Report

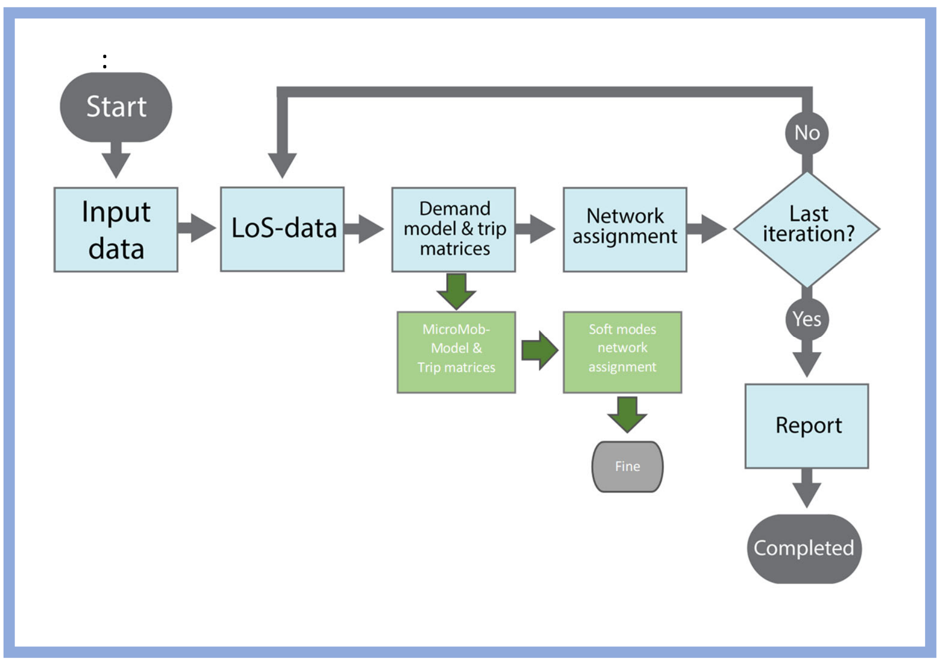
NTNU
The Norwegian University of Science and Technology
Faculty of Engineering
Institute of building and environmental engineering

Trude Tørset, Ellen Heffer Flaata and
Arvid Aakre

Micro mobility in macro models

Implementing e-scooters in the Norwegian Regional Transport Model

Trondheim January 2023



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Authors

Trude Tørset, Ellen Heffer Flaata and
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UTARBEIDET AV

Trude Tørset

KONTROLLERT AV

Ellen Heffer Flaata

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Contents

Foreword

This report is part of the final deliveries of the project **Green city, Green mobility** within the work package Modeling Micro mobility. This part of the project is a carried out in a collaboration between COWI and NTNU, in which COWI has chosen a different approach and software, while NTNUs approach is documented in this report.

NTNU has developed an add-on to the Norwegian Regional Transport Model to estimate demand for micro mobility using a Part Area Model established for an urban area in the northern part of Norway, with Bodø city and surrounding areas.

Arvid Aakre has been the project leader for NTNU, while Trude Tørset and Ellen Heffer Flaata has developed the model and written this report.

Summary

Ideally, we should have started with data collection to monitor how micro mobility is used, who uses it, and which drivers there are for using micro mobility. Also, we should have reestimated the demand model in our strategic transport model, to implement micro mobility as an independent mode in the transport model. However, we have used literature to understand more about how and who uses micro mobility. Lack of data and resources made it impossible to estimate a new demand model. Instead, we developed a model which redistribute trips from other modes to micro mobility.

The regional transport model of Norway is used for basically all transport analysis in Norway. It has the flexibility to select model area but uses inbedded algorithms and parameters. The model framwork uses local data input to calculate demand for the selected area. In our project we chose Bode as study area. Bodø municipality has planes to develop a new area of the city close to the city center, which will house up to 10 000 new residents and many new workplaces.

The project has given insight into how micro mobility could be implemented in a transport model. The mode is sometimes competing against other modes, especially for short trips, which would otherwise have been carried out by foot. In other situations, as complementary mode, as access and egress mode to public transport and potentially between parking facilities and start or end point of the trips.

To implement micro mobility in a transport model there are several considerations to be solved. The network coding should be quite detailed to represent traveling by micro mobility mode. When this project was developed the local fleet was free floating, which mean there could be some search and walk time (vehicle access time) to find a unit for use. The current model design implies five separate modes, car driver, car passenger, public transport, bike and walk. With micro mobility, one solution is to add a sixth mode, but this is not suitable for representing the combination of several modes on the same trip. Season variation is also a consideration that needs to be made, as the units are available only in the summer season.

The model worked as intended, although variables and parameters in the add-on model were based on literature and experiences from elsewhere. The project gave valuable insights into data requirements and necessary changes for the model design to be able to implement micro mobility in the regional transport model of Norway.

1 Introduction

Micro mobility, most notably in the form of rental, dockless e-scooters, are rapidly increasing in numbers and modal shares in cities all over the world. For transport analyses to give accurate predictions, it is necessary to include micro mobility as a separate mode in macroscopic transport models.

Including micro mobility in strategic transport models will ideally require thorough data collection on travel habits with micro mobility, as well as a restructuring of the four-step model from the ground up. However, it is also interesting as an initial project to try to augment existing models for, to some extent, to capture the characteristics of micro mobility. Doing so might also shed light on which steps are needed for a more thorough implementation of micro mobility in these models.

To achieve this, we have developed a test case using an existing four step transport model for the region of Salten in northern Norway. The Norwegian strategic transport model RTM is currently used for all transport analyses in Norway. Our ambition with this test case is not to get an exact prediction of usage of micro mobility units, but rather to look into requirements for modeling it; data, design, coding, etc. of models. Implementing a new transport mode in analyses, it seems natural to test it within the framework of RTM.

Micro mobility is a somewhat vague term, encompassing e-scooters, shared bikes, and more, but in the case of Salten it is most relevant to limit the scope to rental e-scooters, as this is the most prevalent mode available. Expanding the scope to cover more micro mobility modes can be an interesting extension of the work presented here.

To be able to represent micro mobility in an existing macro model, we need to make some assumptions and simplifications, which will be presented later. This said, the work presented here is not to be regarded as a final solution to how to include micro mobility in macro models. Rather, it will be beneficial to view it as an exploratory, conceptual investigation into how far we can get with existing tools, and which requirements are needed when redesigning four step models to incorporate micro mobility.

1.1 The Norwegian regional transport model (RTM)

The regional transport model (RTM) is based on a four-step methodology, where the CUBE framework is used to produce Level of Service matrices for the demand model Tramod-by (Tørset et al, 2022). The demand model produces trip matrices, divided in trip purposes and modes, and optionally also by time intervals (splitting between rush hours and low traffic periods). Then the trip matrices are assigned to the mode specific networks.

The modes included in RTM are:

- Car as driver
- Car as passenger
- Public transport (train, bus, tram etc)
- Bike (conventional)
- Pedestrian

The demand model is estimated separately from the Cube environment, and this estimation is done at roughly eight-year intervals, following extensive, national travel diary collection (the Norwegian national travel survey). It is thus a task which will not be done in this project, although future demand model estimations might consider this.

The approach described in this report is to redistribute trips from the current modes to micro mobility modes within the possibilities of the existing model. This can be done by manipulating the input to or output from the demand model (in the form of matrices), eg. Level of service data and trip matrices.

2 Micro mobility

To reflect the effects of micro mobility on personal transport demand as accurately as possible, we need an overview of what micro mobility is, who uses micro mobility and what their characteristics are. In this project we need to lean on previously established knowledge about these questions.

2.1 Characteristics

The 'micro' in micro mobility is often associated with the range of travel by the micro mobility mode – referring to micro mobility often being used on small legs of a trip in between other, more classical modes such as train or car. As such, micro mobility might include modes ranging from e-scooters to the shared bicycle, privately owned bicycle and walking. However, this definition is too broad to be useful.

Figure 1 shows an overview of a variety of vehicles with their capacity along the horizontal axis and weight on the vertical axis. Here micro mobility is limited to those modes of lowest weight and capacity, including wheelchair and skis. Micro here, then, is referring to the vehicle, and not the trip length – but naturally these small vehicles are associated with shorter trips.

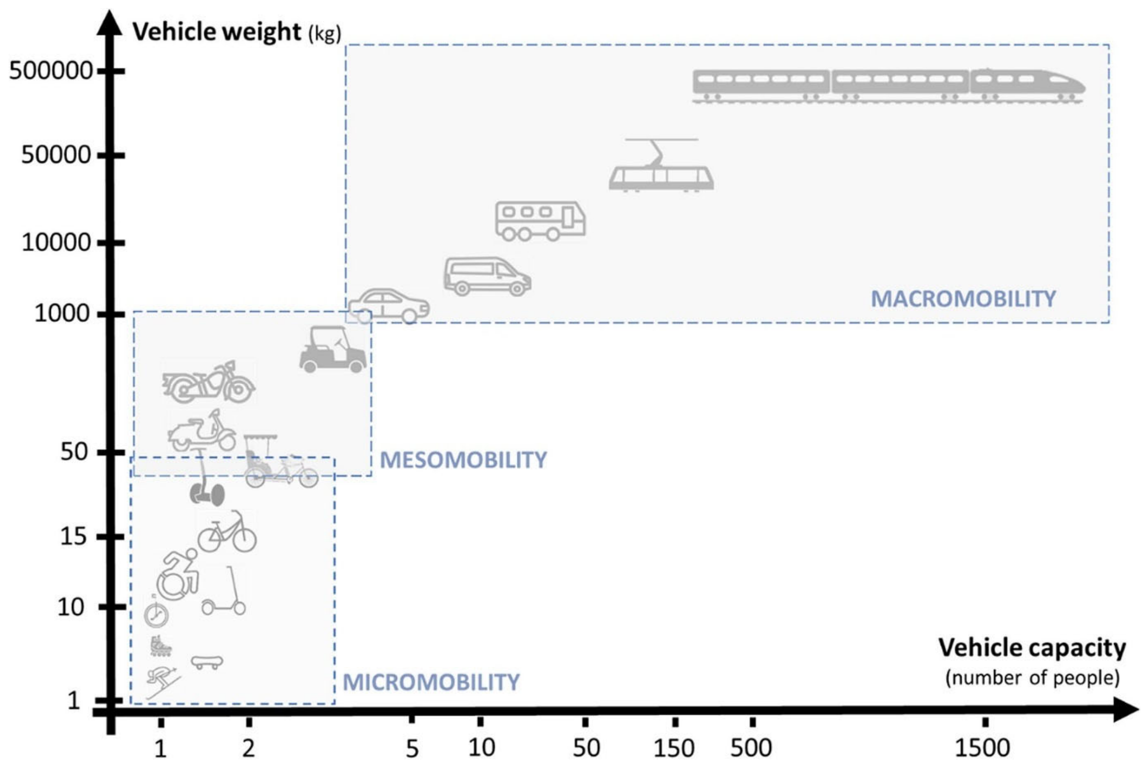
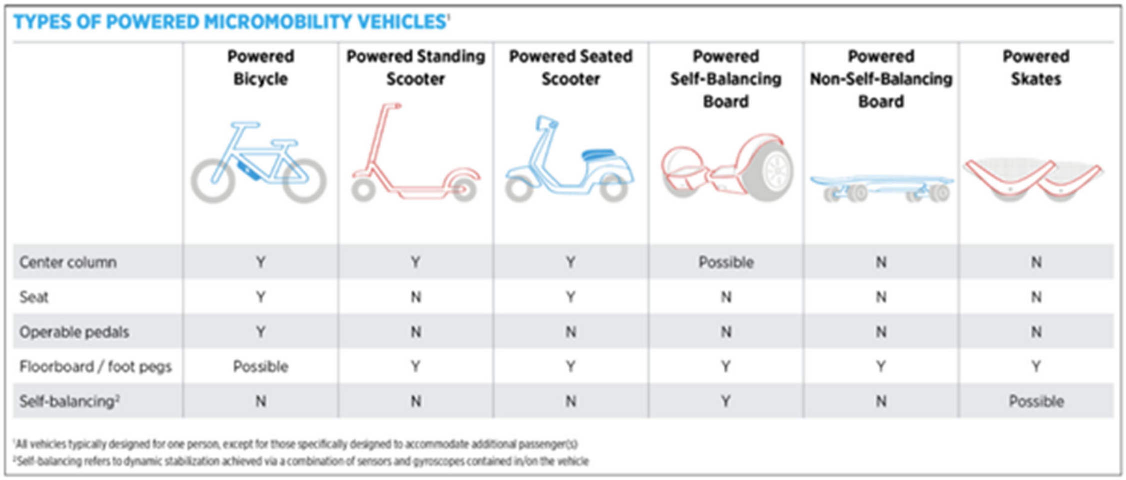


Figure 1: Micro mobility vehicles and capacity, as defined by Christoforou et al (2021)

Another dimension of micro mobility is power. *Figure 2* illustrates different powered micro mobility vehicles and how they can be categorized by how they are operated. Of these, the e-bike and the powered standing scooter are the most common.



TYPES OF POWERED MICROMOBILITY VEHICLES[1]

	Powered Bicycle	Powered Standing Scooter	Powered Seated Scooter	Powered Self-Balancing Board	Powered Non-Self-Balancing Board	Powered Skates
Center column	Y	Y	Y	Possible	N	N
Seat	Y	N	Y	N	N	N
Operable pedals	Y	N	N	N	N	N
Floorboard / foot pegs	Possible	Y	Y	Y	Y	Y
Self-balancing[2]	N	N	N	Y	N	Possible

[1]All vehicles typically designed for one person, except for those specifically designed to accommodate additional passenger(s)
[2]Self-balancing refers to dynamic stabilization achieved via a combination of sensors and gyroscopes contained in/on the vehicle

Figure 2: Powered micro mobility vehicle definitions. Source: SAE international

A central factor in describing micro mobility vehicles is ownership. Docked city bikes have been common in cities for many years already, but their presence has not required alterations to the transport models because they have been grouped together with the regular, privately owned bike. The reason micro mobility now stands out as a separate mode is because of dockless vehicles, which gives the users a lot of flexibility. The price structure is also different, leading to different usage.

Since 2017 the popularity of e-scooters has exploded. As such, although there are many types of micro mobility modes, our focus has been to represent a mode similar to e-scooters. That is a power-driven mode, with a maximum speed of 20 km/h, and weighs less than 50 kg. The dockless rental e-scooters are most commonly used (as opposed to privately owned e-scooters), which is why we concentrate on a rental mode with a cost structure similar to the ones present in Bodø.

2.2 E-scooters in Bodø

E-scooters were introduced in Bodø in August 2020. Initially, they were not dock-less and could not be taken out after midnight. In 2021, the company Bird started an e-scooter service which was more flexible for the users. The cost structure comprises a starting fee of 11 kr and a duration dependent cost of 4 kr/minute.

Figure 3 shows the geographical operation range of the e-scooters. The red area indicates the geographical area where the e-scooters can be found. The dark grey area indicates where one can not park the e-scooter. The implementation of e-scooters in RTM will follow the limitations of the Bird system.

At this point we have no empirical data about how, who or when e-scooters are used in Bodø, thus we turn to national and international literature to make reasonable assumptions.

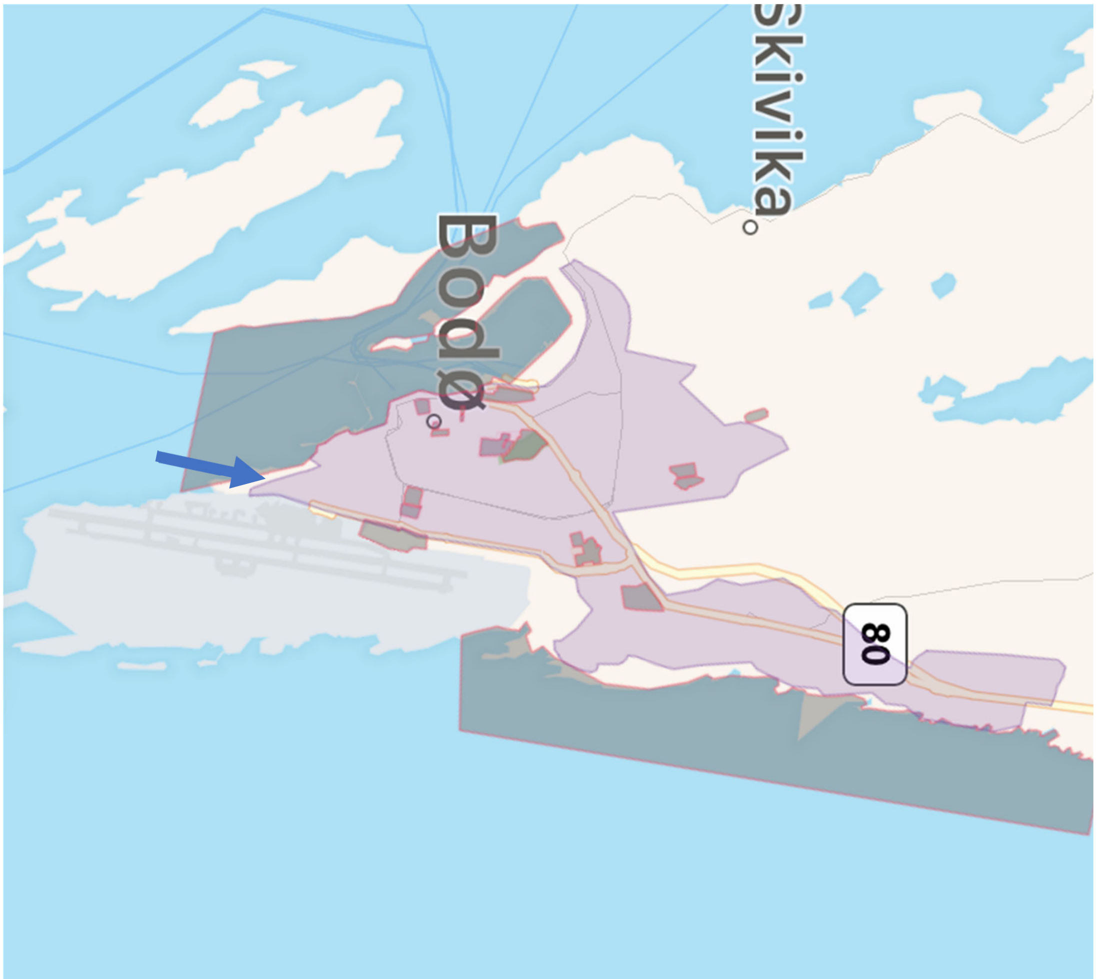


Figure 3: The Bird e-scooter service area. The red area indicates where you can park and find e-scooters. Scource: The Bird app.

2.3 Users of e-scooters

A survey from Zürich, Switzerland from June and july, 2020, showed that users of e-scooters were younger (mean 33 years), a small difference between men and women (32 % women are users, while the population is 50 % women) education on university level (71 % of the e-scooter users, while the population has 58 %) and full-time employment (79 % among e-scooter users, while the population has 68 %). Income household average was 10.000 Euro monthly, slightly more than the population. A slight majority lived in households without children /(87% among e-scooter users, while 70 % in the population) (Reck and Axhausen, 2021).

In Paris, face to face (F2F) interviews were made May-June 2019 with users of e-scooters. They found that the typical users are men, between 18-29 years and highly educated. Frequent travel purposes were leisure, strolling and visits. (Christoforou, et al., 2021)

A Greek F2F/web study in the city of Thessaloniki Jul-Oct 2019 with e-scooter drivers showed an overweight of men (68,6 %) and young people (73,4 % 18–27 years,) in middle income groups. The educational level was relatively high with university students and bachelor's degree holders constituted 35,1 % and 33,3 % respectively. Trip purposes were mainly entertainment and shopping (Raptopoulou et al., 2021).

It has generally been reported that early adapters are the primary users of e-scooters, and younger people and men are more frequent users (Nacto, 2019). However, given that more and more groups start using it, we assume that the user group will expand and that the micro mobility modes will develop further, tempting a wider audience.

2.3.1 Shifts to e-scooters from other modes

Summer of 2019, a survey in Oslo was handed out close to parking lots where e-scooters were located and recruited 431 respondents. 37 % of the respondents had tried an e-scooter, with an overweight of men and young people. Out of 158 respondents, on their last e-scooter trip, the e-scooter replaced walking for 58 %, public transport for 26 %, bike for 7 %, car for 5 % of the trips, while 4 % reported that they wouldn't have traveled at all (Berge, 2019).

As this is a Norwegian study, the results might be relevant to use in our approach. It seems appropriate to look at the walk mode in the transport model, in order to be able to represent micro mobility in RTM. Naturally the sample of the survey in Oslo was not a representative one, as the survey was done on specific locations, but say that we know how many trips are made with e-scooters, we can assume that a majority of them would have otherwise walked, and a significant share would have used public transport. To estimate the total number of trips by e-scooter, we could probably rely on average numbers reported from Nacto (2019), which found that an average number of trips per vehicle per day ranged from 3 trips/unit/day for fleets of more than 2500 units and varies a lot for smaller fleets. Mathew et. al. (2019) reports average usage time for e-scooters to be 40 minutes a day, which corresponds quite well to Nacto's findings.

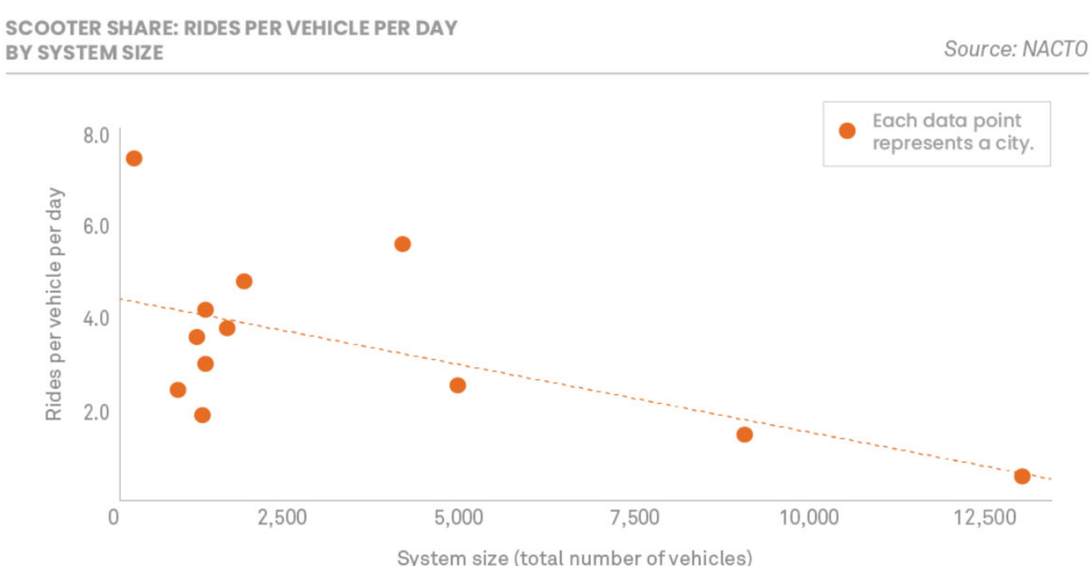


Figure 4: (Source : https://nacto.org/shared-micro mobility-2019)

2.3.2 Micro mobility as access/egress mode to public transport trips

In their review paper about combined trips Oeschger et. al. (2020) mainly focuses on other micro mobility modes than e-scooters. Shared modes are more available and suitable, station-based or dockless systems, or else if they are privately owned, safe parking is essential.

Baek et al. (2021) have focused on dockless or free-floating e-scooter sharing as first and last mile mode in an SP survey in Seoul. They found electric e-scooters to have a lower value of time (VoT) than other alternatives in a last mile situation than "town bus" and walk all the way. They found different perceptions for experienced users, compared to inexperienced users, but surprisingly no gender or age differences were found, although men and younger people seem to use it more.

2.3.3 Weather impact on usage of e-scooters

In our study area, it is very relevant to consider weather effects. Bodø is known to have windy coast-like climate with many rainy and cold days, even in the summer season. One might expect that rain will make it uncomfortable and unattractive to travel exposed to the elements. On the other hand, if the alternative is to walk, using an e-scooter will reduce the exposure time. In Bodø, rain is often accompanied with strong horizontal winds, which would make it harder to avoid getting rain in the face if riding an e-scooter, and this condition is probably worse than the rain itself, making our study area somewhat special compared to other cities. However, earlier research in the US showed that rain and snow will reduce the usage, while wind and temperature had no effect (Noland, 2019; Mathew et al., 2019 and Younes et al., 2020). Noland (2021) found similar effects with data from Texas, and, that wind and rain reduces the distance and duration of the trips.

2.3.4 Trip lengths and duration with e-scooters

As shown in *Figure 3* there are boundaries to where e-scooters can be used, and such boundaries are common other places as well. The area of usage naturally impacts which trips can potentially be carried out using an e-scooter. Naturally, one can use e-scooter on parts of the trip, and use other modes as well, but probably the longer trips have other main modes than e-sooter. The average trip length and duration would probably vary with the geographical area where they are available, but still, reported average trip lengths and durations are quite stable.

Reported trip lengths are from 1,5 km to 2 km and trip duration around 10 minutes.

- San Francisco: average 1,6 km (1 mile) (Ensor et.al., 2021, original reference: Dediu, 2019)
- Indianapolis average (winter) from sept 2018 to february 2019: approximately 13-14 minutes, 1,7 km, 9 km/time (Mathew et al., 2019).
- Mathew et al., (2019): typical ride 8 minutes, 1,1 km in 8 km pr hour. Found in Baek et al. (2021)
- US (2019): Average scooter trip 12 minutes, 1 mile, (https://nacto.org/shared-micro mobility-2019).
- Paris (2019): Average trip duration 15 minutes and 4 km long. (Christoforou et al, 2021)
- Washington (2018): Five e-scooter companies data showed an average distance of 1,9 km and duration 11,2 minutes. McKenzie (2020).

- Noland (2019) Average trip distance 2, 14 km, speed 9,13 km/t, Duration 15,59 minutes in Louisville-Kentucky, usage data from August 2018 up till February 2019 and included almost 90 000 trips.

For our purpose we use an average speed of 12 km/h to represent the e-scooter, faster than the assumed walking speed of 5 km/h and slightly slower than the cycling speed of 15 km/h. The two latter are used as assumptions in RTM.

3 Framework for modeling micro mobility in RTM

This chapter describes the attempt to include micro mobility solutions in a strategic transport model. The existing regional transport model RTM will be manipulated to include micro mobility. An important limitation in this work is that we will not change the current demand model Tramod-by; rather this is an attempt to explore the possibilities of describing the characteristics of a micro mobility mode within a strategic transport model framework, both the supply and demand side.

As a first attempt, the approach will be simplistic, making rough assumptions about how the service are designed and used. Because a majority of micro mobility users state they would have otherwise walked, it is logic to primarily manipulate the walk mode in the transport model to represent the new mode.

3.1 DOM Salten

RTM has a design which is general, independent of model area, and it is possible to limit the model area by making Part Area Models (DOM in Norwegian) for a specific area of interest. In this project DOM Salten is chosen as model area, covering the city of Bodø and surrounding areas. We choose to model a basic scenario for the year 2020. All the input data for the basic scenario has been provided by the Public Roads Administration. RTM has a structure as shown in *Figure 5*.

The model has not been altered to adjust calculations, parameters, or input data. Calibration or validation of the model was also not done.

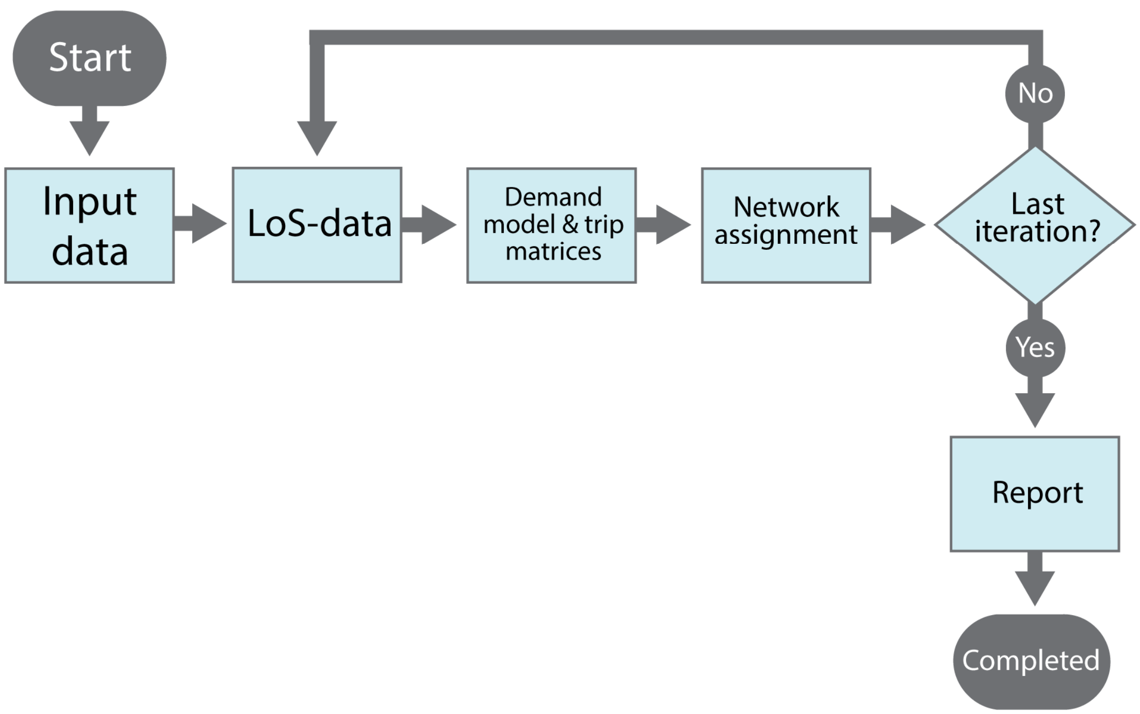


Figure 5: Structure of calculation steps in RTM

In this project we will do calculations on a matrix level, which means that we assume the travelers to use one main mode for the whole trip from start to the destination. We will use **Level-of-service** data prepared for the walk mode, which in principle is limited to distance matrices and assuming micro mobility has a speed of 12 km/h, we get a time use matrix for the micro mobility mode. We then redistribute **trip matrices** from the original modes to a new trip matrix containing micro mobility trips. This is done for all other modes; car as driver, car as passenger, public transport, cycle and walk.

3.2 Case study area

In Bodø the airport is being moved, from the current location close to the city center where it occupies valuable land to a location further away, freeing up areas for developing new buildings, for housing and commercial activities. The new area is named Nybyen.

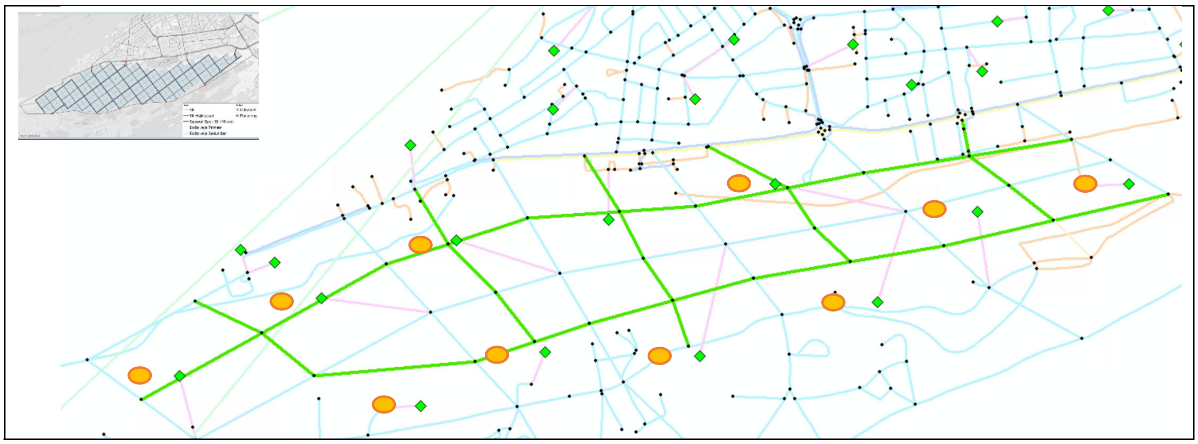


Figure 6: Coded transport network for Nybyen, with 10 new zones. Green links are defined to be cycle and pedestrian links, while light blue links are municipal roads with speed limits 40 km/hour. The small map illustrates principles of development in the new neighborhood.

The public transport service in Nybyen is coded as two separate lines between Nybyen and the city centre (see *Figure 7*). The lines are coded as two one-way lines. The headway is 10 minutes all day.

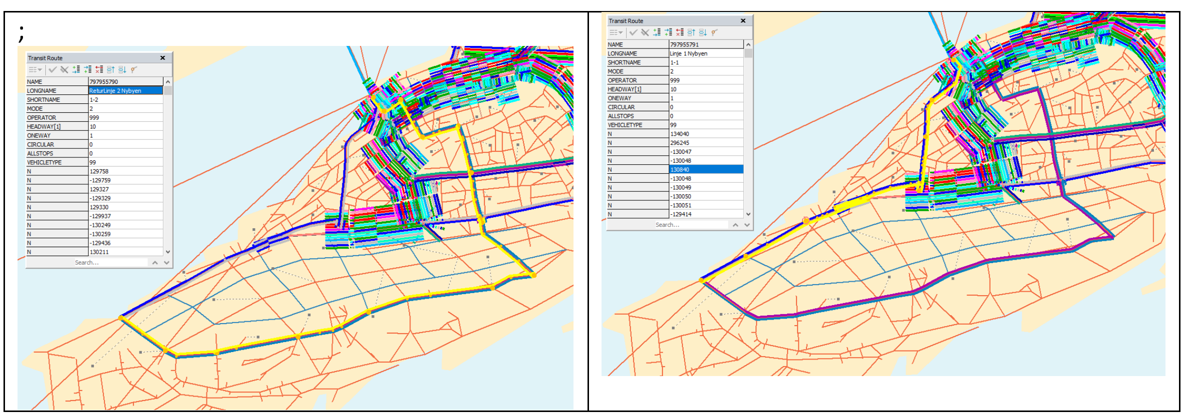


Figure 7: Coded public transport lines serving Nybyen. The left picture shows one line serving the souther area of Nybyen and the right picture shows the line serving the norther area of Nybyen. Both lines land connects the airport area to the city centre

3.3 Zonal data

Nine new zones were created, splitting existing zones, as shown in *Figure 8*. The Nybyen area now include ten zones; 18040209 and 18040213–21. The zonal data for these zones represent the new Nybyen area.

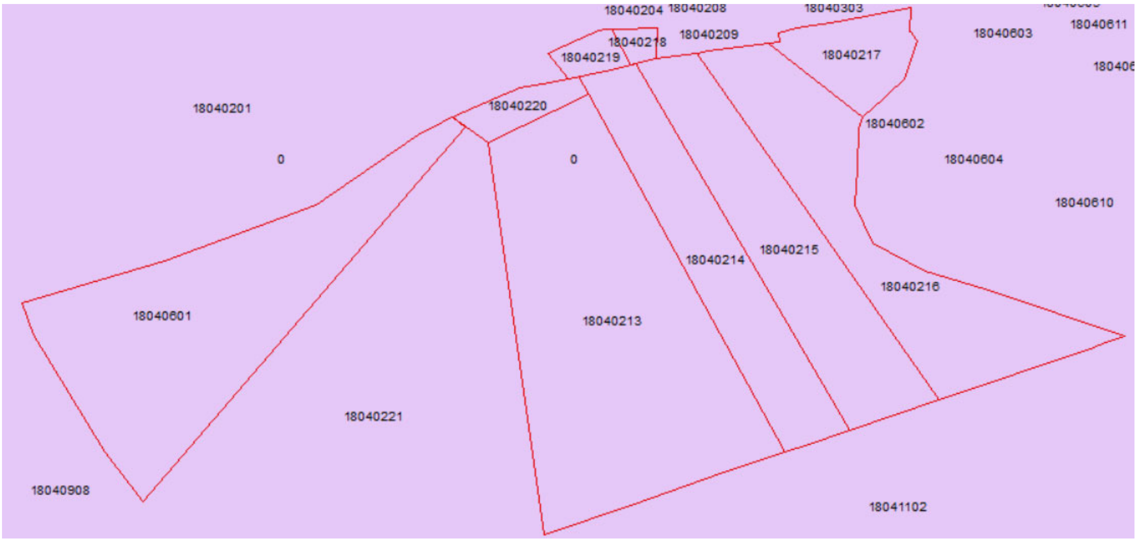


Figure 8: New zones at the old airport area

The new zones with the road network, existing and coded in the new area can be seen in *Figure 9*. The green links in the area are new roads and zone connectors.

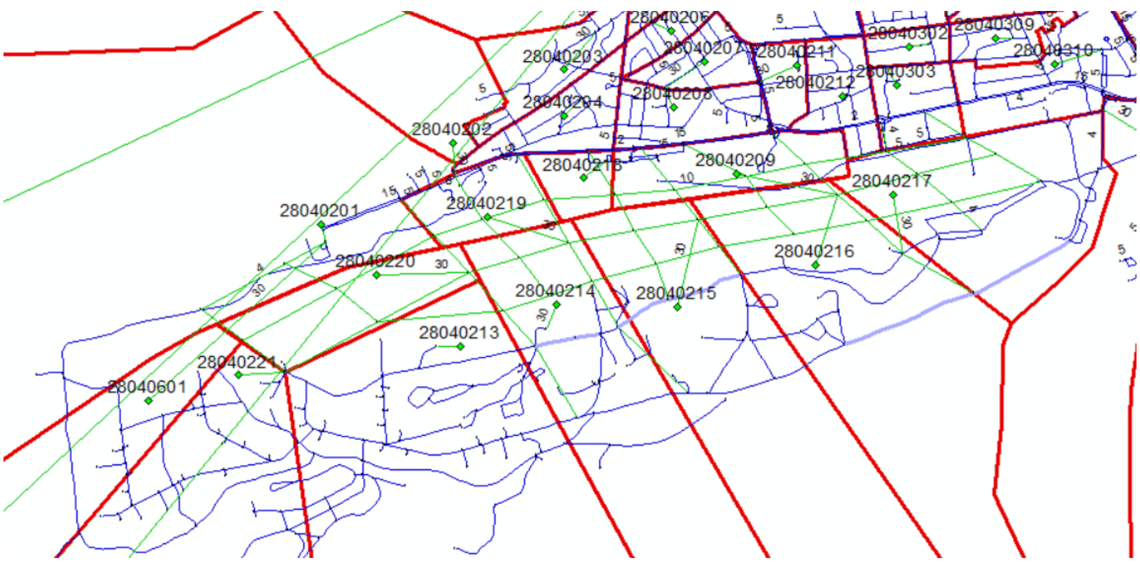


Figure 9: New zones, zone connectors and new road network in Nybyen

The new area will be populated with families, and we created new zonal data to represent the number of people in the new zones according to the numbers in *Figure 10*. The total amount of people in each zone is 1 000. As there are 10 zones receiving new residents, the new area houses 10 000 people. For Bodø municipality this represents a 20 % increase in residents. These new people are not relocated within Bodø; they are assumed to be newcomers from other places. A scenario with a more densely populated area in Nybyen concentrates the new population in two zones, 28040220 and 28040213, which means there are 5 000 residents in each of these two zones.

Sensitivity analyses have been made with decreasing and increasing number of residents in the zones.

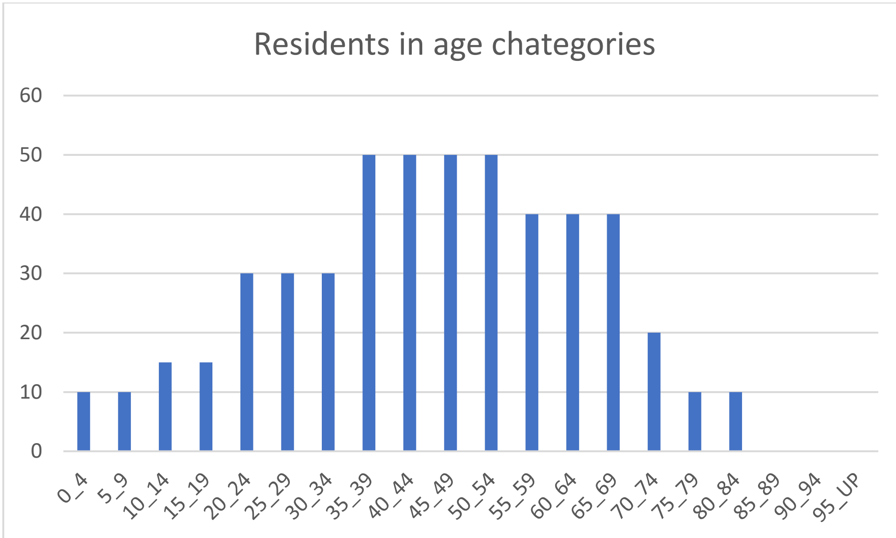


Figure 10: Male and female residents in each zone of the 10 zones, dispersed settlement

To adjust household categories with or without adults with driver's license and access to cars the zonal data file sdat_2_hushold_12_apr_delomr.txt was manipulated for Nybyen to be similar to the rest of the city center.

Using 18040212 as template the file describing education level and income was changed for Nybyen.

The file describing number of workplaces were changed assuming 2000 new jobs, with no specific male or female intensive workplaces. The shopping center zone, City Nord has 1368 in the file, and was used as inspiration.

Schools were adjusted, putting 250 childrens education places in the area (150 primary school and 100 junior high school in zone 18040213).

Area types were manipulated using 18040211 as template to fill in area types for new zones.

Internal distances in the new area were set to 100 meters, for all modes; car, public transport, walk and cycle.

3.4 Principles for calculating demand for micro mobility

3.4.1 Model application for micro mobility

We assume a free-floating fleet of micro mobility modes, with the characteristics of e-scooters. The general approch is to let RTM calculate the demand in a regular fashon and redistribute some of the demand from each matrix to micro mobility. The model for redistribution is a binary logit model.

The calculations are set up in CUBE, as a separate application reading files from an ordinary RTM run of the sceanrios. The RTM model is run capacity independent. The set up of the program application is shown in Figure 11.

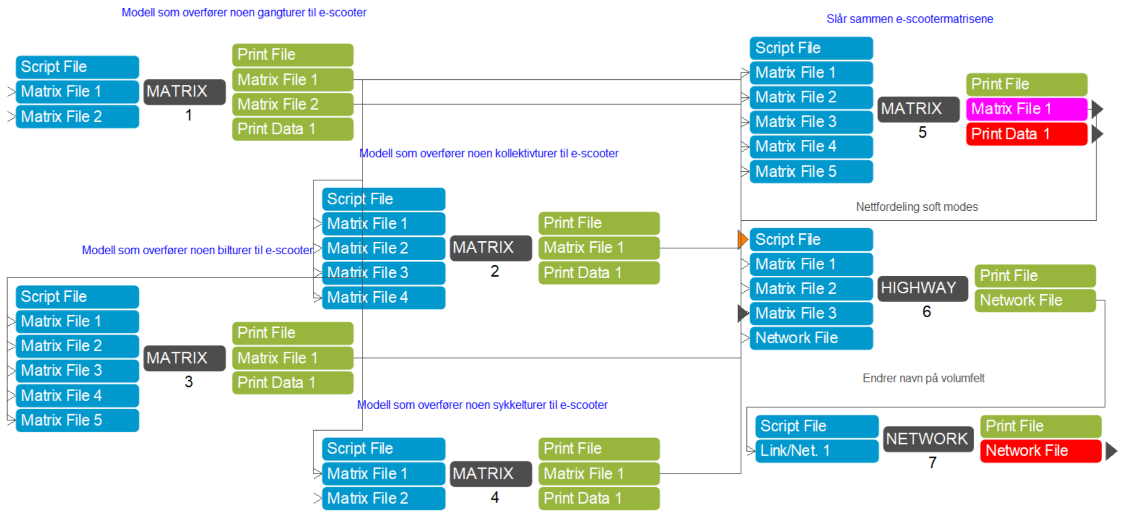


Figure 11: Application for redistributing and assignment of micro mobility

The boxes 1-4 read LoS and trip matrices for each mode, redistributes the trip matrices and sends the matrix files to box 5 which adds the matrixes to totals. Box 6 assign the trips to the network and box 7 organizes the link results.

3.4.2 Generalized cost definition

This section describes how the generalized cost is defined for the six modes. Generalized cost is later used in the utility function of the binary logit model where trips are redistributed to e-scooter. Values of time are inspired by the value of time study carried out by TØI 2018–2020 (Flügel et al, 2020)

Generalized cost for the walk mode

- The input is the distance matrix for walk mode
- Assumed walk speed of 5 km/h to calculate walk time
- Assumed value of time for walk mode 100 NOK/h

Generalized cost for cycle mode

- The input is the distance matrix for walk mode
- Assumed walk speed of 15 km/h to calculate cycle time
- Assumed value of time for cycle mode 120 NOK/h

Generalized cost for the micro mobility (e-scooter) mode

- The input is the distance matrix for walk mode
- Assumed micro mobility speed of 12 km/h to calculate micro mobility time
- Assumed value of time for micro mobility 120 NOK/h
- Cost is calculated by using initial cost of NOK 11 and 4 NOK/minute
- We did not include extra time to pick up or park the unit

Generalized cost for the public transport passengers

- The input is the Level of service matrices for rush hours for public transport and we use the walk time, waiting time, on-board time, number of transfers and fares

- Walk time and waiting time are multiplied with a factor of 1,5
- Transfers get a penalty of 10 minutes
- Walk speed is assumed 5 km/h
- Fares are distance based, e.g. NOK 26,50 for trips within the city centre
- Assumed value of time for public transport mode 80 NOK/h

Generalized cost for car driver and car passenger

- The input is the Level of service matrices for rush and low traffic
- Generalized cost for car driver is time and tolling
- Generalized cost for car passenger is time
- Assumed value of time 100 NOK/h

3.4.3 Distribution of car trips to time periods

To assign trip matrices to generalized cost, we need to specify whether the trips are carried out in rush or low traffic periods. The trip matrices are split with the following shares going in rush hours: Work 90 %, Business 80 %, Leisure 10 %, Escort 70 %, Private services 20 %, Work-based roundtrips 50 %, Scool/education 90 %. The remaining trips are assumed to go in the low traffic periods.

3.4.4 Binary logit model to redistribute trips

The binary logit model uses the generalized cost previously defined to calculate likelihood for trips to be transferred from the RTM modes to e-scooter. The utility functions are defined like this, using walk mode as example:

Uwalk = pgeneralized cost walk*GCwalk

Ue-sc = pgeneralized cost micro mobility *GCmicro mobility + K

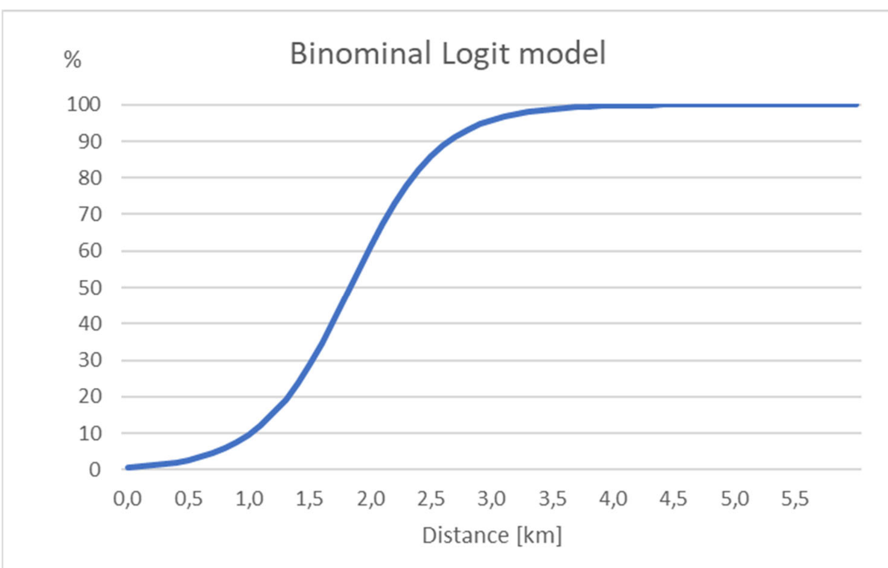


Figure 12: A binominal logit model to calculate the probability of transfer from walk to e-scooter, assuming pgeneralized cost=-0,15 and K=10, showing the probability of choosing e-scooter increasing with distance.

In fact, all the binary logit models use pmode = -15 and constant K=10

3.4.5 Willingness to use and availability of a micro mobility unit

The literature shows that micro mobility is currently used more by young people and slightly more by men than women. Also, since micro mobility is not privately owned, at least in our project, the people wanting to use one must also search for a unit. This is considered in the model by including a factor < 1 which is multiplied with the initial micro mobility matrices calculated by the binominal logit model, reducing number of trips with micro mobility, and increasing the other competing mode accordingly.

This factor is defined as follows:

Table 1: Factors reducing actual choice of micro mobility in the choice model

Mode	Factor indicating willingness to use and availability of micro mobility unit
Walk	0,2 all other purposes 0,5 for school/education
Cycle	0,1 all other purposes 0,5 for school/education
Public transport	0,2 all other purposes 0,5 for school/education
Car	0,1 for all purposes, car driver 0,2 for all purposes, car passenger

4 Results from RTM in the basic situation

This chapter presents results from running the transport model DOM Salten for the basic situation but including the new Nybyen area with residential zones, assuming 10 000 new residents distributed equally in ten zones, workplaces, and the new public transport lines. The transport model has not been calibrated to fit observed transport behavior in Bodø, so results presented here might not match observed travel behavior.

The model area consists of the municipalities Bodø, Saltdal, Fauske and Sørfold. It has 251 internal and 9 external zones. The zonal data represent the year 2020.

The population is almost 70 000 people, with Bodø having the largest population of more than 53 000 inhabitants (Table 2). The number of workplaces is 40 000 with most of them in Bodø (Table 3).

Table 2: The inhabitants living in the model area

Municipality	Men	Women	Total
Bodø	26 645	26 570	53 215
Saltdal	2 027	1 964	3 990
Fauske	4 309	4 226	8 536
Sørfold	863	866	1 729
Total	33 843	33 626	67 469

Table 3: Number of workplaces in the model area

Municipality	Workplaces
Bodø	32 690
Saltdal	2 207
Fauske	4 257
Sørfold	912
Total	40 066

The average number of trips made in the model area on normal workdays, excluding weekends and holidays, are close to 220 000, distributed over modes and purposes as shown in *Table 4*. Long trips over 70 km are excluded in the model runs. The walk trips constitute 25 % of the totals in the model area.

Table 4: Trip totals on modes and purposes (Normal workdays)

											Faste matriser	
Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Flyplass	Gods
Bilf�rer	119811	55%	34017	8930	19335	14791	34595	1405	0	4258	1652	829
Bilpassasjer	9616	4%	1394	367	3737	762	3096	261	0	0	0	0
Kollektiv	18546	8%	3649	478	1460	470	2380	769	0	9007	334	0
Gang	55397	25%	7007	1429	9781	4596	15259	2229	0	15094	0	0
Sykkel	16091	7%	4446	845	4045	1601	4864	292	0	0	0	0
Totalt	219462		50512	12049	38357	22221	60194	4956	0	28359	1986	829

The average travel distance with car as driver is 6,22 km. 64 % of the car driver trips are less than 5 km and almost 85 % of the trips are shorter than 10 km.

Total travel distance and duration with the available modes are shown in *Table 5*. The on-board time in public transport is 20–30 % more than the access and egress part of the trips for public transport passengers, showing the importance of the first and last parts of the trips.

Table 5: Totals travel distance and travel duration normal workdays, excluding internal trips (to and from the same zone) and trips on zone connectors.

Kommune	Område	Bilfører		Bilpassasjer		Kollektiv				Gang		Sykkel	
						Ombord		Tilbringer					
		Distanse	Tid	Distanse	Tid	Distanse	Tid	Distanse	Tid	Distanse	Tid	Distanse	Tid
Bod�	Land	251230	4317	18027	313	40571	778	2682	536	12333	2467	14641	756
	Tettsted	272993	5902	20734	455	62274	2123	10647	2129	43003	8601	23429	1232
	By	0	0	0	0	0	0	0	0	0	0	0	0
	Totalt	524222	10219	38761	768	102845	2901	13329	2666	55336	11067	38070	1988
Saltdal	Land	49614	679	3509	49	5423	102	461	92	1814	363	875	45
	Tettsted	0	0	0	0	0	0	0	0	0	0	0	0
	By	0	0	0	0	0	0	0	0	0	0	0	0
	Totalt	49614	679	3509	49	5423	102	461	92	1814	363	875	45
Fauske	Land	123035	1946	8590	139	20897	344	1813	363	6404	1281	2674	140
	Tettsted	0	0	0	0	0	0	0	0	0	0	0	0
	By	0	0	0	0	0	0	0	0	0	0	0	0
	Totalt	123035	1946	8590	139	20897	344	1813	363	6404	1281	2674	140
S�rfold	Land	19613	279	1123	16	3652	54	132	26	85	17	105	6
	Tettsted	0	0	0	0	0	0	0	0	0	0	0	0
	By	0	0	0	0	0	0	0	0	0	0	0	0
	Totalt	19613	279	1123	16	3652	54	132	26	85	17	105	6
Totalt	Land	443491	7220	31249	517	70543	1278	5088	1018	20637	4127	18295	946
	Tettsted	272993	5902	20734	455	62274	2123	10647	2129	43003	8601	23429	1232
	By	0	0	0	0	0	0	0	0	0	0	0	0
	Totalt	716484	13123	51983	972	132817	3401	15735	3147	63640	12728	41723	2178

Link loads with car traffic is shown in *Figure 13*. The main road, Rv 80, has the highest load, being the main road for traffic going to the city centre, the shopping mall City Nord and the many workplaces in and around the city centre.

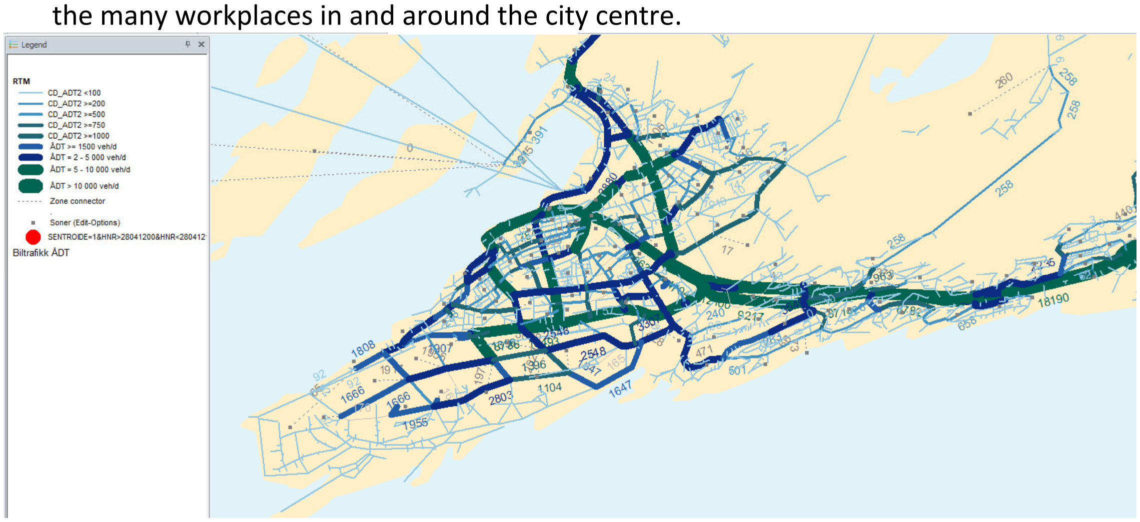


Figure 13: Link loads for car traffic

Walk trips amount to 25 % of the trips, distributed in the network as can be seen in *Figure 14*. Short distances between activities and shopping opportunities make Bodø an attractive city for walking. Whether the link loads actually represent walking traffic in Bodø is unknown. Weather conditions in Bodø can be a demotivating factor, which is not represented in the model, indicating that walk mode might be over-represented in the model.

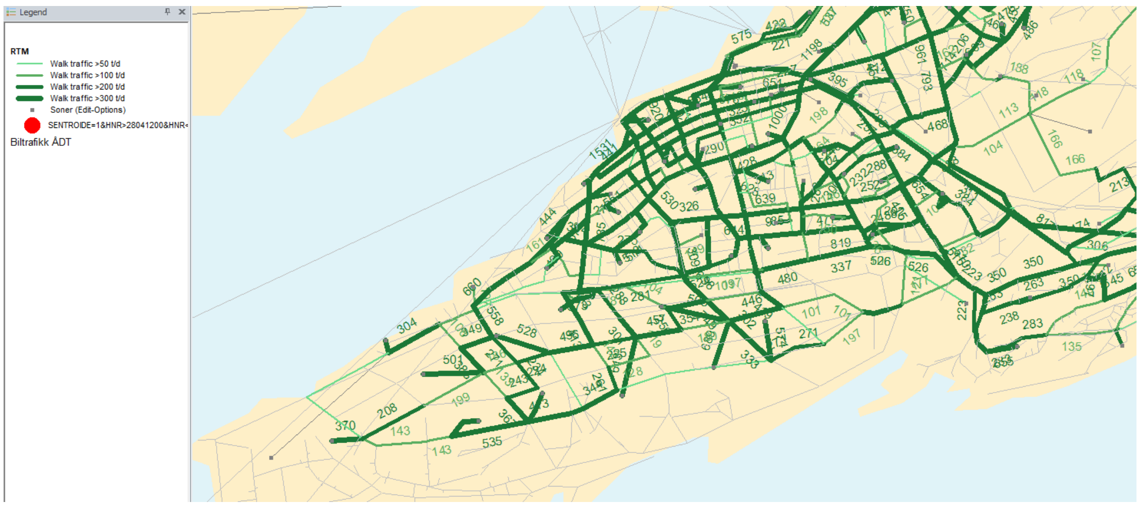


Figure 14: Walk traffic link loads

5 Micro mobility application results

A variety of calculations have been carried out with the micro mobility application, redistributing trips from other modes to e-scooter. The distribution of people in zones have two main scenarios, one where the zones have equal numbers of people; 1 000 each, and the other where two of the zones have 5 000 each. These two zones are located at the westmost zones in Nybyen. Various sensitivity analyses are done decreasing and increasing the number of inhabitants. The two public transport lines have headways of 10 minutes, which is quite frequent, but we have also included sensitivity scenarios where the headways are even lower. One sensitivity scenario has removed the two PT lines to see the overall impact of those lines. The impact from reducing car availability on the calculated use of micro mobility is tested through scenarios where 1) it is assumed that walking from the house to where the car is parked takes longer time and 2) that parking costs are increased. Unfortunately, the home parking costs are not included in the model, so this only reflects costs by parking at the destination of a trip. On the other hand, electric cars have free parking, so one scenario assumes that Nybyen residents only have electric cars.

The results are totals from the entire model area, including the four municipalities in the model. To show results more locally in Nybyen, a section at the end of this chapter isolates results for the ten zones defining Nybyen.

5.1 Basic scenario including Nybyen

Results for the basic scenario using the micro mobility application to reassign trips to the micro mobility mode shows the new mode distribution as presented in *Table 6*. The results seem relatively sound, with most of the micro mobility trips coming from walk mode and public transport, while few from car and bicycle. Since e-scooter is available only in the city centre and the surrounding areas, the average trip distance of micro mobility trips is also within the expected range. The overall share of micro mobility is 5 %, amounted to approximately 10 000 trips, which means that if the fleet has 3 000 units, they are in average used 3,3 times a day.

Table 6: Mode distribution basic scenario

Mode	Remaining		Transfered to mm	
	#	km	#	km
Car driver	116 914	6,25	491	0,51
Car passenger	9 541	5,90		
Public transport	15 666	6,99	2 076	2,48
Walk	47 907	1,48	7 489	1,52
Bicycle	15 970	2,80	121	0,50
Micro mobility			10 177	1,65

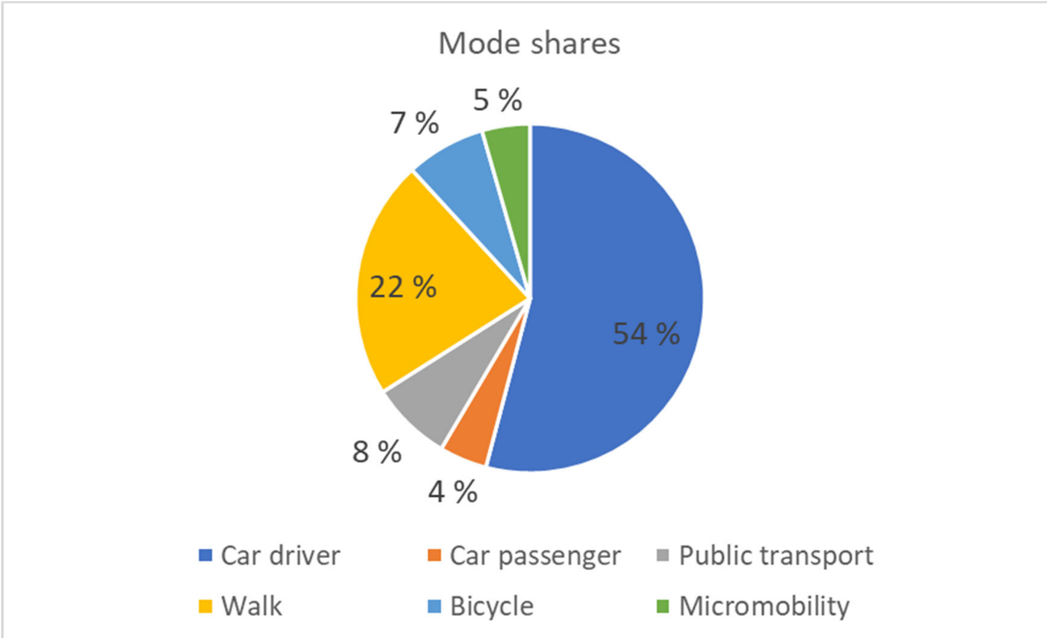


Figure 15: Mode shares Basic scenario with Nybyen

Figure 16 show where the e-scooters are assigned to the network. Darker colors indicate higher traffic volumes with e-scooter, and they are frequently used all over the allowed area.

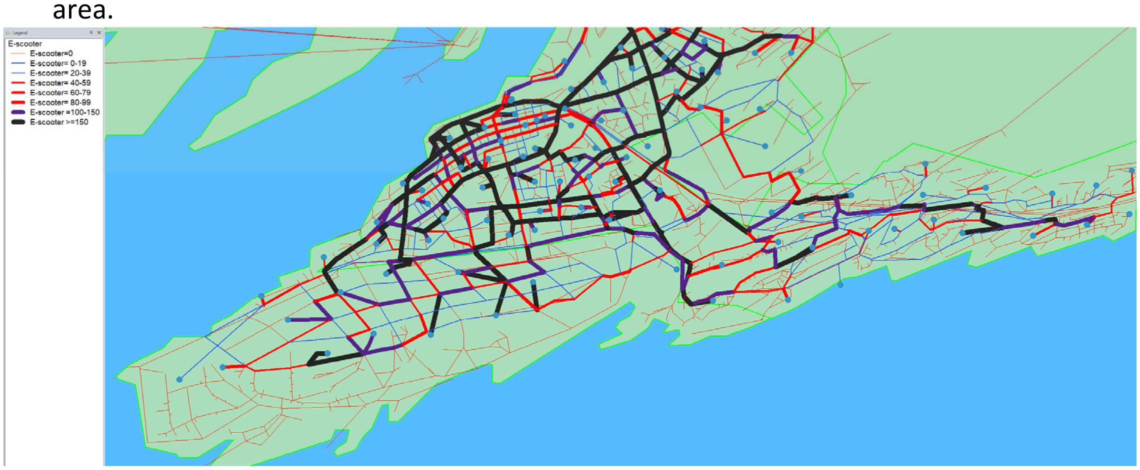


Figure 16: Link loads E-scooter basic scenario

5.2 Results from varying number of residents in Nybyen

In this section we explore the impact from number of residents in the Nybyen area on the trips on the available modes in the model. The scenarios are based on the basis scenario where 10 000 new residents are distributed equally over 10 zones. Then the population is multiplied with 1,5 (Pop*1,5) and 2 (Pop*2), and divided by 2 (Pop/2). The results in *Figure 17* show that number of residents certainly has an impact on number of trips with the various modes. Nybyen will imply that Bodø must expect more traffic in and around the city centre. To prevent the car traffic from increasing, they must introduce hard restrictions. Micro mobility and the other green modes are also increasing with more people but not enough to prevent increased car traffic. Instead, the municipality should prepare restrictive measures against car driving and promote and facilitate greener modes.

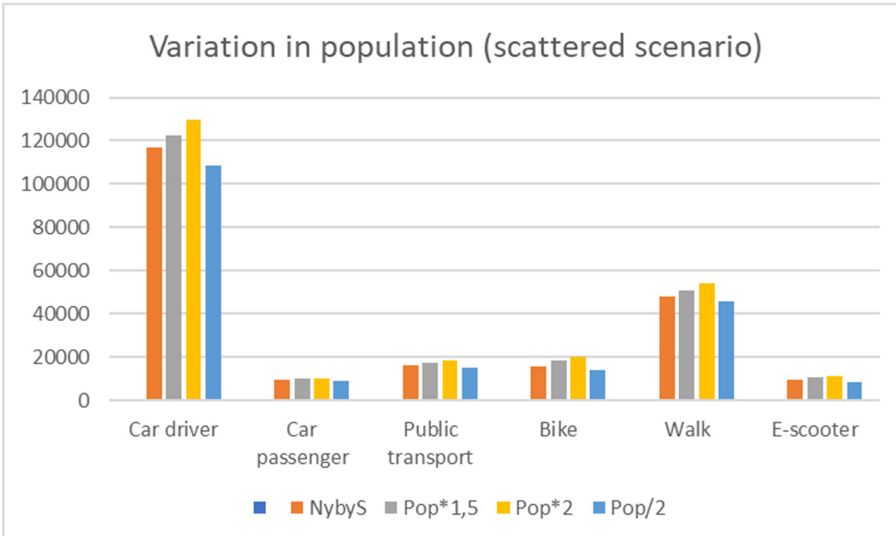


Figure 17: Trips on modes given more or less people living in Nybyen

5.3 Scattered versus densely populated area in Nybyen

One of the hypotheses in the project has been that densely populated areas create less car traffic than scattered. Thus, one of the scenarios was to populate two of the zones with the 10 000 new residents (NybyT in *Figure 18*). A denser area means there are more internal traffic. Also, because the zones are located westmost in Nybyen, the distance to all other zones generally increases, which may impact the destination and mode choices of the population. Overall results comparing the scattered to the densely populated Nybyen is given in *Figure 18*. Car trips are reduced, while public transport and walk trips are increased. This confirms our initial hypothesis.

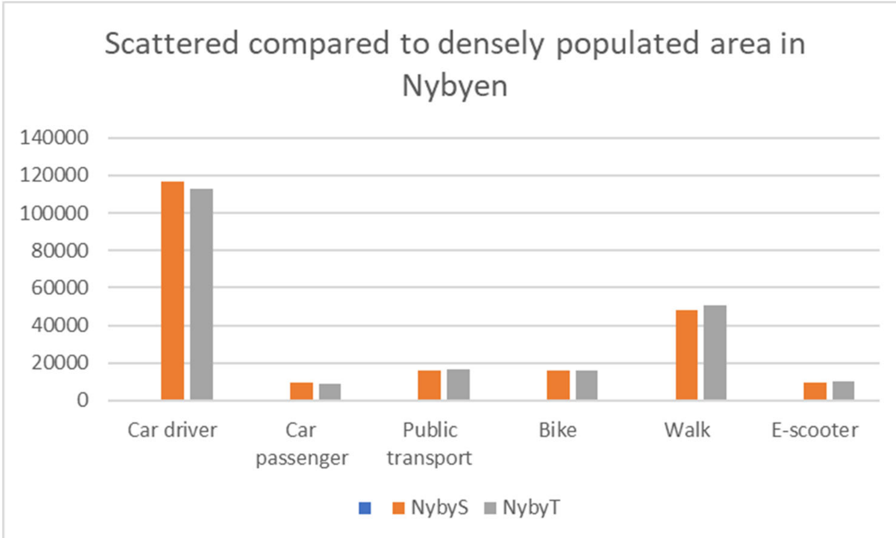


Figure 18: Scattered vs densely populated zones in Nybyen

The car traffic on the road network naturally changes in Nybyen. The population is now concentrated in the two zones marked with a blue ring in *Figure 19*. Traffic to and from those two zones increase, while other linkes get less traffic. What we also see it that the main connection between the city centre in the dense scenario becomes the western route, while with a scattered population there were two main routes, both the western route and one further east. Also, the southmost roads get increased traffic, because they start or end at other places than the city centre.

Figure 19: Difference plot, car traffic (AADT) densely vs scattered populated zones

5.4 Public transport sensitivity analyses

In the basic scenario, two frequent bus lines are going between Nybyen and the city centre. To show impact of the frequency on mode share, several sensitivity analyses were made. Results from these are presented in *Figure 20*.

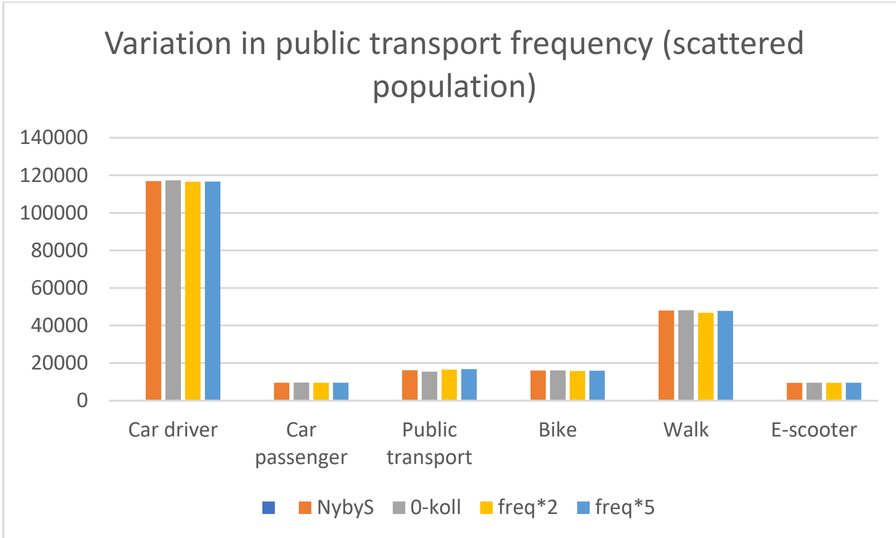


Figure 20: Impact on mode shares from frequency in the public transport lines serving Nybyen

In the transport model RTM, it is assumed that people walk to the bus stop and from the end bus stop to their final destinations (access and egress). RTM defines modes in a discrete, aggregate way, meaning people choose one out of five modes. Combination of modes is thus somewhat problematic. Modeling micro mobility as an alternative access and egress mode for public transport passengers is not straight forward.

From *Table 5* page 24 we get statistics on walk time and distances specified for Bodø municipality, and in the urban area (tettsted) the walk component of the public transport trips is about the same as on-board time (2129 vs 2123 minutes). From time valuation studies we learn that walk time is considerably more inconvenient for travelers than on-board time indicating that access and egress contributes more to the disutility with the public transport mode.

Our approach is to tinker with the links connecting the zones to the bus lines, but this solution does not take into account that the travelers actually choose between different modes and also might change mode from walk to e-scooter along the way to the bus stop. The first attempt was done with adding new zone connectors from the ten Nybyen zones to a bus stop, decreasing the distance and thus time on access from and egress to Nybyen.

Although these links were specified to be public transport connector links, they were interpreted in the model as links which could be accessed by walk mode too. It was also not possible to code a new mode specific link going between two nodes with an existing link.

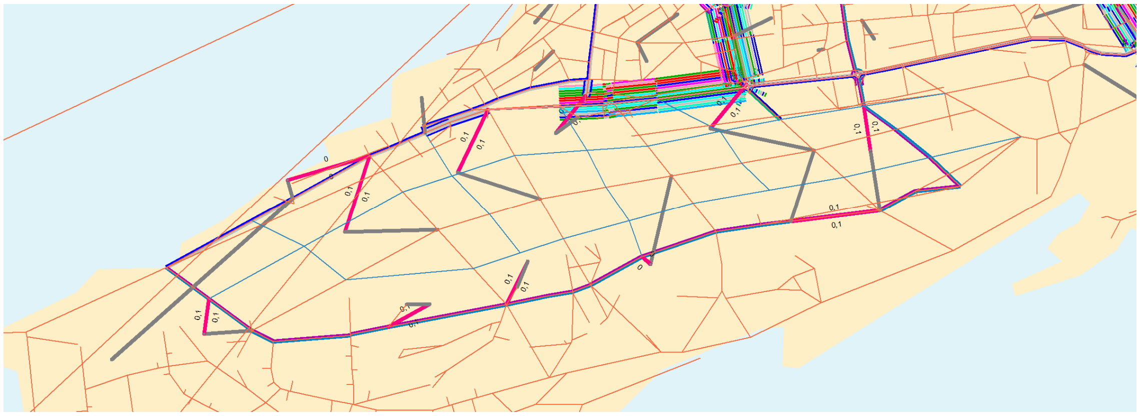


Figure 21: New short ***zone connectors (pink)*** *to public transport*

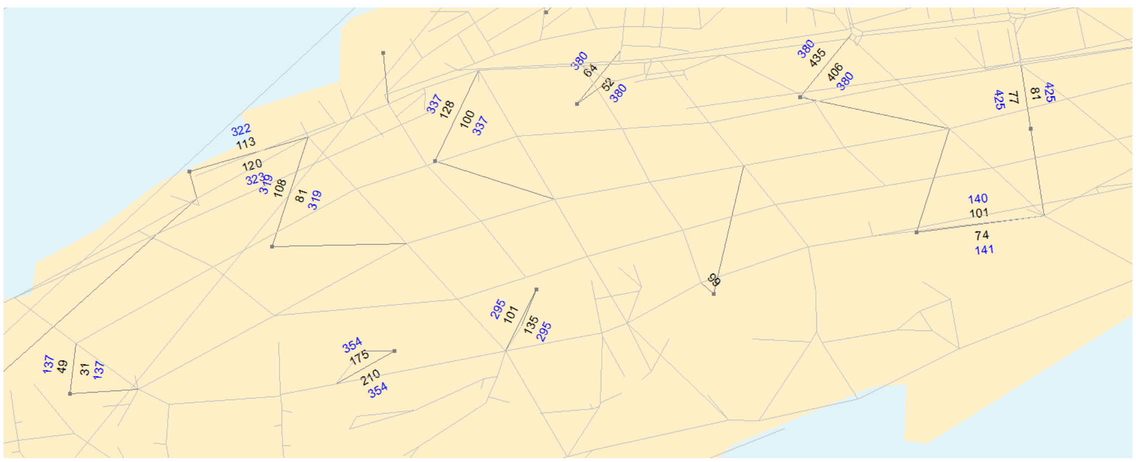


Figure 22: ***Access/egress volumes (black)*** *and* ***walk volumes (blue)*** *on the new links*

Shorter walking distances and access/egress to public transport impacts the initial mode choice towards walk and public transport, which are the two modes which potentially is replaced with or combined with micro mobility; thus, this has an impact on the demand for micro mobility as well.

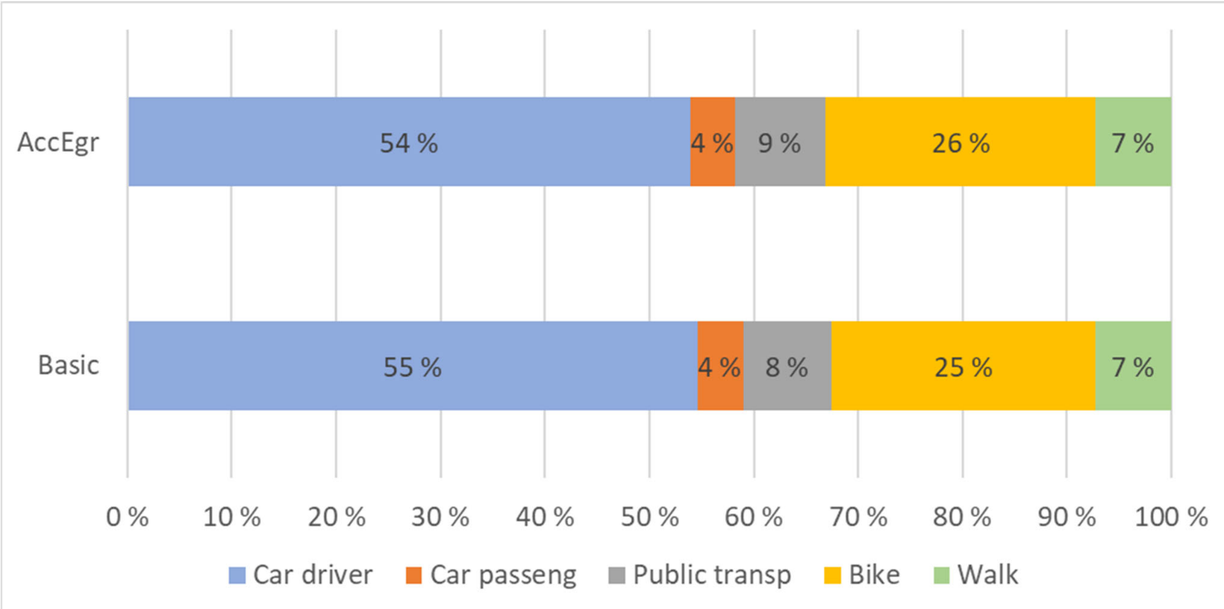


Figure 23: Initial mode distribution New access and egress links compared to the basic situation

To fully represent the combination of micro mobility and public transport through this approach in Bodø, new zone connectors should have been coded for the whole area where e-scooters are available, but for this test we only did it for zones in Nybyen. The mode distribution is presented in the appendix.

5.5 Limiting car use

Few travelers change modes from car to micro mobility. Increasing the time use to represent longer walking time to get to the car would transfer trips away from car and towards other modes, making it more likely to choose green modes, including micro mobility.

In this scenario, the zone connectors have a speed for car traffic of 5 km/h as shown in Figure 24. The change must apply only for car traffic, otherwise the other modes would also be less attractive.

Results are presented in Figure 25. Mode distribution including micro mobility is presented in appendix, Figure 31 page 45 and Table 20 page 46.

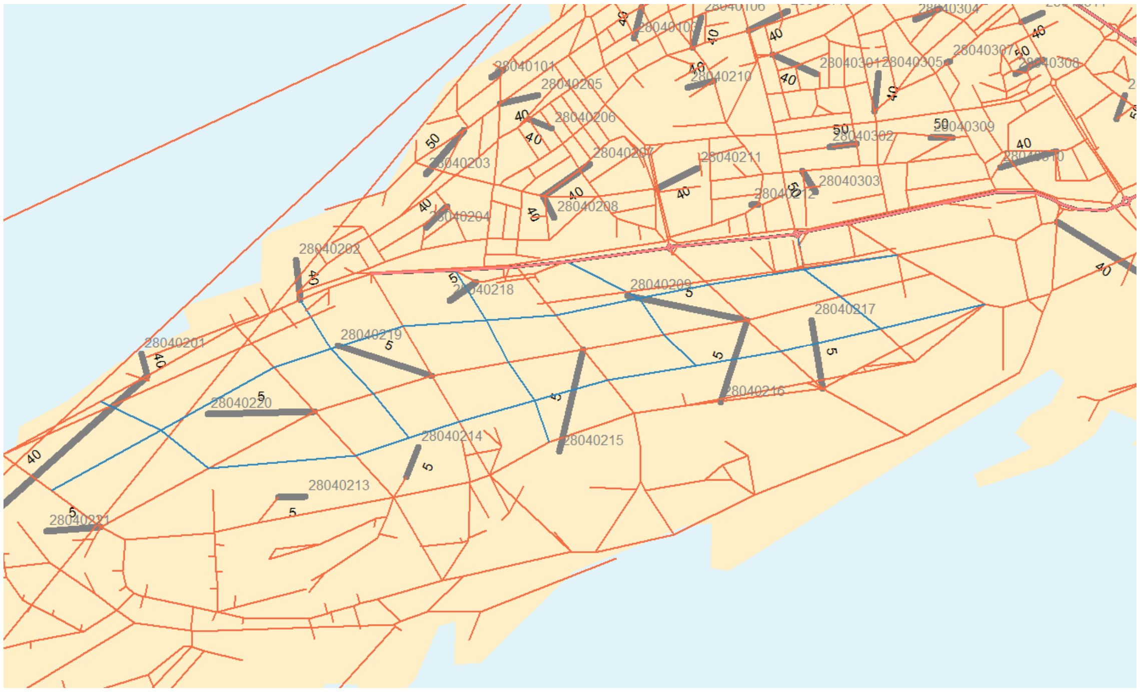


Figure 24: Lower speeds (5 km/h) coded on zone connectors in Nybyen

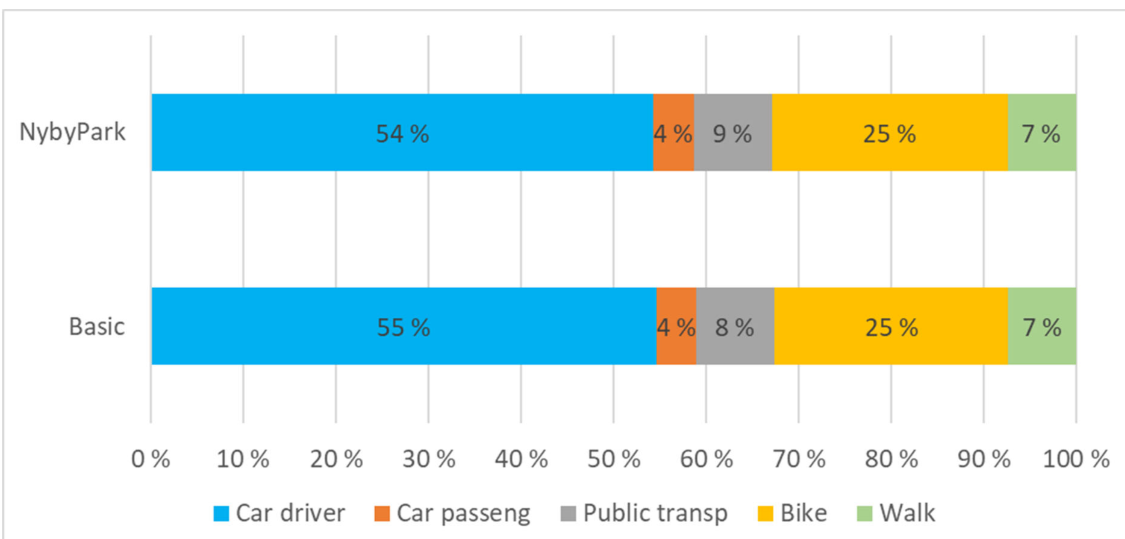


Figure 25: Initial mode distribution longer zone connectors for cars compared to the basic situation

5.6 Results specific to Nybyen

Results from the initiatives in the scenarios might seem insignificant simply because they drown in the overall results from the whole model area. To more clearly reveal differences between the scenarios, results specific to Nybyen are presented in this section. This is done on a matrix level aggregating trips based on where they start and end. Two types of results are extracted; one for trips with both trip ends in Nybyen, named internal trips (orange area in *Table 7*), and the second for all trips starting in Nybyen (orange and blue area in *Table 7*). The trip matrices are almost symmetrical, which means that the results would have been the same if trips ending in Nybyen were presented instead.

Table 7: Aggregation of trips to isolate results from Nybyen

From\To	Nybyen zones	Other zones
Nybyen zones	Internal trips	Starting in Nybyen to other zones
Other zones in the model area	Starting in other zones, ending in Nybyen	Starting and ending in other zones than Nybyen

5.7 Internal trips

Internal trips are the trips starting and ending in the ten zones of Nybyen. This means that the trip distances are generally shorter in average than trips between this area and other zones.

The number of trips are mostly dependent on number of residents, but we also learn that the densely populated scenario has a lot more internal trips than the basic scenario, and that these are dominated by the walk mode and the micro mobility mode.

Number of trips vary, as shown in Figure 26, mostly because some of the scenarios have more or less residents in the area, but also due to the transport service available. The five first scenarios and the two last all have the same number of residents in Nybyen. The biggest difference in number of trips can be found in the scenario where the population is concentrated in two zones. This scenario also has the lowest number of car trips out of the scenarios with 10 000 residents in Nybyen. Instead, the trips are dominated by walk mode and the micro mobility mode

Naturally, as the trips internally in Nybyen are quite short, higher bus frequencies (NybyenFg5/2) or easier access to bus stops (NybyAccEgg) have limited impact on the number of trips or the distribution on modes.

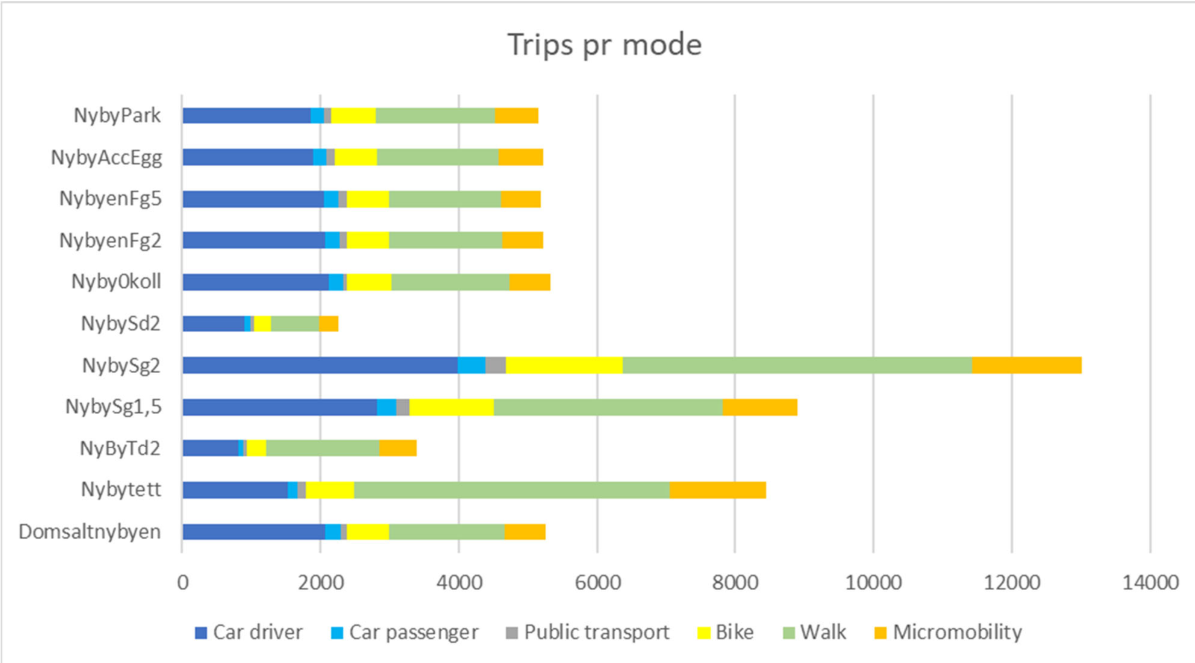


Figure 26: Number of internal trips in Nybyen by modes and senarios

Looking at the mode shares (Figure 27), the difference between the sparsely (Domsaltnybyen) and the densely populated (Nybytett) area in Nybyen is significant. When people live close together, the trip distances are generally short, increasing the active mode shares. Still, looking at the bike mode, the dense scenarios have the lowest shares of bike trips, while especially the walk mode but also micro mobility has large shares of the trips.

Figure 27 also reveals an effect of the parking restrictions tested in NybyPark, with a somewhat lower car share (- 5 %) compared to the basic scenario (Domsaltnybyen).

The number of residents and how densely they live affect the mode distribution. Comparing the results of a dispersed population, multiplying the population with 1,5 (NybySg1,5) and 2 (NybySg2) increases the green mode share, especially walking, while dividing the population by 2 (NybySd2), does the opposite. The dense scenario (Nybytett) has the lowest share of car trips. Also, the public transport share has decreased, although this was minor in the basic scenario as well. All these are in the dense scenario transferred to active modes.

Increasing the frequency of the public transport lines serving Nybyen increases the PT share, but the new passengers come mainly from active modes.

The car shares, both car driver and car passenger, decrease with shorter links to bus stops and longer walk time to get to the car. These are mostly transferred to active modes.

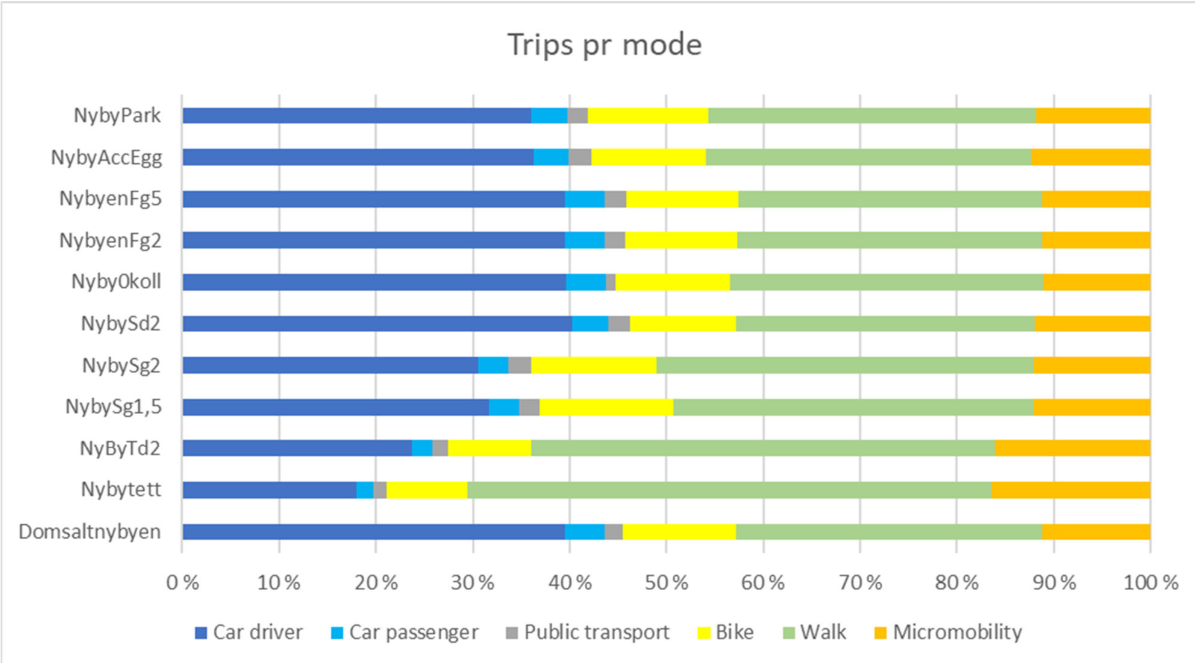


Figure 27: Mode shares of internal trips in Nybyen

5.8 All trips starting in Nybyen

In the following section the internal trips are added to trips starting in Nybyen. The matrices are symmetrical so adding trips that end in Nybyen instead would give approximately the same result. The reason we only added trips that start there, and not the trips that end there, is because then trips to and from would dominate the results. Thus, the figures show all trips that start in Nybyen.

When we also include trips with one end of the trip in Nybyen, and add it to the internal trips, the picture changes slightly, as the total number of trips between scenarios of equal number of residents evens out. The most dramatic difference from Figure 26 to Figure 28 is that the dense scenario now has only slightly more trips than the basic scenario. Otherwise, the number of trips is highly dependent on the number of residents in the area. The mode distribution still varies between scenarios, but the differences are smaller.

The densely populated scenario produces slightly more trips than the basic scenario. This can be explained by two factors. Either the residents in the dense area make more trips because they have a lot of attractions locally, or it could be that people living outside of this area are attracted to this area because many people live there. Unfortunately, it is not possible to separate between these two impacts in the model.

The parking restrictions scenario produces slightly less trips than the basic scenario, and the reduction in trips by car as a driver is the main reason, indicating that the restrictions worked as intended.

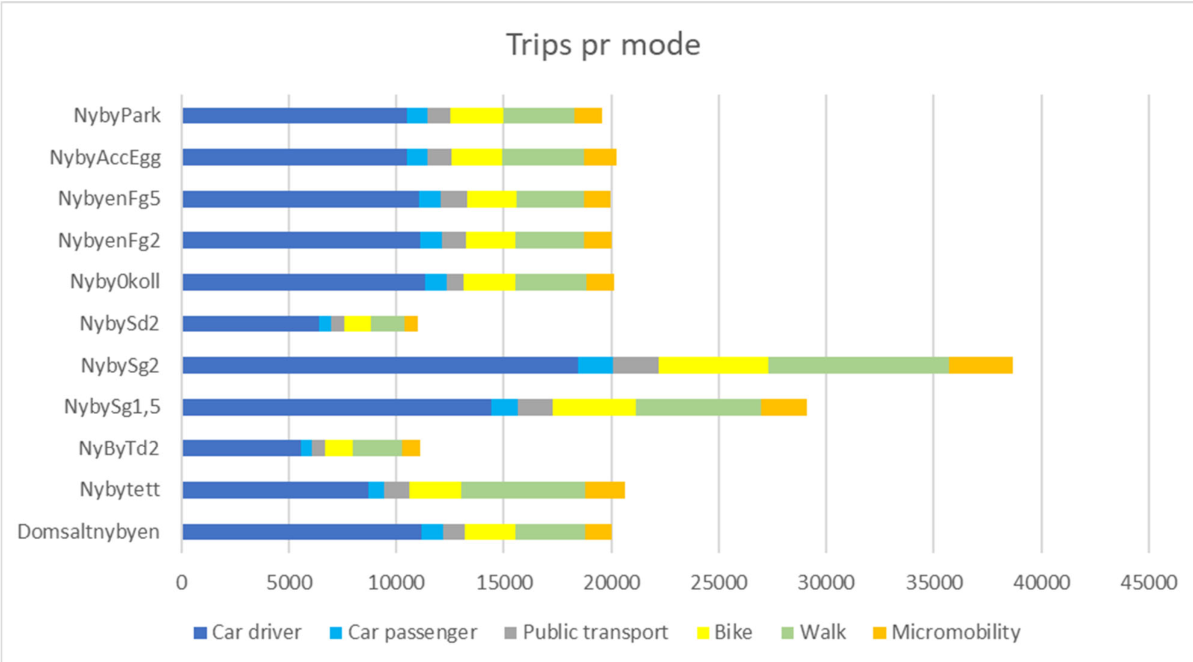


Figure 28: Number of trips starting in Nybyen by modes and senarios

The mode distribution for trips starting in Nybyen shows that the parking scenario works as intended. The access and egress scenario has an impact, but more on walking than public transport shares. Also, there is a difference between having the public transport lines and no lines, but the increased frequencies have little effect.

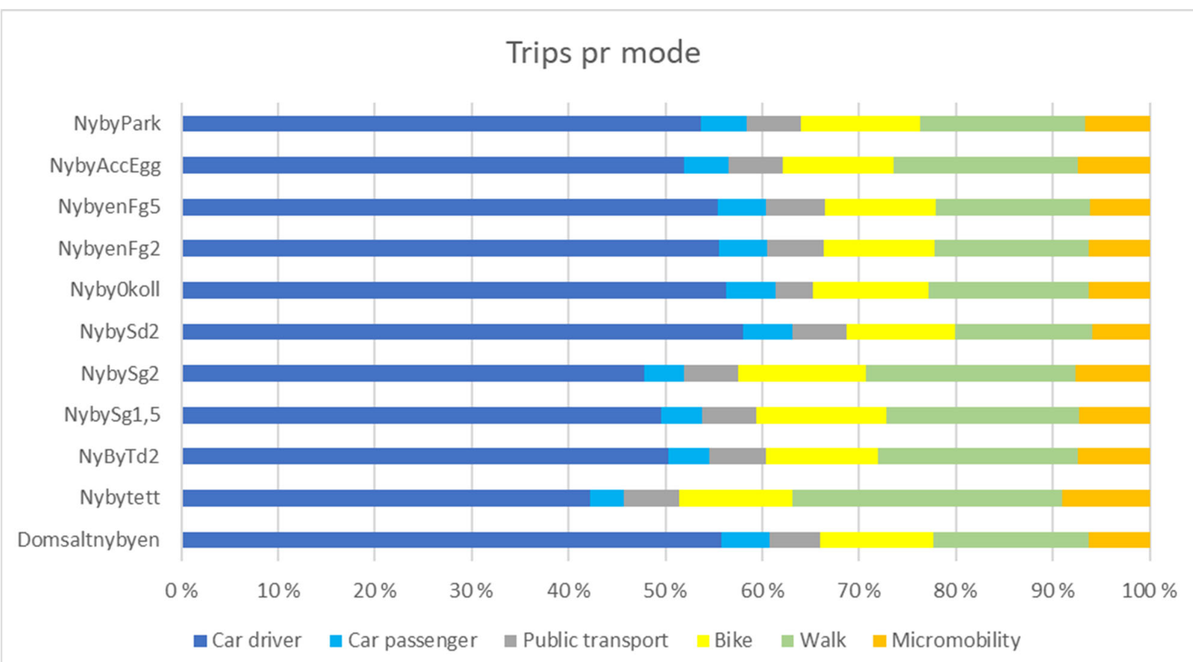


Figure 29: Mode shares of trips starting in Nybyen

As previous figures have shown, the number of micro mobility trips vary between the scenarios tested, both with number of residents in the area, how dense the zones are populated, and with the transport services offered to the population. To extract results for micro mobility, *Figure 30* shows number of trips starting in Nybyen with e-scooter. The number of e-scooter trips increases with the number of residents in the area, with density of the population, and with better walking access to bus stops. The public transport service and parking restrictions have little influence on the number of e-scooter trips.

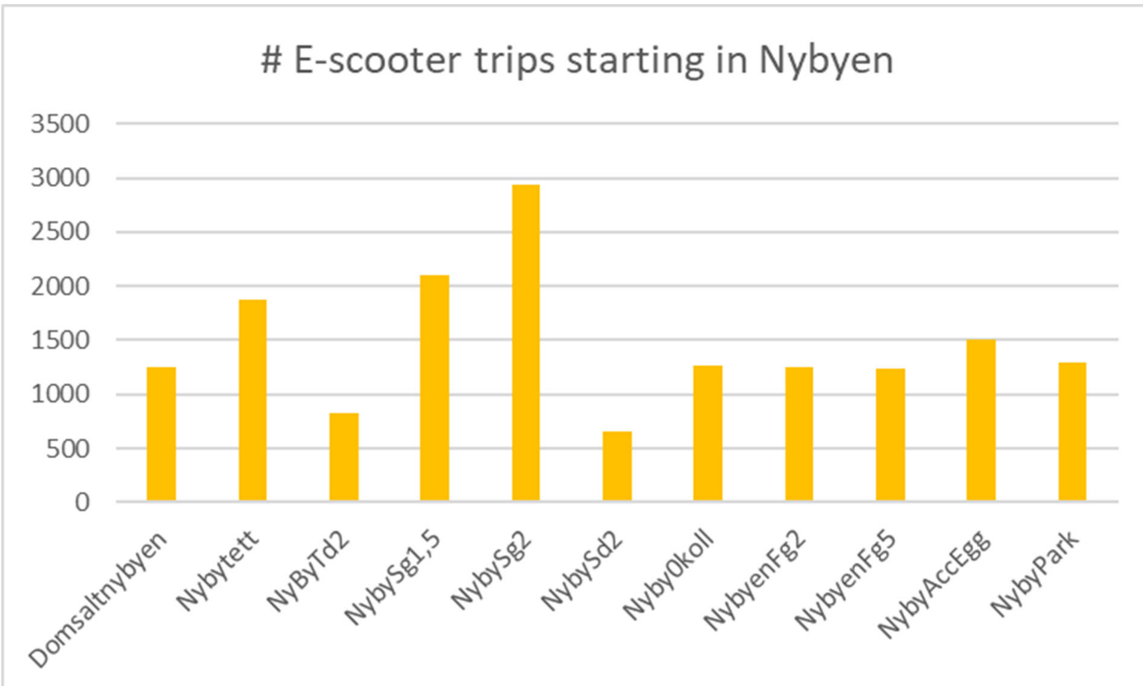


Figure 30: Number of e-scooter trips starting in Nybyen by scenarios

6 Discussion

The discussion in this chapter focuses on the lessons learned from this project, to implement micro mobility in a strategic transport model for the future.

6.1 RTM's suitability for modeling micro mobility

RTM is available for all potential users, with input data, parameters and additional app's for various purposes. It is also the strategic model most used in Norway today and is continuously updated and improved. To actually use it, it is necessary to have a subscription of CUBE, or EMME if the model is to be used in Oslo.

RTM is a strategic model and as such intended for use in predicting the travel demand for the future, and to test various policies suggested by politicians or other stakeholders.

The past years, modeling urban travel behavior has become more common, due to political goals of greener mobility implying reduction in emissions from transport. Therefore, the model needs to develop towards handling urban transport services in a better way. As part of that, micro mobility should be included in the model system.

This project intended to test the inclusion of micro mobility in RTM, using the initial calculated demand and redistributing trips to micro mobility, or more specifically e-scooters. The advantage of this approach was that RTM could be used without altering any routines and, most importantly, using the demand model Tramod-by as provided. This was done by programming an add-on app, which reads results from RTM and produces a new mode distribution, including a sixth mode – micro mobility.

The micro mobility application relies on several assumptions. There are several problems with these assumptions, both on the supply and demand side, and the combination, but given that we lack information, this was the most pragmatic solution. The application still works as intended, and redistributes trips from all the other five modes to micro mobility.

One assumption was problematic along the way: that RTM do not take combined modes on trips into account. This could have been solved by introducing multiple mode, where e.g. micro mobility combined with bus was a separate alternative, micro mobility combined with car as passenger was one alternative etc. This seemed like an overwhelming programming task given the scarce knowledge and data we had available for this project.

Apart from this weakness, RTM in combination with the micro mobility application gives plausible results. It is also sensitive for various scenarios.

6.2 Input data needed to design a model which includes micro mobility

The micro mobility application developed in this project uses international experiences when available and assumptions based on experience to decide parameters for the choice model. Some of these assumptions need to be reevaluated if the application is used for planning purposes. The needed data is listed and explained in *Table 8*, although it is probably not exhaustive.

Table 8: Data needs for modeling purposes

Data	Comments
Willingness to use	Currently younger people and men are using e-scooters more frequently than others. In the future we might experience a development in micro mobility modes, and in the attitudes of the population, leading to more groups of people using the service(s). These developments should be monitored to make reasonable prognoses of usage.
Usage parameters	In this study we relied on international literature and assumptions for many parameters because no, or no Norwegian data, were available. Data about elasticities between other modes and micro mobility, duration, length, and variability in these, are necessary. These should be collected for Norwegian conditions. Also, because the weather and road conditions are challenging in many Norwegian cities, an investigation about how these factors impact the usage is useful. Micro mobility is also seen as an attractive mode in combination with other modes, especially with bus. Knowledge about combined trips is needed to understand the extent of usage.
Price structure of the usage	In this study assumption according to last years' price structure with the local service was used, with a start-up fee and a time dependent rental cost. If a subscription is available, the cost structure changes, making the usage cheaper for frequent users.
Number of units and availability	Some of the Norwegian cities have had problems with too many units, causing conflicts between parked mm-units and other travelers. Some of the municipalities have thus made regulations to restrict parking mm-units to specific places, which probably increases the walking distance from the origin of the trips to the unit, and from the unit to the final destinations. Some municipalities have regulated how many units can be available to limit problems with e-scooters flung everywhere. To reduce the number of accidents with e-scooters, some municipalities have restricted usage of e-scooters at night time, primarily to prevent usage under the influence.

Currently e-scooters can use infrastructure designed for walking, biking, and driving. They are not restricted on any roads. This might change, and if it does, we need to code the specific network available for them. In case they have docking stations, this should also be coded.

Accidents with e-scooters are a problem. Although it wouldn't have affected our modeling approach directly, it could impact how e-scooters are used and regulated by the authorities. In a wider perspective, knowledge about how accidents happen, to whom and how often is needed.

Data can be collected via surveys. It seems natural that the travel surveys should be extended to include micro mobility modes.

Automatic counts of number of people walking and biking might currently be confused by e-scooter trips, thus the counting equipment should be improved to differentiate between various modes.

Data about usage is currently available for the providers of e-scooters. They track the unit and the usage. An initiative should be taken to collect such data for research purposes.

7 Conclusions

Through this project we have identified several knowledge gaps. We have gotten an overview of the knowledge internationally, which is a good start to build on for further research. The model developed in this project could work as a temporary solution, although parameters in the model probably should be reconsidered before using it for new areas/cities.

Micro mobility trips are used for more than just zone internal trips as the average trip distance is around 2 km. The usage has grown and is probably still growing, which means it is a competitor to other active modes and to short public transport trips. In addition, it complements the public transport trips, making the access and egress part of trips much faster. This is probably also true when it comes to car trips, when the parking is located far away from the origin or destination of trips.

Micro mobility is primarily an urban phenomenon and is therefore important to take into account when modeling and planning urban travel behavior. The usage is still dominated by young adults and more men than women use it, but this can change over time. The units and legislation could also develop so that more risk averse people would be tempted to use it, or new forms of micro mobility might appear so that they could be used for more purposes or over longer distances.

If the micro mobility mode has come to stay, we should have a planning tool that takes it into account!

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9 Appendix

9.1 # Total trips from scenarios on modes and purposes from RTM

Table 9: Trip totals, Nyby scattered population multiplied, basic scenario (Domsaltnybyen)

											Faste matriser	
Reisemiddel	**Turer**	**Andel**	**Arbeid**	**Tjeneste**	**Fritid**	**Hentelevere**	**Privat**	**APbasert**	**Innfart-P**	**Skole**	**Flyplass**	**Gods**
Bilf⍰rer	119811	55%	34017	8930	19335	14791	34595	1405	0	4258	1652	829
Bilpassasjer	9616	4%	1394	367	3737	763	3096	261	0	0	0	0
Kollektiv	18546	8%	3649	478	1460	470	2380	769	0	9007	334	0
Gang	55397	25%	7007	1429	9781	4596	15259	2229	0	15094	0	0
Sykkel	16091	7%	4445	845	4044	1601	4863	292	0	0	0	0
Totalt	219461		50512	12049	38357	22221	60194	4956	0	28359	1986	829

Table 10: Trip totals, Nyby dense population multiplied (Nybytett)

											Faste matriser	
Reisemiddel	**Turer**	**Andel**	**Arbeid**	**Tjeneste**	**Fritid**	**Hentelevere**	**Privat**	**APbasert**	**Innfart-P**	**Skole**	**Flyplass**	**Gods**
Bilf⍰rer	115962	53%	33843	8673	18537	14271	32534	1386	0	4238	1652	829
Bilpassasjer	9174	4%	1365	374	3590	702	2886	257	0	0	0	0
Kollektiv	18850	9%	3773	507	1503	483	2468	771	0	9010	334	0
Gang	58489	27%	7034	1454	10661	5030	16960	2239	0	15111	0	0
Sykkel	16384	7%	4488	878	4014	1589	5124	292	0	0	0	0
Totalt	218860		50503	11885	38304	22075	59972	4946	0	28359	1986	829

Table 11: Trip totals, Nyby dense population divided by 2 (NybyTd2)

											Faste matriser	
Reisemiddel	**Turer**	**Andel**	**Arbeid**	**Tjeneste**	**Fritid**	**Hentelevere**	**Privat**	**APbasert**	**Innfart-P**	**Skole**	**Flyplass**	**Gods**
Bilf⍰rer	107382	54%	30156	7887	17212	13519	30583	1393	0	4151	1652	829
Bilpassasjer	8365	4%	1209	319	3264	663	2651	258	0	0	0	0
Kollektiv	17126	9%	3154	411	1287	403	2095	767	0	8675	334	0
Gang	51722	26%	6241	1270	9006	4249	14159	2245	0	14553	0	0
Sykkel	13434	7%	3841	725	3340	1314	3924	290	0	0	0	0
Totalt	198029		44600	10612	34110	20147	53413	4953	0	27378	1986	829

Table 12: Trip totals, Nyby scattered population multiplied with 1,5 (NybySg1_5)

											Faste matriser	
Reisemiddel	**Turer**	**Andel**	**Arbeid**	**Tjeneste**	**Fritid**	**Hentelevere**	**Privat**	**APbasert**	**Innfart-P**	**Skole**	**Flyplass**	**Gods**
Bilf⍰rer	125676	54%	36548	9481	20257	15481	35717	1392	0	4318	1652	829
Bilpassasjer	9978	4%	1485	401	3902	754	3178	259	0	0	0	0
Kollektiv	19871	9%	4010	543	1671	533	2701	781	0	9299	334	0
Gang	59306	25%	7582	1568	10658	4940	16896	2232	0	15431	0	0
Sykkel	18584	8%	4919	962	4625	1839	5942	297	0	0	0	0
Totalt	233416		54545	12955	41112	23546	64434	4960	0	29048	1986	829

Table 13: Trip totals, Nyby scattered population multiplied with 2 (NybySg2)

											Faste matriser	
Reisemiddel	**Turer**	**Andel**	**Arbeid**	**Tjeneste**	**Fritid**	**Hentelevere**	**Privat**	**APbasert**	**Innfart-P**	**Skole**	**Flyplass**	**Gods**
Bilf⍰rer	132424	54%	39081	10108	21350	16204	37432	1395	0	4374	1652	829
Bilpassasjer	10502	4%	1586	434	4107	784	3331	259	0	0	0	0
Kollektiv	21085	9%	4376	602	1829	595	2951	788	0	9610	334	0
Gang	62979	25%	8169	1704	11515	5360	18315	2229	0	15687	0	0
Sykkel	20516	8%	5358	1067	5131	1895	6765	300	0	0	0	0
Totalt	247506		58569	13915	43932	24840	68794	4971	0	29671	1986	829

Table 14: Trip totals, Nyby scattered population divided by 2 (NybySd2)

Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Faste matriser	
											Flyplass	Gods
Bilf□rer	111616	54%	31374	8197	17938	13989	32045	1399	0	4192	1652	829
Bilpassasjer	8908	4%	1282	336	3470	706	2855	259	0	0	0	0
Kollektiv	17596	9%	3309	428	1348	427	2188	767	0	8795	334	0
Gang	52839	26%	6507	1314	9225	4352	14454	2237	0	14749	0	0
Sykkel	14307	7%	4018	753	3593	1412	4240	290	0	0	0	0
Totalt	205267		46491	11030	35574	20886	55782	4953	0	27736	1986	829

Table 15: Trip totals, Nyby scattered population without the new public transport lines (Nyby0Koll)

Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Faste matriser	
											Flyplass	Gods
Bilf□rer	120151	55%	34108	8946	19399	14827	34703	1430	0	4258	1652	829
Bilpassasjer	9670	4%	1398	369	3759	765	3115	264	0	0	0	0
Kollektiv	17693	8%	3490	437	1248	394	2095	688	0	9007	334	0
Gang	55647	25%	7040	1435	9845	4614	15345	2273	0	15094	0	0
Sykkel	16250	7%	4475	851	4090	1612	4922	301	0	0	0	0
Totalt	219411		50511	12037	38340	22213	60180	4956	0	28359	1986	829

Table 16: Trip totals, Nyby scattered population, more frequent bus lines, headway =5 (NybyenFg2)

Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Faste matriser	
											Flyplass	Gods
Bilf□rer	119482	55%	33918	8918	19271	14763	34488	1384	0	4258	1652	829
Bilpassasjer	9585	4%	1391	366	3724	761	3086	258	0	0	0	0
Kollektiv	18915	9%	3698	493	1549	506	2496	833	0	9007	334	0
Gang	54181	25%	6825	1391	9454	4470	14827	2120	0	15094	0	0
Sykkel	15800	7%	4385	831	3966	1572	4769	277	0	0	0	0
Totalt	217964		50217	12000	37964	22072	59665	4871	0	28359	1986	829

Table 17: Trip totals, Nyby scattered population, more frequent bus lines, headway =2 (NybyenFg5)

Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Faste matriser	
											Flyplass	Gods
Bilf□rer	119558	54%	33958	8919	19288	14762	34518	1374	0	4258	1652	829
Bilpassasjer	9576	4%	1390	366	3720	760	3083	256	0	0	0	0
Kollektiv	19188	9%	3749	503	1614	534	2584	863	0	9007	334	0
Gang	55194	25%	6988	1426	9733	4580	15194	2179	0	15094	0	0
Sykkel	15983	7%	4427	842	4013	1591	4826	283	0	0	0	0
Totalt	219499		50512	12056	38369	22228	60205	4956	0	28359	1986	829

Table 18: Trip totals, Nyby scattered population, new access and egress links to the bus lines (NybyAccEgg)

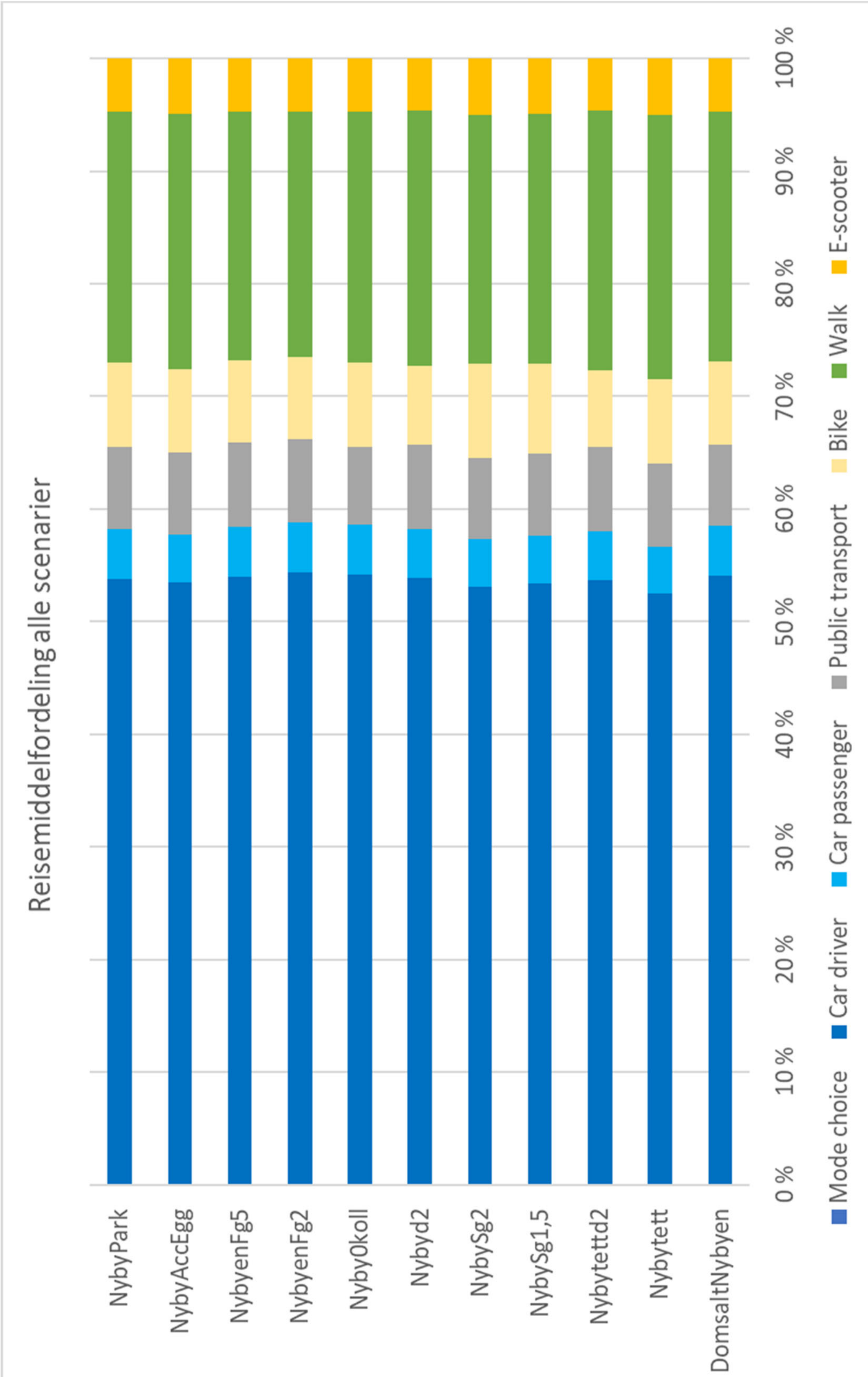
Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Faste matriser	
											Flyplass	Gods
Bilf□rer	118448	54%	33682	8865	19079	14653	34052	1375	0	4260	1652	829
Bilpassasjer	9470	4%	1378	364	3684	753	3036	256	0	0	0	0
Kollektiv	18817	9%	3686	493	1544	510	2481	798	0	8973	334	0
Gang	56871	26%	7345	1499	10065	4732	15866	2239	0	15126	0	0
Sykkel	16005	7%	4423	842	4031	1601	4820	288	0	0	0	0
Totalt	219611		50514	12062	38403	22249	60254	4955	0	28359	1986	829

Table 19: Trip totals, Nyby scattered population, new speeds on the zone connectors (5 km/h) (NybyPark)

Reisemiddel	Turer	Andel	Arbeid	Tjeneste	Fritid	Hentelevere	Privat	APbasert	Innfart-P	Skole	Faste matriser	
											Flyplass	Gods
Bilf□rer	119115	54%	33879	8898	19189	14688	34336	1386	0	4258	1652	829
Bilpassasjer	9518	4%	1345	361	3718	757	3079	258	0	0	0	0
Kollektiv	18651	9%	3698	483	1472	477	2403	777	0	9007	334	0
Gang	55699	25%	7045	1439	9857	4639	15386	2239	0	15094	0	0
Sykkel	16302	7%	4475	853	4095	1628	4956	295	0	0	0	0
Totalt	219286		50443	12035	38331	22188	60160	4955	0	28359	1986	829

9.2 Mode choice all scenarios for the model area?

Figure 31: Mode shares all scenarios RTM Domsalt



9.3 Mode shares in Nybyen

This table shows trips by mode for internal trips, to the rest of Bodø municipality (one way) and the sum of trips starting in Nybyen.

Table 20: Mode distribution all scenarios

Internal											
Modes	Domsaltnybyen	Nybytett	NyByTd2	NybySg1,5	NybySg2	NybySd2	Nyby0koll	NybyenFg2	NybyenFg5	NybyAccEg	NybyPark
Car driver	2075	1523	806	2816	3982	906	2115	2062	2053	1893	1853
Car passenger	214	140	71	277	403	86	220	211	210	190	195
Public transport	98	119	56	197	296	49	48	111	120	124	106
Bike	613	707	289	1224	1695	248	636	606	601	616	644
Walk	1659	4564	1628	3314	5053	693	1720	1639	1626	1753	1736
Micromobility	590	1388	544	1077	1582	270	595	587	584	647	613
SUM	5249	8441	3394	8905	13011	2252	5334	5216	5194	5223	5147
To Bodø											
Modes											
Car driver	9084	7207	4783	11601	14486	5477	9201	9045	9019	8619	8658
Car passenger	796	578	397	956	1184	476	812	790	786	745	746
Public transport	948	1048	603	1424	1881	574	719	1041	1105	1024	973
Bike	1713	1705	986	2664	3392	985	1766	1697	1685	1696	1779
Walk	1565	1187	669	2497	3344	869	1607	1551	1541	2088	1614
Micromobility	665	487	281	1031	1360	380	670	661	659	863	683
SUM	14771	12212	7719	20173	25647	8761	14775	14785	14795	15035	14453
SUM of internal +	Scenario										
to rest of B	Domsaltnybyen	Nybytett	NyByTd2	NybySg1,5	NybySg2	NybySd2	Nyby0koll	NybyenFg2	NybyenFg5	NybyAccEg	NybyPark
Modes											
Car driver	11159	8730	5589	14417	18468	6383	11316	11107	11072	10512	10511
Car passenger	1010	718	468	1233	1587	562	1032	1001	996	935	941
Public transport	1046	1167	659	1621	2177	623	767	1152	1225	1148	1079
Bike	2326	2412	1275	3888	5087	1233	2402	2303	2286	2312	2423
Walk	3224	5751	2297	5811	8397	1562	3327	3190	3167	3841	3350
Micromobility	1255	1875	825	2108	2942	650	1265	1248	1243	1510	1296
SUM	20020	20653	11113	29078	38658	11013	20109	20001	19989	20258	19600

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Kunnskap for en bedre verden