CBI

TEAM NEWTAIR

PROJECT SUMMARY

CHALLENGE BASED INNOVATION PROGRAM
CERN AND FUSION POINT

JANUARY 2022 - APRIL 2022

CBI

Challenge Based Innovation is a 4-6 months programme where teams of university students develop projets that solve complex societal problems, inspired by technological ideas that come from instrumentation development or basic research at CERN. Students work in a multidisciplinary team, develop their critical thinking and get hands-on to make their ideas real through prototyping and testing.

TEAM NEWTAIR

We chose to base our team's name in Newton, who defined the motion equations that refer to mobility and air therefore making allusion to our challenge.

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THE CHALLENGE

Air Quality & Sustainable Mobility

Our challenge stems from the United Nations' global sustainable development goals (SDGs) for 2030 in which we need to take urgent action to combat climate change and its impacts.

The SDGs we are specifically working with are: goal 11 (sustainable cities and communitites) and goal 13 (climate action)

We have to ensure the vital flow of people, goods and services in clean, equitable and sustainable ways and mitigate the negative effects of transportation on air quality.

Creating sustainable transportation solutions requires a mind shift: where transport in private cars and individualistic mind sets give way to public transport and collective solutions.

Out team went through an extensive research regarding what causes air pollution itself and how could we create this change in mentality.
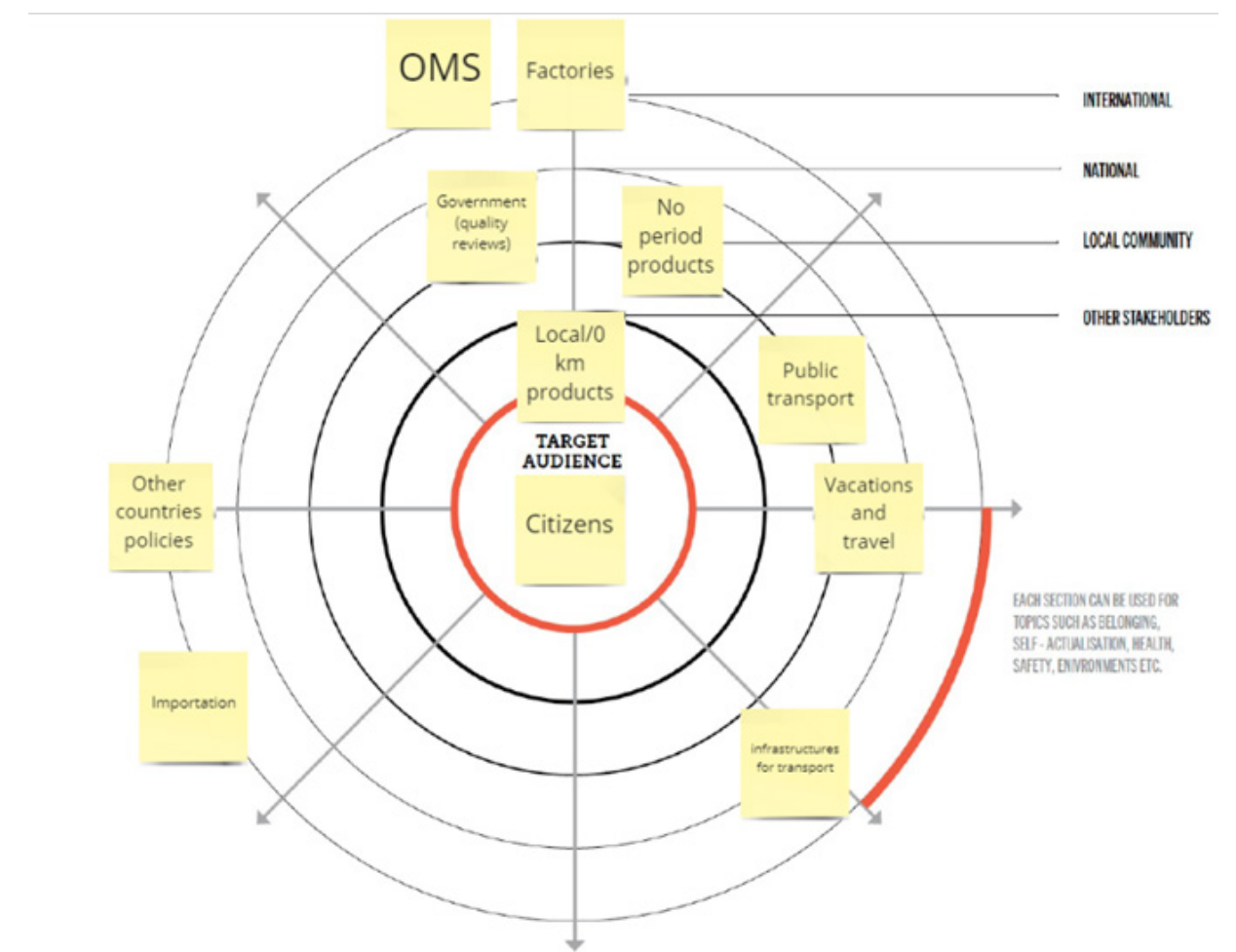
INITIAL RESEARCH

Sustainable Mobility and Air Quality are two very wide topics on their own, and even at their conjunction there are enough issues to look into, problems to solve and room for innovation. There is a wide range of transportation factors that cause air pollution, from urban and inter-city transit of people to land, maritime and aerial transportation of goods. Inspired by our life in Barcelona, we decided to zoom in, as a start, on the relationship between transportation in urban areas and air pollution.

We immediately came up with potential ideas for our challenge, but we quickly discovered that those immediate thoughts were also relevant to our perception of the immediate world and future. Aiming to drop our bias using the methods we learnt for Future Thinking, we looked deeper into numbers and research that would help us identify rising trends in urban mobility and their effect on citizens' surrounding air quality. For the research to be efficient, we mapped the relevant audiences and stakeholders according to their scope and involvement, with the citizens as the target audience in the center.


**Audience Map - Showcasing our target audience**

INITIAL RESEARCH

We divided the research between ourselves to focus on the following:

• Interviewing residents of Barcelona across age and socio-economic status groups to build a comprehensive understanding of the using habits of public and private transportation means

• Interviewing municipal and public transportation authorities' representatives, health and engineering professionals to widen our understanding of possible future scenarios

• Searching studies and articles on urban transportation or air pollution/quality to see where air pollution concentrations are a growing problem

• Inspecting current projects implemented anywhere across the globe, both practical and educational, in big and small cities, to see what is already being done, identify unaddressed issues and rule out ideas we might come with if they are too close in perception to our present time
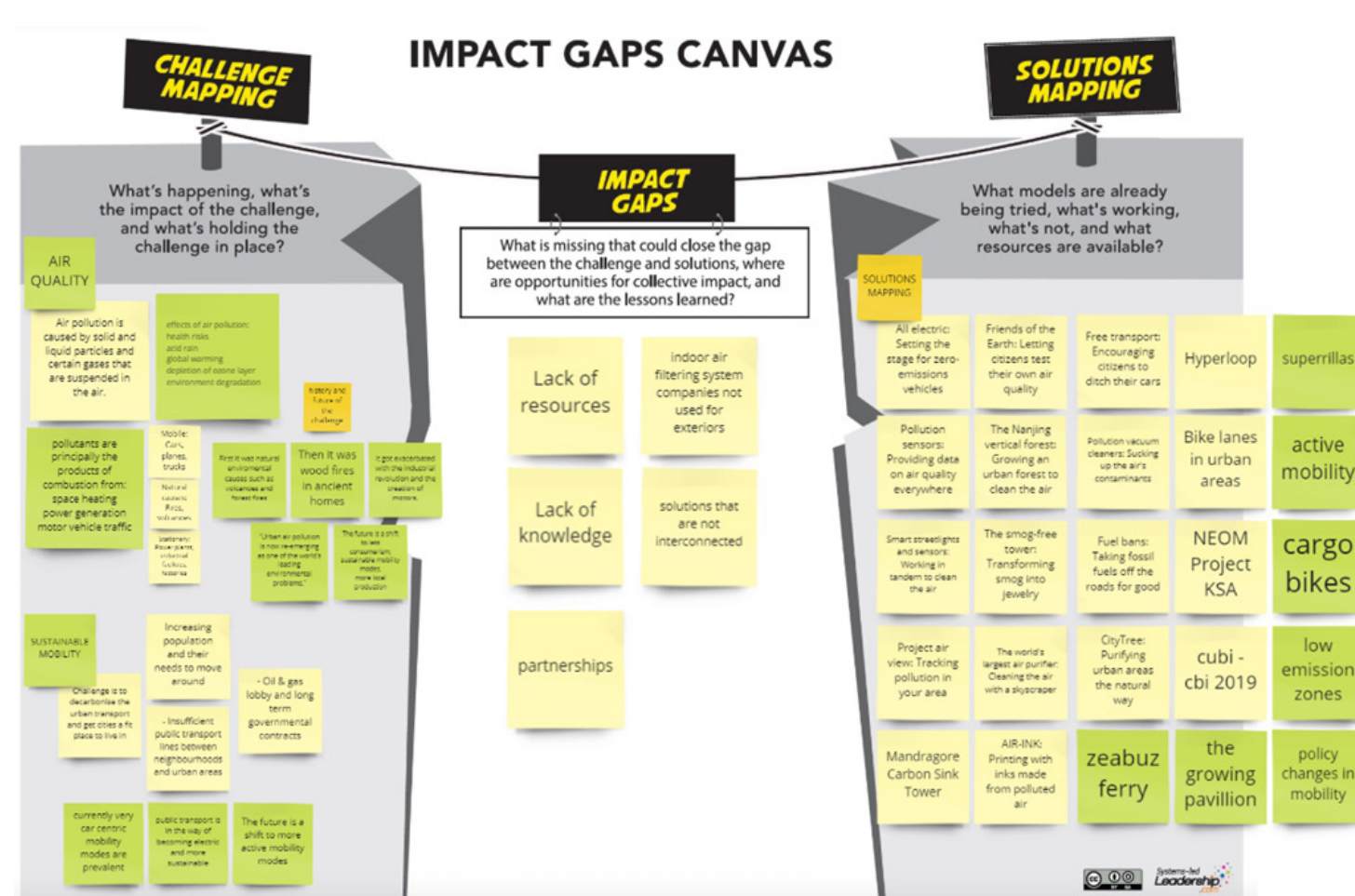
Impact Gaps Canvas - In this map we are trying to map our challenge and pinpoint the overlapping areas in which we could create a significant difference
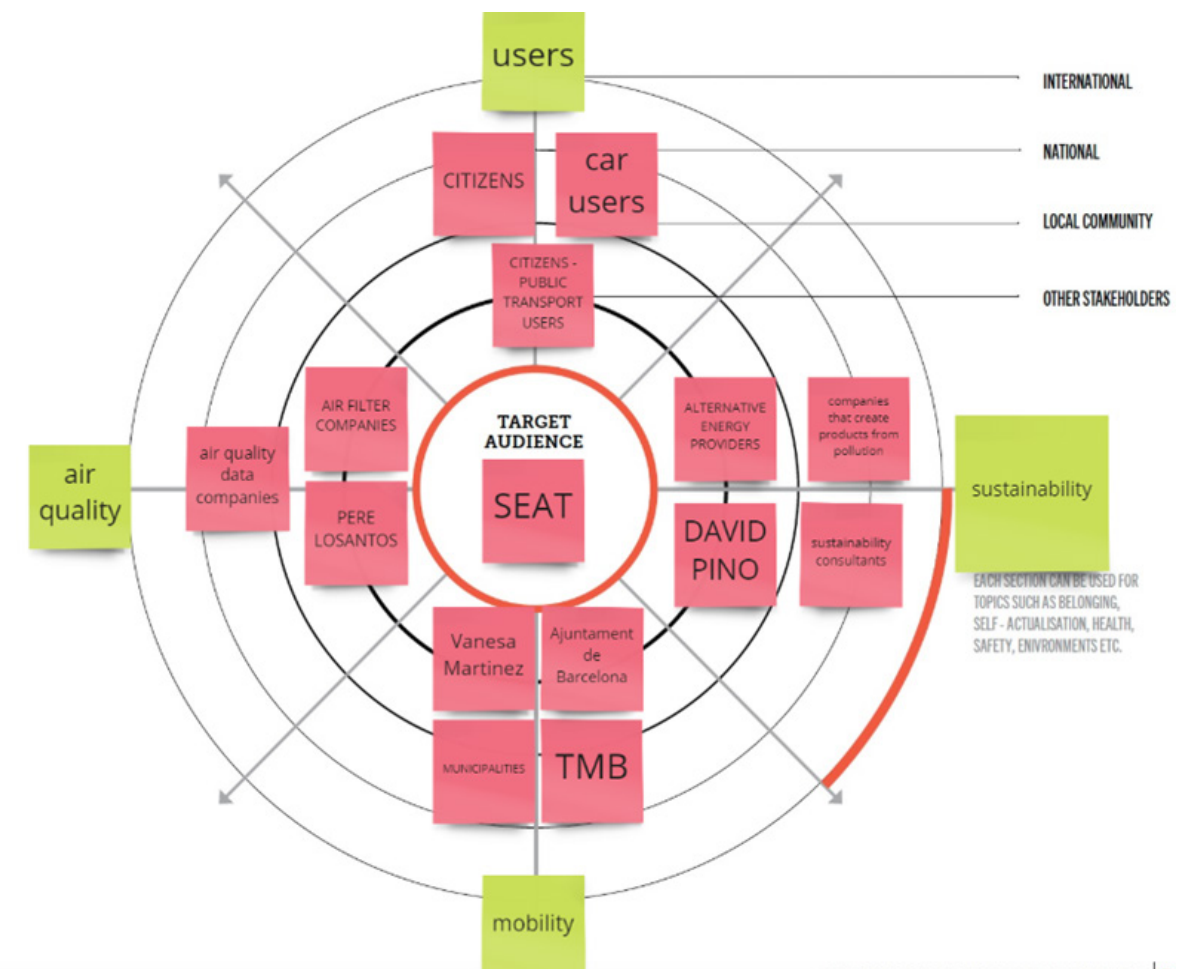
Stakeholders Map - These are the initial stakeholders we wanted to contact for their expertise

INSIGHTS - STAKEHOLDERS

RESUMED INSIGHTS FROM STAKEHOLDERS

STAKEHOLDER	POINT OF VIEW	INSIGHT
Francesc Baró	Air Quality	Look into a change towards healthier cities. Be careful with gentrification as a consequence of these actions
Albert Soret	Sustainable Mobility	A change in the mobility model from goods and a people, optimize cities for that model and implement the new technologies available.
Oier Violet	Sustainable Mobility	De-size our mobility patterns and become more of a 15 minute city.
Sonia Hernandez	Air Quality	Reduce the need to move through means of transport that emit gases and then promote transport systems that do not have such a great impact on land use in cities to create cleaner air.

Francesc Baró

Actualment estas treballant en algun tema relacionat amb qualitat de l'aire o mobilitat sostenible? O quins projectes estas realitzant relacionats amb les zones urbanes (ciutats)?

- Projecte Europeu Cleaning House, Europa i la China: Enfocat a boscos urbans. De quina manera poden contribuir a solucionar diferents reptes que tenen les ciutats. Idea d'utilitzar verd urba per **ciutats mes resilients**, **saludables**, habitables. AMB esta treballant a barcelona en aixo.
- CoolsSchools: adaptació climatica en escoles a traves del verd i adaptacions. (Refugis climatics a barcelona (fa 2-3anys) projecte pilot d'incrementar punts aigua, punts ombra i patis escolars perque siguin mes adaptats al canvi climatic. Tambe als edificis de mes ventilació, mes eficients energeticament.) I a partir d'aquets projectes pilots (Paris, Rotterdam) veure les lliçons apresses de governança ,salut i veure l'impacte. Sobretot en els nens i comunitat educativa i de barri.
- Temes de justicia ambiental, access al verd es quantitatiu a les ciutats i gentrificacio verda: millora espais public a traves del verd acaben incremeentant els preus del vens inmobiliaris i pot provocar aquest proces de **genrificació** i atreus gent de mes poder adquisicio i la gent que hi vivia amb menys poder es vegin obligats a marxar.

A l'article mencionat prèviament conclouen que l'ús de boscos urbans contribuïen poc a la reducció de les partícules analitzades en termes generals, però que podien ajudar a reduir dins d'un conjunt de mesures preses. Creu que ara, 8 anys després, analitzant Barcelona i mesures aplicades com les superilles o les zones de baixes emissions aquesta tècnica podria tenir un major impacte?

- Si el fessim ara no se molt be com estan els nivells, ara sembla que estan pujant una mica (despres de la pandemia). No se si els numuros canviarien molts pero des de l'ajuntament fa anys que intenta naturalitzar la ciutat, menys cotxer i mes espais verds. Com espais escolars. Ara potser aquests numeros d'eleiminacio de contaminats i eleminacio de CO2 podrien augmentar pero seguirien sent molt baixos.
- Infraestructura verda es molt imporant per tots els beneficis culturals recreatius efecte illa calor pero l'important per conaminacio aire es reduir emisions.

- À vegades l'arbrat pot contribuir negativament en temes com el polen (alergies), o en carrers amb bastant transit pot provocar que bloquej la dispersio de contaminants cap a l'atmosfera i quedin atrapats per sota arbres, encara que es complicat de quantificar.

Albert BSC

De l'article es pot apreciar com un canvi dels vehicles a híbrids o elèctrics podia millorar significativament certs indicadors de la qualitat de l'aire (relacionats amb certes partícules). Amb els canvis adoptats a partir del 2015 amb els acords de París, l'augment de cotxes elèctrics-híbrids, la reducció en emissions dels nous cotxers produïts, la introducció de les zones de baixes emissions i superilles. Considera que amb tots aquests canvis els resultats encara poden ser més rellevants i millors del que van estudiar?

A l'article mostrem que per arribar a nivells de millora de la qualitat de l'aire basant-nos únicament en la introducció de vehicle elèctric (incloent vehicle hibrid, endollable.) el canvi en el part vehicular ha de ser molt gran per arribar a millores significatives que permetin estar per sota i amb un marge dels valors legislats. A més tenir en compte que els valors legislats són menys restrictius del que diu la WHO
-> https://iopscience.iop.org/article/10.1088/1748-9326/ac44c7 (General)

En els darrers anys com indiques hi ha hagut canvis:
-Increment de vehicles elèctrics, en flotes específiques com taxis (que són els que més km fan en comparació amb vehicles particulars) si que hi ha hagut un increment significatiu. Però en el conjunt del parc circulant, aquest percentatge encara és baix.
-Vehicles amb tecnologies més netes (EURO VI) En aquest temps hi ha hagut una actualització del parc vehicular; vehicles més antics (amb tecnologies més contaminants) han estat substituits per vehicles més nous amb millors tecnologies (EUROVI..) No obstant hi ha dues coses a tenir en compte. Un canvi tecnològic ajuda, pero per si sol no és la solució ja que és un canvi molt progressiu. A més en els darrers anys no ha estat clar l'emissions reals dels vehicles més nous (tema DIESELGATE).
->https://iopscience.iop.org/article/10.1088/1748-9326/abd5dd (Impact of diessel in emissions in cities)
-Ara mateix tots els ajuntaments de més de 50.000 habitants han de definir plans per millorar la qualitat de l'aire. En el cas de BCN anem una mica tard, a moltes ciutats Europees fa molts anys que han implementat mesures com les zones de baixes emissions. L'impacte a Barcelona de les baixes emissions és una mica dificil d'estimar ja que van entrar en paralel amb la pandemia de la COVID.
-Relatiu a les super illes. Aquestes han d'anar acompanyades d'una reducció del trànsit, del contrari la superi illa per si sola no és la solució. https://www.sciencedirect.com/science/article/pii/S0048969721058216?via%3Dihub (Traffic restrictions extend on improving).

Com a resultat de tot això a Barcelona els nivells han anat baixant progresivament de forma molt lenta en els darrers anys. Tot i això hi ha molt fer encara, els nivells a algunes zones amb molt trànsit encara superen els nivells de NO2 anual. A moltes altres zones, els nivells són molt propers als nivells màxims legislats. La solució definitiva ha de passar per una millora tecnológica constant (vehicles elèctrics, millores tecnologies Euro...) però sobretot per un canvi en el model de mobilitat i fer un canvi modal a anar en bici per exemple o compaginar el treball des de casa. La pandèmia ens ha ensenyat que podem adaptarnos a aquests canvis que tenen efectes positius en la qualitat de l'aire i en el nostre
benestar. https://www.sciencedirect.com/science/article/pii/S2589811620300331?via%3Dihub

Sonia Hernandez (health arch)

- Which is the most affected group by air quality? In terms of age, place, gender and indoor or outdoor.
The most vulnerable groups: children, the elderly, sick people... immunocompromised people whose immune system is more affected by environmental toxins. The lack of equity in urban design and housing also means that there are more disadvantaged areas, with higher levels of pollution. Most of the times they are working-class neighborhoods located in peripheral areas, but each urban area should be analyzed in detail

- How do you see the future of mobility? How do you see the quality of the air in the future?
I am optimistic and I believe that we are becoming more sensitive and aware of the need to breathe clean air, and that it depends on our actions and decisions. I see alternatives to transport that reduce the use of the car and facilitate active mobility: bicycle, scooter... The pandemic has also led to the need to have basic services nearby to live, reducing the segregation of uses in cities and reducing the need to move. There must also be a public commitment to increase public transport. In the case of Barcelona, the "superilles" are proof of this conquest of public space for citizens, taking space away from cars.

- Which is the best way to improve air quality and mobility in the future?
mainly by reducing the need to move through means of transport that emit gases, and then promoting transport systems that do not have such a great impact on land use in cities. This aspect does not have a direct impact on air quality, but it does have a direct impact on the usability of the city.

- What are the challenges countries face and what obstacles are preventing assistance in improving air quality?
reducing car use is a policy that does not always win votes. Politics is sometimes shy in making decisions that can lead to the loss of the next elections. I think this aspect blocks many decisions that could be more drastic. I believe that the benefit of improving air quality is not sufficiently disclosed and explained, so that citizens become empowered and are themselves the ones who motivate those actions.

- What can we do to reduce pollutants from cities?
First of all, empower ourselves and take actions in our lives that lead to reducing these emissions. An of course, support and be part of initiatives that promote the improvement of air quality.

A l'article també conclouen que no tot ha d'estar centrat en els vehicles personals, també vehicles pesants com autobusos o camions s'han de tenir en compte. És cert que s'està fent un esforç per electrificar aquest tipus de vehicles, però com creu que s'haurien d'enfocar, quina creu que seria la millor manera d'actuar en aquest cas? Una reducció? Seguir amb l'electrificació? Limitacions en horaris?

En el treball es dóna importància als vehicles pesats donat que en aquell moment quan es parlava de vehicles elèctrics tothom tenia en ment cotxes i motos (que a zones com a la Xina representen percentatges enormes). Però que passa amb els autobusos? Si es planteja una situació en la que es redueix la mobilitat en transport privat per fomentar el transport públic, hi haurà més busos, o seran més grans per poder transportar a més gent. Crec que a la ciutat s'ha de treballar per limitar el transport privat (cotxe i moto) per fomentar el transport en bicicleta o transport públic. En el cas de gent que viu fora de Barcelona, també s'han de posar facilitats amb parkings grans al costat de medis de transport a les afores per a que la gent pugui accedir a les ciutats en transport públic.
Aquest canvi model té un increment exponencial. Ara mateix les ciutats estan definides (carrers, temps que duren els semàfors...) per optimitzar el transport amb cotxe i evitar embussos. Si hi ha un canvi modal significatiu, els carrils bici, els temps dels semàfors, les parades i linies de tranport públic es poden optimitzar més i ser més eficients amb el que ja hauria de preveuria els avantatges. A ciutats com Dinamarca per exemple això és una realitat i la gent pot anar a la feina més ràpid en bici que en cotxe.

En el cas dels camions no és rellevant per l'estudi ja que si ens centrem a zones urbanes, hi ha pocs camions dins de la ciutat.

Quin creu que és el grup més afectat segons la qualitat de l'aire? En termes tan d'edat, residència, gènere, etc.
Hi ha molts estudis que han analitzat aquest tema, no sóc expert però la qualitat de l'aire afecta a tothom, pero és dificil normalment linkar els nivells de qualitat de l'aire amb la patologia ja que no és una cosa inmediata normalment. Afecta principalment a gent vulnerable i amb enfermetats cròniques, pero s'ha vist que té efecte en nou nats, en la capacitat de concentració dels infants a les escoles...

Veient el canvi en 8 anys respecte el moment de la redacció de l'article, com veu el futur de la mobilitat des de l'actualitat? I el futur en la qualitat de l'aire (sobretot en zones urbanes)?
Crec que ara s'estan posant bases per avançar però anem molt tard. Aquest és un tema molt controvertit políticament i cap partit vol sortir perjudicat i per això els canvis són molt progressius. La part positiva és que en aquesta matèria estem "auditats" per Europa (de fet Barcelona ha estat durant molts anys inclumplint amb els nivells i se li han perdonat multes) i quan es defineix una mesura que permet reduir emissions és molt dificil tirarla enrere a menys que es demostri que per una altre banda (altres mesures més eficients) es mantindran els nivells.

-Quina creu que és la millor manera, el vostè, de millorar aquesta qualitat de l'aire i mobilitat en el futur?
Actualment, el principal problema de qualitat de l'aire està linkat a mobilitat, privada o de mercaderies (que en els darrers temps amb Amazons... també ha esdevingut un tema important a analitzar), el que cal és un replantejament sobre les nostres prioritats i el nostre model. Ara per ara és un tema d'estatus en molta gent anar amb transport privat quan és més barat, més ràpid i menys contaminant altres medis. I ho poden ser més en el futur. Per mi la millor manera és un canvi modal (de cotxe privat a públic, bicicleta, ... o valorar si tots els desplaçaments són necessaris i si hem de fer-los en hora punta) que passa per un replantejament i empoderament de la gent en la pressa de decisions. Crec que de la pandemia que hem viscut podem treure llicons importants.
https://www.sciencedirect.com/science/article/pii/S2589811620300331?via%3Dihub (Teleworking)

Oier Violet (mobility engineer)

In your perspective, which is the most affected group by air quality? In terms of age, place, gender and indoor or outdoor.
That's a personal opinion based on articles I read time ago--> Kids (no gender differentiation) and outside. It's not my knowledge area, but based on the papers I've read it seems the effect of low air quality (that is high pollution levels) on their development (IQ, issues, diseases) is brutal. Way more than in adults or elderly people.
Regarding indoor vs outdoor, I guess both are pretty related but outdoor is more critical.
If you have a really low air quality (e.g. lack of ventilation) in a room BUT good air quality outside, well, it can be sort of easily solved (e.g. further ventilation or an air purifier). Plus, once outside, you can breathe 'good' air.
If low air quality is outside (e.g., due to a highway) you cannot ventilate because outside maybe even worst.
Extra ball:
In big cities (western world), if there isn't any big pollutant industry in the area, the main pollution comes from traffic (somewhere between 50-70%, EU Data, BCN is around 50-55%). Aware that electric mobility does not eliminate all the pollution (as vehicles will still pollute with PM1,PM2,5 and PM10). This Twitter account specifically speaks (in Spanish) about this kind of pollution, if you need further official data.

In your perspective, how do you see the future of mobility? How do you see the quality of the air in the future?
Air quality: From my perspective, air quality will turn to be the new 'fresh water':
"...because clean air will be to the 21st century what clean water was to the 19th..." Johnson, Boris, 2020 Gear change: a bold vision for cycling and walking. Not fan of PM Johnson, but fully agree with the statement. You likely studies the hygienist movement in architecture (or with Marti, maybe). Their main aim was to be hygienic and to get fresh air & water in XIX century. Guess we will have something similar as yearly death toll is increasing due to pollution and people is being more conscious.
Future of mobility: Somehow, we will de-size our mobility patterns or at least change them, mainly private car / long journeys to work. We all need to turn more into a 15-minute city (when possible, at least in big cities) and go local, rather than running a car for 20 km to buy something in CostCo. Cars will exist, will be used, but likely in shared solutions (car ownership is decreasing worldwide, as well as the driving licenses). Here some fresh explained data from Spain. Said that, guess we will have a boom of cycling (even when thats only a fast and really cheap part of the solution) and investment in PT (commuters trains, trams or new bus lines) rather than in new roads. And yes, low density areas will still use the car, but that's not the main issue. Those areas would need PT connection hubs, but car will still exist. Maybe I'm being conservative, but I guess we won't see in the near future disruptive vehicles (e.g., eVtols) and we will have an incremental innovation.

INSIGHTS - STAKEHOLDERS

We interviewed Sonia Hernández-Montaño Bou, a bioarchitect, about urban health and the design of a sustainable city. In her presentation, Sonia describes the determinants of health and well-being in neighbourhoods, categorized into natural and man-made, macro-economic, political, cultural etc. and discussed their impact on public health. The growing challenge of maintaining health in a growing urban environment with edification, and put in context the issue of air quality. We learnt that Barcelona has the highest traffic density in Europe (with 6,000 vehicles per km2), and that approximately 60% of its surface is dedicated for motorized traffic, with over 2 million trips per day, 43% in a private car. The congestion causes air and noise pollution and occupies land, and the estimation is that electric vehicles alone will not be a sufficient solution for that problem.

The occupation of land also affects the distribution and size of green and public areas, which subsequently also affects the air quality in the urban area. Sonia identified children, elderly and sick people as the groups most vulnerable to impaired air quality, and pointed out that the current urban design made some areas in the city more disadvantaged, in that sense, than others. She described the reduction of transit using high emissions means of transportation while promoting alternatives with minimal impact on land use as the best way to improve the air quality and mobility in the cities of the future.

We also interviewed Oier Violet, a mobility engineer, who compared future air-quality with current freshwater access issues. People are becoming more conscious about the importance of reducing pollution, and we will have to de-size our mobility patterns, mainly private cars/long journeys to work. Instead of taking the car for a 20 km ride to buy something at Costco, we should prefer going local, staying within 15 minutes ride (whenever possible). Oier still sees cars in the future, but mostly in a shared format, connecting low-density areas that will require public transportation hubs to connect them to the high-density areas, where a boom of investments in bicycle and public transportation will overtake new roads.

Albert Soret, researcher in the Barcelona's Super Computer (BSC) had a similar opinion about the necessary steps for sustainable mobility in the future. He said that we need to rethink our priorities and mobility model, mostly by empowering them to have a better decision-making process. He also recommended we look at the impact of covid-19 on air quality and its link with mobility, suggesting we could draw a lot of relevant insights for our project.

Professor at the Vrije Universiteit Brussel (VUB), Belgium, Francesc Baró shared the view on the need to change the way we move around in the city, prioritizing public transportation or other non-polluting alternatives. However, he also pointed out a key factor in creating green areas for improving the air quality and reduce traffic, warning that bad planning would lead to gentrification and leaving the access to those areas only for higher socio-economic population segments.
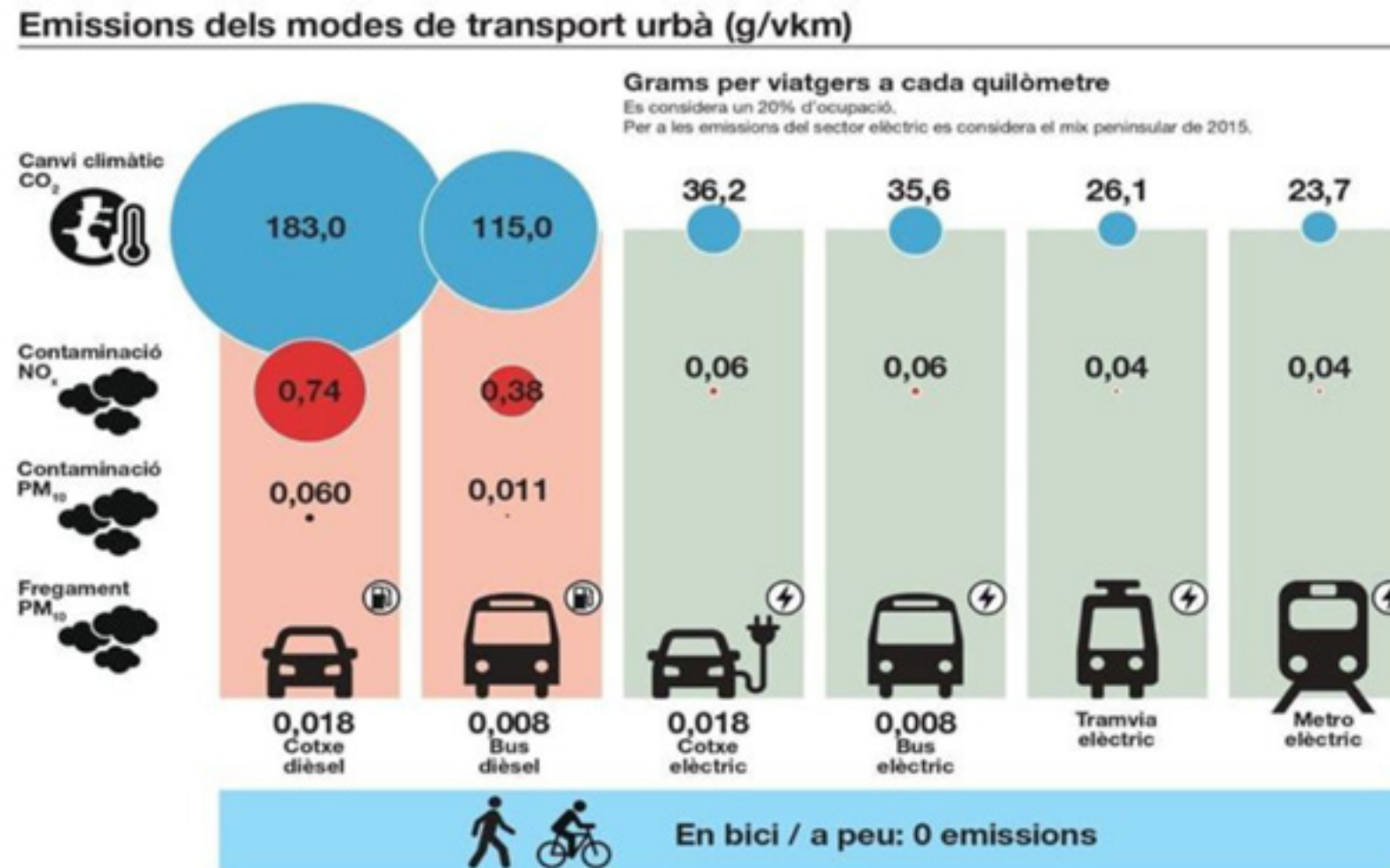
INSIGHTS - INTERVIEWS W/ CITIZENS

RESUMED INSIGHTS FROM CITIZENS

STAKEHOLDER	POINT OF VIEW	INSIGHT
Summary of 5 interviews with Catalans (Residences of Barcelona, Sabadell and Sant Cugat)	Air Quality	Each of the interviewee talked about clean air, seeing blue skies without any pollution, and having many parks and trees in the city. They think the car exhaustion fumes as the main reason for reduced air quality, while surprisingly none of them talked about factories and industrial zones.
	Sustainable Mobility	Main idea emerged out of the five interviews is that people, regardless of the age group think about bikes, and railways when it comes to sustainable mobility. 3 out of 5 mentioned not using fossil fuels, while other 2 talked about reducing the amount of fuel we burned everyday in the cities.
	Transportation Habits	Here the responses are divided. 3 out of 5 respondents are between 24-36 years old, while other two are between 60-65 years old. The young group stated that they're using bicing, TMB buses and FGC for the majority of their trips within the city, except when they're in rush they use taxi (about 10% of their urban trips) However of these three 2 has personal cars, which they use when going out of the city, specifically named Andorra and Costa Brava. 3rd young person who doesn't have the car however states that she rents when in need to go out of Barcelona. From these responses it looked like they make the effort to minimize the emissions within the city, however they like their comfort when going out of town. Older group on the other hand were reluctant to make any sacrifice there. They both have personal cars, and use it literally anywhere they go, no matter how close it is. They are aware of the emissions created however, due to pandemic using a public transportation is a big no for them, and their comfort as well as safety is more important than helping the environment. Second part of the question brought some interesting answers from the different age groups. Young group, all three, stated similarly that apart from trying to use public transportation especially railway, and bike, they focus on meat consumption as a way to mitigate. All three said that past couple of years they have been more aware of their consumption and reduced red meat dramatically. They all praised Heura brand. As it did not come up, I nudged them towards global shipment, they turned out to be huge fans of Amazon, and said that there's no way they will sacrifice the convenience getting what you want, from wherever it is that's located. The idea emerged there was that this has to come from governments rather than individual level. Older group's response was also interesting. Both stated that they will not change their diet, as pork and beef is what they enjoy the most, and younger population should be adjusting if necessary.

INSIGHTS - STUDIES AND ARTICLES

Mobile Sources of Air Pollution:
Traffic is the main source of pollution in urban areas, with personal vehicles being the principal polluters. Transportation creates two different ways of air pollution: smog and PM. Electric vehicles generate a significantly lower volume of emissions:

Emissions dels modes de transport urbà (g/vkm)

Grams per viatgers a cada quilòmetre
Es considera un 20% d'ocupació.
Per a les emissions del sector elèctric es considera el mix peninsular de 2015.

	Cotxe dièsel	Bus dièsel	Cotxe elèctric	Bus elèctric	Tramvia elèctric	Metro elèctric
Canvi climàtic CO_2	183,0	115,0	36,2	35,6	26,1	23,7
Contaminació NO_x	0,74	0,38	0,06	0,06	0,04	0,04
Contaminació PM_{10}	0,060	0,011				
Fregament PM_{10}	0,018	0,008	0,018	0,008		

En bici / a peu: 0 emissions

SOURCE - TMB

People who live, work or attend schools near major roads increase the incidence of health problems related to air pollution. Children and Elders are the most affected population segments.
Covid-19 Impact on Air Pollution:
In a study conducted on 24 major cities around the world, a range of decrease in GHG emissions (NO2 and SO2) was measured – from lowest of 3.3% decrease in Warsaw to 86.9% in Paris. Reduction is associated with the decrease of urban transportation.

INSIGHTS - CURRENT PROJECTS WORLDWIDE

Sustainable Mobility and Air Quality are not recently emerging trends. The awareness to GHG emissions as a result of using transportation means around the world has been here for quite some time, and initiatives to tackle that challenge have been implemented and are in progress at this very moment.

Major cities in Europe are rethinking their public transportation services: Berlin is implementing new technologies in their systems, from a wider distribution of electric bicycles to driverless subway lines; Milan and Paris are investing in new underground lines and cross-city metro lines to address the congestion; Madrid is developing active travel modes and promoting cleaner vehicles together with the health sector; The European Union is sharing an EU-wide real-time traffic data for development of sustainable mobility services.

Outside the continent, Costa Rica is investing in the installation of a new set of electric light-rail transport system with the main goal of encouraging a behavioral change of car users in San Jose; In the Philippines and India, private and public investments are combined for the development and implementation of low-carbon and sustainable transportation methods (for goods and services and for people).

The surge of initiatives is apparent in smaller towns as well, ranging from infrastructure projects mentioned above, to educational plans highlighting the connection between health and sustainable mobility, environment and equality, involving all age groups with an emphasis on younger age groups and children particularly.
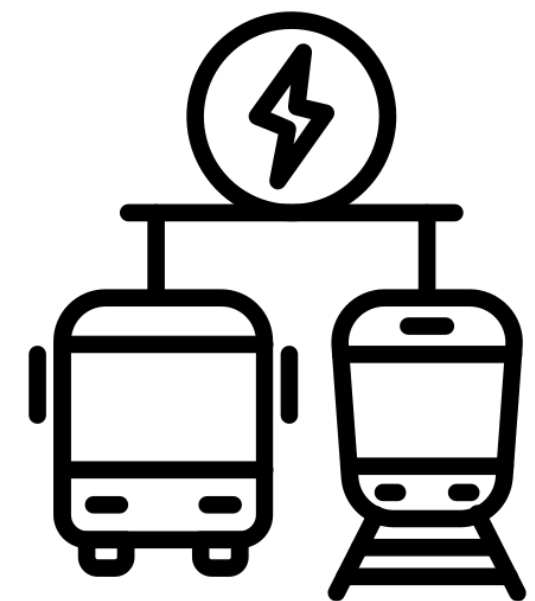
CONCLUSIONS OF INITIAL RESEARCH

From these interview insights, we discovered that cities and urban areas were the most affected by this challenge. The main problem was the mobility model and patterns from people and goods, which made cities unoptimized and thus, the tendency towards the use of personal vehicles that have a bad impact on land and the quality of air.

But, since the main target are citizens in big areas, also users of personal vehicles were interviewed to understand their necessities and needs. A summary of 5 interviews shows that the main cause of air pollution for the users is aligned with the research done previously: the use of personal vehicles in urban areas. The most significant insight though, was that even knowing what the main cause of air pollution was, users didn't want to change their mobility patterns, claiming a bad an inefficient public transport network as the main cause of the problem. As a review of our research report and after taking into consideration research data with interview insights of the different stakeholders, the following conclusions were extracted:

- Traffic is the main source of pollution in urban areas, with personal vehicles as the principal polluters.
- A change in the transport model and people thoughts must be implemented.
- The reduction of these personal vehicles is complex due to the uncomfortably and inefficient public transport network.
- The users are very aware of the problem and challenge, so it is not a problem of consciousness.
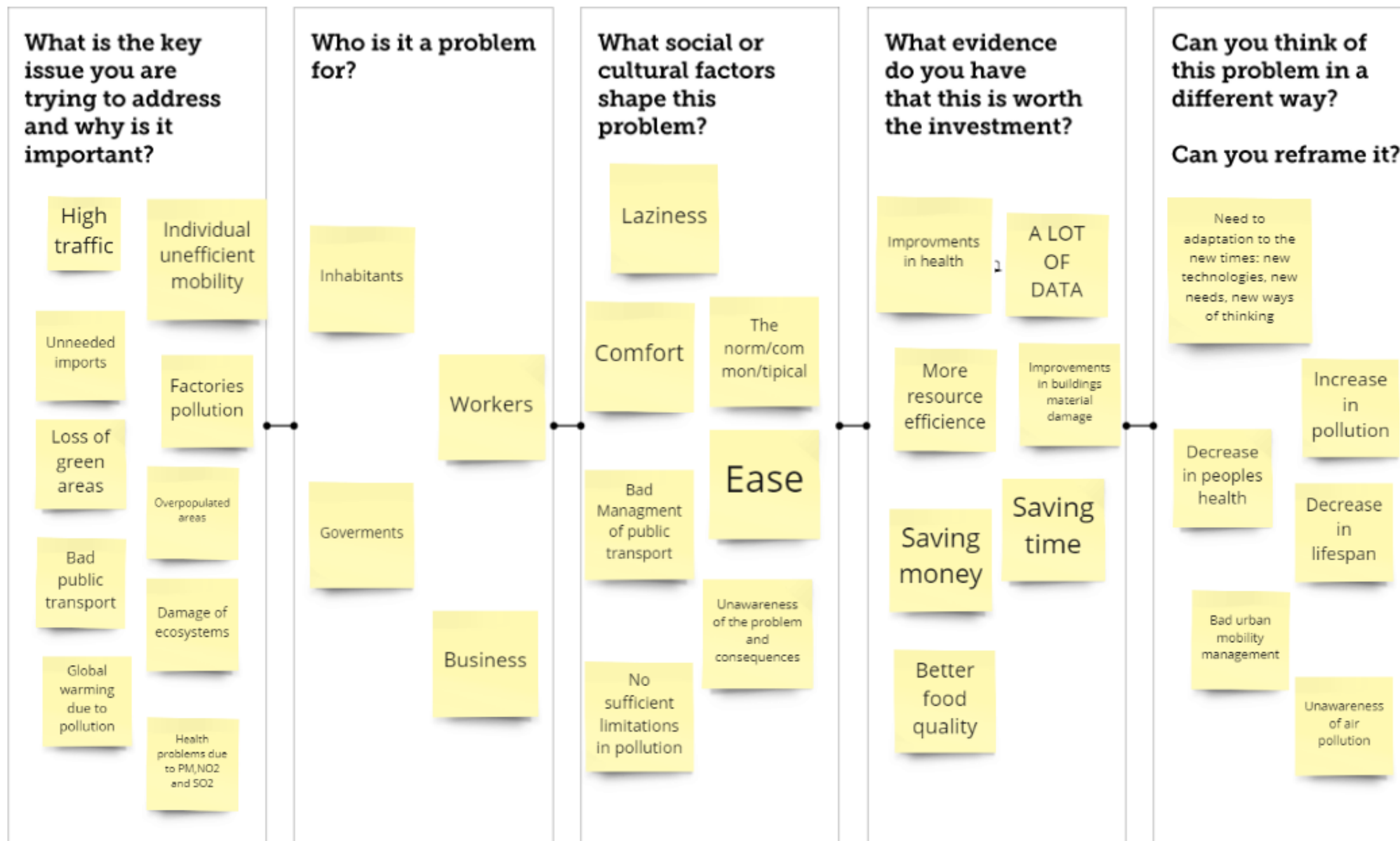
There are many different ideas that also tackle the challenge the way we want: considering a cleaner, faster, safer public transport solution that also offers privacy and comfort.

CONCLUSIONS OF INITIAL RESEARCH

DIY08

I want to clarify my priorities
by focusing on key critical issues

PROBLEM DEFINITION

What is the key issue you are trying to address and why is it important?

- High traffic
- Individual unefficient mobility
- Unneeded imports
- Factories pollution
- Loss of green areas
- Overpopulated areas
- Bad public transport
- Damage of ecosystems
- Global warming due to pollution
- Health problems due to PM,NO2 and SO2

Who is it a problem for?

- Inhabitants
- Workers
- Goverments
- Business

What social or cultural factors shape this problem?

- Laziness
- Comfort
- The norm/common/tipical
- Ease
- Bad Managment of public transport
- Unawareness of the problem and consequences
- No sufficient limitations in pollution

What evidence do you have that this is worth the investment?

- Improvments in health
- A LOT OF DATA
- More resource efficience
- Improvements in buildings material damage
- Saving money
- Saving time
- Better food quality

Can you think of this problem in a different way?

Can you reframe it?

- Need to adaptation to the new times: new technologies, new needs, new ways of thinking
- Increase in pollution
- Decrease in peoples health
- Decrease in lifespan
- Bad urban mobility management
- Unawareness of air pollution

SCREENSHOT FROM OUR MIRO BOARD - PROBLEM DEFINITION

CONCLUSIONS OF INITIAL RESEARCH

We ended up with the following problem statements:

How might we incentivize users to adopt more sustainable methods of transportation?

How might we reduce the use of personal vehicles in favor of public transport, while at the same time reducing costs, reducing travelling times and making it more accessible?

How might we make people aware of the situation and the consequences of air pollution in urban mobility?

How might we de-size our mobility patterns?

CONCEPTUAL DEVELOPMENT

In this process, a straighten overview of the problem is done and different ideas are exposed. First, many problem statements have been defined as possible narrowed challenge:

We know by the data extracted from previous research that, with a reduction of personal vehicles, air pollution would also decrease. On the other hand, and taking into consideration the insights from the users, even knowing perfectly the cause of air pollution, they were not motivated to change their mobility patterns due mainly to the inefficient public transport network. Thus, considering this reduction by making the users more aware of the of air pollution has been discarded as the problem to tackle.

What we discovered while interviewing some of the stakeholders was that the mobility patterns of our citizens could be changed if there were better methods of transport in urban areas.

Thus, and also considering that traffic jams are the main cause of air pollution in urban areas, we wanted to focus our solutions in answering the following question: How can we redefine an efficient transport model to ensure air quality in urban areas?

After asking this question, many ideas came into our minds. Following the different workshops proposed by the coaches, we tried to fit a solution in a future world asking ourselves the following questions: what if everything was different? What if new technologies allowed us to create new transport networks? And if so, how could a user be fitted in this new reality? After discussions and voting on the different solutions, three main ones came into our minds:
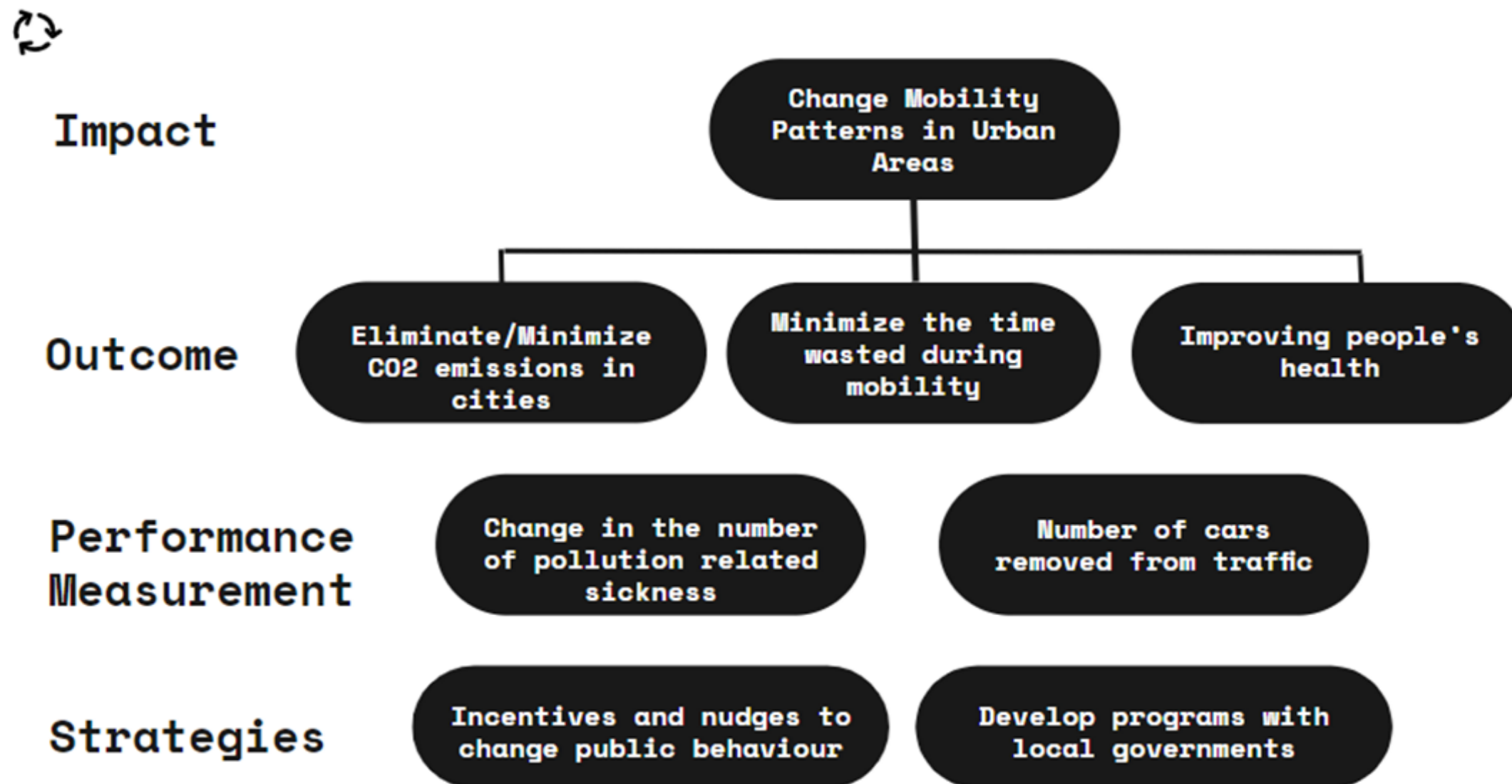
- The use of UAVs as public transport to decentralize the current network and change the model of transportation in urban areas.
- The use of modular vehicles that allow sharing power and space between the different citizens without changing the concept of personal vehicle.
- The use of new materials that can reduce the pollution in personal vehicles.

Because they were very similar (focused on a new concept of public transport giving at the same time privacy and security to the users), we decided to design an impact canvas in order to combine the use of UAVs as public transport with the possibility of a modulation in those vehicles.
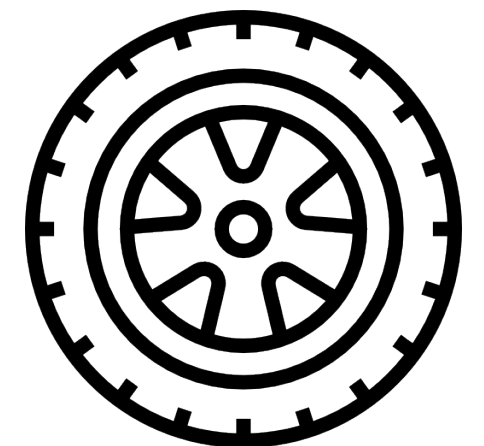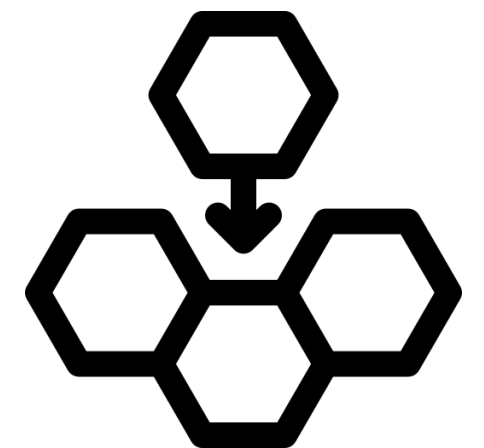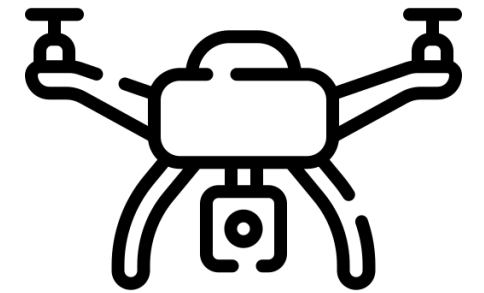
CONCEPTUAL DEVELOPMENT

Our initial Impact Model Canvas signaled the **urban mobility patterns change** as the desired impact, with the outcomes of minimizing GHG emissions, time wasted during travel and improving people's health. We would measure those outcomes through the change in number of cars on the road and through pollution related sickness cases reported, and the strategies to achieve it would be development of programs in partnership with local governments and providing incentives and nudges to change public behavior.

Impact

Change Mobility Patterns in Urban Areas

Outcome

Eliminate/Minimize CO_2 emissions in cities

Minimize the time wasted during mobility

Improving people's health

Performance Measurement

Change in the number of pollution related sickness

Number of cars removed from traffic

Strategies

Incentives and nudges to change public behaviour

Develop programs with local governments

SCREENSHOT FROM OUR 3RD CHECKPOINT - IMPACT CANVAS

CONCEPTUAL DEVELOPMENT

In our visit to CERN, we learnt a lot more about the purpose of innovation, and the difference between an incremental and radical changes' effect on our world. We realized that our journey still lacked some understanding of the problem we were trying to address, as our proposals were not focused enough, and didn't generate an exponential change. We decided to merge our initial problem statements into a single one, that pointed better our perception of the challenge, the insights and our imagined future:

> # How might we change behavioral patterns to adopt cleaner alternatives of urban transportation?

As a user, we imagined the following situation: we decide to go from point A to point B and we want to take the public transport. We realized by the insights of our interviews that many questions come into our minds as users: How much time do I have to wait for the bus? How much time will take the overall trip? How many combinations I will have to take to go home? Is there enough space for me and my stuff?

Those questions, make public transport look like an impossible mission. Thus, in our new reality, cars, bikes, or conventional transports are no longer in our city. We take the mobile phone and ask for a pod (our solution). Few minutes after, at the entrance, a personal vehicle pick us up to drive us where we want.

It was clear to us that we wanted to solve the issue we identified as preventing the goal from being achieved. And so, we took one of our three previously proposed solutions and modified it to allow the comfortable, safe and efficient transit from any point A to any point B within the city limits. Our modular multi-personal vehicle network would reduce air pollution and energy consumption and allow the abandonment of private cars.

DESIGN DEVELOPMENT

In order to solve the problem of a public inefficient network, the network of pods (this is how we decided to call our solution) will be the following: when a pod is requested (via tablets in the street), an algorithm based on AI will search for the nearest (in terms of distance and time) pod available. Then, a message will be sent into the wireless network to alert the pod (using releases of 5G and protocols device to device). In the meantime, the user will be able to see how many minutes of waiting and where the pod is located. The waiting time could also be a request from the user and could be set beforehand.

Once the pod is alerted, its system (based also on AI) will calculate the fastest route that will be actualized in real time. This allows the user to change its destination whenever he or she wants. At the same time, the pod will be recollecting environmental information not only from its sensors but from the messages that the smart city will be sending (like the position of other pods and their itinerary).

With this information, the pod will not only be able to travel safely, but also to know constantly where the other pods are travelling. This allows the pod to connect its resources (in this case the battery power) to other pods that follows part or the full trip. With the connection of different batteries, the pods will be sharing power and therefore, consuming less electricity. There will be up to 10 pods connected simultaneously, to increase the efficiency of the network in terms of mobility and energy consumption.

In overall, the coexistence of AI and the evolution of technology towards smart cities, allows us to present a solution that provides, safety, comfort, and efficiency towards the people, respecting and connecting with the necessities of our planet.
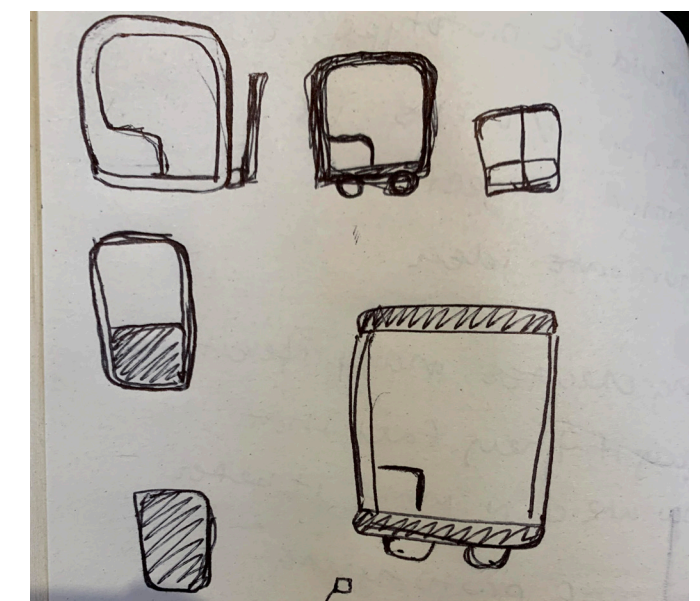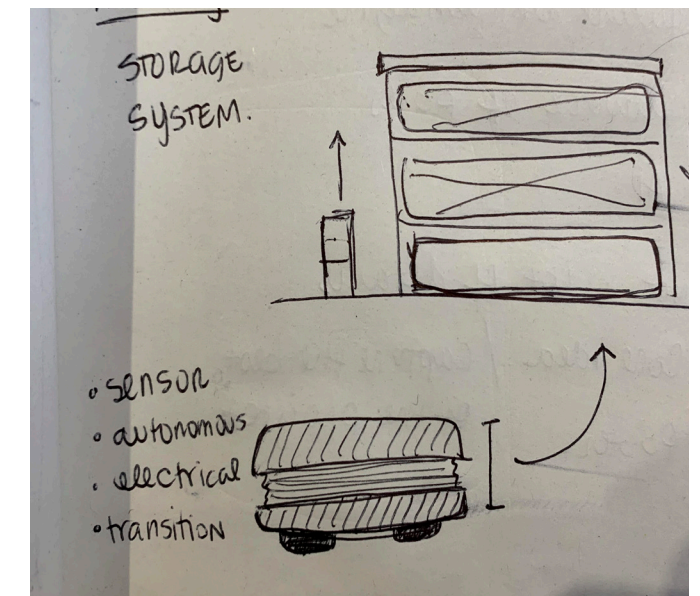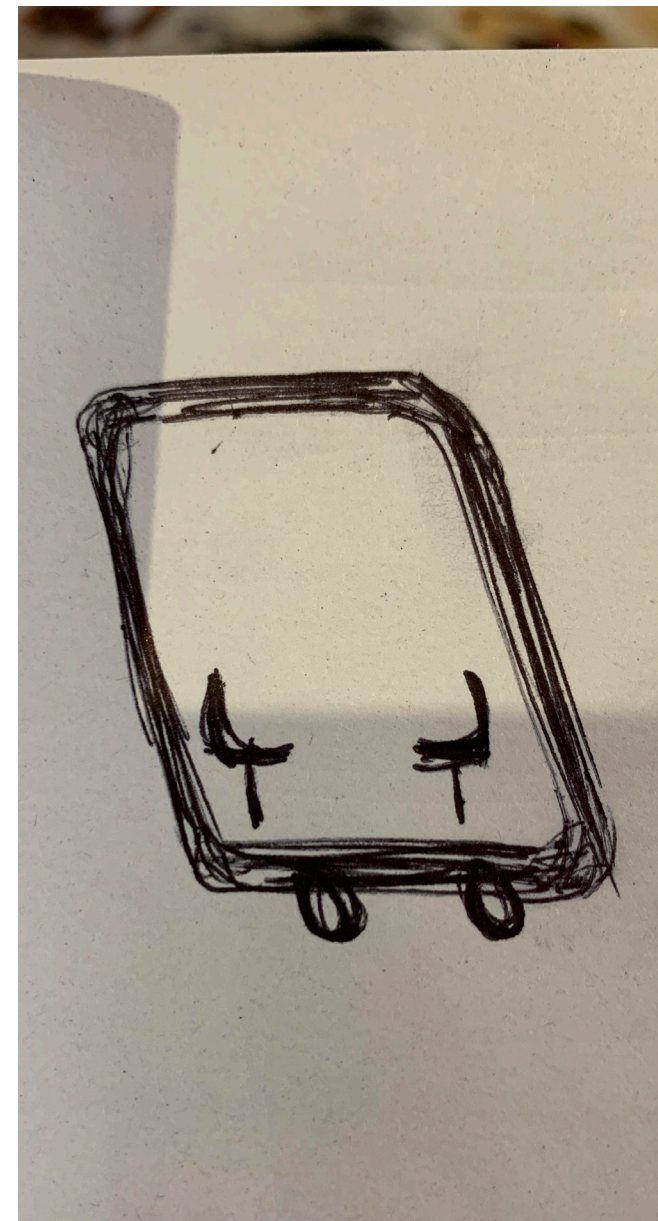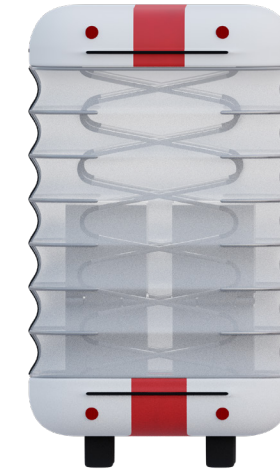

CONCEPTUAL SKETCHES FROM TEAMMATE'S NOTEBOOK

PODNET

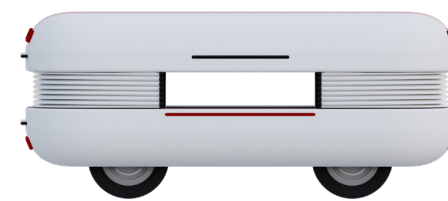FOLDABLE TECHNOLOGY FOR EASIER UNDERGROUND STORAGE

DESIGN

SIDE VIEW

TOP VIEW

BACK AND
FRONT VIEW

BACK AND
FRONT
CLOSED VIEW

SIDE CLOSED
VIEW

DESIGN

FIRST STEP - ORDER POD ON PAD OR PHONE

SECOND STEP - POD WILL EMERGE FROM UNDERGROUND STORAGE

THIRD STEP - STEP IN AND RIDE THE POD ANYWHERE!

TECHNICAL REPORT

First of all, it is worth mentioning that all the numbers used are approximations and adaptations from different sources. The worst-case or a worst-case is considered in all cases and all approximations are being done as a worst-case as well. There are plenty of technical aspects to consider in the Pod-Net project:

- 7G:
We are in 2050 when the Pods network is completely deployed and working at 100% capacity. The actual criterium is to deploy a new network 4G, 5G, 6G... every 10 years, as the demand increases exponentially. Therefore, following this trend in 2050 the 8G network would be the main one used for communications. For this reason, the frequency band of the not that much used 7G would be great to have as the main source for pods (as right now a lot of cars have 3G or 4G incorporated but not 5G). The network would be perfectly capable of dealing with the 4M pods that we are using as a reference in Barcelona. To be able to handle the communication and the data sharing in the network. Not only that but from the actual 5G there is almost zero delays in the network and the bandwidth capabilities of a 7G network would be even better in all these aspects and can be adapted inside the pods to be used in a more optimal and efficient way.

- CO2 emissions:
Pods are electrical for a lot of reasons. Electricity does not produce CO2, it is much more energy efficient, much easier and cheaper to produce, easier to transport, it brings instant power from the moment a motor is started and more. All these aspects contribute to the need to have electricity as the power source for the pods as it brings the possibility to have batteries, which are charged in the stations from the same electricity network that power the streets.

Specifically regarding CO2 emissions, according to the climate emergency declaration done by the Barcelona council in 2020, 27,4% of the CO2 emissions in the city came from transportation sector. The total amount were around 3,4 million tones, which ends up being around 932MT of CO2.

And having in mind an average fuel car consumption around 220gCO2/km this implies a reduction of 93% in the CO2 emissions.

- Autonomous:
The pods being autonomous create improvements and advantages over a conventional vehicle driven by a human. For instance, in terms of security in Barcelona, in the year 2020, there were 5715 accidents 73% (4163) of which were caused by human mistakes. Some of them were due to lack of attention, not respecting the speed limits, not paying attention when doing line changes or when a pedestrian crosses the street.

All these problems are solved with the autonomy of PODNET as they will always respect all these aspects. Not only that but with the AI integrated and everything it has learned it can predict and anticipating some accidents. For example, breaking before a human would ever do. Or seeing someone crossing a street in a prohibited place and anticipating it.

TECHNICAL REPORT

- Cameras, Radars and Sensors:
In each pod, there are several cameras, sensors and radars providing full coverage of the surroundings of the pod. The cameras provide optical information in the visible spectrum to analyze and process being able to understand the environment in a close range. Radars provide distance information in the frequency of operation, giving the possibility to detect objects and the distance to them, not only but their orientation, speed if it is moving, and more. Lastly, sensors provide information relating to events happening around, they could range from proximity, speed, temperature, acceleration, orientation, and so on. The combination of all this information is crucial in the autonomous driving aspect to understand what is happening around and act according to that.

- AI:
For the last 10 years, there is an increasing tendency toward Artificial Intelligence, in specific with Deep Learning and Neural Networks. It is impossible to imagine the capacities and possibilities in 30 years relating this technology, for example, right now every 2 or 3 years actual models get obsolete. What we have for granted is that the use of different systems of cameras, radars and sensors provide a huge amount of information to process. All this data is not only useful for using it in real-time but to use it to train Artificial Intelligence models, which will provide solutions and adaptations to problems when presented in different situations. Not only that but it will help make the pods better in terms of autonomous driving capabilities. It will help the network to share the information in a more efficient and optimal way and use it in a way that humans are not able to process.

POD FEATURING THE LIDAR, SENSORS AND CAMERAS FOR SAFETY AND AUTONOMOUS DRIVING

TECHNICAL REPORT

- Energy consumption:

Lastly, let's talk about the specifications of the pod and the energy consumption.

As mentioned before pods are electric, which means that they have an electric motor and a system of batteries. We will compare pods with an actual existing vehicle, just to show how that would be completely possible but even better as technology improves and expands at a very high ratio and every few years we have new possibilities in every field.

Looking at the specifications of a SmartEV we have:

- It weighs around 1T.
- It has a battery of 17,6kWh with a range of around 140km.
- A 60kW maximum power.
- 2 seats
- Maximum speed of 130km/h.

Each pod can carry 4 people which increases the weight however, it is much lighter as it only goes inside the city at a maximum speed of 30-50km/h on main roads. That brings the possibility to reduce the weight of the body being able to make it much lighter.

About the motor, you do not have to carry that much weight at that maximum speed. However, as pods would interconnect in the main roads and one motor would power up to 10 pods it would need more power. Therefore, the maximum power of the motor will be 120kW. An electric motor does not increase the size or weight as a result of having more power (as would happen in a fuel vehicle). Thus, we will keep a low consumption and weight. Not only that but having a bigger motor does not consume more, as it will only use the energy required to carry the number of pods connected, for instance, if it has only one pod the maximum power used would be the one required for one (much less than 120kW), not consuming more.

Relating to the battery, the pods weigh less and go at a much lower speed adding the fact that the maximum range would be 30km (around going from the furthest points in Barcelona two times) the capacity will be reduced as well.

To talk about the energy consumption with respect to a fuel car we will consider the following
- The time travelled by car inside Barcelona counting red lights, traffic jumps, speed limits, and more is 20 minutes.
- The average speed of the car is 25km/h.
- The average consumption of the car is 10L/100km being inside a city which usually is more than on highways.
- The number of cars entering in 1 day in Barcelona is around 1 million.
- 1L of fuel in terms of energy corresponds with 9,5kW.
- We are considering a x2 as the car has to enter and exit.

Those numbers give a trip of 8,3km moving around the city, which consumes 0,83L times all the cars are 0,830 million litres that in terms of energy is 15,77PW.

Now the pod considerations are:

- There are 4 million pods movements in the city.
- Each pod consumes 4,25kWh/100km (an average car consumes around 20kWh/100km).
Considering the same distance moved, 8,3km, this implies 0,7223kW and a total of 2,89PW. That implies a reduction of energy of around 80%.

PODNET

THROUGH AI AND A 7G NETWORK, PODS MAKE THEIR OWN ROUTES AND CONNECT MAGNETICALLY TO REDUCE ENERGY CONSUMPTION

BUSINESS MODEL

Lean Canvas

Designed for City of Barcelona **Designed by** Team Newtair **Date** March 2020

Problem	Solution	Unique Value Proposition	Unfair Advantage	Customer Segments
- People don't have enough incentives to change their mobility pattern to an emission free version. - Traffic jam causing people waste time.	Collapsible smart pods that are interconnected through AI. These pods will be able to carry maximum 4 people in foldable seats, that could free up space if there's personal equipment with them. Pods will know where to take the passenger through the command given in a personal device. Passenger will be able to leave the route as required.	Our solution allows people to travel to their destination within the urban area while saving time and money, mitigating carbon emission their travel causes in a safe manner.	The combination of the features that our product includes and gained by being first mover in the market will be difficult to imitate	Residents (families, elders, adults) and tourist of the city of Barcelona, who needs to commute to different parts of the city for work and leisure purposes.
Existing Alternatives	**Key Metrics**	**High-level Concept**	**Channels**	**Early Adopters**
Autonomous cars, metro, privately owned vehicles, air taxis, modular pod buses (NEXT transportation in Dubai)	- Number of Travelers, - Average time per travel, - Cost per travel, - Pods used per month/year	Greener, safer, faster and more efficient alternative to traditional urban transport	- Social Media, - Governmental support and incentives for the early adopters (free trial period etc) - Initial operation in the busiest part of the city	- Commuters (business people and students) of the busiest routes of the city - Private car owners who are not using public transportation due to inconvenience

Cost Structure	Revenue Structure
- Manufacturing/purchasing and maintenance of the pods - Infrastructure for the pods mobility, aligning pre-existing infrastructure - Marketing, legal, administration - Training the staff	- One way/Daily/Weekly/Monthly public transportation tickets, - Governmental subsidies for carbon offsetting - Ads on pods

PODNET's unique value proposition is allowing people to travel safely to their destination within the city limits while saving time and money, in a significantly lower carbon emission. Our service doesn't just add another transportation mean, it completely solves the root cause for many inhabitants not to prefer public transportation over their private car, thus potentially lowering not only the use of private vehicles, but also the use of current public transportation.

PODNET

Customer Segments

This alternative for transit will revolutionize the service of TMB, allowing all residents of Barcelona to commute around the city from home to work, school, commercial zones etc; It will also offer a friendly option for tourists, who do not know their way around, to not be dependent on navigation apps and wifi access. We expect that out of all users, private car owners who refrained from using buses and metro for various inefficiency reasons (distribution of stations, safety, etc.) will be the first ones to try this new alternative.

Revenue Streams

On the long-term, PODNET will rely mostly on two sources of revenue:
1. The existing public transportation payment system – users (both residents and tourists) will be able to purchase any option from a single ride to periodical transit contracts, similar to the ones existing today.
2. Ads – both the interior and exterior parts of the pod can host a digital ad, that will change according to the users boarding the pod for each journey. Having this adaptability will be worth more than a standard pre-determined ad across all pods for a given period.

In addition, PODNET hopes to start its activity with various governmental grants and subsidies for carbon offsetting, both from the Generalitat de Cataluña and from the government of Spain.

Cost Structure

The initial costs of manufacturing the pods and laying its infrastructure will be significant and, as a result, its heaviest expense in any given city, however we do estimate that the municipalities will participate in the infrastructure due to the product's benefits described in this dossier, mostly direct and indirect carbon offsetting and improved air quality.
On the long-term there will, of course, be standard costs such as Marketing (though lower, since the pods' visibility will be sufficient), General and Administration expenses and training expenses for operating staff and customer service at the HQ for each new client city.

Go-to-Market Strategy

PODNET is a public transportation vehicle, and therefore will be marketed directly to the relevant municipality, emphasizing the financial benefit from the improved air-quality in the city, ranging from direct impact on quality of life, government spending on air pollution related health issues and indirectly from satisfaction of residents and tourists. The implementation will start with the development of the relevant technologies and the availability of flexible yet durable raw materials for the structure of the pod.

Although the pods will be sold to the municipality, PODNET will be introduced to the general public in a joint promotion of the company together with the municipality and the government of Cataluña. The pods operation has to be across the entire city at once, otherwise it will not serve its purpose. Other cities in Spain, across Europe and around the world will see the implementation of the pods network and will be able to understand its advantages demonstrated live.

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