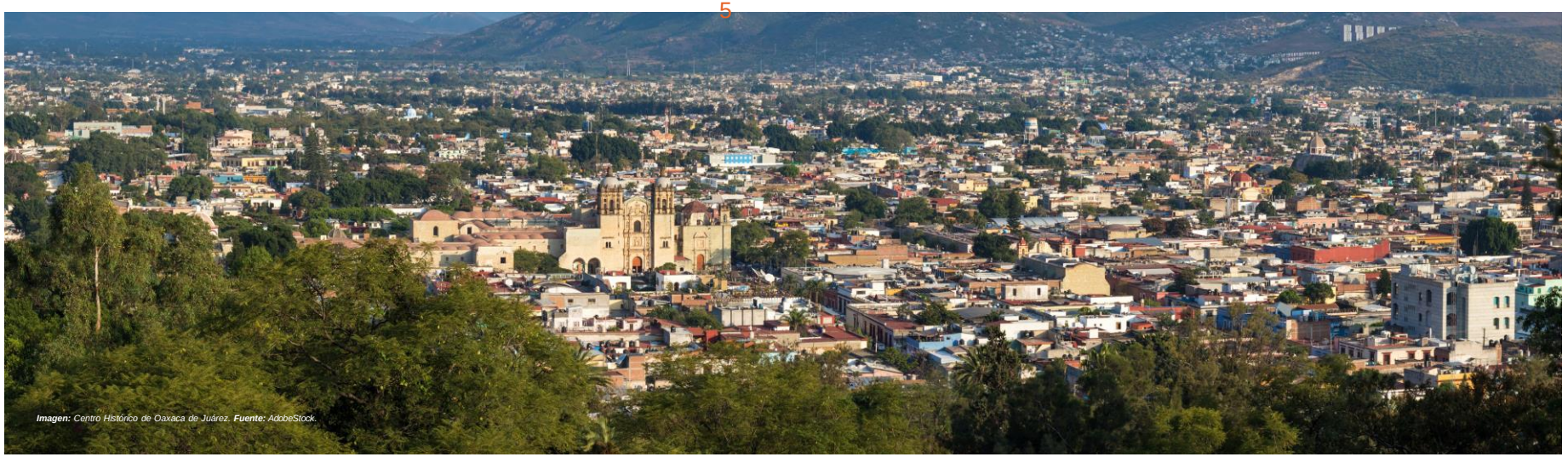
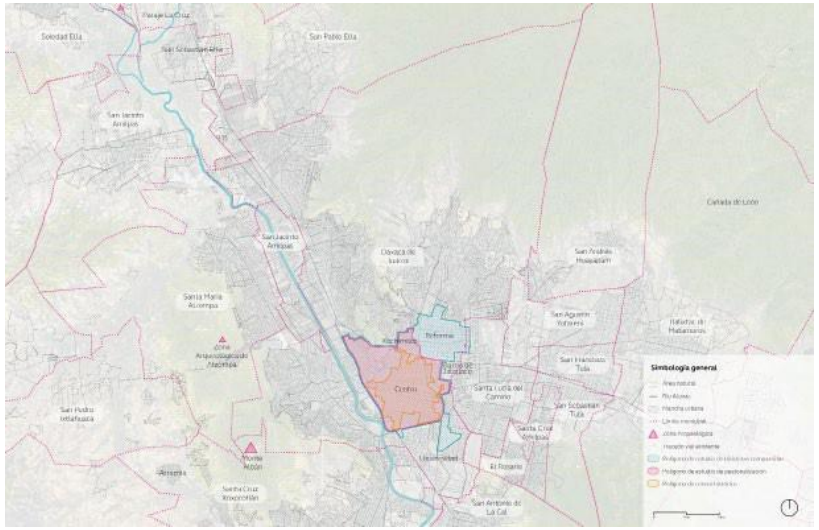


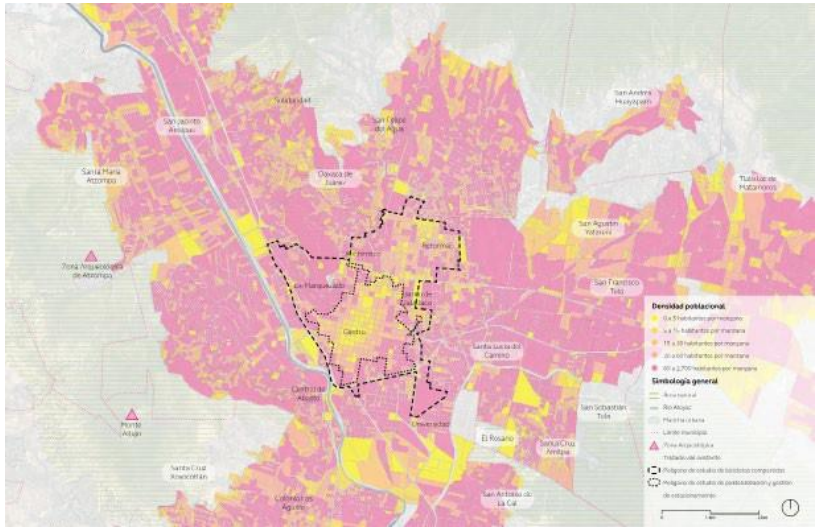
Imagen: *Centro Histórico de Oaxaca de Juárez.* ***Fuente:*** *AdobeStock.*

unesco
World Heritage site

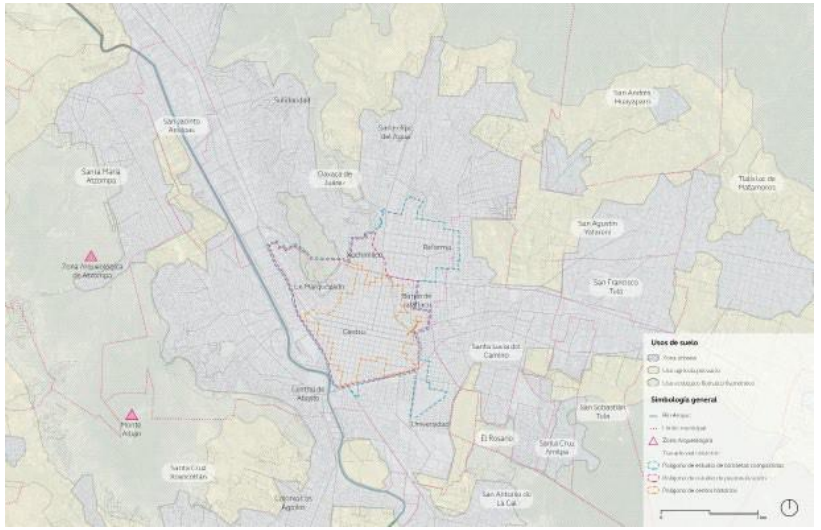
Understanding the city centre through spatial analysis



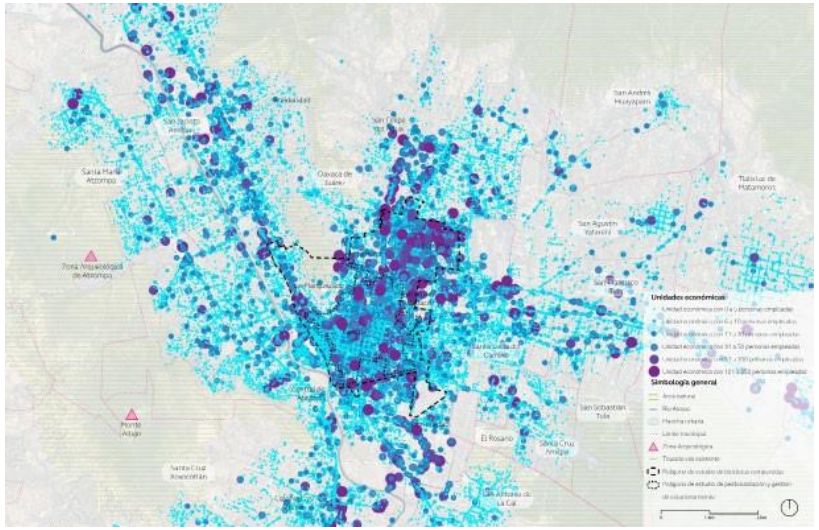
Mapa: *Ubicación regional del polígono de estudio.*



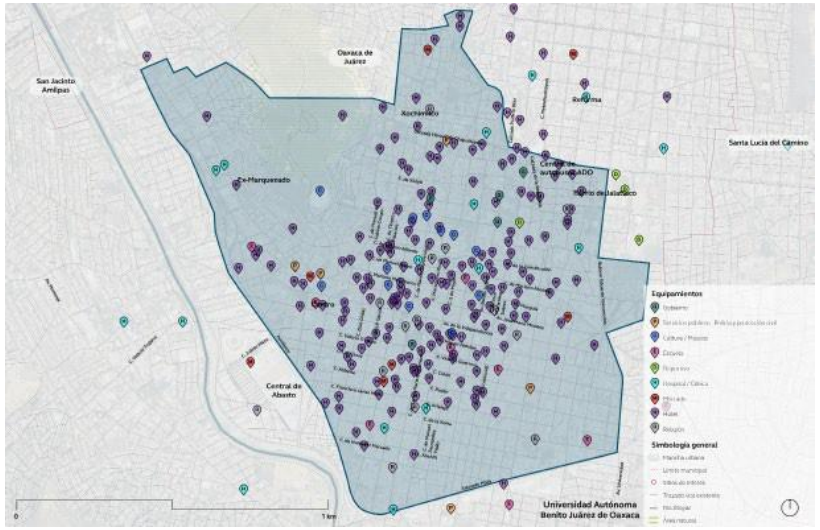
Mapa: *Densidad poblacional por manzana.*



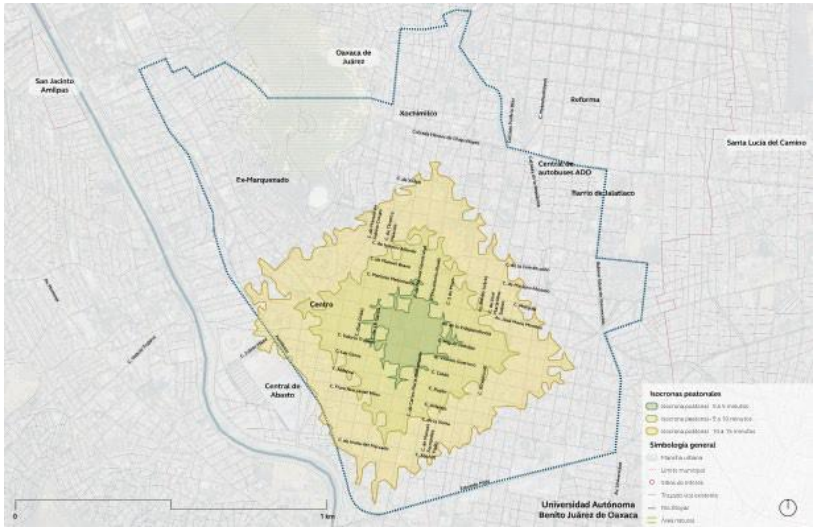
Mapa: *Uso de suelo.*



Mapa: *Unidades económicas y empleo.*



Mapa: *Equipamientos existentes.*



Mapa: *Isocrónas peatonales.*

What is the voice and vision of the people of Oaxaca?




	Description	Date
W1: Site visit and vision workshop with key public authorities and local community	Strategic session designed to facilitate collaboration between different key institutions, focusing on the collective construction of a shared vision for the project.	**February 2024**
W2: Strategic design workshop with local community	Participatory meeting aimed at involving citizens in the design of the project, providing a space to collect their visions, aspirations and concerns regarding the integrated mobility system.	**April 2024**
W3: Review and validation workshop with key public	Participatory meeting aimed at key agents and members of the local community to review and validate proposals, ensuring alignment with the needs and perspectives of those involved, and	**June 2024**

The people of Oaxaca want pedestrian-oriented streets

Frequent cyclist

37%

Frequent pedestrian

31%

Sporadic cyclist

16%

Sporadic pedestrian

16%

What is most important for you as a pedestrian?

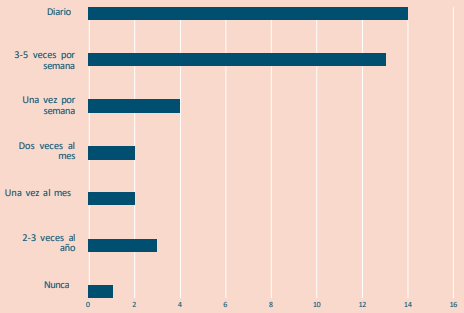
Cobbled streets to preserve Heritage

Flat surface streets where it's easier to bike, roll or walk.

Pedestrian-oriented streets with limited vehicles

Pedestrian-only streets

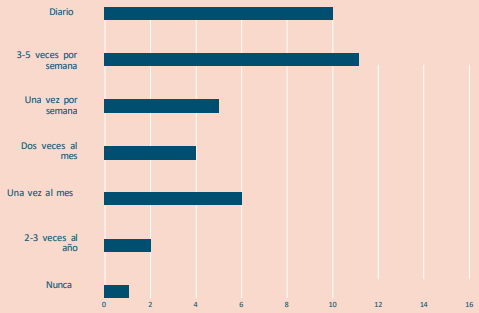
How often you use a car?



36%

Of workshop participants use a private vehicle every day.

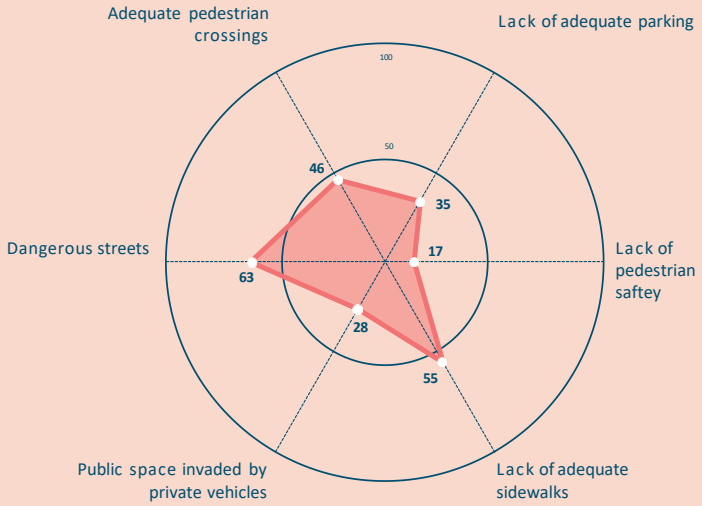
How often you walk to your destination?



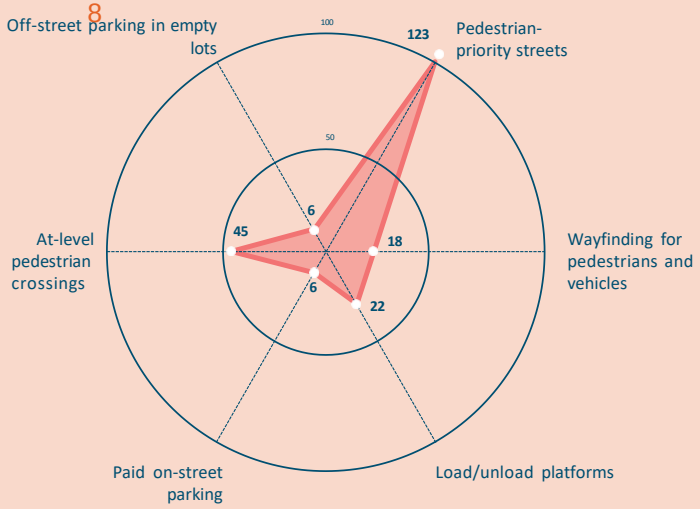
26%

Of workshop participants walk daily to their destinations

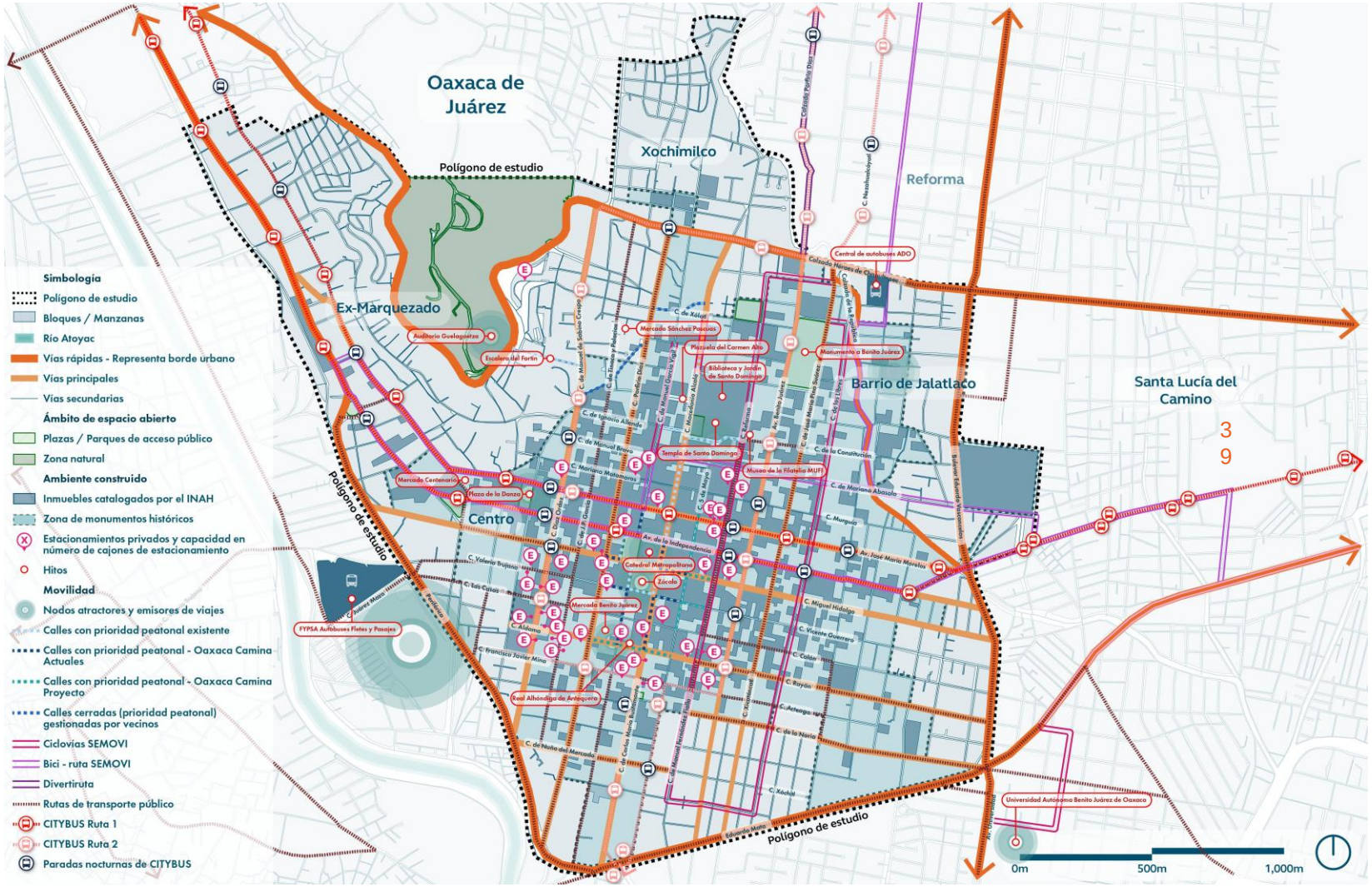
Challenges

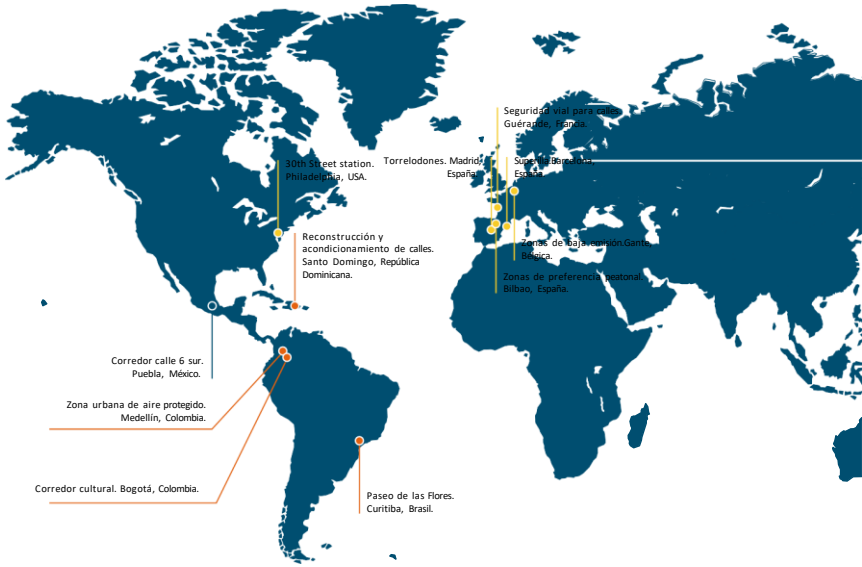


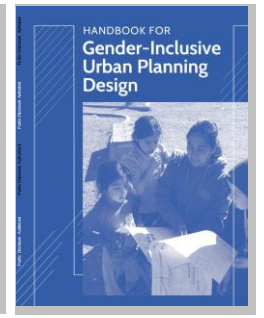
Opportunities

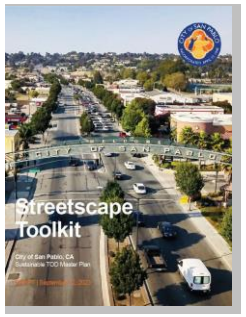


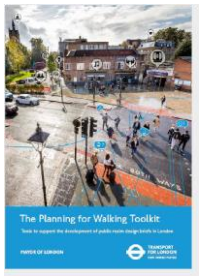
How to transfer best practice to a Heritage Site in constant development?

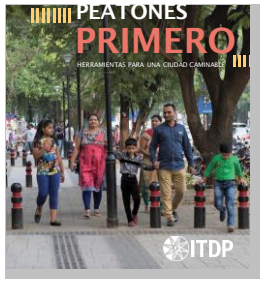




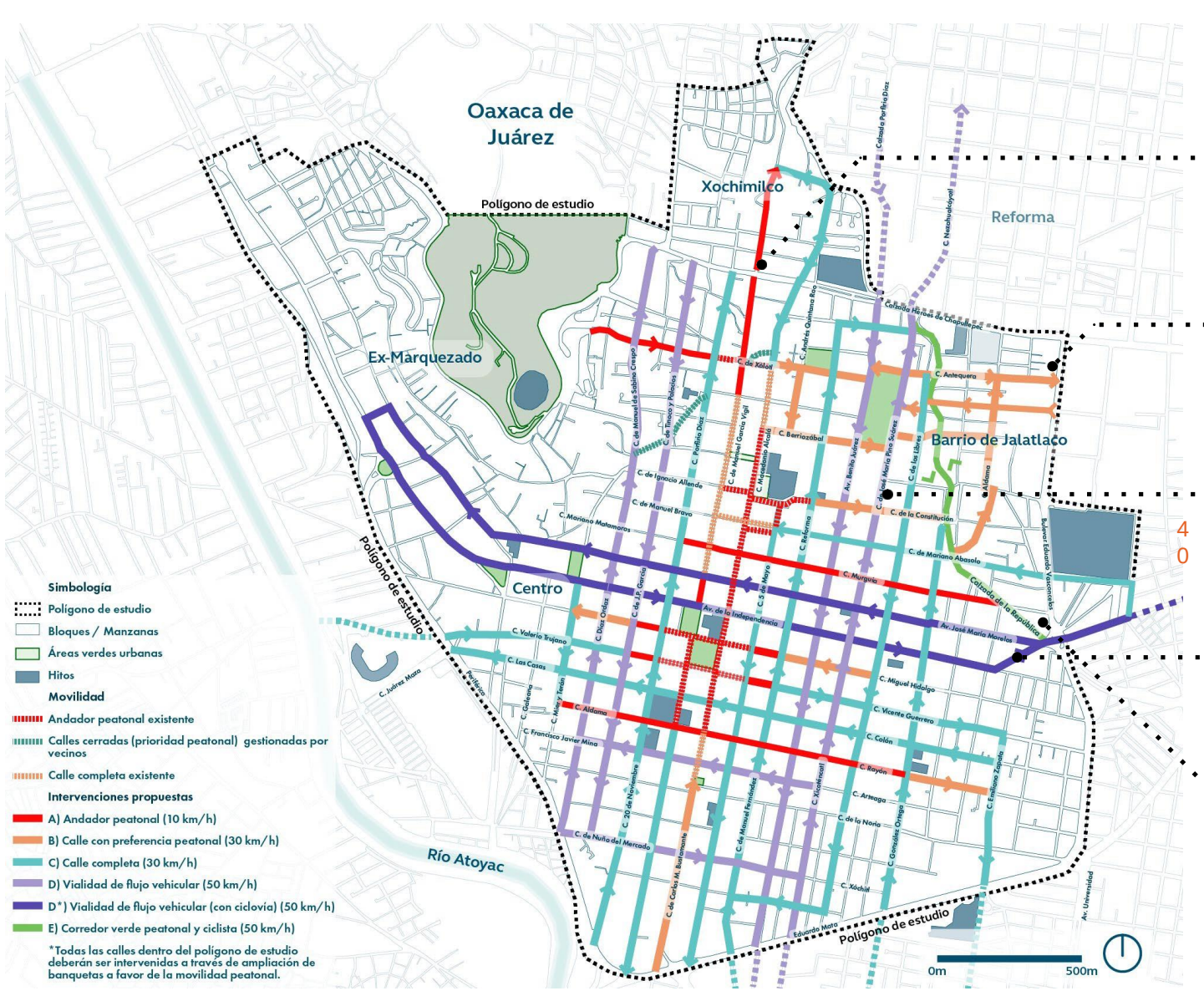


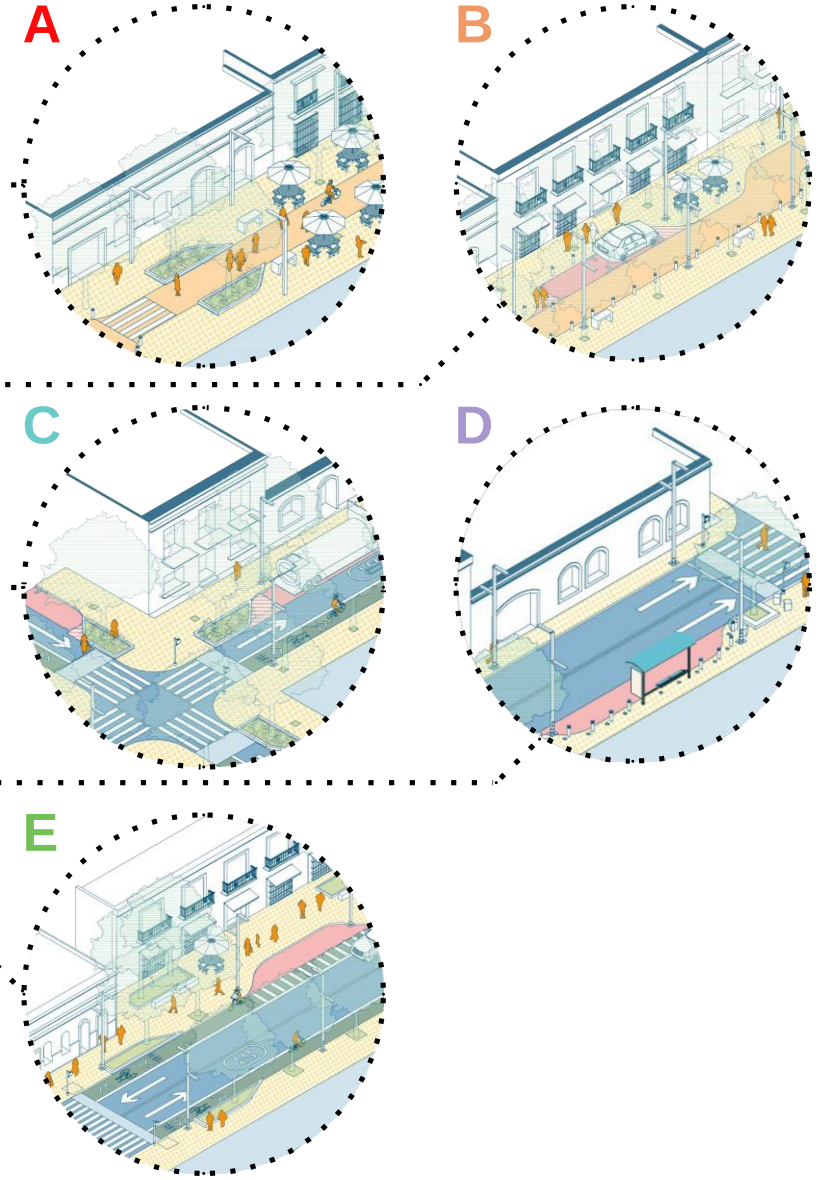






Street typology design for context-based solutions





Different streets for a variety of users and priorities

User matrix and compononets of street typology

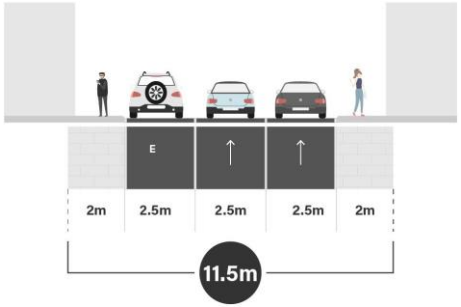
Users	Street components	Typology					
		A	B	C	D	D	E
Pedestrians	Single platform with differentiated materials	☑	☑	☐	☐	☐	☐
	Sidewalk with > 3 m width	☐	☐	☐	☐	☐	☑
	Sidewalk with > 2.5 m width	☐	☐	☑	☐	☐	☐
	Sidewalk with > 1.5 m width	☐	☐	☐	☑	☑	☐
Active modes	Cycling and active modes tolerated	☑	☐	☐	☐	☐	☐
	Cycle lane with priority < 3m width	☐	☑	☐	☐	☐	☐
	One-way cycle lane > 1.5 m width & > 0.3m protection	☐	☐	☑	☐	☑	☐
	Double one-way cycle lanes aligned with street directiion > 1.5 m width & > 0.3m protection	☐	☐	☐	☐	☐	☑
	Not allowed	☐	☐	☐	☒	☐	☐
Public Transport	Shared lane in local roads	☐	☐	☑	☐	☐	☐
	Priority lane in transport axis and main roads	☐	☐	☐	☑	☑	☐
	Shared lane in transport axis and main roads	☐	☐	☐	☐	☐	☑
	Not allowed	☒	☒	☐	☐	☐	☐

User matrix and compononets of street typology

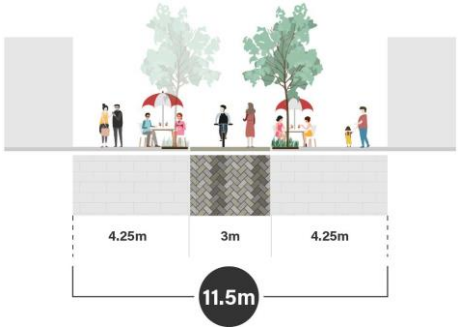
Users	Street components	Typology					
		A	B	C	D	D	E
Private vehicles	Cycle lane with priority < 3m width	☐	☑	☐	☐	☐	☐
	Shared lane on local roads	☐	☐	☑	☐	☐	☐
	Shared lane on transport axis and main roads	☐	☐	☐	☑	☑	☑
	Not allowed (circulation exclusive for residents)	☒	☐	☐	☐	☐	☐
On-street parking	On both sides of the street = 2.5m	☐	☑	☑	☐	☐	☐
	Not allowed	☒	☐	☐	☒	☒	☒
Emergency, loading/ unloading platform	Emergency vehicles on shared lane with no timetable	☑	☐	☐	☐	☐	☐
	Emergency vehicles with priority on right lane with no timetable	☐	☐	☐	☑	☑	☐
	Emergency and service platforms interspersed on both sides of the street	☐	☑	☑	☐	☐	☑
	Service vehicles (pipas, gas, mercancías con restricted timetables)	☐	☐	☐	☑	☑	☐

Growing the existing pedestrian network

Typology A: Pedestrian corridor (10 km / h)

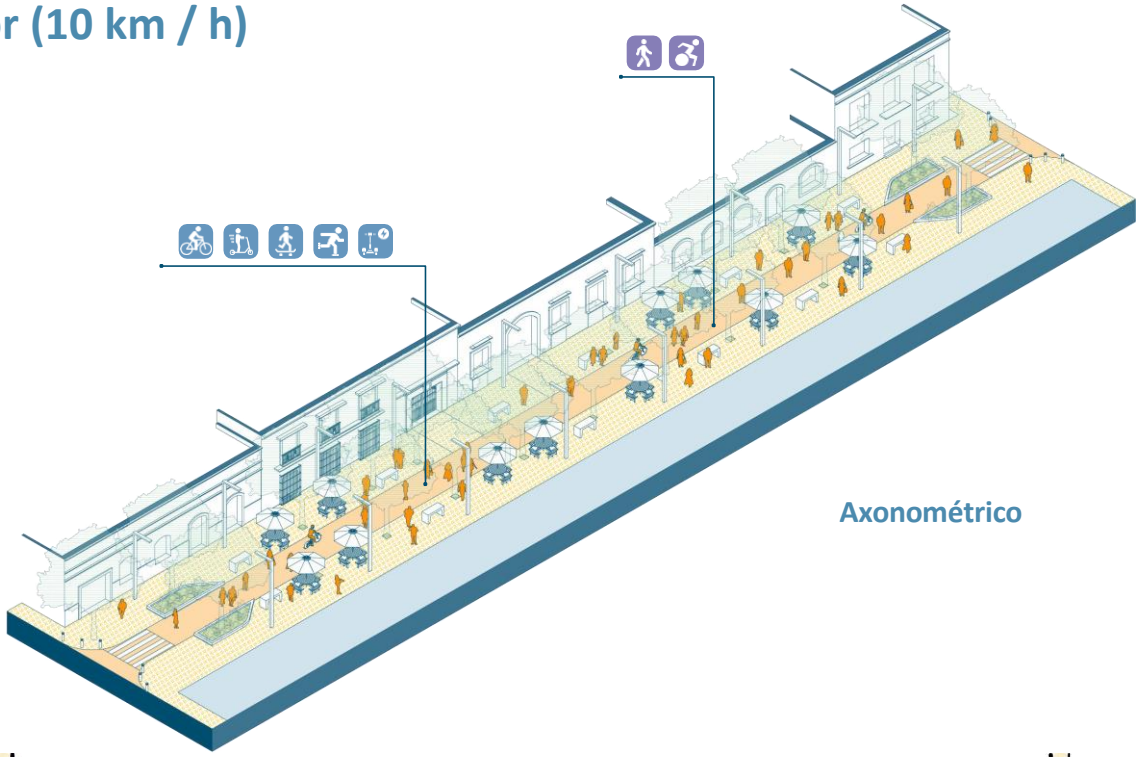


Sección de calle - Estado actual

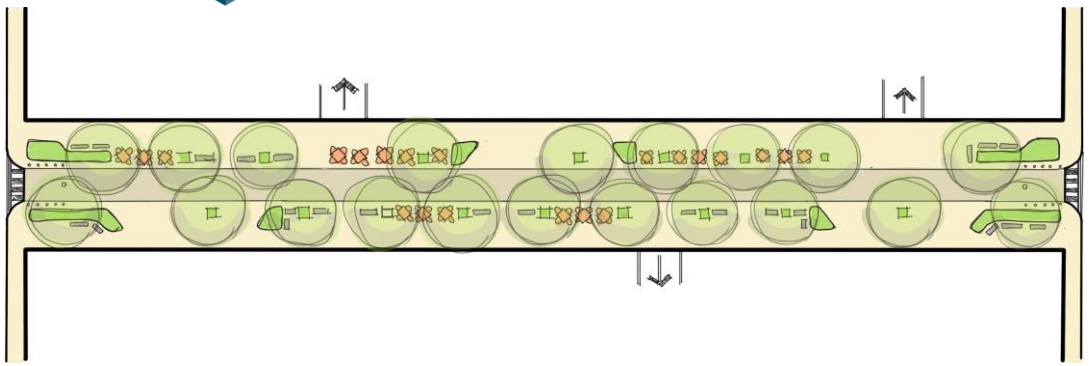


Sección de calle - Propuesta

Presupuesto paramétrico:
$19,499.84 MXN por metro lineal



Axonométrico



Planta de conjunto

Ubicación de tipología

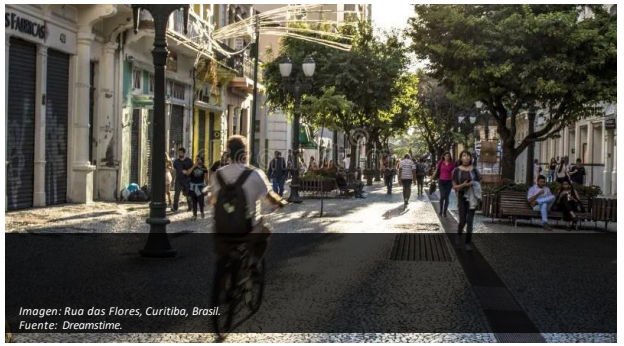


Imagen: Rua das Flores, Curitiba, Brasil.
Fuente: Dreamstime.

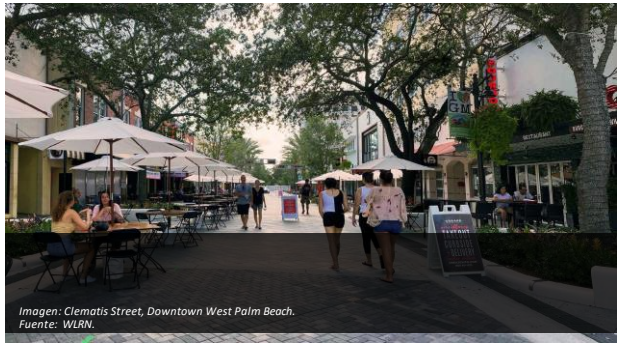
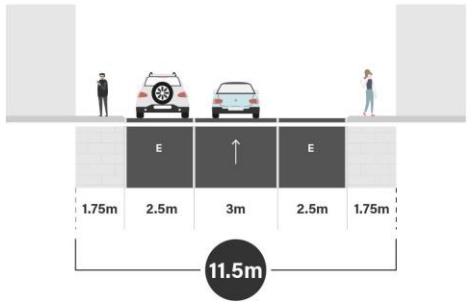


Imagen: Clematis Street, Downtown West Palm Beach.
Fuente: WLRN.

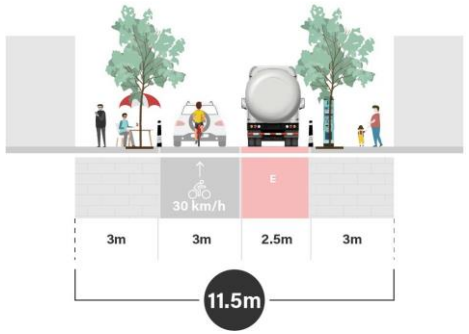
Casos análogos

Enhancing streets with pedestrian vocation

Typology B: Pedestrian priority street (30 km / h)

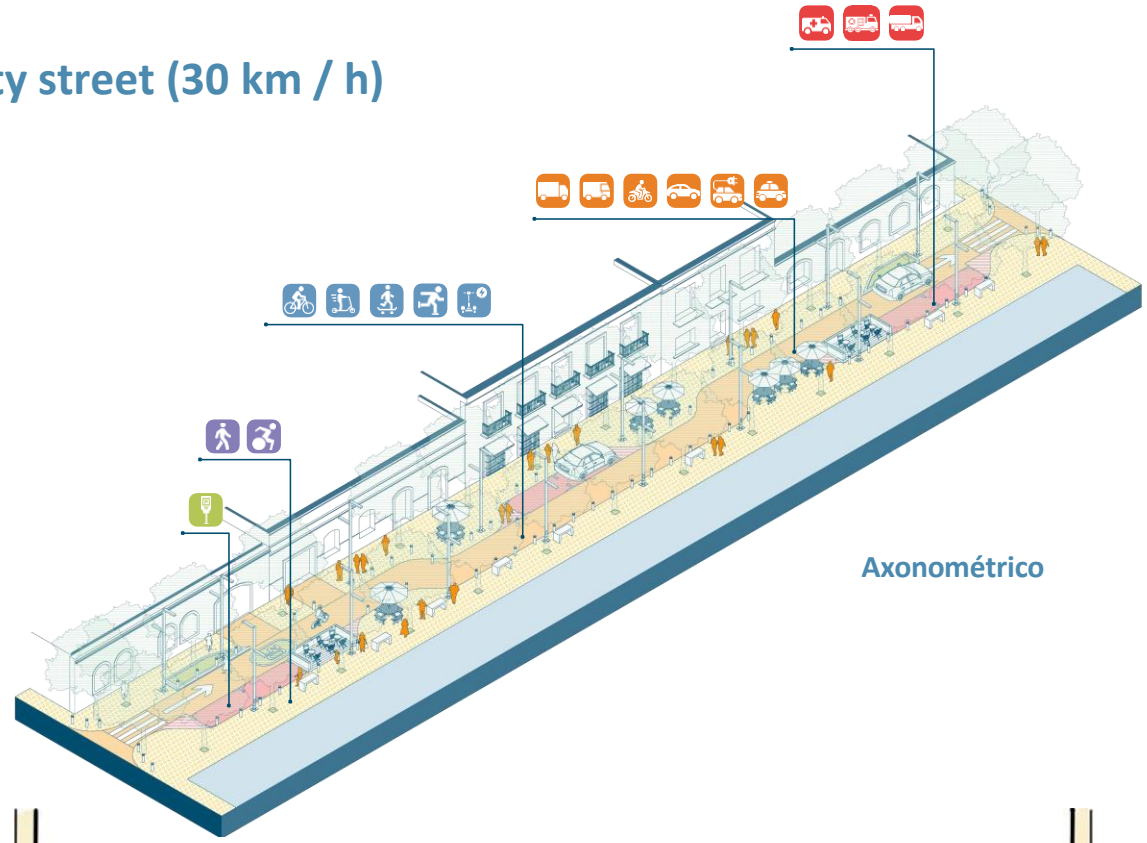


Sección de calle - Estado actual

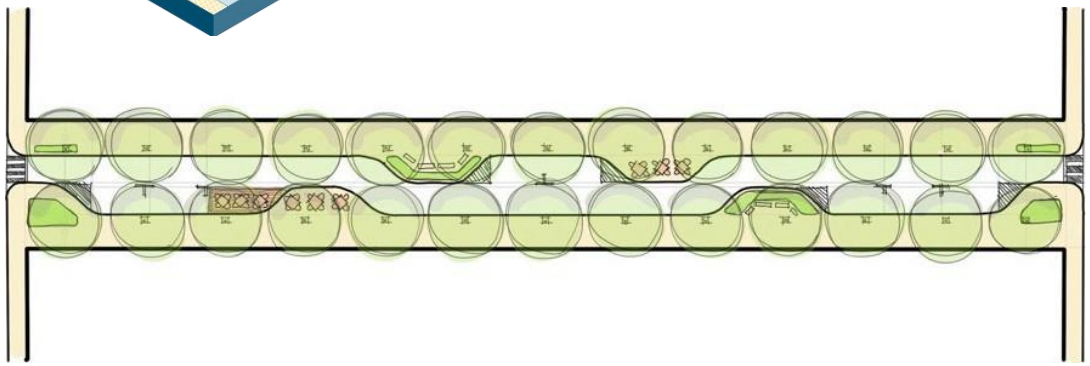


Sección de calle - Propuesta

Presupuesto paramétrico:
$27,886.66 MXN por metro lineal



Axonométrico



Planta de conjunto

Ubicación de tipología

Imagen: Calle 16 de Septiembre, Centro Histórico CDMX.
Fuente: ITDP México.

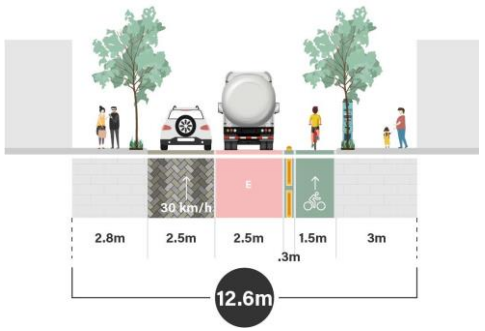
Imagen: Calle 16 de Septiembre, Puebla.
Fuente: Agencia Enfoque.

Casos análogos

Re-designing strategic streets that work for all modes

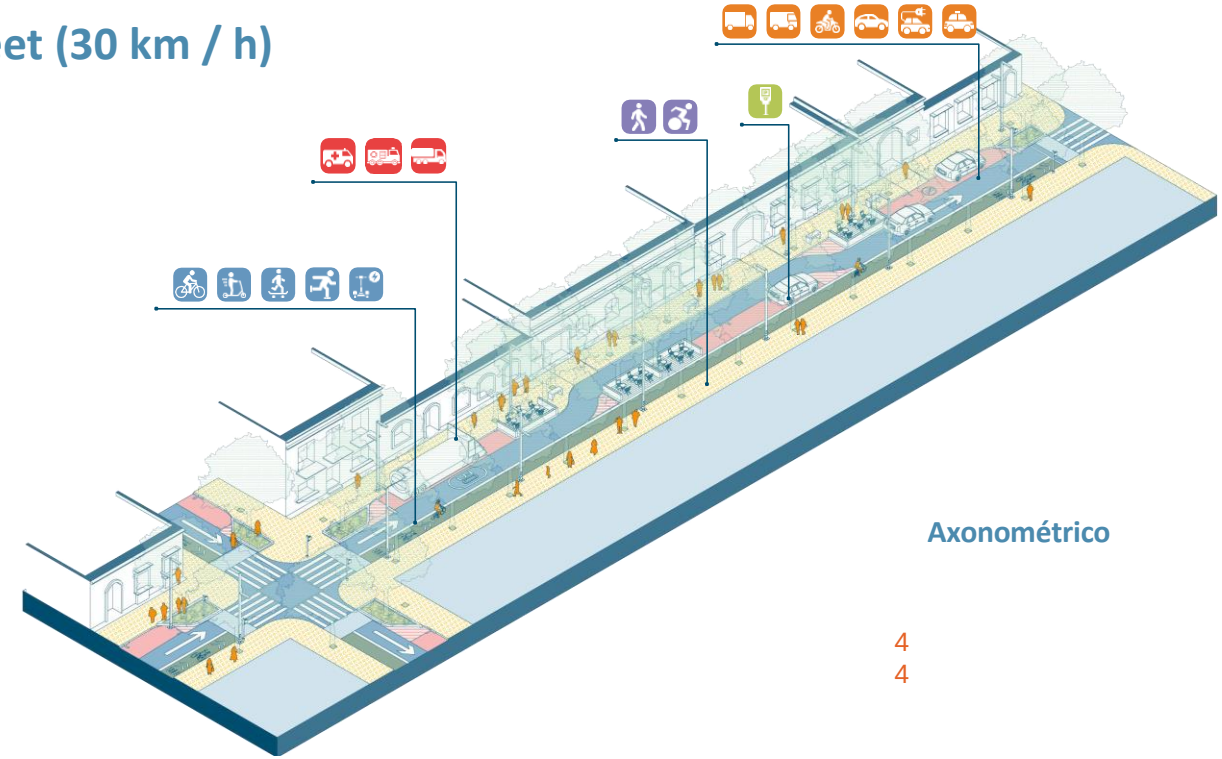
Typology C: Complete Street (30 km / h)

Sección de calle - Estado actual



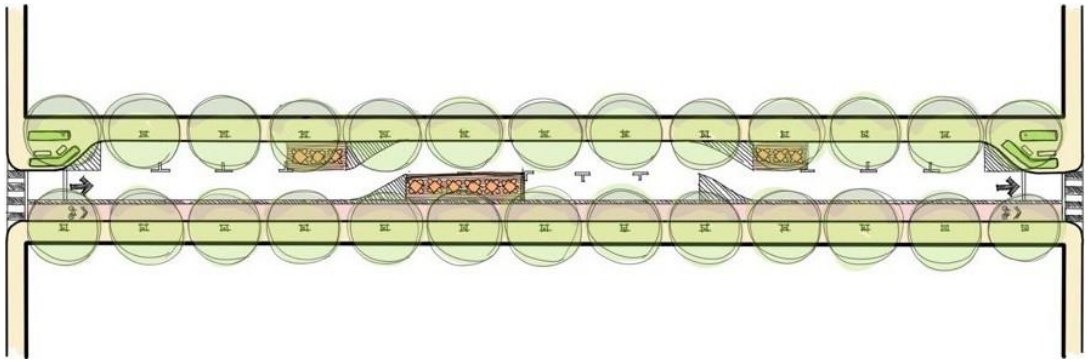
Sección de calle - Propuesta

Presupuesto paramétrico:
$26,788.68 MXN por metro lineal



Axonométrico

4
4



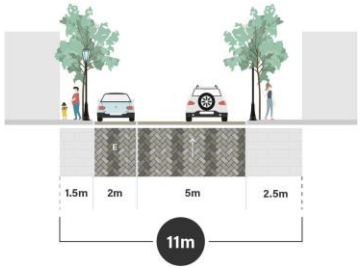
Planta de conjunto

Ubicación de tipología

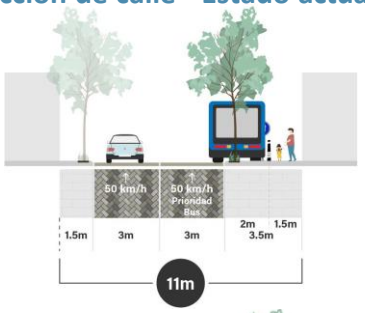
Casos análogos

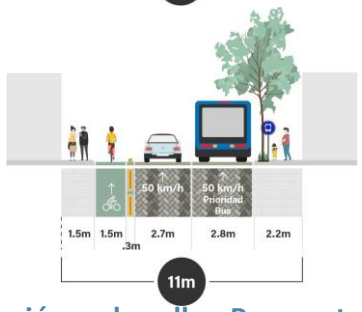
Providing efficient transit corridors

Typology D: Main transit road (50 km / h)



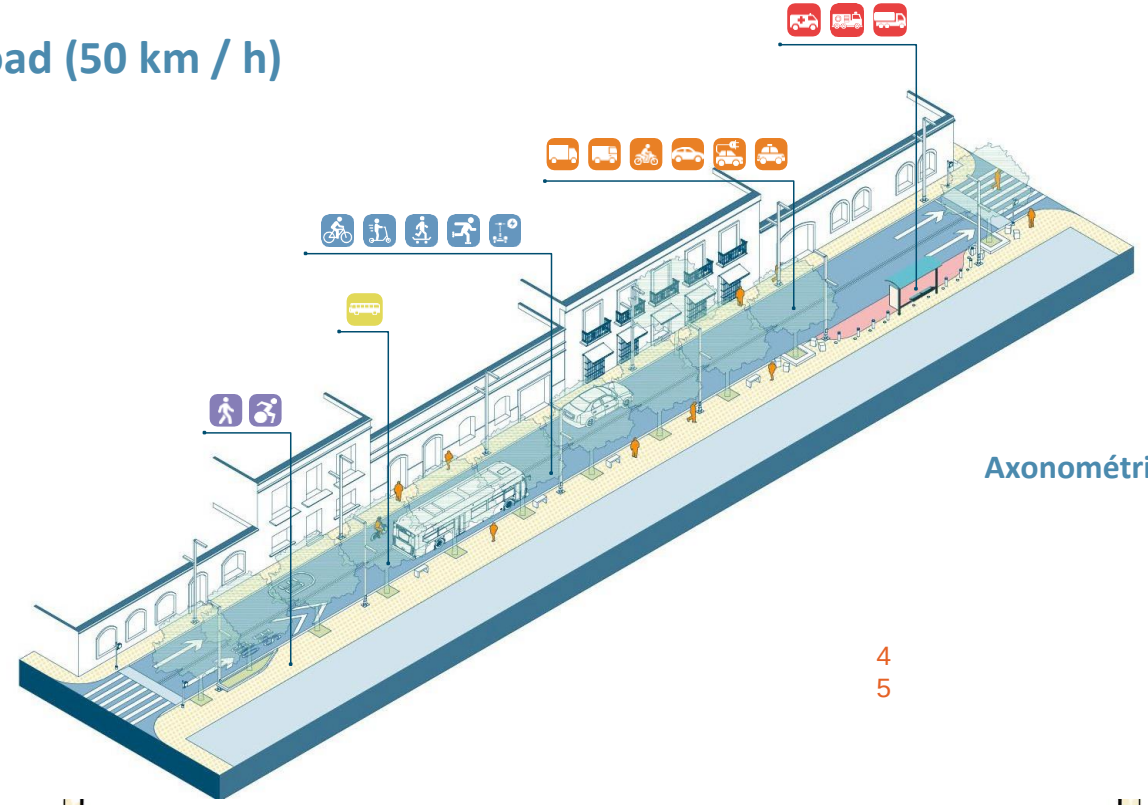
Sección de calle - Estado actual





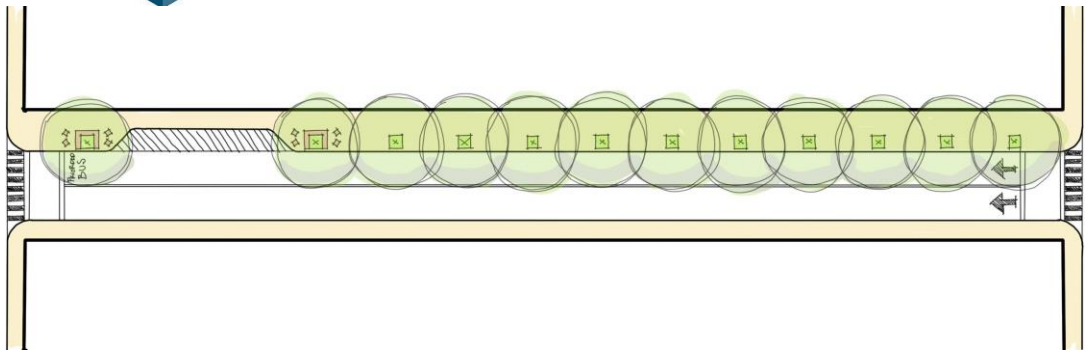
Secciónes de calle - Propuesta

Presupuesto paramétrico:
D) $13,474.39 MXN por metro lineal
D*) $16,486.85 MXN por metro lineal



Axonométrico

4
5



Planta de conjunto

Ubicación de tipología

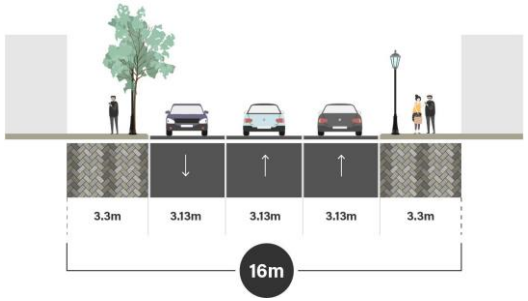
Imagen: Diseño de paisaje urbano en Vancouver.
Fuente: Rhodeside & Harwell.

Imagen: Plaza de la Ciudad de Evanston.
Fuente: Teska Associates, Inc.

Casos análogos

Enhancing microclimate to improve walkability

Typology E: Green corridor (50 km / h)



Sección de calle - Estado actual

Sección de calle - Propuesta

Presupuesto paramétrico:
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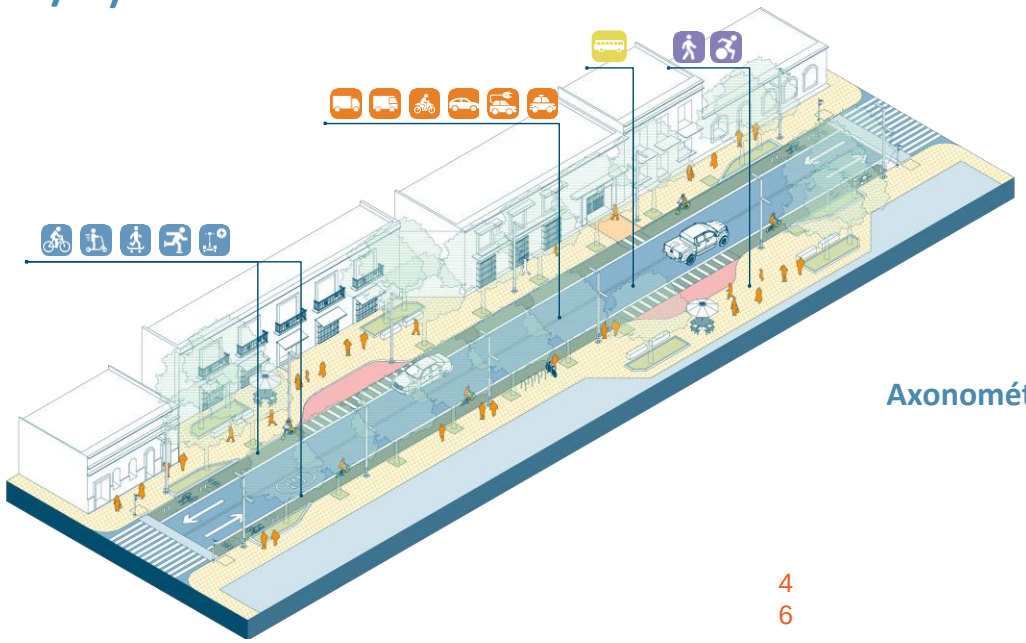
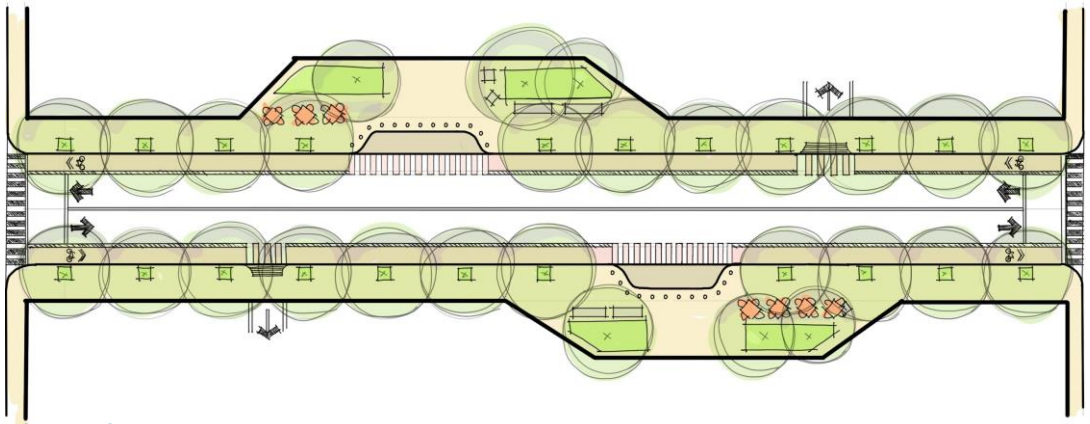


Axonométrico



Planta de conjunto

Ubicación de tipología

Imagen: Vialidad principal con red de ciclovías en Córdoba.
Fuente: EcoObjetivo.

Imagen: Avenida La Playa.
Fuente: Germán Darío T. y David Vélez S.

Casos análogos

Selecting endemic species and adequate materials is key

Endemic trees and vegetation species


Lluvia de oro (Cassia fistula)


Pata de vaca (Bauhinia variegata)


Primavera amarillo (Tabebuia chrysantha)

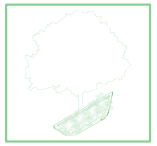

Cacalosúchitl (Plumeria rubra)


Guayacán (Tabebuia spp.)

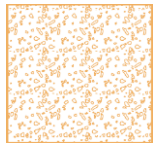

Huizache (Acacia farnesiana)

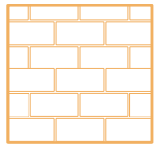

Huaje (Leucaena spp.)

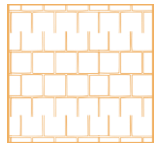

Flamboyán (Delonix regia)

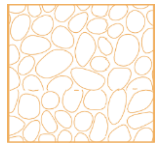

Jardineras de infiltración

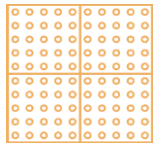
Materials for street pavements


Hidrocreto

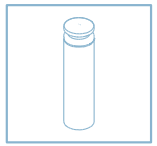

Piedra cantera verde

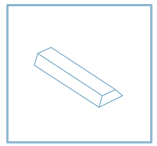

Concreto hidráulico con textura

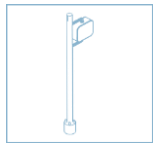

Piedra de monte

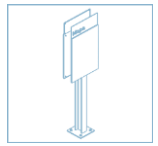

Piso pododáctil

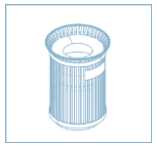
Urban furniture and wayfinding

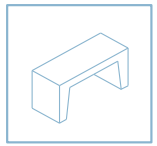

Bolardo fijo

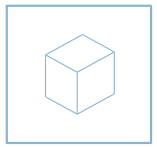

Delimitadores


Semáforo para peatones y ciclistas

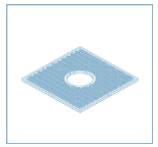

Paneles informativos/mupis

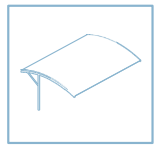

Basurero

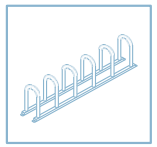

Banca

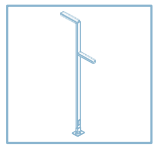

Asiento

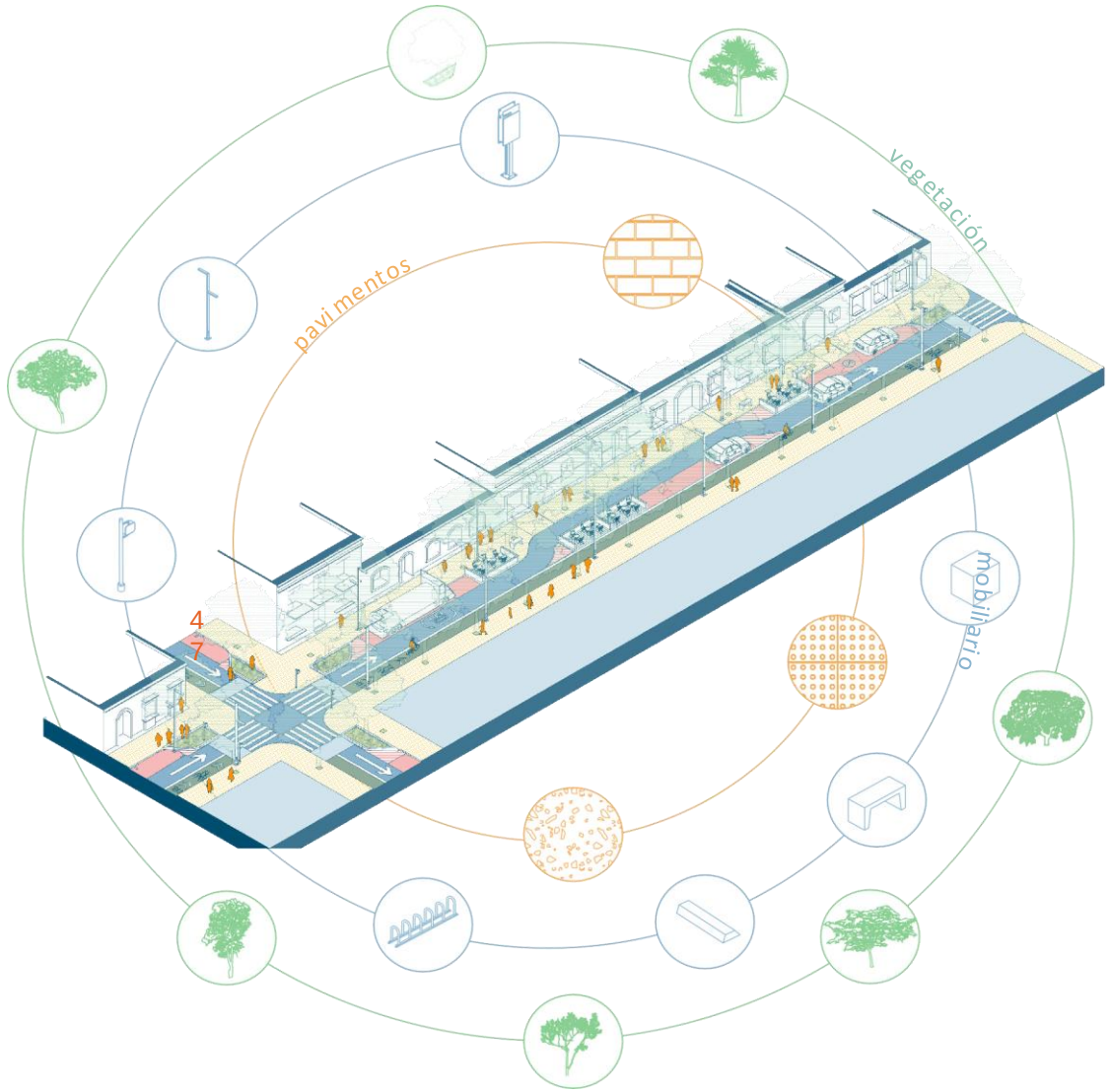

Macetón


Alcorques


Mobiliario para sombra


Rack para bicicletas


Luminaria doble



A parking management strategy that responds to demand

Five key elements:

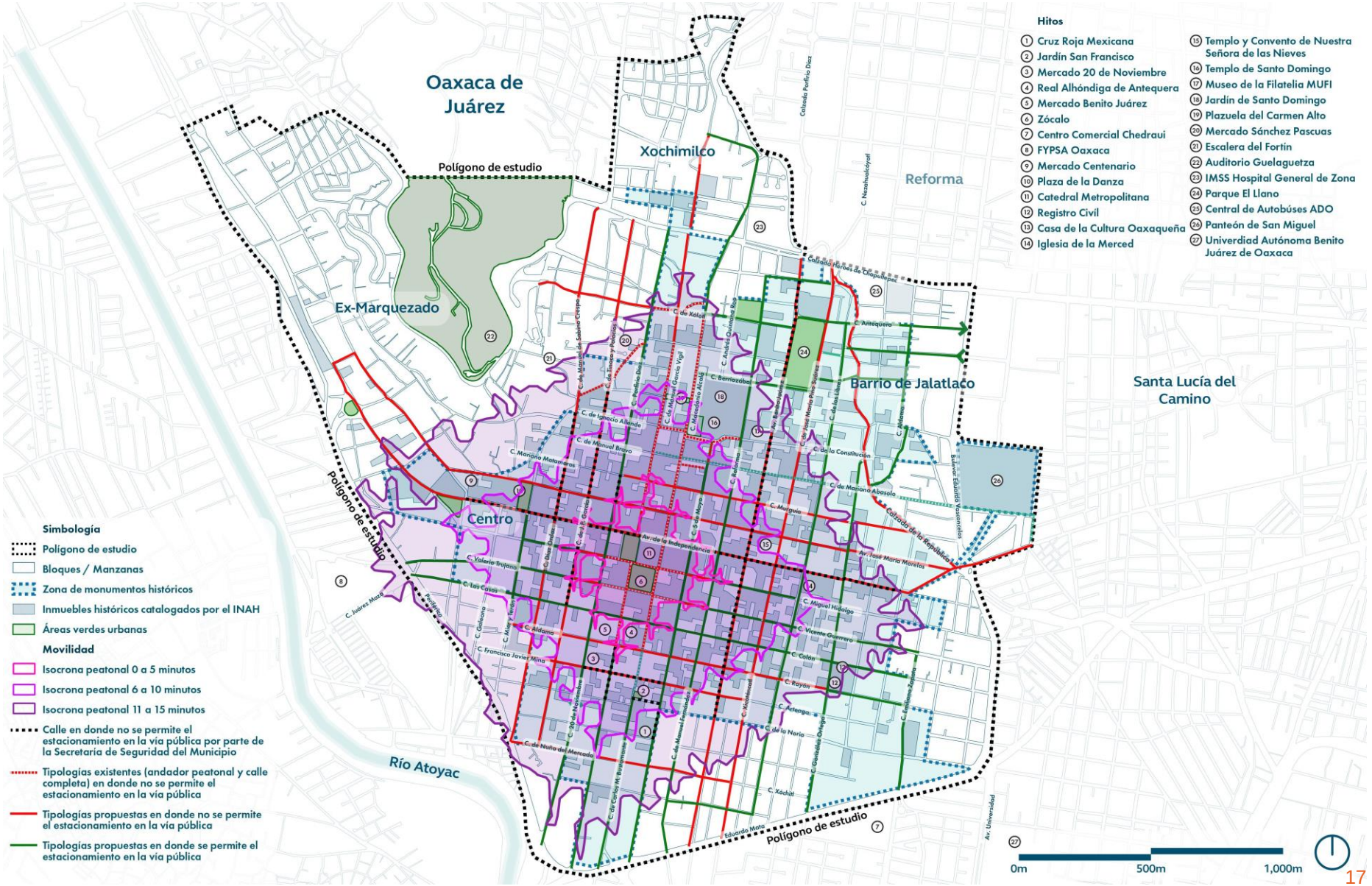
1. Polygon of the Historical Monuments Zone of the Historic Center of Oaxaca de Juárez

2. Analysis of pedestrian isochrones from 0 to 5 minutes, 6 to 10 minutes and 11 to 15 minutes.

3. Parking restrictions on public roads by the Security Ministry of the Municipality of Oaaca de Juárez.

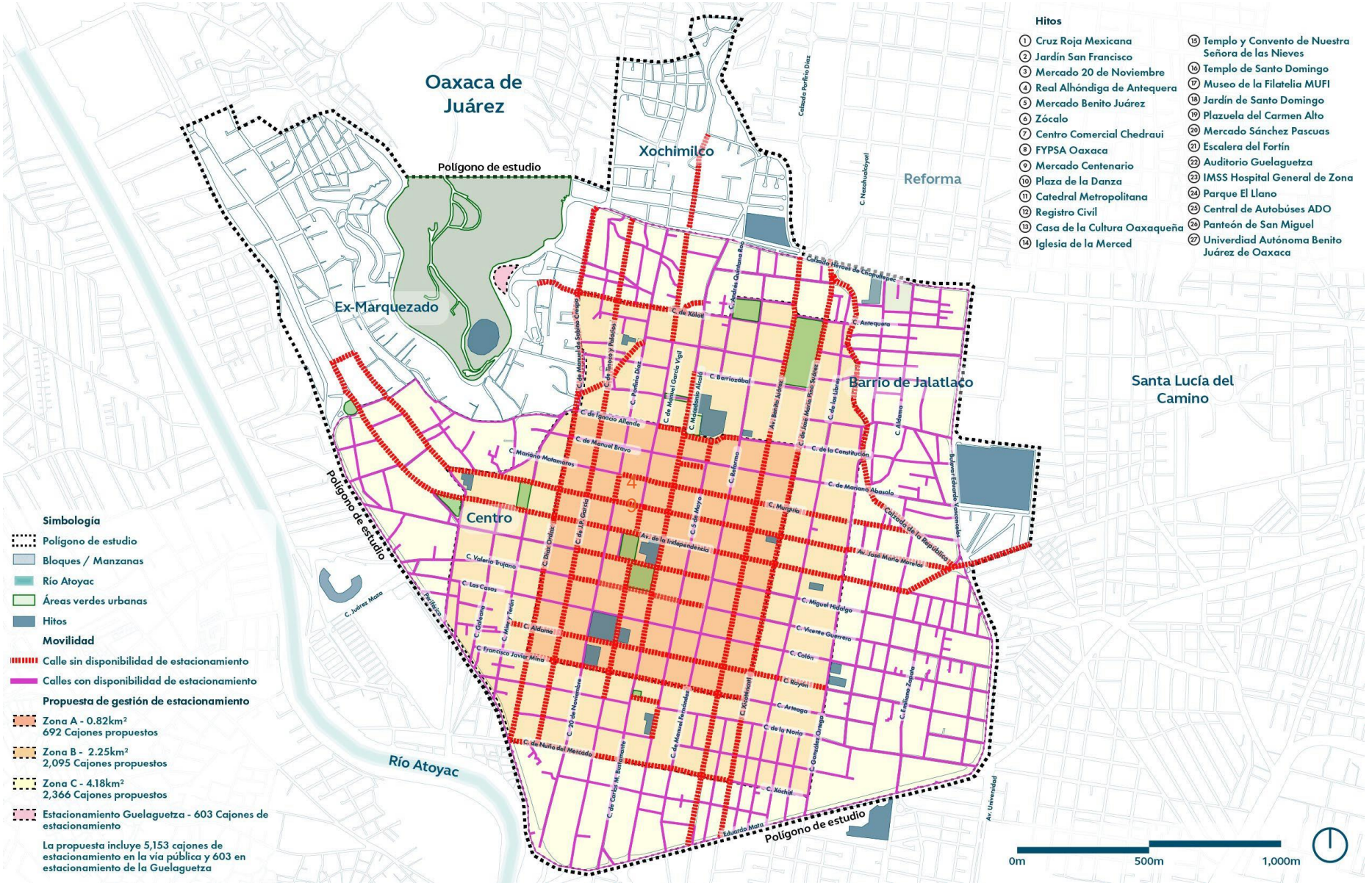
4. Spatial analysis of the number of spaces that could be located within the area with the possibility of parking was carried out.

5. Proposal for the pedestrianization program.



Differentiated pricing scheme to promote vehicle rotation

Proposal for on-street parking management polygons and differentiated areas



Interventions that respond to gender-sensitive challenges

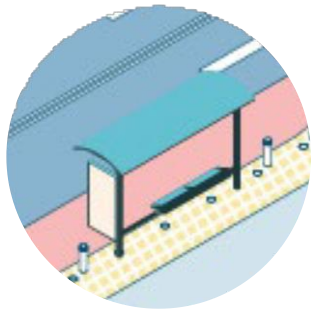
55% #1 Visioning

61% #2 Co-Design

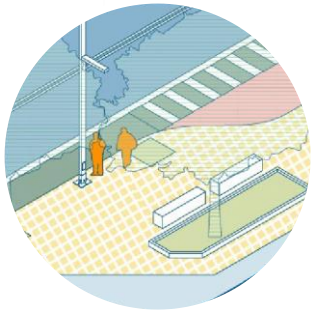
60% #3 Feedback

Accesibility

Streets should be accessible to all people, regardless of gender, age or physical ability. The following measures were implemented in the project to achieve this goals.



Accesible public transit

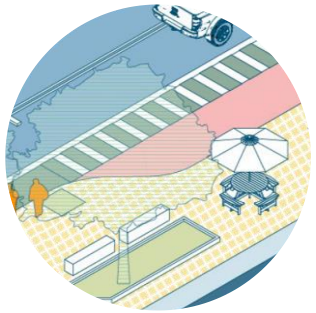


Ample and clear sidewalks

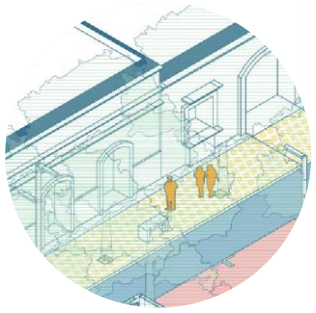
Leveled surfaces

Mobilities of care

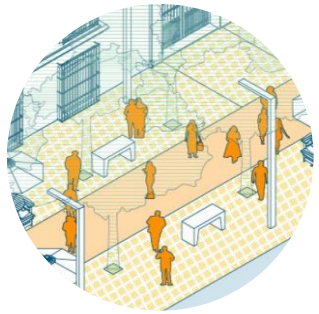
Mobilities of care, which include activities such as childcare, shopping for groceries, and caring for the elderly, are frequently performed by women and should be considered in the design of pedestrian streets.



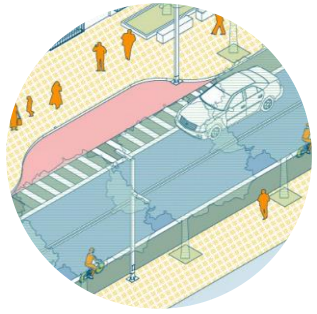
Waiting and resting areas



Access to services

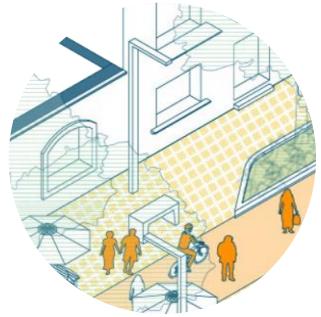


Clear sightlines



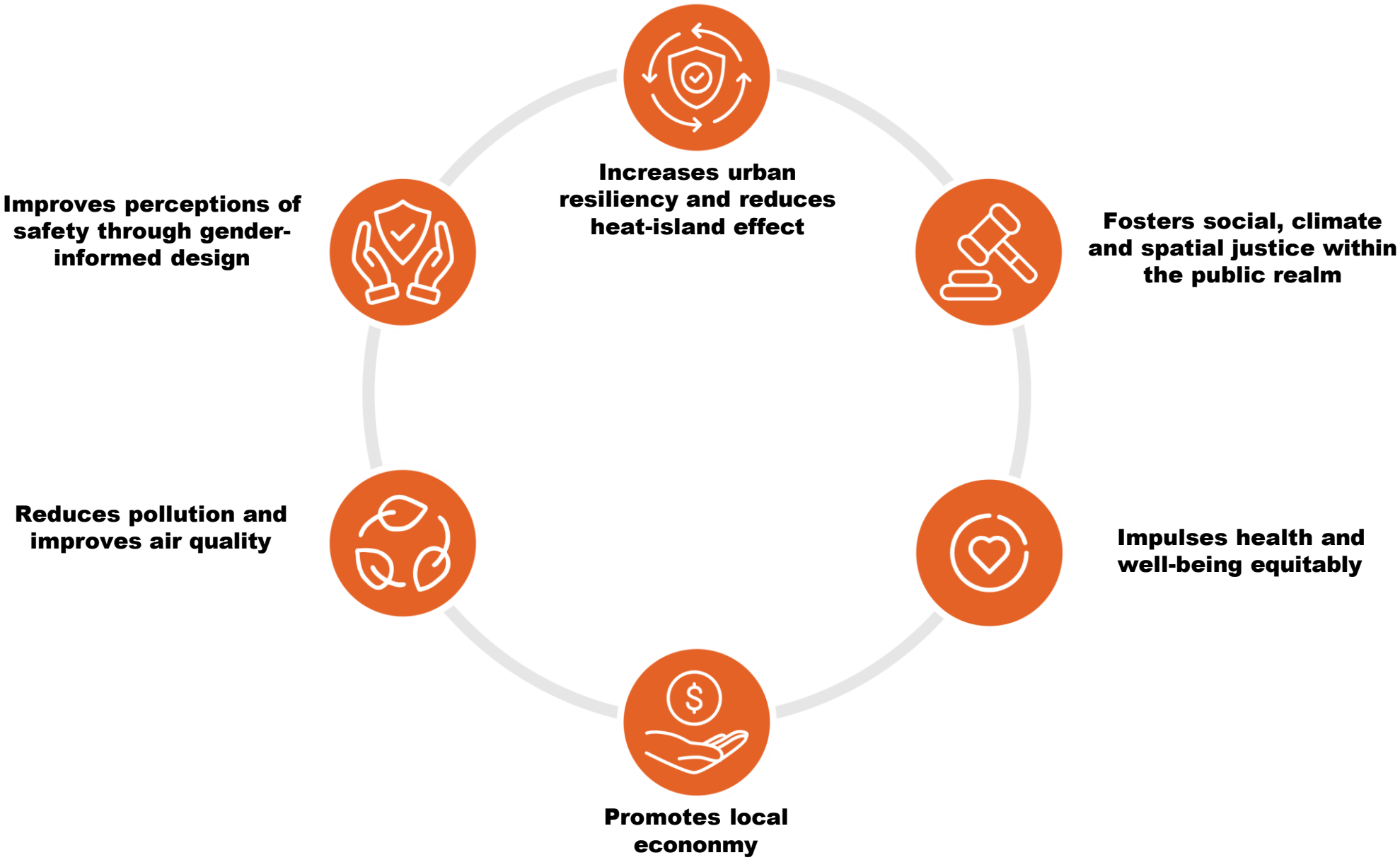
Wayfinding elements

Safe intersections

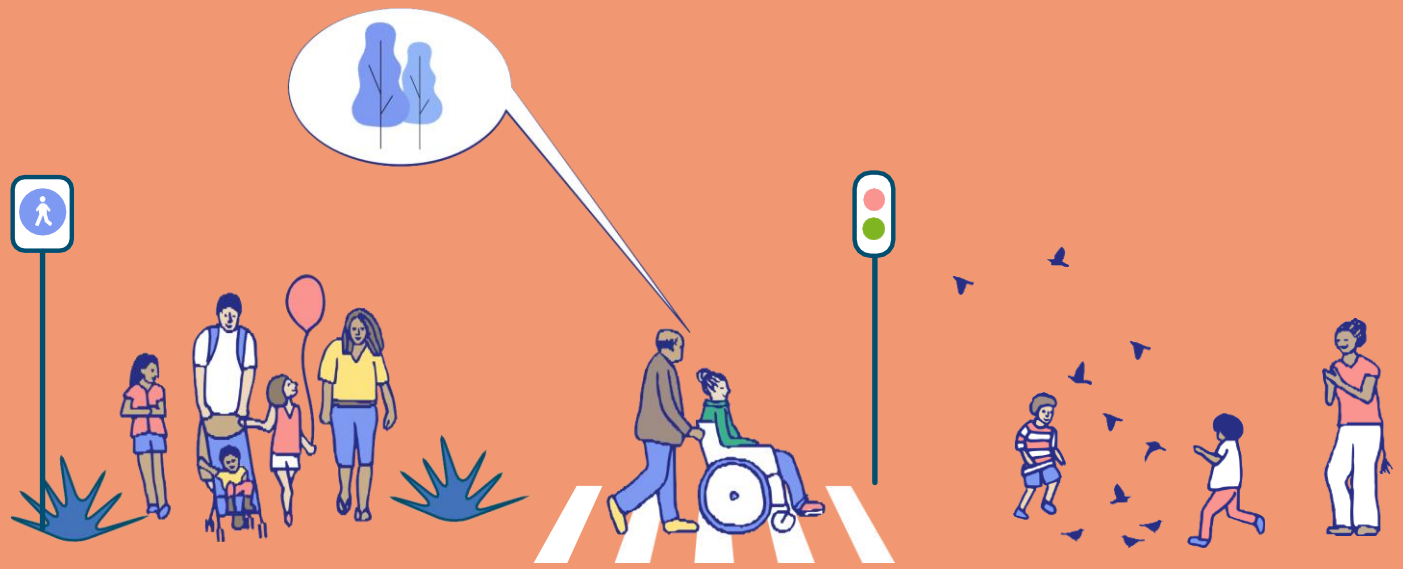


Adequate lighting

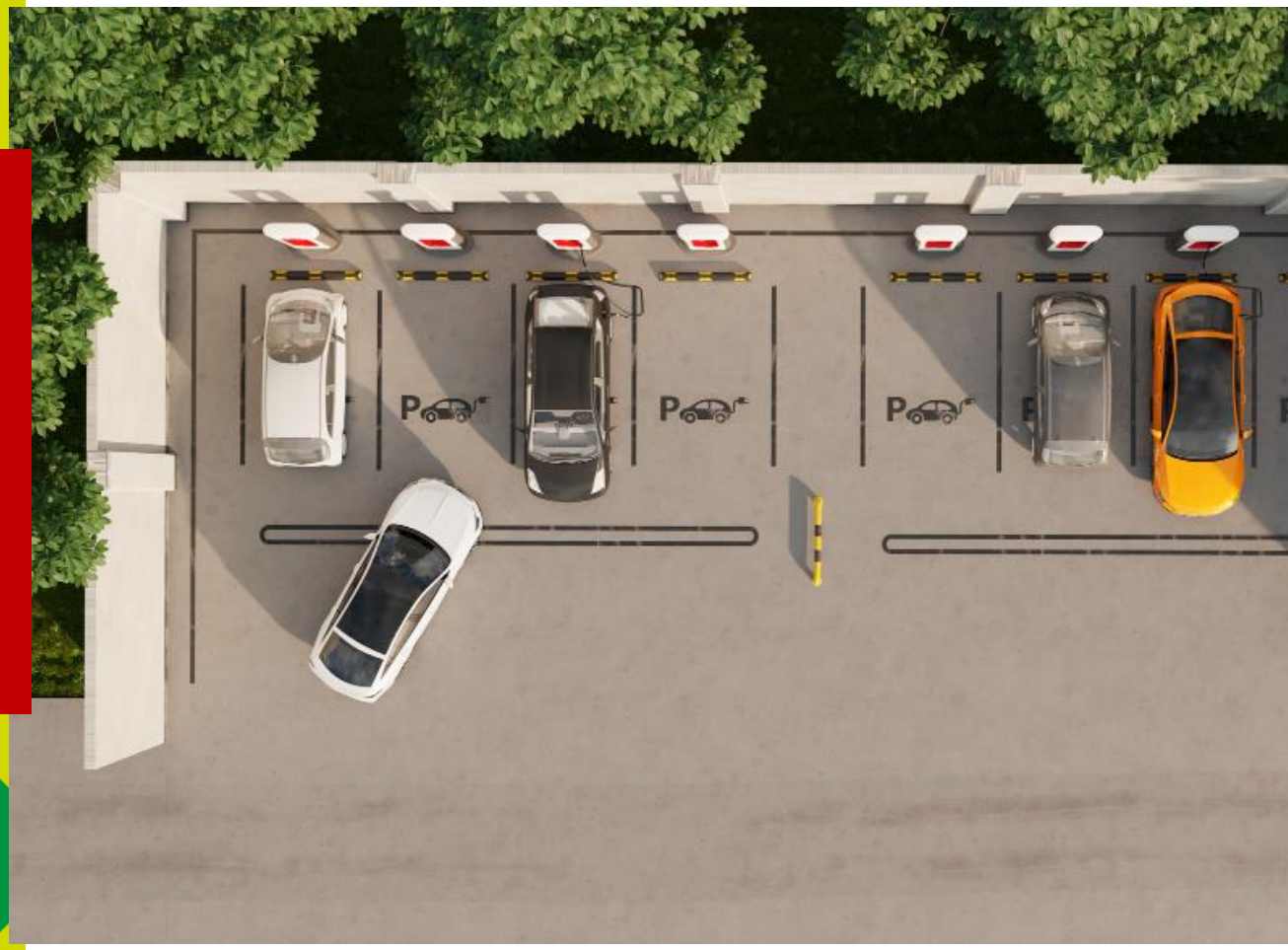
Sustainability benefits for the people of Oaxaca



Thank you



Distribution effects of parking interventions among different income groups



Jyotsna Singh

TU Delft

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Parking Interventions

Hard interventions, aimed at ***reducing attractiveness*** of private car usage

Popular intervention, especially in the Netherlands, however, there is no research studying their ***distributional effects***

Predominance of ex-post studies on parking interventions; ***Ex-ante*** studies are needed to plan the parking policies of low car areas

Aim: Mitigate the risk of increased inequity for different population groups such as lower ***income groups***, and contribute to tackle the ***social barriers in mobility***

Distribution Effects

Equity

Equity is a measure of distribution effects

Distribution effects measured over different income groups

Gini's Coefficient

Gini's Coefficient an indicator of social inequality

Value ranges between 0 & 1;

where 0 indicates a scenario of perfect equality and 1 indicates perfect inequality

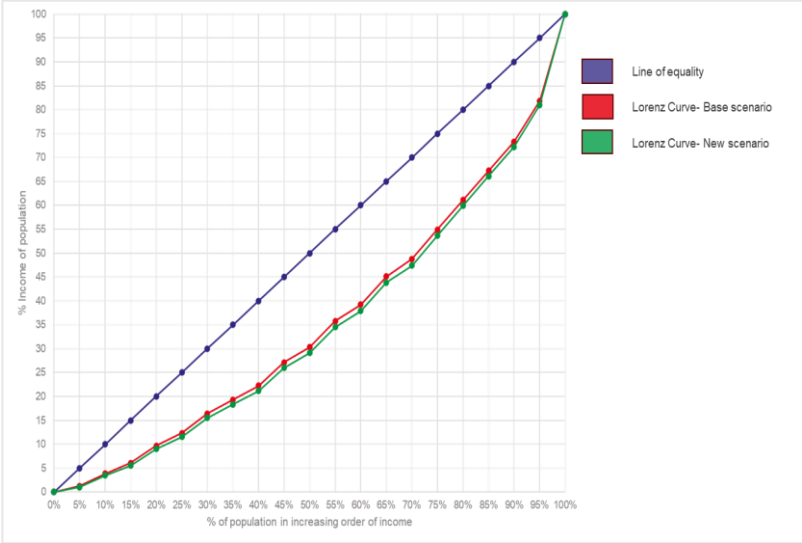
$$G = \frac{1}{2N^2\mu}\sum_i\sum_j |y_i - y_j|$$

G=Gini Coefficient
N= Population groups
i = [1,N]
j= [1,N]
y_i = Welfare of a user group 'i'
μ = Mean welfare value

Utilised in conjunction with Lorenz curve

Lorenz Curve

Lorenz Curve is used to visualize the distribution effects by plotting the cumulative distribution function of an attribute across the population



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Gini's Coefficient- Application

Economic Impact Analysis
Economic equity change as a consequence of change in parking capacities and cost across different income groups

$$dCg_{kl} = dC_{kl} + v_m dT_{kl}$$

dCg = change in genarilsed cost of travel

dC = change in monetary cost (including parking price change)

v = value of time for a household 'm'

dT = change in travel time

Impact On Mode Shift
Change in car usage across different income groups as a consequence of change in parking capacities and cost

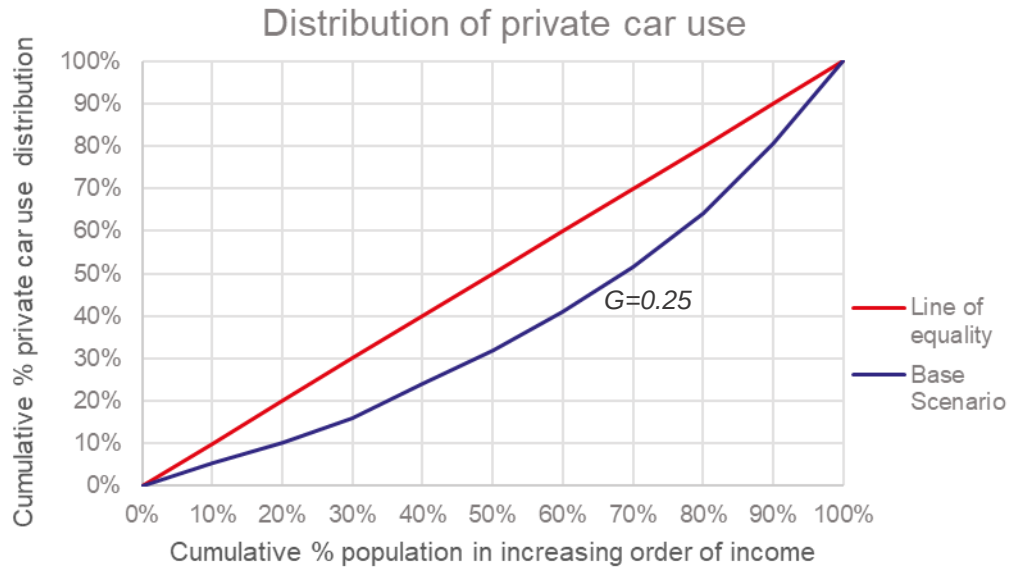
For the Netherlands

Survey

- Representative travel survey data of the Netherlands
- Age>18 Purpose: Work/Business
  N: 62791 Urbanization: High

Analysis

- Higher the household income, higher the private car usage
- Higher income households travel more distance than lower income households



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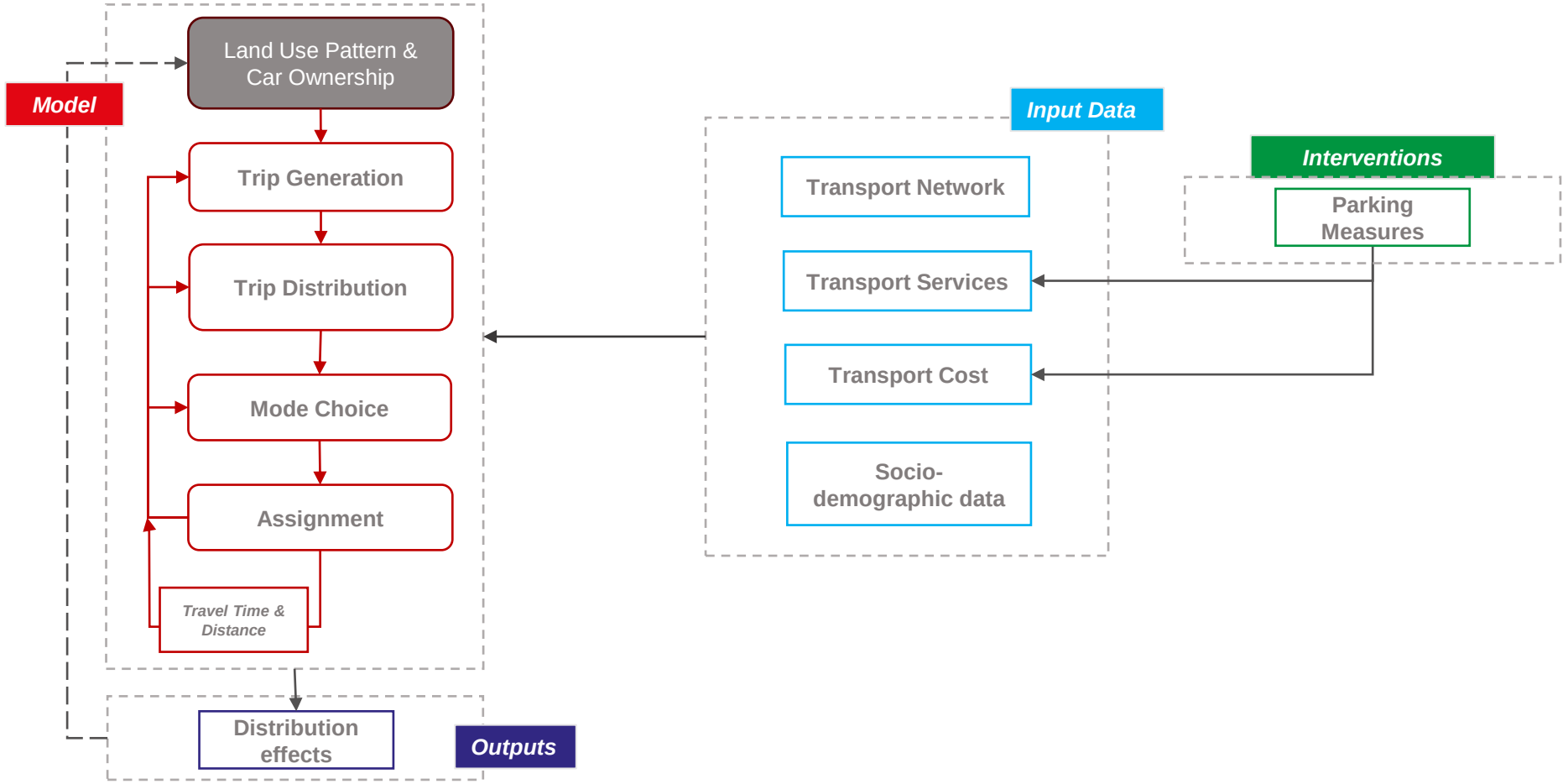
Conceptual Framework



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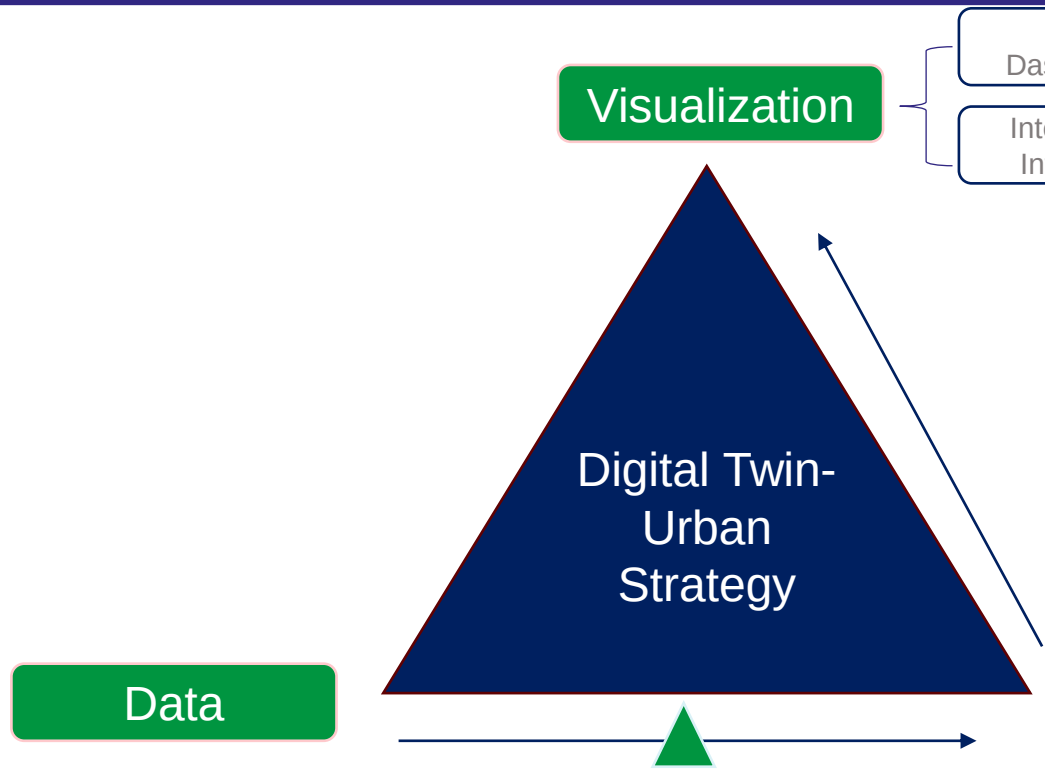
Urban Strategy



Traffic Module

- Static Traffic Assignment
- Deterministic User Equilibrium
- Parking assignment based on parking capacity and occupancy

New Mobility Modeller Module

- Performs mode choice based on MNL principle
- Multiple population groups included
- Traditional and innovative modes of transport included

Next Steps

Traffic Module

- Include parking price effects in traffic assignment stage, within parking assignment
- Include different income classes in the traffic assignment stage using Multi-User Class Assignment

New Mobility Modeller

- Include different income classes in the mode choice stage

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Working on better cities with less cars

Urbanism Next

Multi-objective Multimodal Network Design

Tygo Nijsten

TNO innovation for life

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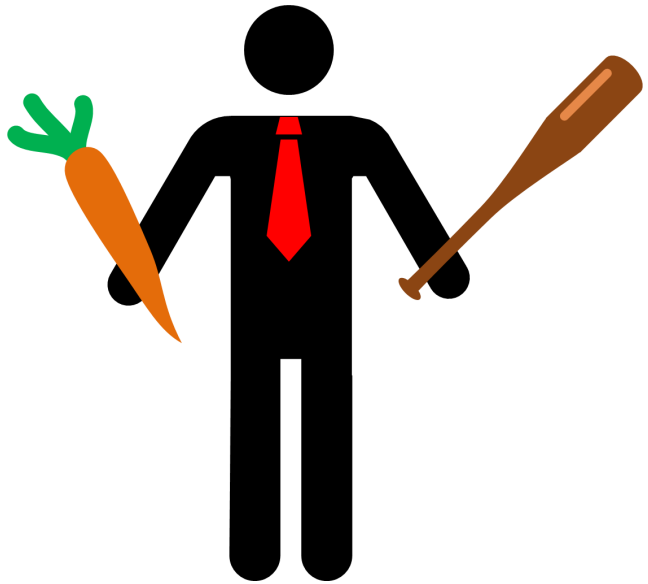
Reducing Car Usage: Carrot vs. Stick

- “Carrot” measures: encourage other modes of transport, i.e.
  - Improve public transport;
  - Introduce shared vehicles;
  - Build Park-and-Rides (P&Rs).
- “Stick” measures: discourage car usage, i.e.
  - Reduce road capacity;
  - Introduce road tolls;
  - Increase parking fees.



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Reducing Car Usage: Carrot vs. Stick

- Literature on combining the two types is limited.
- We aim to fill this gap by combining:
  - The improvement of public transport;
  - The optimisation of parking fees.

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Conflicting Objectives

- When we reduce car usage by improving transit and optimising parking fees, this can have some negative effects.
- User or operator costs might increase.
- To take these trade-offs into account, we consider multiple objectives simultaneously:
  1. Minimise the number of car users;
  2. Minimise user costs
  3. Minimise the operator deficit.

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Research Question

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Research Question

How do we design the transit network, i.e. how do we choose line routes and frequencies,

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Research Question

How do we design the transit network, i.e. how do we choose line routes and frequencies, and how do we select parking fees to simultaneously minimise the number of car users, the user costs and the operator deficit?

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Solution Method

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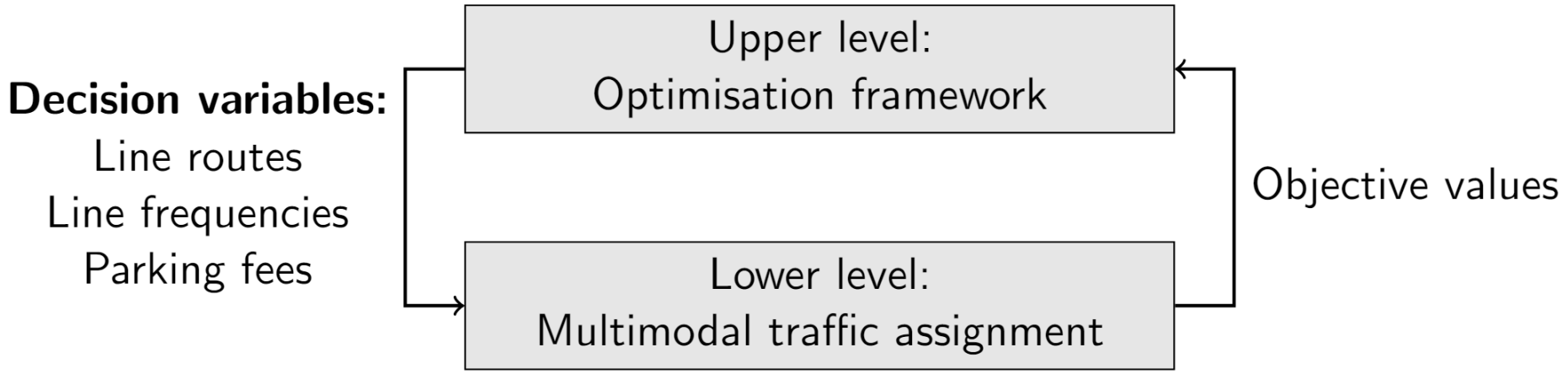
Solution Method



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Lower Level

- The multimodal traffic assignment model simulates how people travel given the values of the decision variables, i.e.:
  - Which mode do travellers take?
  - Which route do travellers choose?
  - How do travellers perceive their trip, i.e. what are their generalised costs?
- From the results obtained by this model, we can compute corresponding objective values.

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Upper Level: MOOP

- Trade-off between the objectives:
  1. Minimise the number of car users;
  2. Minimise user costs;
  3. Minimise operator deficit.
- Not one single optimal solution.
- Multi-objective optimisation to find a Pareto front.

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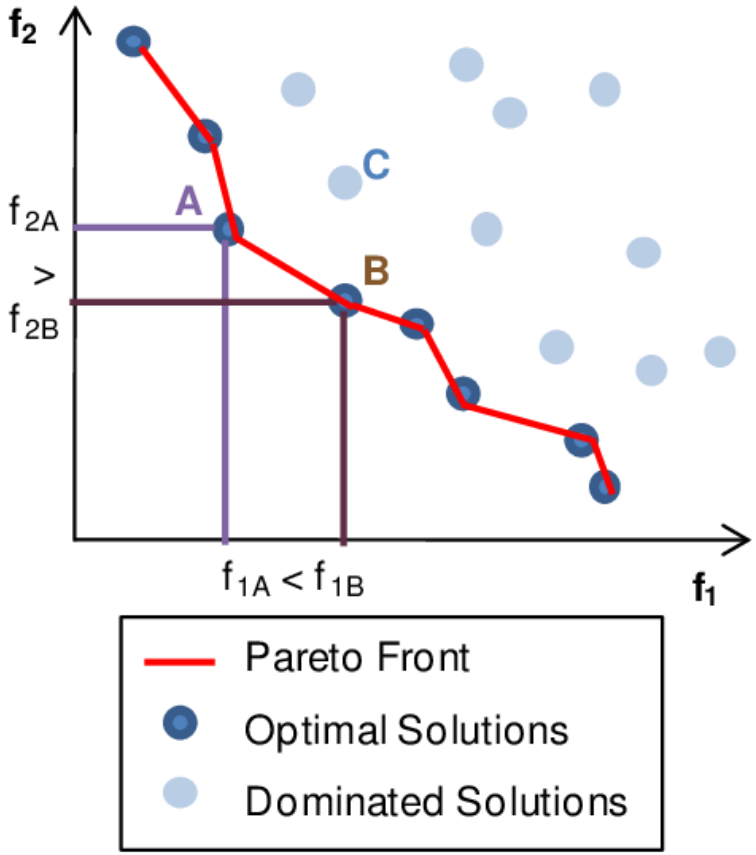
Upper Level: MOOP



Upper Level: NSGA-II

- Transit network design problem on its own already NP-hard.
- Need for heuristics, as exact methods are infeasible for large instances.
- NSGA-II is an evolutionary algorithm often used for multi-objective optimisation problems.
- Idea: first rank on Pareto dominance for quality, then on ”difference” in objective values for diversity.

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Experimental Results

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Experimental Results: Setup

- We compare three cases:
  - Constant parking fees and frequencies;
  - Constant parking fees, frequencies as decision variable;
  - Parking fees and frequencies as decision variable.
- We use Mandl's network, which is a widely used benchmark in transit network design.

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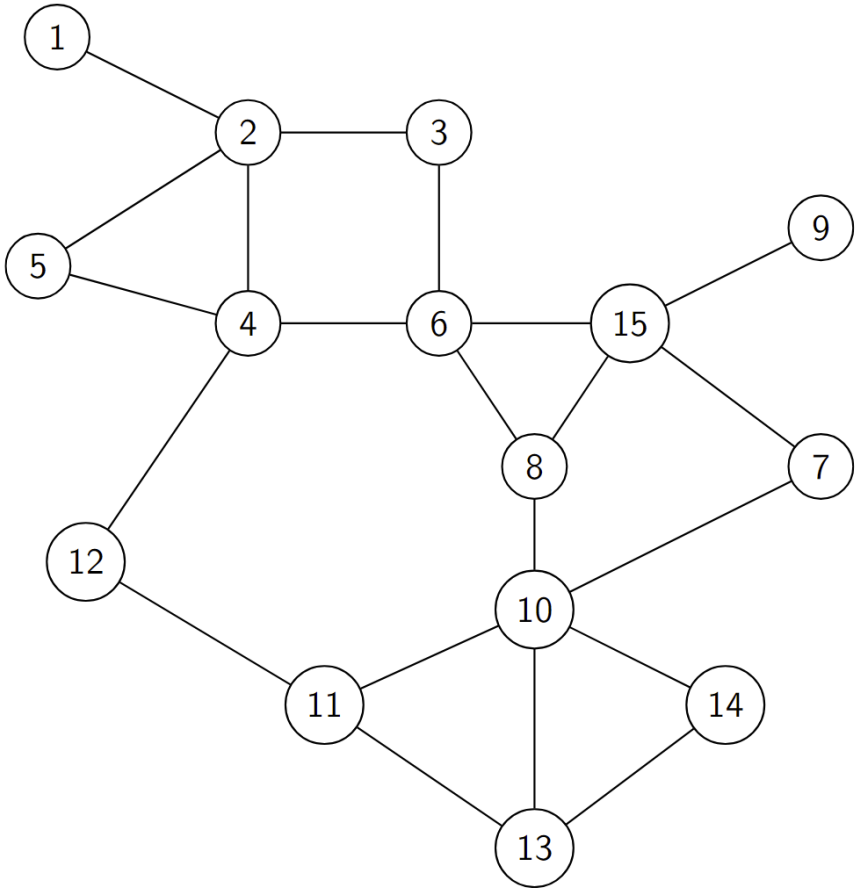
Experimental Results: Setup



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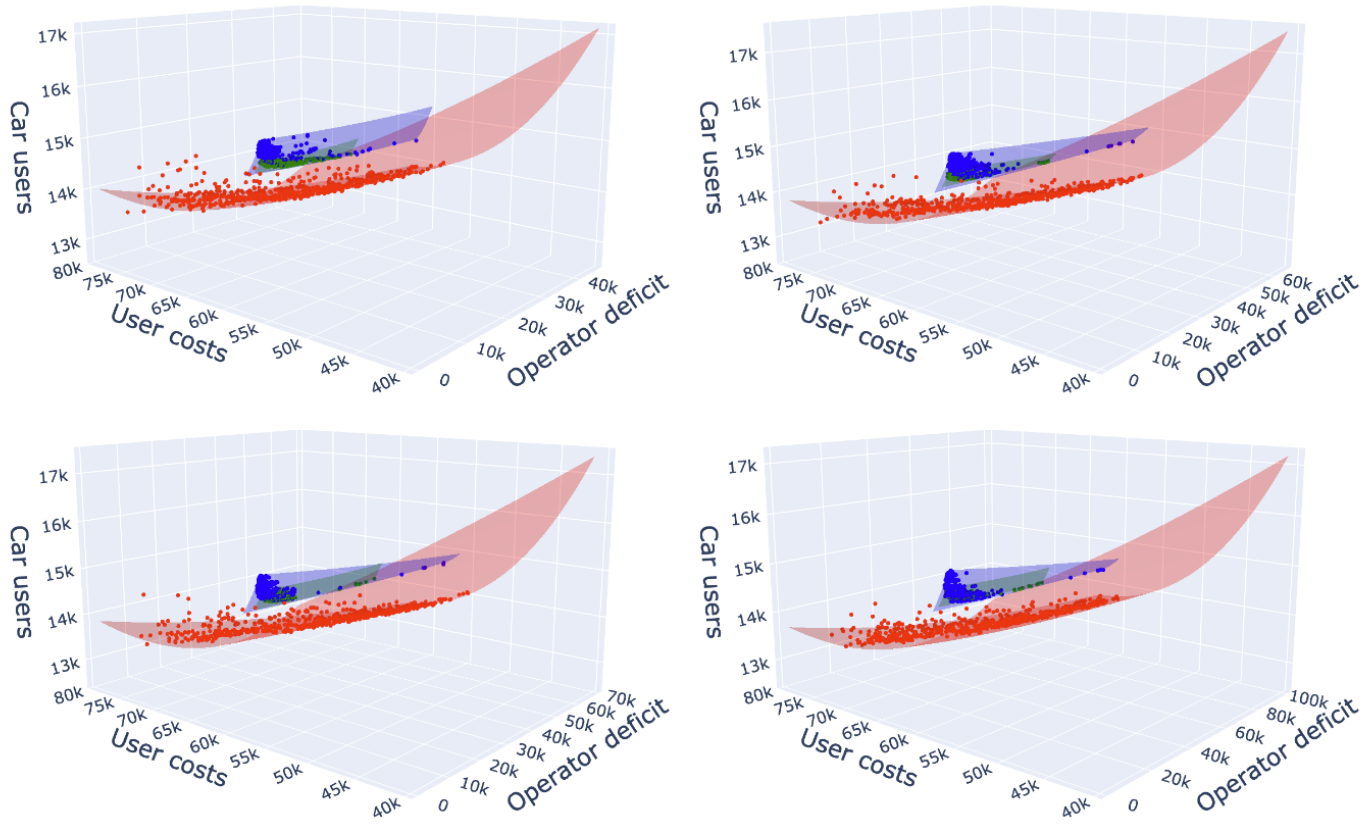
Experimental Results



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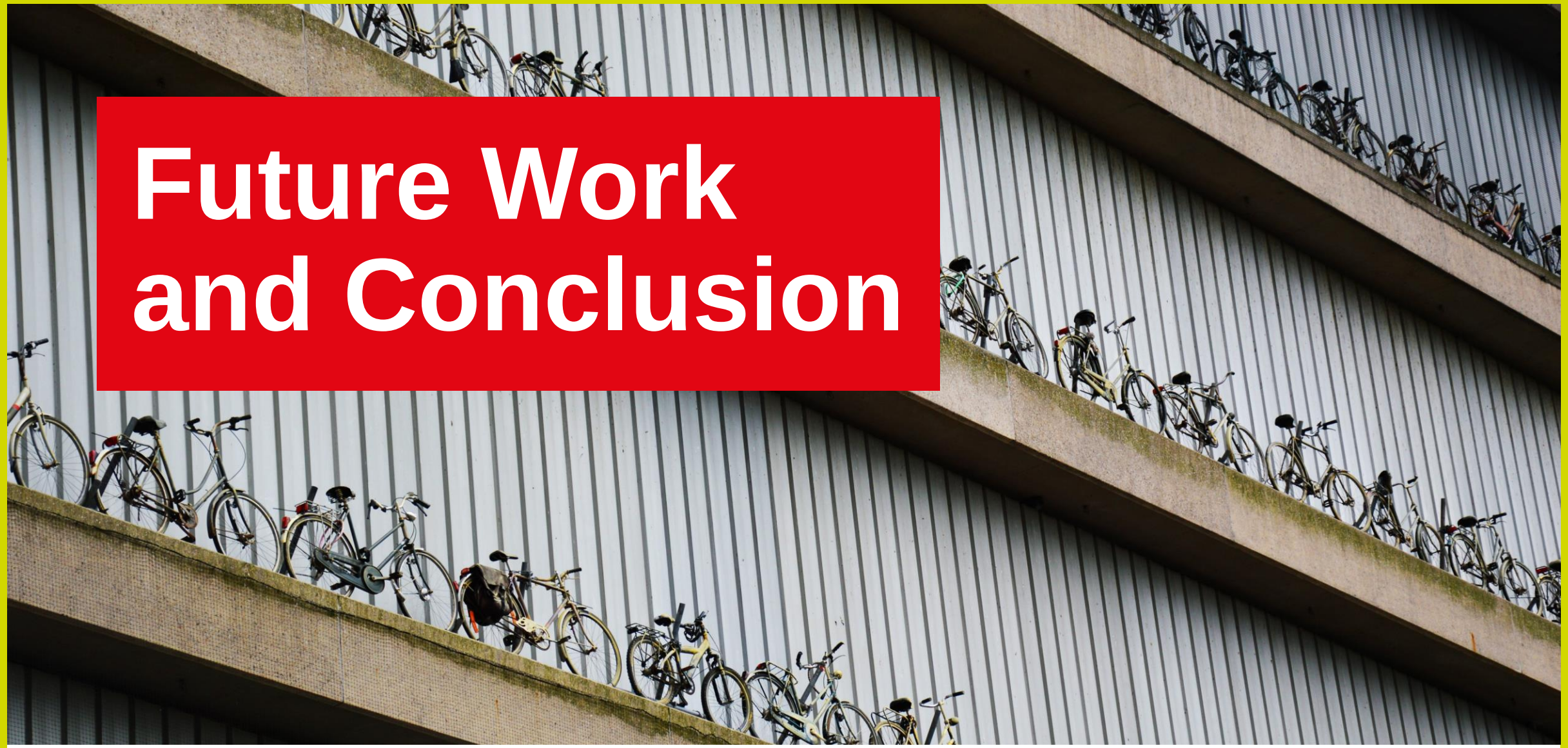

Future Work and Conclusion

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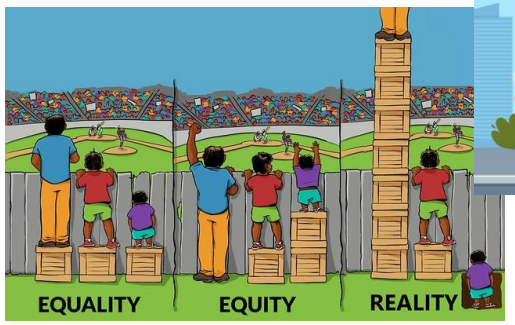
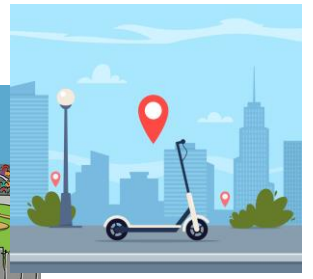
Future Work

- Case study.
- Speed up the multimodal assignment.
- Look at more decision variables, i.e. transit fee.
- Consider equity.
- Integrate more modes, i.e. active or shared modes.





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Conclusion

- We provide a framework for the optimisation of transit routes, transit frequencies and parking fees.
- We are able to analyse and visualise the trade-offs between our different objectives: minimising the number of car users, the user cost and the operator cost.
- For both policymakers and operators, such a wide variety of solutions can contribute to creating a more sustainable mobility system.

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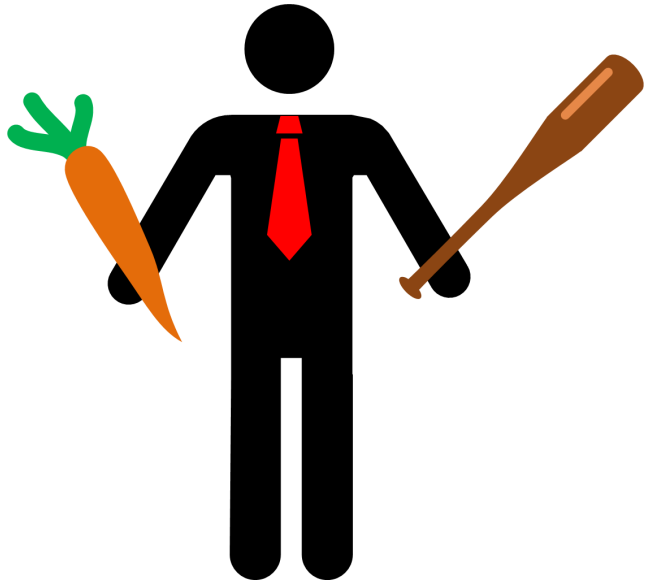
Conclusion

- Combining ”carrot” measures to encourage other modes of transport and ”stick”measures to discourage car usage potentially more effective than these measures inisolation.



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Plenary: Review the Challenges

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Thank you!

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