Sustainable Mobility Transitions in Skellefteå by 2050

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1. Executive summary

- Ususally contains a brief statement of the problem or proposal, background information, concise analysis, and main conclusions
- Typically intended as an aid for decision-makers

Introduction This project aims to propose a solution that can lead to a transition in Skellefteå to reach their vision by 2050. Aiming to develop a mobility system that is necessary to make Skellefteå "a sustainable place for a better everyday life", the vision of this project is set out to be "A sustainable, accessible, and flexible mobility system in Skellefteå by 2050." The solution is delivered by the *modular participatory backcasting framework*, and it will be presented along with the pathway and corresponding experiments.

Problem formulation As a large municipality with several suburban and urban areas scattered among the rural areas (Skellefteå kommun, 2020) while lacking a robust public system, Skellefteå is now having a high proportion of private vehicles, which conflicts with its sustainability vision, especially with the expected population growth. Therefore, a transition in their mobility system is necessary, which needs to be accomplished by not only the Skellefteå municipality and mobility agencies like Skellefteå buss but also academic institutions like Campus Skellefteå, companies like Northolt, and citizens as the target users. The function of the system is distinguished from the citizens as to "enable people's accessibility in a safe and sustainable way to help people fulfil their life".

Solution Our solution is a green transportation system with both the flexibility of private vehicles and public transportation's energy efficiency. The system is based on shared self-driving vehicles which is accessible for everyone by using an ordering app that supports users to book cars and plan the route. The vehicles are able to connect with each other to form into a train automatically, and charging is possible while they are moving on the highway. This system is suggested to be municipality-owned while operated by Skellefteå buss so that it's easier for the municipality to develop the city comprehensively in a long-term perspective, also it will be useful for evacuating citizens under emergent scenarios.

Pathway The transition requires changes in sectors of technology, culture, and institutional structure. The technical changes include the development of the infrastructure and supporting softwares, where collaboration between the municipality and local academic institutions is recommended. The cultural changes involve the municipality, citizens, and campus Skellefteå, aiming to make people adapt to the new system and complete necessary supporting systems. Finally, structural changes happen in each institution, including Skellefteå buss, education institutions, companies, and the municipality, where collaboration among them is required. A visible pathway is presented in the report where the changes are placed on a timeline.

Experiment Five experiments have been recommended to help implement the system.

(1) Online questionnaire to understand people's needs and expectations.

(2) Release educational videos and VR interaction media to introduce the system to the users and provide insight into their behaviours and reactions.

(3) Test the ordering app and the concept of booking for travelling by the existing bus system.

(4) Test the system in the lab first and then move onto real life.

(5) Connect important destinations by collaborations with companies.

2. Introduction

The importance of sustainable transportation was first recognized at the 1992 United Nations' Earth Summit (United Nations, 2021). Later, the central position of transportation and mobility in sustainable development was consolidated at the 2012 United Nations Conference on sustainable development (United Nations, 2021). Gradually, promoting sustainable mobility and associated transition has broadly become widespread objectives in transport policy and decision making (Gallo and Marinelli, 2020). The United Nations Sustainable Development Goal (SDG) 11 mentions global ambition of "providing access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons by 2030" (United Nations, 2021).

The vision of Skellefteå is "a sustainable place for a better everyday life" from which it can be seen that sustainable development has already been integrated into the Skellefteå municipality's planning. Thus, as a key division of sustainable development, sustainable mobility cannot be neglected. Moreover, the future scenario of Skellefteå is to create more employment and attract more people to move to Skellefteå. Mobility, as a fundamental component of the city, could be challenged by the growing population. Currently, people are opting for travelling by private cars in Skellefteå where public transportation has trouble reaching rural areas and trains are missing. With this in mind, this study aims to explore solutions to improve the current mobility situation and make it reconcile with the vision of the whole city and achieve sustainable transformation.

3. Methods

A big part of data collected in this report is from Skellefteå, agencies' and organisations' official websites and documents, which are reliable and credible first-hand sources. The vast majority of secondary data utilised in the study are from three seminars communicating and interviewing with the Skellefteå municipality, which indicates dependability. Information from scientific literature is also used to support some arguments in the report. However, there are limitations in the data as part of the information about stakeholders are not from first-hand sources which could be improved in future studies.

Modular Participatory Backcasting (mPD) is chosen as the analytical framework of this study. As opposed to forecasting methods of predicting the future, backcasting is about working backwards. In a nutshell, backcasting is about setting a desirable final state for a system and then defining the necessary subgoals needed to achieve it. Ultimately, the main difference between forecasting and backcasting is that the former focuses on designing how desirable futures can be obtained while the latter works on figuring out futures that are likely to happen based on the current state of the system. In the specific case of participatory backcasting, future desired scenario is not set in a technocratic manner, but rather in a participatory and holistic manner; the desired future is not determined in advance by experts, but rather the desired future is a product of the different visions of the stakeholders engaged in the process.

Participatory backcasting is characterised by being participatory, normative, long term and consensus-building oriented. It is comprised of 13 modules or steps, which include:

1. Defining the problem
2. Setting system boundaries
3. Identifying the system´s current situation
4. Conducting a stakeholder analysis
5. Identifying needs and functions of the current system
6. Creating a joint vision that defines the desired future
7. Setting the criteria for measuring progress against that vision
8. Identifying external drivers that might affect the final state of the system
9. Formulating different solution configurations which yield the desired outcome
10. Testing the solution configurations based on the specified criteria
11. Selecting a pathway that is the most desirable to achieve the system vision
12. Designing a concrete and concise action plan to execute the chosen pathway
13. And finally, constantly monitoring progress towards achieving the system vision

Results from each module will follow in order.

4. Results

4.1 Problem orientation

Stakeholders have multiple understandings and hold different views towards the current status of Skellefteå mobility system. Researchers regard the problem in the mobility system from a broad perspective. For instance, the sustainable mobility paradigm, the possible actions and policies of sustainable mobility transition and sustainable mobility indicators, which concentrate on how to create and improve knowledge about sustainable mobility. The Swedish transport administration focuses more on the insufficient outer city travel means, lacking cycling infrastructures, and the transport sector’s environmental impacts. The municipality also put the problem of environmental impacts of the transport sector into a remarkable position, meanwhile, they were concerned about problems brought by industry and population growth,

like more transport demands, choices, and interactions with urban planning. In comparison, commuters regard the problem more from an individual perspective. They frame the problem as long commuting time and low accessibility.

From the perspective of Skellefteå development, if its mobility system maintains current conditions, some issues could arise. If the resident population of Skellefteå grows as the municipality expects, the current transportation system will be put to test, especially in the morning and evening rush hours, whether the public transportation could withstand the heavy traffic should be considered. Also, the growing population will be accomplished by the newly constructed residences. How to reconcile those new communities with the existing mobility system can be a big challenge. In addition, the municipality plans to introduce more companies and businesses into Skellefteå which brings new problems to the mobility system. The increasing travelling needs between Skellefteå and other cities or even countries can put pressure on the cross-city transport system, like intercity buses, trains, and planes. The lack of rails could be a big obstacle. Moreover, many residents are currently relying on cars for commuting which has already led to poor air quality in the city centre of Skellefteå. If people keep doing that, the problem will only get worse. Hence, aggregating key stakeholders' views towards current issues on Skellefteå's mobility system and the needs of Skellefteå's development, our study focuses on "Sustainable people mobility in Skellefteå by 2050".

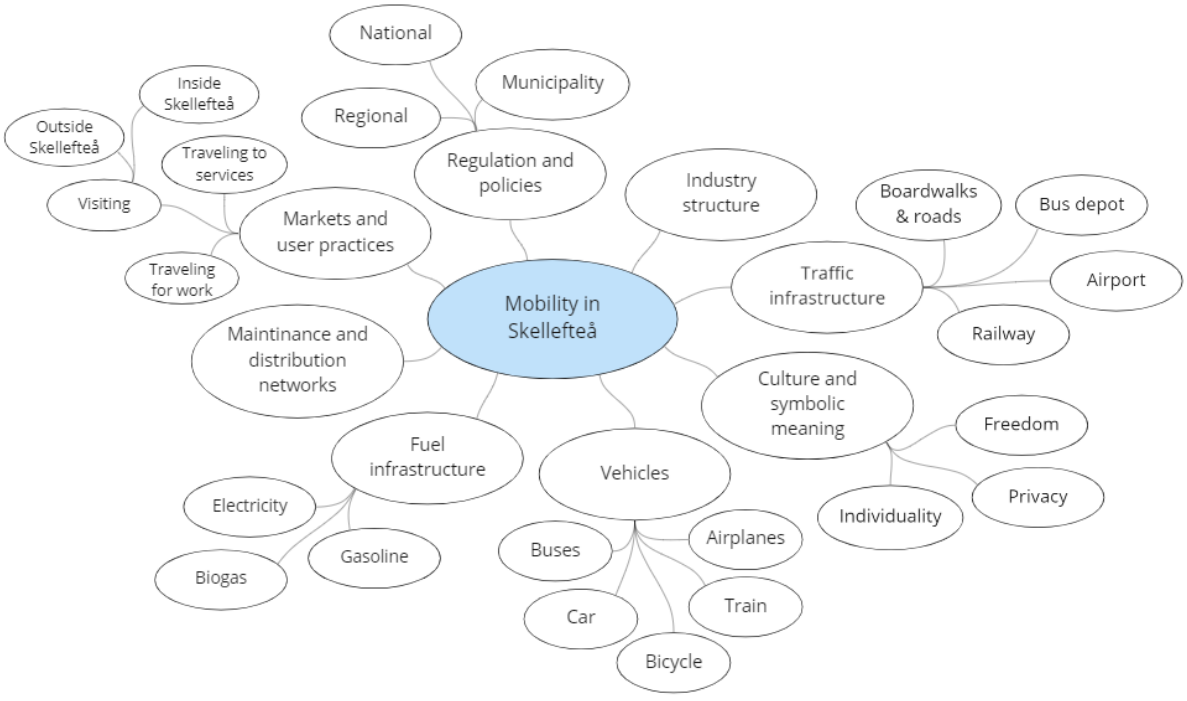


Figure 1. Sociotechnical system of Skellefteå mobility system.

Referring to the framework of transport system transition established by Auvinen and Tuominen (2014), the sociotechnical system of mobility in Skellefteå could be illustrated through transport system organisations, users, means of transportation, and transport infrastructure. Transport system organisations are responsible for proposing legislation and

regulation, managing financing and marketing events, and designing transport modes. Users with different transport habits, cultures, and behaviours have a direct experience of the system. Means of transport include all kinds of vehicles in the system, associated materials, consumed energy, and maintenance work. Transport infrastructure not only contains roads, stations, and terminals but also includes technologies, solutions, and regional structures which support the transport services.

Although the common understanding of the problem is developed as holistic as possible, there still are some limitations of this PB project, especially for stakeholder involvement. Everyone is a consumer of mobility, so everyone is the key stakeholder of this project. It will be beneficial to engage them in the whole designing process, however, due to the time and source limitation, the project group is not able to reach all stakeholder groups to conduct interviews. In addition, the major source of accessing information is the Skellefteå official website and the introduction and two interviews with the Skellefteå municipality which does not give totally comprehensive information about actual experience and measured real-life data and could possibly affect the feasibility of this PB project.

4.2 System boundaries

Skellefteå municipality wants to meet their citizens' needs for sustainable transportation until 2050. Skellefteå in this case refers to the administrative power which the municipality has, the geographical boundaries of the municipality and the citizens of Skellefteå. Citizens may want to travel to destinations outside of Skellefteå and vice versa are also included in this boundary. Whilst no transportation of goods will be handled in this report. 2050 will be the temporal boundary as that is when the goals of a sustainable Skellefteå are to be achieved. The technological components include vehicles, fuel infrastructure and traffic infrastructure.

As we are working from the perspective of Skellefteå municipality, parts of the sociotechnical systems which cannot be affected by Skellefteå municipality will not be assessed in this report.

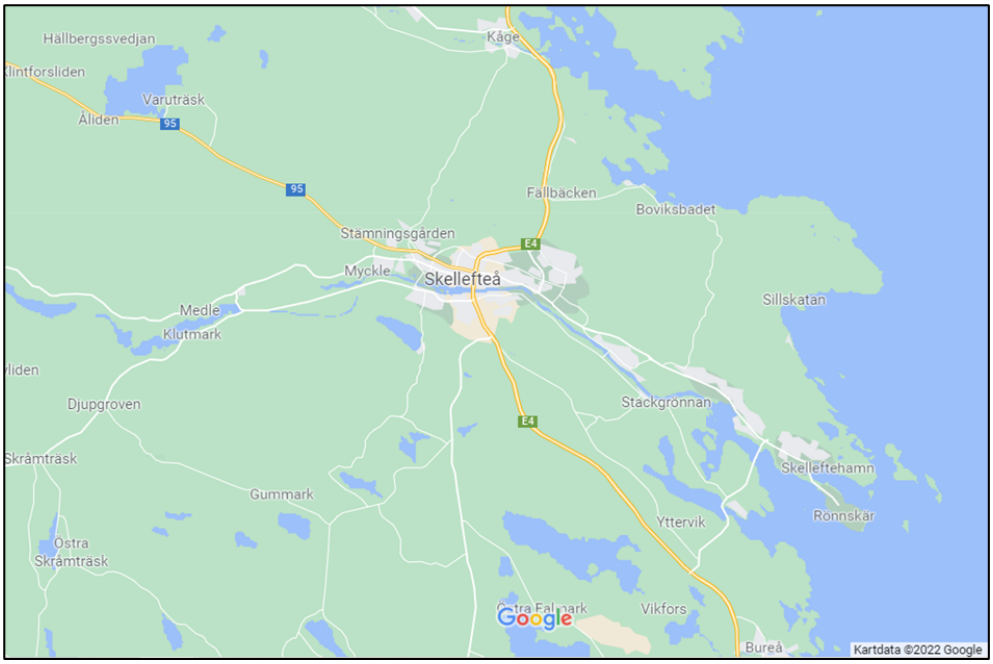
Some important actors and their relationships within the system:

- Trafikverket are responsible for building and maintaining state owned roads and railways. Citizens and the municipality may address them if they wish for a new road to be built. When planning on altering the traffic system, Trafikverket needs to be included.
- The current transportation system (on the ground) consists of private transportation via cars, bikes and buses. The bus system is run by the municipality owned company Skellefteå buss.
- The national, regional and municipal laws and regulations need to be abided by, by citizens, companies and even the municipality itself. The municipality has limitations such as needing to have a tender process to hire a company.

- Citizens provide taxes to the municipality and are the users of the public transport system. It is mainly their needs which needs to be met when considering system change. The citizens are the ones upholding user practices which may be influenced by companies or nudging campaigns by the municipality. It is the citizens which care most about the culture and symbolic meaning of the system.
- The new technology is being developed by privately or publicly funded researchers to be used by the companies which maintain the current system or sell vehicles. Researchers may also be found at campus Skellefteå which is part of Umeå university and Luleå technical university.
- Companies provide work for the citizens and taxes to the municipality. They need the citizens to travel to work and their production and operation upholds the system. Including fuel production and infrastructure and industry structure.

4.3 Current situation analysis

Skellefteå municipality is one of Sweden's largest municipalities seen to the area with a total population of 72 840 by the end of 2020 whereas 36 388 (50%) lived in Skellefteå city (SCB, n.d.). Meaning Skellefteå municipality has both a lot of rural areas and small suburban areas as well as a large urban area (Skellefteå kommun, 2020). The city is built by a river and has expanded along the river which ends in the Baltic sea, there is a port by the estuary for transporting goods. This has resulted in a very long city.



The Sami people are the only group of indigenous people in Europe which live in the northern connection of Sweden, Norway, Finland, and Russia including the area where Skellefteå resides. One important source of income and livelihood is their reindeer herds which require large areas to roam. Historically, their rights have been discriminated against by Swedish landowners who have forcefully taken their lands and killed their reindeer. While

the situation has become better, their voices are still not prioritised, and the effects of land use and climate change affect the reindeer herds grazing patterns (Sametinget, 2007, 2019, 2021). When discussing changes which affect the Sami people, they should be included in the process.

The demographic of Skellefteå is heavily affected by the municipality's history as a labour intensive city. This has resulted in many young people and women leaving for larger cities while leaving behind the male population and the elderly.

The north of Sweden has great potential for green and cheap electricity production, this combined with the fact that Skellefteå has its own electricity company has led to the municipality being one of the richest in Sweden. This has also attracted Northvolt to build a large battery factory in Skellefteå and need 3 000 workers. This will cause a grand expansion of housing and support structure in Skellefteå when as many as 10 000 people might be moving in.

Today (2022) Skellefteå only offers transportation by road and air, meaning the available forms of transportation are walking, cycling, by bus or by car. Skellefteå also offers an airport for travel in and out of the municipality. In fact, Skellefteå is the biggest city in Sweden without passenger rail services (Skellefteå kommun, 2020). Currently Trafikverket is working on the Norrbotniabanan project, a railway with the goal of connecting Skellefteå to both the north and south of Sweden by train (Trafikverket, 2021).

Different parts of Skellefteå's transport system are managed by different authorities with different administrative borders which need to cooperate to make the entire system work. Such as Trafikverket and the municipality are cooperating in the early stages of urban planning (Skellefteå kommun, 2020).

Skellefteå is affected by various action plans and goals from authorities on multiple levels. Sweden has the national action plan for traffic in the country and region Västerbotten decides and is responsible for the regional road network including the county transport plan. Skellefteå also has to follow local, national and regional objectives for the transport sector, for the environment, spatial planning and public health when planning expansions in the municipality (Skellefteå kommun, 2020). These are:

- National goals
- Regional strategies and plans
- Local goals
- Goals for Skellefteå transport system
- The four-step principle

Skellefteå has acknowledged several challenges within the municipality:

1. Skellefteå is a large municipality which means many are dependent on their car because public transport cannot serve all the rural areas and cycling opportunities are poor.

2. Skellefteå has a growing population even before the addition of Northvolt. Both old and new residents will need to travel to services, friends and loved ones and to work.
3. Travel in Skellefteå needs to become more sustainable in all three aspects, particularly by reducing the importance of the car and giving more sustainable and fast options to the commuters.
4. Planning in Skellefteå needs to be coordinated so urban planning and transport planning are interlinked to make sure inhabitants can sustainably get to their destinations.
5. Reducing negative impacts on climate, the environment and human health, this includes noise, air pollution and greenhouse gas emissions, again, mainly from the car.
6. More social aspects need to be accounted for to make an inclusive and equal transport system. Making sure everyone can access the transport system regardless of conditions.
7. Skellefteå lacks passenger rail traffic which limits travel times between cities. In turn, this improves education and work possibilities for the citizens of Skellefteå (Skellefteå kommun, 2020).

4.4 Stakeholder analysis

Before determining the vision of this project, understanding relevant actors in the system will be helpful to make the project more realistic, efficient, and impactful. Therefore, this section aims to figure out the ways to handle each stakeholder involved in the mobility development in Skellefteå, which will work as the guideline for each further step.

Following the Multi-actor Perspective (MaP) proposed by Avelino and Wittmayer (2015), stakeholders involved are categorised into four types of actors to help further discussion about their power and roles during the transition. The four actors are *state*, *market*, *community*, and *Third Sector*, and their power will be discussed based on the Welfater Mix Model (Evers and Laville, 2004; adapted from Pestoff,1992).

Starting from the top, *state,* including Skellefteå municipality, Västerbotten county, and the Swedish government, which are non-profit, formal, and public, has the power to determine the largest picture of the whole development. Especially, in our case, the Swedish transport administration, Trafikverket, is an important actor who belongs to the *state* sector working on the development of the national mobility systems. Second, *market,* which is also formal but private and for-profit, includes Northvolt, the local paper industry, and residential companies. Besides, municipality-owned companies like Skellefteå buss, airport, and Kraft are also considered, distinguished as a sector in between of the *state* and *market*, who are formal, public, but for-profit. Next, *community*, which can be considered as the user of the mobility system, has the properties of private, informal, and non-profit. Although there is an empirical result showing that regimes, including dominant actors in *state* and *market,* have more power than niches, small entrepreneurs in *market* and *community*, the power dynamic between ‘citizens’ and ‘authorities’ gives *community* a non-negligible power in the transition (Avelino

and Wittmayer, 2015). Finally, the *Third Sector*, referring to *labour unions, NGOs,* and *science* (Avelino and Wittmayer, 2015), acts as intermediary and has dynamic characteristics along with the development. In our case, the most relevant sector is *science,* which can be local or international academic institutions, universities, researchers, etc.

Fig. 2, the power and interest grid, shows the relationship among the stakeholders. Since the dominant mobility companies in Skellefteå we take into consideration are all municipality-owned, only they are considered as high power on the grid. Their interests are determined based on their focused area of work.

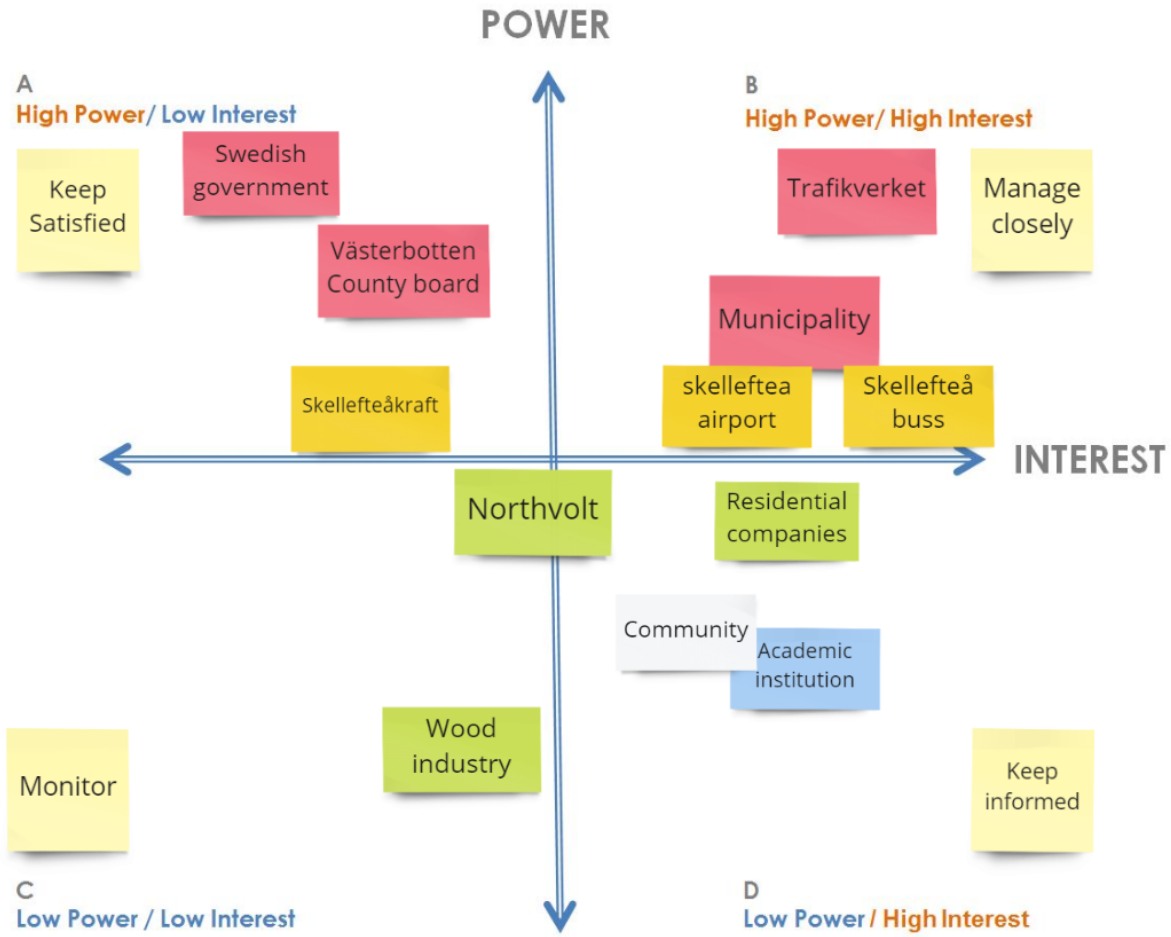


Figure. 2 Power-Interest grid of stakeholders related to Skellefteå's mobility transition

From the grid, we understand that:

1. Our vision should be consistent with the visions from each authority-related actor.
2. Actors in the right-upper corner of the grid have control and most of the resources related to Skellefteå's mobility system. That is, they are the actors we need to manage closely.

3. Private companies don't have formal power in the mobility transition but those whose businesses are highly dependent on the mobility system will have a high interest in the transition. Therefore, they could be considered as potential resources in our project.
4. Although 'community' is located in the right-down corner of the grid, they are the users of the system, which means that we should not only keep them informed but also dig into them while not disturbing them.

It seems that the stakeholders are many and most of which are not available to connect. However, in our case, half of the stakeholders are municipality-owned, meaning that municipality is the stakeholder we should pay more attention to.

4.5 Needs and system functions

To think about mobility from a broader perspective, this section is to dig into the core reason why people need a mobility system. As our target users, *community* will be the focus of this investigation, determining the main functions of the system. The analysis will take the *community* sector as a whole to understand the general need of people, which will be used to decide the basic function of the mobility system.

As a start, the question of why people need transportation systems should be answered. Or more generally, why do people need mobility? Based on Maslow's Hierarchy of need (Maslow, A. H., 1943), people's need related to mobility is summarised in Table 1.

Table 1. People's needs related to mobility

Maslow's Hierarchy of need	Example
Physiological needs	Food, clothes
Safety needs	Work, education, administrative services, health cares, feel safe, healthy environment
Love and belonging needs	Friends, family, sense of connection
Esteem and Self actualization	Confidence, achievement, experience (sports, nature, travel, entertainment, ect…)

From the table, the core of the needs is then distinguished as the necessity to access different things to fulfil their life. The things people need to assess can be physical stuff, services, atmosphere, or functionality. At the same time, the need to feel safe and have a healthy environment should also be considered, providing the important quality of the system. Therefore, the general function of the mobility system is determined as "enabling accessibility in a safe and sustainable way to help people fulfil their life".

Accessibility can be enabled by either the mobility of humans or the needs. Even though the mobility of the needs might change dramatically to make the physical movement of humans won't be required, physical interaction among people is believed to be necessary still as humans are social animals. Therefore, in this project, we still focus on the physical mobility of people, but at the same time, keep in mind that the needs and the ways to access the needs can be changed along with the development.

4.6 Future vision

Generally, the extreme vision for a mobility system we believe is "A world that seems small". Narrowing down to Skellefteå, in addition to aim at the vision of "A Skellefteå that seems small", the vision is specified in order to be in line with the most important values from the local community and the visions from the authorities.

Keywords for ideal mobility based on the local condition of Skellefteå are shown in Table 2, and are clustered into three core criteria.

Table 2. Keywords for visions.

Important criteria	keywords	descriptions
Accessibility	Easy to access	Users can access the system without problem
	Efficient	The whole experience should be efficient enough so that people will be willing to access the system
	Fast	Users can access the system without being time-consuming
Sustainability (social/environmental/systemetic)	Comfortable	The experience should be comfortable enough so that the system can have reasonable usage amount to keep operating. Not only physically comfortable like whether the carriers are running stably or whether the chairs are soft but also whether users are mentally fulfilled during the whole using experience.
	Equal	Everyone should have equal accessibility and user

		experience no matter who they are so that the system is worth keeping running.
	Affordable	The system should be affordable so that the system can have reasonable usage amount to keep operating.
	Healthy and safe	The system shouldn't pose negative influences on people's health and safety. Therefore, the pollutant generated while running, the inconvenience caused by construction process, or the risks due to the energy generation all need to be considered.
	Environmentally friendly	The system shouldn't pose negative influence on the environment. Therefore, the pollutant generated while running, construction process, or from the energy generation side are all important to look at.
Flexibility	Adjustable	Due to the fast development and transformation of a city, it's better to make the system adjustable and flexible when it comes to different scenarios and developing plans.
	Robust	One important criterion to make mobility robust is flexibility. This can also enhance accessibility and sustainability in some ways.

Therefore, summarising everything we have above along with the system boundary determined in the previous section, the vision of our project is formulated as "Sustainable, accessible, flexible mobility for Skellefteå by 2050".

4.7 Criteria

Deriving from the future vision of Skellefteå transitions, three key elements of the vision, environmentally friendly, accessibility, and flexibility become the major criterion of the transition. Aligning with the vision of Skellefteå transitions, we get inspiration from globally recognized sustainable transport indicators from UN Sustainable Development Goals and related literature. Table 3 presents the criterion and their associated sub-criterion with measuring methods and sources, which correspond to the current state of Skellefteå.

Table 3. Criterion and sub-criterion of the Skellefteå transition

Sustainability			
Criteria	Sub-criteria	How to measure	Sources
Environmentally friendly	Air pollution	Emissions of local air pollutants (CO, NO_x, VOC) per capita	(Haghshenas and Vaziri, 2012)
	Energy consumption	Transport energy use per capita	(Haghshenas and Vaziri, 2012)
		GHG emissions (CO_2, CH_4) from transport per capita	(Haghshenas and Vaziri, 2012)
	Noise pollution	Population exposed to noise[1] >55dB	(Haghshenas and Vaziri, 2012)
Accessibility		Sum of transportation systems for every citizen passenger, km per area	(United Nations, 2021)
Equity		Quality of transport for disadvantaged, disabled, children, non-driver[2]	(United Nations, 2021)
Affordability		Average daily user cost over GDP per capita (‰GDP per capita)	(United Nations, 2021)
Flexibility	Mobility variety	Sum of mobility option vehicle per capita divided per maximum of that option vehicle per capita	(Hall, 2006)

1. The noise source is transport noise.
2. Considering that personal experience and feelings are important for criteria “Equity”, so we choose a qualitative way to measure it.

4.8 Driver analysis

Outside of the transportation system of Skellefteå are driving forces which affect the decisions within the system. Skellefteå, being a city in Sweden and therefore in Europe may be affected by European trends such as urbanisation, decrease in overall population, ageing population, gender equality, automatization of jobs, EU fragmentation and change in security (UK Ministry of Defence, 2018). While some of these are relevant to Skellefteå, others are too general to be of significance in relation to mobility and will therefore not be assessed.

Much emphasis is being put on creating a circular economy in the EU, making sharing economy practises more normal. While this is mainly an internal driver, there are external incentives to implement a circular economy which puts pressure on Sweden and Skellefteå (European Commission, n.d.).

Swedish external drivers include national population change which is expected to increase to 13 million by the year 2070 (SCB, 2021). Sweden has a long history of environmental protection and ambitious sustainability goals which most likely will continue (Swedish Institute, 2021). However, looking at the follow-up of Sweden´s sustainability goals, it is clear that the progress is very slow. Making it uncertain if they will be reached unless more action is taken (Sveriges Miljömål, 2021), depending much on the willingness of politicians.

Climate change will with all certainty continue to be a trend far into the future even with great mitigation actions. While there is little uncertainty regarding the phenomenon itself, the extent of the effects of climate change are less clear. We only know climate change increases the risk of droughts, floods, extreme sea levels, heatwaves, coastal Impacts, glacier and permafrost melting, geomorphological and geological Impacts, and seasonal/biological changes. Skellefteå, being a city in the further northern part of the hemisphere, is particularly vulnerable to global temperature changes, which are more extreme towards the poles (Easterling et al., 2012).

The Covid-19 pandemic has introduced new trends and accelerated many present ones. Such as the deglobalization trend, as governments wish to become less interdependent, or the digitalization trend by moving social activities and retail online, making it harder for smaller businesses to establish and transform long-term jobs into short-term because of the increasing unemployment. While many functions will require more digital platforms such as remote education, medical advice and remote work will become more common, other functions require physical presence like grocery shopping. This has sparked a boom in grocery delivering services which require no contact and delivery by robots. Socio-economic differences may also increase such as digitalization disconnecting the elderly from the rest of society and the increased ratio of short-term jobs primarily affecting the youth. Finally, the relationship between citizens, businesses and the government might change (Centre for strategic futures, 2021, p. 42-47).

Covid-19 also taught us that pandemics are not as rare as we may think. The possibility of a pandemic of this size may be 2% in any year and that possibility will likely grow three-fold in the next few decades. Some important factors for this increase are population growth, changes in food systems, environmental degradation and more frequent contact between humans and disease-harbouring animals (Penn, 2021).

In the case of Skellefteå, the construction of the Northvolt factory is expected to create 3000 job opportunities and a potential for 10 000 to move in. The influx of people might also change the demographic of Skellefteå which has a disproportionate ratio of men and elderly. With these factors being dependent on the success of the Northvolt factory. The success of

Northvolt may be affected by both internal and external drivers but one such external driver is lithium batteries becoming obsolete.

Additionally, some general drivers have been fetched from the mPD manual, namely Change in demographic and Political will for change in the transport sector at national level and technological trends (self driving cars) (Urban Analytics and Transitions, n.d.).

Following drivers will be assessed which are depicted in figure 3:

- National focus on sustainability transition
- Automatization of jobs
- Climate change
- Urbanisation
- Digitalization
- War
- Effects of climate change
- Lithium batteries becomes obsolete
- Change in demographic
- National population change
- Deglobalization
- Political will for change in the transport sector at national level
- Pandemics
- Sharing economy
- Reaching sustainability goals

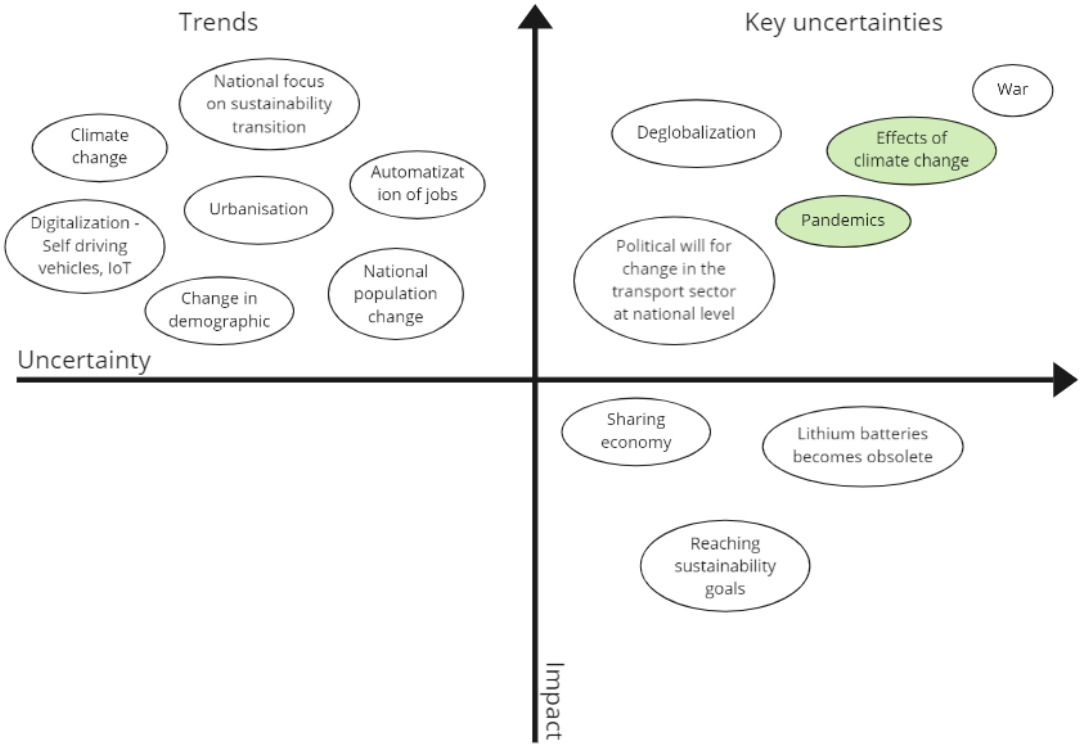


Figure 3. Drivers have been assessed in an impact-uncertainty analysis where two key uncertainties have been chosen to be used in developing external scenarios.

Effects of climate change and pandemics have been chosen as the most interesting key uncertainties for the mobility of Skellefteå. With both having the possibility to impact the mobility system profoundly. Starting with the effects of climate change, the increased likelihood of extreme weather events may increase the risk of delays, disruptions, damage,

and failure of the transport system (EPA, n.d.). Regarding pandemics, the effect Covid-19 had on the transportation system included many social, economic and environmental aspects such as more people losing their jobs than other industries and also prevented minority groups from working more than others (Mack et al., 2021).

There are some potential co-effects from the combination of pandemics and effects of climate change that needs to be addressed as well. With increased levels of climate change, many factors change which increases the likelihood of a pandemic. Mostly by allowing species which wouldn't usually interact to meet, which creates an opportunity for pathogens to spread to new hosts (Harvard Chan C-CHANGE, n.d.). There may also be a risk of increased spread of the pandemic when in a catastrophe situation. These effects are depicted in figure 4.

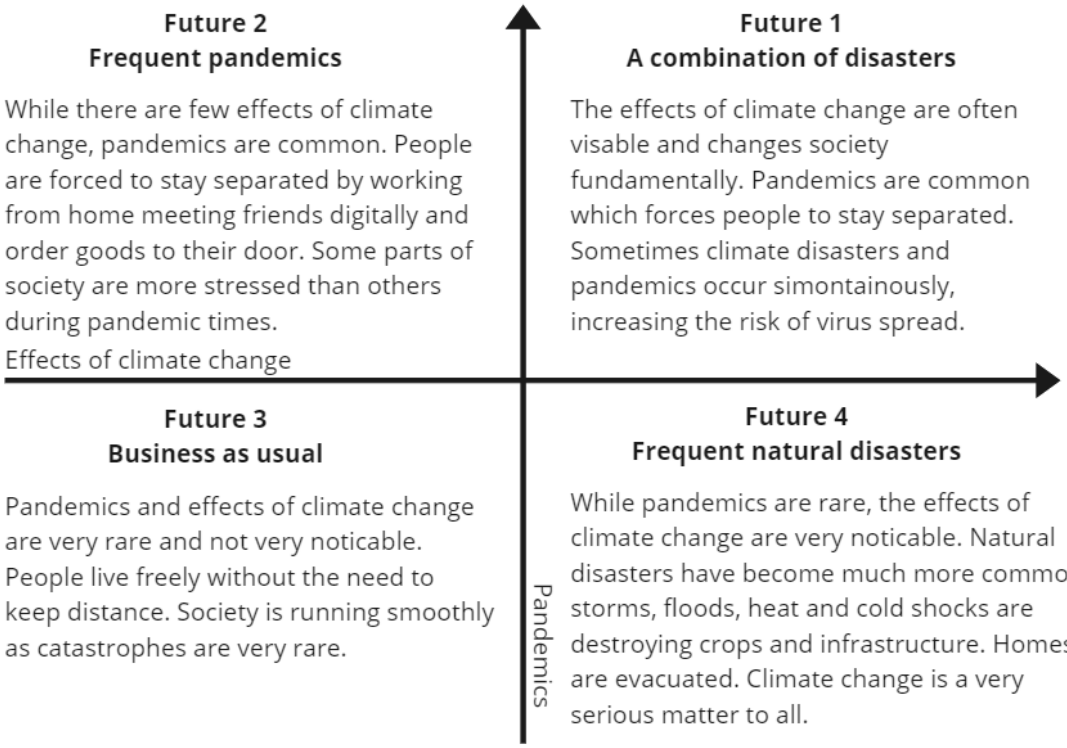


Figure 4. Four external scenarios or futures have been developed from the two key uncertainties.

4.9 Internal scenarios / solutions

After understanding the external drivers, this step is to picture the solutions, which are the possible future scenarios by extrapolating from the current condition. Solutions are the theoretically achievable future with alternative sociotechnical system configurations. Table 4 shows the dimensions that we think can be reconsidered for the mobility transition.

Table 4. Dimensions to be used to derive internal scenarios/solutions.

Dimension	Description
Variety of options	The system is formed by a single type of transportation or by several types of transportation? For example, aiming to make a very robust bus system; or aiming to complete the system by cars, bus, metro, train, boat, etc...
Level of sharing	How are things shared in the system? Is the system based on people's privately owned carriers (private cars or bicycles)? Or the carriers are publicly shared and people take turns to use them (like shared bicycles)? Or do people share the space on carriers (like bus or train)?
System control	Does the system operate under centralised control or run decentralised based on local communication?
Variety of delivery	What can be delivered? For example, is the system focusing on human mobility or it's a system that can deliver food, products, or even services and experiences.
City infrastructure	Is the city infrastructure built tightly or sparsely? What is the most common average distance to daily travel?

Based on these dimensions, potential solutions we come up with are:

1. Shared economy 2.0

   The solution aims to make a system where people's need for accessibility can be fulfilled without the need to own their own private transportation. Transportations in the system are all shared, either owned by the municipality or by a company. The method considers a low variety of delivery, and might be more suitable for a tight city.

2. Very connected system

   The solution pictures a system with each transportation well-connected, which can be either physically connected or time-matched. In this case, both shared transportation or public shared ones can work; and also the control method can be adjusted based on different needs. This solution focuses on the mobility of humans, and it doesn't matter whether the city infrastructure is tight or sparse.

3. Private owned busy city

   This solution is similar to our current system, where various transportation, both private and public shared ones, run simultaneously everywhere.

4. High accessibility from home

   This solution focuses on the mobility of things except for humans. Things from products, services, to even experience can be accessed from home, meaning that the mobility for humans will be minimised. This realisation might involve digitalisation and a new type of mobility system designed based on objects, which could be different from what we have, the human-based system.

Each solution puts strength on different dimensions, making each of them fit more in certain scenarios. For instance, *high accessibility from home* works better during pandemics compared with the case of *shared economy 2.0*. Therefore, investigation into how each solution works in the future scenarios, especially unpredictable ones, can help us figure out which could be the most robust solution that can fit most of the possible scenarios.

4.10 Scenario testing

After generating all possible solutions, testing against criterion and robustness testing should be done to ensure the final solution corresponds to the future vision and is capable of resisting abrupt changes. Implementing multi-criteria decision analysis, all solutions are rated through group discussion according to five criteria aligning with the vision. Different weighting coefficients are given to criteria. As Table 5 presented, the result of testing against criteria shows that a "Very connected system" is the best solution. However, for individual rating scores, the "Very connected system" solution does not act well in "Equality". Although the

integrated scores of "Shared economy 2.0" and "High accessibility from home" are lower than "Very connected system", they behave better in "Equality".

Table 5. Multi-criteria solution evaluation

Weight	Criteria	Very connected system	Shared economy 2.0	High accessibility from home	Private owned busy city
28%	Environmentally Friendly	4	4	5	3
30%	Accessibility	5	3.5	3.5	4
16%	Equality	3.5	4	5	3
16%	Affordability	5	4	5	3
10%	Flexibility	5	4	3	5
100%	Total	4.48	3.85	4.35	3.5

Until now, all criteria considered are in the system boundary. However, the final solution for future transition also has to consider impacts from uncontrollable external factors. By conducting robustness testing, we could see all solutions are not sufficiently resistant to unpredictable variations. In comparison, the "Very connected system" solution could confront most future uncertainties and has the best behaviour in future 1 and future 4 among all solutions but has vulnerabilities under "Frequent pandemics" and "Business as usual" situations.

The "High accessibility from home" solution could also cover most of the future plane, but confronts the risk from impacts of severe climate change. It is highly reliant on delivery services. When severe climate change results in huge changes in geographical level, delivery services which are based on the road or air transport could be trapped. How to meet people's basic daily living goods' needs is one major challenge for this solution. The two remaining solutions are only suitable for half of the future plane. The "Private-owned busy city" solution is more like the current mobility system which could meet some needs of the future with severe pandemics but may behave inflexibly and inefficiently. Vehicles are owned separately, so the ability to rapidly adapt to the emergent situation could be weakened. On the contrary, the "Shared economy 2.0" solution fills in this gap but faces other dilemmas, especially for the future which is highly affected by climate change. The principle of a shared economy is making various properties and items fully used according to people's different demands at different times. Because of this, when people have the same needs at the same time, the capacity of the shared economy will be challenged. There is a high possibility that this system will crash.

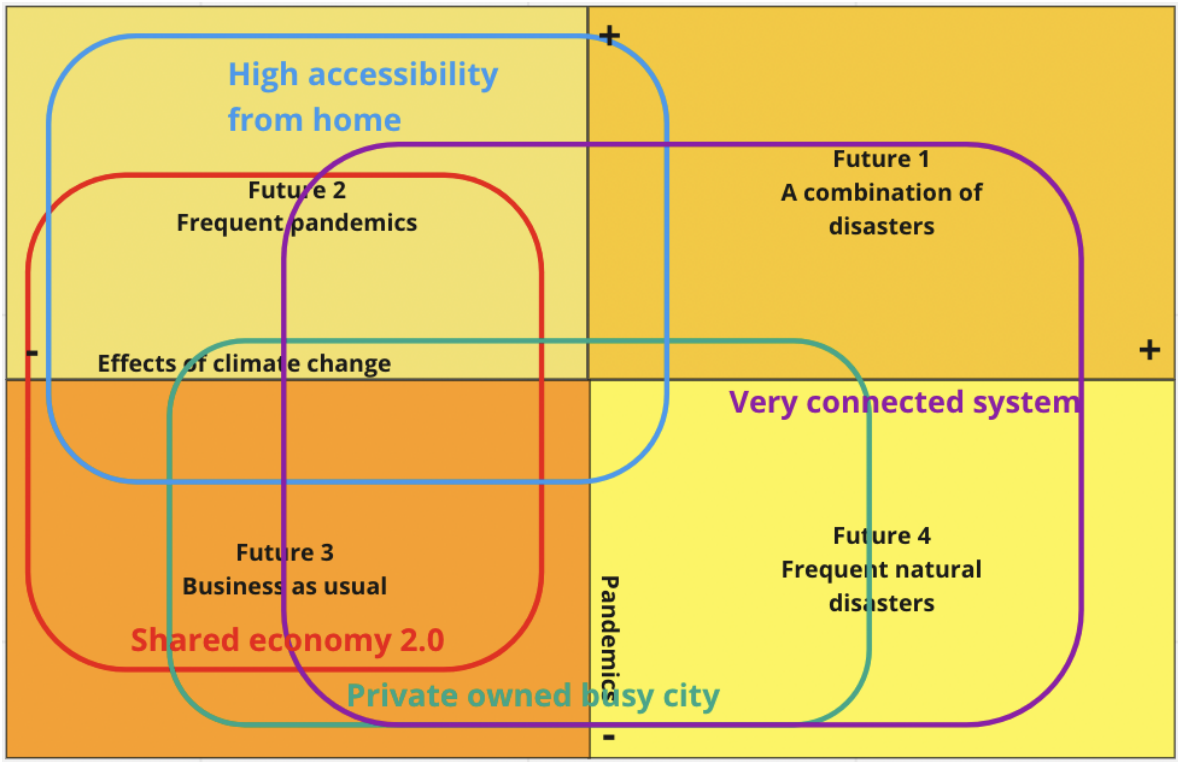


Figure 5. Solution Robustness Testing

4.11 Final combined scenario for implementation

Hence, the solutions we come up with still need improvements and combinations to make the final solution adjustable, robust, and resistible. After the solution testing against the criterion, the “Very connected system” turns out to be the most appropriate one. Then, the final solution will be figured out based on the framework of the “Very connected system”. For the “Equality” criteria against which it got a low score, the “Shared economy 2.0” solution could be referred to improve its performance on special needs of those in vulnerable situations, like persons with disabilities, older and injured persons. When confronted with uncertainties and risks, improvements could be done for the “Very connected system” solution, especially for the ownership of vehicles. Vehicles owned by individuals can be easier to meet people’s needs of hygiene and safety when disasters or pandemics occur, while vehicles owned by the government or governmental controlled enterprises can be more flexible when facing unpredictable events. The limited sources could be dispatched efficiently. Aspects from insights brought by external uncertainties, there is also a need to focus on the risks arising from unique characteristics of the solution. Here it is the highly digitised platform which may cause the problem of privacy security. Robust policies and regulations are supposed to propose to standardise the way of dealing with used personal information. Likewise, facial recognition doors and security cameras could be equipped to maintain the safety after broadly asking for stakeholders’ opinions, especially commuters’ thoughts.

4.12 Pathway for implementation of the final combined scenario

To be able to fully implement the system, several changes need to happen on a cultural, structural and institutional, and technological level both before and after implementation. Different available stakeholders can help provide different strategies and need to be involved in each change. The solution testing also gave us insight into opportunities and challenges an uncertain future may provide. Such as a risk assessment having to be carried out with bigger focus on the systems adaptability to effects of climate change.

The municipality will be owning the company which will run the system and can provide plenty of opportunities in easing the implementation of the system. Such as providing subsidies for the system until it is in place, implementing policies which aid the system, help industry start-ups for manufacturing parts to the system and help companies in the repair service market, public procurement for construction of the system hub and charging pathways.

The researchers will be responsible for developing the new technology whether they are from an institution or a company. Much of the technology for the system is already being tested such as self-driving vehicles, highways which charge electric vehicles while moving and communicating AI. The challenge may lie in the technology which allows for physically connecting vehicles, which may connect and disconnect at will and while moving.

Campus Skellefteå offers opportunities with regard to the studies carried out there. Such as UX and game designer students potentially helping in developing the app for the system. Much focus has been put on wood construction and the students working in the wood technology program may help design the hub for the system in a wood exterior. Finally, the machine engineer students may help researchers with system implementation and infrastructure. With such a specialised system where Skellefteå is at the forefront of developing, campus Skellefteå could also provide education for building and repairing the system in the municipality or elsewhere.

Skellefteå buss can be a valuable asset as they are already a municipality-owned transportation company with a lot of experience with transportation in Skellefteå. They may be a bus company, but with the future perhaps replacing buses for this new system, them being the operating company for the new system gives them a new purpose.

The citizens will also be important for the implementation of the systems as they need to learn and adopt the system. As the system is for them, it is crucial that their voices are heard to make sure their needs of transportation can be met by the new system. The new system will mean an entirely new way for the citizens to travel which will require a new mindset, especially toward sharing rather than owning the vehicle.

Miscellaneous changes include union start-up for the system, and the creation of specialised companies in the market for repair services and manufacturing parts. All changes have been summarised in table 6. Additionally, more studies on how the mobility system can increase

equality, accessibility, flexibility and decrease environmental impact may need to be conducted to make sure the system is as optimised for the citizens of Skellefteå and the environment as possible.

Table 6. Summary of changes to implement the system.

Cultural changes	**Stakeholders**
Learning how to use the new system	Citizens
Change in mindset toward sharing rather than owning	Citizens
Change in mindset how to prepare for travel	Citizens
Unions and associations for system	Citizens, Municipality
New education for building and repairing system	Municipality, Campus Skellefteå
Structural and institutional changes	**Stakeholders**
Skellefteå buss transformation	Skellefteå buss
Build-up of operating company for system	Skellefteå buss
Subsidies for the system until it is in place	Municipality
Implementation of policies which aid the system	Municipality
Help industry start-ups for manufacturing parts	Municipality
Specialised companies in market for repair services	Market
Construction of system hub and charging pathways	Municipality, Skellefteå buss, Campus Skellefteå
Technological changes	**Stakeholders**
Development of self-driving vehicles	Researchers

Development of new ordering system app	Researchers, Campus Skellefteå
Development of charging infrastructure for moving vehicles	Researchers
Development of connecting vehicles	Researchers
Development of communicating AI	Researchers

These changes and the additional study must be done in a specific order as some changes enable others and therefore need to precede them. In figure 6. The changes and the study are placed upon a timeline from 2022 to 2050 which give an approximation of when and in which order the changes are to be implemented.

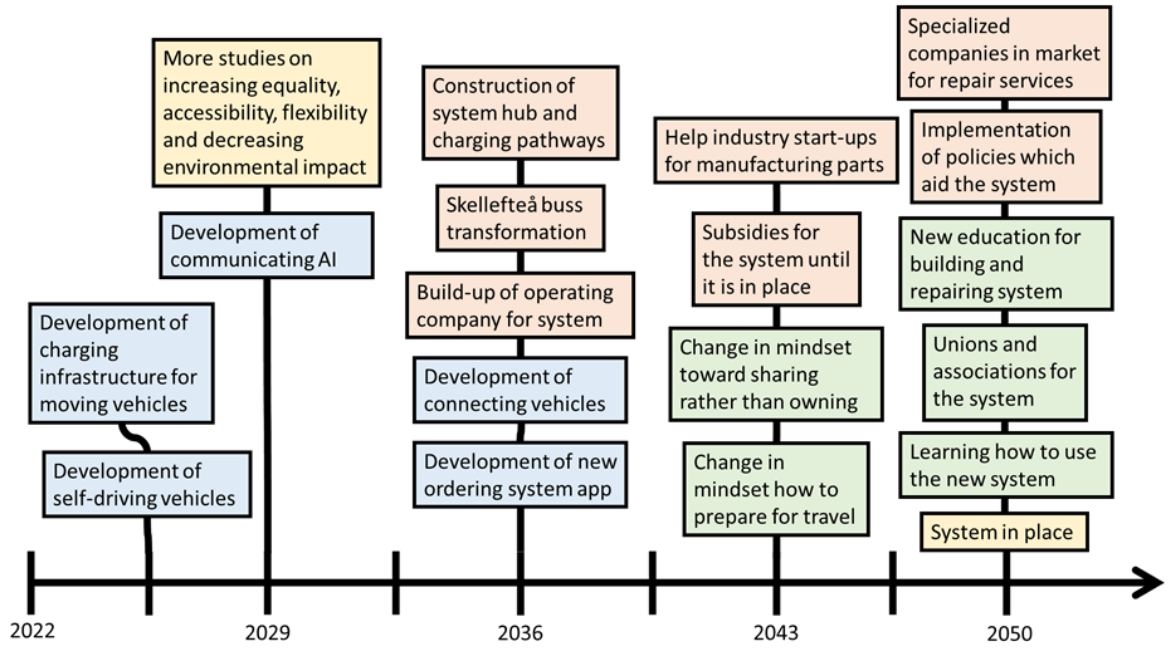


Figure 6. Timeline of changes and studies from 2022 to 2050. Blue boxes represent technological changes, orange represent structural and institutional changes and green represent cultural changes. Yellow boxes represent a study and when the system is in place.

4.13 Experiments

Usually, the pathway is followed by an action plan and follow-up in the typical modular participatory backcasting procedure. However, this report will instead recommend five experiments based on the pathway which have been designed to kickstart the transition toward the new system, these are shown in table 7.

To aid the experiments and start-up of the system project, some supporting structures may be useful. Social media will be one such important supporting structure which makes it easier for citizens, as well as other stakeholders, to partake in the experiment and experiment results. Some experiments enable others and must therefore come before. One of the first experiments to be conducted is the use of questionnaires on social media to find people's needs and make sure everyone feels involved. This then prepares for the next experiment of educational videos/VR interactions to visualise what the system may look like and how it would function.

Another such example is to test parts of the concept by using the existing bus system. Before even considering the implementation of the system it is preferable to see if the concept works. This can be tested relatively early, which is preferable because it enables the next two experiments. One of the second phase experiments is the system test, where learnings from the test by the existing bus system are incorporated to make the system better adapted to suit the needs of the citizens. The other second phase experiment focuses on the system collaborating with important destinations such as big companies with specific work schedules, where the learnings from the first experiment are the basis for the collaboration potential and company interest in the system.

These experiments require the involvement from several different stakeholders which need to cooperate as the experiments are based on learnings from each other. To ease this, campus Skellefteå will be the supporting structure with the responsibility of easing and guiding collaboration between responsible stakeholders for these experiments. The aim for campus Skellefteå being the supporting structure is that they may enable reflexivity and learning from the experiments by easily transferring information between stakeholders and experiments and by institutionalising the experiment results and their impact on system transitions.

Table 7. Experiments to ease the implementation of the system.

Experiment 1. Questionnaires on social media	
Field:	Culture
Date to begin/ Due date:	2034 - 2039
Responsible:	Skellefteå municipality & campus Skellefteå

Description:	Questionnaires will be sent out on social media with the aim of gathering information about what people from both rural and urban areas want a new system to achieve. This includes the potential importance of the system being able to travel far into the rural areas, economic concerns, meet the needs of people with different kinds of disabilities, and being able to transport reasonably sized luggage or items. As this is the first interaction the citizens will have toward the new system, it also seeks to understand people's attitudes toward sharing transportation and their need for privacy. Hopefully, people's attitudes toward a new system will be more favourable if they are involved in the creation of the system. The findings from the questionnaire will help shape the system and provide the informational basis for experiment 2 and 3.
Experiment 2. Educational videos/VR interactions	
Field:	Culture
Date to begin/ Due date:	2039 - 2047
Responsible:	Skellefteå municipality & campus Skellefteå
Description:	The results from the questionnaire in the previous experiment will help shape the system and create a visualisation of what the system may look like in the future, either through videos or VR interactions. The aim of the experiment is to introduce and educate people to and about the new system, when it will be in place and how it will work. The result of the experiment should be that more people can give final input based on the new knowledge they have on the system, but also be more prepared to use the system when it is implemented.
Experiment 3. Test by existing bus system	
Field:	Technology and culture
Date to begin/ Due date:	2036 - 2043
Responsible:	Skellefteå buss

Description:	The experiment tests the operation of the new system using means available before the system is implemented and will provide the basis for the next two experiments. The experiments let people try out the new app to order a car or small bus to fetch them and other nearby people who wish to travel and take them to their destinations, much like a taxi service but shared. Routes are planned after people have booked their trips, much like some garbage collection systems where full bins report to the central via the internet when they are full. There should also exist an opportunity to try booking a spontaneous trip, with the waiting time for that service being monitored to investigate reasonability. The results from this experiment should be information about the system operation feasibility and on people's willingness to change behaviour to plan their trip further in advance than usual.
Experiment 4. System test	
Field:	Technology
Date to begin/ Due date:	2043 - 2050
Responsible:	Researchers, Skellefteå municipality and Skellefteå buss
Description:	If the previous experiment is successful, further development of the system can proceed and a system test experiment may be performed. This experiment represents a critical system test in a lab environment and in the smaller scale of Skellefteå city centre. The lab experiment results will yield information about whether the technology can operate in both ideal scenarios but also under environmental stresses such as different temperatures, different weather, and uneven terrain. While the small-scale test in Skellefteå city centre will reveal whether the system can operate safely in the real world and when exposed to different stresses, such as maintaining safety while carrying large luggage, pets, or objects, if it can serve people of all functional variability and handle complicated travel routes, as in if the system may plan routes and transport people as expected.
Experiment 5. Initiate collaboration with important destinations	
Field:	Technology and structure/institutions
Date to begin/ Due date:	2043 - 2050

Responsible:	Skellefteå municipality, Skellefteå buss, big companies, and other organizations
Description:	When the two previous studies are completed or well on their way, the last experiment of collaboration with important destinations may start. The aim of this experiment is to initiate collaboration between the system and important destinations such as big companies or other locations for work or activity run by an organisation. The collaboration makes sure the system and destinations adapt to each other to ease the use of the system at that location where many may travel to or from. One example of this could be a big company far into the countryside with specific work hours having use of the system vehicles waiting outside the facility, so that the employees who are done working for the day do not need to wait for the system to arrive. This will hopefully result in more stakeholders favouring the system and easing its implementation.

5. Discussion and Conclusions

The process of mPD even in this smaller project has been very educational. Both regarding the collected method of mPD to be used on a large scale, but also the methods and learnings of the individual processes being very useful in other projects which either use mPD or something entirely different. One example of such a learning is the importance of brainstorming each module together before giving out tasks, this makes sure everyone is on the same page and provides much better creative opportunities for each module. While it is possible to make deviations from the method in the manual, we have chosen not to do so. Following this section comes learnings and reflections from the modules one by one.

At the beginning, the group had a hard time generating the exact problem due to the limited background information about Skellefteå. Thanks to the introduction seminar, the municipality introduced initial problem formulations from their side. Combining with other information from official websites and social media, we figure out our key problem. During the process, reminders from the “Problem Orientation” module were really useful. We are often inclined to narrow down the problem unintentionally, like “Whether the energy source is renewable or not?”, “Are the means of transportation diverse enough?” and “If it is possible to commute by drones?”. While the manual inspires us to think broadly and try not to directly focus on solutions and details. The common understanding of the problem is supposed to be open-minded so that there is enough space for further discussion and the implementation of other processes.

The system boundary requires limitations to be set across multiple different dimensions. Besides the usual geographical and temporal boundaries, boundaries also have to be set for administrative, sectorial, social components and technical components. The boundaries which were set for these proved easier to convey in a socio-technical system illustration rather than

in text. Much has been learned from having to include the latter dimensions to boundaries. It is apparent in mPB that geographical and temporal boundaries are not enough which has created a perfect opportunity to learn how to widen one's views, instead of just assuming that the other boundaries sort themselves and create problems down the line.

The current situation analysis was relatively easy to understand and complete in comparison to other modules. This is reflected in the manual as well as there is barely no information on how it's to be conducted, not that it was necessary. That said, it is still one of the more important modules as none in the group knew anything or very little about Skellefteå. Skellefteå has many special properties which makes them unique in comparison to other municipalities. Including its location, size, demographic and customs. Making it a relatively good case for learning how to include these properties when planning a radical change in a municipality, especially in contrast to a big city like Stockholm.

Stakeholder analysis is a big task, and difficult to deal with especially in the early stage as all of us are unfamiliar with the city, which is also the reason why it's important to understand the stakeholders. It wasn't until the solution step that we turned back and reconsidered the stakeholders. This time, we know more about the city and have a clearer idea of what to look for during the analysis of the stakeholders. Instead of only understanding their power, interests, and perspectives, we also tried to distinguish their relationship and interactions, some of which are invisible but important to push the transition. The structure of the individual within the system is complex but the theory in the literature provided us a clear guideline to cluster the stakeholders and distinguish the dynamic among them. The most important takeaway from this step is that we understood how to deal with all the players involved in the system transition and how to use them as resources to push the transition. This analysis could be done better by dividing each sector of the actors into many specific roles. For example, *community* can be categorised into 'commuters', 'elders', 'singles', 'parents', 'kids', etc, which can improve the robustness of the system by covering more specific needs from them.

Understanding the needs and functions really helps formulate the key function of the system. Before doing the analysis, we thought about mobility systems only from the aspect of how to move people based on the currently existing system, which is quite limited. Although in the end we still focus on delivering people themselves instead of figuring out another way to enable accessibility, the result made us understand the core purpose for the system and was kept in mind throughout the process. In addition, the analysis stimulates us to think about the different needs of individuals with various roles, which is a good way to improve the robustness of the system. In short, we find this step very useful since it prevents us from thinking directly about the solutions, and forces us to pause, step back, and think deeply into the core of the problem, which works as the guide to keep us moving toward the correct direction.

Forming a vision is quite a difficult step, especially for the first time, we were not clear about how specific or general a vision should be. Sometimes, it's easy to mix up vision and solution, which might limit our thinking since solution implies the extrapolation of the

current trends. The method of brainstorming the keywords does prevent us from thinking about the improvement of the current system, instead, we focus on the concept of a mobility system itself. Generating one concise sentence as a vision to cover every keyword is nearly impossible since each word has its unique meaning and scenario. Therefore, we try to figure out the connection between each word and the system and pick up the words that's both robust for mobility and in line with the vision of authority. In the end, we understand that the vision should be broad and not specific but with a clear system boundary like time and domain.

The vision also served as the first divergence and convergence in the project. This we tackled together with relative ease during the seminar where we brainstormed keywords and decided on a vision on the spot. The keywords would lay the groundwork for the criteria.

The module of criteria in the manual was really helpful for us to establish criteria to be used in the later solutions testing module. It provides detailed instructions and a clear sequence. Following the recommended steps, we firstly figured out the main criteria based on the key concepts in the vision of our project. Then we brainstormed associated sub-criterion as many as possible and classified them according to the main criteria. In order to ensure the most relevant and crucial criterion are included, we compared the criterion we came up with and those presented by professional organisations or in the literature. After the comparison and prioritisation, the final criteria table was derived. Additionally, we also derived indicators from the sub-criterion referring to some literature to make sure that the criteria are quantitative and convincing. The process of criteria establishment was not only to bring us to the final result, but also let us know what a complete and comprehensive set of criteria looks like.

The driver analysis may have been the hardest module to get right, as it had to be redone three times. The main hardship arose from the difficulty of distinguishing external from internal drivers. The first futures plane made paired Citizen´s willingness to change habits with Sustainability transition, with the futures deciding if the citizens would or wouldn't adopt a new sustainable or unsustainable system. While the reasoning was fairly sound, both key uncertainties used for this futures plane we learned could be affected by processes in Skellefteå, such as with nudging campaigns and focusing on helping sustainability projects. The second futures plane paired Working more from home with Digitalization. This time we came closer, but the same problem was still present. Additionally, the plane was originally used for the solution robustness testing which did not provide any useful insights because the futures mirrored the solutions, so it too, was scrapped.

Finally we figured out what external drivers ment and came up with the futures plane which is featured in this report. This one uses both external drivers and gives useful insights in the robustness testing. Albeit they use two key uncertainties which can be considered occasional disasters, which could be seen as a flaw. Because they do not alter daily life as much as other uncertainties could and it is uncertain if they would occur at the same time. Indeed, much was learned from the driver analysis part of the process.

Coming up with solutions was where we integrated everything we have collected and learned from the previous steps. With the help of the analysis of the current condition focusing on a well-bounded issue, the vision based on the analysis of needs & function, and the well-defined criteria, the picture of the gap between the ideal future and current condition gets clear, and therefore might be a good stage to think about the solution to fix the gap. Instead of making up the solutions from our imagination, brainstorming based on dimensions made sure that we followed the definition of solutions, which refers to the internal drives. The first try, we found that we had some similar concepts in the internal and external drivers. For instance, digitalization was considered as an external driver but at the same time, also a solution to enhance accessibility. To differentiate the internal and external drivers, we rethink how controllable they are, and understand that internal drivers need to be well-planned and developed while the external drivers can be either a trend that's happening now or the possible scenarios that can happen unexpectedly. However, after obtaining several solutions, we found each of them puts stress on different dimensions while neglecting some of the dimensions. Therefore, we combined them into one solution in the end. However, this issue might come from the dimensions we chose, which made our solutions difficult to be compared.

The solutions also meant the second divergence and convergence in the project with this one being harder and more time consuming than the previous one. The strategy for handling divergence was everyone separately brainstorming dimensions and derived solutions based on the dimensions we came up with on the seminar. Then we met to combine our most similar ideas resulting in 4 solutions which became the solutions presented in the report. The method ultimately explored several possibilities and the resulting solutions were interesting and brought insight. However, the process was very time consuming.

Solution testing is one of the key processes when conducting the mPD method. Both testing against criteria and robustness testing are supposed to be done to evaluate solutions comprehensively. The first part of testing we understood was for us to find out the most suitable solution for the transition. However, we are a bit confused about the purpose of robustness testing which initially led us in the wrong direction. As mentioned previously, the two uncertainties we selected were more or less related to our solutions. Because of this, we had a hard time comparing different solutions and could not reach one final appropriate solution. After communicating with the teachers in the coaching session, we finally understood the key point of robustness testing which is to instil insights and inspirations for our combined solution. In the previous process, what we had done was only about the internal system, while the final combined solution should also be capable of confronting uncontrollable future challenges, and that is the necessity of conducting robustness testing. Hence, we also realised the importance of solution testing which is not only a way to find out the most applicable solution, but also an approach offering insights to improve the solution and make it more resistant.

Perhaps the most iconic step of the modular particular backcasting process is the pathway where you develop a set of necessary changes and place them on a timeline going backwards from the goal until today. This module was fairly straightforward except for the lack of

literature we used to back it up. The changes are mostly based on our brainstorming and creativity which is more difficult to back up with literature compared to other modules before the solution module.

Following the manual, it was very useful and educational to categorise the changes to not get stuck in thought on the more straightforward changes like development of self-driving cars. Especially since this was the most difficult step in the module. The second step of recognizing stakeholders to be involved in the change was also a bit tricky. The mentioned stakeholders in the pathway module as it is in the report are probably too few. However, identifying more with the risk of adding a stakeholder which shouldn't be there was not an option, so it remains a bit bare-boned.

The final modules, action plan and follow-up was instead replaced with an experiment module for this report in order to save time. While they are not to be considered the same, it was still educational and let us further brainstorm what can be done as a first step to kickstart the transition. Much inspiration for the experiment development has still been acquired from the manual for action plan, such as the experiments following the example of table structure for action plan in the manual. In contrast, next to no inspiration has been taken from the follow-up module, something which could definitely be further explored.

We realise of course that much more needs to be done in every sector beyond the suggested 5 experiments for the system to be implemented. To make the 5 systems kickstart as much of the process as possible without being overwhelmingly big, it was decided to involve many different stakeholders, have the experiments be spread out in the different fields and make the responsible stakeholders cooperate. Hopefully this will force stakeholders in all sectors to start following the project.

Limitations and recommendations for further exploration

The data used for the report was of varying quality but it is sufficient for the purpose where it was used. Some are from less reliable websites but most are from Skellefteå's official documents, official documents from different agencies, research articles and the interviews with Skellefteå. The interviews with the municipality was a valuable resource as it provided both the starting point for the research of the unique properties of Skellefteå but also what could and could not be done in the perspective of a municipality. It would have also been useful to acquire the perspective of other stakeholders in the case of this specific project.

Some modules were more data and literature heavy than others. This depends on the level of creativity used in the module, with examples such as solution, solution testing and pathway. However, the level of creativity should not get in the way of using literature as least for inspiration for brainstorming and decision making. The lack of literature in some modules could be seen as a flaw in the report, probably weakening the results. An example of a flaw which may have come from the lack of sources is the lack of description which resources are needed to make the solution happen and where those resources would come from. These

issues could perhaps be a consequence of the lack of time and workforce this project has been under.

As mentioned previously, this report does not deal with the follow-up of the solution implementation. A fitting recommendation would be to develop follow-ups for the suggested solution in this report.

Concluding remarks

Skellefteå is a unique municipality with many aspects and different needs of citizens to take in mind. Using the mPB method, this report successfully proposes a highly technological solution based on today's cutting-edge technology and possible futures. This aims to provide Skellefteå with a sustainable, flexible and accessible mobility system.

The method of mPB fitted well for the purpose of this study, to investigate desirable futures for Skellefteå. The main hardships and limitations came not from the method but from the limited time and resources available for the project. Much has been learned from using this method both for the purpose of mPB and for projects using similar aspects. The method has proven to us that it is possible to plan for necessary changes and also consider the needs of current and future generations.

This report was written in the context of a horrible war in Ukraine. This has changed views on uncertainties in a seemingly peaceful europe, including the views on uncertainties in this report. May it never be forgotten what heinous crimes are being committed in Ukraine.

6. Description of a teamwork organisation

We in group three Aurora consist of three group members, Qiutong Xu, Clara Haag Johansson, and Jui Lien Hsia as we unfortunately had two early dropouts. Being three instead of five proved to be a challenge as more research had to be done and text had to be written per person, also less combined creativity can be achieved. However, being exposed to this hardship early has strengthened our connection and made our teamwork and decision making relatively smooth.

Our approach to the project has been to attend and start the brainstorming of new modules on every seminar and then follow up every seminar with a meeting. The meetings consist of discussing the previous seminar as well as planning ahead, brainstorming the modules together on Miro and giving out tasks to the group members. The tasks are usually to document our brainstorming, do the research for a specific module and write the corresponding part in the report. We have very much had a worker ant approach to the project as we knew we had less than optimal time, and therefore as soon as we can start writing about something in the report, we did, while still making sure to balance between courses and workload on individuals.

The planning, schedule, brainstorming, to-do list and notes can all be found on Miro, however communication is done via a WhatsApp group and document sharing has been done through Google drive. Early in the project, all meetings were situated on Zoom because of tight schedules, but as time went on and more difficult questions and modules needed to be brainstormed (such as solution), the meetings started to be performed in person, preferably with a real whiteboard.

Link to our Miro board: https://miro.com/app/board/uXjVOSxqnUU=/

Link to our Google drive: https://drive.google.com/drive/folders/1KKsZAvkXQ_xFma3AOpzXJY_j6HmKlCQG?usp=sharing

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