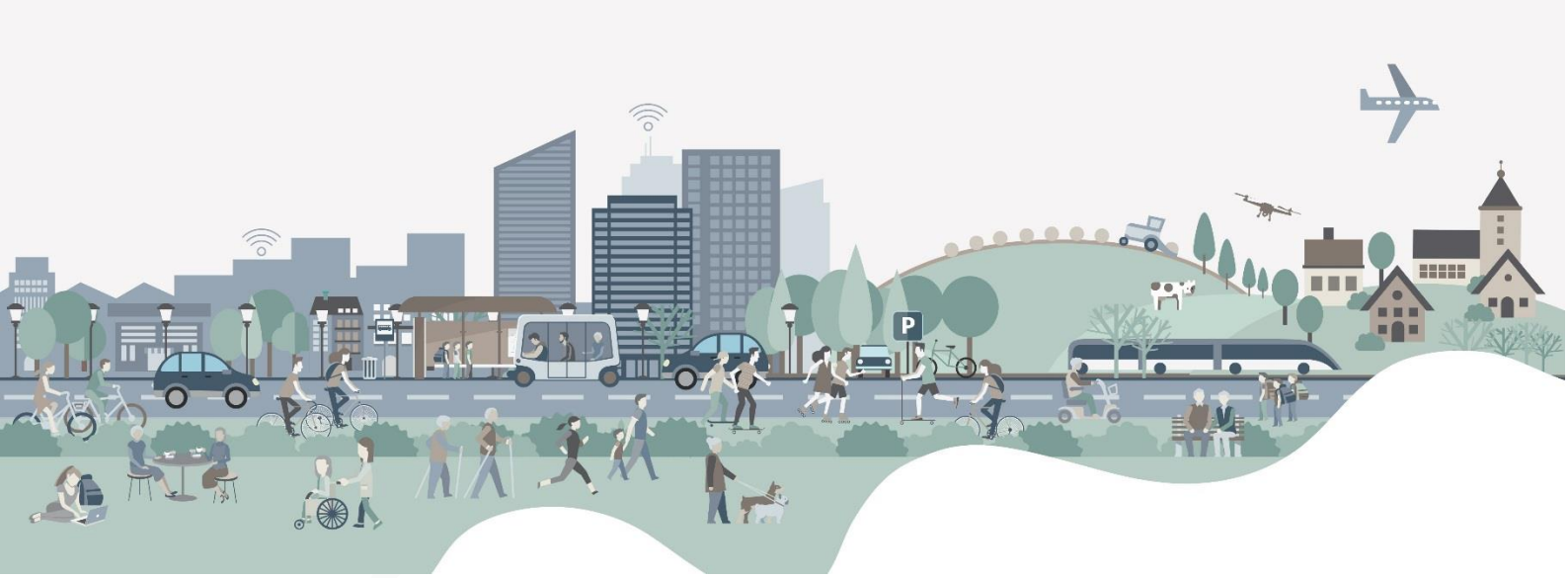
SEPTEMBER 2017

BORGARLÍNA RECOMMENDATIONS

SCREENING REPORT



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CONTENTS

1 Background

The focus for improving the public transport system in the Reykjavik Capital Area has increased over the last years. The Regional Plan for the area is therefore aiming for a high-class public transport system called Borgarlína. The goal is to develop a solid backbone of public transport in the main corridors in the Capital Area. The concept will be either bus rapid transit (BRT) or a light rail transit (LRT) – in both cases ensuring a congestion free, fast and high frequent transport option.

1.1 Process

The overall work process towards the operation of the *Borgarlína* can be perceived as five phases as pictured in Figure 1. Phase A has finished and the project are now in Phase B.

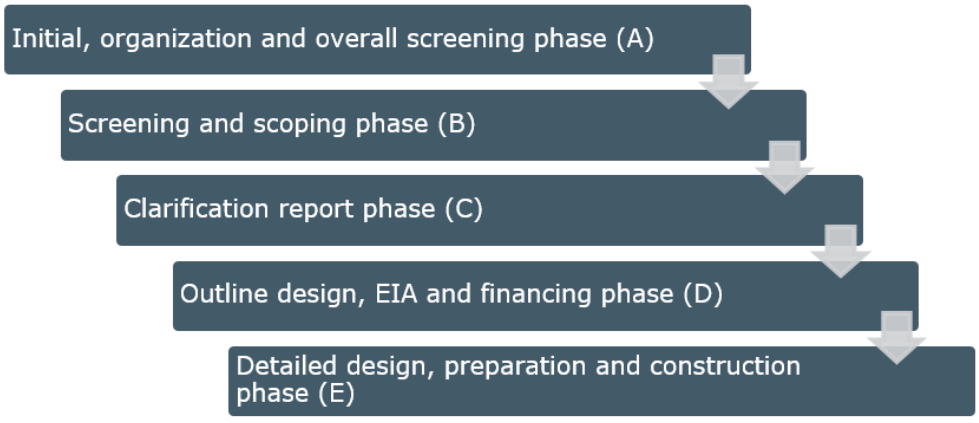


Figure 1 Phases in the process towards the opening of Borgarlína.

The purpose of each of the phases B to E in the *Borgarlína* project is to narrow the project in scope and increase the level of detail for the recommended alignment. This journey can be referred to as the "*Stairs of knowledge*", where the project is moving from a holistic level to a detailed level. At the start of the project the knowledge is scarce and the stairs small, but as the scope decreases and the knowledge slowly accumulates, the stairs grow and the project moves on through the various phases.

1.2 Purpose

In February 2017, the screening and scoping phase started up aiming at selecting the most appropriate alignments for Borgarlína.

The output of this phase is an evaluation and priority of the corridors and potential alignments based on a multi-criteria analysis that makes it possible to;

- choose and prioritize the alignments in the corridors
- narrow the scope of the project down to the most appropriate alignment(s)
- choose which type of high-class public transport system to use (BRT/LRT)

2 Market analysis

This chapter gives an overview of the current market situation in Reykjavik based on existing knowledge and with a focus at the public transport system and the passenger potential. This knowledge is necessary prior to the multi-criteria analysis process and recommendations.

The urban structure and its transport needs are of major importance for the passenger base for the public transport. This passenger base combined with the urban development leads to a passenger potential that is essential for where to build high-class public transport (*Borgarlína*). Therefore, this chapter looks at:

- Residents (locations and density)
- Generated trips (locations and density)
- Points of interest
- Travel pattern
- Today's passenger numbers
- Passenger potential

2.1 Residents

The density of residents is a very important measure when planning public transport as this indicates where the passenger potential is. Most trips-chains during the day start and end at the place of residence, meaning that the density of residents gives a good picture of the potential demand for public transport.

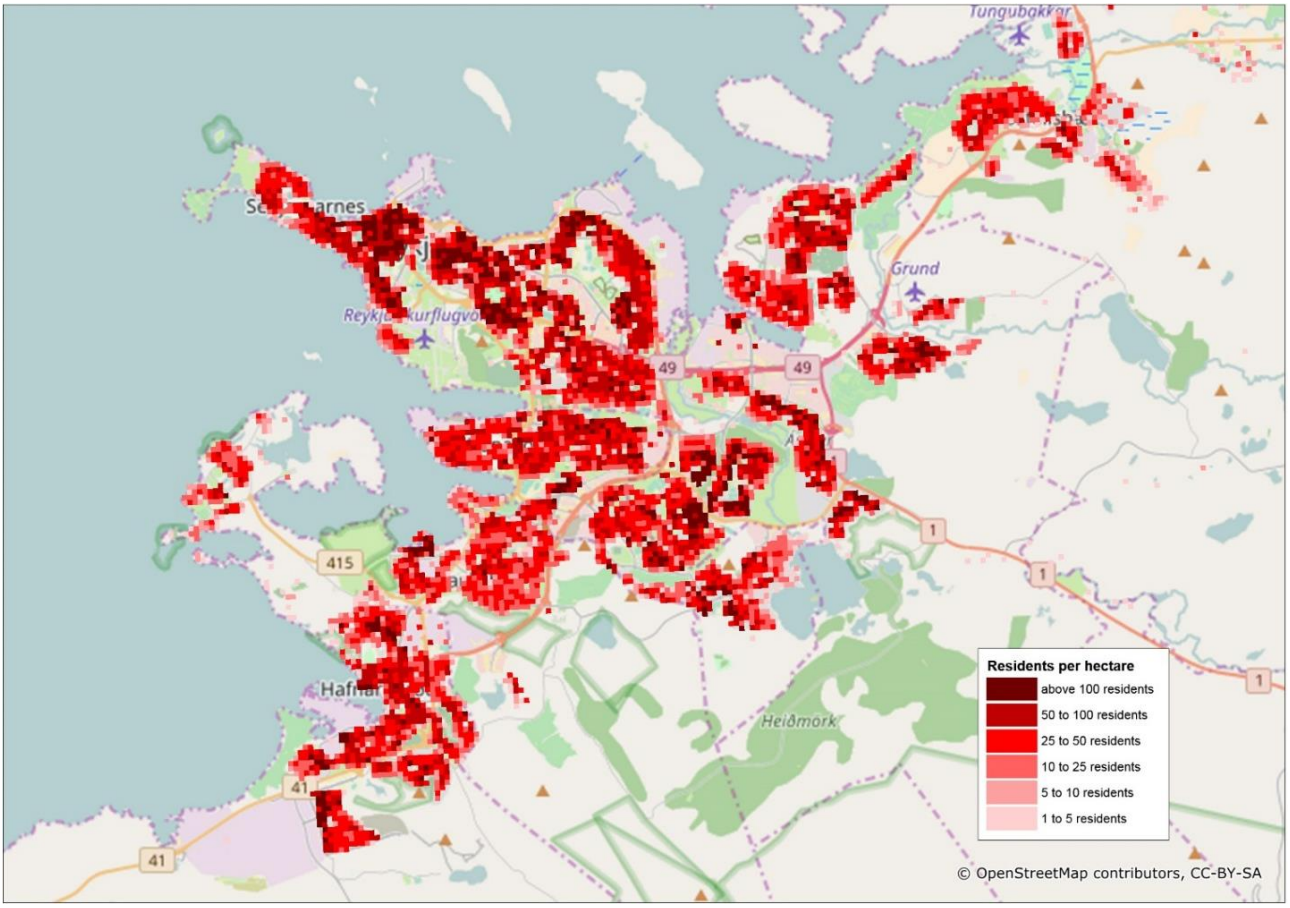


Figure 2 Density of residents in the Capital Area within a hectare (2016).

The total population of the Capital Area is around 215.000 residents. The densest areas are in the city centre of Reykjavik – stretching between Vesturbær, Miðbær and Laugardalur. Breiðholt, Mjódd and Sel has some very dense areas as well.

Hafnarfjörður, Grafarvogur and Kópavogur also has some concentrations of very dense residential areas – e.g. around Smáralind, the town area around Fjörður, Vellir and Rimar.

2.2 Generated trips

The location of business and commercial activities is also part of most trips generated during the day. Most people have to go to and from work every day and/or are in contact with commercial activities during the day for shopping, leisure or other reasons. Normally the density of employees is used to identify areas where many commuters travel to and from. These data are not available for employees – but only for size of business (sq.m. employment).

Instead the number of trips are estimated based on specific trip generation factors for the different kinds of business and commercial activities.

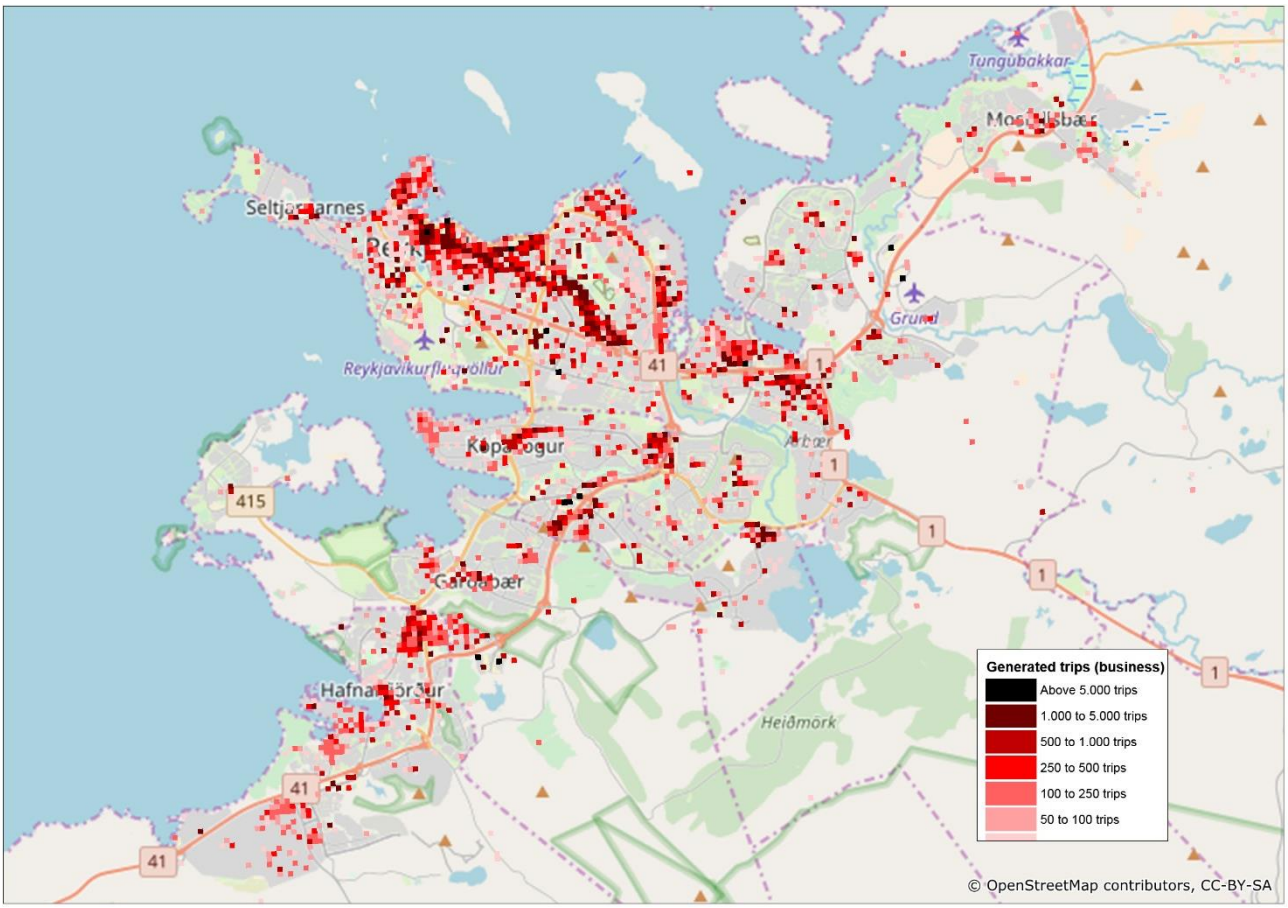


Figure 3 *Number of trips generated within a hectare (Viaplan/VSÓ, 2017).*

The total number of trips within the Capital Area is estimated to around 870.000 daily trips. The highest density of the trips is in the city centre of Reykjavik along Laugavegur and Suðurlandsbraut. Smáralind also has a high concentration of business trips. Areas like Ártún, Kringlan, Hamraborg and Stakkahraun in Hafnarfjörður have some concentrations of high densities.

2.3 Points of interest

Points of interests are locations particularly important to public transport, that generate a higher number of trips in addition to the commuting of the employees here, and are therefore not fully represented in the analysis of business trips above. These include:

- education
- shopping
- hospitals (medical structure)
- tourists and tourist destinations
- sport and culture

2.3.1 Education

Education covers different kinds of secondary schools such as junior colleges, technical colleges and universities. Junior colleges are located in most municipalities, technical colleges in Reykjavik centre and Hafnarfjörður and universities in Reykjavik centre.

Figure 4 Education and schools in the Capital area.

2.3.2 Shopping

Big scale shopping activities in the Capital Area is mostly in Smáralind shopping mall, the shopping street in Reykjavik city (Laugavegur and Skólavörðustígur) and Kringlan shopping mall. Here is the big scale shopping activities located and most customers do their shopping.

Figure 5 Shopping malls in the Capital area.

2.3.3 Hospitals

The medical structure in the Capital Area is based on the two main hospitals, a rehabilitation hospital, a psychiatric hospital and the medical emergency clinic in Smárinn.

Figure 6 Hospitals in the Capital area.

Future plans for medical structure in the area, is one main hospital located at Hringbraut. This is an expansion/renewal of the existing University Hospital gathering all hospital functions in Reykjavik. This means that the functions in Fossvogur will be transferred to the new hospital at Hringbraut. The new hospital will include university activities.

The public transport system should support this new medical structure and offer high class public transport as an integrated part of the new hospital project.

2.3.4 Tourist destinations

The tourist destinations in the Capital area are shown below. These are found based on Internet search[1] ("top 10" or "best places to visit") for the most attractive tourist destinations. Most tourist destinations are located in the city centre of Reykjavik.

Figure 7 Tourist destinations in the Capital area.

[1] http://www.visitreykjavik.is/places-interest

https://www.tripadvisor.dk/Attractions-g189970-Activities-Reykjavik_Capital_Region.html

http://www.touropia.com/tourist-attractions-in-reykjavik

https://www.europeanbestdestinations.com/destinations/reykjavik/https://guidetoiceland.is/reykjavik-guide/top-10-things-to-do-in-reykjavik

2.3.5 Sport and culture

There are several sport grounds in the Capital Area. The sport grounds with the highest number of activities are Laugardalshöll, Kórinn and Egilshöll. Kórinn also service as a big event arena.

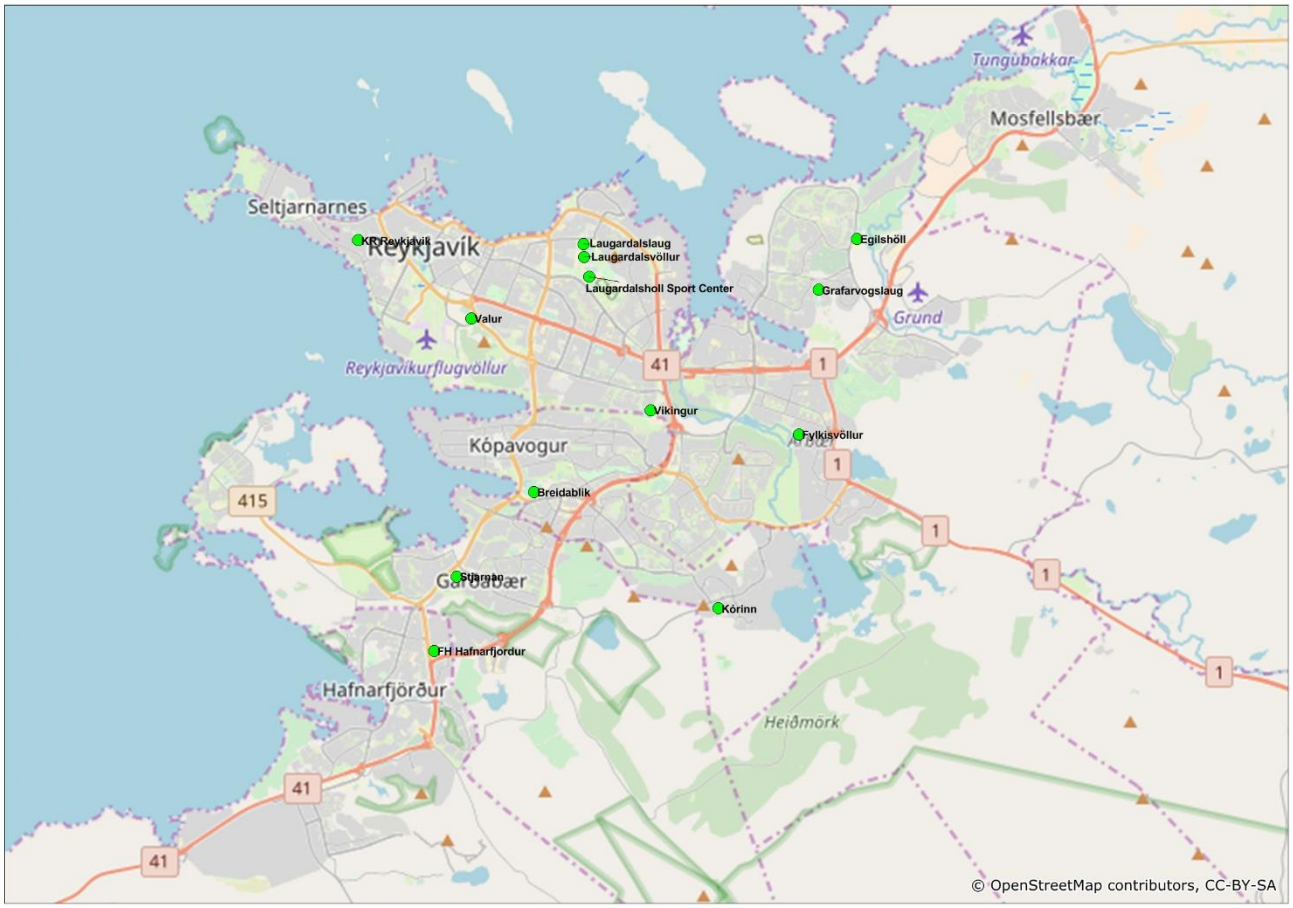


Figure 8 Sport and culture in the Capital area.

2.4 Travel pattern

A survey of travel patterns in the capital area was carried out both in 2011 and 2014 by asking a representative share of the inhabitants about their travel pattern with motorised transportation (cars and public transport all together). Based on the this COWI created one map showing all the weight of all relations (travel pattern), see Figure 9.

This analysis provides an important basis for investigating the travel pattern in the Capital Area. In general, the survey and Figure 9 shows that the majority of motorised trips are characterised by internal travel within each postal zone, between neighbour-zones or a radial pattern that start or ends in Reykjavik city centre.

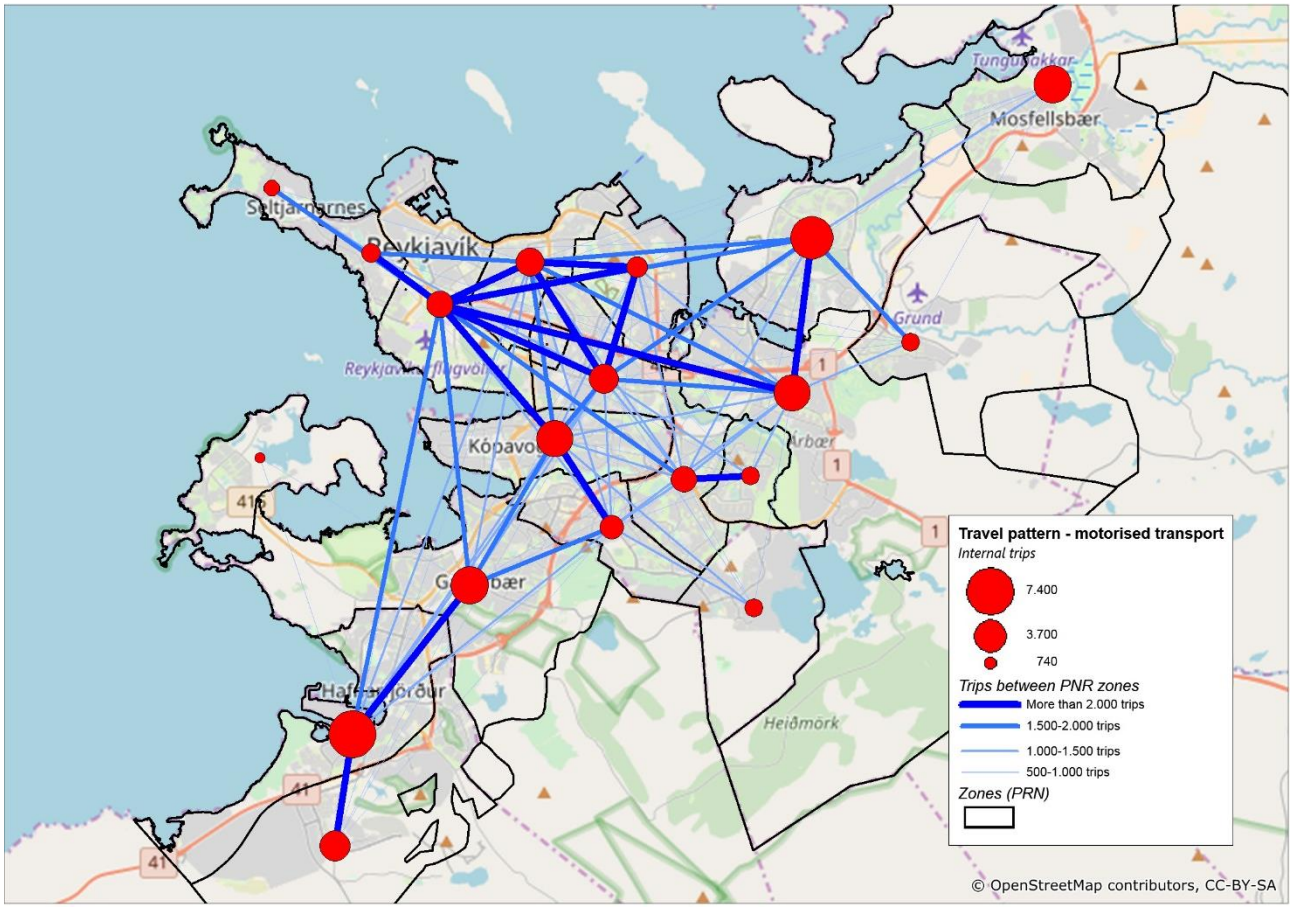


Figure 9 *Travel pattern in Greater Reykjavik – illustration of all motorized trips (source: Capacent travel survey, 2011/14).*

The travel pattern is dominated by large trip relations within Reykjavik city and outside the city centre we find the "neighbour-relations":

- Garðabær – Hafnarfjörður – Vellir
- Salir – Smáralind – Hamraborg – city centre
- Breiðholt – Mjódd – city centre

- Grafarvogur – Ártún – Árbær – Norðlingaholt
- Norðlingaholt – Árbær – Artún – city centre
- Vesturbænum – city centre

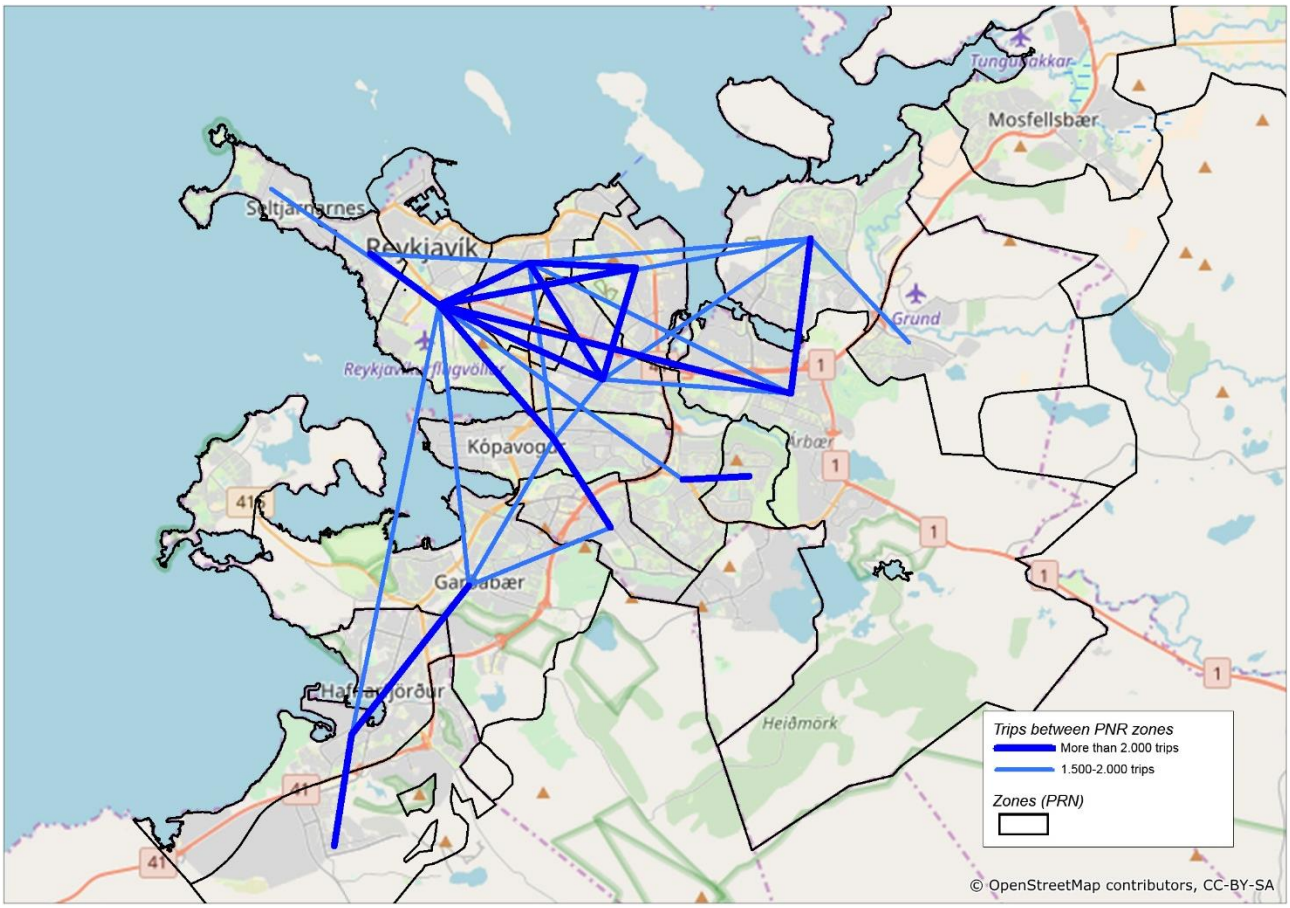


Figure 10 *Travel pattern (more than 1.500 trips) in Greater Reykjavik – illustration of all motorized trips (source: Capacent travel survey, 2011/14).*

2.5 Today's passenger numbers

The existing number of passengers in the public transport system gives a good indication of where both the supply and demand for public transport is located. Figure 11 shows the daily number of boarding's on each bus stop (grouped) for all bus routes on a weekday. There is a clear connection to the structure of residential density seen on Figure 2.

The four largest hubs contribute to more than 25 % of all daily boarding's in the network (Strætó buses). The 20 most used bus stops handle around 50 % of all daily boarding's. It is here important to emphasize that the terminals generate transfer between the bus routes. This results in a large number of boardings at the terminals – even though the passengers might be travelling to other places, meaning that the terminal itself might not be the main attraction point..

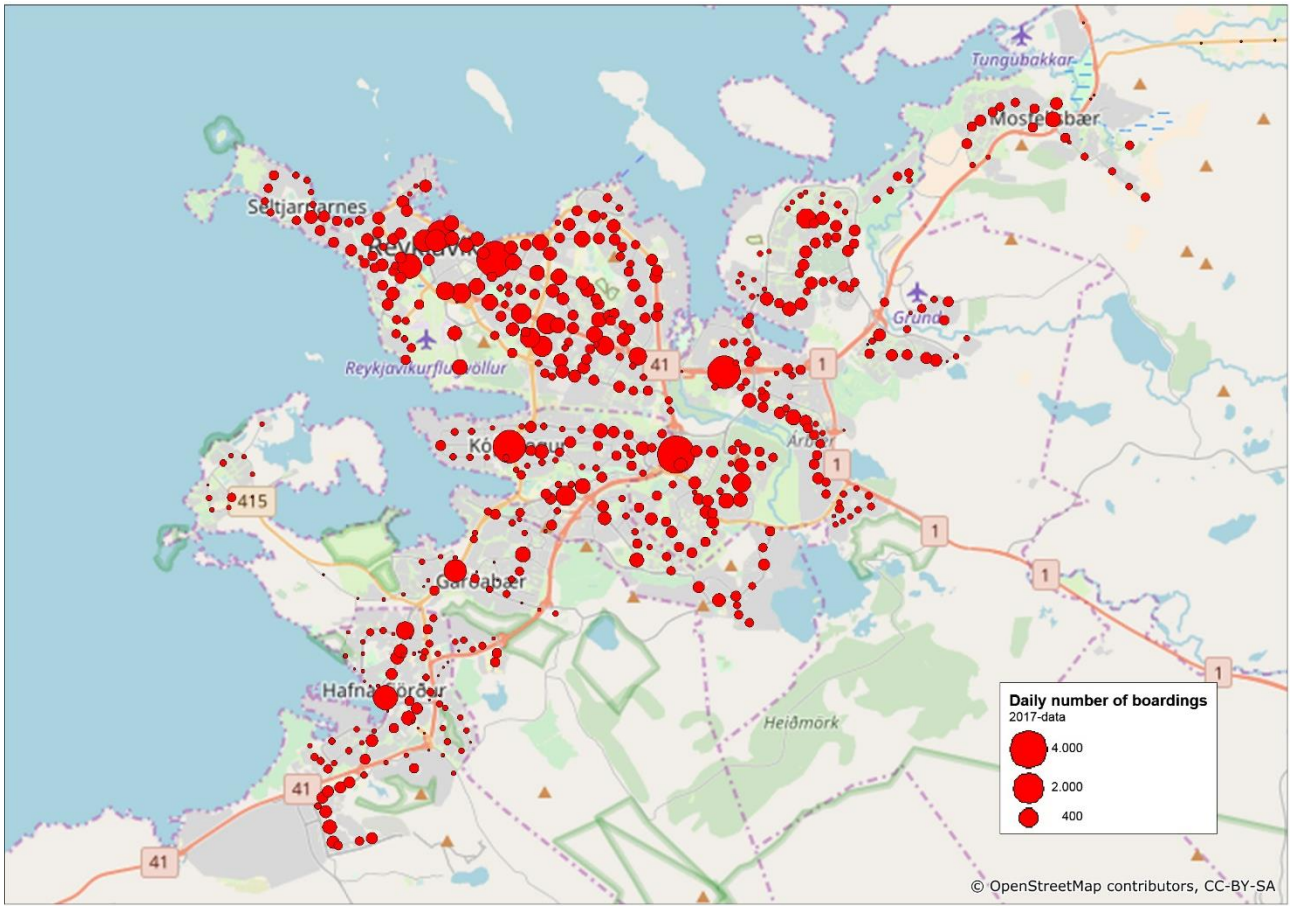


Figure 11 Number of daily boarding's per grouped stop (source: Strætó, 2017).

The largest bus stops/hubs are (number of boarding's shown in brackets):

- Mjódd (4.000)
- Hlemmur (3.400)
- Ártún (2.500)
- Hamraborg (2.500)
- Lækjatorg (1.600)
- Fjörður (1.000)

- Háskóli Íslands (900)
- Ásgarður (700)

This coincides with the fact that these bus stops are all hubs for transfer (terminal function) and some of them function as urban centres in each municipality. The University (Háskóli Íslands) is not a transfer hub but mostly a destination with many passengers (students).

Bus stops in the two city centre zones (postal zones) covers together nearly 30 % of all boarding's. The third largest public transport zone is Mjódd (and Sel) with around 11 % followed by zones covering Hamraborg and Ártún (Árbær/Norðlingaholt) with each 9 %.

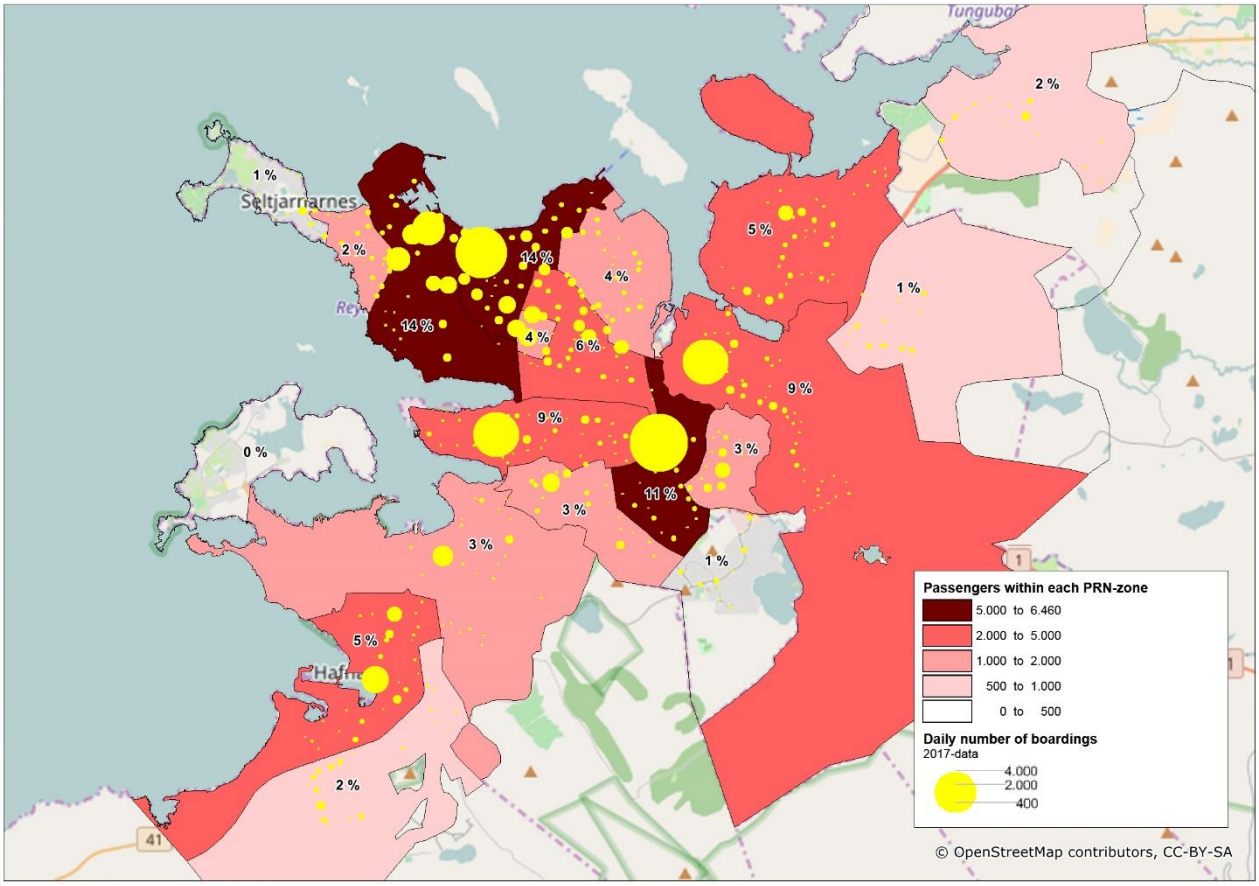


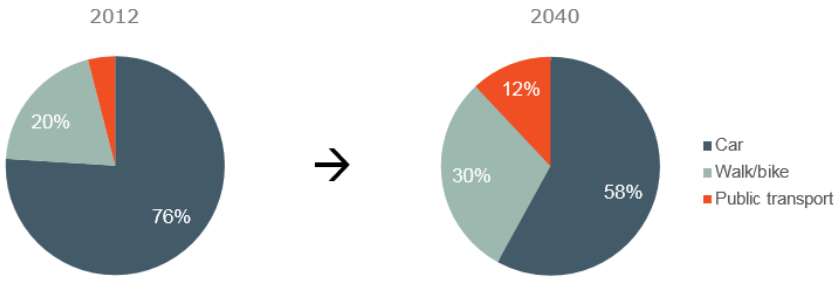
Figure 12 *Number of daily boarding's within each PRN-zone, share of all boarding's and number of daily boarding's per grouped stop (source: Strætó, 2017).*

Figure 12 shows the existing use of public transport in the Capital Area. A future situation with increased population, transit oriented development, increased tourism, increased road pressure and a more competitive high-class public transport will most likely change this picture.

2.6 Passenger potential

The passenger numbers are expected to increase significantly in the coming decades. This is in line with the vision for the public transport in the Capital Area

aiming at tripling the public share from todays 4 % to 12 % public transport trips in 2040.



Some of the reasons for the expected increase are described below.

2.6.1 Increased population

The total number of residents in the Capital Area is expected to grow by 60.000 and reach approximately 275.000 in 2040 - equal to an increase of around 28%. According to the new Regional Plan most of this growth must be located within the walking distance to the high-class public transport (Borgarlína). This means that there will be an interdependency between future location of housing areas and the Borgarlína, which will increase the passenger potential for the public transport.

2.6.2 Transit-oriented development

The transit-oriented development will ensure that more residents will live within walking distance of the high-class public transport. The vision is to increase the proportion of residence living in these areas from 30% to 66%. Furthermore, business with high passenger potential will be located in these areas.

For each alignment that will be analysed in the MCA in Chapter 4, the urban growth potential for residents and business area is defined. The urban growth potential is defined by Viaplan and SSH.

The investigation assesses that each alignment has a growth potential of between 20-150 % new residents and up to 50 % new business area within 400 m's from a Borgarlína-station. This means that the total urban growth potential is assumed to be between 20-80 % for the different Borgarlína-alignments.

The effect of these urban growth factors depends on the existing base of residents and business near the Borgarlína stations – but most alignments has an urban growth potential of around 30-40 %.

2.6.3 Attractive high-class public transport

The passenger potential for the public transport increases by investing in an attractive high-class public transport system that goes hand in hand with the

transit-oriented development. The high-class public transport system needs to be attractive and competitive in terms of:

- High frequency and long service hours
- Simple, direct and fast (prioritising the main transport corridors)
- High regularity (no delays in traffic)
- High comfort buses
- High quality stations

Investing in a high-class public transport system that gives the best conditions for the service parameters above will attract passengers, due to the focus at low travel time and high quality/comfort. Furthermore, the fact that the passengers can trust the system due to the high regularity is a reason for choosing the public transport.

2.6.4 Increased tourism

Tourism has increased rapidly during the past years. The number of tourists tripled in the Capital Area during the last 5 years to an average of 17.600 daily tourists registered in 2015. Forecasts show that the growth is expected to continue and numbers as high as 70.000 daily tourists during the summer in the Capital Area have been estimated. This is however hard to predict and is linked with much uncertainty.

What is important to have in mind when discussing tourism is:

- The tourists are expected to use the public transport system even more in the future as Borgarlína will be a concept the tourists will understand (like cities that got light rails have experienced). This will further increase ridership and hence revenue of the system.
- Borgarlína makes it possible for the tourists to travel around the capital area and not stay in the city centre – this also supports the tourism industry increasing accessibility and attractivity of the city as a tourist goal.
- Borgarlína also makes it possible for the tourists not to use and depend on renting a car to get around Reykjavik. Large parts of the current tourists rent a car and thereby contribute to filling up the city centre with cars.

Therefore, the tourists and Borgarlína could be very beneficial for each other as Borgarlína will support the tourism and the tourists will support the revenue for Borgarlína.

2.6.5 Increased road pressure

Car congestion is one of important reasons for choosing a high-class, congestion free public transport option like Borgarlína.

However, the new Regional Development Plan "*Capital Area 2040*" states that the population growth will be addressed without proportional extra pressure on the trunk-road system meaning that increased congestion will not be a reason to skip the car and choose Borgarlína. To triple the ridership of public transport with no increased road pressure will hence require a very restrictive policy to reduce the number of car trips per citizen. This means a restrictive parking policy (less parking lots and much higher pricing), priority for the sustainable transport (running in separate lanes and enabling smooth transit regardless of car traffic) and perhaps even tolls for driving in the dense urban areas where the high-class public transport is built.

The focus should be to create a high-class public transport network instead of improving the conditions for car traffic:

- High-class public transport is necessary in the major transport corridors
- Effective road traffic depends on efficient public transport

This focus will lead towards an attractive public transport and reaching the vision for more passengers.

3 Public transport system

3.1 Bus network

The public transport system in the Capital Area has 27 urban bus routes and they ensure a high coverage in most of the relevant areas. The urban routes are divided into "single number routes" and other (multiple number) routes (see Figure 13). The "single number routes" are route 1-6 that operate with high frequency (minimum 15-minute service in peak hours) and connects the city centre with the densest urban areas outside the city centre. The multiple number routes are shown below (Figure 15) – they have different functions and great variation in frequency (from 15-minute service to only service during morning or afternoon peak).

The urban bus routes are supported by some regional routes to Keflavik Airport (Reykjanesbær), Suðurnes, north (west and east) and south (east) Iceland.

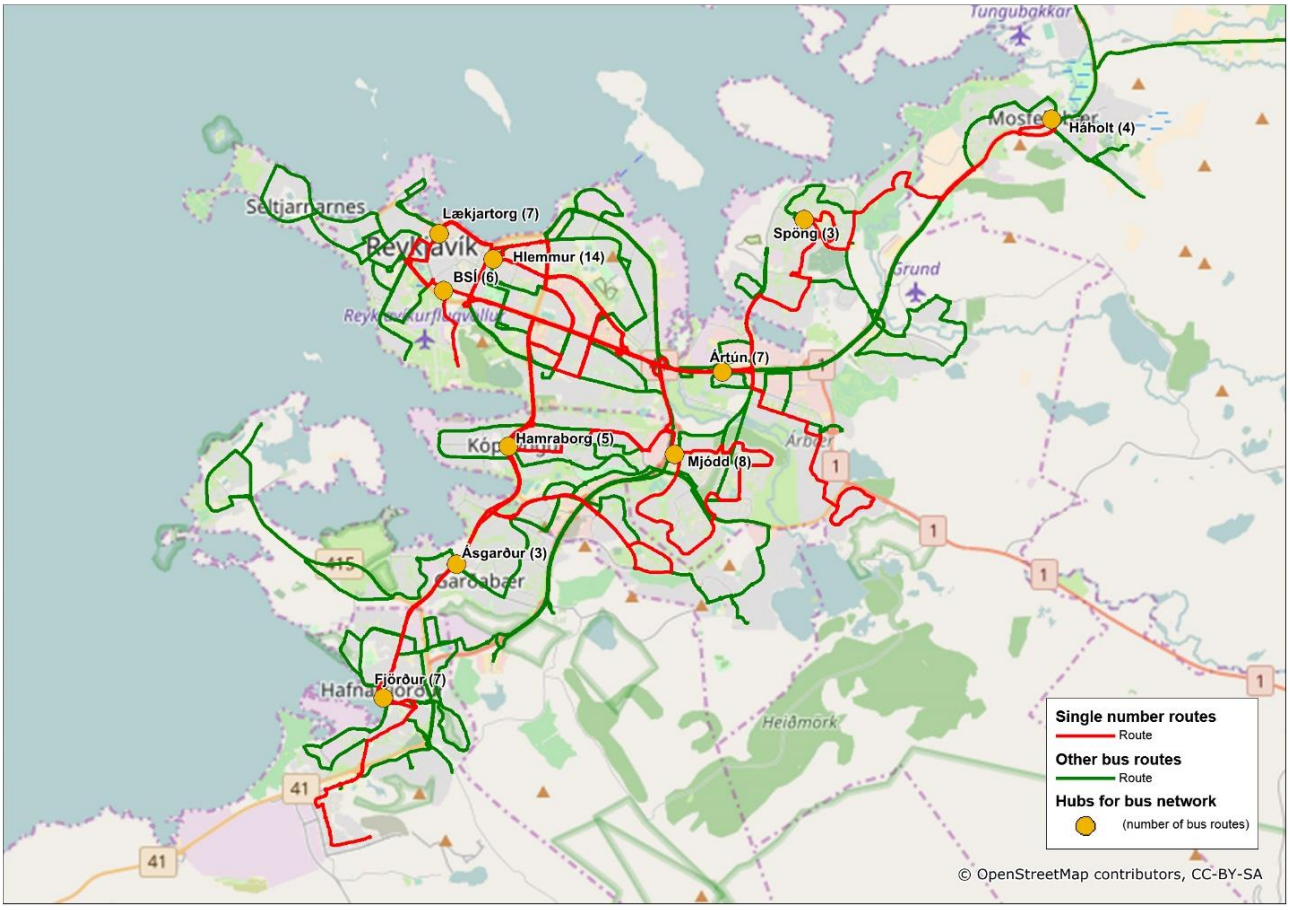


Figure 13 *Existing bus network – shown as "single number" bus routes and other bus routes. Furthermore, hubs are shown with number of bus routes serving the hub.*

The bus network has several hubs for transfer between the bus routes. These are marked at Figure 13. The number of bus routes servicing the hubs are:

- Hlemmur with 14 bus routes

- Mjódd with 8 bus routes
- Ártún with 7 bus routes
- Lækjartorg with 7 bus routes
- Fjörður with 7 bus routes (Hafnafjörður)
- BSÌ with 6 bus routes
- Hamraborg with 5 bus routes (Kopavogur)
- Háholt with 4 bus routes (Mosfellsbær)
- Spöng with 3 bus routes
- Ásgarður with 3 bus routes (Garðabær)

The "single number routes" are among the bus routes with the highest number of passengers and the highest number of daily departures (see Figure 14). More than 50 % of the passengers use the "single number routes" and they count for around 40 % of the service hours.

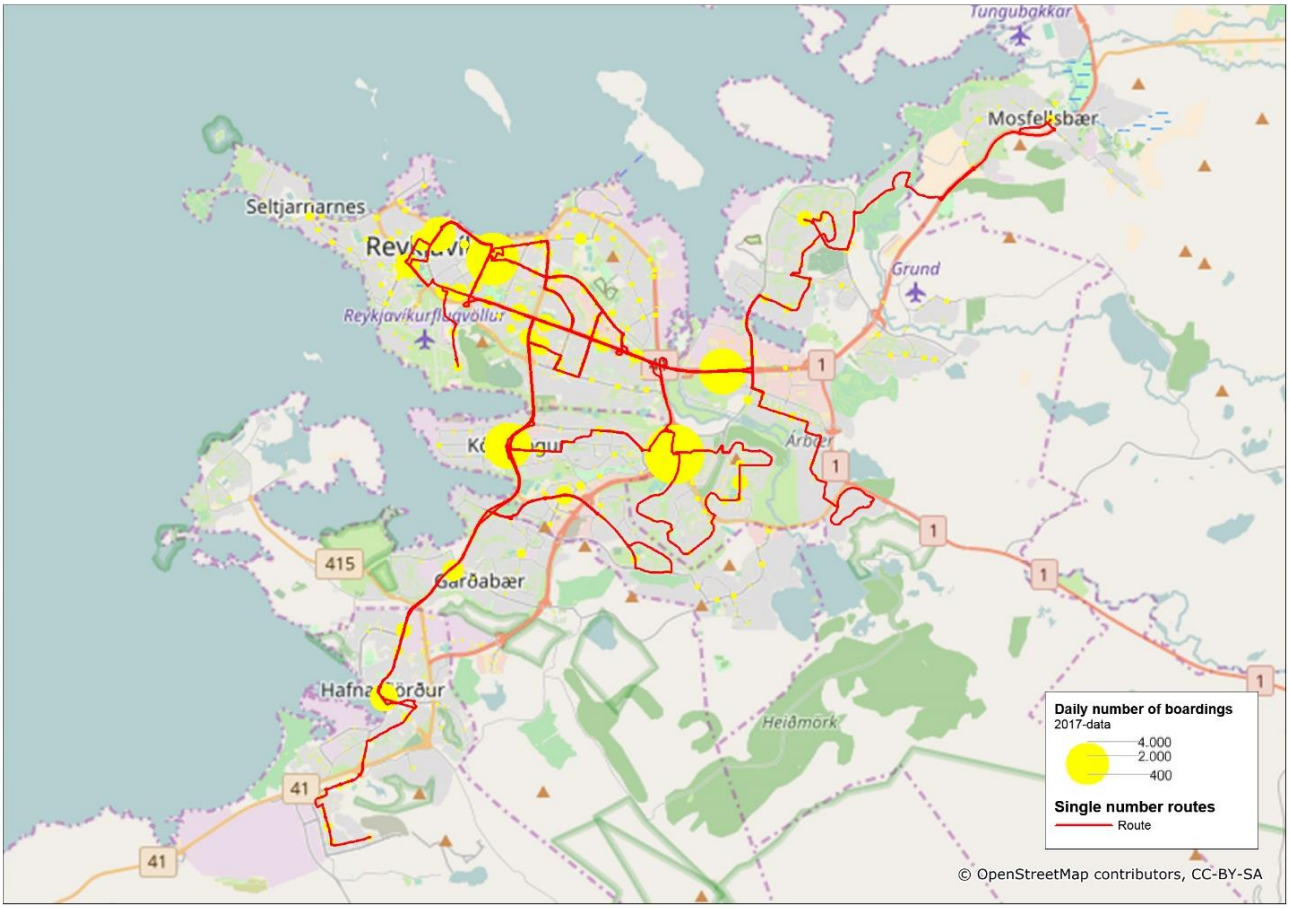


Figure 14 Existing bus network's "single number" bus routes and daily number of boardings per stop (grouped).

The "single number routes" form the backbone in the public transport in the Capital Area creating a radial network towards Reykjavik city centre and linking the hubs and other important points of interest (e.g. Smáralind, Kringlan, University of Iceland and Skeifan).

The multiple number routes have several kinds of functions, such as local function, feeder-function and ring ("non-radial") function. These routes primarily cover the secondary commuter relations to ensure a wider coverage. Therefore, the number of passengers are lower on these routes compared to the "single number" routes. These 21 routes handle half of the daily passengers but at 60 % of the total service hours.

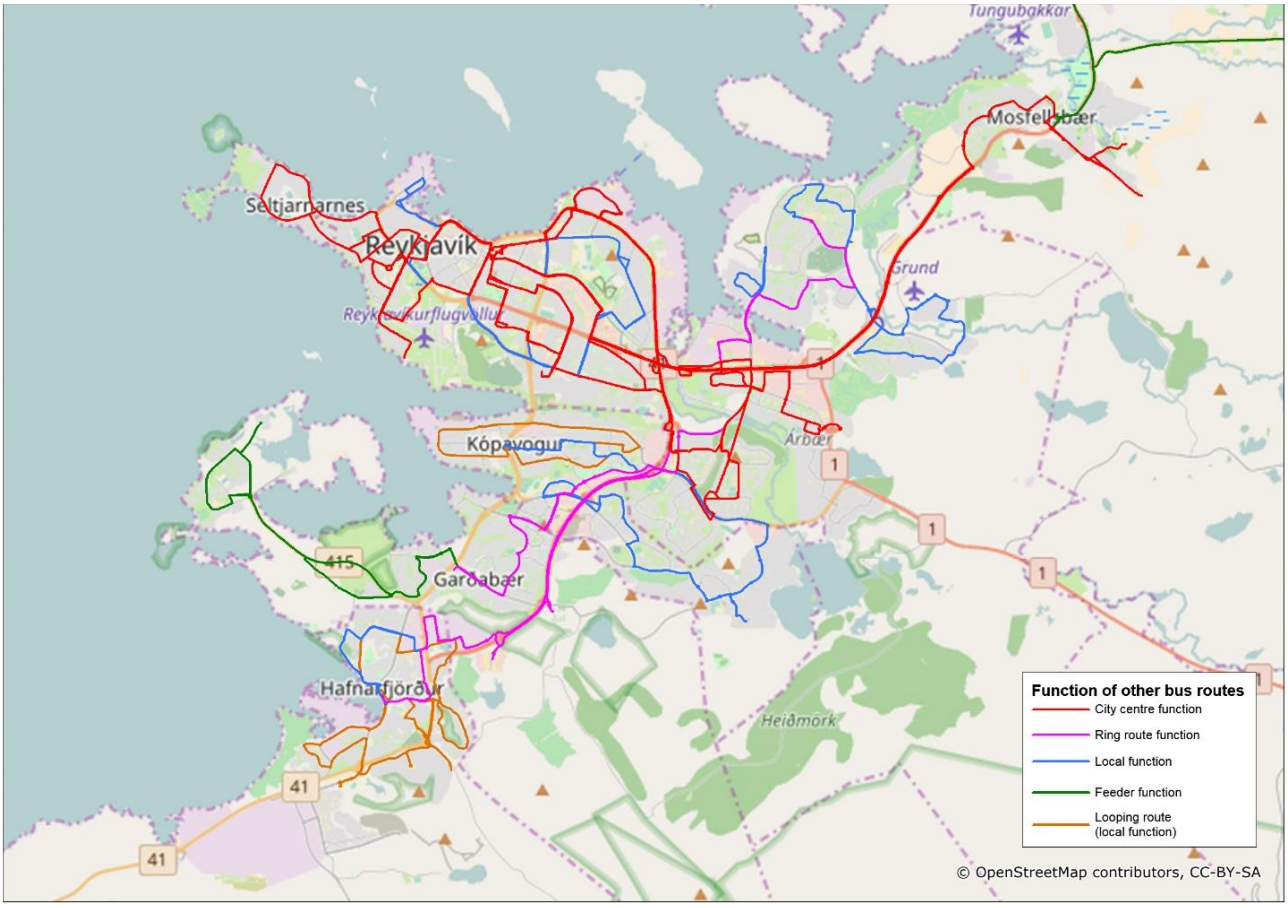


Figure 15 Existing bus network's "multiple number" bus routes by function.

3.2 Frequency

Public transport networks require a high frequency to be attractive both in terms of total travel time and inconvenience for transfer between bus lines. A high frequent route increases the probability for a departure that fits all passengers and potential users and increases the comfort knowing that the next departure runs within a short time.

The higher frequency – the lower average waiting time. At best, such a network functions without the need for the passenger to look at timetables at all. This is based on a minimum service level with bus service every 5-10 minutes throughout

the day (=interval timetabling). This interval gives the optimal frequencies - resulting in low average waiting times.

An even higher frequency does not give any remarkable reduction in average waiting time – but is more a capacity and thereby a comfort matter. On the other hand, this high frequency can also cause some disadvantages such as congestion problems (reduced pass ability) at stations and in junctions with crossing trunk routes.

A frequency lower than 10-minutes service leads to high average time spend waiting for the next bus, and the need to consult timetables and plan your journey becomes important.

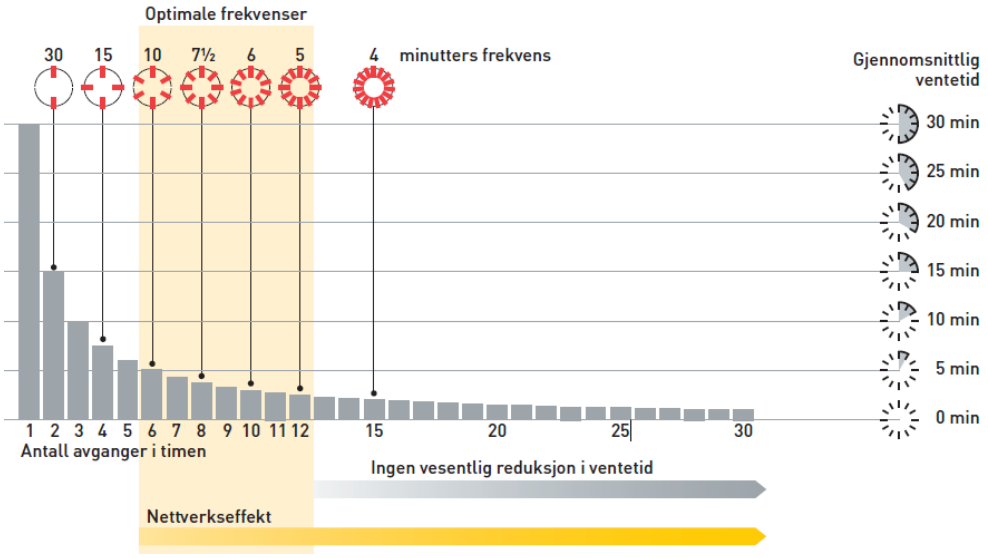


Figure 16 *Optimal frequency for bus service indicating the number of departures per hour and the average time spend waiting for the next bus. Source: Ruter, 2011.*

Due to optimal resource utilization, the high frequencies should be prioritized along the corridors with high demand for transportation as this is where the potential for attracting new passengers is highest. In the end, it is also a matter of net operational costs – to find the optimal balance between passengers (demand), and service hours (supply) for the whole network of bus routes.

The number of daily departures (frequency) for each bus route in the Capital Area is illustrated in Figure 17. The Figure shows that:

- Route 1 is the most frequent bus route and operate with a 10-minute service in the peak hours and 15-minutes service in-between the peak hours. In total, this is around 70 daily departures per direction on a weekday.

- Route 6 is the second most frequent bus route with a 15-minute service in and between the peak hours – equal to around 60 daily departures per direction on a weekday. There are considerations of improving the frequency to match route 1's 10-minute service in the peak hours.

- 12[2] bus routes operate with a 15-minute service in the peak hours and 30-minute service between the peak hours and in the evening. This is equal to around 50 daily departures per direction on a weekday.

- The rest of the bus routes[3] do not operate all day – leading to a lower number of daily departures. Some of the routes do operate with a 15-minute service in either the morning or afternoon peak hours.

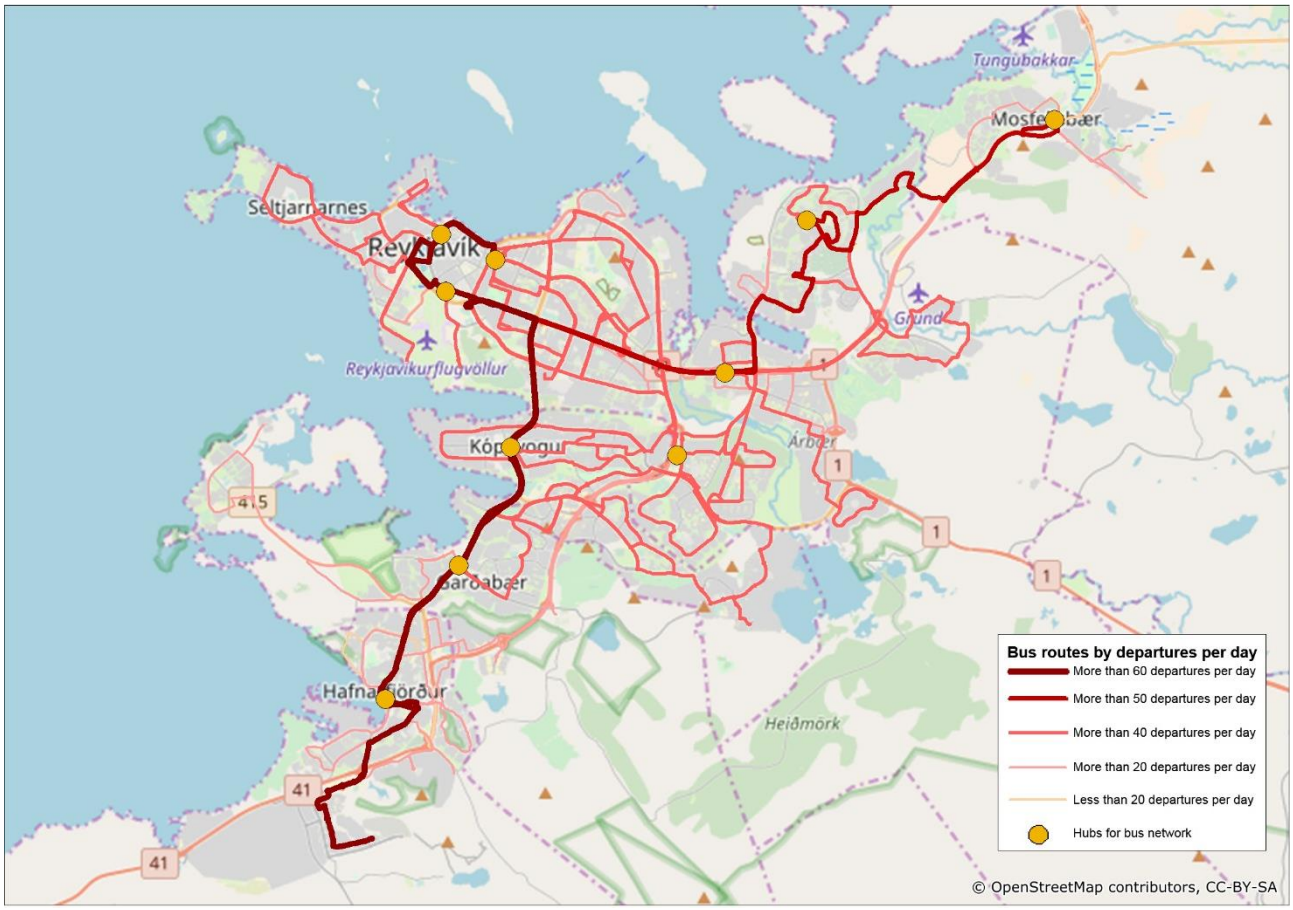


Figure 17 Number of estimated daily departures per bus route (weekday – winter schedule 2016/17).

Figure 17 illustrates the number of daily departures per bus route and not the total number of departures on a section (road network). This picture is illustrated on Figure 18 where the number of daily departures per bus stop in the Capital Area for all bus routes are shown. It shows that:

- Hlemmur and Mjódd is the bus terminals with the highest number of daily departures

- followed by BSÍ, Landspitalin, Lækjatorg, Sæbraut, Ártún, Hamraborg, Fjörður, Spöng, Ásgarður and Gerði (Miklabraut)

The roads (sections) with the highest number of daily departures is:

[2] Route 2-5, 11-14, 18, 24, 28 and 35.

[3] Route 15-17, 21-23, 31, 33-34 and 43-44.

- Lækjargata, Laugavegur, Suðurlandsbraut, Grensásvegur, Bústaðavegur, Borgartún and Miklabraut
- Fjallkonuvegur and Borgavegur in Grafarvogur
- Austurberg and Norðurfell in Breiðholt

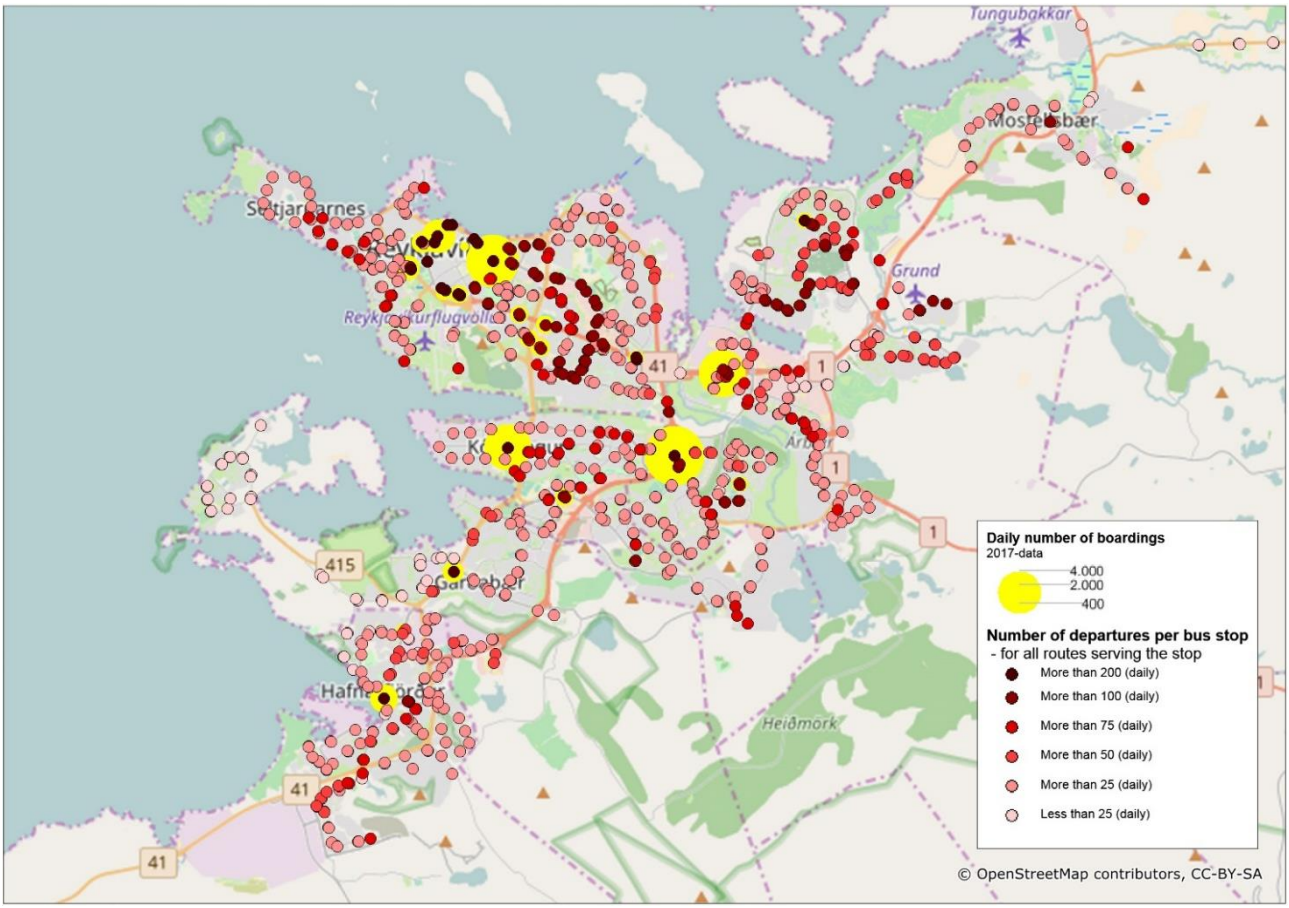


Figure 18 *Number of daily departures per bus stop for all routes serving the stop and daily number of boardings per stop (grouped).*

4 Multi-criteria analysis

The purpose of this project phase is to define the potential alignments within the corridors and evaluate these based on a multi-criteria analysis;

- to be able to choose and prioritize the alignments in the corridors
- to narrow it down to the most appropriate alignment
- choice of technology (BRT/LRT)

The analysis is carried out in several steps to involve the stakeholders as much as possible to get their input for the process. The starting point for this process was to agree on the relevant criteria used for the MCA and selection the corridors and alignments to be analysed in the MCA.

The recommendation of criteria, corridors and alignments for the MCA was presented for the different stakeholders involved in the Borgarlína-project (working group, project committee, steering committee and Regional Planning committee) in February. Based on the input from these meetings the selection of criteria, corridors and alignments was agreed.

4.1 Selection of criteria

The selection of criteria is based on MCA-criteria that has been used for evaluating and selecting alignments in similar projects in the Nordic countries. The criteria has been assessed to ensure that they fit the local circumstances and can be used for the Borgarlína-project.

In this process some criteria was opted out – primarily due to insufficient data.

The recommended criteria was presented for the involved stakeholders and it was agreed to use the criteria in Table 1 for the MCA.

Table 1 Agreed criteria for the MCA.

Criteria	Themes
Passenger estimates	Two estimates: Reach the vision of 12 % and projection of existing passenger numbers combined with urban development potential and elasticity assessment.
Residents and business	Number/density of residents and business (sq.m)
Urban development potential	Transit-oriented development, densification
Service levels	Three parameters: Frequency, travel time, regularity
Network for high-class PT	Coherence in the network
Potential for bus savings	Overall adaption of bus network → savings in operational costs for bus network
Construction costs	Distance based price combined with special constructions
Operational costs	Distance based operation costs
Physical challenges	Bridges, tunnels, utilities, expropriation of buildings, terrain conditions, mixed traffic, NATURA 2000 conditions

Passenger estimates

The passenger numbers are estimated in two different ways;

- Elasticity model – increasing existing passenger numbers based on the urban growth and effects of service improvements (higher frequency, lower travel time and effect of having a high-class public transport system).
- Trip generation model – estimating the number of trips generated in 2040 based on today's trips and the urban growth potential and reaching 12 % public transport share in Greater Reykjavik. For the Borgarlína stations the public transport share is estimated to be 15 % to be able to reach the 12 % in total (due to that 66 % of all urban growth should be within 400 m of a Borgarlína station).

While the first model emulates the situation in 2040 with urban growth and improved transport service on Borgarlína, the second shows how many passengers Borgarlína should have in order for the capital area to reach its vision of a 12 % public transport share. The difference between the numbers indicates the level of supporting measures and restrictions that will be needed on top of the Borgarlína service to reach the vision.

The trip generation model hence emphasizes the need to not only improve the public transport service but also to support the system in the best possible way. This means further densification (transit oriented development) around the high-class public transport stations, prioritisation of the public transport at the expense of the car traffic, restrictive parking policy and strategy and good accessibility to Borgarlína with other modes of transport (feeder bus service, bike and ride, walking paths, park and ride etc.).

Both models give a passenger estimate for the year 2040.

Residents and business

The number of residents and business within the walking distance of Borgarlína stations gives a good indication of whether the alignment is located where people are living and working. This makes it possible to benchmark the different alignments and see which of them are covering the highest potential for future passengers.

The data for residents are calculated for both today´s population and the expected 2040 population.

This criteria is therefore assessed as the catchment area of;

- Residents within 400 m - 2017
- Residents within 400 m – 2040 (incl. growth potential)

Figures are given as a total for each Borgarlína alignment and as residents per km of Borgarlína to be able to benchmark the alignments.

The employment data is only available as square meters of business making it difficult to link it to estimate the number of employees within the walking distance. Hence this parameter is not analysed here, but business is included as an important part of the passenger estimate.

Urban development potential

Based on the transit-oriented development agreed on in The Regional Plan for the Capital Area, the densification potential for residents and employment is estimated in all zones. The estimate is provided by SSH and includes planned development as well as an assessment of realistic long-term development.

This is converted to daily trips and compared with today's number of trips. For each Borgarlína alignment this gives an urban growth factor used for the two passenger estimates.

Service levels

Three parameters has been used to evaluate the service level for each Borgarlína alignment;

- Frequency (the given frequency along the alignment). Borgarlína is assumed to run with 7½-minute frequency.
- Travel time (the total travel time for each Borgarlína and the change in travel times compared to today´s travel time)
- Regularity (the change in regularity compared to today).

Network for high-class public transport

This criteria looks at the coherence in the network – and how it connects with the total public transport network. The more bus lines it connects to the better coherence in the network.

The criteria doesn’t look at the consequences for the travel time to obtain the coherence.

Potential for bus saving

An initial adaption of the existing bus network to avoid parallel service has been made for each of the Borgarlína alignments. This means abolishing, shortening and rerouting existing bus routes or adjusting frequency to support the Borgarlína and avoid competition with the bus routes.

The output is focusing on the changes in existing bus network for each Borgarlína alignment and estimate the savings in operational costs for the existing bus network (only at the cost side – not the revenue side). Hence the bus network has not been completely re-planned and optimised. This should be done in the next planning phase with only one alternative, to get more knowledge about the total level of subsidies for the public transport.

Construction costs

Construction costs for the Borgarlína infrastructure is based on the required space for a light rail (LRT) infrastructure. Therefore, a BRT system later on could be upgraded to an LRT-system as the space for a BRT system is dimensioned to a later upgrade. Each Borgarlína alignment is drawed as LRT and all elements to construct the infrastructure for both BRT and LRT are estimated and priced based on experience figures. Construction costs are compared to an Icelandic context to ensure that the price level is at the right level.

Construction costs covers all infrastructure necessary to operate the service – but not the rolling stock which is considered a part of the operational cost.

The same method for estimating the construction costs are used for all alignments which makes the construction costs comparable looking across the Borgarlína alignments. This makes the benchmarks of the Borgarlína alignments reliable even though the price level is estimated in a general way as the level of details for each alignment is still in the initial phase.

Operational costs

Operational costs for Borgarlína are based on the number of service hours to operate Borgarlína. This provides a good measure for comparing the different alignments at this level of the MCA.

The service hours for the calculation are;

Frequency at weekdays:

- Peak hour service: 7½ minutes service (07-19)
- Daytime service: 10 minutes service (06-07+19-20)
- Evening service: 15 minutes service (20-23)
- Night service: 30 minutes service (23-06)

Frequency at weekends:

- Daytime service: 10 minutes service (10-19)
- Morning and evening service: 15 minutes service (08-10+19-22)
- Night service: 30 minutes service (22-08)

Physical challenges

This criteria mainly addresses if the alignments have any major physical challenges construction wise (bridges, tunnels, large utilities) – but also physical challenges that affects the surroundings in terms of expropriation of buildings, terrain conditions, mixed traffic and NATURA 2000 conditions.

Furthermore, the criteria look into if the alignments causes any risks in terms of political obstacles (such as transforming the city airport into an urban development area).

4.2 Selection of corridors and alignments

Based on the previous work, workshops and COWI ideas for how Borgarlína alignments could be outlined the project group identified the relevant corridors and alignments for the Borgarlína. Stakeholders were involved at this point and adjustments were made based on their input.

Four principle corridors were selected as a starting point for defining the possible alignments for the Borgarlína.

- A-corridor: north-south corridor between Hafnarfjörður, Garðabær, Kópavogur and Reykjavik city centre
- B-corridor: east-west corridor between Reykjavik city centre and Artún and further towards Mosfellsbær, Grafarvogur or Norðlingaholt
- C-corridor: ring corridor utilising the ring roads (e.g. Reykjanesbraut or city airport) connecting the centres Smáralind or Mjódd with Reykjavik city centre
- D-corridor: east-west corridor between Reykjavik city centre and Seltjarnarnes

The naming of the corridors does not mean that the A-corridor is higher prioritised than the D-corridor – they do only function as a help when discussing the different defined alignments in the MCA. All alignments are handled equally and the priority of the alignments are based on the analysed figures for each alignment.

The defined alignments for the MCA are shown in Figure 19. In total 16 alignments are analysed in the MCA.

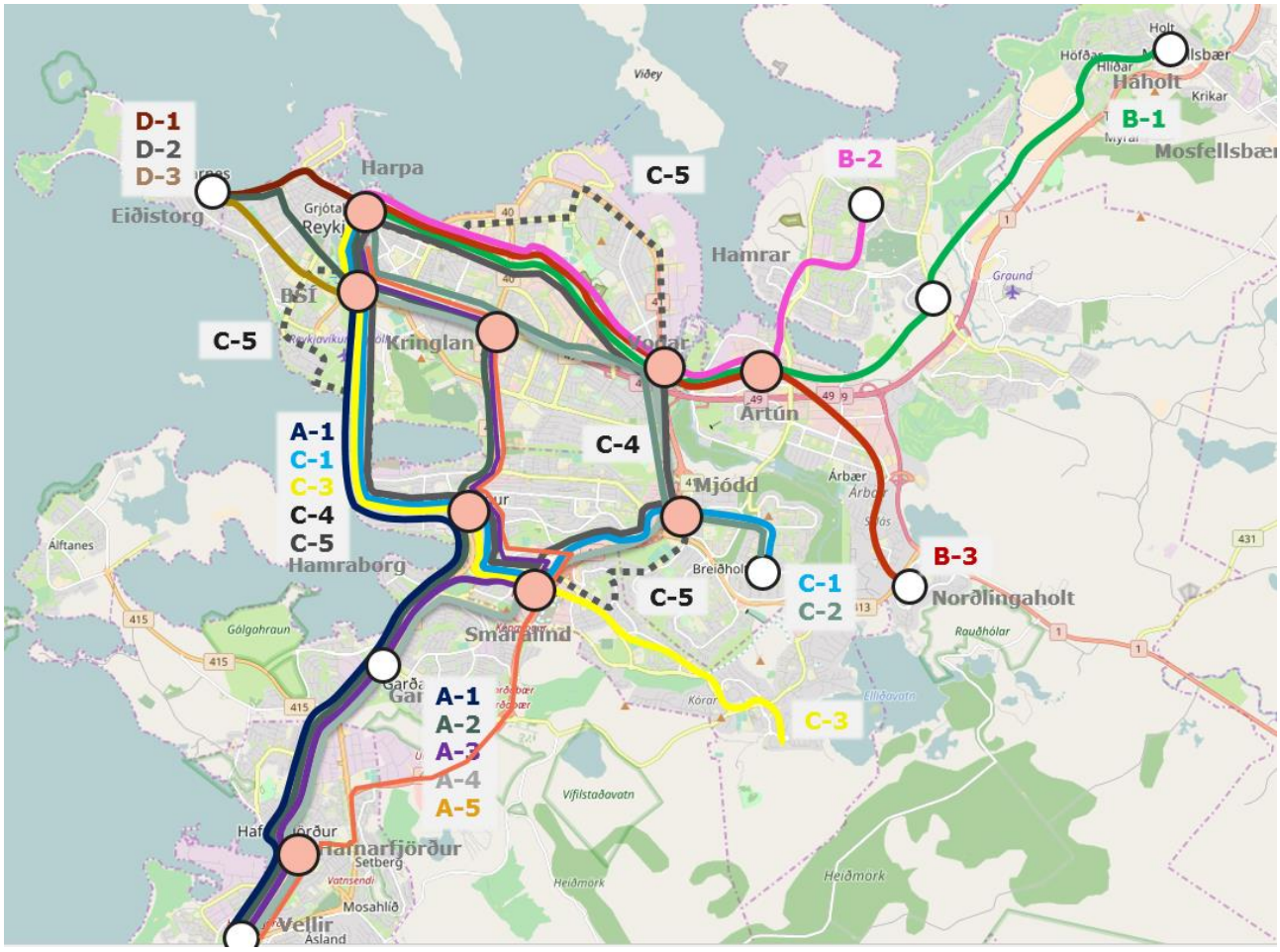


Figure 19 All the analysed alignments within the defined corridors.

4.3 Analysis of alignments (MCA)

The outcome of the MCA depends on the given data – but for the planning proposal the MCA aims at eliminating some of the alignments that will not perform well and end up with the most appropriate alignment(s) to be built in a long time perspective.

4.3.1 A-corridor

Five alignments were analysed in the A-corridor:

- A1 (Kársnes): Connects Hafnarfjörður, Garðabær and Kopavogur directly with the city centre, crossing Kársnes and utilizing a possible bridge connection to the city airport area and Reykjavik University.

- A2 (Direct Hafnarfjarðarvegur): Borgarlína mostly along the existing line 1 in Hafnarfjarðarvegur directly connecting Vellir, Fjörður, Garðabær and Hamraborg to the city centre via Kringlan.

- A3 (Smáralind loop): Route mostly equal to A2, but with a loop in Kopavogur serving the regional centre Smáralind, hence providing better coverage and coherence, but with a longer travel time.

- A4 (Mjódd-Miklabraut): Route mostly equal to A3 from Vellir to Smáralind apart from alternative routing in Fjörður and Kopavogur. From here it continues on Reykjanesbraut through Mjódd and turn on Miklabraut towards the city centre. The alignment combines a ring-connection between Smáralind, Mjódd and Skeifan with a city centre connection from Hafnarfjörður, Garðabær and Kopavogur. The latter however with rather long travel time.

- A5 (Reykjanesbraut-Kauptún-Smáralind): This alignment seek to cover Smáralind like A3, but by utilising the space and high travel speed along Reykjanesbraut to get there. The route is a little faster than A3, but also misses out the coverage of important parts of Hafnarfjörður, Garðabær.

Figure 20 A-corridor alignments.

Table 2 Characteristics of the A-alignments.

	A1	A2	A3	A4	A5
Length (km)	16,1	16,0	18,2	21,1	18,9
Stops	20	19	23	26	21
Travel time (min)	36	34	41	47	39
Avr. speed (km/h)	26,7	28,0	26,7	27,2	29,0

Table 3 MCA-results for the alignments within the A-corridor.

Criteria	A1	A2	A3	A4	A5
Passenger estimates per km (elasticity model)	**780**	**800**	700	620	610
Passenger estimates per km (Trip gen. - vision)	**1.510**	**1.460**	**1.520**	**1.540**	1.380
Catchment area today, inh. per km (400 m)	1.680	**1.900**	**1.910**	1.670	1.620
Catchment area, incl. growth potential per km	**2.820**	**2.810**	**2.830**	2.710	2.390
Frequency and capacity	++	++	++	++	++
Travel time improvement (min.)	**+++(36)**	**+++(34)**	+ (41)	÷ (47)	++ (39)
Coherence	0	0	+	**++**	+
Urban growth potential	**+44 %**	+35 %	+34 %	+40 %	+31 %
Construction Cost – total cost index (BRT)	**100%**	**99%**	103%	118%	106%
Construction Cost – total cost index (LRT)	**100 %**	**99 %**	105 %	113 %	107 %
Physical challenges and risks	÷÷÷	÷	÷	÷	÷
Operation costs Borgarlína (hours/year)	58.900	55.600	66.600	**75.400**	63.000
Bus savings	**+++**	**+++**	**+++**	**+++**	+
Recommendation for planning proposal		✓	✓		

Elimination of A-alignments

A5 (Reykjanesbraut-Kauptún-Smáralind) performs lower than the other A-alignments for passenger estimates and catchment areas – and combined with a higher travel time (operation costs) and construction costs this alignment is eliminated for the further analysis. Furthermore, the bus saving potential is assessed to be low. On that background A5 is eliminated.

A4 (Mjódd-Miklabraut) is performing low on travel time where the travel time from south (Hafnarfjörður and Garðabær) to the Reykjavik city centre increases a lot compared to today's bus service. Furthermore, this alignment has a low passenger estimate in the elasticity model and a high construction cost. Therefore, the alignment is eliminated.

A1 (Kársnes) and A2 (direct Hafnarfjarðarvegur) are similar and the only difference is whether to serve Kársnes and the Reykjavik city airport area or Kringlan on the route between Hamraborg and BSÍ. Comparing these two alignments highlights the risk of whether the Reykjavik city airport is ready to be transformed (closed for operation and developed into an urban area) within the early stages of the Borgarlína project and whether the bridge between Kársnes and the Reykjavik city airport will be build. Based on this risk, the A1 alignment has been eliminated as A2 seems more realistic in the shorter time horizon for a Borgarlína.

Recommendation of A-alignments

The recommendation is to bring A2 (direct Hafnarfjarðarvegur) and A3 (Smáralind loop) into the planning proposal and the further analysis of where to build the most appropriate Borgarlína infrastructure in the first phase.

They are both performing well in terms of passenger estimates and catchment areas – which is the most important when aiming for increasing the number of passengers (vision of 12 % public transport share).

A2 scores best on travel time, passenger estimate in the elasticity model and on operation costs. A3 on the other hand serves the regional centre Smáralind and improves coherence by increasing accessibility to that destination, at the cost of increased travel time.

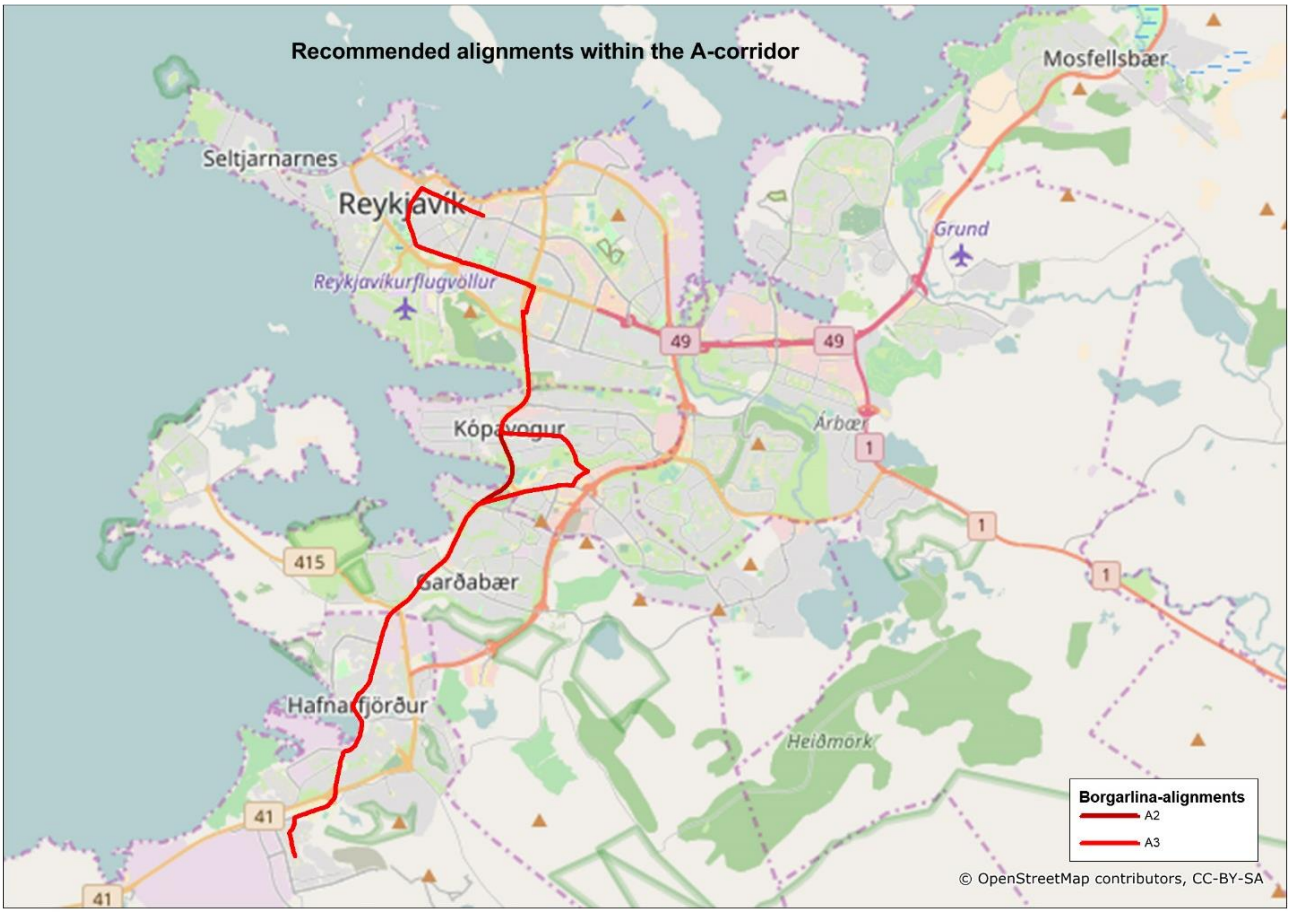


Figure 21 Recommended alignments within the A-corridor.

4.3.2 B-corridor

The B-corridor is special since all three alignments B1, B2 and B3, share the same alignment between BSÍ and Ártun. Hence this shared part has been analysed on its own as well, to assess the benefits of the "extensions" from Ártun in each of the main alternatives.

Three alignments were analysed in the B-corridor:

- *B (Ártun):* The alignment from BSÍ through the city centre and Suðurlandsbraut to Ártun is common for the B-alternatives and cover some of the densest areas of the Capital Area as well as areas with a high development potential.

- B1 (Mosfellsbær): Extending the B-alignment from Ártun and eastwards will connect the municipality Mosfellsbær to the Borgarlína network. Between Mosfellbær and Ártun the alignment passes through green field area with a large urban growth potential.

- B2 (Spöngin): Extending the B-alignment northwards will cover the dense residential area Grafarvogur terminating at Spöngin with shopping and educational functions.

- B3 (Norðlingaholt): A southbound extension from Ártun is also possible passing through a relatively dense residential and commercial area Árbær and terminating in the dense residential neighbourhood Norðlingaholt.

Figure 22 B-corridor alignments.

Table 4 Characteristics of the B-alignments.

	B(Ártun)	B1	B2	B3
Length (km)	*7,5*	16,3	11,9	12,7
Stops	*13*	23	20	20
Travel time (min)	*20*	42	32	33
Avr. speed (km/h)	*22,1*	23,4	22,1	23,0

Table 5 MCA-results for the alignments within the B-corridor.

Criteria	*B(Ártun)*	B1	B2	B3
Passenger estimates per km (elasticity model)	***970***	600	**810**	660
Passenger estimates per km (Trip gen. - vision)	***2.190***	1.660	**1.750**	1.620
Catchment area today, inh. per km (400 m)	***1.950***	1.230	**2.060**	1.800
Catchment area, incl. growth potential per km	***3.910***	3.060	**3.720**	3.250
Frequency and capacity		++	++	++
Travel time improvement (min.)		+ (42)	**++ (32)**	**++ (33)**
Coherence		0	0	0
Urban growth potential		+80 %	+42 %	+37 %
Construction Cost – total cost index (BRT)		100 %	**84 %**	**88 %**
Construction Cost – total cost index (LRT)		100 %	**86 %**	**88 %**
Physical challenges and risks		÷	÷	÷
Operation costs Borgarlína (hours/year)	***33.000***	67.900	**52.500**	54.100
Bus savings		+++	++	++
Recommendation for planning proposal	✓	✓	✓	

Elimination of B-alignments

B3 (Norðlingaholt) scores among the lowest measuring catchment area, passenger numbers and growth potential. Compared to B2, which is the best scoring of the three alignments, B3 scores lower or similar on every aspect, and is hence eliminated from the process at this stage.

Recommendation of B-alignments

The common part for the B corridor – B (Ártún) - seems very promising and scores the highest passenger and catchment area levels across all the 16 alignments analysed.

B2 (Spöngin) is performing as the best among the three full-length candidates on both passenger estimates and catchment areas as well as travel time improvement and cost wise. Therefore, we recommend this alignment for further investigation and for the planning proposal.

B1 (Norðlingaholt) has significantly lower performance on most parameters compared to B2. However, a part of the new Regional Development Plan was to connect main centres with a high-class public transport system, which is an argument for the connection to Mosfellsbær. Furthermore, the corridor covers the biggest development potential in the area east of Ártun. Here Borgarlína could play an important role in developing a full-scale transit oriented development.

Based on these two aspect we recommend keeping B1 in the process and the planning proposal. However, we emphasize that much focus should be put into supporting measures for the Borgarlína if B1 is to attract a feasible level of passengers.

The recommendation hence is to bring B1 and B2 into the planning proposal and the further analysis of where to build the most appropriate Borgarlína infrastructure in the first phase.

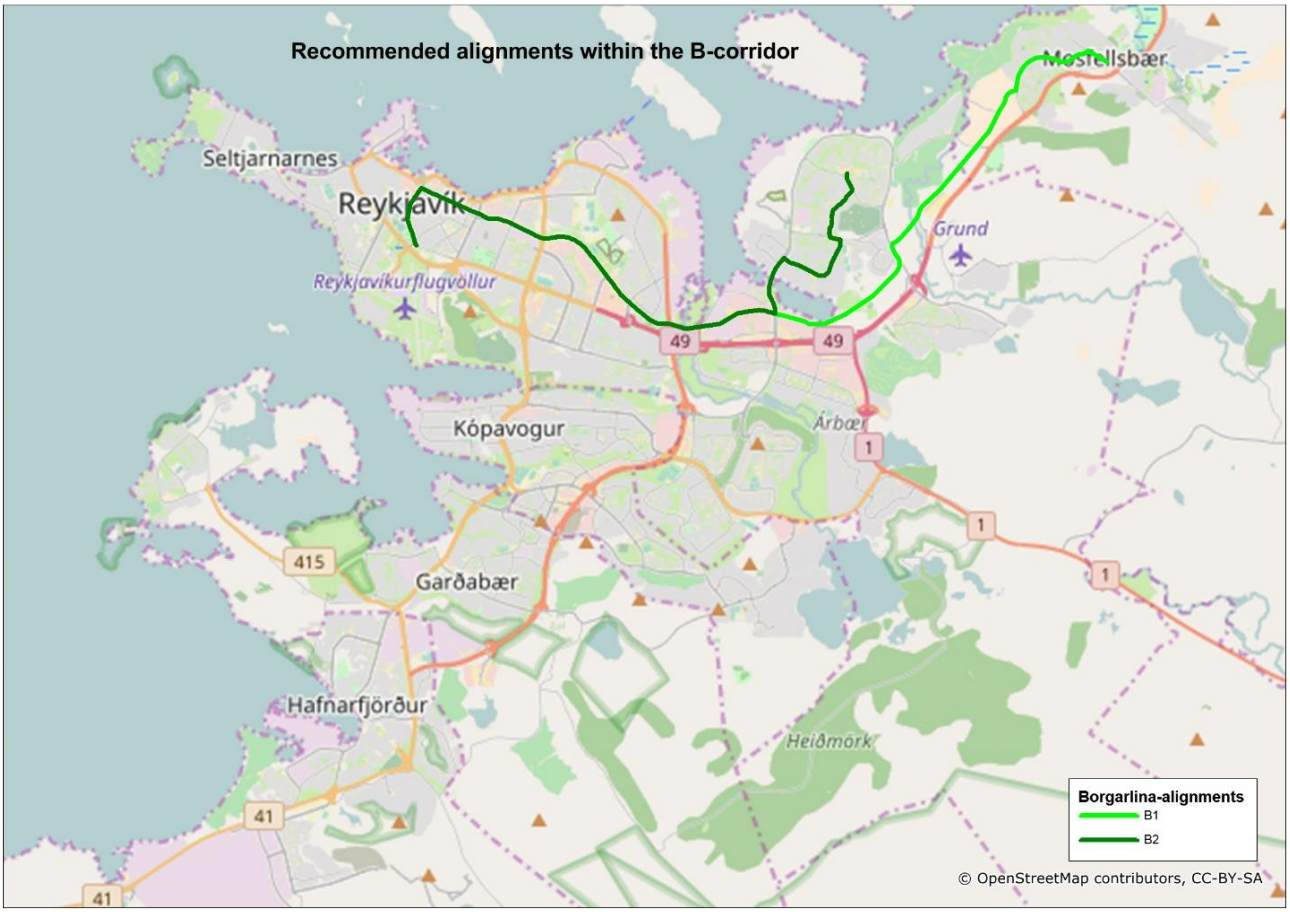


Figure 23 Recommended alignments within the B-corridor.

4.3.3 C-corridor

The C-corridor has five alignments that are analysed (see Figure 24). C1, C2 and C3 shows radial lines from the city centre to the southeast. C4 and C5 shows options for circle lines connecting the radial lines in the system.

Five alignments were analysed in the C-corridor:

- C1 (Breiðholt-Kársnes): Connects the very dense residential area Breiðholt with Mjódd and Smáralind and the city centre via Kársnes combining a direct city center line with ring connection Mjódd – Smáralind – Hamraborg.

- C2 (Breiðholt-Milabraut): Connects Breiðholt with the city centre in the most direct way following Miklabraut.

- C3 (Þing- Kársnes): Connects Salir and Þing with Smáralind and the city centre via Hamraborg and Kársnes. This alignment combines a fast city connection with a good connection across the entire Kopavogur municipality.

- C4: (Small circle line): Provides a short circle with possibilities to travel between the radial corridors connecting Hlemmur, BSÍ, Hamraborg, Smáralind, Mjódd and Vogabyggð.

- C5: (Large circle line): Provides a larger circle line covering the same hubs as C4, but in addition serving the areas around Sæbraut and the University of Iceland providing more relevant transfer options.

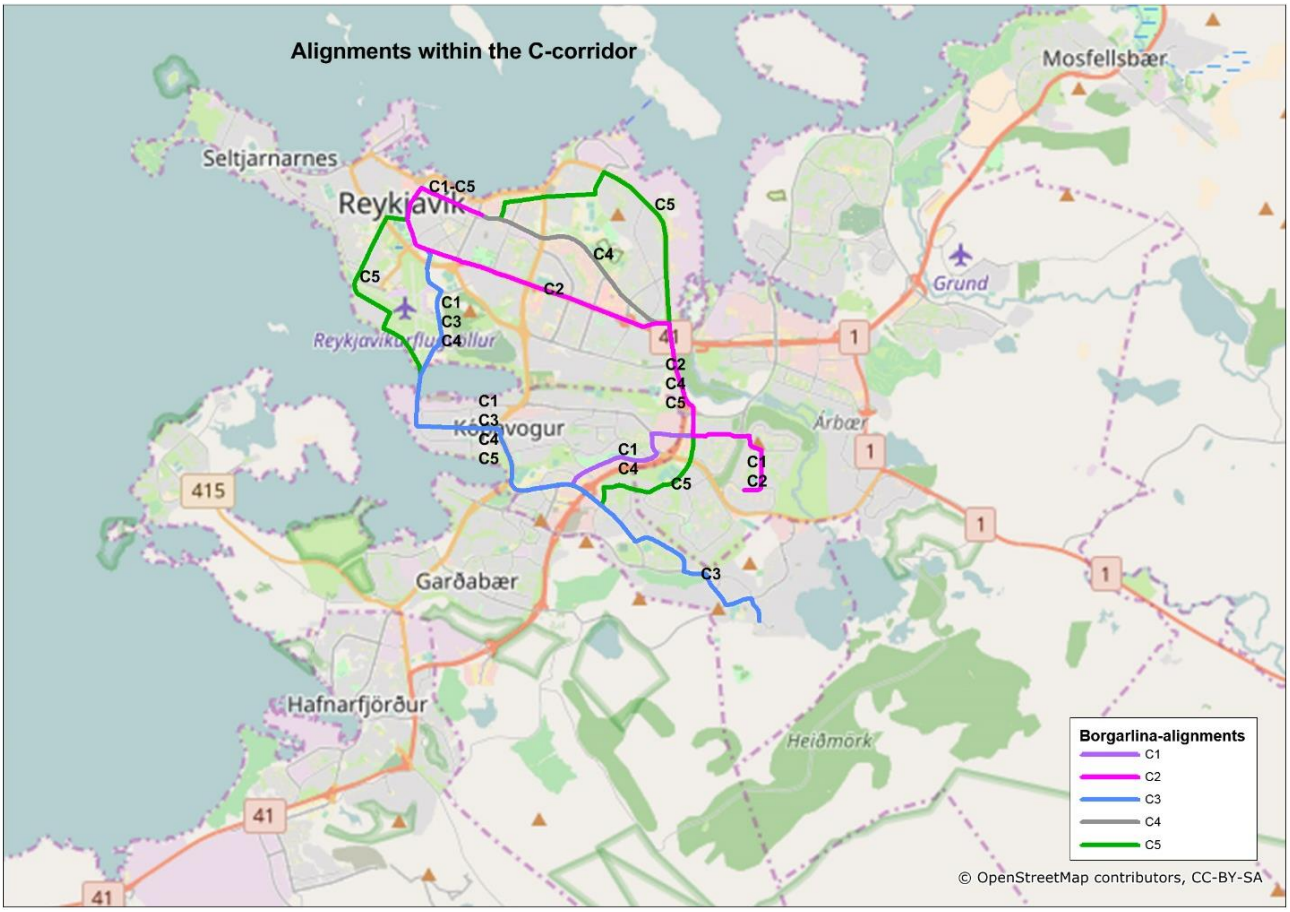


Figure 24 C-corridor alignments.

Table 6 Characteristics of the five C-alignments.

	C1	C2	C3	C4	C5
Length (km)	14,2	11,0	13,7	17,8	20,6
Stops	21	17	18	25	29
Travel time (min)	36	28	32	43	50
Avr. speed (km/h)	23,7	23,7	25,4	24,7	24,7

Table 7 MCA-results for the alignments within the C-corridor.

Criteria	C1	C2	C3	C4	C5
Passenger estimates per km (elasticity model)	770	**980**	760	660	590
Passenger estimates per km (Trip gen. - vision)	**1.650**	**1.640**	**1.710**	1.450	1.170
Catchment area today, inh. per km (400 m)	2.060	**2.530**	1.850	1.520	1.680
Catchment area, incl. growth potential per km	**3.300**	**3.690**	**3.130**	2.750	2.630
Frequency and capacity	++	**+++**	++	++	++
Travel time improvement (min.)	0 (36)	**++ (28)**	**++ (32)**	+ (43)	÷ (50)
Coherence	+	+	+	**++**	**++**
Urban growth potential	+37 %	+30 %	**+43 %**	**+42 %**	+36 %
Construction Cost – total cost index (BRT)	100%	**74%**	**89%**	128%	140%
Construction Cost – total cost index (LRT)	100 %	**93 %**	98 %	113 %	122 %
Physical challenges and risks	÷÷÷	**÷÷**	÷÷÷	÷÷÷	÷÷÷
Operation costs Borgarlína (hours/year)	58.600	**45.000**	52.500	70.300	81.300
Bus savings	**+++**	**+++**	**+++**	+	0
Recommendation for planning proposal		✓	✓		

Elimination of C-alignments

C4 (Small circle line) and C5 (Large circle line) performs lower than the other C-alignments for passenger estimates and catchment areas. In addition, the construction costs of these alignments are high and the bus saving potential is assessed to be low. Hence, we recommend eliminating these alternatives for the further analysis. We would however like to emphasise the importance of good bus service connecting the radial lines – they just do not seem to have potential for a full scale Borgarlína.

C1 (Breiðholt-Kársnes) and C2 (Breiðholt-Miklabraut) are similar in start- and end destination and the only difference is whether to serve Smáralind, Kársnes and the city airport area or Skeifan and Kringlan on the route between Mjódd and BSÍ. Comparing these two alignments C2 has the highest passenger estimate and catchment area, and travel time, construction and operation costs also favours this alignment. The risks on C1 crossing Kársnes and the city airport should also be taken into account. Hence, we recommend C2 as the best option to bring into the planning proposal, while C1 is eliminated.

Recommendation of C-alignments

C2 (Breiðholt-Milabraut) is recommended due to high catchment area and passenger potential.

C3 (Þing- Kársnes) is recommended due to potential high passenger numbers and the travel time improvement. They both has good conditions for bus savings.

C3 still has the risk of whether the Reykjavík city airport is ready to be transformed within the early stages of the Borgarlína project and whether the bridge between Kársnes and the Reykjavík city airport will be build. But this alignment seems as the most appropriate for a Kársnes-city airport connection due to the radial routing and offering direct bus service to both the Reykjavík city centre and Smáralind. As a positive side effect, the line runs through the entire Kopavogur municipality increasing the coherence across the municipality.

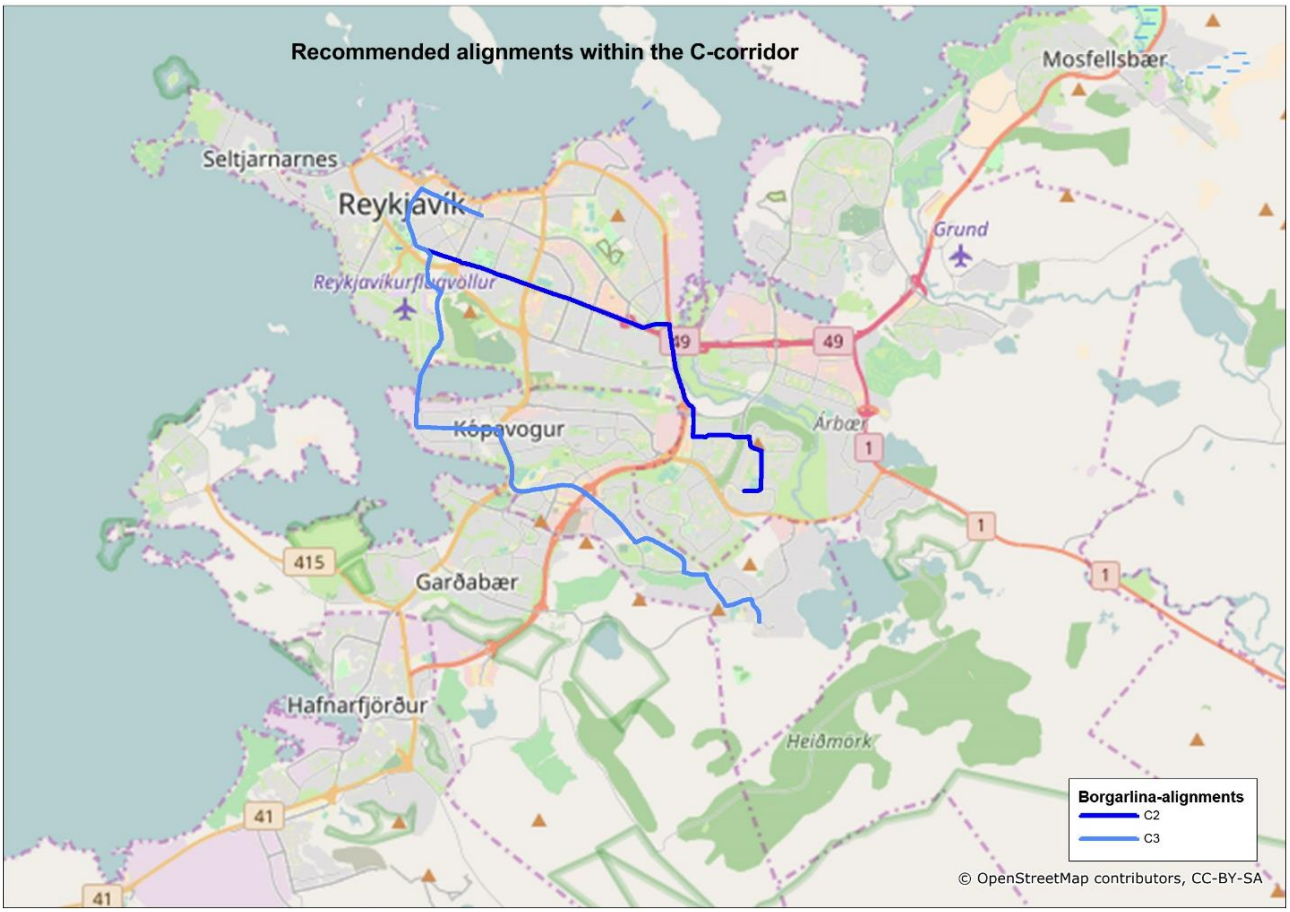


Figure 25 Recommended alignments within the C-corridor.

4.3.4 D-corridor

The D-corridor covers alignments that connect Seltjarnarnes with the city centre. These alignment are rather short, and hence cannot stand alone as Borgarlína, but should be connected to an alignment from one of the other corridors. Such a connection will provide a good double radial line that offers the passengers a wide range of destinations without shifting and creates coherence across the city centre.

- D1 (northern - Geirsgata): Follows the north coast covering the harbour area as well as the residential neighbourhood south of Eiðsgrandi.
- D2 (central - Hringbraut): Follows the D1 alignment along Eiðsgrandi but turns on Hringbraut to provide a more central service of the area and coverage of the University of Iceland.
- D3 (southern – Nesvegur): Covers the University of Iceland like D2, but covers the southern parts of the peninsula from Nesvegur instead of the central and northern parts.

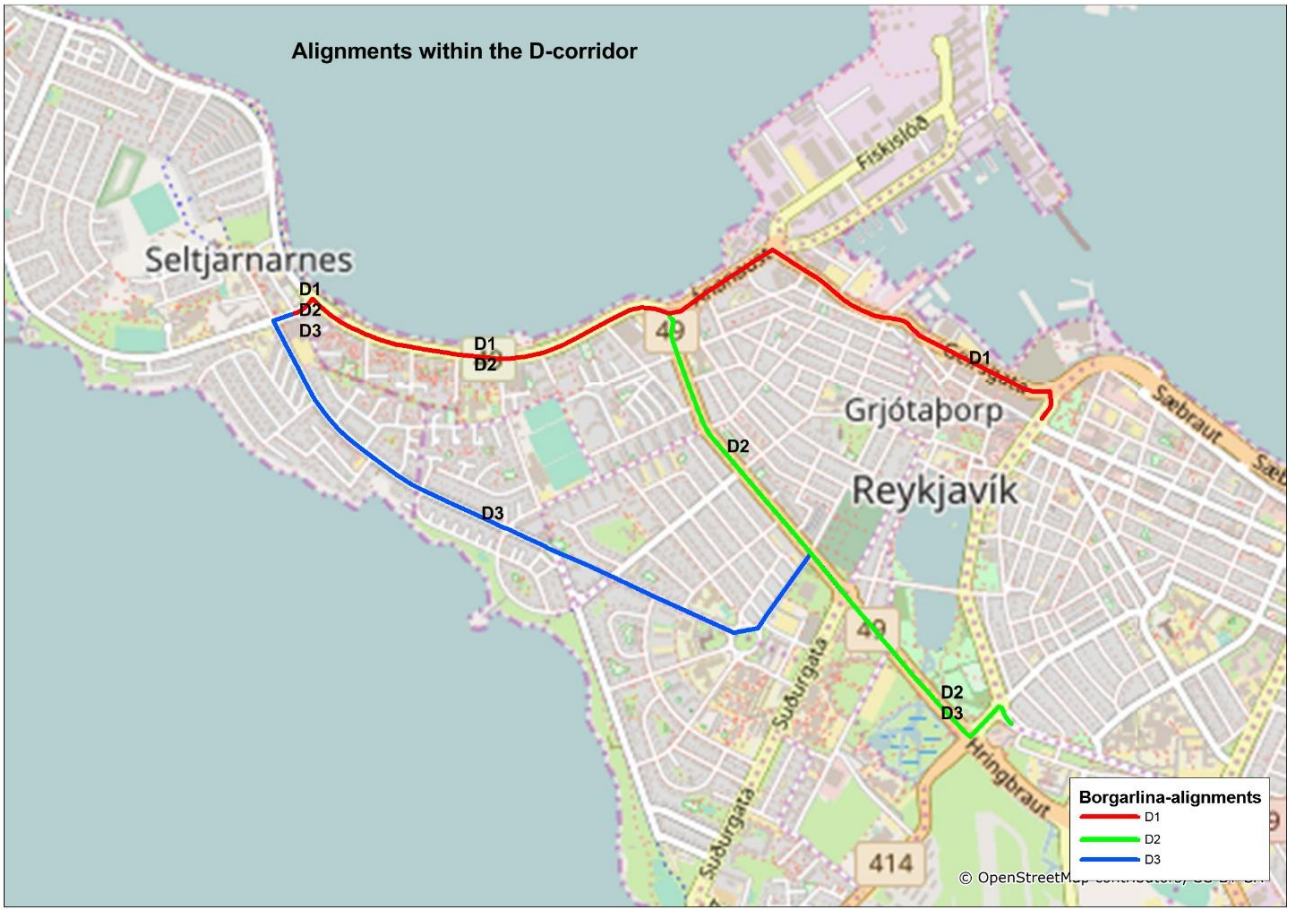


Figure 26 D-corridor alignments.

Table 8 Characteristics of the D-alignments.

	D1	D2	D3
Length (km)	2,9	3,3	3,2
Stops	5	6	6
Travel time (min)	7	8	8
Avr. speed (km/h)	25,8	24,8	24,1

Table 9 MCA-results for the alignments within the D-corridor.

Criteria	D1	D2	D3
Passenger estimates per km (elasticity model)	810	**1.110**	970
Passenger estimates per km (Trip gen. - vision)	1.470	**1.630**	1.270
Catchment area today, inh. per km (400 m)	3.200	**3.510**	2.700
Catchment area, incl. growth potential per km	3.820	**4.890**	3.830
Frequency and capacity	+++	+++	+++
Travel time improvement (min.)	+++ (7)	+++ (8)	+++ (8)
Coherence	++	++	++
Urban growth potential	+17 %	**+40 %**	**+44 %**
Construction Cost – total cost index (BRT)	**100 %**	127 %	127 %
Construction Cost – total cost index (LRT)	100 %	105 %	102 %
Physical challenges and risks	0	0	0
Operation costs Borgarlína (hours/year)	**10.800**	13.000	13.600
Bus savings	0	0	0
Recommendation for planning proposal		✓	

Elimination of D-alignments

D1 (northern - Geirsgata) and D3 (southern – Nesvegur) is eliminated. See arguments below.

Recommendation of D-alignments

D2 (central - Hringbraut) is performing better than D1 and D3 looking at both catchment area and passenger estimates. This is the best argument for recommending the D2 and thereby eliminating D1 and D3. For the other criteria, the three alignments are not differing much.

The passenger numbers are the reason for investing in Borgarlína combined with the transit-oriented development, which D2 offers with a high urban growth potential.

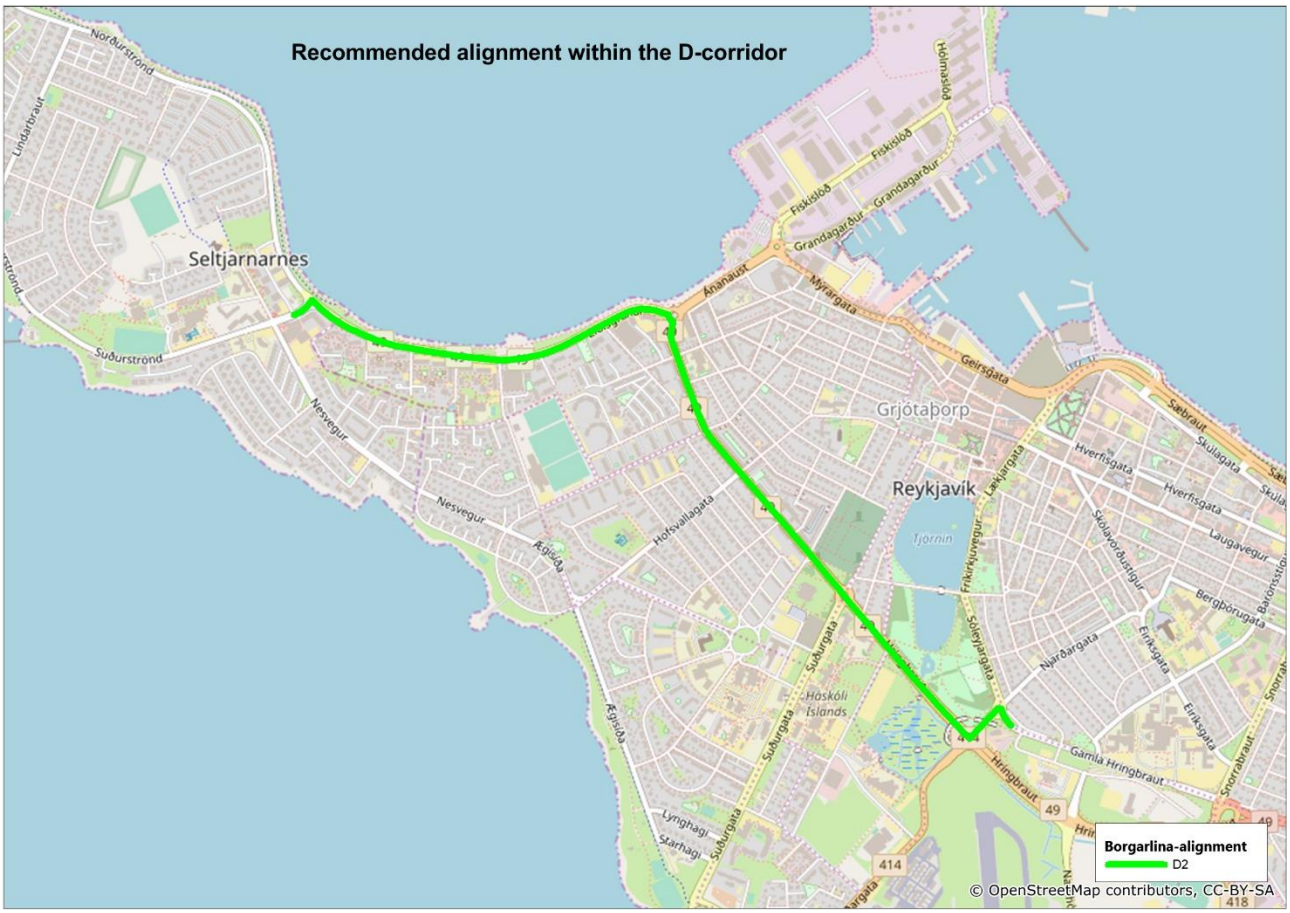


Figure 27 Recommended alignment within the D-corridor.

5 Recommendation for further process

Based on the MCA we have recommended seven of the screened alignments for the further process of Borgarlína.

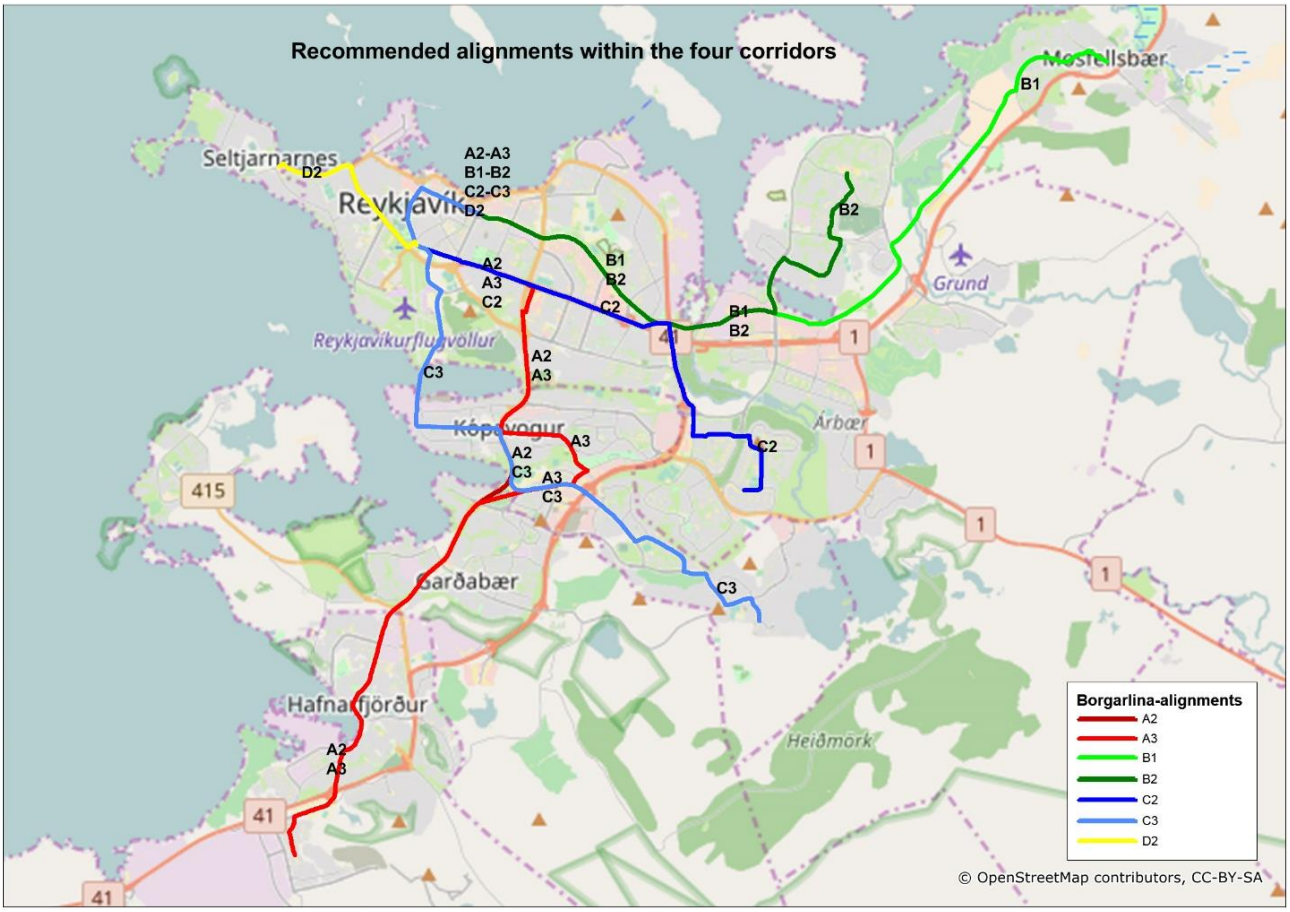


Figure 28 Recommended alignment within the four corridors.

5.1 Input from open hearing

The outcome of the MCA has been through an open process that started May 29th and ended June 21st.

Among the input from the hearing were some extra alignments to consider for the further process for Borgarlína. Alignments that were not among the 16 candidates in the MCA and hence were not assessed as a part for the process. These are branches to (see Figure 29):

- Laugarnes
- Örfirisey
- Rofabær

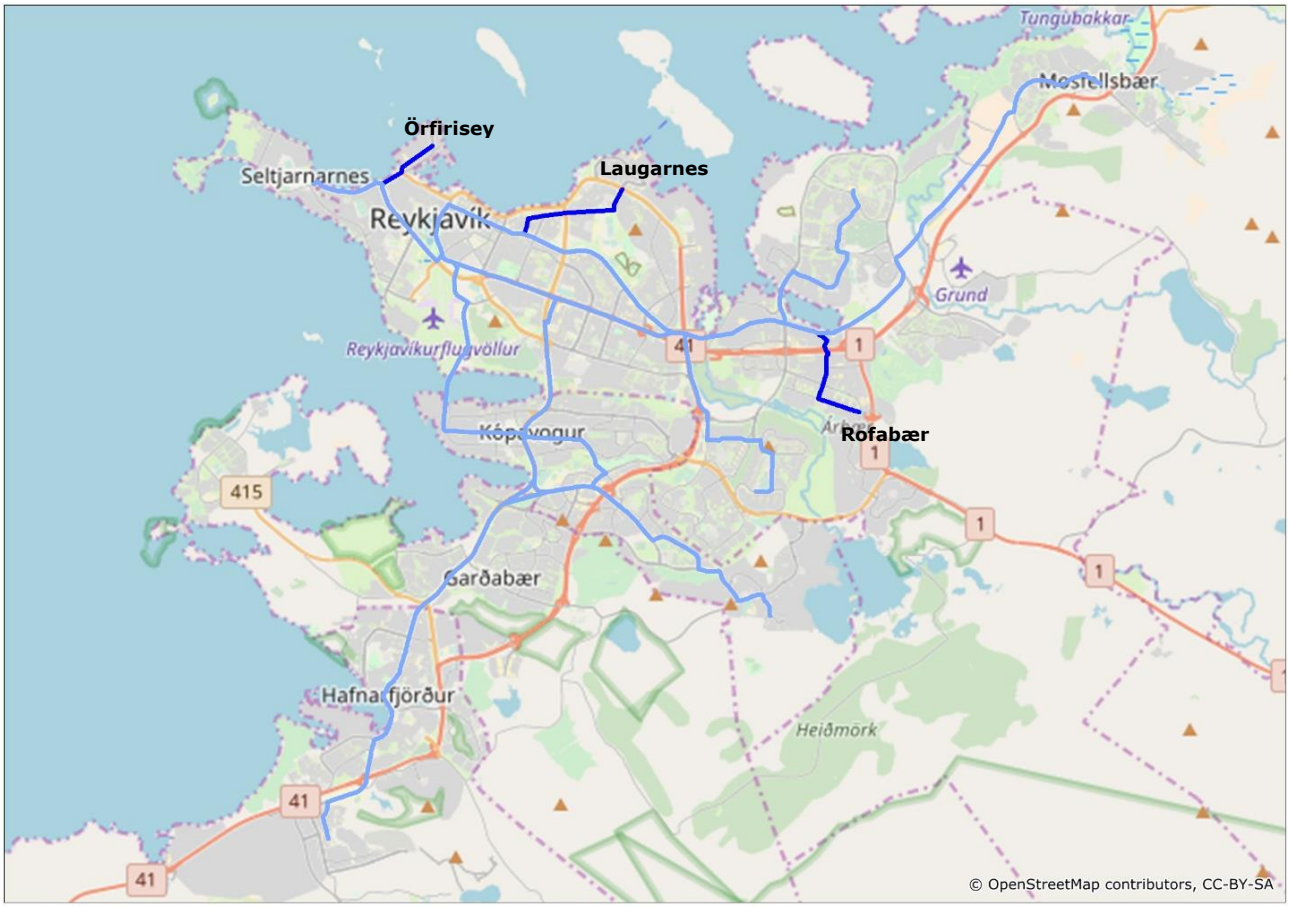


Figure 29 Recommendations based on the MCA and input from the open hearing.

Laugarnes

Comments from the hearing, suggest to connect Laugarnes and Hlemmur with a short branch. This branch covers some very dense areas for both existing residents and business. Furthermore, the Laugardalur pool attract many daily visitors making it an important point of interest for the Borgarlína-network. The urban development potential is high between Hlemmur and Laugardalslaug, and therefore creates a large passenger potential.

This alignment was a partly included in the MCA (C5 under the C-corridor) as a ring line, where it didn't come out as a recommended alignment. This was however mainly due to low passenger potential and conflict along other parts of the alignment.

The benefits of this short branch are obvious due to the density of existing passenger potential. Furthermore, the driving speed for bus service today is very low on Borgartún and Sundlaugavegur. With Borgarlína the speed will increase due to the separated bus lanes and prioritation in the intersections.

It seems possible that this short branch with high passenger potential and high travel time improvements could be a feasible extension to Borgarlína.The branch might be a logic end-station for the Borgarlína-system avoiding it having to end in the middle of the city at Hlemmur and instead continue through the city as a double radial route. Therefore, we recommend to add this branch for the further process of Borgarlína and as part of the planning proposal for the future Reykjavik.

Örfirisey

A branch of the Borgarlína network to Örfirisey was suggested in the hearing to support a potential development of the area. The future plans for the development of Örfirisey are however still unknown and therefore the passenger potential for the area is very hard to estimate. Today the area contains functions that require much space, such as old industry, car rental (requires parking lots) and grocery functions.

Due to the low transport need today and the uncertainty of the future development of the area and thereby the passenger potential we find it hard to recommend this branch for the further process of Borgarlína. On the other hand, high-class public transport and strict limits to car traffic easily becomes a prerequisite if the area is to undergo a revitalisation and densification. The location of the area means that a car based dense development will impose major traffic problems dragging traffic all the way through the city centre. Hence any redevelopment of the area should include good public transport and restriction on cars to develop a sustainable urban area and avoid further pressure on the central road network. Any decision on redeveloping the area hence should include an assessment of how to provide sufficient green mobility to the area (possibly including Borgarlína).

Rofabær

A shorter version of B3 ending in Rofabær instead of Norðlingaholt was suggested in the open hearing. We have assessed the option, but find that the catchment area (including urban development potential) does not improve by the suggested alignment compared to the original B3. The current passenger numbers however indicate that most passengers board on this section.

The connection between Ártun and Arbær/Rofabær would be relevant to ensure congestion free public transport here. The premise for Borgarlína in this phase has been to focus on the concept, meaning that the infrastructure will be build all the way to the end station (like light rails) to end up as the Borgarlína concept.

Looking at the possible bus network – there will still be a need for bus service to Norðlingaholt and leaving Norðlingaholt outside Borgarlína will cause extra bus service to serve the urban area. Today Norðlingaholt is served by single number route 5 with 15-minute service.

Therefore, we recommend sticking to the total B3 instead of a shorter branch to Rofabær and having additional bus service between Norðlingaholt and city centre. The existing route 5 is quite similar to B3 and even though B3 is not part of the recommended Borgarlína-network, route 5 should still should be seen as an important route that in the future will operate with an even higher frequency to be able to fulfil the vision for the public transport. In the longer perspective, this could be a part of Borgarlína if the right circumstances are found. Most of the infrastructure to Ártun is part of the recommendation and therefore this extension to Rofabær and Norðlingaholt is a last-mile investment.

5.2 Other input for recommendation

The final recommendation for Borgarlína is based on the MCA-recommendations and the input from the open hearing and then linking together the

recommendations towards a Borgarlína-network. Still multiple alignments exists in the different corridors, and it would not be feasible to build all eight alignments at the same time. Also the recommended network structure will require that different alignments are merged together in the city centre to provide the best double radial service.

Hence the project needs to identify the most appropriate infrastructure for the entire Borgarlína network and the operation of it. In this process we have identified three aspects that should be taken into consideration in identifying the final network.

"Missing link along Kringlumyrarbraut"

The coverage of the city centre and connecting the alignments here is a puzzle and requires good points for changing between the different routes of Borgarlína and other bus routes. In our work, we have noticed that taking the city growth into account, the centre of gravity in the Capital area is actually moving to the east. This underlines the importance of changing possibilities further to the east than BSI and Hlemmur.

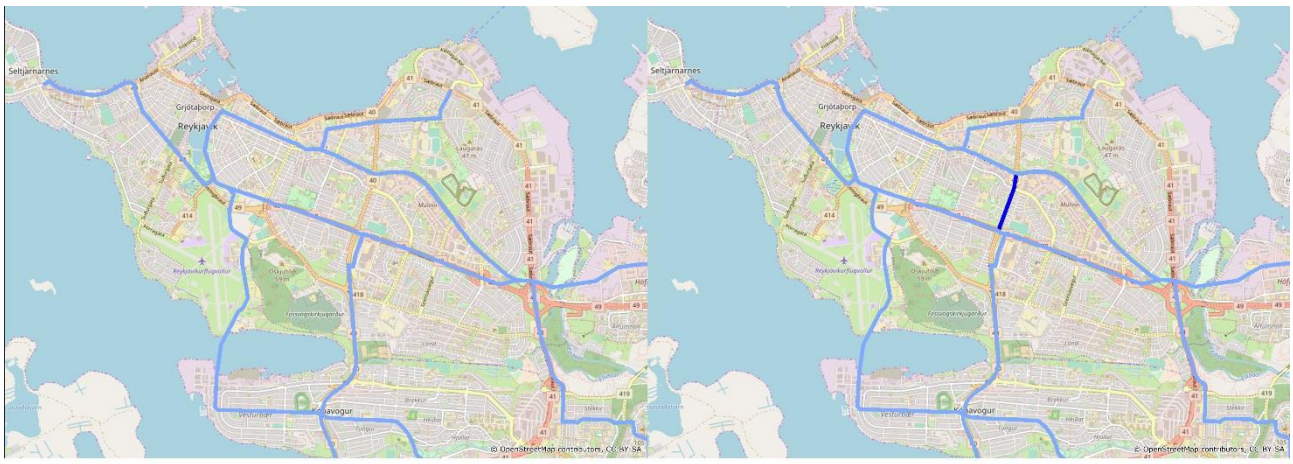


Figure 30 Borgarlína network with and without link along Kringlumyrarbraut.

Therefore, we recommend building the link between Kringlan and Sudurlandsbraut as a part of the Borgarlína-network, see Figure 30. This will create a stronger network and more flexibility in the system both for Borgarlína and for other busses. The link will provide the option for routes from the south to drive directly to Hlemmur and create the transfer option between routes from south and east instead of having the detour through the city centre.

This link could also be relevant in case of disturbance on the infrastructure in the city centre or incidents causing temporary disruption of the infrastructure.

A-alignment

Two of the recommended alignments (A2 and A3) run between Hafnarfjörður, Garðabær, Hamraborg and the city centre. A2 is similar to existing route 1 and A3 takes a loop to connect to Smáralind, see Figure 31.

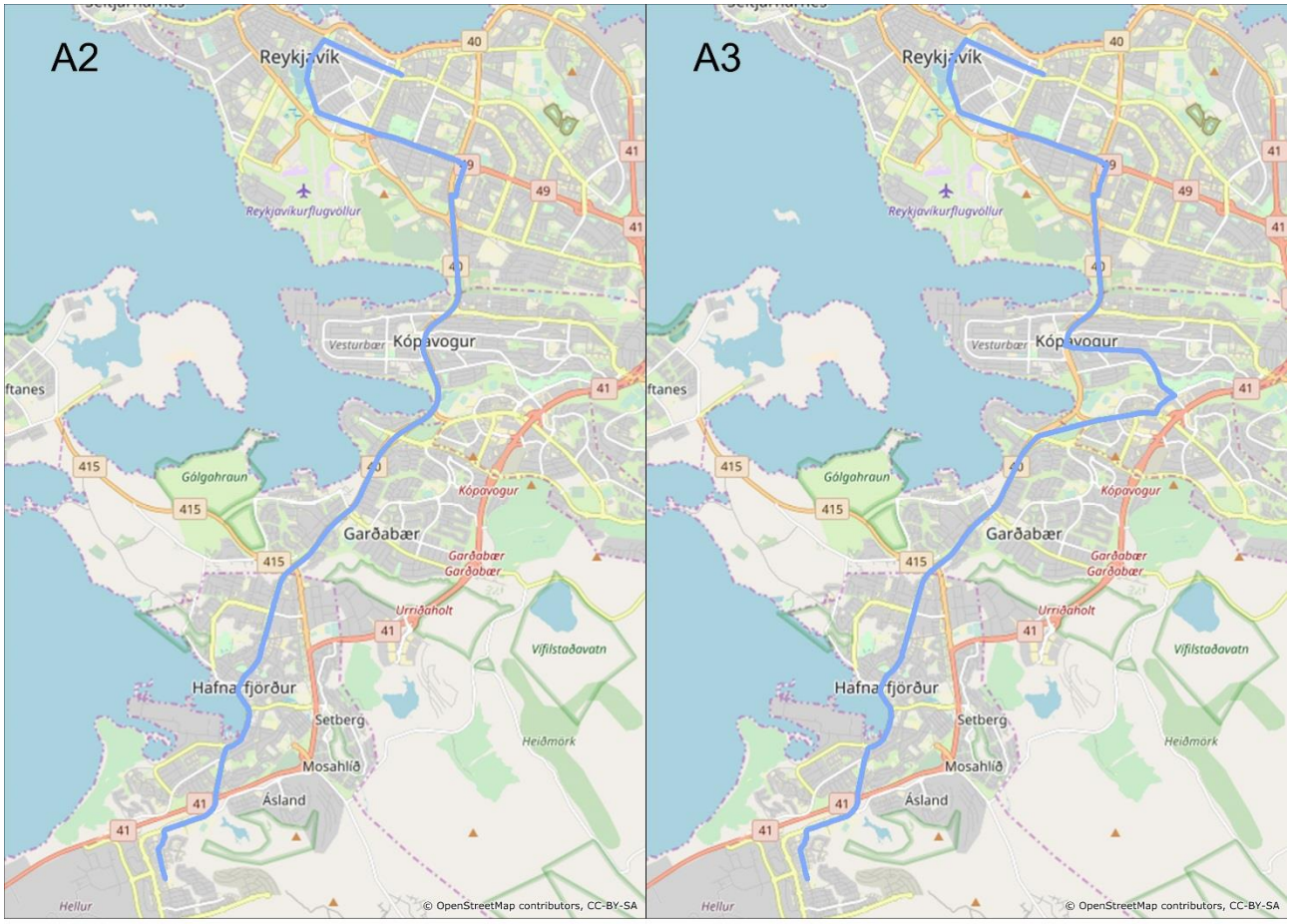


Figure 31 A2 (like route 1 today) and A3 that connects with Smáralind.

The comparison of the two A-alignments (A2 and A3) shows that A2 provides the best service improvement in the most important travel relations, and will hence improve conditions for existing passengers on route 1 and provide a strong system for increased public transport share[4].

A3 improves the service between Smáralind/Hamraborg and the city centre, which has an important transport need today[5]. But the passengers from Hafnarfjörður/Garðabær to the city centre (and Hamraborg) will experience around 20 % longer travel time compared to today's route 1.

Based on this we recommend A2 over A3. It is our assessment that the negative effect of the longer travel time from south to the city centre is not outweighed by the positive effect of a direct connection to Smáralind.

The recommended (rerouted) C3-alignment will create the direct connection between Smáralind-Hamraborg-city centre, which was one of the main benefits

[4] 24 % of motorised trips from Hafnarfjörður ends in Hamraborg or the city centre. Based on data from Capacent travel survey, 2011/14.

[5] 40 % of all trips generated in Smáralind. Based on data from Capacent travel survey, 2011/14.

for A3. Thereby the recommendation of A2 and the rerouted C3 supports each other and the travel pattern that we see today.

Kopavogur

Based on recommending A2 instead of A3 (see above) we recommend rerouting the C3-alignment in Kopavogur between Smáralind and Hamraborg to give better service in Kopavogur. This service was offered by A3 and not the recommended A2. The rerouting enables extra stop at Digranesvegur that offers access to Borgarlína for a part of the eastern Kopavogur.

Figure 32 Re-routing C3 in Kopavogur due to recommended A-alignment.

This causes no significant changes for driving time (except extra stop). This changed alignment might mean a new location for the Borgarlína stop at Smáralind.

This smaller re-routing of the alignment will give a good service for Kopavogur and could save some service hours on the supporting bus network.

5.3 Borgarlína recommendation

Based on the MCA recommendations, the input from the open hearing and the above adjustments to the alignments we recommend narrowing the scope of the Borgarlína-project to the network shown at Figure 33. This potential Borgarlína-network is for the longer perspective aiming at reaching the vision for the future public transport.

This Borgarlína-network consists of 58 km infrastructure and connects all six municipalities in the Capital Area.

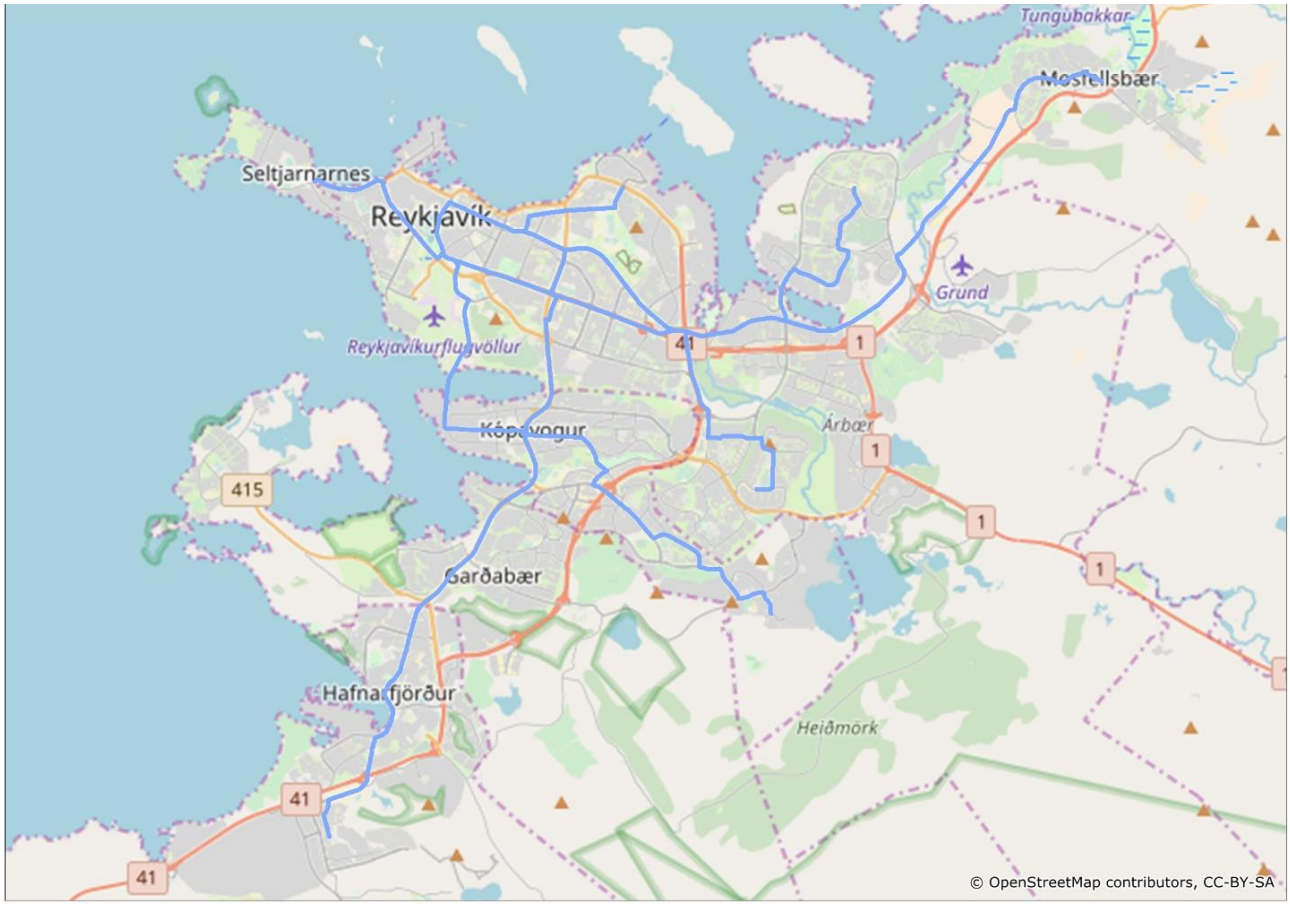


Figure 33 Recommendations for the further Borgarlína-process.

5.3.1 Today's residents

The recommended Borgarlína-network has a good coverage of existing residents in the capital area (see Figure 34):

- 95,000 residents live within a 400 m radius of the Borgarlína stations (44 % of all residents)
- 138,000 residents live within a 600 m radius of the Borgarlína stations (63 % of all residents)

This means that nearly half of the today's residents will have good accessibility to the future Borgarlína-network with no more than 400 m to a station. Moreover, 2/3 of all residents will have the Borgarlína within 600 m.

Benchmarking this coverage of residents with similar plans for future BRT/LRT systems in Denmark's second-fifth largest cities (Aarhus, Odense, Aalborg and Esbjerg), we see that the planned high class public network will cover 40-50 % of all residents within 500 m. This indicates that the coverage of the Borgarlína-network is on line with the planned networks in Denmark.

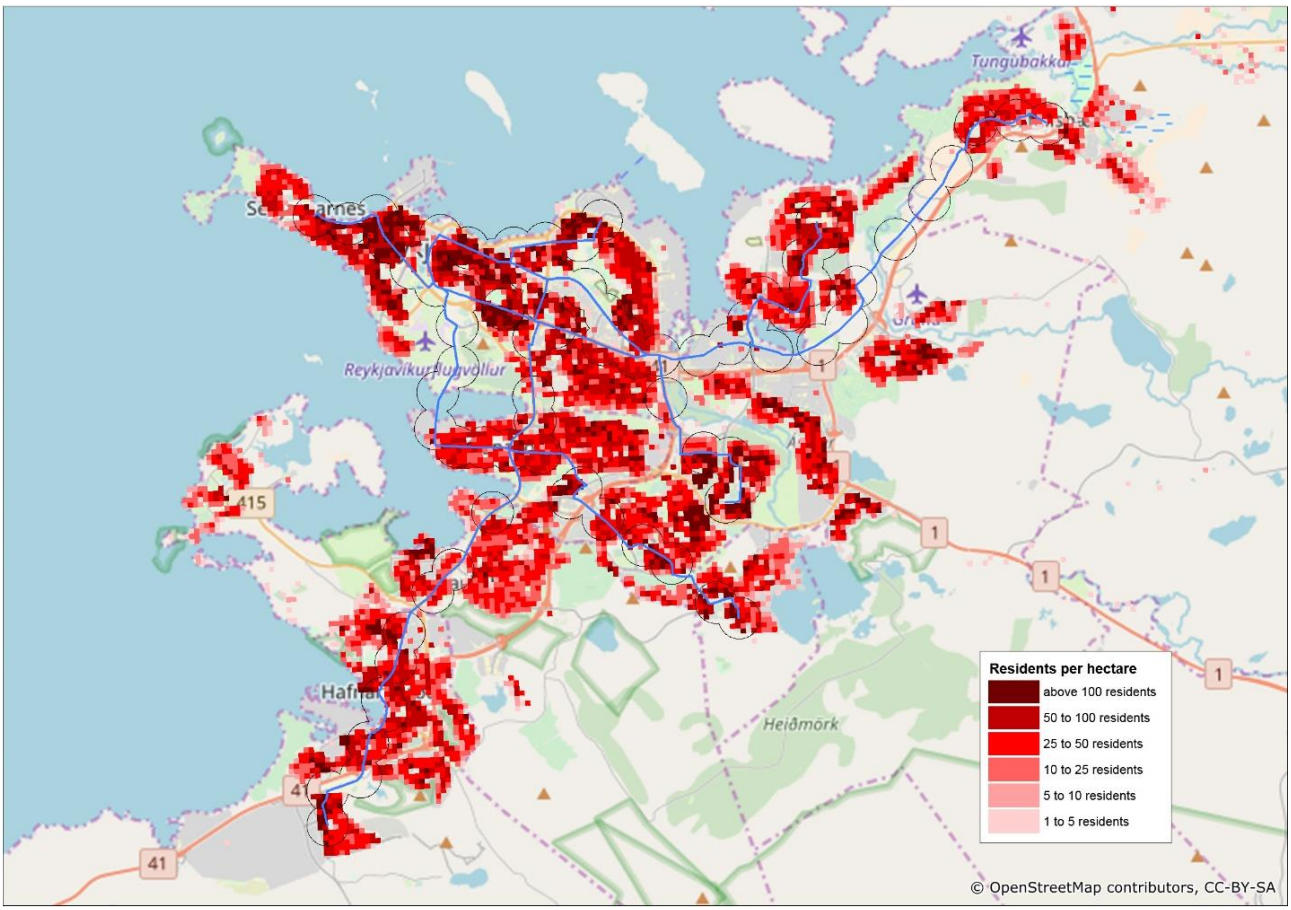


Figure 34 Borgarlína-recommendations seen in relation to existing density of residents.

5.3.2 Generated trips

The recommended Borgarlína-network has a good match with the generated trips in the capital area (see Figure 35). The Borgarlína-network has:

- around 557,000 trips within 400 m radius of Borgarlína-stations (64 % of all generated trips)
- around 627,000 trips within 600 m radius of Borgarlína-stations (72 % of all generated trips)

This means that nearly 2/3 of the today's generated trips takes place within walking distance of a future Borgarlína station. Moreover, 3/4 of all trips will have the Borgarlína within 600 m.

Most of the locations that generate a very high number of trips are within 400 m of the Borgarlína-network. Of these only Fossvogur (hospital) and Kauptún (Ikea andCostco) not within 400 m of a station. Ikea, Costco and Bauhaus are not among traditional locations for public transport. Hospitals are on the other hand locations with high use of public transport. Fossvogur would be an interesting area for the public transport – also when transformed into something else due to the relocation and centralization of the hospitals in Reykjavik.

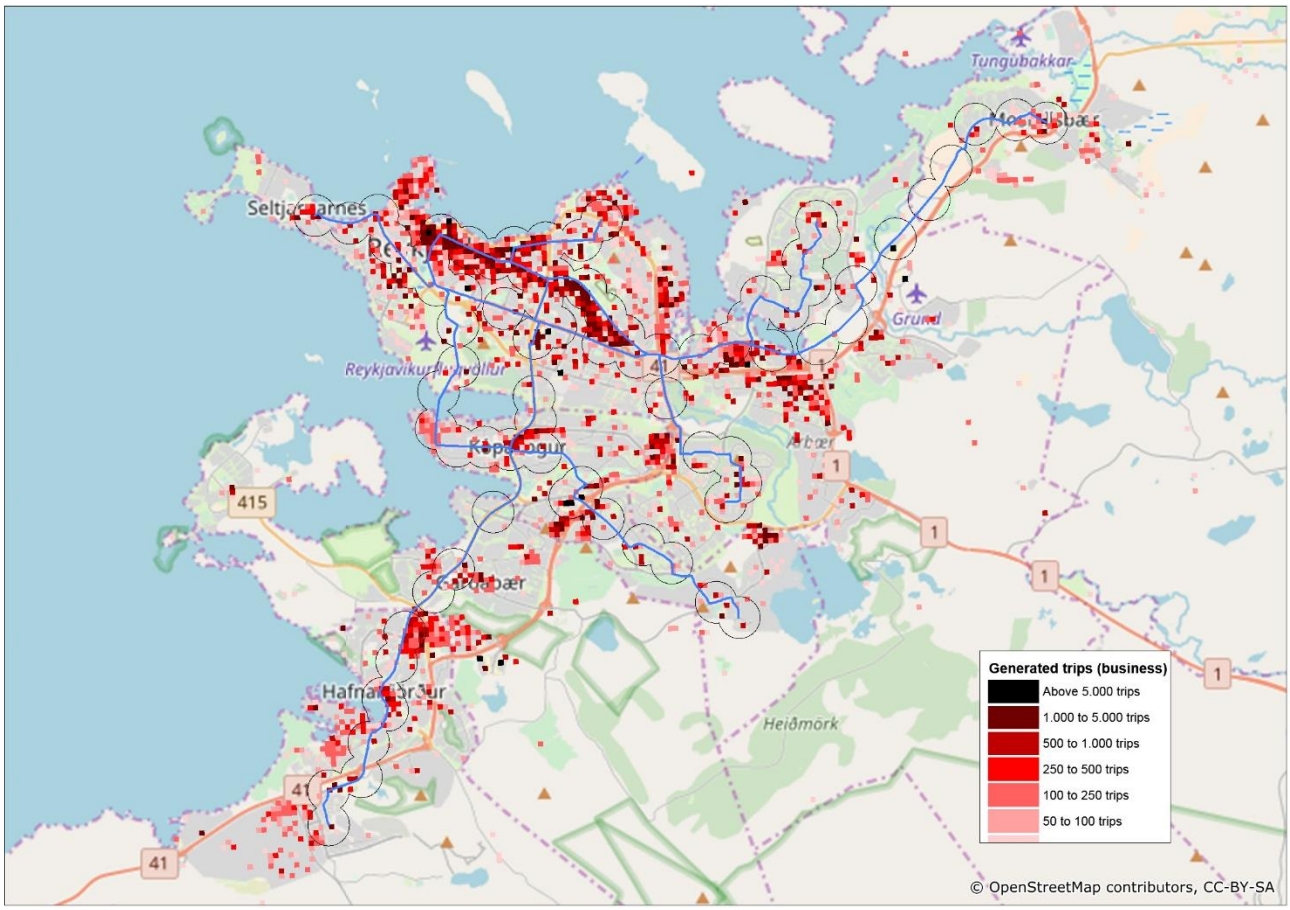


Figure 35 Borgarlína-recommendations seen in relation to existing density of generated business trips.

5.3.3 Points of interest

The recommended Borgarlína-network has a good match with the location of the identified points of interest in the capital area (see Figure 36).

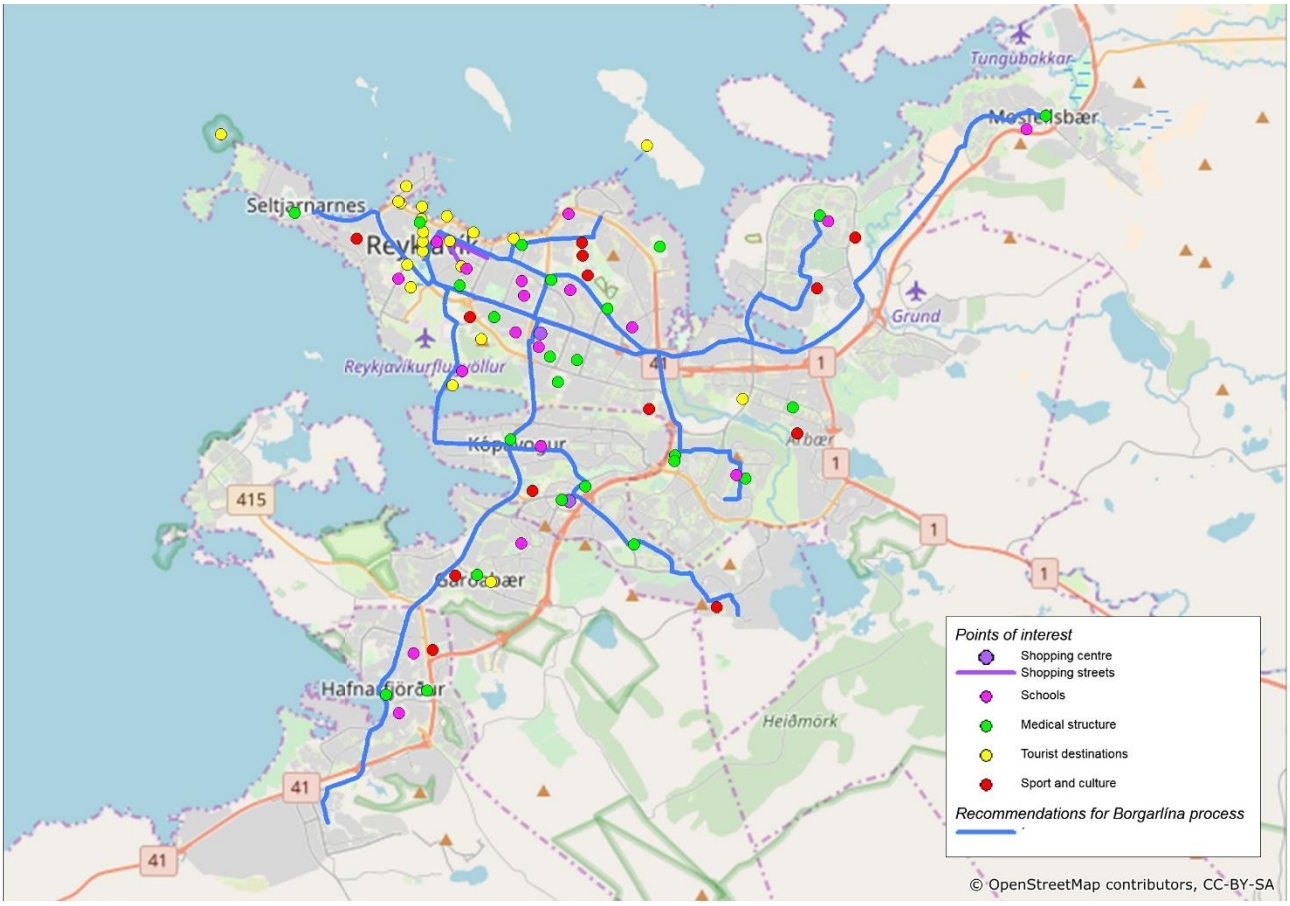


Figure 36 Borgarlína-recommendations seen in relation to identified points of interest.

5.3.4 Existing passenger numbers and the existing number of daily departures

› Around 68 % of today's boardings happen at bus stops within 400 m of a Borgarlína-station.

The recommended Borgarlína-network has a good match with the existing passenger numbers and the existing number of daily departures (see Figure 37).

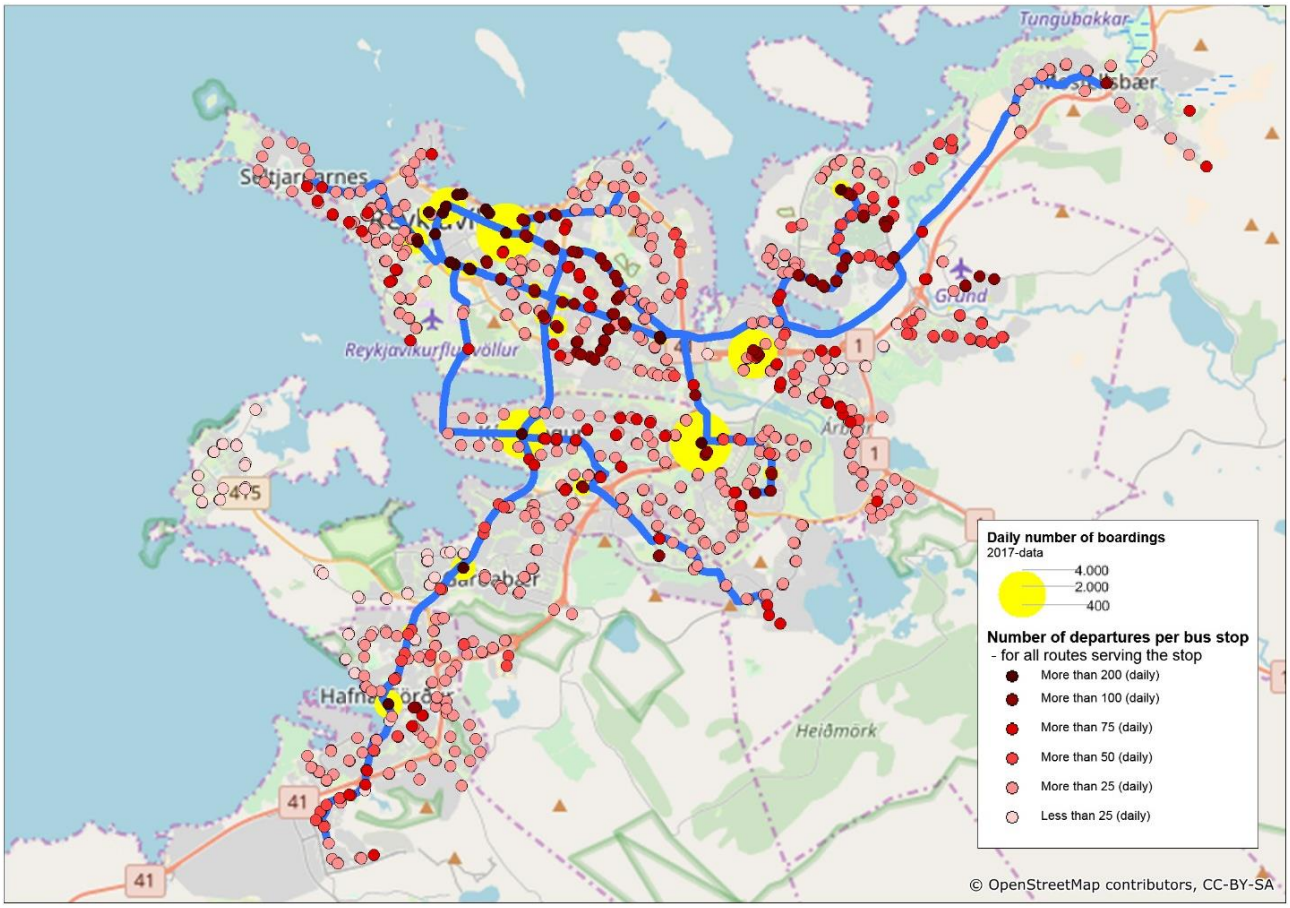


Figure 37 *Borgarlína-recommendations seen in relation to existing passenger numbers and the existing number of daily departures.*

5.3.5 Travel pattern

The blue relations show the travel pattern with the most trips (where people tend to travel between PNR zones) and the yellow lines illustrate the recommended Borgarlína-network. Figure 38 shows that the most frequent travel pattern has a good match with the recommended Borgarlína-network. For example can it be seen that the B2 (Grafarvogur-city centre) covers some of the high travel relations along the alignments (Grafarvogur-Artun, Grafarvogur-city centre zones, Artun-city centre zones are all among the larger travel relations).

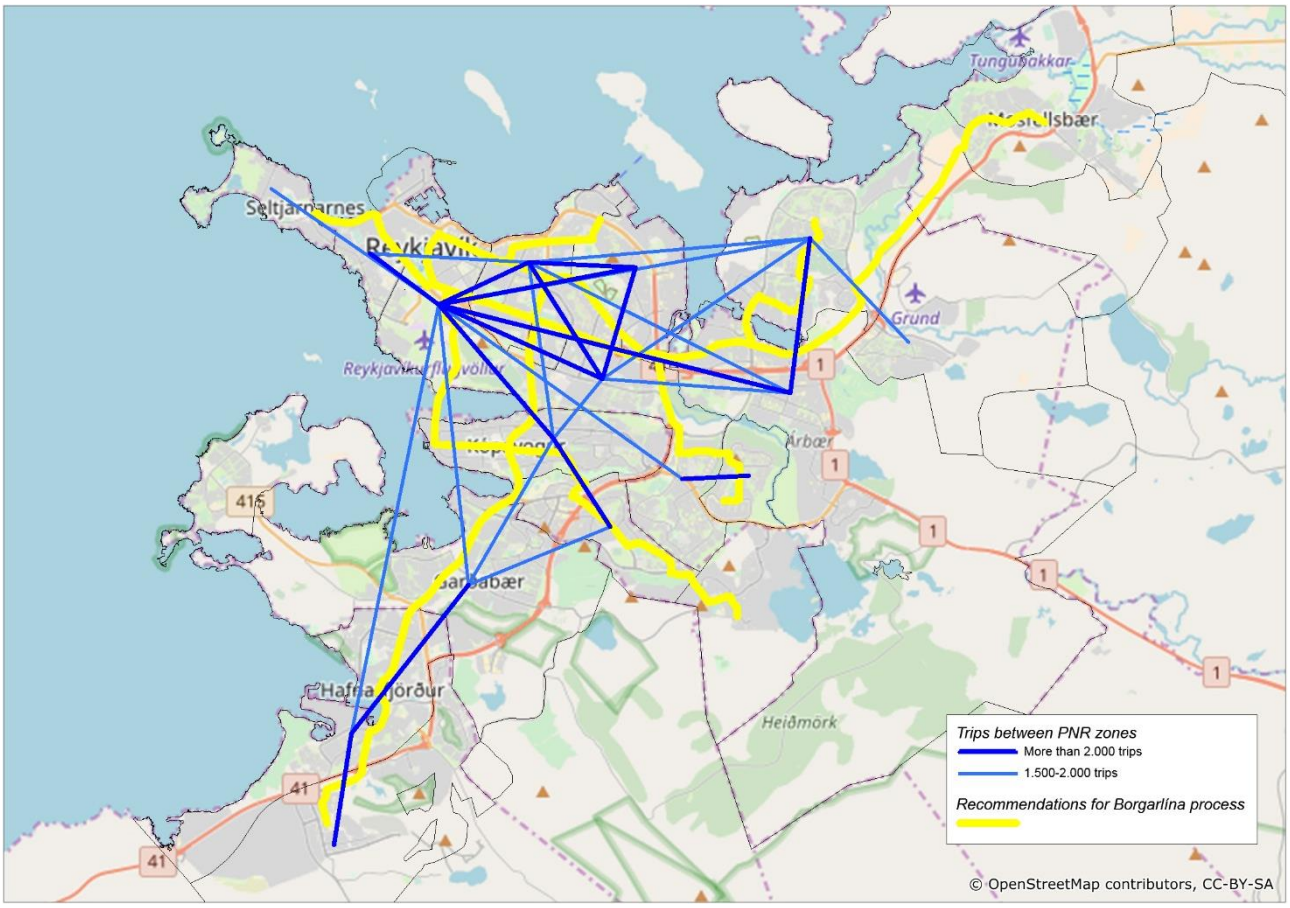


Figure 38 Borgarlína-recommendations seen in relation to the existing travel pattern for motorized transport.

5.4 Prioritizing recommended alignments (phasing)

The next step would be to prioritize the recommended alignments in terms of an implementation plan or phasing of the total Borgarlína network. An efficient way to implement the Borgarlína would be to define phases that ensure that the most important infrastructure is built first.

Recommending alignments for the first phase of the Borgarlína network is especially based on the outcome of four of the MCA-criteria:

- Catchment areas – residents/km today and in the future
- Number of passengers/km (elasticity model and vision-model)

- Travel time improvement
- Physical challenges and risks

Table 10 Relevant MCA-results for the recommended alignments.

Criteria	A2	B1	B2	C2	C3	D2
Threshold at 2,000 *(inh. per km)*			2.060	2.530		3.510
Threshold at 3,500 in future *(inh. per km)*			3.720	3.690		4.890
Threshold at 800 - passenger estimate *(elasticity model)*	800		810	980		1.110
Threshold at 1,500 - passenger estimate *(vision-model)*		1.660	1.750	1.640	1.710	1.630
Travel time improvement (higher than +)	+++		++	++	++	+++
Physical challenges and risks	÷	÷	÷	÷÷	÷÷÷	0

The first phase is important to be a success as no further phases will be built if the first phase ends as a failure. Therefore is it important to select the best of the analysed alignments for the first phase.

During the next phase of the Borgarlína-project, a clarification report should be made to define the project, the scope of the project and increase the level of details. The definition of the project and the higher level of details will be used to e.g. estimate the construction costs, the traffic numbers and the consequences for the surroundings of the Borgarlína.

5.5 Borgarlína as BRT or LRT?

The decision of whether to discuss BRT (bus rapid transit) or LRT (light rail) depends on many things – but in the end the passenger numbers and the costs (operation and construction) is the heaviest arguments for this decision.

Bergen looked into the key figures for light rails around Europe and found a benchmark that is used for them to decide whether to decide for a BRT or LRT system. This benchmark is looking at the passenger numbers per km and secondarily the number of inhabitants within a 400 m catchment area.

The primary benchmark in Bergen is:

- +3.500 passengers/km: Clear LRT recommendation
- +2.000 passengers/km: Possible light rail if other major motives speaks for it;

- high chance of further development
- the wish to lift an area
- create a possible system effect

- +1.000 passengers/km: BRT recommendation

The secondary benchmark in Bergen is:

- +2.000 inhabitants/km (400 m catchment area): Possible light rail

None of the Borgarlína alignments gets near the threshold for clear LRT recommendation. Some of the alignments are close to the lower threshold (+2.000 passengers per km) that could argue for a possible LRT recommendation and the mutual part of the B alignment (BSÍ – Hlemmur - Àrtun) reach it, using the vision model for estimating the passenger numbers. But none are even close that benchmark using the elasticity model.

The passenger numbers clearly argues for a BRT – depending on the passenger estimate model. The vision model clearly argues for a BRT and the elasticity model are close to a BRT recommendation.

Based on this we recommend that the BRT system is built. We also recommend a strong enforcement of supporting measures required to boost the passenger potential. This means that Borgarlína should be supported by densification (transit oriented development) around the high-class public transport stations, prioritising the public transport at the expense of the car traffic, restrictive parking policy and strategy and make the good conditions for supporting the high-class public transport (feeder bus service, bike and ride, walking paths, park and ride etc.) to become a success.

Since it is hard guess the future public transport share, we do recommend that the building of the BRT network take the requirements of a light rail system into consideration, and adapt them where no significant cost is added. Thereby the system is prepared for a possible transformation in the future, should the passenger estimates prove to be too conservative.