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The value of travel and waiting time for ferry passengers in fjord crossings

The case of the Trondheimfjord, Norway

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Abstract:

New transport infrastructures projects leads to a change in the users' perception, directly affecting to how they value their time, hence the socio-economic profitability of the projects. The value of time provides a large part of the benefits due to the travel time savings. These benefits come from the consumer surplus, so it is necessary to know the value of time before the implementation of the projects.

The Norwegian topography entails that many road trips need the ferries' services to cross the fjords, which implies waiting times and longer travel times. Therefore, the great potential of improvement makes that many ferry replacement projects are being developed in the current Norwegian road network. These projects considerably modify the transportation network in its surroundings, causing large travel time savings and an increase of the reliability and the flexibility, as these connections are open 24/7. They are and will be one of the highest costs in the road investments in Norway, so studying the value of time in detail could provide the decision makers with valuable information. The value of travel and waiting time are already calculated for other transportation projects, but there are few studies specifically for the fjord crossings. This study tries to contribute to the literature in this field.

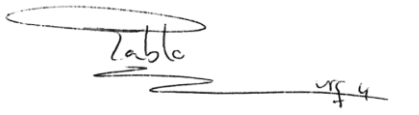
This article studies and quantifies the value of travel and waiting time for the different ways of crossing a fjord in Norway, by car and ferry, bus and ferry or speed boat. The aim is obtaining the users' perception in terms of travel time and cost. The Trondheim fjord is the chosen case of study as it includes the third largest city in Norway which attracts a high variety of trips, from commuting trips till leisure ones.

A stated preference survey was developed in order to build a discrete choice model which allow for calculating the value of travel and waiting time. The survey took place in three strategic areas along the fjord. A general questionnaire classified the respondents according to their travel patterns to provide them six different hypothetical situations to choose between, being these situations as close as reality as possible. Each situation had three alternatives: car, bus or speed boat. Each alternative had four attributes, travel time, waiting time, cost, and frequency, with three levels each.

As a result, differences in the values of time between modes were found. While the modes that are affected directly by a ferry replacement (bus and car) will suffer a considerable decrease, the speed boat value of travel time will keep almost equal. Therefore, the gain of availability, the inexistence of a ferry waiting time and the travel time savings of a ferry replacement will affect to the value of time. Not only it will be significant for the socio-economic analysis, but also this change could cause an enlargement of the metropolitan area of Trondheim, including the other side of the fjord, so the number of fjord crossing trips will be higher.

Keywords:

1. Value of travel time
2. Value of waiting time
2. Stated preference
3. Mixed logit
4. Ferry replacement



Preface

This is the master thesis of Pablo Urzainqui Merino in collaboration with the Deparment of Civil and Environmental Engineering of the Norwegian University of Science and Technology due to an agreement with the Escuela de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid. This master thesis corresponds to 30 credits in the NTNU (12 credits in the UPM) and it is the final project after a two-year master program.

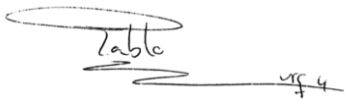
The master thesis deals with road transport planning in Norway and it was chosen based on capacity-based and my interest on increasing my knowledge in this field in Norway. The subject of the fjord crossings trips was determined in cooperation with professor Eirin Ryeng and the topic of the value of time was finally established with my supervisor, Trude Tørset, and my co-supervisor, María Díez Gutiérrez.

The goal of this master thesis is to develop a research project, presented in a scientific article, which was selected for the European Transport Conference 2017. The master thesis also contains a process report, where the whole work process is explained. Therefore, the master thesis is composed by two parts, the scientific article and the process report, both written in English.

I would like to thank to my supervisor, Trude Tørset, and my co-supervisor, María Díez Gutiérrez, who have contributed with ideas, suggestions and solutions, which helped me to complete the master thesis. Due to their implication and their insight into both, the research community and the topic of this thesis, I have been able to achieve useful results and new knowledge in this field.

I appreciate also the willingness to help of AtB and Fjord1, providing the necessary data to carry out the project and allowing me to do the survey on their vessels. Finally, I would also like to thank to all the people that helped me in many different ways during the whole master thesis process: Eirin Ryeng, Elisabetta Cherchi, Liliya Zhupanova, Gunnhild B.A. Svaboe, Sofie Ottersland Granås, Ellen Heffer Flaata and Tage Sverin Wærdahl.

Trondheim, June 2017



Pablo Urzainqui Merino

Abstract

Transport infrastructures projects entail a change in the users' perception, directly affecting to how they value their time, hence the socio-economic profitability of the projects. The value of time provides a large part of the benefits due to the travel time savings. These benefits come from the consumer surplus, so it is necessary to know the value of time before the implementation of the projects.

The Norwegian topography causes that many road trips need the ferries' services to cross the fjords, which implies waiting times and longer travel times. Therefore, the great potential of improvement makes that many ferry replacement projects are being developed in the current Norwegian road network. These projects considerably modify the transportation network in its surroundings, causing large travel time savings and an increase of the reliability and the flexibility, as these connections are open 24/7. They are and will be one of the highest costs in the road investments in Norway, so studying the value of time in detail could provide the decision makers with valuable information. The value of travel and waiting time are already calculated for other transportation projects, but there are few studies specifically for the fjord crossings. This study tries to contribute to the literature in this field.

This article studies and quantifies the value of travel and waiting time for the different ways of crossing a fjord in Norway, by car and ferry, bus and ferry or speed boat. The aim is obtaining the users' perception in terms of travel time and cost. The Trondheim fjord is the chosen case of study as it includes the third largest city in Norway which attracts a high variety of trips, from commuting trips till leisure ones.

A stated preference survey was developed in order to build a discrete choice model which allow for calculating the value of travel and waiting time. The survey took place in two strategic areas along the fjord. A general questionnaire classified the respondents according to their travel patterns to provide them six different hypothetical situations to choose between, being these situations as close as reality as possible. Each situation had three alternatives, car, bus and speed boat. Each alternative had four attributes, travel time, waiting time, cost, and frequency, with three levels each. 250 valid observations were modeled using mixed logit models.

As a result, differences in the values of time between modes were found. While the modes that are affected directly by a ferry replacement (bus and car) will suffer a considerable decrease, the speed boat value of travel time will keep almost equal. Therefore, the gain of availability, the inexistence of a ferry waiting time and the travel time savings of a ferry replacement will affect to the value of time. Not only it will be significant for the socio-economic analysis, but also this change could cause an enlargement of the metropolitan area of Trondheim, including the other side of the fjord, so the number of fjord crossing trips will be higher.

Sammendrag [NORSK]

Transportinfrastrukturprosjekter fører til en endring i brukernes oppfatning. Det påvirker direkte på hvordan de verdsetter tiden sin, og dermed prosjektets sosioøkonomiske profittabilitet. Verdsetting av tid utgjør en stor del av fordelene på grunn av bespart reisetid, så det er nødvendig å kjenne til verdsetting av tid før implementering av prosjektene.

Den norske topografien innebærer at mange reiseruter trenger fergeservice for å krysse fjordene. Det antyder ventetider og lengre reisetider. Derfor er det et stort forbedringspotensial, så mange ferjeavløsningsprosjekter blir utviklet på dagens norske veinett. Disse prosjektene endrer transportnettverket betydelig, noe som medfører store reisetidsbesparelser og økt tilgjengelighet, da disse forbindelsene er åpne 24/7.

Denne artikkelen studerer og kvantifiserer verdsetting av reisetid og ventetid for de forskjellige måtene å krysse Trondheimfjorden i Norge. En stated preferance undersøkelse ble gjennomført i 2017 ved de forskjellige kryssingspunktene av fjorden. Brukerne ble presentert forskjellige scenarier som simulerte den nåværende situasjonen og et potensielt ferjefri prosjekt. De 250 gyldige observasjonene ble modellert med mixed logit modeller for å oppnå verdsetting av reisetid og ventetid for de forskjellige scenariene. Resultatene viser en stor forskjell mellom den nåværende situasjonen og en ferjefri situasjon. Verdsettingen av tid er lavere hvis det er en fast forbindelse. Det betyr da at tidskostnaden ved å krysse fjorden med ferge er høyere, og at brukerne opplever denne måten å krysse på som en ulempe.

Sinopsis [ESPAÑOL]

Los proyectos de infraestructuras de transporte conllevan un cambio en la percepción del usuario, afectando directamente a la rentabilidad socio-económica de estos. El valor del tiempo de viaje produce gran parte de los beneficios, por lo que es necesario conocerlo antes de la puesta en marcha de los proyectos.

La orografía de Noruega conlleva la utilización de ferries para cruzar los fiordos, implicando mayores tiempos de espera y de viaje y una menor disponibilidad. Por lo tanto, el gran potencial de mejora de la red de carreteras actual hace que se estén desarrollando proyectos que sustituyen los ferries por puentes y túneles. Estos proyectos modifican considerablemente la red de transporte, causando grandes ahorros de tiempo y un aumento de la disponibilidad, ya que las nuevas conexiones están operativas 24/7.

Este estudio trata de cuantificar el valor del tiempo de viaje y espera para las diferentes formas de cruzar un fiordo de Trondheim (Noruega) mediante una encuesta de preferencias declaradas. Los usuarios se enfrentaron a distintos escenarios que simulaban la situación actual y una potencial sustitución del ferry por un puente. 250 respuestas sirvieron para crear modelos *mixed logit* con los que se obtuvieron los valores del tiempo de viaje y espera. Como resultado, se ha obtenido que el valor del tiempo es mayor en la situación actual que si hubiese un puente. Podría deberse a la visión del ferry como un inconveniente por parte de los usuarios.

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Part 1

Article

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The value of travel and waiting time for ferry passengers in fjord crossings. The case of the Trondheimfjord, Norway

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Ferry replacement projects considerably modify the transportation network in its surroundings, causing large travel time savings and an increase of the availability, as these connections are open 24/7. This leads to a change in the users' perception, directly affecting the socio-economic profitability of these projects. In the socio-economic analysis, the value of travel time provides a large part of the benefits, so studying it in detail could provide the decision makers with valuable information. This article studies and quantifies the value of travel and waiting time for the different ways of crossing the Trondheimfjord in Norway. A stated preference survey was conducted in 2017 at the different crossing points of the fjord. Users were presented different scenarios simulating the current situation and a potential ferry replacement project. The 250 valid observations were modeled using mixed logit models to obtain the value of travel and waiting time for the different scenarios. The results show a lower value of time if there is a fixed link. This means that the time cost to cross the fjord by ferry is higher, so the users could see this way of crossing as an inconvenience.

Key words

Value of travel time; value of waiting time; stated preference; mixed logit; ferry replacement

1. Introduction

Road network projects require a deep analysis in order to study its profitability which means to obtain all the socio-economic benefits and the costs of the projects (Barfod & Leleur 2013). One of the most important inputs in transportation project analysis is the value of travel time (VTT). This is due to the benefits that the time savings could provide to the society. These benefits are calculated through the consumer surplus, which means that it is necessary to know the VTT before and after the implementation of the project (Jara-Diaz 1990). In some cases, this benefit represents 60% of the total benefits (Hensher, 2014) which means that it is a crucial element for a successful prioritizing of a project.

Nevertheless, the VTT is a subjective value that refers to the user's behavior. Predicting the users' behavior is crucial in order to get a satisfactory project. Normally, it is supposed that the users' behavior is optimal, which means they maximize the utility of the trip (Mc Fadden 1974). Uchida (2014) uses two main factors to calculate the utility: the travel time and the cost of the trip which can include tolls, fuel or tickets. The travel time is considered an aggregate of different values of time during the trip such as the onboard time, the onboard time in congestion conditions, the waiting time or the access and egress time. (Jara-Díaz, Guevara 2016). Hanssen (2012) simplifies this division in two different values: value of the onboard time (VOT) and value of the headway time (VHT). The VHT and the value of waiting time (VWT) are directly related by studying the arrival distribution. If there is a lack of capacity, this relation is affected because the waiting time could be longer than the headway due to saturation (Hendrickson 1981).

Besides the distinction between VOT and VHT, other factors, which vary among the literature, affect to the VTT such as the purpose of the trip, the user income or the transport mode. For instance, the *equity approach* (Flügel 2014), used in Denmark, does not make any differentiation. The VTT is always the same despite the differences between regions, modes or incomes. In Norway, the approach is *project specific*, which means that the VTT depends only on the current users of the infrastructure and not on the whole society (NOU 2012:16 2012). Therefore, the grade of heterogeneity of the current users determines how many segments should be taken into account for each project.

Moreover, the VTT depends on the individual conception of each user's usefulness of their time, which, eventually, leans on many subjective aspects such as comfort, access to information or personal preferences (Ramírez Salgado 2013). Despite the fact that each user is different, it is common to group them according to the characteristics of their trips which are the purpose, the length and the mode. There is a high difference between the VTT of long distance trips and short distances ones (Halse & Killi 2015).

Moreover, there are some differences between regions, gender and income. However, this differences are

not taking into account to plan a new infrastructure due to political-philosophical reasons (Mouter 2016). The only differentiations, that are acceptable both technically and politically, are by mode, by purpose and by distance. The VTT differs considerably between modes, so there should be a different value for each one (Truong, P. T., Hensher, D. A., 2016). For instance, the VTT on road trips might depend mostly on the travel time, whereas on ferry trips the availability could also affect the VTT.

Nowadays, ferries are the main way to cross a fjord, being the link of the roads from one side to the other. However, ferries have some significant drawbacks such as limited departures and capacity, regularity or punctuality. Sometimes the frequency is not high, being really low or non-existence during the nights. Besides, the weather might affect to the availability of the fjord crossing ferries. In the current Norwegian road network, ferries play an essential role.

Internationally, for instance, in Denmark (Fosgerau et al. 2007) and the Netherlands (de Jong et al. 2007) there are several studies related to the calculation of the VTT. However, they are focused on road and rail trips, neglecting maritime transportation trips, like ferries. In Norway, studies published by the Institute of Transport Economy in Norway (TØI) obtained the VTT for road (private vehicles and buses), railway and ferry trips, but there is a lack of information in the mixed trips road-ferry.

TØI calculates VTT, VOT, and VWT values periodically in Norway (Halse & Killi 2015), but the degree of detail is low for the fjord crossing trips. For instance, there is only one value for all the ferry trips, which includes any kind of ferry route. There is a wide range of ferry trips in Norway, being the fjord crossings only one of them. This kind of ferry trips is part of a major trip which includes other modes such as car or public transport. TØI gives a VTT for each mode, but there is not a value for trips that includes more than a mode.

In order to improve the Norwegian road network, many projects are being developed. The general aim is replacing the ferries by fixed crossings as well as improving the current roads. Ferry replacements will be one of the higher costs in the future road investments in

Norway (Falk-Petersen, Dimmen, Enger, Gustavsen, 2010), so studying in detail the consequences provides the decision makers with valuable information.

One of these consequences is the change in the VTT. Shortening a 30 minutes ferry trip to a 5 min car or bus trip by the means of a fixed link could change considerably the users' perception, hence the VTT. However, the user perception is not only based on the time savings; the availability 24/7 of a fixed link and the fact of a "new infrastructure" could also affect to the VTT (Kesten et al. 2015).

Under these premises, this article aim to shed light into the VTT for trips that include a fjord crossing. The research questions are:

1 **Which are the values of travelling and waiting time for trips that involves a fjord crossing?**

2 **How does the user perception change between crossing a fjord by ferry and speed boat or through a fixed linked?**

The fjord of Trondheim is used as case study, where is located the third largest city of Norway (Trondheim) and there is high variety of trips in terms of mode and purpose. Section 2 describes the area and the transport network in more detail. In order to solve the research questions, a revealed and stated preference survey among the current users of the ferry services was conducted in 2017, finding 250 valid answers. The methodology is detailed in section 3. The results were analyzed by discrete choice models to find the VTT and the VWT for the different users and modes in two situations: current situation and in the hypothetical case of a fixed link. These results are gathered in section 4. The discussion and conclusion of this research are in sections 5 and 6, respectively.

2. Case of study

This research is based on the fjord of Trondheim. Trondheim, with around 180.00 inhabitants, is linked to the other side of the fjord, with approximately 23435 inhabitants (SSB 2017), by two potential modes, ferries and speed boats, as Figure 1 shows. While the speed boats are only for pedestrians and cyclers, the ferries are roll-on/roll-off ships, allowing vehicles for crossing the fjord.

The current Flakk – Rørvik ferry line is located 13 km west from Trondheim city center, which makes Trondheim the major source of trips for this ferry. It is used by both private and commercial vehicles, and regional buses. The ferry schedule varies among day and night, and weekday or weekend. The average headway time in a workday is 30 minutes and the total traffic of Flakk - Rørvik route is 652,540 vehicles a year (750,112 passengers a year) (Fjord1 2015). The highest demand is during summer, influenced by the leisure trips. However, in winter the demand is still quite high, which means that there are a high number of recurring trips, probably commuting trips.

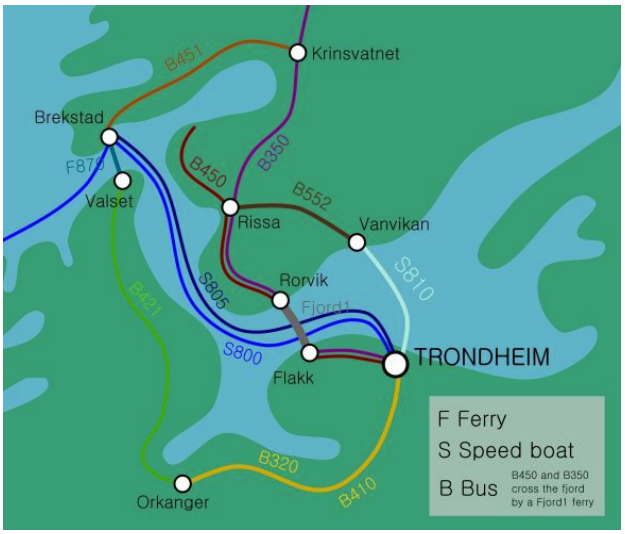


Figure 1. Public transport in the Trondheimfjord

The speed boat line between Trondheim city and Vanvikan was used in 2015 by 190.823 passengers (AtB), being October the peak month. Not having the peak in summer shows that there are a high number of commuters in this route.

There are two other ways to cross the Fjord, but the traffic is lower: a ferry line between Valset and Brekstad and a speed boat line between Trondheim city and Brekstad. It is possible to drive around the fjord, but the users do not see it as a feasible way due to the duration of the trip, around 3-4 hours.

A ferry replacement project in the Trondheimfjord has appeared in the media the last years (Tørstad 2016). One of the ideas is building a floating bridge, replacing the current Flakk – Rørvik ferry route. This will have many consequences for the surroundings, principally due to the 24/7 availability and the travel time savings. Moreover, the waiting time for the ferry will disappear with the bridge, so, as the isochronal maps in Figure 2 shows the time savings will be approximately between 30 min and an hour.

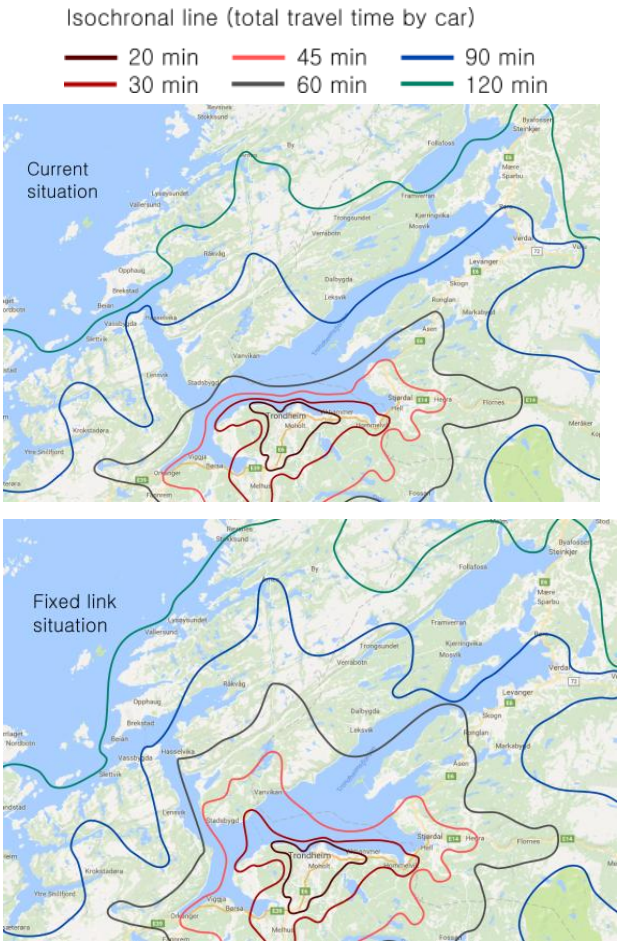


Figure 2. Travel time for a car trip from/to Trondheim

3. Methodology

3.1. Survey

The questionnaire included both revealed (RP) and state (SP) preference surveys. The RP survey was based on observing the current users' behavior: way of travelling and their alternatives. Whereas the SP survey presented the user several hypothetical situations (games) where, given the level of impact at a certain price of each alternative, the users have to choose their preferable alternative (Hensher & Rose 2007).

The survey was designed with a logical map system, which means that that the games depended on what the user answers in the previous general questions. This leads to a complex survey with many different paths and combinations. Starting with some background questions, then several paths were designed depending on the current way of crossing the fjord (ferry or speed boat), the mode to get to the ferry and the total travel time. Finally, each user was headed for the games. The games are composed of four attributes (travel time, waiting time for the ferry, cost and frequency) and their values for each mode, called levels.

Table 1 and Table 2 show how the levels were calculated. The d-efficient method (Choice Metrics 2014) was used to find the games that give the most information with the lowest possible error. It was decided to create two blocks of 6 games to avoid the exhaustion of the respondents. Three games were based on current trips and other three shows situations with and a hypothetical new fixed link in the fjord.

The survey was done during 5 days in March 2017, using the survey platform Typeform and PDAs. Two locations were chosen: the ferry Flakk – Rørvik and the speed boat Trondheim – Vanvikan.

Ferry users	**CURRENT SITUATION** Car + Ferry	**CURRENT SITUATION** Bus + Ferry	**WITH FIXED LINK** Car	**WITH FIXED LINK** Bus
Total travel time (min)	+20% T1 -20%	1.5 T1 1.3 T1 1.1 T1	+20% T2 -20%	1.5 T2 1.3 T2 1.1 T2
Waiting time for the ferry (min)	+5 min WT -5 min	0	-	-
Cost (NOK)	+15% 229+1.2 T2 -15%	+15% CB -15%	+15% 229+1.2 T2 -15%	+15% CB -15%
Frequency	-	1 per hour 2 per hour	-	1 per hour 2 per hour

Table 1. Attributes and levels for the ferry users. T2 = T1 – 30

Speed boat users	**CURRENT SITUATION** Car + Ferry	**CURRENT SITUATION** Bus +Ferry	**CURRENT SITUATION** Speed boat	**WITH FIXED LINK** Car	**WITH FIXED LINK** Bus	**WITH FIXED LINK** Speed boat
Total travel time (min)	+20% T3 -20%	1.5 T3 1.3 T3 1.1 T3	+20% TS -20%	+20% T4 -20%	1.5 T4 1.3 T4 1.1 T4	+20% TS -20%
Waiting time for the ferry (min)	+5 min WT -5 min	0	-	-	-	-
Cost (NOK)	+15% 229+1.2 T4 -15%	+15% CB -15%	+15% CS -15%	+15% 229+1.2 T4 -15%	+15% CB -15%	+15% CS -15%
Frequency	-	1 per hour 2 per hour	1 per hour 2 per hour	-	1 per hour 2 per hour	1 per hour 2 per hour

Table 2. Attributes and levels for the speed boat users. T4 = T3 – 30

3.2. Model

The discrete choice model software used in this research was Pythonbiogeme (Bierlaire 2003). Different logit models and utility functions were tested to find the models that fit better the behavior of the respondents. In this case, the chosen models were mixed logit models which they follow the mathematical expression in Equation 1. The utility of a mode j included the systematic utility, V_{jq}, and an error component, ε_{jq}.

$$U_j = V_{jq} + \varepsilon_{jq} = \sum_{k=1}^{K} \beta_{jkq} X_{jkq} + \varepsilon_{jq}$$

Equation 1

V_{jq} is composed by attributes (X_{jkq}), which are the information from the user and parameters (β_{jkq}), which depends directly on the mode and indirectly in the users' behavior. These parameters are the ones that have to be calculated to get the willingness to pay in terms of travel time, hence the VTT, by Equation 2 (Ortúzar & Willumsen 2001).

$$VTT_j = \frac{\partial V_j / \partial TT_j}{\partial V_j / \partial C_j}$$

Equation 2

4. Results

283 users answered the questionnaire in a mean time of 7 minutes, from which 250 were acceptable to build the models, meaning a 6% of marginal error. If it is compared to the socio-economic characteristics of the total population in the area, the sample was similar, so the error could be low enough. 50% of the respondents were commuters and there were significant differences between the people that live in Trondheim and on the other side of the fjord. While 76% of the commuters that lives at the other side use public transport modes (speed boat and bus), only 45% of Trondheim side inhabitants use them. Moreover, there were some important gender differences. 79% of the car users were men, whereas 68% of the bus users were women. All these socio-economic information should be reflected in the models.

The two models in Table 3 were built, one for the current situation and one for a fixed link situation, both based on the stated preference answers. The revealed preferences were not used due to the inconsistency of its results.

MODELS	CURRENT SIT.	FIXED LINK SIT.
Attributes	**Parameters value (t-test)**	
Constant car	0.837 (1.32)	1.01 (1.52)
Constant bus	-0.682 (-1.07)	-2.29 (-1.45)
$e^{TT_{car}/100}$	-0.853 (-3.08)	-
$e^{TT_{car}/1000}$	-	-25.2 (-2.24)
$e^{TT_{bus}/100}$	-0.648 (-3.02)	-
$e^{TT_{bus}/1000}$	-	-22.8 (-2.12)
$e^{TT_{sb}/100}$	-0.782 (-1.96)	-
$e^{TT_{sb}/1000}$	-	-26.1 (-2.33)
$\ln\left(1+\frac{WT}{1000}\right)$ (Car)	-0.069 (-1.05)	-
$\ln\left(\frac{f_i}{10}\right)$ (bus, speed boat)	0.159 (0.53)	0.296 (0.94)
$\frac{10000\ C_i}{Income}$ Pay	-0.484 (-4.42)	-0.870 (-2.47)
Gender	-1.00 (-2.76)	-1.19 (-3.16)
Commuting	-0.627 (-1.23)	0.302 (0.58)
Business trip	0.707 (1.46)	2.79 (3.53)
Full time job	-0.948 (-2.08)	-2.95 (-2.81)
Part time job	-0.961 (-1.54)	-2.32 (-2.10)
Student	-	-1.32 (-1.28)
Housing · Com	-0.589 (-1.30)	-0.117 (-0.27)
Corr1 (correlation bus- speed boat)	0.328 (0.42)	-
Corr2 (correlation car-sp. boat)	-	0.729 (0.97)
Panel B	-0.227 (-0.23)	-
Panel C	0.095 (0.27)	-
Panel 1	-	0.613 (0.76)
Panel 2	-	-2.18 (-1.63)
Evaluation: Log likelihood and rho-square		
LL (max)	-438.498	-558.726
LL (0)	-651.231	-651.231
LL (c)	-624.322	-632.043
ρ_0^2	0.327	0.142
ρ_c^2	0.301	0.116

Table 3. Models.
TT=Travel time; WT=Waiting time; f=Frequency; Ci=Cost. The "Panel" parameters took into account that each user faced more than one situation.

As it is seen in both models, the travel time attributes follow different functions and the cost parameter depends on the household income. This affects to the VTT, VWT and VHT.

Evaluating the accuracy of the models is important in order to choose the proper one for each situation. The rho-square test and the t-test for the constants show that there is a lack of information for the fixed link situation, so the mode distribution might be inaccurate.

4.1. Value of travel time

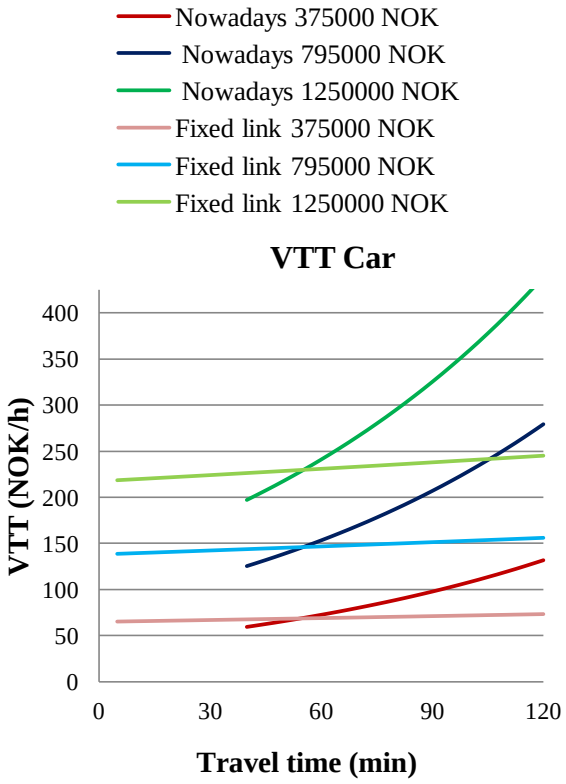
The travel time parameter is multiplied by an exponential function of the total travel time, which is reflected in the VTT expressions (Equation 3 and Equation 4).

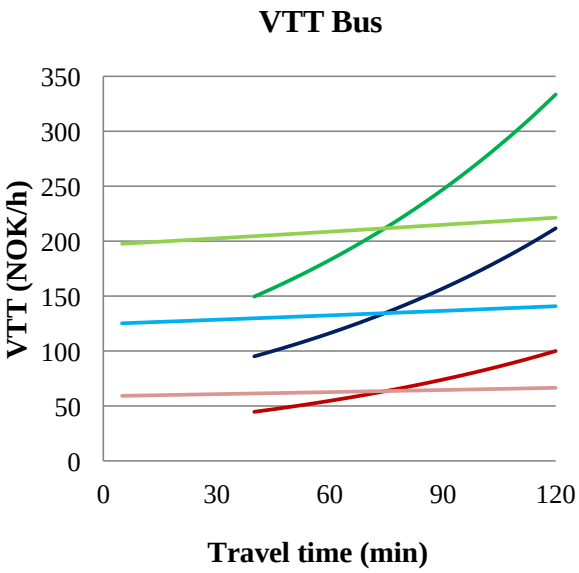
$$VTT_{nowadays,mode\ i}[NOK/h] = 60\ \frac{\beta_{TT_{mode\ i}}\ e^{TT_{mode\ i}/100}}{1000000\ \beta_C}\ income$$

$$VTT_{fixed\ link,mode\ i}[NOK/h] = 60\ \frac{\beta_{TT_{mode\ i}}\ e^{TT_{mode\ i}/1000}}{10000000\ \beta_C}\ income$$

Equation 3 and Equation 4.
TT= travel time; β_{TT}= travel time parameter; β_C= cost parameter.

Figure 3, Figure 4 and Figure 5 shows the VTT for the three analyzed modes. The difference between them is due to the travel time parameters, so the difference keeps constant along the household income.





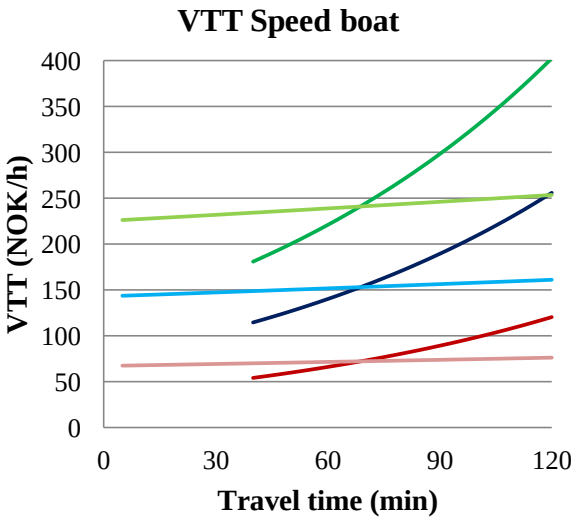


Figure 3, Figure 4 and Figure 5

4.2. Value of waiting time in the ferry dock

The car is the only alternative that has to wait for the ferry in the current situation due to the synchronization between the bus and ferry schedules. The waiting time parameter was only significant for commuters and, as it is seen in Equation 5, the VWT depends on the household income and the waiting time.

$$VWT_{car}[NOK/h] = \frac{8.5 \cdot 10^{-3} \cdot \text{income}}{(1000 - \text{WT})}$$

Equation 5

If it is calculated for every combination of waiting time (0-60 min) and income, the range of VWT is between 0 and 1.6 NOK/h, so it is quite insignificant compared to the VTT. This could show that the commuters know perfectly the ferry schedule.

4.3. Value of headway time

The VHT is calculated for commuters for the bus and speed boat alternative, obtaining the same value for both.

Equation 6 and Equation ***7*** shows that the VHT depends on the household income and the headway time.

$$VHT_{nowadays}[NOK/h] = \frac{0.0197 \cdot \text{income}}{\text{HT}}$$

$$VHT_{fixed\ link}[NOK/h] = \frac{0.0204 \cdot \text{income}}{\text{HT}}$$

Equation 6 and Equation 7

HT = headway time

As it is seen, the difference between VHT is less than 3%, so the VHT could be considered the same in both situations. Figure ***6*** shows the VHT for different household income levels. The headway time in the Trondheimfjord is at least 30 minutes for the speed boats and one hour for the buses. Therefore, with this high headway time, it is possible to unify the VHT into an average household income.

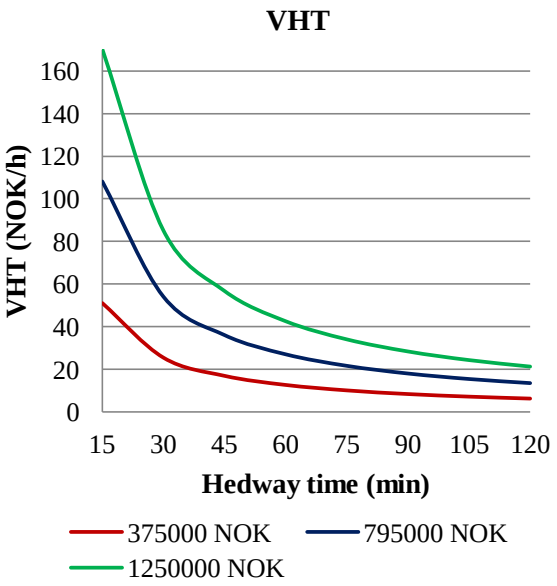


Figure 6. VHT for the bus and speed boat alternatives

5. Discussion

5.1. Survey limitations

The survey had some limitations that could have influenced the final results. There are mainly five limitations: the location, the season, the simplicity of the games, the sample and the difficulty of obtaining information from retired people.

The survey was done in the two locations with the highest traffic flow: the ferry Flakk – Rørvik and the speed boat Trondheim - Vanvikan. However, 26.7% of the fjord crossing trips in the fjord took place in other locations (AtB, Fjord1 2015). Therefore, if the survey had been done in all the locations, the

results would have probably slightly changed. Moreover, the survey was done to current users. This means neglecting the future potential users of the fixed link, which could be a high number.

The season the survey took place influenced also in the results. As the statistics from the past years show, the traffic changed considerably from winter to summer. If it was supposed a quasi-constant demand for commuting and business trips, the drop would be probably related to the fluctuation of leisure trips. Therefore, it will be interesting to do the survey at least in two different seasons of the year. During the low season the VTT would be dominated by commuting trips, whereas in the high demand season, the VTT would come from different kinds of trips.

However, probably the main limitation was the design of the survey itself. It was decided to design a questionnaire with six simple games and only four attributes in order to ease the understanding for the user. This is positive in terms of getting the willingness to answer of most of the users and not to lose their attention when they were answering the questionnaire. Nevertheless, it also leads to a lack of information for building the models. According to the results, the alternatives were well chosen, but the choice also depended on other factors such as the availability of the parking, the walking time or the type of payment.

Adding more attributes to the games would have increased the complexity of the games, leading to a higher number of combinations of different games and a convoluted survey logical map, where two problems must be faced. First, the survey would be longer in order to drive the user to the proper games, which enlarge the probability of lose the user attention (Rose et al. 2008).

Secondly, nowadays, the platforms are not specifically for SP surveys and only allow uploading pictures of the games; so there are specific games for each group of people, but not for each individual. In order to add a more complex logical map, the program should be able to build logical games based on the previous answers, which means a specific set of games for each user.

Another limitation is the sample. The sample is important but not as influential as other aspects. In order to decrease the error, a larger sample is

necessary which causes also an extra cost for a project. The relationship between the marginal error and the sample size is not linear and there are three different parts: one where the error decreases rapidly if the sample is slightly increased; another where the error decreases slowly with a high increase of the sample; and finally, a middle part, where the error decreases with a similar increase of the sample. Consequently, working in this middle part gives us a reasonable balance between accuracy and cost.

During the whole process, some evidences indicated that the retired people behave in a different way than the rest. First of all, it was the hardest group to approach because they were the most unwilling to do the survey. Only 5.5% of the answers came from retired people which are much less in comparison to how many retired were in the ferries and speed boats during the survey. Moreover, it was detected that the ones that answered, struggled to understand the SP survey or became tired due to the length of the survey. For further studies, it could be convenient to consider another way to approach the retired people.

5.2. The value of travel time

As it is seen in Table 4,the VTT has a different value for each mode. In the current situation the car VTT is higher, whereas the public transport modes (bus and speed boat) have lower values. In the fixed link situation the higher value is the speed boat one. This could be because the other two modes will improve their situation (not depending on a ferry), while the speed boat will not change. In terms of time, the demand of the speed boat could drop if a fixed link is build. The gain of competitiveness of the other two modes will cause that some speed boat users will change to them. It will be crucial to adapt the services of the public transport modes to the demand for the new situation.

	Current situation		**Fixed link situation**	
	Mean travel time (min)	VTT (NOK/h)	Mean travel time (min)	VTT (NOK/h)
Car	69	167	38	143
Bus	81	144	52	131
Speed boat	66	148	66	151

Table 4. Mean VTT

The travel time savings of a ferry replacement will affect the VTT as the expressions depend on the total travel time. These changes differ between modes, so the analysis has to be separated.

Figure 7 and Figure 8 shows the travel time cost for an average household income of the modes that are affected directly by a fixed link, car and bus. The mean cost decreases around 14% for the car and 10% for the bus alternatives. This means that the VTT for the travel time that the users spend crossing the fjord with a ferry is higher than driving in the road. The increase of the availability could explain this.

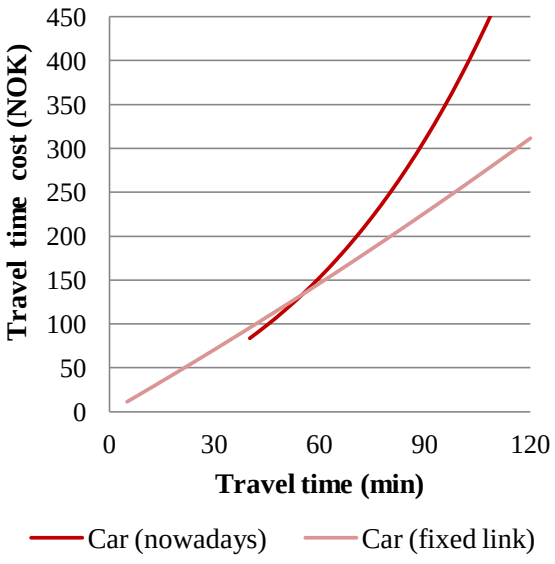


Figure 7

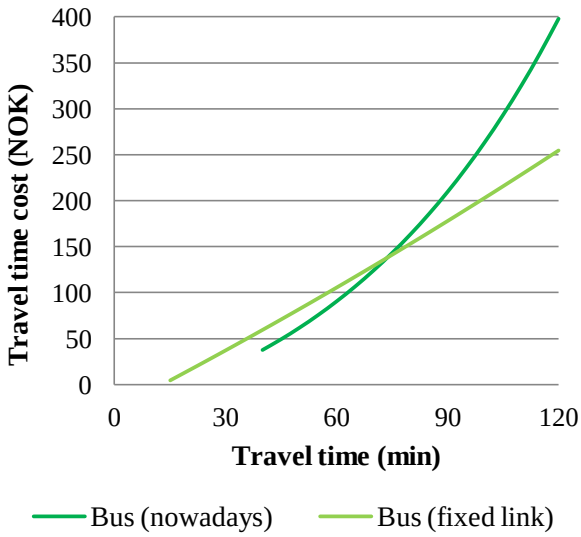


Figure 8

The Norwegian Institute of Transport Economics (TØI) value of travel time report, published in 2015, provided some interesting data to compare with the results of this study. While TØI calculated the VOT, this study shows the VTT. In order to compare them, the onboard time costs were calculated by subtracting the waiting time cost from the total travel time costs. The average of the car trip cost for the fixed link situation is slightly higher in this study than in the TØI report. This difference could be due to the effect of "new infrastructure". This means that the users not only will value the travel time savings and the availability, but also other problems related to the ferries. This difference would probably be reduced after some years, when the users get used to the

fixed link and the "new infrastructure" effect will disappear. In the bus alternative, this difference is higher, which means that the effect of "new infrastructure" could affect the public transport strongly. The users may penalize the need of using different public transport modes in a single trip, so transforming these trips to trips without transfers would be visible as a considerably positive change.

However, there is a quite high difference for the nowadays situation between this study and the TØI report one, which could be due to the synergy of using two modes (car and ferry or bus and ferry) in the same trips. This means that is not the same calculating the value of the trip dividing it in separated pieces or getting the value as one piece.

Taking a ferry probably produces more inconvenience to the user than just the longer travel time and the waiting time. For instance, a low availability could make the trip much more inconvenient. The difference for the bus alternative is smaller than for the car trips because, in this case, the availability is limited by the bus schedule, not the ferry.

The speed boat alternative, displayed in Figure 9, has a slightly different behavior; probably due to the affection of a fixed ink is indirectly. For the average travel time (66 minutes) has a really similar VTT before and after the fixed link is built.

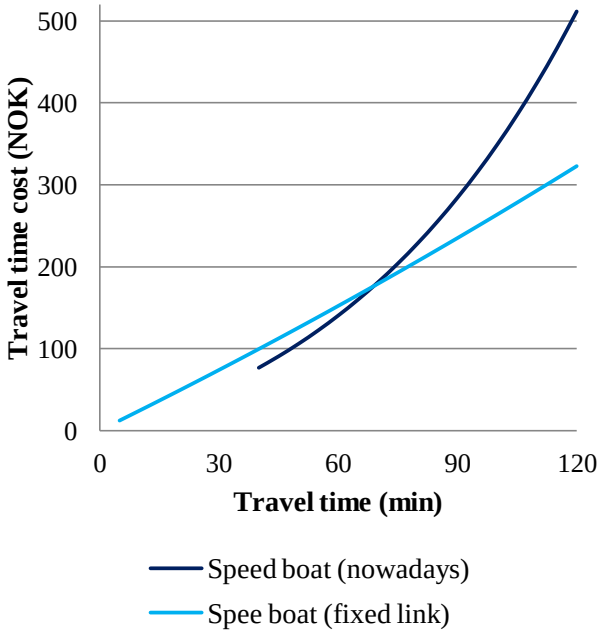


Figure 9

The comparison with the TØI report of the speed boat trips is quite complicated due to the VTT is composed by many values: the VOT, the VHT and the values of time of the other modes that are used to get to the speed boat dock.

5.3. The effect of the fixed link

The achievement of a 24/7 availability and the travel times savings due to a fixed link will cause some consequences which are reflected in the models.

The availability is reflected in the parameters of the models that take into account the place of residence of the user, "Housing · Com" in Table 3. While in current situation this parameter is significant for commuters, in the fixed link situation this parameters could be neglected. The availability 24/7 causes that the difference for commuters between living in one side or the other is just the length of the trip, but not the fact of crossing a fjord. This could lead to an increase of the population at the other side of the fjord.

Moreover, the travel time savings will influence in the place of residence. For instance, there is a considerably large area below 60 minutes driving at the other side of the fjord if a fixed link is built. This means that this area may be below the daily commuting time tolerance. Joining all this to the decrease of the VTT, new urban developments at the other side may appear, turning it into the metropolitan area of Trondheim.

Some of these consequences are detailed in other publications like the impact of a fixed link in the land-use (Díez Gutiérrez et al., 2015), in the labor market (Nilsen et al., 2016) and in the regional development (Bråthen 2001).

6. Conclusion

This study contributed to the literature by obtaining the VTT of trips that include a fjord crossing, meaning that more than one mode of transport is used in the same trip. It seems like there is a synergy between VTT of the modes, not being the same as the addition of both modes VTT separately.

Moreover, the fjord crossing trips VTT will suffer a significant change if a fixed link is built, involving many consequences such as the influence in the benefits in a socio-economic profitability analysis of this infrastructure. Furthermore, this decrease in the VTT could lead to new urban developments, creating new suburbs and enlarging the metropolitan area of the city.

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Part 2

Process report

The value of travel and waiting time for ferry passengers in fjord crossings. The case of the Trondheimfjord, Norway

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Master thesis.

June 2017

NTNU

Content

Appendices

Tables

Figures

1. STATE OF THE ART

The Norwegian road network is determined by sheer topography and extreme weather conditions. The high complexity in road planning and design in some areas gives us a slow-speed network, which means a lack of efficiency and availability comparing to other European countries (European Comission, 2016). This means that there is a high socio-economic potential to gain efficiency developing new projects in road transportation in Norway.

All these new project requires a deep analysis in order to study its profitability which means to obtain all the benefits and the costs of the project (Barfod & Leleur 2013). One of the most important inputs in transportation project analysis is the value of travel time (VTT). This is due to the benefits that the travel time savings could provide to the society. These benefits are calculated through the consumer surplus, which means that it is necessary to know the VTT before and after the implementation of the project (Jara-Diaz 1990). In some cases, this benefit represents 60% of the total benefits (Hensher, 2014) which means that it is a crucial element for a successful implementation of a project.

The VTT depends on the conception the users have of the usefulness of their time, which, eventually, leans on many subjective aspects such as comfort, access to information or personal preferences. Despite each user is different, it is possible to group them according to the characteristics of their trips which are the purpose, the length and the mode. The VTT differs considerably between modes, so there should be a different value for each one (Truong, P. T. , Hensher, D. A., 2016). There are many studies in Norway, published by the Institute of Transport Economics in Norway (TØI), related to the VTT in road, railway and ferry trips, but there is a lack of information in the mixed trips road-ferry.

In the current Norwegian road network, ferries play an essential role. They are the way of crossing the fjords, being the link from one side to the other. However, ferries have some significant drawbacks such as limited departures and capacity, regularity or punctuality. Sometimes the frequency is not high, being really low or non-existence during the nights. Besides, the weather affects to the availability of the fjord crossing ferries. Due to these facts, ferries are considered a loss in terms of travel-time and efficiency.

In order to provide Norway with a better road network many projects are being developed. The general aim is replacing the ferries by fixed crossings as well as improving the actual roads. One of the most profiled projects in this topic, including some of the most challenging crossings, is the E39, along the western coast of Norway.

The E39 is one of the main roads in Norway. It starts in Trondheim and ends in Kristiansand going through Bergen and Stavanger. Nowadays, there are seven fjords without any fixed crossing structure, which means that ferries are required. The current travel time from Trondheim to Kristiansand is around 21 hours (Table 1.1).

	Time	**Percentage of the total time**
Driving (car)	15h 50min	75.4%
Waiting	2h	9.5%
Fjord crossing (ferry)	3h 10min	15.1%

Table 1.1. Travel time between Trondheim and Kristiansand through the E39.
Source: Statens vegvesen, Fjord1, Nordled, Google Maps

The main aim of the E39 project (Statens vegvesen 2015) is to reduce this travel time to 12 hours by building a four lines highway with a speed limit of 110 km/h. In order to achieve that, it is needed to replace these ferries with fixed structures (Figure 1.1). This is a considerable challenge due to the characteristics of the fjords: a width between 2 and 5 kilometers and depth from 500 to 1250 meters. As a result, floating bridges and submerged floating tunnels are being designed for the project. The singularity of these structures involves an advanced research with the aim of achieving a new technological development.

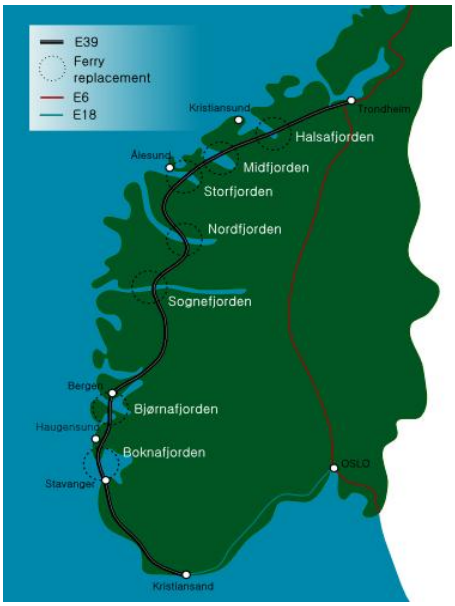

Figure 1.1. E39 project

It is important to emphasize that there will be many ferry replacement apart from the ones included in the E39, but the ones in the E39 are really important in terms of traffic flow, travel time savings and new technologies development. These projects aspire to achieve other goals such as increasing the availability, the accessibility or the driving safety as well as developing the regional economies and the renewable energy generation.

Ferry replacements will be one of the higher costs in the future road investments in Norway (Falk-Petersen, Dimmen, Enger, Gustavsen, 2010), so studying in detail the consequences provides the decision makers with valuable information. TØI (Hansen 2015) published some studies about general cost in ferry replacements. However, there is not a specific analysis of all the consequences of this kind of projects. Some of these consequences are detailed in other publications like the affection of a fixed link in the land-use (Díez Gutiérrez et al., 2015), in the labor market (Nilsen et al., 2016) and in the regional development (Bråthen 2001) or the construction costs and planning (Statens vegvesen, 2016).

Nevertheless, it is also necessary going in depth into other consequences (the influence of travel time savings, in the mode distribution, in the natural surroundings,…) in order to get a better accuracy. For instance, in terms of time savings, most of the save in road projects come from ferry replacements. A 30 minutes ferry trip could be done in 5 min by car or bus if a fixed link is built. A change of this significance could affect considerately to the users' behavior.

Predicting the users' behavior is crucial in order to get a satisfactory project. Normally, it is supposed that the users' behavior is optimal, which means they maximize the utility of the trip (Mc Fadden 1974). Uchida (Uchida 2014) uses two main factors to calculate the utility: the travel time and the cost of the trip (tolls, fuel, tickets…). Associated to these objective factors, there are subjective values which refer to how the users behave. The one that is associated to the travel time is called value of travel time (VTT). This value is an aggregate of different values of time during the trip such as the onboard time, the onboard time in congestion conditions, the waiting time, the access/egress time, etc (Jara-Díaz, Guevara, 2016). The access/egress time is defined as the time that is used to entry or exit from a mode of transport. This is taking into account when this time is significant; for example, in a ferry trip.

Hanssen (2012) simplifies this division in two different values: value of the onboard time (VOT) and value of the headway time (VHT). In the case of the ferries, studying both separately will give us a more accurate result of the total value (Lai & Lo 2004). The VOT refers to the value of the time that the user spends in the vehicle traveling and the VHT indicates the value of the time between two departures. There is a direct relation between the VHT and the value of waiting time (VWT), as long as there is not a lack of capacity. Sometimes, in the rush hour, there could be capacity problems, which cause differences between the VHT and the VWT. Therefore, it is necessary studying the transportation capacity along the daily demand distribution in order to determine how reliable the relation between VHT and VWT is (Trust 2013).

Besides the distinction between VOT and VHT, other factors affects to the value of time such as the purpose of the trip, the user income or the transport mode. There are different approaches to the differentiations of VTT (Flügel 2014). For instance, the *equity approach*, used in Denmark, does not make any differentiation. The VTT is always the same despite the differences between regions, modes or incomes. In Norway, the approach is *project specific*, which means that the VTT depends only on the current users of the infrastructure and not on the whole society (NOU 2012:16 2012). Therefore, the grade of heterogeneity of the current users determines how many differentiations should be taken into account for each project.

In Norway, there is a high difference between the VTT of long distance trips and short distances ones. Moreover, there are some differences between regions (cities, rural areas,…), gender and income. However, this differences are not taking into account to plan a new infrastructure due to political-philosophical reasons (Mouter 2016). The only differentiations, that are acceptable both technically and politically, are by mode, by purpose and by distance. Table 1.2 resume the VOT depending in these factors (Halse & Killi 2015).

VOT [NOK/h]		**<70 km**	**70-200 km**	**>200 km**
Commuting trips	Car	85	184	-
	Bus	59	80	-
Business trips	Car	380	380	380
	Bus	380	380	380
Leisure trips	Car	72	143	143
	Bus	54	67	82
All trips	Car	85	178	168
	Bus	62	115	110
Speed boat			122	
Ferry			124	

Table 1.2. VOT in Norway. Source: TØI rapport 1389/2015

As it is shown in the Table 1.2 ,the differences are quite high, so joining them in only one general value could cause an unacceptable loss of information (Zamparini & Reggiani 2007). In general, the VOT tends to increase till certain distance, when it starts to decrease slowly. The TØI report 1053/2010 (Samstad et al. 2010) calculated also the VWT and ferry access/egress factor, as Table 1.3 shows.

VWT (Waiting time cost = factor·VOT·WT)			
WT	**Factor**	**WT**	**Factor**
0-5 min	2.30		
6-15 min	1.88	**0-30 min**	2.00
16-30 min	0.92	**31-240 min**	1.00
31-60 min	0.56	**>240 min**	0.80
>60 min	0.28		
Access/egress time cost = 1.36·VOT·ET			

Table 1.3. VWT and value of access/egress time in Norway. Source: TØI rapport 1053/2010

As it was shown, in Norway, there are some researches, mainly from the Transportøkonomisk institutt about the VTT but there is a lack of information of combined trips car-ferry or bus-ferry, as well as the consequences of a ferry replacement in terms of VTT.

In other countries, ferry replacement studies were published like in Canada (Rieser et al. 2016) or Greece (Diamandis et al. 1997). Nonetheless, due to the differences between those countries and Norway in terms of user habits, land use, transport network and wealth, it is not possible to use their results.

2. RESEARCH QUESTIONS

2.1. Which are the values of travel and waiting time for trips that involves a fjord crossing?

There are many researches concerning to the calculation of the values of travel and waiting time for different modes. As it is mentioned in section 1, TØI calculated these values periodically in Norway, but the degree of detail is not enough. For instance, there is only one value for all the ferry trips, which includes any kind of ferry route. There is a wide range of ferry trips in Norway, like the fjord crossings. This kind of ferry trips is part of a major trip which includes other modes like car or public transport. TØI gives a VTT for each mode, but is the combination of two modes the simple addition of both modes values (Equation 2.1)?

$$VTT_{mode\ I} \cdot TT_{mode\ I} + VTT_{mode\ II} \cdot TT_{mode\ II} \overset{??}{=} VTT_{mode\ I\ \&\ mode\ II} \cdot TT_{total\ trip}$$

Equation 2.1

The goal is studying the combined VTT for the three most important ways to cross a fjord in Norway: private vehicle + ferry, public transport + ferry and speed boat.

2.2. How does the user perception change between crossing a fjord by ferry and speed boat or through a fixed linked?

A ferry replacement causes a high impact in the area. Due to the reduction in travel time and the increase of availability, changes in transportation network in the area could be required. As the way of crossing the fjord changes completely, the user perception will do it too. Therefore, it is interesting to study deeply in which way this perception change and in which way the VTT is the responsible for it.

It is interesting to differentiate between VTT in the current situation and the VTT in the future situation because the user perception is not only based on the time savings. The availability and the fact of a "new infrastructure" have to be taking into account in the new VTT (Kesten et al. 2015).

User perception is different in each person, but it is possible to aggregate their perceptions in groups depending on the purpose, the mode and the distance of the trips (Figure 2.1). It is interesting to study all the cases in order to discover if the differences are considerable enough or it is possible getting a general perception from the users.

As the Figure 2.1 shows, 16 groups of users are defined; 8 in the current situation and the same 8 in the future situation. However, in the case of study that is going to be developed, the majority of the trips are short ones, which, probably, focusing on them is the most interesting part.

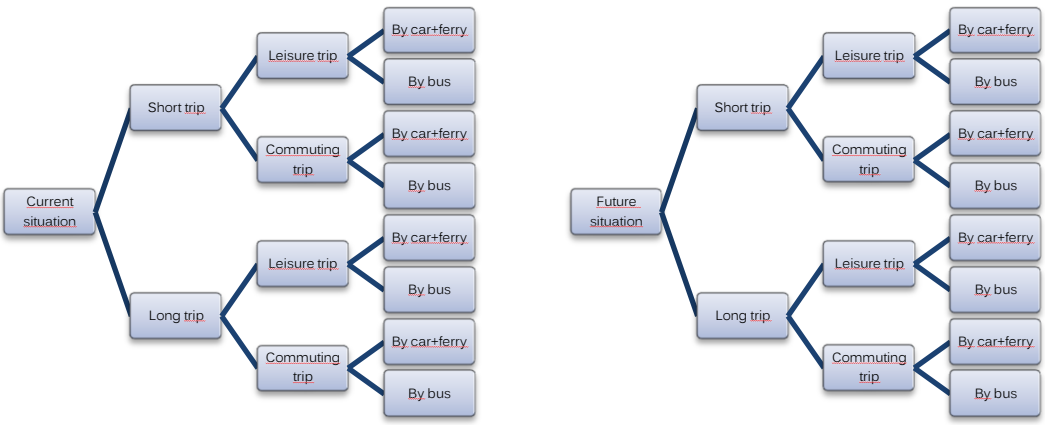

Figure 2.1. Groups of users in a ferry replacement Project in Norway.

3. CASE OF STUDY

3.1. Introduction

The case of study is the fjord of Trondheim which includes a possible ferry replacement in the surroundings of the city of Trondheim. This chapter is a description of the current situation of the area: population, road transport network, fjord crossing transport and public transport (offer and demand) and the possible ferry replacement.

3.2. Demography

Trondheim, with 177617 inhabitants (SSB, 2016), is the largest municipality in the fjord and it is the economic centre of the area, producing a considerably high quantity of trips along the fjord, including some fjord crossings. Most of the crossing fjord trips has as origin or destination one of the municipalities at the other side of the fjord, shown in Table 3.1.

Municipality	Population (SSB, 2013)
Rissa	6650
Ørland	5147
Bjugn	4650
Åfjord	3234
Leksvik	3516

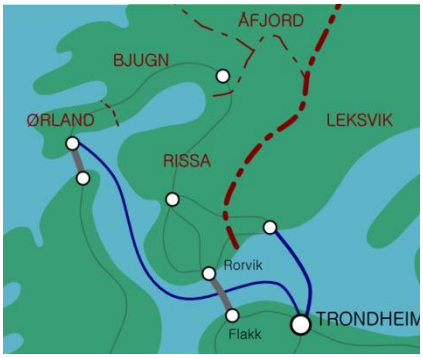

Table 3.1. Main municipalities at the other side of the fjord.

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A fixed link would be a high influence for the population forecast in the area. Nowadays, there is a tendency of gaining population in the big cities, in this case, Trondheim. However, a fixed link will shorten the travel time and increase the availability in such a way that the other side of the fjord municipalities could experience an important increase of their population. Similar cases in other fjords in Norway have showed this effect (Díez Gutiérrez et al. 2016).

3.3. Transport network

Trondheim and the other side of the fjord are linked by two different ways, ferries and speed boats, as it is displayed in Figure 3.1. The speed boats are only for pedestrians and cyclers and there are two lines, F800 and F805-F810. There are two ferry lines (Flakk – Rørvik, Valset - Brekstad) which allow cars and bus lines (B350, B450) for crossing the fjord. All the detailed figures are in Appendix II.

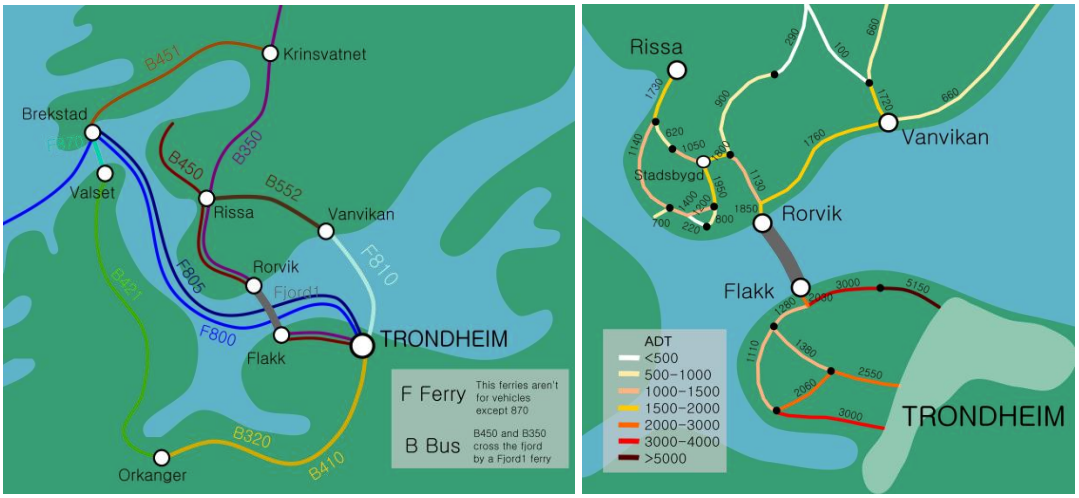


Figure 3.1. AtB regional bus network in the area (left) and ADT (right).
Source: AtB and Statens Vegvesen

3.3.1. Ferries and buses

The Flakk – Rørvik ferry is located 13 km west from Trondheim city centre, which makes Trondheim city the major source of trips for this ferry. It is used by both private and commercial vehicles and AtB regional buses. Fjord1 runs the business offering 249 services per way and week. As Table 3.2 shows that the headway time is normally 30 minutes during the rush hour for everyday.

Day	Services per way	Rush hours		Low traffic periods		Nights (22.30 to 5.00)
Monday to Thursday	36	5.00 to 20.00	Each 30 min	20.00 to 22.00	Each 45 min	An average of 2 services per way
Friday	42	14.00 to 19.30	Each 20 min	5.00 to 14.00 19.30 to 22.00	Each 30 min	An average of 2 services per way
Saturday	29	9.00 to 18.30	Each 30 min	6.00 to 9.00 18.30 to 22.30	Each 60 min	An average of 2 services per way
Sunday	34	13.00 to 19.00	Each 20 min	6.30 to 13.00 19.00 to 22.30	Each 60 min Each 30 min	An average of 2 services per way

Table 3.2. Flakk – Rørvik ferry services. Source: Fjord1

The total traffic of Flakk-Rørvik ferry is 652,540 vehicles a year and 750,112 passengers a year (Fjord1, 2015). In Figure 3.2, it is seen that the highest demand is during summer, influenced by the leisure and touristic trips. However, in winter the demand is still quite high, which means that there are a high number of recurring trips, probably commuting trips.

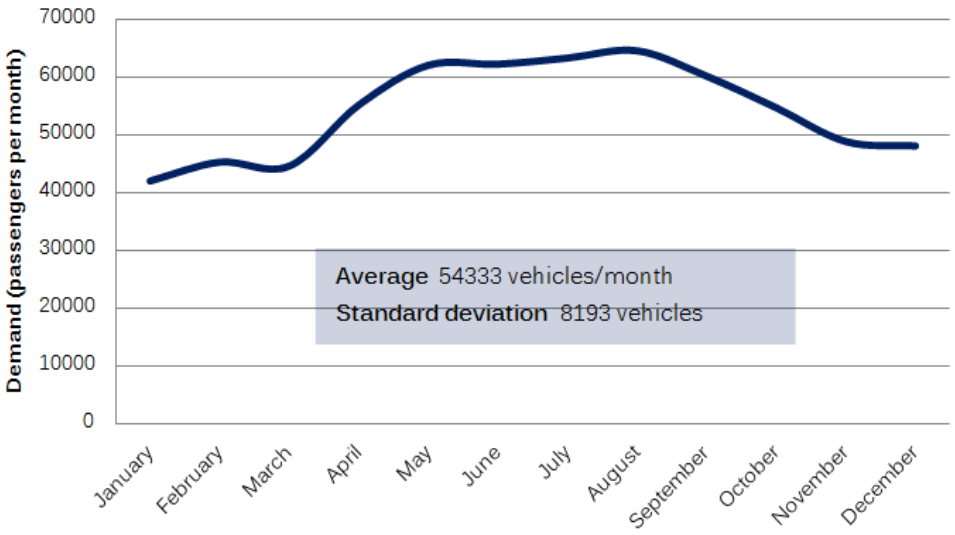


Figure 3.2. Number of vehicles per month in the ferry Flakk-Rorvik during 2015. Source: AtB

These figures include the passengers of the two AtB regional buses that use the ferry. The bus line 450 has a total of 6528 passengers per month. As Figure 3.3 shows, most of the departures are only during weekdays, so most of its demand is from Monday to Friday (98%). It is used mostly by commuters. The other bus line, number 350 has a total of 4036 passengers per month and there are both commuting trips and leisure trips.

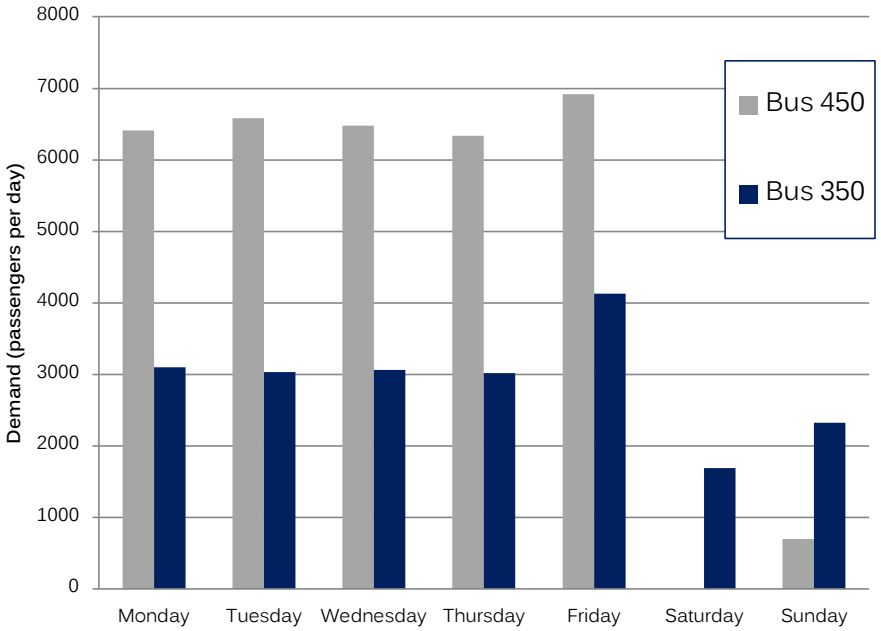


Figure 3.3. Weekly demand distributed by days

The other ferry that crosses the Trondheimfjord is F870 between Valset and Brekstad. The total traffic is 184,406 vehicles a year and 321,490 passengers a year (AtB, 2015). In this case, there is high peak of demand during the summer (21,843 vehicles in July 2015) and a lower demand during winter (10,868 vehicles in January 2015), as it is shown in the Figure 3.4. It is also remarkable, that the increase of passengers in summer is higher than the vehicles one. This is probably due to the increase of leisure trips which normally have a higher occupancy per vehicle. There is not any bus line that uses this ferry.

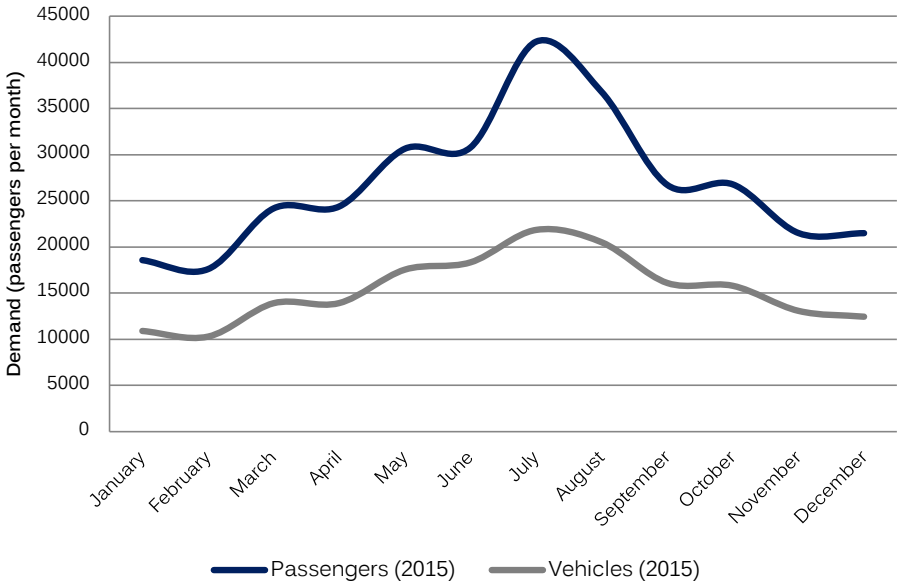


Figure 3.4. Annual demand distribution in the ferry between Valset and Brekstad. Source: AtB

3.3.2. Speed boats

The other possibility to cross the fjord is using one of the two speed boats routes, F810 between Trondheim city and Vanvikan and F800-F805 between Trondheim city and Brekstad. The route till Vanvikan is used by 190823 passengers a year, distributing quite constant along the year: a maximum of 17771 users in October and a minimum of 14210 users in January (AtB, 2015). Concerning to the weekly distribution, the demand is higher during the weekdays, which means a high number of commuting trips.

The total number of passenger between Trondheim city and Brekstad in the F800-F805 route is 202859 (AtB, 2015). In this case, there is also a quite constant demand distribution along the year and the weekdays demand is higher than the weekend one, which also means a high number of commuting trips.

3.4. The travel time and the consequences of the ferry replacement

The following Table 3.3**¡Error! No se encuentra el origen de la referencia.** shows the most common trips that include a fjord crossing way. Nowadays, in some routes public transport is a competitive mode in terms of cost and travel time.

Rute	By car (+ferry)		By bus (+ferry)		By speed boat (+bus)	
	Travel Time* (min)	Cost (NOK)	Travel Time (min)	Cost (NOK)	Travel Time (min)	Cost (NOK)
Trondheim – Flakk	21	13	25 10 services a day per way	50	NOT REAL POSSIBILITIES	
Trondheim – Rørvik	65	244 Including 229 NOK of ferry ticket	65 10 services a day per way	79	NOT REAL POSSIBILITIES	
Trondheim - Vanvikan	72	254 Including 229 NOK of ferry ticket	NOT REAL POSSIBILITIES		34 13 services a day per way	102
Trondheim - Rissa	90	270 Including 229 NOK of ferry ticket	97 10 services a day per way	118	90 2 services a day per way	178
Trondheim - Stadsbygd	76	254 Including 229 NOK of ferry ticket	76 10 services a day per way	89	NOT REAL POSSIBILITIES	
Trondheim – Brekstad (Through Orkanger)	130	240 Including 95 NOK of ferry ticket	170 1 service a day per way	210	66 8 services a day per way	244
Trondheim – Brekstad (Through Rissa)	140	330 Including 229 NOK of ferry ticket	180 3 services a day per way	210		

*Table 3.3. Travel time and cost of some of the busiest routes in the area from Monday to Friday. *It is included 15 minutes of average waiting time for the ferry crossing. Source: AtB, Fjord1 and Google maps*

A ferry replacement project in Trondheimfjorden has appeared in the media the last years (Tørstad 2016). One of the ideas is building a floating bridge in the same area as the current Flakk – Rørvik ferry route. The increase of the availability, the travel time savings and the disappearance of the waiting time for the ferry will have many consequences for the transport system in its surroundings.

Probably, there will be an increase of the traffic between Trondheim and the other side of the fjord due to the higher accessibility. The transportation system in the area will change, not only in the trip route, but also in the mode choice. Some of the users that use the speed boat could find a better route through the fixed link, causing a decrease in the speed boat demand. Moreover, the fjord crossing would be concentrated mostly in one location of the fjord, the fixed link.

4. METHODOLOGY

4.1. Introduction

This chapter resumes the theoretical aspects of the methodology that it is used. Figure 4.1 shows the basic scheme of the process. The methodology is based on the use of the utility functions in order to get the values of travel and waiting time. A discrete choice model is built based on data that was collected in a survey. The time plan and the budget are display in Appendix III and Appendix IV respectively.

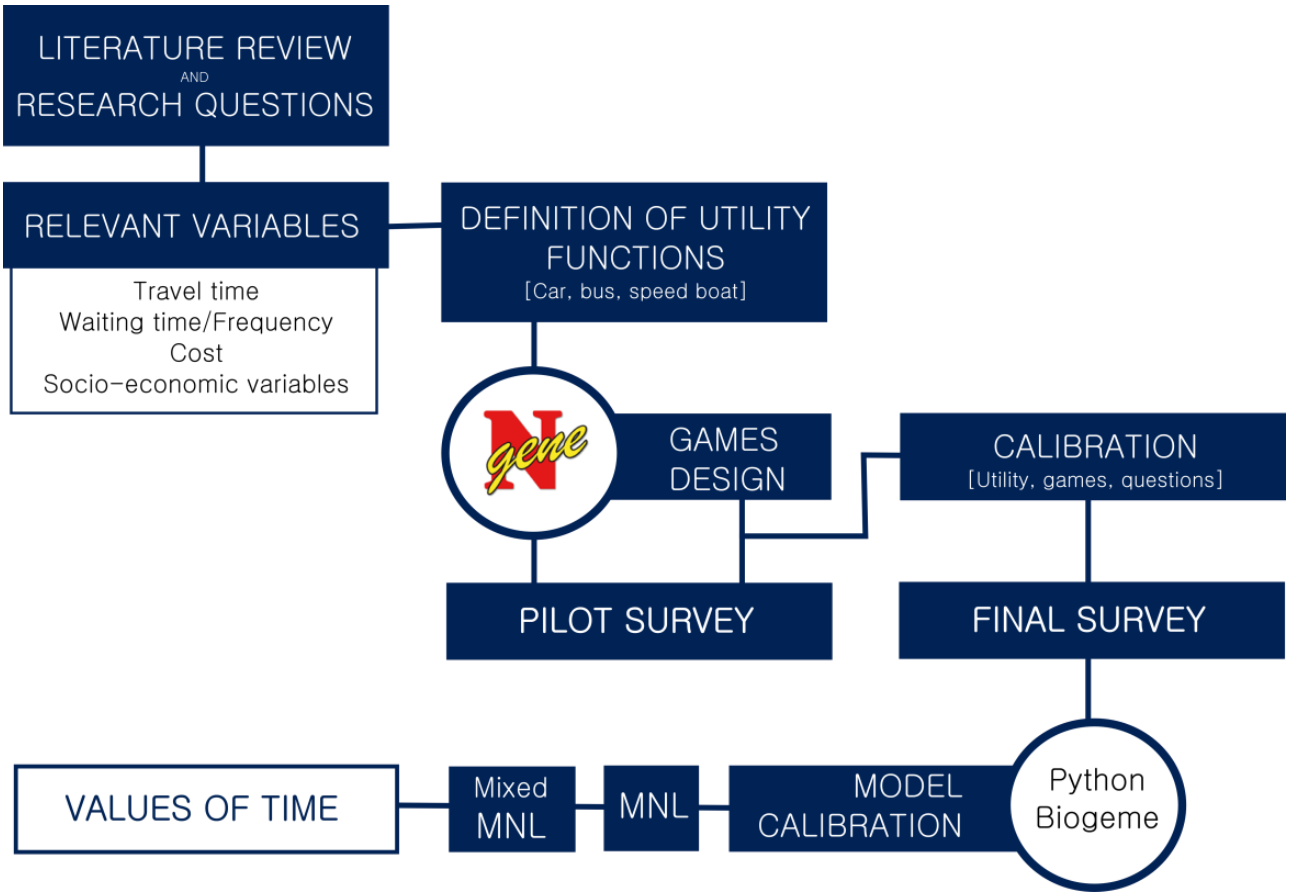


Figure 4.1. Methodology scheme

4.2. Discrete choice models and utility

The discrete choice models (DCM) theories are based in economics theories. The DCMs are based in microeconomic theories with individual level mathematic problems and several statistical hypotheses. It is assumed that the utility that the individual q associates to the alternative i_j is defined by the Equation 4.1. The users ordered the alternatives according to their preferences and between all the available alternatives, they choose the most desirable one depending on many different aspects (time, income, cost, taste,…) (Mcfadden & Train 1996).

The individual will choose the alternative with the highest utility in comparison with the others, so the absolute utility number is not important. The essential fact is the difference between the different alternatives utilities.

$$U_j = V_{jq} + \varepsilon_{jq}$$

Equation 4.1

U_j is the utility of the mode j (attractiveness of choosing this mode) for the individual q which is represented by two components, V_{jq} and ε_{jq} (Ortúzar & Willumsen 2001). ε_{jq} is the random component, called Error term, that tries to reflect the different individual preference and it is unknown by the modeler (Rose et al. 2008). As the main point is comparison between alternatives, the difference between the error terms of two alternatives should be analyzed. Equation 4.2 shows the join distribution function of the difference of errors.

$$F(\varepsilon) = \frac{1}{1 + e^{\alpha(\sum V_{jq})}}$$

Equation 4.2.

j=1,2,…; α is a scale factor

V_{jq} are all the measurable components that affects to the mode choice decision, called systematic utility (Equation 4.3).

$$V_{jq} = \sum_{j=1}^{J} \beta_{jkq} X_{jkq}$$

Equation 4.3

X_{jkq} are the attributes such as travel time, cost, waiting time or income; and β_{jkq} are the parameters or explanatory variables which depends directly on the mode and indirectly in the users' behavior. The value of travel time (VTT) is the amount of money a person is willing to pay to reduce the travel time keeping the same utility level (Ortúzar & Willumsen 2001). As the Equation 4.4 shows, the VTT is directly related to the parameters, so building a model is necessary to get it. This value has to be always positive (Hess et al. 2005).

$$VTT_j = \frac{\partial V_j / \partial TT_j}{\partial V_j / \partial C_j}$$

Equation 4.4.

TT is the travel time for the alternative j and C is the cost for alternative j

The parameters, β_{jkq}, could be divided in three types (Ben-Akiva & Lerman 1985): generic, specific and alternative specific. The generic ones share the same coefficient in all the alternatives, which typically could be the cost. The specific ones appear only in one of the options or have a different parameter for each alternative. A common example is the travel time, which has a different parameter for each alternative or purpose. Finally, the alternative specific ones take the value 1 for one alternative and zero for the others and they cannot be in all the alternatives. These parameters try to explain systematic behaviors that are not explain by the other parameters.

There are many DCM that tries to approach to the reality as feasible as possible but the goal should be to get the highest accuracy with the lowest number of parameters. It is important to underline that all the models have some limitations due to the lack of complete information about all the elements that the users consider to make their choice. The most used (also the most basic one) is the Multinomial Logit Model (MNL). In the MNL, the parameters do not depend on the user, only in the alternative (β_{jk}), so a fixed marginal utility for all the individuals is achieved; changing an attribute X causes the same variation in utility and in the attractiveness between:

- Users that belongs to different socio-economic standards
- Trips with different features (travel time, cost,…). For instance, it is perceived at the same an extra minute in a trip of 5min and in a trip of 2 hours.

This implies that the MNL has some limitations (Train 2009). First, it cannot take into account different observations from the same individual (panel data). It will appear correlation between observations. Moreover, MNL needs independent alternatives but there is always a risk of correlated alternatives (alternatives are perceived similar by the individuals). Furthermore, individuals do not have the same preferences and the MNL cannot measure the heterogeneity.

Due to MNL's limitations, the Mixed-Multinomial Logit Model (ML) is becoming quite popular. The ML does not assume a fixed marginal utility for all the individuals. The parameters β depends on the individuals or groups of people: $f(\beta_{qk}|Population)$. This function tries to represent the heterogeneity of the population and its distribution could be set in many different ways: a linear formula, random, normal distribution, etc. The Equation 4.5 shows one of the most common one. The parameter is based in a constant value plus the standard deviation of the attribute (σ_j) multiply by a random number (V_q) which follows a normal distribution.

$$\beta_{jq} = \beta_j + V_q \sigma_j$$

Equation 4.5

In general, the result of the ML is more accurate, but also the calculations are more complex. Evaluating the accuracy of the model is important in order to choose the proper methodology for each case. There are three main criteria for the evaluation: t-test, the microeconomic conditions and Likelihood ratio test. The t-test calculates the significance of a single parameter and also to compare a couple of parameters between them. First of all a critical t (tcrit) should be set. Normally is 1.96, which in the t-student table means that there is a 95% chance of not being equal to zero (Equation 4.6).

$$\frac{\beta_k^* - \beta_k}{S_k} \approx N(0,1)$$

Equation 4.6. where β_k^* is the estimated attribute, β_k is the preference and $S_k$is the standard error of k parameter

The t is got when the preference is zero in Equation 4.6. If the t of a parameter is higher than 1.96, which means a probability of being significant of a 95%, the significance of the parameter is high enough. If the t is lower, it is necessary to obtain more data (standard deviation and/or covariance) in order to understand the reasons behind it.

The microeconomic conditions test the consistency of the parameters sign. For instance, if the VTT depends on the cost and the travel time parameters, both must have the same sign in order to get a positive VTT. Table 4.1shows how to evaluate a parameter depending on the t-test and the microeconomic conditions for botht the policy parameters and the rest. If a wrong sign appear in policy parameters, the model must be readjusted.

		Policy parameters	**Other parameters**
Correct sign	Significant	Include	Include
	Not significant	Include	May reject
Wrong sign	Significant	Big problem	Reject
	Not significant	Problem	Reject

Table 4.1. Criteria for the significance of the socioeconomic parameters (Ortúzar & Willumsen 2001)

The likelihood ratio (LR) test is applicable if a model is restricted from another one (two models with the same data). In Equation 4.7, LR is smaller than χ_r^2, then the restricted model is acceptable. the highest value is get, the best.

$$LR = -2[l^*(\beta_{res}) - l^*(\beta)] \sim \chi_r^2$$

Equation 4.7

$l^*$is the value of the likelihood of the maximum value of the attribute

This test is used to compare models that were estimated with equally likely (same probability of all the alternatives) or market share (all the coefficients are zero except the constant). It also tests the genericity and linearity of an attribute and the sample homogeneity.

4.3. Data collection

In order to calculate the utilities and the parameters it is need it to know the users' preferences. One of the most effective ways of getting them is a survey. Through a survey the users expresses their preference in two different ways: reveled preferences and stated preferences.

4.3.1. Reveled preference survey

The reveled preference (RP) survey is based on observing the current users' behavior. Therefore it is important to know how the users are doing their current trip and also the other alternatives they have. The users will give all the main information about their current trip (travel time, cost, waiting time,…), but also the information of the alternatives. In that way it is possible to analyze why the user choose the current mode instead of the others.

This method is only possible to be used for current situations because it is analyzed the current trip.

4.3.2. Stated preference survey

A stated preference (SP) survey tries to get the values of the parameters from hypothetical situations (Hensher & Rose 2007). Given a level of an impact at a certain cost, the users are asked how much they are willing to pay. In this case, the impacts would be the different alternatives of crossing the Trondheimfjord. Therefore, several different situations are suggested to the users and they should decide what to do in each situation. Each situation is called game.

The situations in the games should be similar in order to study if slight changes in the given information cause an appreciable change in users' choices. In the ferry replacement we have to compare the current situation with the future fix link, so three games will be about the current one and other three about the future one. This way of collecting data is called panel data collection because it is got different observations from the same questions. In this case, a ML model should be used to analyze the data.

This kind of survey is not really accurate if the main goal is to forecast the mode distribution (Cherchi & Ortúzar 2002)because there is a significant change between what people answer and what it will happen in reality. However, these surveys are one of the best approaches to get the VTT.

4.3.3. Data collection in the case of study

As both surveys give relevant information and it is not clear than one method of collecting data is better than the other, it is decided to use both. Therefore, the users faced a survey with questions of RP and SP survey. While in the current situation (non-fixed link) RP and SP were got, in the future situation (fixed link) is not possible to get RP.

4.4. Data analysis

The analysis of the data is done mainly with Pythonbiogeme (Bierlaire 2003), which is used to build the utility functions which together make a model. By programming utilities, the program gives the value of the parameters as well as the t-test and likelihood. Therefore, by doing little changes and comparing the models, it is possible to achieve the most efficient model that could be created with the data from the survey.

5. DESIGN OF THE SURVEY

5.1. Introduction

In this chapter is described everything related to the design of the survey. It is included all the data was necessary, the time plan, the sample and the questions. The SP survey took place in two main phases, a pilot survey (phase 1) and the complete survey (phase 2). The goal of phase 1 was to try out how the survey worked in the real field. Afterwards, small modifications were done in order to prepare the survey for the phase 2, which is the one that was used for getting the final results. The details of the survey in phase 2 are explained in the following sections.

5.2. Location of the survey

The location of the survey could be crucial and may determine the results of the survey (Hanssen 2012). The aim is getting the most realistic sample as possible by picking the best locations. It was studied all the ways of crossing the fjord and it was determined that most of the flow was located in four docks (Figure 5.1):

- The Trondheim Hurtigbåtterminal: speed boat lines Trondheim – Vanvikan (AtB) and Trondheim – Brekstad (AtB).
- Vanvikan: speed boat line Trondheim – Vanvikan (AtB)
- Flakk: ferry line Flakk – Rørvik (Fjord 1)
- Rørvik: ferry line Flakk – Rørvik (Fjord 1)

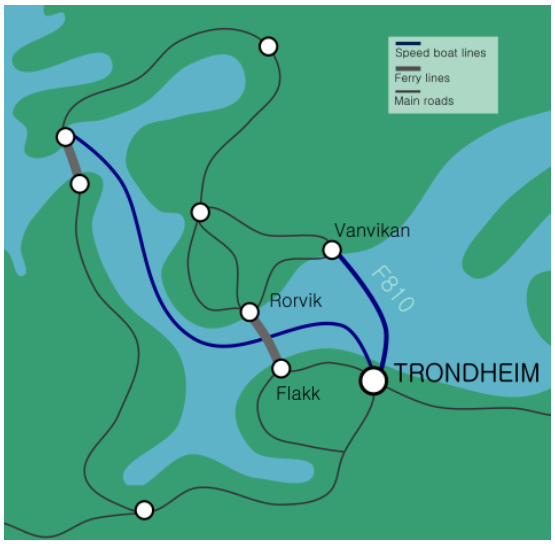


Figure 5.1. Locations of the survey

5.3. Sample

An important question is how large the sample of the second phase should be. It depends principally on three items: the total amount of people that cross the fjord, the users' behavior (homogenous or heterogeneous) and the acceptable error of the survey (confidence level) (Al-Subaihi 2003). The total amount of trips for crossing the fjord is around 1.2 million, including both ways. As it is seen in Table 5.1, half of the trips came from the ferry route Flakk – Rørvik, where is planned the ferry replacement. However, the figures refer to the total amount of trips and not to the absolute number of users. There is not data to know the absolute number of users, but it is possible to get some data from the monthly demand. For example, if there was a high difference on the demand between summer and winter, it would mean that there would be many leisure trips and fewer commuters. Nonetheless, this is not sufficient accurate to get a sample, so the sample was estimated from the total number of trips.

Mode to cross the fjord		**Passengers a year (2015)**	**Kind of trips (based on the monthly demand)**
Speed boat	Trondheim – Vanvikan	130608	Predominance of commuters
	Trondheim – Brekstad	131231	Predominance of commuters
Ferry (Includes vehicles, cyclers and pedestrians)	Flakk – Rørvik	750112	Predominance of commuters
	Brekstad – Valset	189210	Heterogeneity commuting-leisure
	TOTAL	**1201161**	

Table 5.1. Number of crossing fjord trips a year (2015). Source: AtB and Fjord 1

The second main factor that determines the samples is the heterogeneous nature of the users. The most heterogeneous users, the biggest the sample has to be. In the Trondheimfjord, it is possible to find many kinds of trips: commuting trips, leisure trips (especially to the cabins the weekends), business trips, private issues, etc. However, there are not specific figures that quantify each kind of trip in this fjord; so, it was not possible to know it before doing the survey.

The last main factor is the acceptable error. This level changed considerably the size of the sample. In an idealistic case, 1% of marginal error (Richardson et al. 1995) would be perfect, but that leads to an unmanageable sample. Therefore, it has to be a balanced between the error and the size of the sample. Table 5.2 shows how the sample changes depending on the population and the error. It is supposed a 95% of confidence level and a heterogeneous sample based on a normal distribution for different populations. The population was calculated depending on the average frequency of travelling.

Average frequency	**Once a year**	**Twice a year**	**Once a month**	**Once a week**
Population	1 201 161	600 581	100 097	25 024
Marginal error				
1%	9533	9471	8868	7229
5%	383	383	382	378
10%	96	96	96	96

Table 5.2. Size of the sample depending on the total population and the marginal error (normal distribution and 95% of confidence interval are supposed)

As it is seen, the size of the total population does almost not affect in the sample, so the marginal error is the most determinant factor. A reliable balance could be around 300 people due to the marginal error is 5.6%, shown in Table 5.3.

Sample	**Marginal error**	**Sample**	**Marginal error**
400	4.9%	**250**	6.2%
350	5.2%	**200**	6.9%
300	5.6%		

Table 5.3. Marginal error depending on the sample

5.4. Time planning to do the survey

The kind of trips differed depending on the day of the week. From Monday to Thursday, most of the trips were commuting ones, while during the weekends the majority was leisure trips. Therefore, it was interesting to do the survey in two different kinds of dates in order to get realistic information. One of the days had to be a regular weekday day and the other a weekend day or Friday afternoon. As it is displayed in Table 5.4, the phase 2 took place during five different days.

Date	Time	Location	Number of answers
Thursday 9 March	13.30 – 17.30	Ferry Flakk - Rørvik	47
Friday 10 March	6.30 – 9.00	Ferry Flakk - Rørvik	29
	13.30 – 17.30	Ferry Flakk - Rørvik	39
Monday 13 March	6.30 – 9.00	Ferry Flakk - Rørvik	26
	14.45 – 17.00	Speed boat 810	25
Wednesday 15 March	6.30 – 9.00	Ferry Flakk - Rørvik	22
	13.30 – 17.00	Speed boat 810	28
Friday 17 March	7.00 – 9.00	Speed boat 810	38
	14.45 – 17.00	Speed boat 810	29
		Total phase 2	**283**

Table 5.4. Day planning for the survey

5.5. General scheme of the survey

The survey was divided in two groups from the beginning depending on the way the user crosses the fjord: by ferry or speed boat. Two different questionnaires were built, one for each mode. In order to indentify the kind of user that was answering the questionnaire, both had some common general questions related to personal information such as age, gender, occupation, income or place of residence. As it was personal data, NSD permission had been necessary. Then, there was other general questions related to the trip itself like origin, destination, total travel time, purpose, waiting time or other current mode alternatives to do the trip. These questions were important both to get the reveled preference (RP) and to present the most suitable games for each user for the SP survey.

This survey was designed with a logical map system, leading to to a complex survey with many different paths and combinations. Figure 5.2 shows and scheme of the logical map.

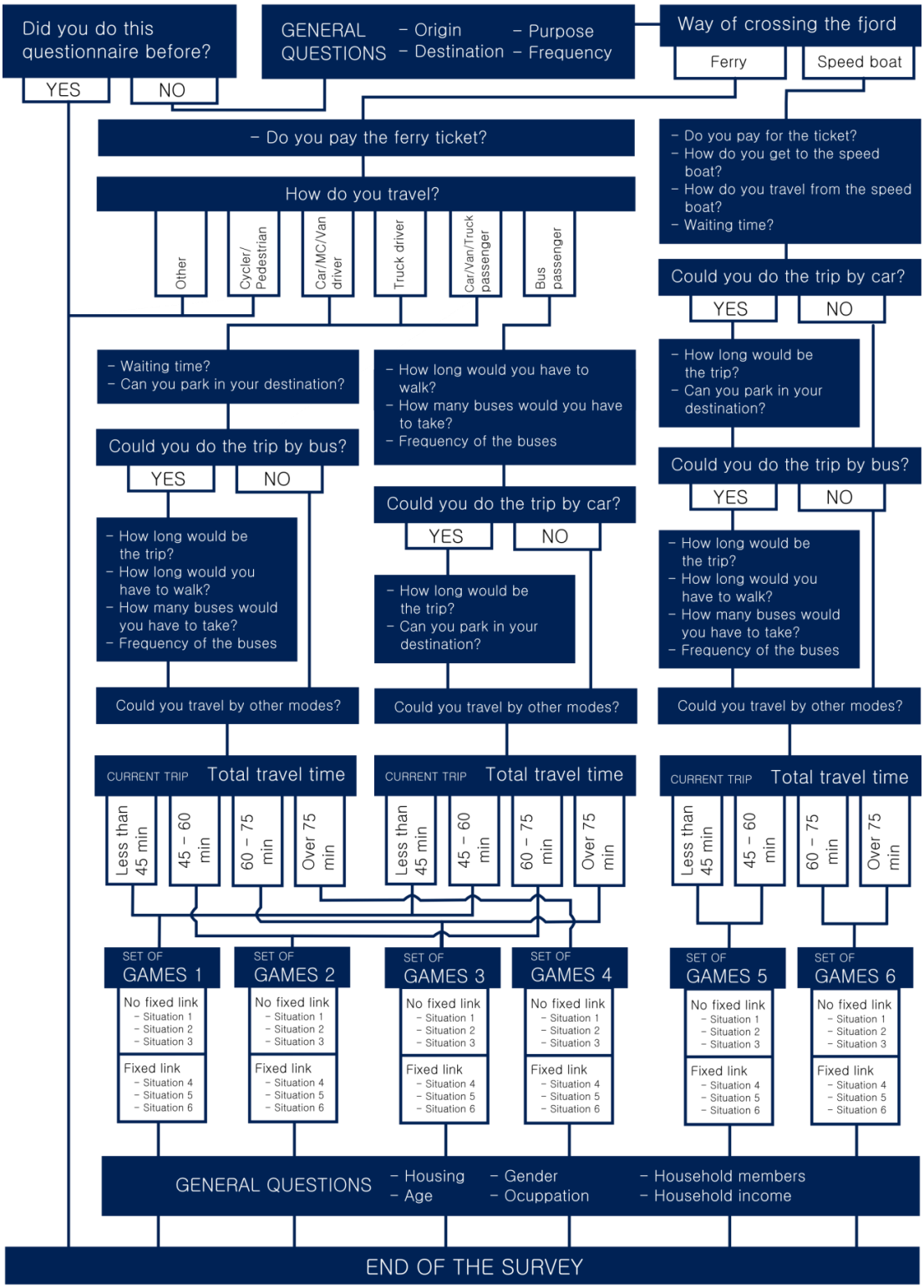


Figure 5.2. Logical map of the survey

As it is seen, the games varied depending on the mode to cross the fjord (2 options), the mode for the whole trip (6 options) and the total travel time (4 options). Therefore, there are 48 different set of games. However, due to the complexity of managing that, some of these sets were regrouped.

For the users that use the ferry to cross the fjord, the modes were grouped by joining all the private vehicle options together, so there are only 4 mode groups, private vehicle, public transport (bus), pedestrian/cyclers and others. As the ferry lines data showed that the pedestrian and cyclers are a minority, they were out of the case of study. Therefore, there are two mode groups: private vehicle and bus. If it is related the travel time of the bus with the car, it is possible to reduce the mode variety til one. Therefore, the games for the users that use the fjord depended only on the total travel time (4 options).

For the users that use the speed boat to cross the fjord, there were not mode distinctions and the travel time was grouped in two. Finally, Figure 5.2 and Table 5.5 show the final 6 sets of games.

Set of games	Way of crossing the fjord	Mode for the whole trip	Total travel time
1	Ferry	Private vehicle	Less than 45 min
		Bus	Less than 45 min
		Bus	45 – 60 min
2	Ferry	Private vehicle	45 – 60 min
		Bus	60 – 75 min
3	Ferry	Private vehicle	60 – 75 min
		Bus	Over 75 min
4	Ferry	Private vehicle	Over 75 min
5	Speed boat	All	Less than 45 min
		All	45 – 60 min
6	Speed boat	All	60 – 75 min
		All	Over 75 min

Table 5.5. Regrouped set of games

5.6. Set of games

Each set of games is composed of six different games. Three of them present situations without a fixed link, while the other three shows hypothetical situations with a fixed link between Flakk and Rørvik.

Each game has three different alternatives of travelling for the users. If there was not a fixed link, the users chose between car and ferry, bus and ferry or speed boat. If there was a fixed link, the alternatives were car, bus or speed boat.

Each alternative of travelling has four different information attributes: total travel time, ferry waiting time, monetary cost and frequency of the bus or speed boat. This information provided the users the enough knowledge of the situation in order to be able to choose which situation they would have used to travel.

Taking into account that there were three alternatives and four attributes, the users faced a game with twelve cells of information. The key of success in a SP survey is the figures are picked for these twelve cells. The range of figures that could be in each cells is called levels.

The levels are each piece of information is giving to the user in each game. They have to be selected by studying the real case in order to get games as realistic as possible. In order to get the most accurate levels as possible, the study was divided in two groups:

- Levels and attributes for the games for users that cross the fjord by ferry.
- Levels and attributes for the games for users that cross the fjord by speed boat.

5.6.1. Levels and attributes for the games for users that cross the fjord by ferry

In most of the cases, the user has not a real option to cross the fjord by a speed boat because these routes are really limited. As a result the alternative of travelling by speed boat was vanished, so there were only two alternatives: private vehicle or public transport (bus). This made a total number of four attributes. As the games vary depending on the total travel time, attribute's levels were calculated for the four different ranges of travel time: less than 45 min, 45 – 60 min, 60 – 75 min and over 75 min.

5.6.1.1. Attribute 1: Total travel time

This attribute is referred to the total time the user spends travelling, from the origin to the destination (door to door), including all the waiting time.

Car

The total travel time for the car alternative without fixed link is defined by the users themselves. Previously in the questionnaire, there is a question about how long their trip is. The user's answer in this question will determine the car total travel time (Table 5.6).

Answer	Total travel time in the games		
	Expected	Maximum	Minimum
Less than 45 min	35	42	28
45 – 60 min	55	66	44
60 – 75 min	70	84	56
Over 75 min	85	102	68

Table 5.6. Total travel time (min) for the car alternative without a fixed link

The expected value was the most likely trip for each answer. There are not problematic congestion problems in the area; so, it is reasonable to assume a maximum and the minimum using a deviation of ±20% from the expected value.

From this data, it was possible to get the levels for the games with a fixed link. The process was simply to subtract from the current situation the time that the car users spend waiting for the ferry and in the ferry. Moreover, the time that is used to cross the new fixed link had to be added. Therefore, as Table 5.7 shows, 30 minutes were subtracted to the values without fixed link. In the case of a travel time lower than 45 min, 25 min were subtracted.

Answer	**Total travel time in the games**		
	Expected	Maximum	Minimum
Less than 45 min	10	12	8
45 – 60 min	25	30	20
60 – 75 min	40	48	32
Over 75 min	55	66	44

Table 5.7. Total travel time (min) for the car option with a fixed link.

Bus

In order to simplify the survey, the travel time for the bus alternative was directly related to the travel time for the car alternative by multiplying it by a factor (Equation 5.1).

$$Bus\ travel\ time = Car\ travel\ time \cdot factor$$

Equation 5.1

. This factor was calculated by comparing the travel time in some of the most recurring trips in the fjord. Table 5.8 shows the most characteristic trips in the fjord that includes a fjord crossing. The trips were selected based on the ADT (Statens Vegvesen) and the AtB data about the bus demand.

	Onboard time (min)		ADT (from very high to very low)
	Car	Bus	
Tr.heim - Rørvik	50	65	Very high
Tr.heim - Rissa	75	97	High
Tr.heim - Stadsbygd	62	76	High
Tr.heim - Brekstad (throgh Orkanger)	115	150	Medium
Tr. heim - Brekstad (through Rissa)	125	160	Low
Orkanger - Brekstad	80	130	Very low
Tr.heim -Krinsvatnet	85	125	Very low

Table 5.8. frequent trips that implies crossing the Trondheimfjord

The general conclusion was that the bus trips take 30% longer than the car trips with a standard deviation of 9%. As it is displayed in Table 5.9, if it was supposed that the spectrum of trips follows a normal distribution, the bus trips would take between 50% and 13% longer than the car trips (with a confidence interval of 90%).

Confidence interval		Increase of onboard time in bus trips	Multiplying factor
50%	μ	30%	1.3
15% - 85%	$\mu - \sigma$	22%	1.22
	$\mu + \sigma$	40%	1.40
10% - 90%	$\mu - \sigma - \sigma$	13%	1.13
	$\mu + \sigma + \sigma$	49%	1.49

Table 5.9. Increase of travel time for bus trips in caparison with car trips

Therefore, it was applied Equation 5.1 using a multiplying factor of 1.3 for the car travel time expected value, 1.13 for the minimum value and 1.49 for the maximum value. As a result bus total travel times were calculated for both without and with fixed link in Table 5.10.

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min	46	52	39	13	15	11
45 – 60 min	72	82	62	33	37	28
60 – 75 min	92	104	79	52	60	45
Over 75 min	111	127	96	72	82	62

Table 5.10. Total travel time (min) for the bus option

5.6.1.2. Attribute 2: Waiting time for the ferry

This attribute reflects how long the users wait for the ferry in the dock.

Car

The waiting time for the ferry does not depend on the previous answers in the survey. It was calculated statistically depending on two parameters: the headway time and the arrival process.

The headway time means the time between departures. Calculating from Table 5.11 the headway time weighted average, 31.5 minutes and the standard deviation 1.7 minutes were got. As a result, a headway time of 32 minutes was chosen.

Headway time (min)	Frequency (times/week)
20	34
30	169
45	12
60	17

Table 5.11. Headway time (min) for the Flakk-Rørvik ferry

Regarding the arrival process, this consisted of two components:

- Random arrival
- Non-random arrival because the users are aware of the departures schedule.

If it was supposed a random arrival of the cars to the dock, the expected waiting time would be 16.8 minutes. Following a normal distribution, 90% of the cars wait between 14 and 17.5 minutes. However, the random arrival hypothesis only is assumable if the headway time is really low and there is a predominance of leisure trips becuase the users do not check the departures schedule in advance. As this case the headway time is not really low and there is a predominance of commuting trips, it is better to assume a non-random arrival.

If it was supposed a non-random arrival, it would be necessary to determine how high the users' knowledge of the ferry schedule was. The highest the users' knowledge was, the less average waiting time would be obtained. Figure 5.3 shows different models (exponential functions) that provided us with different level of users' knowledge. The average waiting time for each function is the area below the graph divided by the 100 (total users). Therefore, the smallest area gives the lowest average waiting time.

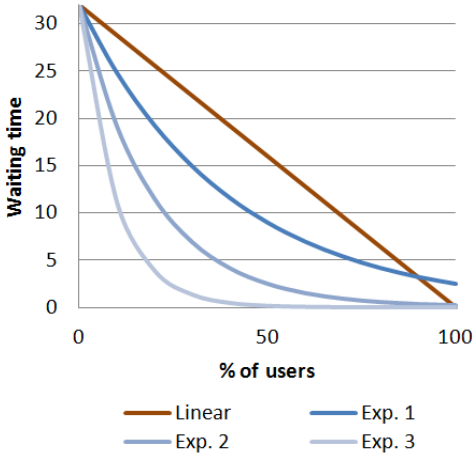


Figure 5.3. Waiting time

The question at this point was guessing which profile fitted better to the reality. In the Table 5.12 is possible to examine the degree of users' knowledge. The Exp. 3 means that the knowledge and punctuality is almost perfect, which was quite far away from reality. The Exp. 2 shows also a really high level of

knowledge, which is normally representative of longer headway times. For this case of study, the Exp. 1 distribution was the most realistic.

		% of users			
Distribution	Formula	20 %	40 %	60 %	80 %
Linear	32*(1-0.01U)	<6 min	<13 min	<19 min	<26 min
Exp. 1	0.975^{U}	<4 min	<7 min	<12 min	<19 min
Exp. 2	0.95^{U}	<1 min	<1 min	<4 min	<11 min
Exp. 3	0.90^{U}	0	0	0	<4 min

Table 5.12. Waiting time (min) depending on the arrival process. U=% of users

As Exp. 1 was chosen as the model because it was the closest to reality, the average waiting time will be 10 minutes. As it is displayed in Table 5.13, the maximum and the minimum are calculated with a deviation of ±20% from the expected value.

	WITHOUT fixed link		
	Expected	Maximum	Minimum
Less than 45 min	10	12	8
45 – 60 min	10	12	8
60 – 75 min	10	12	8
Over 75 min	10	12	8

Table 5.13. Waiting time (min) for the ferry

If a fixed link is build, there is not waiting time.

Bus

In this case the bus timetable is synchronized with the ferry departures, so the waiting time for the ferry is nearly zero. The waiting time for getting on the bus is written on attribute 4 (frequency).

5.6.1.3. Attribute 3: Monetary cost

This attribute encompasses all the expenses that the users pay during their trips.

Car

The monetary cost of the car trips included basically the tolls, petrol and ferry tickets. In the Trondheimfjord there was not any toll, apart from the one to get into the Trondheim city centre (9 NOK). As the distance and the speed are quite low, the petrol cost was generally low. Therefore the main costs in nowadays trips at the fjord were the ferry tickets. As the fixed link is going to be between Flakk and Rørvik, the cost was calculated from that ferry service. It was considered and average fare of 229 NOK per vehicle. The final levels are a bit higher due to a small cost from the petrol was included, as the Equation 5.2 shows. This small cost was proportional to the travel time. It was considered that the car was stopped 30 min due to the ferry and it was supposed a cost of 6 NOK every 5 min driving.

$$Cost = 229 + \frac{6\,(Total\ travel\ time - 30)}{5}$$

Equation 5.2

Applying this formula, the following levels are got in Table 5.14. It was considered that the toll of the fixed link will be as high as the ferry ticket. The maximum and the minimum are calculated with a deviation of ±15% from the expected value.

	WITHOUT fixed link			**WITH fixed link**		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min	235	270	200	235	270	200
45 – 60 min	259	298	220	259	298	220
60 – 75 min	277	319	235	277	319	235
Over 75 min	295	339	251	295	339	251

Table 5.14. Monetary cost (NOK) of the car alternative

Bus

The monetary cost of the bus was just the bus ticket. As all the bus services were ran by AtB, the fares were quite homogeneous and depended mostly on the distance of the trip. Therefore, based on AtB fares and the distances the attributes were calculated and displayed in Table 5.15. It is not expected changes in these fares when the fixed link will be build. The maximum and the minimum are calculated with a deviation of ±15% from the expected value.

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min	90	104	77	90	104	77
45 – 60 min	130	150	111	130	150	111
60 – 75 min	170	196	145	170	196	145
Over 75 min	200	230	170	200	230	170

Table 5.15. Monetary cost (NOK) of the bus alternative

5.6.1.4. Attribute 4: Frequency

The frequency is a way of reflecting the waiting time for bus option. As the frequency is quite low, it is difficult to represent it by a waiting time.

Car

Cars or any other private vehicles are modes with full flexibility.

Bus

There were only two bus lines that cross the Trondheimfjod, so the frequency of the bus option should be related to their frequencies. During the week days, there were 10 services per line and way. In this case, there were only two attributes; one 10 services per day and the other 20 services per day. It was decided to double the services in order to help the users to notice the difference.

The concept of services per day and way was difficult to be understood by the users that were participating in the survey. Therefore, it was turned into a frequency, as it is seen in Table 5.16.

Services per day and way	Frequency [Attributes]
10	1 bus per hour
20	2 bus per hour

Table 5.16. Levels for the frequency of the bus alternative. These levels are for all the different travel times.

5.6.2. Levels and attributes for the games for users that cross the fjord by speed boat

The most used speed boat line for commuters was Trondheim – Vanvikan. Therefore, the two set of games were created trying to model this line and depending on the total travel time; one set for the users who answered "less than 45 min" and "45 – 60 min" and the other for the ones who answered "60 – 75 min" and "over 75 min".

In this case, the games had three alternatives of travelling (car, bus and speed boat) and four attributes (total travel time, waiting time for the ferry, monetary cost, frequency of the service) which makes a total of twelve cells per game.

The trips that could be made only by speed boat were really limited (Figure 5.4). Normally, the users needed other mode to get to the dock and to achieve the destination from the speed boat. Therefore, the model had to compare the speed boat trips with the ones by bus and by car that are similar.

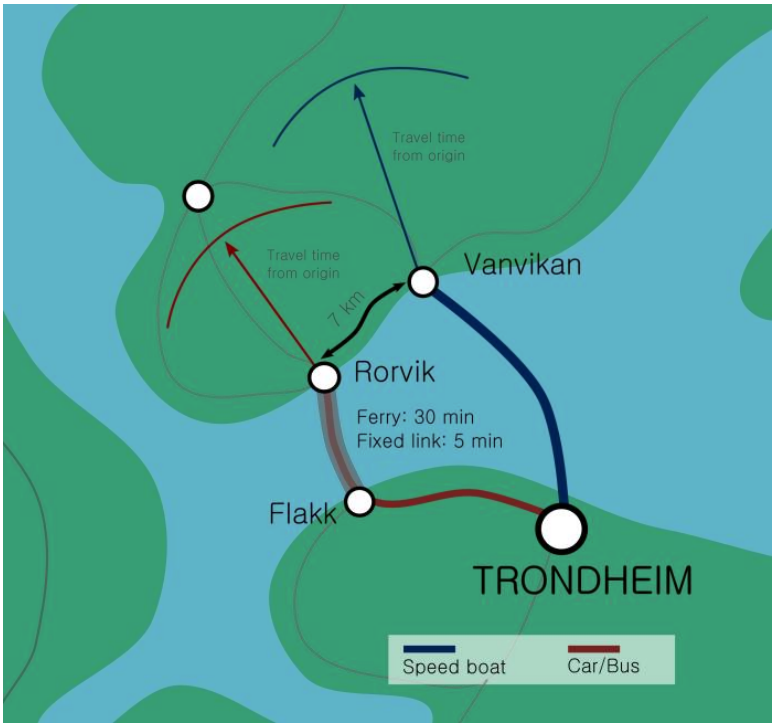


Figure 5.4. Speed boat lines and their car/bus alternatives

5.6.2.1. Attribute 1: Total travel time

Car

The levels were referred to how long the trip would be if it was done by car instead of using the speed boat. The routes in the

Figure 5.4 were taken as the model for calculating the total travel times. For the times in the games with fixed link, it was subtracted the ferry onboard time and the waiting time from the games without fixed link. As the Table 5.17 shows, the maximum and the minimum were calculated with a deviation of ±20% from the expected value.

	WITHOUT fixed link			**WITH fixed link**		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min **45 – 60 min**	65	78	52	35	42	28
60 – 75 min **Over 75 min**	85	102	68	55	66	44

Table 5.17. Total travel time (min) for the car option

Bus

The same process as 5.6.1.1 was used obtaining the following figures in Table 5.18.

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min **45 – 60 min**	85	97	73	46	52	39
60 – 75 min **Over 75 min**	111	127	96	72	82	62

Table 5.18. Total travel time (min) for the bus option

Speed boat

The travel time included the speed boat onboard time, the waiting time and some extra time to go from the origin to the dock and from the dock to the destination. This extra time was the one that makes the difference between the set of games (less than 60 minutes and over 60 minutes).

Changes in the attributes are not expected if a fixed link is built. The maximum and the minimum are calculated with a deviation of ±20% from the expected value (Table 5.19).

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min **45 – 60 min**	55	66	44	55	66	44
60 – 75 min **Over 75 min**	70	84	56	70	84	56

Table 5.19. Total travel time (min) for the speed boat option

5.6.2.2. Attribute 2: Waiting time for the ferry

Car

As the cars would have got on the same ferry as in the case in 5.6.1.1, the same figures are taken (Table 5.20).

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min 45 – 60 min	10	12	8	10	12	8
60 – 75 min Over 75 min	10	12	8	10	12	8

Table 5.20. Waiting time (min) for the car option

Bus and speed boat

In this case the bus, timetable is synchronized with the ferry departures, so the waiting time for the ferry is zero. The waiting time for getting on the bus and the speed boat is written on attribute 4 (frequency).

5.6.2.3. Attribute 3: Monetary cost

This level encompasses all the expenses that the users pay during their trips, including ferry tickets, bus tickets, petrol and tolls.

Car

The monetary cost of the car alternative was calculated with the same process as 5.6.1.3, getting the values in Table 5.21.

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min 45 – 60 min	244	281	207	244	281	207
60 – 75 min Over 75 min	290	334	247	290	334	247

Table 5.21. Monetary cost (NOK) for the car option

Bus

The monetary cost of the bus alternative was calculated following the same process as 5.6.1.3, getting the values in Table 5.22.

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min 45 – 60 min	90	104	77	90	104	77
60 – 75 min Over 75 min	210	242	179	210	242	179

Table 5.22. Monetary cost (NOK) of the bus option

Speed boat

The speed boat monetary cost included the speed boat ticket and the cost of getting to the dock and going from the dock to the destination (bus tickets, petrol, tolls,…). This cost was estimated as an average depending on the total travel time; the longer was the travel time, the higher was the cost. Table 5.23 shows the expected values which were the fares that users have to pay nowadays.

It is not expected changes in these fares when the fixed link will be build. The maximum and the minimum are calculated with a deviation of ±15% from the expected value.

	WITHOUT fixed link			WITH fixed link		
	Exp.	Max	Min	Exp.	Max	Min
Less than 45 min 45 – 60 min	102	117	87	102	117	87
60 – 75 min Over 75 min	244	281	207	244	281	207

Table 5.23. Monetary cost (NOK) of the speed boat option

5.6.2.4. Attribute 4: Frequency

It was followed the same process as in 5.6.1.4. The Table 5.24 and Table 5.25 show the levels for the bus and the speed boat alternative respectively. Cars or any other private vehicles are modes with full flexibility.

	WITHOUT fixed link		**WITH fixed link**	
	Atrrib. 1	Attrib. 2	Atrrib. 1	Attrib. 2
All travel times	1 bus per hour	2 bus per hour	1 bus per hour	2 bus per hour

Table 5.24. Frquencies for the bus option

	WITHOUT fixed link		**WITH fixed link**	
	Atrrib. 1	Attrib. 2	Atrrib. 1	Attrib. 2
All travel times	1 speed boat per hour	2 speed boat per hour	1 speed boat per hour	2 speed boat per hour

Table 5.25. Frequencies for the speed boat option

5.7. Building the sets of games

5.7.1. Attributes and levels per set

In order to build the final games, all the attributes and levels were reordered in 6 sets, as it was described in the Table 5.5. The levels from the calculations in 5.6 were round it to make it easier to the user. (Table 5.26, Table 5.27, Table 5.28, Table 5.29, Table 5.30, Table 5.31)

SET 1

FERRY
Car: less than 45 min
Bus: less than 45 min, 45 – 60 min

WITHOUT FIXED LINK	Car+ Ferry	Bus+ Ferry
Total travel time (min)	35 40 50	45 50 60
Waiting time for the ferry (min)	5 10 15	0
Cost (NOK) Tolls, fuel, tickets,...	200 235 270	75 90 105
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour

WITH FIXED LINK	Car	Bus
Total travel time (min)	15 20 25	20 25 30
Waiting time for the ferry (min)	0	0
Cost (NOK) Tolls, fuel, tickets,...	200 235 270	75 90 105
Frequency (Number of services a day)	Full Flexibility	1 bus per hour 2 bus per hour

Table 5.26. Set 1

SET 2

FERRY
Car: 45 – 60 min
Bus: 60 – 75 min

WITHOUT FIXED LINK	Car+ Ferry	Bus+ Ferry
Total travel time (min)	45 55 65	60 70 80
Waiting time for the ferry (min)	5 10 15	0
Cost (NOK) Tolls, fuel, tickets,...	220 260 300	110 130 150
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour

WITH FIXED LINK	Car	Bus
Total travel time (min)	25 30 35	35 40 45
Waiting time for the ferry (min)	0	0
Cost (NOK) Tolls, fuel, tickets,...	220 260 300	110 130 150
Frequency (Number of services a day)	Full Flexibility	1 bus per hour 2 bus per hour

Table 5.27. Set 2

SET 3

FERRY
Car: 60 – 75 min
Bus: over 75 min

WITHOUT FIXED LINK	Car+ Ferry	Bus+ Ferry
Total travel time (min)	55 70 85	80 90 105
Waiting time for the ferry (min)	5 10 15	0
Cost (NOK) Tolls, fuel, tickets,...	235 275 320	145 170 195
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour

WITH FIXED LINK	Car	Bus
Total travel time (min)	30 40 50	45 50 60
Waiting time for the ferry (min)	0	0
Cost (NOK) Tolls, fuel, tickets,...	235 275 320	145 170 195
Frequency (Number of services a day)	Full Flexibility	1 bus per hour 2 bus per hour

Table 5.28. Set 3

SET 4

FERRY
Car: over 75 min

WITHOUT FIXED LINK	Car+ Ferry	Bus+ Ferry
Total travel time (min)	70 85 100	95 110 125
Waiting time for the ferry (min)	5 10 15	0
Cost (NOK) Tolls, fuel, tickets,...	250 295 340	170 200 230
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour

WITH FIXED LINK	Car	Bus
Total travel time (min)	45 55 65	60 70 80
Waiting time for the ferry (min)	0	0
Cost (NOK) Tolls, fuel, tickets,...	250 295 340	170 200 230
Frequency (Number of services a day)	Full Flexibility	1 bus per hour 2 bus per hour

Table 5.29. Set 4

SET 5

SPEED BOAT
All: less than 45 min, 45 – 60 min

WITHOUT FIXED LINK	Car+ Ferry	Bus+ Ferry	Speed boat
Total travel time (min)	50 65 80	75 85 95	45 55 65
Waiting time for the ferry (min)	5 10 15	0	-
Cost (NOK) Tolls, fuel, tickets,...	210 245 280	75 90 105	85 100 120
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour	1 speed boat per hour 2 speed boat per hour

WITH FIXED LINK	Car	Bus	Speed boat
Total travel time (min)	30 35 40	40 45 50	45 55 65
Waiting time for the ferry (min)	0	0	-
Cost (NOK) Tolls, fuel, tickets,...	210 245 280	75 90 105	85 100 120
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour	1 speed boat per hour 2 speed boat per hour

Table 5.30. Set 5

SET 6

SPEED BOAT
All: 60 – 75 min, over 75 min

WITHOUT FIXED LINK	Car+ Ferry	Bus+ Ferry	Speed boat
Total travel time (min)	70 85 100	95 110 125	55 70 85
Waiting time for the ferry (min)	5 10 15	0	-
Cost (NOK) Tolls, fuel, tickets,...	245 290 335	180 210 240	210 245 280
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour	1 speed boat per hour 2 speed boat per hour

WITH FIXED LINK	Car	Bus	Speed boat
Total travel time (min)	45 55 65	60 70 80	55 70 85
Waiting time for the ferry (min)	0	0	-
Cost (NOK) Tolls, fuel, tickets,...	245 290 335	180 210 240	210 245 280
Frequency (Number of services a day)	Full flexibility	1 bus per hour 2 bus per hour	1 speed boat per hour 2 speed boat per hour

Table 5.31. Set 6

5.7.2. D-efficient design

The games are composed of some combinations of levels of the sets. The ideal case is that the user is able to answer all the possible combinations (full factorial) but in this case there are too many: 486 combinations for sets 1, 2, 3 and 4 and 8748 for sets 5 and 6. Therefore, the goal is finding the games that give more information to get the minimum error as possible.

The use of upcoming efficient designs permits to estimate the parameters with small standard errors (Choice Metrics 2014). Therefore, it was used D-efficient experimental design developed using the software Ngene. The program's algorithm uses the levels, attributes and utility of each alternative in the game. In this case, there four kinds of scripts: sets 1 to 4 (ferry users) with and without fixed link and sets 5 and 6 (speed boat users) with and without fixed link.

It is decided that, in order not to lose the motivation of the users, they only have to face 6 games, three without fixed link and three with it. In order to reduce this error, it is decided to get 6 games from each script divided in two blocks. Therefore, half of the users will face each block.

All the program codes are listed in the Appendix V.

5.7.3. Games

After getting the results from the program, they have to be checked manually in order to avoid predominance. This means than one of the alternative must not have all the attributes better than the others. Figure 5.5 shows an example but all the games are listed in Appendix VI.

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	50 min	1t 25min	55 min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter...	210 NOK	105 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	30 min	40 min	1t 5min
Kostnad [NOK] Bompenger, billetter...	210 NOK	90 NOK	100 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

Figure 5.5. Example of games before and after a ferry replacement.

Bil = Car; Buss = Bus; Hurtigbåt = Speed boat; Total reisetid = Total travel time; Ventid på ferjen = Waiting time for the ferry; Kostnad = cost; Antall avganger per dag = Frequency; Time = Hour

5.8. Final questionnaire

The final questionnaire is in Appendix VI. The complexity of the logical map (Figure 5.2) makes that the survey has to be asked through a webpage (Typeform). Typeform drives the user directly to the questions that are designed for each kind of user. The links to see the design of the questionnaire in Typeform are also in Appendix VI.

6. RESULTS

The results were gotten by building models using Pythonbiogeme. This section just shows the final results, whereas the discussion is in section 7.

6.1. Analysis of the quality of the answers

Before any calculation, the first step was to check all the users' answers and select the ones that were going to be used for the models. For instance, the ones that went cycling or walking into to the ferry (3% of the answers) were neglected. The sample is too small to analyze as an independent group and the SP survey was not prepared for this kind of users.

Moreover, there were users that answered the survey twice. The questionnaire was prepared for that, so it was easy to delete the second answers. This case was quite common (8.5% of the total answers) due to the high amount of commuters.

Neglecting these two kinds of answers, 250 answers are considered acceptable for the models. This means a marginal error around 6% above the total population (the total trips in the fjord).

6.2. General socio - economic figures

The first analysis to do with the survey is study the profile of the users that answered the questionnaire. This gives some clues on where to focus to design the models and which socio-economic parameters could be interesting to analyze. In this section, the most essential is explained; the rest is listed in Appendix VIII.

As the Figure 6.1 shows, the gender distribution differs considerably between modes. While car is used mostly by men, the bus is used by women. The speed boat has an equity distribution.

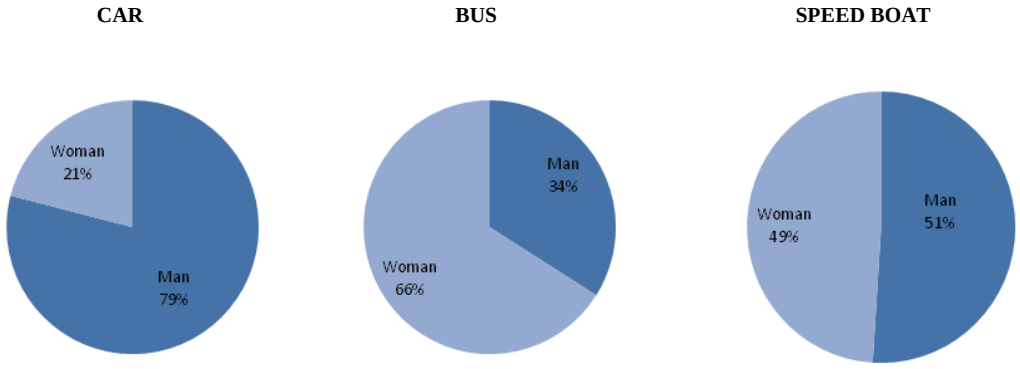


Figure 6.1. Gender by mode

The purpose, displayed in Figure 6.2, also differs between modes. While commuting trips prevails in the public transport (bus and speed boat), the purposes of the car users is more diverse. If we analyze the joined data, 48% are commuting trips, while the other half of the trips has really diverse purposes.

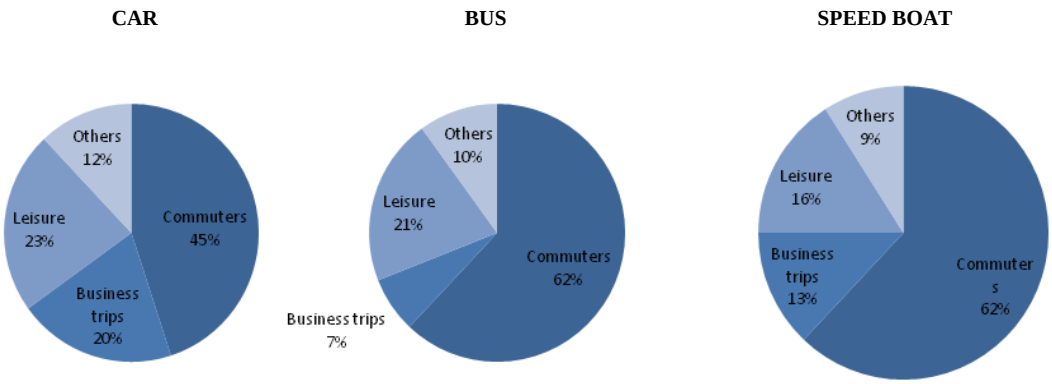


Figure 6.2. Purpose by mode

The Figure 6.3 shows where the people live, either the Trondheim side of the fjord (42%) or the other side (48%). The public transport is used by the people that live the other side of the fjord, whereas the people that live in Trondheim and its surroundings use mostly the car.

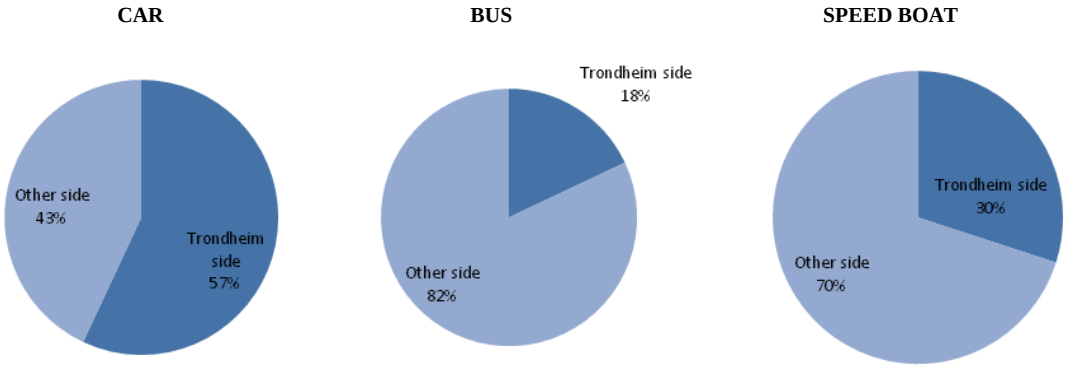


Figure 6.3. Place of residence by mode

The analysis of these three figures all together gave also some remarkable relations. For instance, 76% of the commuters that live at the other side of the fjord used public transport (57% speed boat and 19% bus). Whereas, only 46% of the commuters that live in the Trondheim side use public transport (41% speed boat and 5% bus). Furthermore, while only 45% of the women are commuters, 63% of the men are doing commuting trips.

6.3. Models

A model consists of getting the utility function of the three modes that were being analyzed: car, bus and speed boat. Based on the answers of the users, the parameters were calculated, which was the based to get the value of time.

As in the survey there are three kinds of answers, RP, SP in the current situation and SP in the fixed link situation, three different models are studied. Despite the fact that there are differences between surveys, some of the utility parameters and the attributes in Table 6.1

Table 6.1 are used on each of the models.

	Parameters	Explanation	Attrib.	Units	Explanation
Constants p.	β_{car}	For the car utility	TT_{car}	Min	Total travel time for the car alternative
	β_{bus}	For the bus utility	TT_{bus}	Min	Total travel time for the bus alternative
	β_{sb}	For the speed boat utility	TT_{sb}	min	Total travel time for the speed boat alternative
Policy parameters	β_{TT_c}	For the car travel time	WT_{car}	min	Waiting time in the ferry dock for the car alternative
	β_{TT_b}	For the bus travel time	f_{bus}	buses /h	Frequency for the bus alternative
	$\beta_{TT_{sb}}$	For the speed boat travel time	f_{sb}	boats /h	Frequency for the speed boat alternative
	β_C	For the cost (common for the three modes)	C_{car}	NOK	Monetary cost for the car alternative
	β_f	For the frequency (just for the bus and speed boat utilities)	C_{bus}	NOK	Monetary cost for the bus alternative
	$\beta_{WT_{car}}$	For the waiting time for the car in the ferry dock (no applicable for the fixed link model)	C_{sb}	NOK	Monetary cost for the speed boat alternative
Dummy parameters	β_{gend}	Gender	Pay	If the user pay for the trip [Pay = 1; Not pay = 0]	
	β_{com}	Purpose: commuters	Gend	Gender [Woman = 1; Man = 0]	
	β_{bt}	Purpose: business trips	Com	Purpose: commuting [True = 1; False = 0]	
	β_{FTjob}	Occupation: full time job	Bt	Purpose: business trip [True = 1; False = 0]	
	β_{PTjob}	Occupation part time job	FTjob	Occupation: full time job [True = 1; False = 0]	
	β_{Stud}	Occupation: student	PTjob	Occupation: part time job [True = 1; False = 0]	
	β_{Ret}	Occupation retired	Stud	Occupation: student [True = 1; False = 0]	
	β_{hou}	Housing/place of residence	Ret	Occupation: reteired [True = 1; False = 0]	
	Corr1	Correlation between public transport (bus – speed boat)	Hou	Housing [The other side of the fjord = 1; The Trondheim side of the fjord = 0]	
	Corr2	Correlation between speed boat and car			
	Panel1, Panel2, PanelB, PanelC	Panel data effect			

Table 6.1. Common utility parameters and attributes for all the models

Some general steps were followed to build the models. First, a MNL model should be created with only the policy parameters. This model normally gives us bad results due to many reasons. For instance, in the SP counts each user answer as a different person, which causes correlation. In order to avoid the next step is to design a ML model. Keeping the same utility functions, the model should be better, obtaining smaller constant parameters and more significant policy parameters. Despite this improvement, the constants are normally quite influential, which means that there is a lack of information. Therefore, the next step is to add small changes to the model and see if it improves or not. The following possibilities were tried.

- Including non-linear functions. For instance, it is true that the highest is the travel time the worst, but it is unknown if it follows a linear function. Normally, it is interesting to study how exponential and logarithm functions work (Figure 6.4).

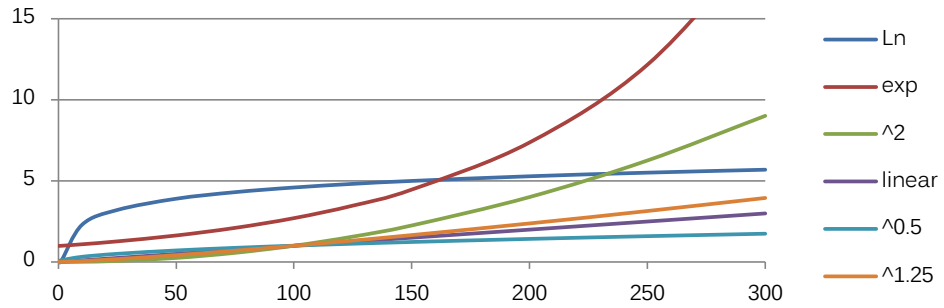


Figure 6.4. Plot of different functions

- Including preference heterogeneities for some parameters. For instance, adding a random individualization of travel time parameter.
- Correlating two parameters in the same alternative. For example, the frequency parameter could depend on the total travel time. It is not the same waiting 5 minutes for an onboard time of an hour or waiting 5 minutes for a onboard time of 3 minutes.
- Adding socio-economic parameters. Probably, the users don't choose one mode just due to travel time, cost, waiting time and frequency. Purpose, age or gender could be important.
- Adding a correlation parameter between alternatives. For example, it could be a correlation between public transport modes (speed boat and bus).

All these changes gave us a high number of similar models which had to be compared. First, the microeconomic conditions were checked (sign of the parameters) and the models with wrong signs were discarded. Afterwards, the t-test of each parameter was studied and finally the likelihood test is used to compare the models. The model that fulfilled the previous statements and had the smallest likelihood test should be the best. In this section, only the final models are shown.

The others models and its figures are shown in Appendix IX.

6.3.1. Reveled preference model

None acceptable models were obtained with the reveled preference survey data. The microeconomic conditions are not satisfied because the cost and travel time parameters have different sign which leads to a negative value of travel time. Moreover t-tests of the constant parameters were quite high, which is a lack of information. The explanation of these problems is discussed in section 9.

6.3.2. State preference model (current situation)

The Equation 6.1 shows the model and the Table 6.2, the value of the parameters.

$$\boldsymbol{V_{car}} = \beta_{car} + \beta_{TTcar}\, e^{TT_{car}/100} + \beta_{WT_{car}} \ln\left(1 + \frac{WT_{car}}{1000}\right) Com + \beta_C \frac{10000\, C_{car}}{Inc} Pay + \beta_{gend} Gend + \beta_{com} Com + \beta_{bt} Bt + \beta_{FTjob}\, FTjob + \beta_{PTjob}\, PTjob + \beta_{hou}\, Hou \cdot Com + Panel\mathrm{C}$$

$$\boldsymbol{V_{bus}} = \beta_{bus} + \beta_{TTbus}\, e^{TT_{bus}/100} + \beta_f \ln\left(\frac{f_{bus}}{10}\right) \mathrm{Com} + \beta_C \frac{10000\, C_{bus}}{Inc} Pay + \beta_{gend}\, Gend + \beta_{com}\, Com + \beta_{bt}\, Bt + \beta_{FTjob}\, FTjob + \beta_{PTjob}\, PTjob + \beta_{hou}\, Hou \cdot Com + \mathrm{Corr1} + Panel\mathrm{B}$$

$$\boldsymbol{V_{speed\ boat}} = \beta_{TTsb}\, e^{TT_{sb}/100} + \beta_f \ln\left(\frac{f_{sb}}{10}\right) \mathrm{Com} + \beta_C \frac{10000\, C_{sb}}{Inc} Pay + Corr1$$

Equation 6.1

Policy parameters			Dummy parameters		
	Value	t-test		Value	t-test
$\boldsymbol{\beta_{car}}$	0.837	1.32	β_{gend}	- 1.00	- 2.76
$\boldsymbol{\beta_{bus}}$	- 0.682	- 1.07	$\boldsymbol{\beta_{bt}}$	0.707	1.46
$\boldsymbol{\beta_{TT_c}}$	- 0.853	- 3.08	$\boldsymbol{\beta}_{\text{com}}$	- 0.627	- 1.23
$\boldsymbol{\beta_{TT_b}}$	- 0.648	- 3.02	$\boldsymbol{\beta_{FTjob}}$	- 0.948	- 2.08
$\boldsymbol{\beta_{TT_{sb}}}$	- 0.782	- 1.96	$\boldsymbol{\beta_{PTjob}}$	- 0.961	- 1.54
$\boldsymbol{\beta_C}$	- 0.484	- 4.42	$\boldsymbol{\beta_{Hou}}$	- 0.589	- 1.30
$\boldsymbol{\beta_{WT}}$	- 0.0689	- 1.05			
$\boldsymbol{\beta_f}$	0.159	0.53			

Parameters for correlation			
	Value	t-test	Explanation
Corr1	0.328	0.42	$Corr = \beta_{corr} \cdot N(0,1)$ where β_{corr} is a constant
PaneB	- 0.227	- 0.23	$PanelB = \beta_{panelB} \cdot N(0,1)$ where β_{panelB} is a constant
PanelC	0.0947	0.27	$PanelC = \beta_{panelC} \cdot N(0,1)$ where β_{panelC} is a constant

Log likelihood	LL (0)	-651.231	**Rho-square**	0.327
	LL (max)	-438.498	**Rho-square market**	0.301
	LL (c)	-627.322		

Table 6.2. Parameters and tests for the SP (current situation) model.

It is important to note that retired people were excluded for the travel time parameter. When this exclusion was done, the parameter became much more significant. This issue could have many explanations: a different way of valuing their time, misunderstandings when they faced the survey, etc. This is discussed later on.

6.3.3. State preference model (fixed link situation)

This model, in terms of choosing the parameters, was almost equal to the last one. Only some exchanges in some attributes functions were done. Due to the difference between data from the current situation and the stated preference situation the value of the parameters differs. The Equation 6.2 shows the utility functions and the Table 6.3 shows the value of the parameters and its t-test. As the model for the current situation, the retired people were excluded from the study for the calculations of the values of time.

$$\boldsymbol{V_{car}} = \beta_{car} + \beta_{TTcar}\, e^{TT_{car}/1000} + \beta_C \frac{10000\, C_{car}}{Inc} Pay + \beta_{gend} Gend + \beta_{com} Com + \beta_{bt} Bt + \beta_b Bt + \beta_{FTjob}\, FTjob + \beta_{PTjob}\, PTjob + \beta_{Stud}\, Stud + \beta_{Ret}\, Ret + Panel1 + \text{Corr } 2$$

$$\boldsymbol{V_{bus}} = \beta_{bus} + \beta_{TTbus}\, e^{TT_{bus}/1000} + \beta_f \ln\left(\frac{f_{bus}}{10}\right) \text{Com} + \beta_C \frac{10000\, C_{bus}}{Inc} Pay + \beta_{gend}\, Gend + \beta_{com} Com + \beta_{bt}\, Bt + \beta_{FTjob}\, FTjob + \beta_{PTjob}\, PTjob + \beta_{Stud}\, Stud + \beta_{Ret}\, Ret + Panel2$$

$$\boldsymbol{V_{speed\ boat}} = \beta_{TTsb}\, e^{TT_{sb}/1000} + \beta_f \ln\left(\frac{f_{sb}}{10}\right) \text{Com} + \beta_C \frac{10000\, C_{sb}}{Inc} Pay + Corr2$$

Equation 6.2

Policy parameters			**Dummy parameters**		
	Value	t-test		Value	t-test
$\boldsymbol{\beta_{car}}$	1.01	1.52	$\boldsymbol{\beta_{gend}}$	- 1.19	- 3.16
$\boldsymbol{\beta_{bus}}$	- 2.29	- 1.45	$\boldsymbol{\beta_{bt}}$	2.79	3.53
$\boldsymbol{\beta_{TT_c}}$	- 25.2	- 2.24	$\boldsymbol{\beta_{\text{com}}}$	0.302	0.58
$\boldsymbol{\beta_{TT_b}}$	- 22.8	- 2.12	$\boldsymbol{\beta_{FTjob}}$	- 2.95	- 2.81
$\boldsymbol{\beta_{TT_{sb}}}$	- 26.1	- 2.33	$\boldsymbol{\beta_{PTjob}}$	- 2.32	- 2.10
$\boldsymbol{\beta_C}$	- 0.870	- 2.47	$\boldsymbol{\beta_{Stud}}$	- 1.32	- 1.28
$\boldsymbol{\beta_f}$	0.296	0.94	$\boldsymbol{\beta_{Hou}}$	- 0.117	- 0.27

Parameters for correlation			
	Value	t-test	Explanation
Corr2	0.729	0.97	$Corr = \beta_{corr} \cdot N(0,1)$ where β_{corr} is a constant
Pane1	0.613	0.76	$PanelB = \beta_{panelB} \cdot N(0,1)$ where β_{panelB} is a constant
Panel2	- 2.18	- 1.63	$PanelC = \beta_{panelC} \cdot N(0,1)$ where β_{panelC} is a constant

Log likelihood	LL (0)	-651.231	**Rho-square**	0.142
	LL (max)	-558.726	**Rho-square market**	0.116
	LL (c)	-632.043		

Table 6.3. Parameters for the model with a fixed link

6.4. Value of travel time

As it was explained in the methodology section, the values of time are got from the utility function and applying the following Equation 6.3. The VTT has to be always positive, as it is the opportunity cost of the trip travel time, measured in monetary and time units (NOK/time units).

$$VTT_j = \frac{\partial V_j / \partial TT_j}{\partial V_j / \partial C_j}$$

Equation 6.3

6.4.1. Value of time in the current situation

Applying Equation 6.3 the formulas for the values of time are developed (Equation 6.4, Equation 6.5, Equation 6.6). As the utility functions were not linear in terms on travel time, the VTT depends on the total travel time of each trip. The parameter of the cost depends on the household income, which also affects to the VTT.

$$VTT_{car}[NOK/h] = 60\ \frac{\beta_{TT_{car}}\ e^{TT_{car}/100}}{1000000\ \beta_C}\ income$$

$$= 60\ \frac{0.853\ \ e^{TT_{car}/100}}{484\ 000}\ income$$

Equation 6.4

$$VTT_{bus}[NOK/h] = 60\ \frac{\beta_{TT_{bus}}\ e^{TT_{bus}/100}}{1000000\ \beta_C}\ income$$

$$= 60\ \frac{0.648\ \ e^{TT_{bus}/100}}{484\ 000}\ income$$

Equation 6.5

$$VTT_{speed\ boat}[NOK/h] = 60\ \frac{\beta_{TT_{sb}}\ e^{TT_{sb}/100}}{1000000\ \beta_C}\ income$$

$$= 60\ \frac{0.782\ \ e^{TT_{sb}/100}}{484\ 000}\ income$$

Equation 6.6

As they depend on two values, surfaces are plotted in Figure 6.5. As it is seen, the VTT increases with the income in a linear way, whereas the increase due to the travel time is exponential.

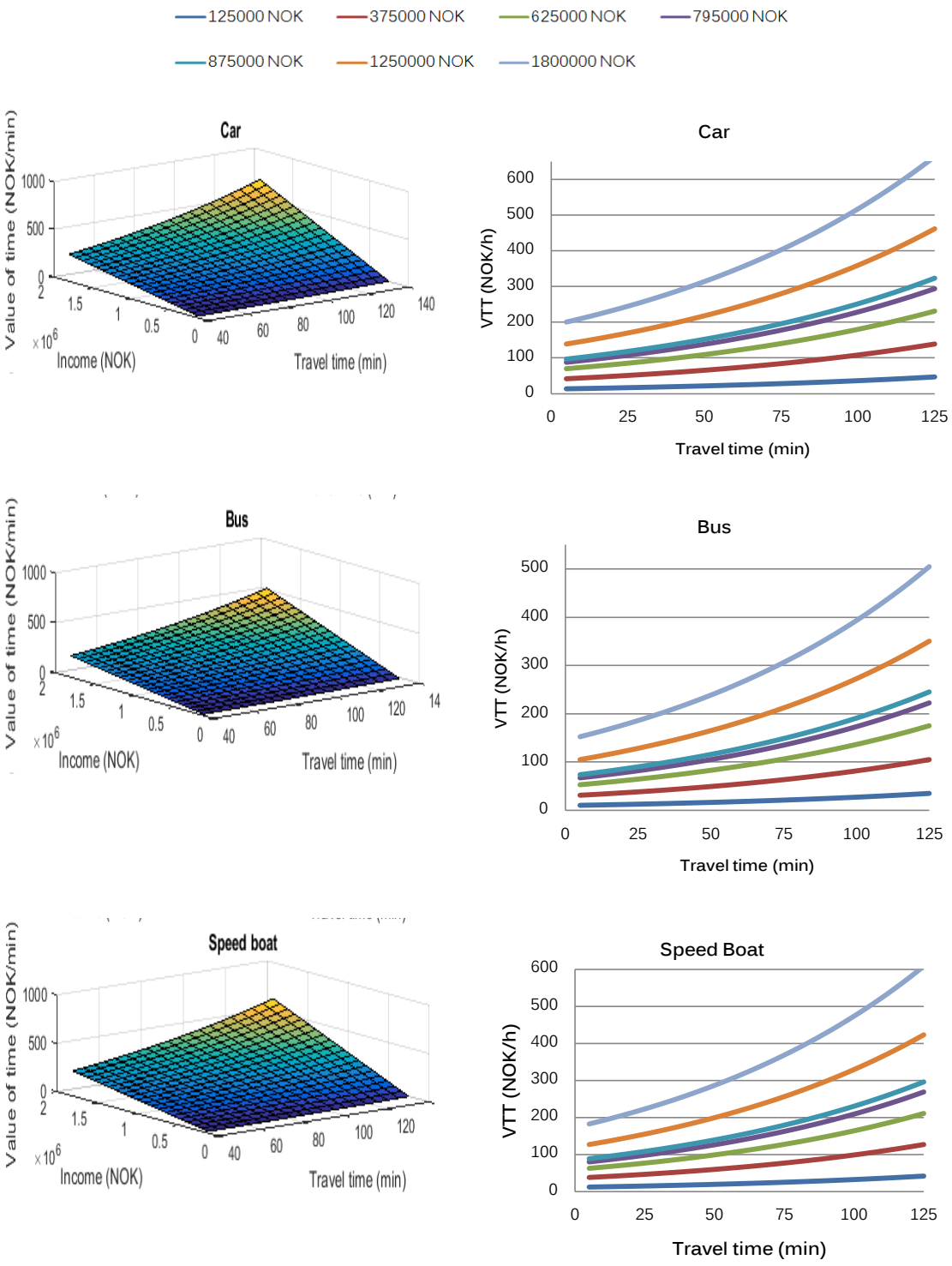


Figure 6.5. VTT for the current situation

As the formulas are really similar, the surfaces look alike. In order to compare 2D graphs are used in Figure 6.6. It is calculated an average household income of the users that answer the survey. which is approximately 795000 NOK/year. As the formulas depend linearly on the income, the difference between modes is constant at any income. It only should be studied the area between 40 and 120 minutes of total travel time. This is because, after studying the trips in the fjord, this is the range of travel times in the fjord that could include a fjord crossing. The speed boat trips are between 45 and 85 min, the car trips between 40 and 100 minutes and the bus trips between 50 and 120 minutes.

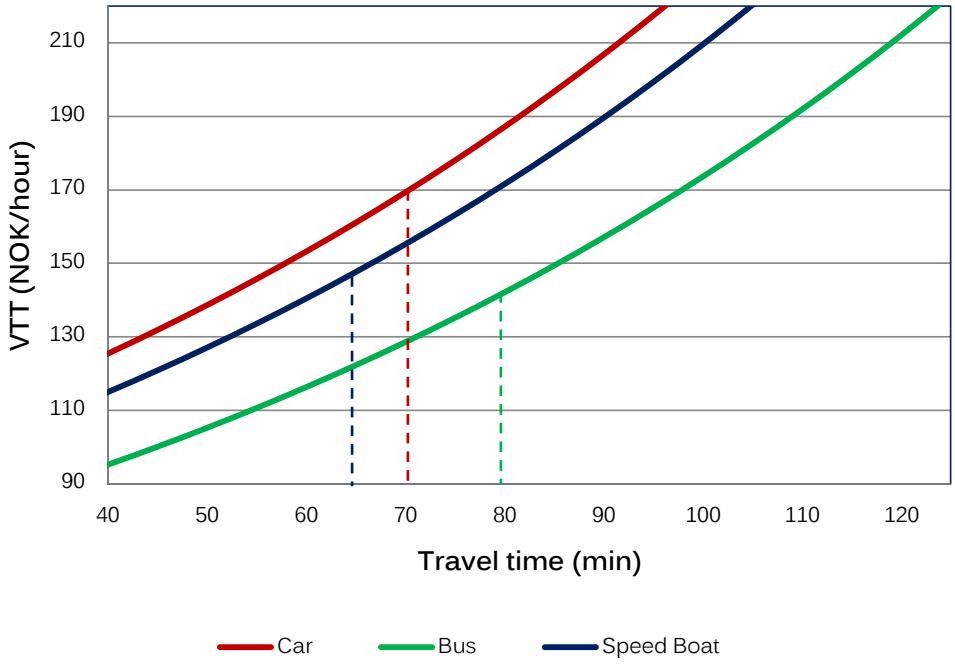


Figure 6.6. VTT for the current situation for an average income. The vertical lines are the mean value of the travel time for each mode.

As it is showed, the car has the highest VTT, whereas the bus is the lowest. This is logical as the VTT for public transport is normally lower than for private vehicles.

6.4.2. Value of time with a fixed link situation

Applying Equation 6.3 the formulas for the values of time are got (Equation 6.7, Equation 6.8, Equation 6.9).

$$VTT_{car}[NOK/h] = 60\ \frac{\beta_{TT_{car}}\ e^{TT_{car}/1000}}{10000000\ \beta_C}\ income$$
$$= 60\ \frac{25.2\ \ e^{TT_{car}/1000}}{8\ 700\ 000}\ income$$

Equation 6.7

$$VTT_{bus}[NOK/h] = 60\ \frac{\beta_{TT_{bus}}\ e^{TT_{bus}/1000}}{10000000\ \beta_C}\ income$$
$$= 60\ \frac{22.8\ e^{TT_{bus}/1000}}{8\ 700\ 000}\ income$$

Equation 6.8

$$VTT_{speed\ boat}[NOK/h] = 60\ \frac{\beta_{TT_{sb}}\ e^{TT_{sb}/1000}}{10000000\ \beta_C}\ income$$
$$= 60\ \frac{26.1\ \ e^{TT_{sb}/1000}}{8\ 700\ 000}\ income$$

Equation 6.9

As it also depends on two items, the surfaces are plotted (Figure 6.7). In this case, the VTT changes slightly due to the total travel time. The income modifies the VTT linearly.

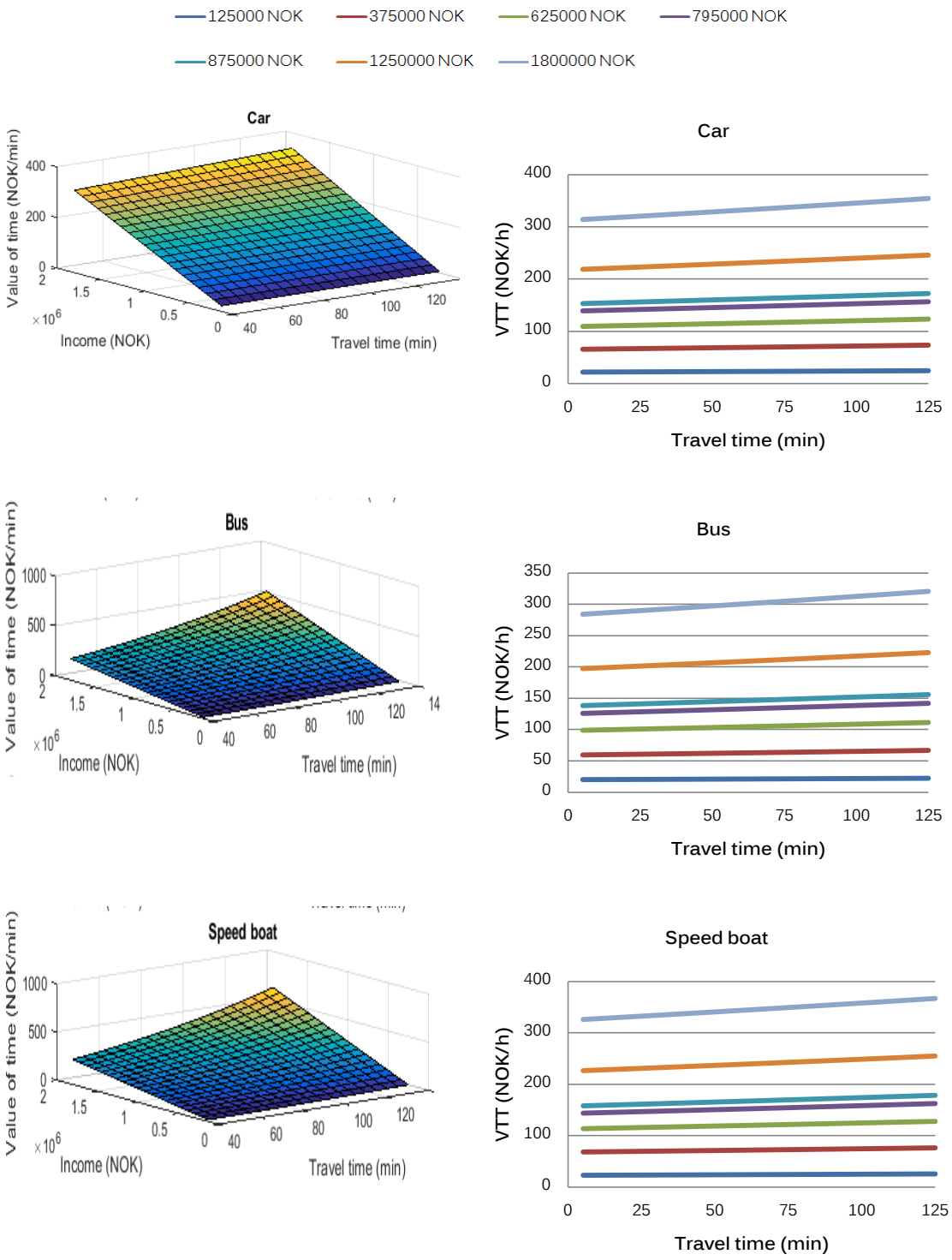


Figure 6.7. VTT for the fixed link situation

In order to compare modes it is also used an average household income of 795 000 NOK/year in Figure 6.8. In this case the VTT follows almost a straight line. The speed boat is the highest while the bus is the lowest.

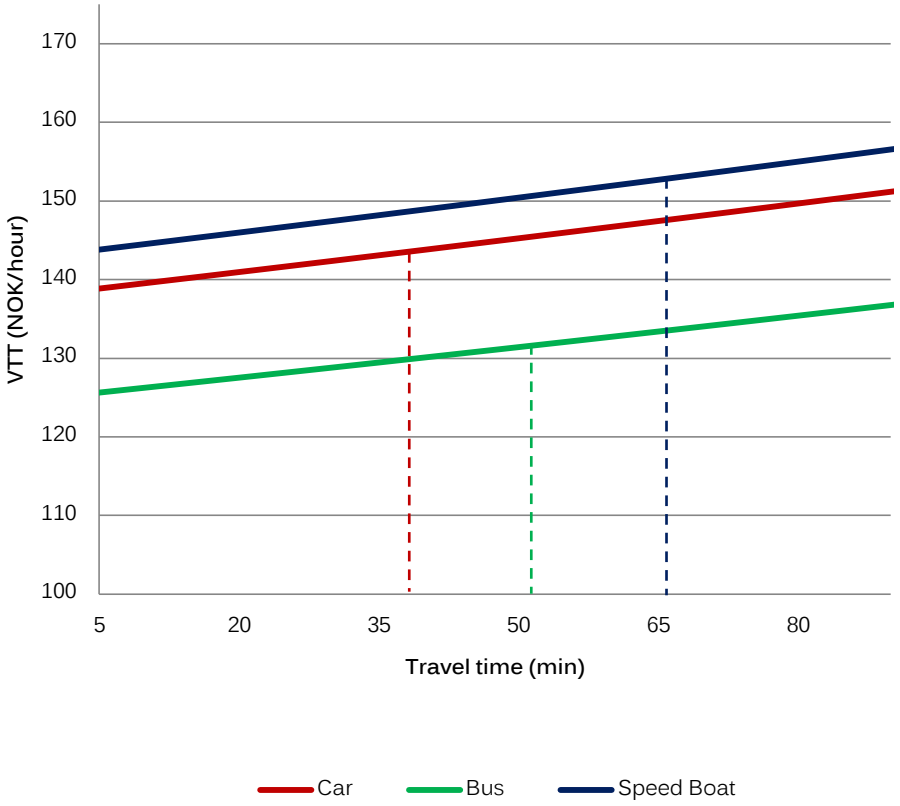


Figure 6.8. VTT for the fixed link situation for an average household income. The vertical lines are the mean value of the travel time for each mode.

6.4.3. The value of travel time by purpose

It was interesting to find out what happened if the VTT by purpose is tried to be found. These models are based on the previous ones but creating a parameter for the travel time for each purpose (commuting, business trips and others). As the Table 6.4 shows, the microeconomic conditions were not satisfied and the parameters were not significant in terms of the t-test. The full models are in the Appendix IX.

Current situation			Fixed link situation		
Parameter	**Purpose**	**t-test**	**Parameter**	**Purpose**	**t-test**
$\boldsymbol{\beta_{TTcar}}$	Commuting	-0.65	β_{TTcar}	Commuting	-1.45
	Business trip	-0.78		Business trip	-0.25
	Other	-1.02		Other	-1.01
$\boldsymbol{\beta_{TTbus}}$	Commuting	-2.05	β_{TTbus}	Commuting	-0.64
	Business trip	+0.32		Business trip	+0.30
	Other	-0.54		Other	-1.20
$\boldsymbol{\beta_{TTsb}}$	Commuting	+0.71	β_{TTsb}	Commuting	+1.58
	Business trip	-0.63		Business trip	-0.33
	Other	-0.90		Other	-0.25

Table 6.4. t-test for the travel time parameters by purpose

6.5. Value of waiting time in the ferry dock

The value of waiting time (VWT) is only possible to calculate for the current situation for the car. With a fixed link, this waiting time will disappear. Moreover, as it is seen in the model, this parameter is only al slightly significant for commuters. The VWT is go applying the Equation 6.10.

$$VWT_j = \frac{\partial V_j / \partial WT_j}{\partial V_j / \partial C_j}$$

Equation 6.10

Therefore, Equation 6.11 shows the VWT for the car in the current situation. It depends on the household income and the waiting time.

$$VWT_{car}[NOK/h] = 60 \frac{\beta_{WT} \cdot \text{income}}{10000\ \beta_C\ (1000 - \text{WT})}$$
$$= 60\ \frac{0.0689 \cdot \text{income}}{484\ (1000 - \text{WT})}$$

Equation 6.11

The Figure 6.9 shows the VWT for an average household income of 795 000 NOK/year. As it is seen the VWT is really low. This means that is not important in terms on mode choice decision. This is logical as almost every user in the survey said that they waited less than 5 min in the ferry dock. The user normally knows the schedule.

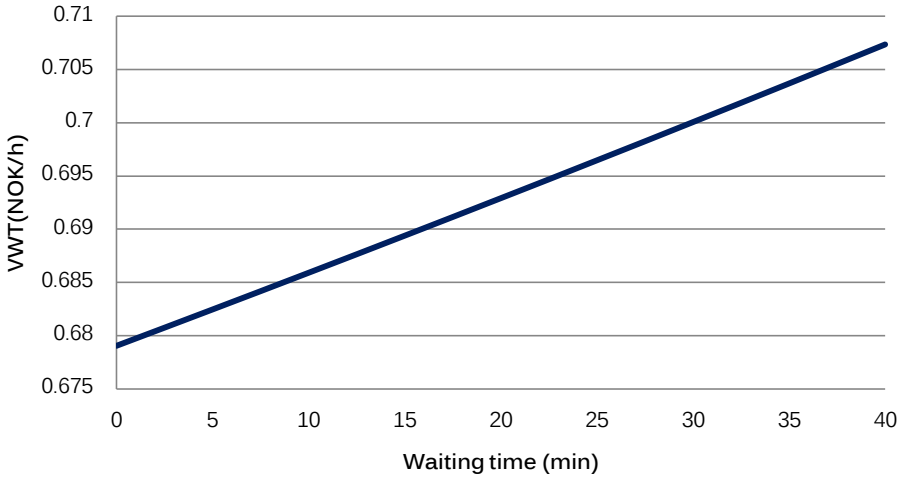


Figure 6.9. VWT in the ferry dock for cars in the current situation

6.6. Value of headway time

The headway time is the time between departures, so it is inversely proportional to the frequency (Equation 6.12). Therefore this value of headway time (VHT) is calculated for the bus and the speed boat.

$$F\ [veh/h] = \frac{60}{HT\ [min]}$$

Equation 6.12

The VHT formula is similar to the VWT formula (Equation 6.13).

$$VHT_j = \frac{\partial V_j / \partial HT_j}{\partial V_j / \partial C_j}$$

Equation 6.13

However, the utilities are function of the frequency, so some transformations are needed. Finally using Equation 6.12, Equation 6.13 and the utility functions, the VHT for the bus and the speed boat are got (Equation 6.14).

$$\mathrm{VHT}[NOK/h] = -60\,\frac{\beta_f \cdot \mathrm{income}}{10000\ \beta_C\ \mathrm{HT}}$$

Equation 6.14

It is possible to relate the VHT with the VWT, but it has to be known the distribution of the user arrivals to the bus stop or speed boat dock. The Table 6.5 shows some examples of arrival functions, but further studies are necessary to decide which one fits better to this case.

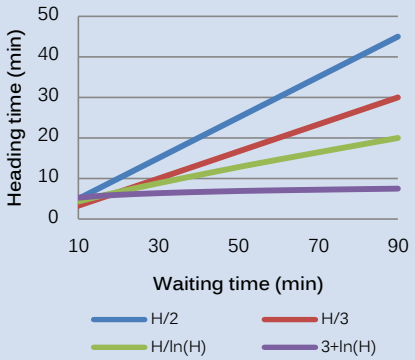
Kind of arrival		Average waiting time	If H = 30 min	Graph
Users don't know the timetable (Random arrival)		$WT = H/2$	WT = 15 min	
Users know the timetable	Linear	$WT = H/3$	WT = 10 min	
	Logarithm	$WT = \frac{H}{\ln(H)}$	WT = 8.8 min	
		$WT = 3 + ln(H)$	WT = 6.4 min	

Table 6.5. Arrival functions examples

6.6.1. Value of headway time for the current situation

The parameter is the same for both bus and speed boat, so the VHT is the same (Equation 6.15).

$$VHT_{bus}[NOK/h] = VHT_{sb}[NOK/h]$$
$$= 60\,\frac{0.159 \cdot \mathrm{income}}{484\ \mathrm{HT}}$$

Equation 6.15

The Figure 6.10 shows the results of the VHT depending on the income. As it is seen the highest is the headway time, the least important is its value.

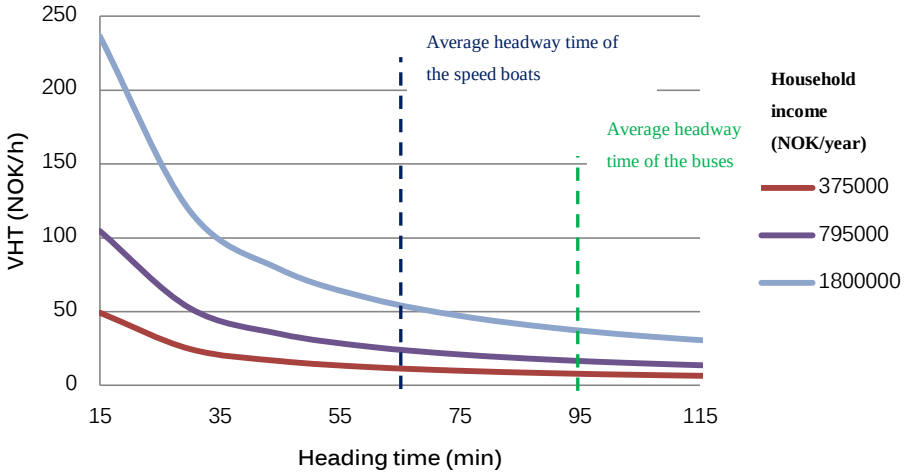


Figure 6.10. VHT for the current situation

6.6.2. Value of headway time for the fixed link situation

In the fixed link situation, the formula is the same but with different parameters (Equation 6.16). As in the current situation, the highest is the headway time, the least important is its value (Figure 6.11).

$$VHT_{bus}[NOK/h] = VHT_{sb}[NOK/h] = 60\ \frac{0.296 \cdot \text{income}}{870\ \text{HT}}$$

Equation 6.16

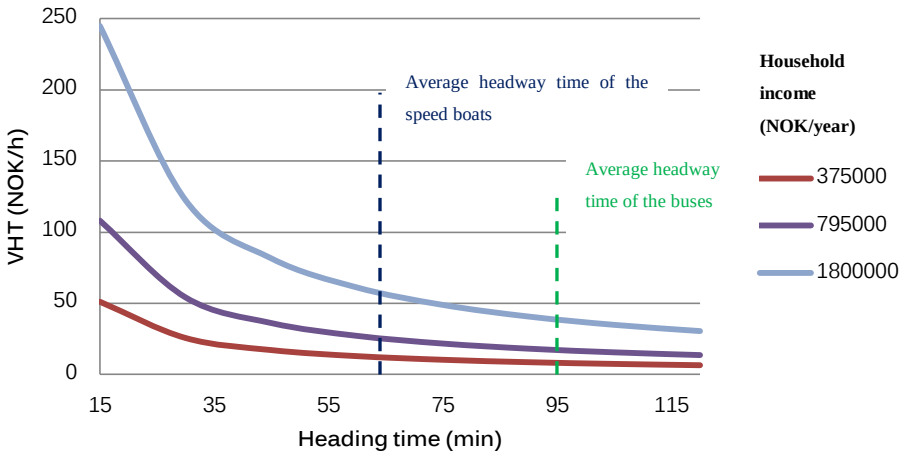


Figure 6.11. VHT for the fixed link situation

6.7. Joined model

Joined the surveys to obtain another model is also possible. The joined models are used if it is got two kinds of data for the same situation. For instance, if there is a RP and a SP for the current situation (Cherchi & Ortúzar 2002). In this case, the RP did not give us reliable results, so there is no reason to try a joined model.

The other possibility could be to do a join model with the two SP. As the situations are different, it is not going to give more reliable information.

7. DISCUSSION

7.1. Survey limitations

Before going deeply in the discussion, it is interesting to remark some limitations of the survey that could influence in the final results. There are mainly five limitations: the location, the season, the simplicity of the games, the sample and the approach to the retired people.

The survey was done in two locations: the ferry Flakk – Rørvik and the speed boat Trondheim – Vanvikan. Despite the fact that the main flows to cross the fjord move through them (73.3%), there are other two ways to take into account: the ferry Valset – Brekstad (15.8%) and the speed boat Trondheim – Brekstad (10.9%). If the survey had been done in all the locations, the results would have probably slightly changed.

Another important point is the season of the year the survey was done. As it is seen in the statistics from the past years, the traffic changed considerably from season to season. There is a drop of the demand in winter and if it was supposed a quasi-constant demand for commuting and business trips, the drop would be probably related to the decrease of leisure trips. Therefore, it will be interesting to do the survey at least in two different seasons of the year: a low demand season and a high demand season. During the low season the VTT would be based more in commuting trips, whereas in the high demand season, the VTT would come from different kinds of trips. It would be interesting compared both VTT in order to quantify how important is the season of the year to do a survey in the Trondheimfjord.

However, probably the main limitation is the design of the survey itself. It was decided to design questionnaire with six simple games (only four attributes) in order to ease the understanding for the user. This is positive in term of getting the willingness to answer of most of the users and not to lose their attention when they were answering the questionnaire.

Nevertheless, it also leads to a lack of information for building the models. According to the results, the alternatives were well chosen, but as it is seen in the models, the choice also depends in other factors. For instance, the alternative of the car depends considerably on the availability of the parking. The Table 7.1 resumes the other attributes that might be included for further studies.

Alternatives	Attributes to add
Car	The availability of parking
	Differ between kinds of car: electric and non-electric
	Differ between driver and passenger in the game
Bus	The walking time to/from the bus stop
	The way of payment: montly card, single ticket,…
Speed boat	The mode to get to the initial dock
	The mode from the final dock to the destination
	The way of payment: monthly card, single ticket,…

Table 7.1. Attributes to add to the games

Adding more attributes and levels to the games will cause a higher number of possible combinations, which brings to more possible games. This affects to the number of games that has to face each user in order to obtain reliable data. The highest is the number of games to answer, the most likely to lose the user attention. The problem is to decide how many games and how many attributes should be included. As it is logical, this depends on each user, but the surveys have to design for every potential user.

This fact also causes that the logical map becomes more complex. Nowadays, the programs that are used are not specific for SP surveys, causing some problems and limitations. This project used an online survey platform called Typeform, which is not able to do this kind of complex logical map. To add this kind of complex games, the program should be able to build itself the games based on the previous answers, which means a specific set of games for each user. Typeform only allows tovupload pictures of the games, so there are specific games for each group of people, but not for each individual. For further studies, it would be crucial to develop new software just for SP surveys.

Finally, another limitation is the sample. It is true that the largest is the sample, the most accurate results will be found. However, as it was studied in the previous section 5.3, the sample is important but not as influential as other aspects. This study achieved a marginal error of 6% with 250 answers. In order to decrease the error, a largest sample is necessary which causes also an extra cost for a project. Figure 7.1 shows the relationship between the marginal error and the sample size. As it is seen there are three areas in the graph. One where the error decreases rapidly if the sample is slightly increased; another where the error decreases slowly with a high increase of the sample; and finally a middle part where the error decrease with a similar increase of the sample. Consequently, working in this middle part gives us a reasonable balance between accuracy and cost.

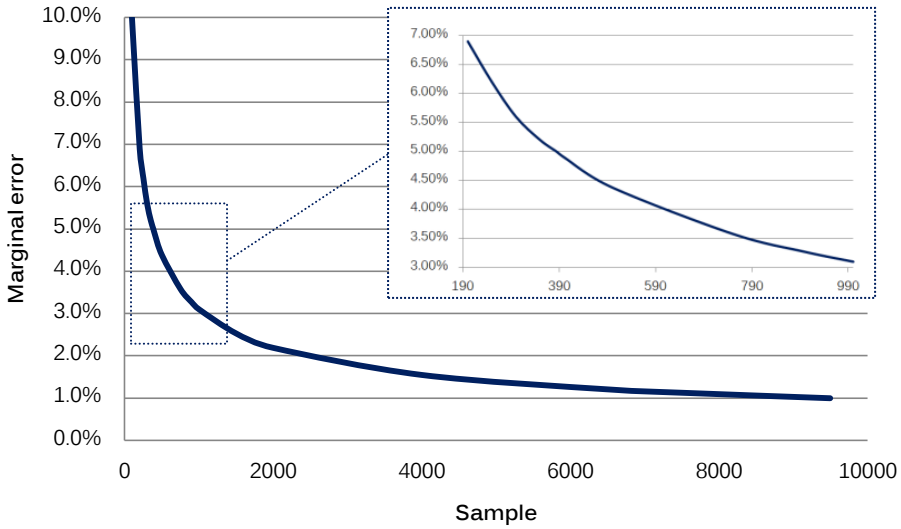


Figure 7.1. Marginal error depending on the sample

In order to see the adequacy of the 6% error of the survey is necessary to analyze how similar the socio-economic figures from the survey and from total population are. SSB provides the data from total population of the municipalities, but this is not exactly the characteristics of the total users that cross the fjord. Table 7.2 shows this comparison in terms of age and household income. The household income is similar in both, being slightly higher in the survey. This is logical as the mobility of high income users is normally higher (Miralles-Guasch & Cebollada 2009). The age distribution is different because there is a lack of respondents in the survey in the age range "Over 67", which was reflected in the models.

AGE		
	SSB	**Survey**
20-44	47%	50%
45-66	35%	43%
Over 67	18%	7%

HOUSEHOLD INCOME		
NOK/year	**SSB**	**Survey**
Less than 499 999	24%	17%
500 000 - 1 000 000	42%	50%
Over 1 000 000	34%	33%

Table 7.2. Comparison between SSB and the survey data. The SSB income data was transform to income before taxes using the average tax rates (Tradingenomics)

It is possible to confirm that the error is small enough to consider the data a reliable representation of the population. However, it could be quite high for finding some specific results for a specific group of the population.

During the whole process, some evidences indicated that the retired people behave in a different way than the rest. First of all, it was the hardest group to approach because they were the most unwilling to do the survey. Only 5.5% of the answers came from retired people which are much less in comparison to how many retired were in the ferries and speed boats during the survey. Moreover, it was detected that the ones that answered, struggled to understand the SP survey or became tired due to the length of the survey. This is easy to detect when a user answered always the first option from a certain point of the survey.

As it was only got few answers from this group, it is not possible to make a specific model for them. For further studies, it could be convenient to consider another way to approach the retired people.

7.2. The RP model limitations

The RP model was not possible to build due to the inconsistency of the parameters (Appendix IX). Some of the policy parameters have a wrong sign and seem insignificant, in terms of the t-test. In contrast with the SP surveys, the RP are easier to answer for the user, so more questions could be added to the questionnaire: the availability of parking, the walking time, the mode to get to the speed boat, etc. Despite this fact, the constant parameters have a high t-test, representing the market share of the mode. This could be due to the size of the sample is three times less than in the SP. Each user answer three games in each SP, which makes a sample of 750 observations per SP, whereas for the RP it is only possible to obtain one answer per user, 250. This could too small to find a proper model. Moreover, there is a considerably number of users that only have one alternative available. In some of these cases, there could be more alternatives but the users do not see them as possible alternatives due to their high cost or long travel time. As they only gave the information of one alternative, they do not provide information for the model.

Despite the model is not working for estimate the values of time or the mode distribution, it is possible to seen some common conclusions in all the try outs. For instance, the parameter that considers the availability of free parking, as well as the ones which takes into account how to get to the speed boat dock were quite significant.

7.3. The effect of the fixed link

One of the main goals of the study is detect how a fixed link will change the behavior of the users. As it is seen, the value of travel time differs between the current situation and the fixed link situation, so it is important to search for the reasons of this phenomenon. The main reasons may be the 24/7 availability and the time savings. These two reasons are justified in the models.

The availability is reflected in the housing parameters in the models. Both models included a dummy parameter about where the commuters live: the Trondheim side of the fjord and the other side of the fjord. While in current situation this parameter is quite significant, in the fixed link situation this parameter could be neglected (it was not neglected just to reflect the difference between models).Table 7.3 shows the t-test and the probability of being significant of both parameters. Both probabilities are lower than 95% but the one for the current situation is way closer.

Housing parameters β_{Hou}	**t-test**	**Prob. of being significant**
Current situation	1.30	81%
Fixed link situation	0.27	22%

Table 7.3. Comparasion of the housing parameters before and after building a fixed link

The availability 24/7 causes that it does not matter the side of fjord to live for commuters, which could lead to an increase of the population at the other side of the fjord. Moreover, the travel time savings will influence in the place of residence, enlarging the metropolitan area of the city.

Maps in the Figure 5.2 show the travel time differences for a car trip to/from Trondheim nowadays and with a fixed link. If the travel time tolerance of the commuters is at least 2 hours, in the fixed link situation there is a considerably large are at the other side of the fjord below 60 minutes driving to Trondheim. Joining this to a decrease of the VTT, it could lead to new urban developments at the other side, turning it into the metropolitan area of Trondheim.

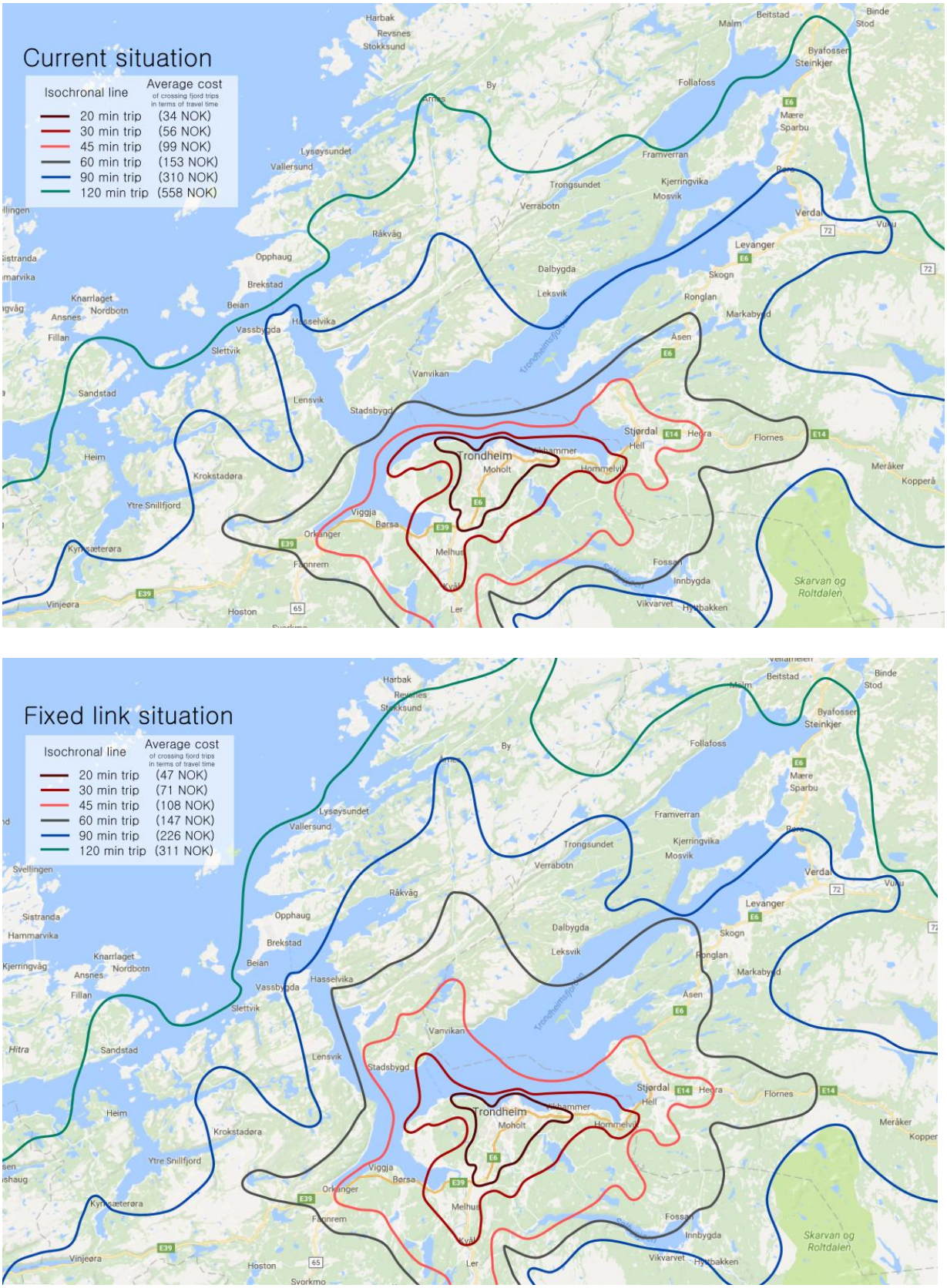


Figure 7.2. Isochronal lines maps for car trips from Trondheim before and after building a fixed link between Flakk and Rørvik. An average travel time saving of 30 minutes was supposed.

Despite the increase of availability, the cost of crossing the fjord would be similar, except for electric cars. While the electric cars have to pay a ferry ticket (lower than the normal cars), they have not to pay the tolls. Therefore, if there is a bridge or a tunnel, crossing the fjord by an electric car would be free. When the ferry was free for electric cars, it was detected a growth of the population at the other side, so it could happen the same if the fixed link is built. This is an important aspect to taking into account for further studies due to the high number of electric vehicles in Norwegian cities.

The change of the VTT is another consequence of a fixed link. As the results the VTT depends on the total travel time, the time savings will affect to the VTT. Figure 7.3 shows the VTT for the three modes before and after building a fixed link for an average household income.

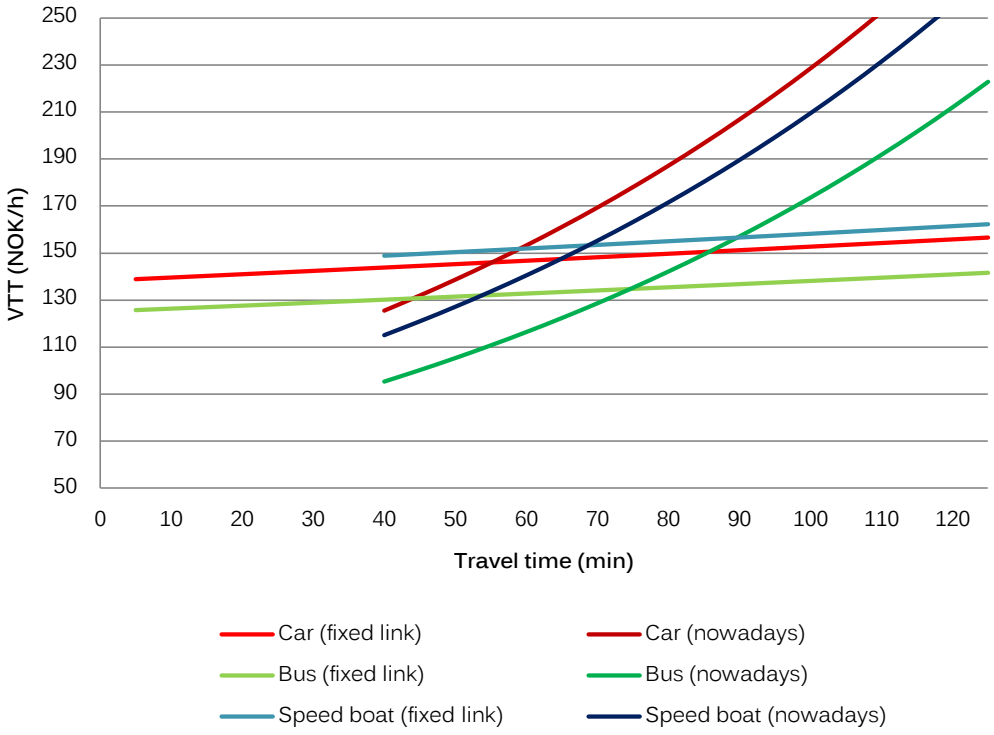


Figure 7.3. VTT for the different modes before and after the building a fixed link for an average household income.

The graphs about the current situation start in 40 min because it is the minimum travel time that includes a fjord crossing. Same happened to the speed boat with a fixed link.

The speed boat VTT should be similar before and after for a mean travel time. The mean travel time is 66 minutes, being the VTT 148 NOK/h nowadays and 151 NOK/h with a fixed link. The small difference could be because the modes are not independent. This is show in the model with a parameter of correlation, which is slightly significant.

The duration of the bus and car trips before and after the fixed link changes considerably.

Table 7.4 displays the VTT for the mean travel time and household income before and after building a fixed link. The VTT of the modes, which are affected directly by the fixed link, decreases, around 14% for the car and 10% for the bus. This means that the VTT for the travel time that the users spend crossing the fjord with a ferry is higher than driving in the road. For instance, the speed boat has a higher VTT than the other modes with a fixed link because it is still depends on an unfixed way to cross the fjord.

	Current situation		**Fixed link situation**	
	Mean travel time (min)	VTT (NOK/h)	Mean travel time (min)	VTT (NOK/h)
Car	69	167	38	143
Bus	81	144	52	131
Speed boat	66	148	66	151

Table 7.4. VTT before and after building the fixed link for a mean travel time and household income

The VHT, displayed in Figure 7.4, is almost the same before and after the fixed link. The VHT for the current situation is 3% lower than for a fixed link situation. This could be because the models have always a marginal error, as well as the correlation between modes.

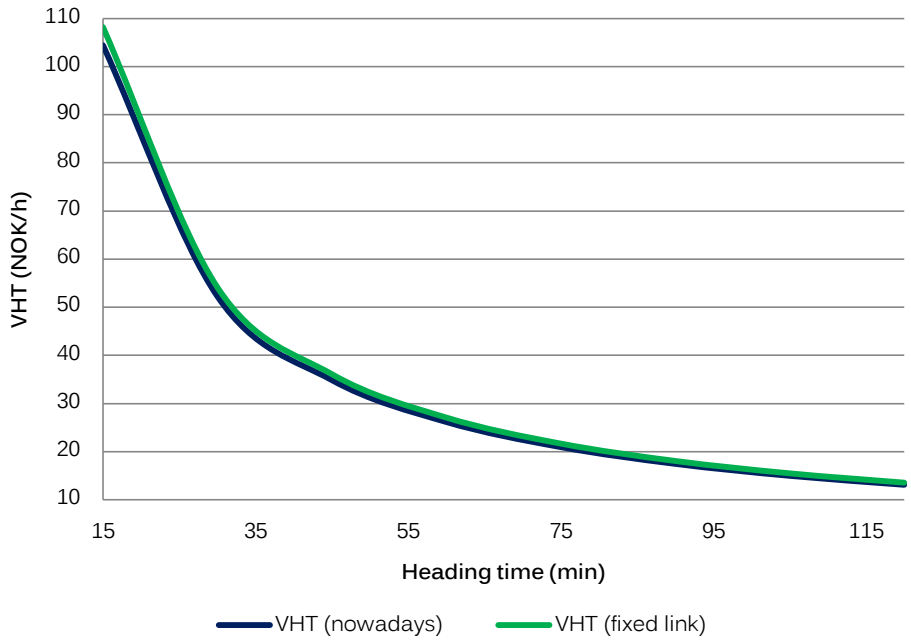


Figure 7.4. VHT for the bus and speed boat for a mean household income before and after building a fixed link

7.4. The value of time by purpose

As it was explained in the research questions, it is interesting to study how the value of travel time varies between population groups. The goal was detecting if there are differences between modes, distances and purposes. For the two first statements, it is shown in the previous sections the answers. In section 6.4.3, models with parameters of travel time for different purpose were designed. The t-tests of those parameters were below 1.96, which means that they are not significant for the utility. Therefore, it is possible to assume a unique VTT for all the purposes

The insignificancy of the parameters could be also related to the size of the sample. It is an acceptable sample for an aggregated VTT, but if the sample is divided in groups by purposes, the size of these groups is not reliable enough. The case of the VHT was already done in the original models. As it is seem in the models, the headway time is only significant for commuters. Even for commuters, the t-test is below 1.96 (0.53 for the current situation and 0.94 for the fixed link situation), so it is slightly important

7.5. Comparison of the results with the TØI report

The Transport Økonomisk Institutt (TØI) value of time report, published in 2015, provided some interesting data to compare with the results of this study. While TØI calculated the VOT, this studied shows the VTT, which includes the whole trip (waiting time + travel time). In order to compare them, some assumptions are going to be done.

Moreover, the TØI report values depends on the distance of the trip, whereas the values in this studies depends on the total travel time. Therefore, in order to compare both studies, a relation between the length and the travel time is necessary: the average speed of the trip (Equation 7.1).

$$TT\ [min] = \frac{D\ [Km]}{S\ [Km/h]}60 \qquad D = \frac{TT \cdot S}{60}$$

Equation 7.1

It is assumed an average speed of 50 Km/h for the car and 45 Km/h for the bus.

7.6.1. Comparison of the car trips

In the current situation, the VTT mixes two modes, car and ferry. The TØI report has a VOT for ferry and another one for cars. However as the ferry travel time is known (around 35 min), it is possible to estimated mixed VOT (Equation 7.2). In this case, as the VWT could be neglected, the VOT and the VTT is the same.

$$Trip\ cost_{TØI} = \frac{35\ min}{60} VOT_{ferry,TØI} + \frac{(OT - 35)}{60} VOT_{car,TØI}$$

Equation 7.2

OT = onboard time (min)

When a fixed link is built, the car trips will not depend any more on the ferries. That turns the trip into a regular road trip, so the VTT could be compared to the VOT of the TØI report.

Figure 7.5 shows both comparisons. The trip cost in the fixed link situation for a car trip is really similar in both studies. The average of the trip cost is 156 NOK in this study and 141 NOK in the TØI report. This difference could be due to the effect of "new infrastructure". This means that the users not only will value the travel time savings, but also others problems related to the ferries. Users see the ferry as a barrier or a discomfort step in their trip. This difference should be reducing after some years, when the users get used to the fixed link and the "new infrastructure" effect will disappear.

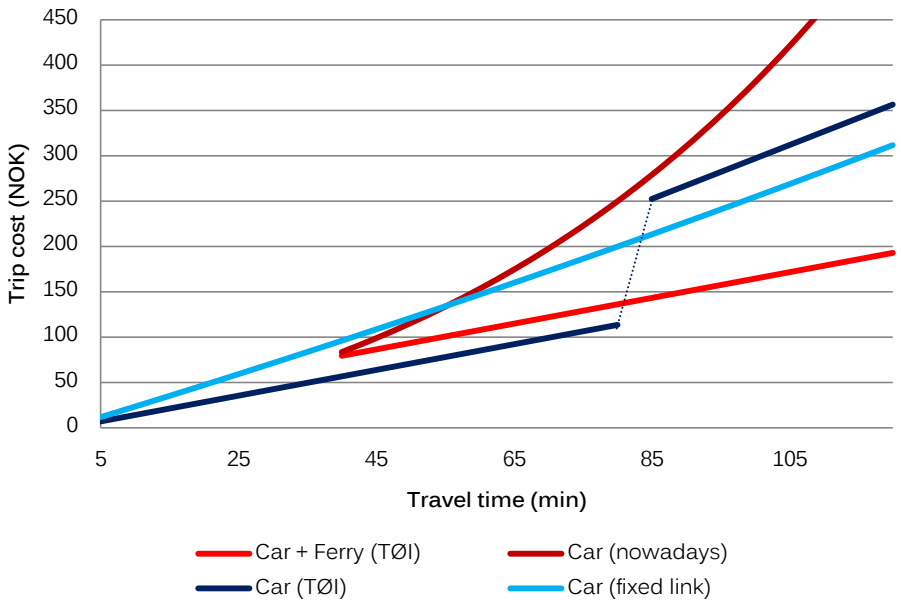


Figure 7.5. Comparison with the TØI report of the VTT for the car.

However, there is a quite high difference for the nowadays situation. The trip cost of this study is higher than the TØI report one, which could be due to the synergy of using ferry and car in the same trips. This means that is not the same calculating the value of the trip dividing it in separated pieces (ferry and car) or getting the value as one piece. The fact of taking a ferry probably produces to the user more inconvenience than just the longer travel time and the waiting time. For instance, a low availability could make the trip much more expensive.

7.6.2. Comparison of the bus trips

The comparison of the bus is more complex because it is not possible to neglect the VHT and assumed that VOT is equal to VTT. However assuming that VTT is the addition of VHT and VOT, it is possible to compare them (Equation 7.3).

$$VTT \cdot TT = VHT \cdot HT + VOT \cdot OT$$

Equation 7.3

TT = total travel time; HT = headway time; OT = onboard time

$$VOT = \frac{VTT \cdot TT - VHT \cdot HT}{OT} = \frac{VTT \cdot TT - VHT \cdot HT}{TT - WT}$$

Equation 7.4

In the Equation 7.4, all the values are known except the waiting time, which has to be supposed. In the survey, most of the users answered that wait less than 10 min, so choosing a waiting time between 5 and 10 minutes should work.

As it happened with the car, when a trip is composed by bus and ferry, it is necessary to disaggregate the onboard time cost in two values, one for the ferry and one for the bus (Equation 7.5).

$$Onboard\ time\ cost_{T\emptyset I} = \frac{35\ min}{60} VOT_{ferry,T\emptyset I} + \frac{(OT\ [min] - 35)}{60} VOT_{bus,T\emptyset I}$$

$$= \frac{35\ min}{60} VOT_{ferry,T\emptyset I} + \frac{(TT - WT - 35)}{60} VOT_{bus,T\emptyset I}$$

Equation 7.5

Doing all this calculations is possible to compare both studies in Figure 7.6. In the fixed link situation, the average onboard time in this study is 125 NOK and in the TØI report 93 NOK. This difference is higher than the in the car trips. It could be due to the effect of "new infrastructure", which would affect strongly to the public transport. The users may penalize the need of using different public transport modes in a single trip, so transforming these trips to trips without transfers would be visible as a considerably positive change.

In the current situation, the difference between the study and the TØI report are higher than in the fixed link situation. As in the car trips, this could be due to the synergy of combined trips bus+ferry. The difference is smaller than in the car trips because, in this case, the availability is limited by the bus schedule, not the ferry.

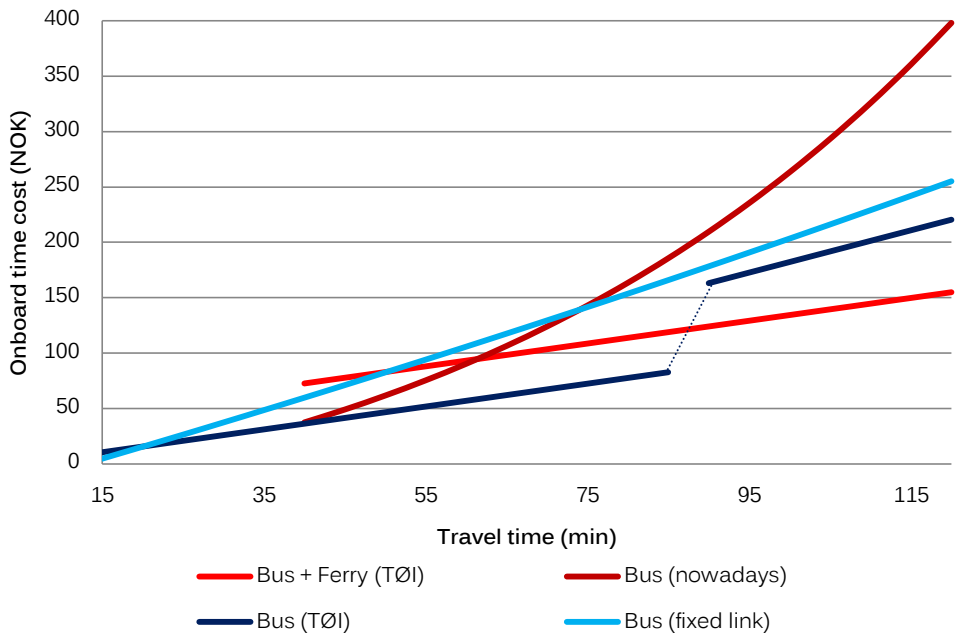


Figure 7.6. Comparison with the TØI report for the bus trips

7.6.3. Comparison of the speed boat trips

The comparison of the speed boat trips is quite complicate due to the VTT is composed by many values: the VOT, the VHT and the values of time of the other modes that are used to get to the speed boat dock. The only comparison could be done with a trip of around 35 min due to the onboard time of the speed boat is 30 minutes, so the VOT is closed to the VTT, as Table 7.5 shows.

TØI report	**122 NOK/h**
Current situation	119 NOK/h
Fixed link situation	148 NOK/h

Table 7.5. Comparison with the TØI report of the VOT of the speed boat

The current situation has almost the same value as the TØI report, while in the fixed link situation the value is much higher. This could be because the other two modes will improve their situation, while the speed boat will not change. In terms of time, the demand will drop if a fixed link is build.

8. CONCLUSION

The study of the value of time in transport is a highlight topic nowadays due to the importance in the development of new infrastructures. This process report tries to explain step by step how to achieve the answers of the research questions; in this case, calculating the value of travel and waiting time and its affection in a ferry replacement project.

The survey has some limitations which some of them could be avoided in order to improve the results. For instance, part of the RP survey could have been left out and the user could have used that answer time to face more games. Increasing the number of games would have provided a large number of answers. Therefore, it would have been better just to focus the SP surveys to obtain a good model to calculate the value of time. If an accurate mode distribution had been wanted to achieve, the RP survey should have been longer. This is possible to know after doing the survey, so for future surveys it would be convenient to have a single goal: the value of time or the mode distribution.

However, there are other limitations which are not possible to handle in a master thesis due the lack of time or inexistence of previous information. For instance, if a value of time depending by purpose, it would be necessary a large sample as well as doing the survey in different season. If an enough number of leisure trips had been wanted to achieve, it would have been necessary to ask in summer.

The survey online platform was another limitation as there is not any platform for specifically for state preference surveys. If one is created, the potential of these surveys will increase exponentially. The individualization and personalization of the games will provide a high knowledge of the users' perception, not only in the field of transport.

Nevertheless, the survey has some remarkable strengths that made possible to achieve decent results. The questionnaire was properly designed as they were not misunderstandings and the users could face the games correctly. The choice of the attributes and levels gave, as a result, acceptable models.

It was calculated the VTT of trips that include a fjord crossing, so more than one mode of transport is used. It seems like there is a synergy between VTT of the modes, not being the same as the addition of both modes VTT separately.

Moreover, the fjord crossing trips VTT will suffer a significant change if a fixed link is built, involving many consequences such as the influence in the benefits in a socio-economic profitability analysis of this infrastructure. Furthermore, this decrease in the VTT could lead to new urban developments, creating new suburbs and enlarging the metropolitan area of the city.

This study also gave much information about how to perform a survey for fjord crossings in Norway. It shows the high potential of used state preference and mixed logit model in terms of value of time calculation. Using a powerful tool as Phytonbiogeme and a proper new survey platform, it will possible to obtain very accurate models in a high efficiently way.

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Appendices

APPENDIX I.

NTNU
Faculty of Engineering Science and Technology
Institute of Civil and Environmental Engineering

MASTER DEGREE THESIS

(TBA4945 Transport, masteroppgave)

Spring 2017
for
Pablo Urzainqui Merino

The value of travel and waiting time for ferry passengers in fjord crossings. The case of the Trondheimfjord, Norway

BACKGROUND

The ferry replacement projects are and will be one of the highest costs in the road investments in Norway and the travel time savings are one of their largest benefits. These benefits come from the consumer surplus, so, in order to calculate it, it is necessary to know the value of travel and waiting time before and after the implementation of the projects. This could provide the decision makers with valuable information. The value of travel and waiting time are already calculated for other transportation projects, but there are few studies specifically for the fjord crossings.

TASK

Task description

Conduct a research work about the value of travel and waiting time in fjord crossing trips, which has to be presented as a scientific article.

Objective and purpose

The objective is obtaining the value of travel and waiting time for trips that includes a fjord crossing in different situations. The research is based in data which is collected by a survey.

Subtasks and research questions

Through a stated preference survey, the value of travel and waiting time is calculated in different situations in order to investigate the affection of a ferry replacement in a fjord.

General about content, work and presentation

The text for the master thesis is meant as a framework for the work of the candidate. Adjustments might be done as the work progresses. Tentative changes must be done in cooperation and agreement with the professor in charge at the Department.

In the evaluation thoroughness in the work will be emphasized, as will be documentation of independence in assessments and conclusions. Furthermore the presentation (report) should be well organized and edited; providing clear, precise and orderly descriptions without being unnecessary voluminous.

The report shall include:

- Standard report front page (from DAIM, http://daim.idi.ntnu.no/)
- Title page with abstract and keywords.(template on: wiki page for students at CEE Departement)
- Preface
- Summary and acknowledgement. The summary shall include the objectives of the work, explain how the work has been conducted, present the main results achieved and give the main conclusions of the work.
- The main text.
- Text of the Thesis (these pages) signed by professor in charge as Attachment 1.

The thesis can as an alternative be made as a scientific article for international publication, when this is agreed upon by the Professor in charge. Such a report will include the same points as given above, but where the main text includes both the scientific article and a process report.

Advice and guidelines for writing of the report is given in "Writing Reports" by Øivind Arntsen, and in the departments "Råd og retningslinjer for rapportskriving ved prosjekt og masteroppgave" (In Norwegian) located at wiki page for students at CEE Departement

Submission procedure

Procedures relating to the submission of the thesis are described in DAIM (http://daim.idi.ntnu.no/). Printing of the thesis is ordered through DAIM directly to Skipnes Printing delivering the printed paper to the department office 2-4 days later. The department will pay for 3 copies, of which the institute retains two copies. Additional copies must be paid for by the candidate / external partner.

The master thesis will not be registered as delivered until the student has delivered the submission form (from DAIM) where both the Ark-Bibl in SBI and Public Services (Building Safety) of SB II has signed the form. The submission form including the appropriate signatures must be signed by the department office before the form is delivered Faculty Office.

Documentation collected during the work, with support from the Department, shall be handed in to the Department together with the report.

According to the current laws and regulations at NTNU, the report is the property of NTNU. The report and associated results can only be used following approval from NTNU (and external cooperation partner if applicable). The Department has the right to make use of the results from the work as if conducted by a Department employee, as long as other arrangements are not agreed upon beforehand.

Tentative agreement on external supervision, work outside NTNU, economic support etc.
Separate description is to be developed, if and when applicable. See wiki page for students at CEE Departement for agreement forms.

Health, environment and safety (HSE) http://www.ntnu.edu/hse
NTNU emphasizes the safety for the individual employee and student. The individual safety shall be in the forefront and no one shall take unnecessary chances in carrying out the work. In particular, if the student is to participate in field work, visits, field courses, excursions etc. during the Master Thesis work, he/she shall make himself/herself familiar with "Fieldwork HSE Guidelines". NTNU student HSE policy is fonud here: https://innsida.ntnu.no/hms-for-studenter

If you are doing labwork for your project og master thesis, you have to take an online e-course in lab HSE. To get link, email kontakt@ibm.ntnu.no.

The students do not have a full insurance coverage as a student at NTNU. If you as a student want the same insurance coverage as the employees at the university, you must take out individual travel and personal injury insurance.

Startup and submission deadlines
Startup and submission deadlines are according t o information found in DAIM.

Professor in charge: Trude Tørset

Other supervisors: María Díez Gutiérrez

Department of Civil and Environmental Engineering, NTNU
Date: 06.06.2017

Trude Tørset

APPENDIX II. Analysis of the AtB data

The source of all the data is AtB Trondheim.

Regional buses

350 Trondheim – Rissa – Osen

Data from 18/01/2016 till 19/06/2016

	Total per day (whole period)	Week distribution	Passengers per day
Mandag	3103	15%	141,0
Tirsdag	3030	15%	137,7
Onsdag	3060	15%	139,1
Torsdag	3018	15%	137,2
Fredag	4131	20%	187,8
Lørdag	1689	8%	76,8
Søndag	2325	11%	105,7

Total trips	Average per day	Average per week	Average per month
20356	132,2	925,3	4036,5

January	1821	Only from the 18th
February	4058	
Mars	3988	
April	4062	
May	4038	
June	2389	Only til 19th

410 Trondheim – Orkanger (via Fv800)

Data from 18/01/2016 till 19/06/2016

	Total per day (whole period)	Week distribution	Passengers per day
Mandag	15103	16%	686,5
Tirsdag	15790	17%	717,7
Onsdag	16194	18%	736,1
Torsdag	15519	17%	705,4
Fredag	15002	16%	681,9
Lørdag	9776	11%	444,4
Søndag	4483	5%	203,8

Total trips	Average per day	Average per week	Average per month
91867	596,5	4175,8	17958,25

January	8990	Only from the 18th
February	18199	
Mars	17245	
April	18882	
May	17507	
June	11044	Only til 19th

421 Orkanger – Lensvik – Valset

Data from 18/01/2016 till 19/06/2016

	Total per day (whole period)	Week distribution	Passengers per day
Mandag	2041	21%	92,8
Tirsdag	1890	19%	85,9
Onsdag	1926	20%	87,5
Torsdag	2095	21%	95,2
Fredag	1837	19%	83,5
Lørdag	0	0%	0,0
Søndag	0	0%	0,0

Total trips	Average per day	Average per week	Average per month
9789	63,6	445,0	1907,5

January	1223	Only from the 18th
February	1687	
Mars	1953	
April	2169	
May	1821	
June	936	Only til 19th

450 Trondheim – Stadsbygd – Rissa – (Rakvag)

Data from 18/01/2016 till 19/06/2016

	Total per day (whole period)	Week distribution	Passengers per day
Mandag	6412	19%	291,5
Tirsdag	6584	20%	299,3
Onsdag	6476	19%	294,4
Torsdag	6334	19%	287,9
Fredag	6918	21%	314,5
Lørdag	0	0%	0,0
Søndag	702	2%	31,9

Total trips	Average per day	Average per week	Average per month
33426	217,1	1519,4	6528

January	3096	Only from the 18th
February	6630	
Mars	6308	
April	6904	
May	6270	
June	4218	Only til 19th

552 Vanvikan – Rissa

Data from 18/01/2016 till 19/06/2016

	Total per day (whole period)	Week distribution	Passengers per day
Mandag	481	14%	21,9
Tirsdag	769	22%	35,0
Onsdag	749	22%	34,0
Torsdag	724	21%	32,9
Fredag	698	20%	31,7
Lørdag	0	0%	0,0
Søndag	0	0%	0,0

Total trips	Average per day	Average per week	Average per month
3421	22,2	155,5	673,75

January	374	Only from the 18th
February	637	
Mars	701	
April	720	
May	637	
June	352	Only til 19th

Speed boats

800/805 Trondheim – Brekstad – Kristiansund

Data from 01/01/2013 till 31/08/2016

Total passengers from one zone to the other

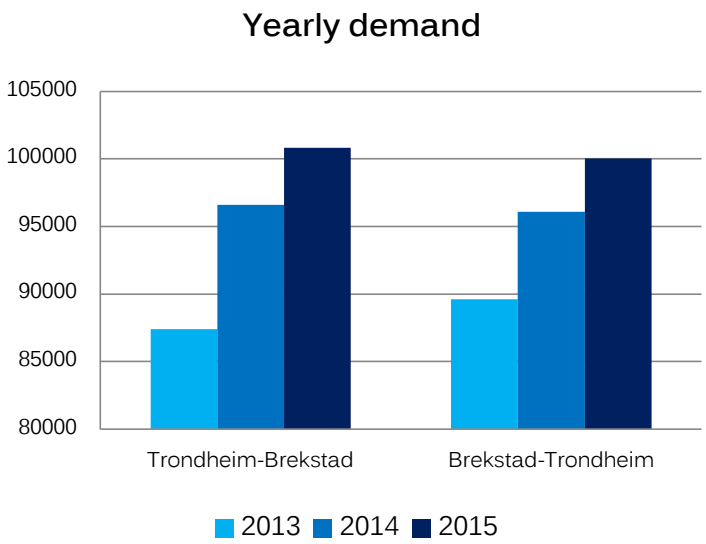
	2013	2014	2015	2016*
Trondheim-Brekstad	87406	96598	100832	72484
Brekstad-Trondheim	89600	96083	100027	72486

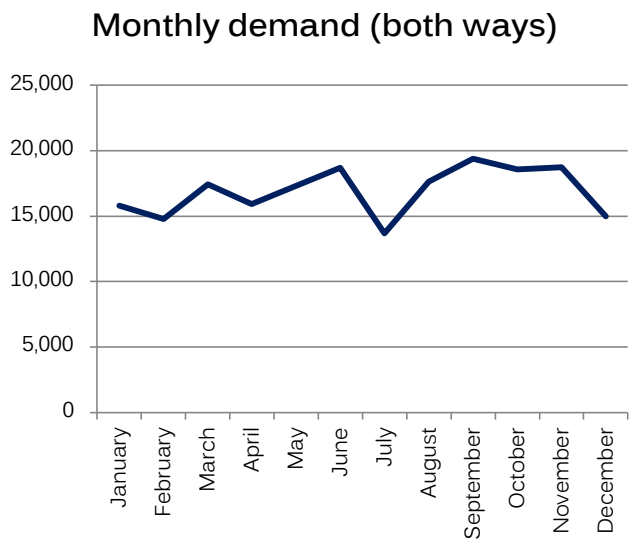
**til August*

2015

	January	February	March	April	May	June	July	August
Trondheim-Brekstad	7,825	7616	8786	7946	8702	9326	6684	8870
Brekstad-Trondheim	7984	7158	8622	7964	8614	9375	7009	8750

	September	October	November	December
Trondheim-Brekstad	9610	8976	9111	7380
Brekstad-Trondheim	9772	9578	9599	7602





Total passengers in the lines 805 and 800

(Regardless of where they got on or off)

Week 19, 2015

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total week
805	Trondheim-Brekstad	204	210	243	207	313	110	107	1394
	Brekstad-Trondheim	263	240	259	247	233	127	53	1422
800	Trondheim-Kristiansund	343	341	256	255	316	169	0	1680
	Kristiansund-Trondheim	312	320	320	301	482	131	53	1919

Week capacity

		Capacity	Passenger	Occupancy rate
805	Trondheim-Brekstad	4915	1394	28%
	Brekstad-Trondheim	4655	1422	31%
800	Trondheim-Kristiansund	4950	1680	34%
	Kristiansund-Trondheim	4950	1919	39%

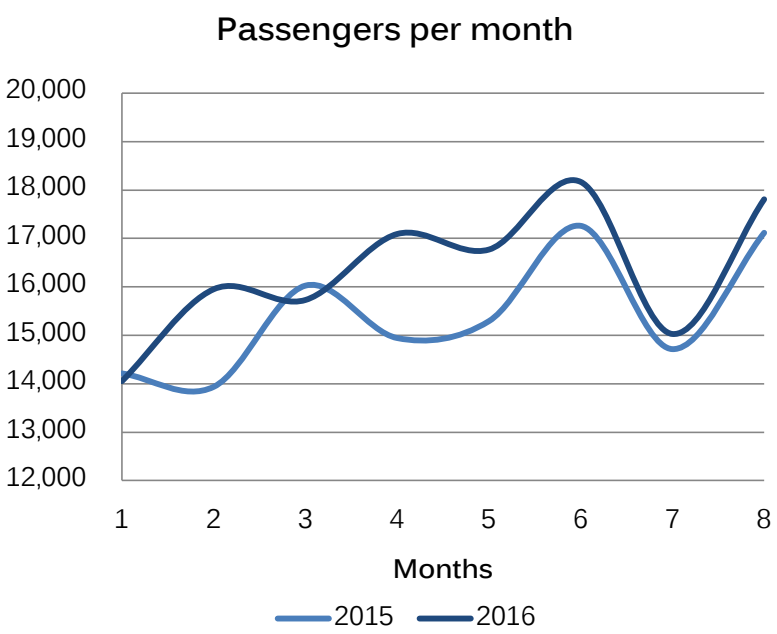
810 Trondheim – Vanvikan

Data from 01/01/2016 till 31/08/2016

	Average per day of the week	Week distribution
Mandag	608	16%
Tirsdag	608	16%
Onsdag	608	16%
Torsdag	608	16%
Fredag	608	16%
Lørdag	295	8%
Søndag	395	11%

Total trips	Average per day	Average per week	Average per day
130608	18658	3732	18658

	2015	2016
January	14210	14056
February	13933	15953
Mars	16021	15731
April	14940	17092
May	15288	16771
June	17255	18167
July	14711	15030
August	17111	17808
September	17749	
October	17771	
November	16988	
Decemer	14846	
TOTAL	190823	130608



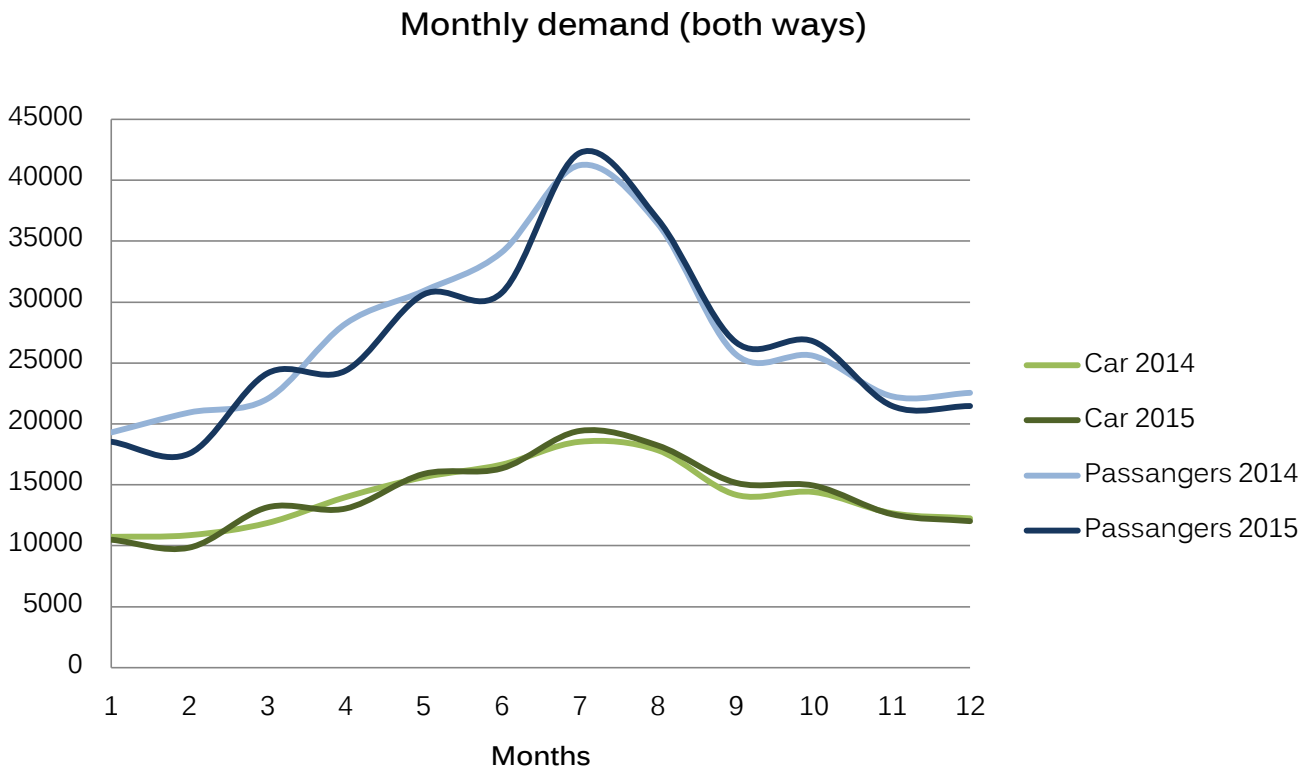
Ferries

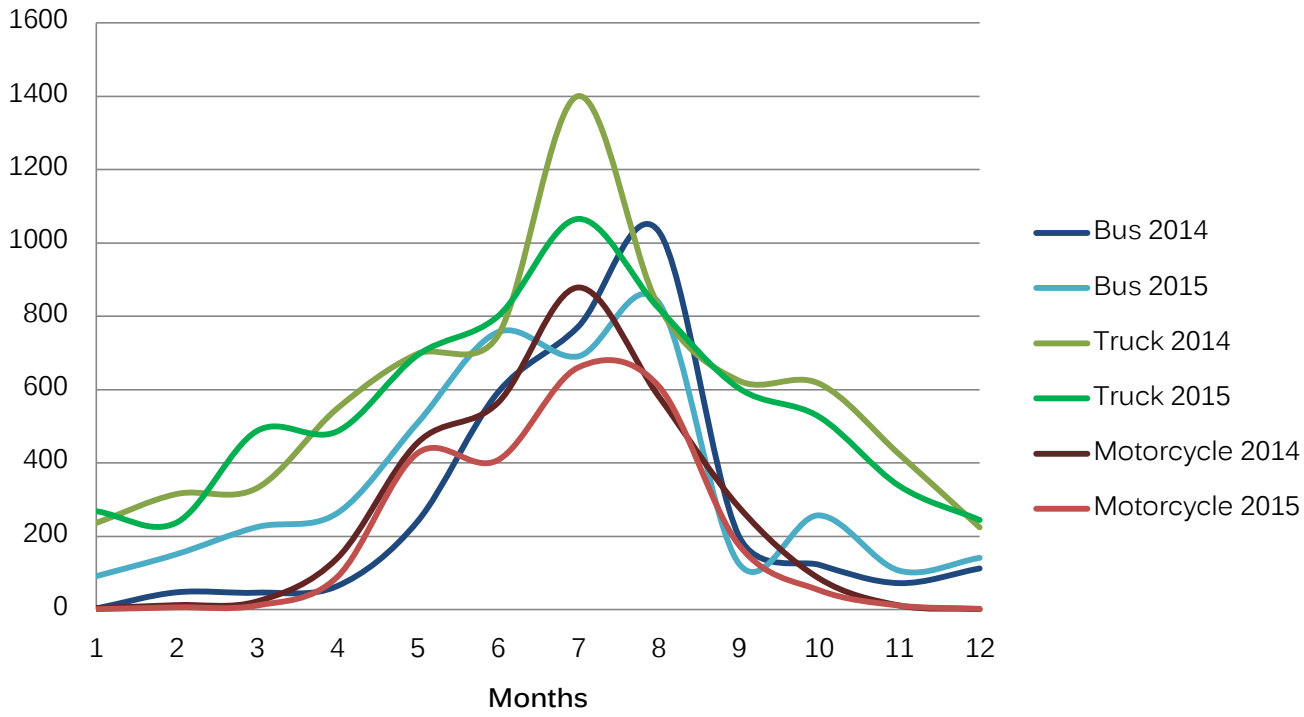
870 Balset – Brekstad

Data from 01/01/2014 till 31/08/2015. The distribution between directions is around 50%, so the following data includes the total amounts (both directions together)

	Car		Bus		Truck		Motorcycle		Passengers	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
January	10731	10508	4	91	237	268	4	1	19314	18541
February	10864	9858	48	151	316	237	12	6	20949	17564
March	11867	13158	47	225	332	487	22	11	22072	24155
April	13980	13059	65	263	549	486	140	89	28238	24363
May	15621	15895	241	509	698	694	455	427	30930	30630
June	16652	16352	592	757	747	800	564	408	34099	30759
July	18525	19425	771	691	1400	1066	879	661	41259	42251
August	17833	18232	1032	839	829	823	583	611	36449	36806
September	14182	15174	202	126	625	604	280	177	25724	26709
October	14404	14938	123	257	617	526	85	53	25592	26761
November	12667	12595	73	106	424	337	11	11	22284	21482
December	12250	12027	113	141	225	244	1	2	22565	21469
TOTAL	169576	171221	3311	4156	6999	6572	3036	2457	329475	321490

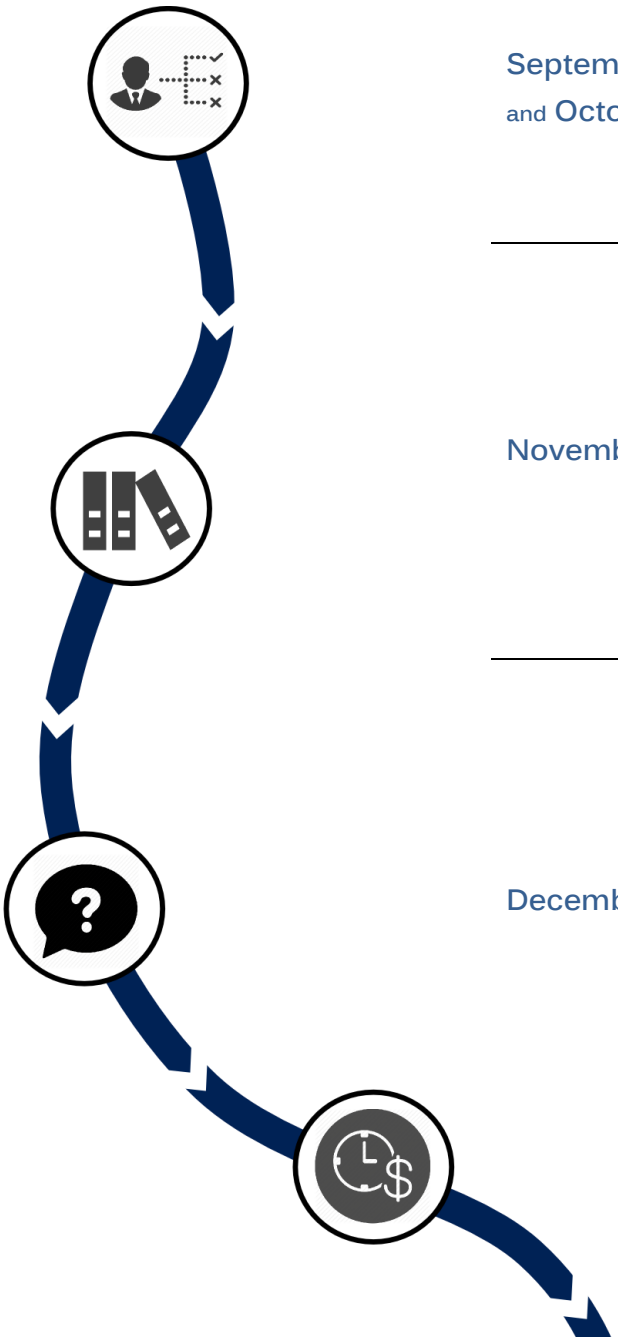
	2014	2015
Total vehicles	182922	184406
Total passengers	476646	482280


Monthly demand (both ways)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1
2
3
4
5
6
7
8
9
10
11
12
Months
Car 2014
Car 2015
Passangers 2014
Passangers 2015


1600
1400
1200
1000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
11
12
Months
Bus 2014
Bus 2015
Truck 2014
Truck 2015
Motorcycle 2014
Motorcycle 2015

APPENDIX III. Time plan

The time plan is divided in four main blocks. The first is related with the previous research of the topic, the stated of art, and setting the research questions. Then, the survey was designed and done. Afterwards, the models were built with the data from the survey. Finally, the results are analyzed and discussed.



2016

September and October	Topic decision	During these two months the topic should be decided. At the beginning a general topic is chosen. After that, the details are defined till a precise topic is got.
November	Literature and References Starting with the introduction. SotA	During the definition of the topic, literature is needed. However, it is not enough. Once the topic is decided, more references should be read. Reading articles is a good point to start with the State of the Art (SotA) or introduction.
December	Finishing the SotA Abstract Research questions Time plan and budget 20th Dec.	Once the references are read and the highlights are taken, the SotA should be written. It has to be really precise because it will define the whole Master Thesis. When the introduction is clear the goals should be set, which are the research questions. After that, it is a good point to write the abstract and to do the time plan and the budget PROJECT REPORT

2017

January

Methodology

The methodology consist in the way of achieve the answer to the research questions. In this case is focused in getting the value of time of fjord crossing trips. In order to get it, it is necessary to specify the utility functions for the different modes in the different situations: before and after the ferry replacement.

February

Preparing the survey

It is decided that the data is collected by both reveled preference (RP) survey and state preference survey (SP).

The design of the survey is the key to get proper results, so it takes some time. It is really important to show the proper questions to the user.

Survey. Phase 1

Once it is designed a small test (phase 1) should be done just to adjust the survey to the reality. This test is used to correct question mis-understandings as well.

March

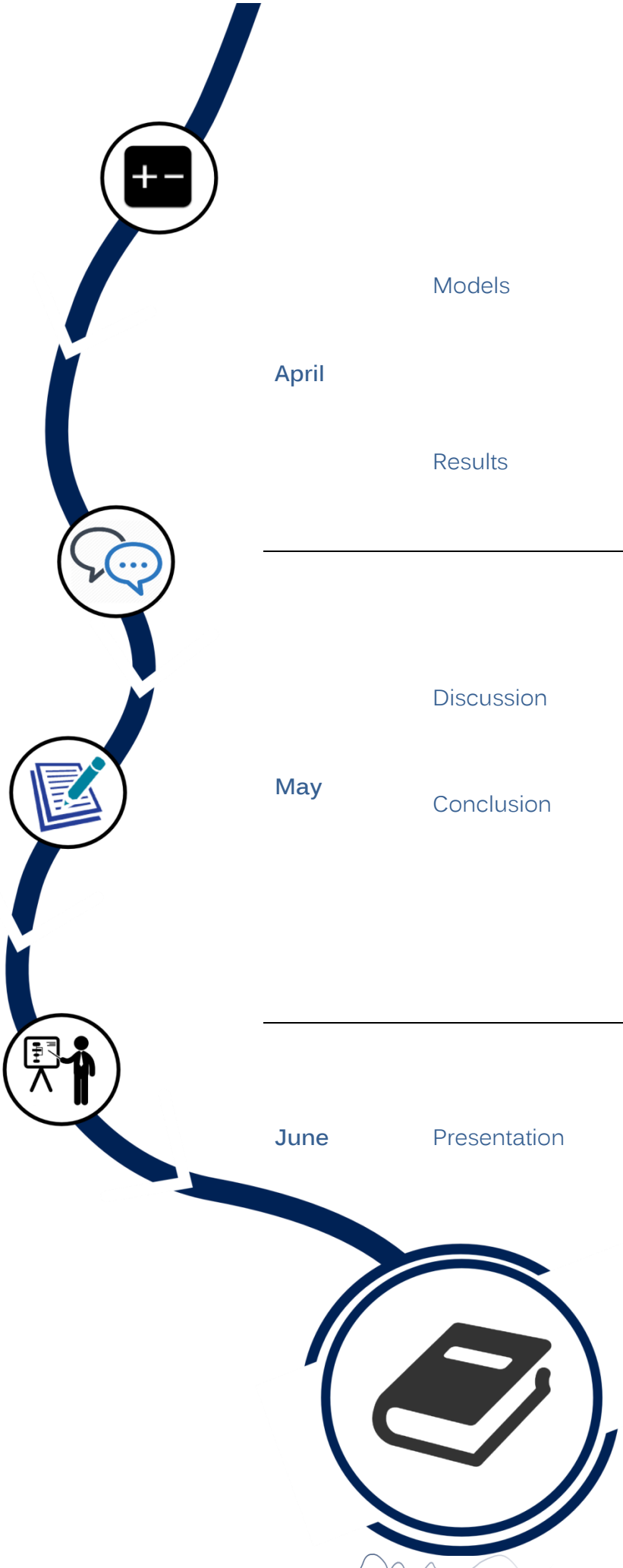
Survey. Phase 2

After that, the important survey (phase 2) takes place. Assistants' help will be needed.

Discretization

Then, all the collected data has to be organized (discretization) which will take a sometime. SPSS and Excel are useful tools.

2017



April

Models

In order to obtain the utility, previously it will be calculated the parameters and attributes through the data from the survey by building models using Pythonbiogeme.

Results

Once the utility is got (including the VTT), it will be possible to answer the research questions and set the discussion.

May

Discussion

Discussion refers to answer the research questions based on the results. It is not just a simple answer, but a reflection about the expected results, the final results and what they could show. For instance, it will be interesting discuss if the results in this case of study could be applicable in other ferry replacement projects.

Conclusion

The conclusion should summarize the article saying what was achieved and the importance of that for the future.

June

Presentation

Presentation is also an important task which includes finishing to organize the writing master thesis structure and the slides presentation.

MASTER THESIS

APPENDIX IV. Budget

The main cost of the master thesis is the survey. Assistants and transportation will be needed. The assistants' tasks are translating the survey to Norwegian and doing the survey in the different locations. In total, it is necessary 64 hours of assistants work. The survey is going to be made in four days, one for the phase 1 and three for the phase 2. This is because the distance between locations and to get the differences between the trips during a weekday and a weekend. In the

Table *¡Error! No hay texto con el estilo especificado en el documento..**1*** is resumed the tasks and the amount of time needed for them.

Task	Time
Translating the survey	
Survey	4 h
Survey changes after phase 1	2 h
Phase 1	
One assistant to do the survey in Trondheim Hurtigbåtterminal	3 h
Phase 2	
Day 1. Afternoon, Flakk. 1 assistant	4 h
Day 2. Morning, Flakk 2 assistants	5 h
Afternoon, Flakk. 3 assistants	12 h
Day 3. Morning, Flakk. 2 assistants	4 h
Afternoon, Trondheim hurtigbåtterminal. 2 assistants	5 h
Day 4. Morning, Flakk. 2 assistants	5 h
Afternoon, Trondheim hurtigbåtterminal. 2 assistant	4 h
Day 5. Morning, Trondheim hurtigbåtterminal. 1 assistant	2 h
Afternoon, Trondheim hurtigbåtterminal. 2 assistants	4 h
TOTAL	54 h

*Table **¡Error! No hay texto con el estilo especificado en el documento.**..1. Assistants' task and work load*

Moreover, there are some transportation costs which are basic to reach the specific location for the survey. This transportation costs include car renting, tolls, gas for the car, ferry tickets and bus tickets. Finally, there is a small cost which is gift cards in order to motivate users to answer the survey. Taking all these costs into account,

Table *¡Error! No hay texto con el estilo especificado en el documento..2* shows the total amount, which is a budget of 15090 NOK.

Concept	Price per unit	Units	Total price (NOK)
Assistants for the surveys	250 NOK/h	54 h	13 500
Bus tickets Trondheim (Semtrum) – Flakk ferjekai	41 NOK/trip	24	984
Speed boat tickets* Trondheim – Vanvikan	102 NOK/trip	3 trips	306
Gift cards	100 NOK/card	3 cards	300

TOTAL COST	15 090 NOK

*Table **¡Error! No hay texto con el estilo especificado en el documento.**.2. Budget*

**Only it was necessary to purchase tickets during the pilot survey. Afterwards, Fjord1 and AtB gave permission to do the survey for free in both the ferry and the speed boat.*

APPENDIX V. Ngene codes

"U" refers to the utility of each mode and "b", to the different parameters that are in the games.

SETS 1 TO 4	
Without fixed link	**With fixed link**
design	design
;alts = car, bus	;alts = car, bus
;rows = 6	;rows = 6
;eff = (mnl,d)	;eff = (mnl,d)
;con	;con
;block=2	;block=2
;model:	;model:
U(car) = b1[0.06]	U(car) = b1[0.06]
+b2[-0.005]*TTC[1,2,3]	+b2[-0.005]*TTC[1,2,3]
+b3[-0.005]*WTC[1,2,3]	+b4[-0.005]*CC[1,2,3]/
+b4[-0.005]*CC[1,2,3]/	
	U(bus) =
U(bus) =	b5[-0.005]*TTB[1,2,3]
b5[-0.005]*TTB[1,2,3]	+b4[-0.005]*CB[1,2,3]
+b4[-0.005]*CB[1,2,3]	+b6[0.005]*FB[1,2]
+b6[0.005]*FB[1,2]	$
$	

SETS 5 AND 6	
Without fixed link	**With fixed link**
design	design
;alts = car, bus, speedboat	;alts = car, bus, speedboat
;rows = 6	;rows = 6
;eff = (mnl,d)	;eff = (mnl,d)
;con	;con
;block=2	;block=2
;model:	;model:
U(car) = b1[0.06]	U(car) = b1[0.06]
+b2[-0.005]*TTC[1,2,3]	+b2[-0.005]*TTC[1,2,3]
+b3[-0.005]*WTC[1,2,3]	+b4[-0.005]*CC[1,2,3]/
+b4[-0.005]*CC[1,2,3]/	
	U(bus) =
U(bus) =	b5[-0.005]*TTB[1,2,3]
b5[-0.005]*TTB[1,2,3]	+b4[-0.005]*CB[1,2,3]
+b4[-0.005]*CB[1,2,3]	+b6[0.005]*FB[1,2]/
+b6[0.005]*FB[1,2]/	
	U(speedboat) =
U(speedboat) =	b7[-0.005]*TTS[1,2,3]
b7[-0.005]*TTS[1,2,3]	+b4[-0.005]*CS[1,2,3]
+b4[-0.005]*CS[1,2,3]	+b6[0.005]*FS[1,2]
+b6[0.005]*FS[1,2]	$
$	

APPENDIX VI. Games

Ferry. SET 1. BLOCK 1

Car: less than 45 min

Bus: less than 45 min, 45 – 60 min

WITHOUT FIXED LINK	WITH FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	50 min	50 min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	200 NOK	105 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	35 min	45 min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	75 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	40 min	1 time
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	90 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	20 min	30 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	75 NOK
Antall avganger per dag	–	2 busser per time

	BIL	BUSS
Total reisetid Dør til dør [min]	25 min	25 min
Kostnad [NOK] Bompenger, billetter,..	200 NOK	105 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	15 min	20 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	90 NOK
Antall avganger per dag	–	1 buss per time

Ferry. SET 1. BLOCK 2

Car: less than 45 min

Bus: less than 45 min, 45 – 60 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	40 min	45 min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	200 NOK	105 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	35 min	1 time
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	90 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	50 min	50 min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	75 NOK
Antall avganger per dag	–	2 busser per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	25 min	25 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	75 NOK
Antall avganger per dag	–	2 busser per time

	BIL	BUSS
Total reisetid Dør til dør [min]	20 min	30 min
Kostnad [NOK] Bompenger, billetter,..	200 NOK	105 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	15 min	20 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	90 NOK
Antall avganger per dag	–	2 busser per time

Ferry. SET 2. BLOCK 1

Car: 45 – 60 min

Bus: 60 – 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	45 min	1t 20min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	110 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1 time
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	260 NOK	110 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1 time
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	130 NOK
Antall avganger per dag	–	1 buss per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	25 min	45 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	110 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	35 min	40 min
Kostnad [NOK] Bompenger, billetter,..	260 NOK	150 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	30 min	35 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	110 NOK
Antall avganger per dag	–	2 busser per time

Ferry. SET 2. BLOCK 2

Car: 45 – 60 min

Bus: 60 – 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	45 min	1t 10min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	220 NOK	150 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 5min	1t 10min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	220 NOK	150 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 5min	1t 20min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	260 NOK	130 NOK
Antall avganger per dag	–	2 busser per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	25 min	35 min
Kostnad [NOK] Bompenger, billetter,..	220 NOK	130 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	30 min	45 min
Kostnad [NOK] Bompenger, billetter,..	220 NOK	130 NOK
Antall avganger per dag	–	2 busser per time

	BIL	BUSS
Total reisetid Dør til dør [min]	35 min	40 min
Kostnad [NOK] Bompenger, billetter,..	260 NOK	150 NOK
Antall avganger per dag	–	2 busser per time

Ferry. SET 3. BLOCK 1

Car: 60 – 75 min

Bus: over 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1t 45min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	145 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	1t 20min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	275 NOK	145 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	1t 20min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	170 NOK
Antall avganger per dag	–	1 buss per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	30 min	60 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	145 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	50 min	50 min
Kostnad [NOK] Bompenger, billetter,..	275 NOK	195 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	40 min	45 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	145 NOK
Antall avganger per dag	–	2 busser per time

Ferry. SET 3. BLOCK 2

Car: 60 – 75 min

Bus: over 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1t 30min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	195 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 15min	1t 30min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	195 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 15min	1t 45min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	275 NOK	170 NOK
Antall avganger per dag	–	2 busser per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	30 min	45 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	170 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	40 min	1 time
Kostnad [NOK] Bompenger, billetter,..	235 NOK	170 NOK
Antall avganger per dag	–	2 busser per time

	BIL	BUSS
Total reisetid Dør til dør [min]	50 min	50 min
Kostnad [NOK] Bompenger, billetter,..	275 NOK	195 NOK
Antall avganger per dag	–	2 busser per time

Ferry. SET 4. BLOCK 1

Car: over 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	2t 5min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	340 NOK	170 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 25min	1t 35min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	295 NOK	170 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 25min	1t 35min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	340 NOK	200 NOK
Antall avganger per dag	–	1 buss per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	45 min	1t 20min
Kostnad [NOK] Bompenger, billetter,..	340 NOK	170 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	1t 5min	1t 10min
Kostnad [NOK] Bompenger, billetter,..	295 NOK	230 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	55 min	1 time
Kostnad [NOK] Bompenger, billetter,..	340 NOK	170 NOK
Antall avganger per dag	–	2 busser per time

Ferry. SET 4. BLOCK 2

Car: over 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	1t 50min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	250 NOK	230 NOK
Antall avganger per dag	–	2 busser per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 40min	1t 50min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	250 NOK	230 NOK
Antall avganger per dag	–	1 buss per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 40min	2t 5min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	295 NOK	200 NOK
Antall avganger per dag	–	2 busser per time

WITH FIXED LINK

	BIL	BUSS
Total reisetid Dør til dør [min]	45 min	1 time
Kostnad [NOK] Bompenger, billetter,..	250 NOK	200 NOK
Antall avganger per dag	–	1 buss per time

	BIL	BUSS
Total reisetid Dør til dør [min]	55 min	1t 20min
Kostnad [NOK] Bompenger, billetter,..	250 NOK	200 NOK
Antall avganger per dag	–	2 busser per time

	BIL	BUSS
Total reisetid Dør til dør [min]	1t 5min	1t 10min
Kostnad [NOK] Bompenger, billetter,..	295 NOK	230 NOK
Antall avganger per dag	–	2 busser per time

Speed boat. SET 5. BLOCK 1

All: less than 45 min, 45 – 60 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 5min	1t 15min	1t 5min
Ventid på ferjen [min]	5 min	–	–
Kostnad [NOK] Bompenger, billetter,..	280 NOK	90 NOK	100 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	50 min	1t 25min	55 min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter,..	210 NOK	105 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 20min	1t 35min	45 min
Ventid på ferjen [min]	15 min	–	–
Kostnad [NOK] Bompenger, billetter,..	245 NOK	75 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

WITH FIXED LINK

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	30 min	50 min	45 min
Kostnad [NOK] Bompenger, billetter,..	280 NOK	75 NOK	120 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	30 min	40 min	1t 5min
Kostnad [NOK] Bompenger, billetter,..	210 NOK	90 NOK	100 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	40 min	45 min	55 min
Kostnad [NOK] Bompenger, billetter,..	245 NOK	105 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

Speed boat. SET 5. BLOCK 2

All: less than 45 min, 45 – 60 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	50 min	1t 35min	55 min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter,..	280 NOK	90 NOK	120 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 5min	1t 15min	1t 5min
Ventid på ferjen [min]	15 min	–	–
Kostnad [NOK] Bompenger, billetter,..	245 NOK	75 NOK	120 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 20min	1t 25min	45 min
Ventid på ferjen [min]	5 min	–	–
Kostnad [NOK] Bompenger, billetter,..	210 NOK	105 NOK	100 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

WITH FIXED LINK

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	40 min	45 min	55 min
Kostnad [NOK] Bompenger, billetter,..	245 NOK	105 NOK	100 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	35 min	40 min	1t 5min
Kostnad [NOK] Bompenger, billetter,..	280 NOK	90 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	35 min	50 min	45 min
Kostnad [NOK] Bompenger, billetter,..	210 NOK	75 NOK	120 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

Speed boat. SET 6. BLOCK 1

All: 60 – 75 min, over 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 10min	1t 35min	1t 25min
Ventid på ferjen [min]	5 min	–	–
Kostnad [NOK] Bompenger, billetter...	335 NOK	210 NOK	210 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 25min	1t 50min	55 min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter...	245 NOK	240 NOK	245 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 40min	2t 5min	1t 10min
Ventid på ferjen [min]	15 min	–	–
Kostnad [NOK] Bompenger, billetter...	290 NOK	180 NOK	210 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

WITH FIXED LINK

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	45 min	1t 20min	55 min
Kostnad [NOK] Bompenger, billetter...	335 NOK	180 NOK	245 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	45 min	1 time	1t 25min
Kostnad [NOK] Bompenger, billetter...	245 NOK	210 NOK	210 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 5min	1t 10min	1t 10min
Kostnad [NOK] Bompenger, billetter...	290 NOK	240 NOK	280 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

Speed boat. SET 6. BLOCK 2

All: 60 – 75 min, over 75 min

WITHOUT FIXED LINK

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 10 min	2t 5min	1t 25min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter,..	335 NOK	210 NOK	245 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 25min	1t 35min	55 min
Ventid på ferjen [min]	15 min	–	–
Kostnad [NOK] Bompenger, billetter,..	290 NOK	180 NOK	280 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 40min	1t 50min	70 min
Ventid på ferjen [min]	5 min	–	–
Kostnad [NOK] Bompenger, billetter,..	245 NOK	240 NOK	280 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

WITH FIXED LINK

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 5min	1t 20min	1t 25min
Kostnad [NOK] Bompenger, billetter,..	290 NOK	240 NOK	210 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	55 min	1 time	1t 10min
Kostnad [NOK] Bompenger, billetter,..	335 NOK	180 NOK	245 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	55 min	1t 10min	55 min
Kostnad [NOK] Bompenger, billetter,..	245 NOK	210 NOK	280 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time

APPENDIX VII. Questionnaires

Questionnaire for the users in the ferry (example)

Din deltakelse i denne undersøkelsen bidrar til økt kunnskap om transportsystemet i Trondheimfjorden og hvordan man kan gjennomføre framtidige prosjekter på en best mulig måte. Ved å delta i undersøkelsen kan du bli med i trekningen av et gavekort. Takk for at du deltar!

Undersøkelsen er kun for personer over 18 år.

1. **Har du svart på denne undersøkelsen tidligere?**
   ☐ Nei
   ☐ Ja (slutt på undersøkelsen)

2. **Hvor startet denne reisen?**
   Kommune *(for eksempel: Trondheim)*.....
   Postnummer/sted *(Eksempel: 7015 eller Solsiden)*.....

3. **Hvor ender denne reisen?**
   Kommune *(for eksempel: Rissa)*.....
   Postnummer/sted *(Eksempel: 7015 eller Solsiden)*.....

4. **Hva er formålet med denne reisen?**
   ☐ Reise til/fra arbeidsplass (arbeidreise)
   ☐ Reise til/fra skole/universitet/studiested
   ☐ Reise i arbeid (tjenestereise)
   ☐ Innkjøpreise
   ☐ Medisinske tjenester (lege/sykehus, tannlege)
   ☐ Fritidsaktiviteter (sport, konsert, kino, teater,...)
   ☐ Hente/Bringe barn til/fra fritidaktivitet
   ☐ Besøk (privat besøk hos venner og/eller familie)
   ☐ andre (spesifiser): .....

5. **Hvor ofte foretar du denne reisen?**
   ☐ Mer enn 7 ganger i uken
   ☐ 4 – 7 ganger i uken
   ☐ 1 – 3 ganger i uken
   ☐ 1 – 3 ganger i måneden
   ☐ 1 – 5 ganger i året
   ☐ Færre enn 1 gang per år

6. **Betaler du for reisen selv?**
   ☐ Ja
   ☐ Delvis
   ☐ Nei

7. **Hvordan reiser du vanligvis?**
   ☐ Som fører av bil/varebil/MC (gå til spørsmål 8)
   ☐ Som lastebilsjåfør (gå til spørsmål 8)
   ☐ Som passasjer i bil/varebil/MC/lastebil (gå til spørsmål 8)
   ☐ Som busspassasjer (gå til spørsmål 17)
   ☐ Som fotgjenger/sykelist (slutt på undersøkelsen)
   ☐ Andre (slutt på undersøkelse)

8. Hvor lenge måtte du vente på ferja etter at du ankom ferjekaia?

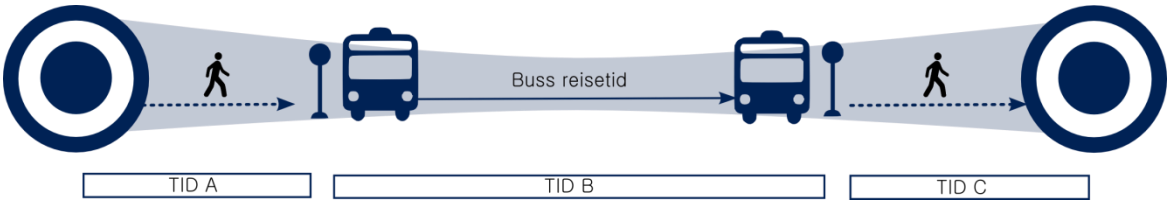
☐ mindre enn 10 minutter
☐ 10 - 19 minutter
☐ 20 – 29 minutter
☐ 30 minutter eller lengre

9. Kan du parkere på din destinasjon?

☐ Nei
☐ Ja, og det er gratis
☐ Ja, men jeg må betale

10. Kan du foreta reisen med buss?

☐ Nei (gå til spørsmål 15)
☐ Ja (gå til spørsmål 11)



11. Hvor lang tid vil reisen ta med buss?

(Tid A + Tid B + Tid C)

☐ Mindre enn 45 minutter
☐ 45 - 59 minutter
☐ 60 - 74 minutter
☐ 75 minutter eller lengre

12. Hvor lenge må du gå?

(Tid A + Tid C)

☐ Mindre enn 10 minutter
☐ 10 - 19 minutter
☐ 20 – 29 minutter
☐ 30 minutter eller lengre

13. Hvor mange forskjellige busser må du benytte for å komme til destinasjonen?

☐ 1 buss
☐ 2 busser
☐ 3 busser eller mer

14. Hvor store er frekvensen på bussavgangene?

☐ 4 busser eller mer i timen
☐ 2-3 busser i timen
☐ 1 buss i timen
☐ 1 buss hver 2 timer eller mindre

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15. Hvilke andre alternative transportmidler har du tilgang til for å gjennomføre den samme reisen?

Her kan du krysse av for flere alternativer

☐ Det er ingen andre alternativer
☐ Som forgjenger
☐ Som sykelist
☐ Andre:.....

DIN PÅGÅENDE REISE

16. Hvor lang tid bruker du på denne reisen fra start til slutt (e.g. hjem, arbeidsplassen,...)?

☐ Mindre enn 45 minutter (gå til spørsmål 25)
☐ 45 - 59 minutter (gå til spørsmål 27)
☐ 60 - 74 minutter (gå til spørsmål 29)
☐ 75 minutter eller lengre (gå til spørsmål 31)

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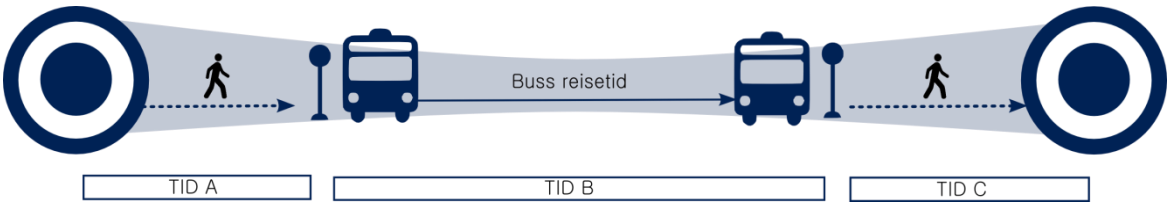

17. Hvor lenge må du gå?
(Tid A + Tid C)
- ☐ Mindre enn 10 minutter
- ☐ 10 - 19 minutter
- ☐ 20 – 29 minutter
- ☐ 30 minutter eller lengre

18. Hvor mange forskjellige busser må du benytte for å komme til destinasjonen?
- ☐ 1 buss
- ☐ 2 busser
- ☐ 3 busser eller mer

19. Hvor stor er frekvensen på bussavgangene?
- ☐ 4 busser eller mer i timen
- ☐ 2-3 busser i timen
- ☐ 1 buss i timen
- ☐ 1 buss hver 2 timer eller mindre

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20. Kan du foreta reisen med bil?
Her kan du krysse av for flere alternativer
- ☐ Nei (gå til spørsmål 23)
- ☐ Ja, som fører (gå til spørsmål 21)
- ☐ Ja, som passasjer (gå til spørsmål 21)

21. Hvor lang tid vil reisen ta med bil?
- ☐ Mindre enn 45 minutter
- ☐ 45 - 59 minutter
- ☐ 60 - 74 minutter
- ☐ 75 minutter eller lengre

22. Kan du parkere på din destinasjon?
- ☐ Nei
- ☐ Ja, og det er gratis
- ☐ Ja, men jeg må betale

---

23. Hvilke andre alternative transportmidler har du tilgang til for å gjennomføre den samme reisen?
Her kan du krysse av for flere alternativer
- ☐ Det er ingen andre alternativer
- ☐ Som fotgjenger
- ☐ Som sykelist
- ☐ Andre:.....

DIN PÅGÅENDE REISE

24. Hvor lang tid bruker du på denne reisen fra start til slutt (e.g. hjem, arbeidsplassen,...)?
- ☐ Mindre enn 45 minutter (gå til spørsmål 25)
- ☐ 45 - 59 minutter (gå til spørsmål 25)
- ☐ 60 - 74 minutter (gå til spørsmål 27)
- ☐ 75 minutter eller lengre (gå til spørsmål 29)

TOTAL REISE TID: MINDRE ENN 45 MIN

25. Nedenfor er tre situasjoner presentert. Hvilket av følgende alternativer ville du valgt?

SITUASJON 1. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	50 min	50 min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	200 NOK	105 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 2. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	35 min	45 min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	75 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 3. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	40 min	1 time
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	235 NOK	90 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

26. Det er foreslått å bygge en bro mellom Flakk og Rørvik i Trondheimfjorden. Hvis denne ble bygget, hvilket av følgende alternativer ville du valgt?

SITUASJON 4. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	20 min	30 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	75 NOK
Antall avganger per dag	–	2 busser per time
Valg?	☐	☐

SITUASJON 5. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	25 min	25 min
Kostnad [NOK] Bompenger, billetter,..	200 NOK	105 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 6. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	15 min	20 min
Kostnad [NOK] Bompenger, billetter,..	270 NOK	90 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

GÅ TIL SPØRSMÅL 33

TOTAL REISE TID: 45 – 60 MIN

27. Nedenfor er tre situasjoner presentert. Hvilket av følgende alternativer ville du valgt?

SITUASJON 1. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	45 min	1t 20min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	110 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 2. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1 time
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	260 NOK	110 NOK
Antall avganger per dag	–	2 busser per time
Valg?	☐	☐

SITUASJON 3. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1 time
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	130 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

28. Det er foreslått å bygge en bro mellom Flakk og Rørvik i Trondheimfjorden. Hvis denne ble bygget, hvilket av følgende alternativer ville du valgt?

SITUASJON 4. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	25 min	45 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	110 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 5. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	35 min	40 min
Kostnad [NOK] Bompenger, billetter,..	260 NOK	150 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

	BIL	BUSS
Total reisetid Dør til dør [min]	30 min	35 min
Kostnad [NOK] Bompenger, billetter,..	300 NOK	110 NOK
Antall avganger per dag	–	2 busser per time
Valg?	☐	☐

GÅ TIL SPØRSMÅL 33

SITUASJON 6. Hvilket transportmiddel vil du bruke?

TOTAL REISE TID: 60 – 75 MIN

29. Nedenfor er tre situasjoner presentert. Hvilket av følgende alternativer ville du valgt?

SITUASJON 1. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	55 min	1t 45min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	145 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 2. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	1t 20min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	275 NOK	145 NOK
Antall avganger per dag	–	2 busser per time
Valg?	☐	☐

SITUASJON 3. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	1t 20min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	170 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

30. Det er foreslått å bygge en bro mellom Flakk og Rørvik i Trondheimfjorden. Hvis denne ble bygget, hvilket av følgende alternativer ville du valgt?

SITUASJON 4. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	30 min	60 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	145 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

SITUASJON 5. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	50 min	50 min
Kostnad [NOK] Bompenger, billetter,..	275 NOK	195 NOK
Antall avganger per dag	–	1 buss per time

Valg? ☐ ☐

	BIL	BUSS
Total reisetid Dør til dør [min]	40 min	45 min
Kostnad [NOK] Bompenger, billetter,..	320 NOK	145 NOK
Antall avganger per dag	–	2 busser per time

Valg? ☐ ☐

GÅ TIL SPØRSMÅL 33

SITUASJON 6. Hvilket transportmiddel vil du bruke?

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TOTAL REISE TID: OVER 75 MIN

31. Nedenfor er tre situasjoner presentert. Hvilket av følgende alternativer ville du valgt?

SITUASJON 1. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 10min	2t 5min
Ventid på ferjen [min]	10 min	0 min
Kostnad [NOK] Bompenger, billetter,..	340 NOK	170 NOK
Antall avganger per dag	–	1 buss per time

Valg? ☐ ☐

SITUASJON 2. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 25min	1t 35min
Ventid på ferjen [min]	15 min	0 min
Kostnad [NOK] Bompenger, billetter,..	295 NOK	170 NOK
Antall avganger per dag	–	2 busser per time

Valg? ☐ ☐

SITUASJON 3. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]
Total reisetid Dør til dør [min]	1t 25min	1t 35min
Ventid på ferjen [min]	5 min	0 min
Kostnad [NOK] Bompenger, billetter,..	340 NOK	200 NOK
Antall avganger per dag	–	1 buss per time

Valg? ☐ ☐

32. Det er foreslått å bygge en bro mellom Flakk og Rørvik i Trondheimfjorden. Hvis denne ble bygget, hvilket av følgende alternativer ville du valgt?

SITUASJON 4. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	45 min	1t 20min
Kostnad [NOK] Bompenger, billetter,..	340 NOK	170 NOK
Antall avganger per dag	–	1 buss per time

Valg? ☐ ☐

SITUASJON 5. Hvilket transportmiddel vil du bruke?

	BIL	BUSS
Total reisetid Dør til dør [min]	1t 5min	1t 10min
Kostnad [NOK] Bompenger, billetter...	295 NOK	230 NOK
Antall avganger per dag	–	1 buss per time
Valg?	☐	☐

	BIL	BUSS
Total reisetid Dør til dør [min]	55 min	1 time
Kostnad [NOK] Bompenger, billetter...	340 NOK	170 NOK
Antall avganger per dag	–	2 busser per time
Valg?	☐	☐

GÅ TIL SPØRSMÅL 33

SITUASJON 6. Hvilket transportmiddel vil du bruke?

33. Bosted

Postnummer: .....

Andre land enn Norge (oppgi): .....

34. Alder

☐ 18 – 24 år
☐ 25 – 34 år
☐ 35 – 44 år
☐ 45 – 54 år
☐ 55 – 64 år
☐ 65 – 74 år
☐ Over 75 år

35. Kjønn

☐ Kvinne
☐ Mann

36. Hva er din primære yrkesstatus?

☐ Yrkesaktiv fulltid
☐ Yrkesaktiv deltid/vikariat
☐ Hjemmeværende/foreldrepermisjon
☐ Militærtjeneste/siviltjeneste
☐ Studerer
☐ Sykemeldt/trygdet
☐ Arbeidsledig
☐ Pensjonert
☐ Annet:.....

37. Oppgi antall personer i din husstand

Personer under 18 år: .....

Personer som er 18 år eller eldre: .....

38. Anslå husholdningens samlede brutto årsinntekt

☐ Mindre enn 249 999 kr
☐ 250 000 – 499 999 kr
☐ 500 000 – 749 999 kr
☐ 750 000 – 999 999 kr
☐ 1 000 000 – 1 500 000 kr
☐ Over 1 500 000 kr
☐ Vil ikke oppgi inntekt
☐ Vet ikke

39. Har du kommentarer til undersøkelsen?

Tusen takk for at du deltok på undersøkelsen!

SLUTT PÅ UNDERSØKELSEN

Questionnaire for the users in the speed boat (example)

Din deltakelse i denne undersøkelsen bidrar til økt kunnskap om transportsystemet i Trondheimfjorden og hvordan man kan gjennomføre framtidige prosjekter på en best mulig måte. Ved å delta i undersøkelsen kan du bli med i trekningen av et gavekort. Takk for at du deltar!

Undersøkelsen er kun for personer over 18 år.

1. **Har du svart på denne undersøkelsen tidligere?**
   ☐ Nei
   ☐ Ja (slutt på undersøkelsen)

2. **Hvor startet denne reisen?**
   Kommune *(for eksempel: Trondheim)*.....
   Postnummer/sted *(Eksempel: 7015 eller Solsiden)*.....

3. **Hvor ender denne reisen?**
   Kommune *(for eksempel: Rissa)*.....
   Postnummer/sted *(Eksempel: 7015 eller Solsiden)*.....

4. **Hva er formålet med denne reisen?**
   ☐ Reise til/fra arbeidsplass (arbeidreise)
   ☐ Reise til/fra skole/universitet/studiested
   ☐ Reise i arbeid (tjenestereise)
   ☐ Innkjøpreise
   ☐ Medisinske tjenester (lege/sykehus, tannlege)
   ☐ Fritidsaktiviteter (sport, konsert, kino, teater,...)
   ☐ Hente/Bringe barn til/fra fritidaktivitet
   ☐ Besøk (privat besøk hos venner og/eller familie)
   ☐ andre (spesifiser): .....

5. **Hvor ofte foretar du denne reisen?**
   ☐ Mer enn 7 ganger i uken
   ☐ 4 – 7 ganger i uken
   ☐ 1 – 3 ganger i uken
   ☐ 1 – 3 ganger i måneden
   ☐ 1 – 5 ganger i året
   ☐ Færre enn 1 gang per år

6. **Betaler du for reisen selv?**
   ☐ Ja
   ☐ Delvis
   ☐ Nei

7. **Hvordan reiser du til hurtigbåten?**
   ☐ Som fører av bil/varebil/MC
   ☐ Som passasjer i bil/varebil/MC
   ☐ Som busspassasjer
   ☐ Som fotgjenger/sykelist
   ☐ Andre (spesifiser): .....

8. **Hvordan reiser du fra hurtigbåten til din destinasjon?**
   ☐ Som fører av bil/varebil/MC
   ☐ Som passajer i bil/varebil/MC
   ☐ Som busspassasjer
   ☐ Som fotgjenger/sykelist
   ☐ Andre (spesifiser): .....

9. **Hvor lenge måtte du vente på hurtigbåten etter at du ankom ferjekaien?**
   ☐ mindre enn 10 minutter
   ☐ 10 - 19 minutter
   ☐ 20 – 29 minutter
   ☐ 30 minutter eller lengre

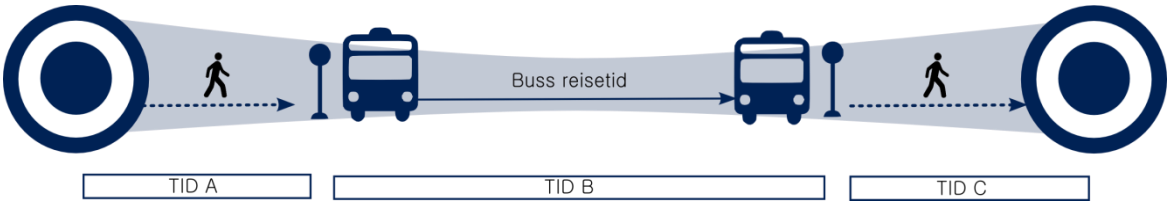
10. **Kan du foreta reisen med bil?**
    Her kan du krysse av for flere alternativer
    ☐ Nei (gå til spørsmål 13)
    ☐ Ja, som fører (gå til spørsmål 11)
    ☐ Ja, som passasjer (gå til spørsmål 11)

11. **Hvor lang tid vil reisen ta med bil?**
    ☐ Mindre enn 45 minutter
    ☐ 45 - 59 minutter
    ☐ 60 - 74 minutter
    ☐ 75 minutter eller lengre

12. **Kan du parkere på din destinasjon?**
    ☐ Nei
    ☐ Ja, og det er gratis
    ☐ Ja, men jeg må betale

13. Kan du foreta reisen med buss?

☐ Nei (gå til spørsmål 18)
☐ Ja (gå til spørsmål 14)



14. Hvor lang tid vil reisen ta med buss?

(Tid A + Tid B + Tid C)

☐ Mindre enn 45 minutter
☐ 45 - 59 minutter
☐ 60 - 74 minutter
☐ 75 minutter eller lengre

15. Hvor lenge må du gå?

(Tid A + Tid C)

☐ Mindre enn 10 minutter
☐ 10 - 19 minutter
☐ 20 – 29 minutter
☐ 30 minutter eller lengre

16. Hvor mange forskjellige busser må du benytte for å komme til destinasjonen?

☐ 1 buss
☐ 2 busser
☐ 3 busser eller mer

17. Hvor store er frekvensen på bussavgangene?

☐ 4 busser eller mer i timen
☐ 2-3 busser i timen
☐ 1 buss i timen
☐ 1 buss hver 2 timer eller mindre

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18. Hvilke andre alternative transportmidler har du tilgang til for å gjennomføre den samme reisen?

Her kan du krysse av for flere alternativer

☐ Det er ingen andre alternativer
☐ Som forgjenger
☐ Som sykelist
☐ Andre:…….

DIN PÅGÅENDE REISE

19. Hvor lang tid bruker du på denne reisen fra start til slutt (e.g. hjem til arbeidsplass,...)?

☐ Mindre enn 45 minutter (gå til spørsmål 20)
☐ 45 - 59 minutter (gå til spørsmål 20)
☐ 60 – 74 minutter (gå til spørsmål 22)
☐ 75 minutter eller lengre (gå til spørsmål 22)

TOTAL REISE TID: MINDRE ENN 60 MIN

20. Nedenfor er tre situasjoner presentert. Hvilket av følgende alternativer ville du valgt?

SITUASJON 1. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 5min	1t 15min	1t 5min
Ventid på ferjen [min]	5 min	–	–
Kostnad [NOK] Bompenger, billetter,...	280 NOK	90 NOK	100 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time
Valg?	☐	☐	☐

SITUASJON 2. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	50 min	1t 25min	55 min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter,...	210 NOK	105 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

SITUASJON 3. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 20min	1t 35min	45 min
Ventid på ferjen [min]	15 min	–	–
Kostnad [NOK] Bompenger, billetter,...	245 NOK	75 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

21. Det er foreslått å bygge en bro mellom Flakk og Rørvik i Trondheimfjorden. Hvis denne ble bygget, hvilket av følgende alternativer ville du valgt?

SITUASJON 4. Hvilket transportmiddel vil du bruke?

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	30 min	50 min	45 min
Kostnad [NOK] Bompenger, billetter,...	280 NOK	75 NOK	120 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time
Valg?	☐	☐	☐

SITUASJON 5. Hvilket transportmiddel vil du bruke?

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	30 min	40 min	1t 5min
Kostnad [NOK] Bompenger, billetter,...	210 NOK	90 NOK	100 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time
Valg?	☐	☐	☐

SITUASJON 6. Hvilket transportmiddel vil du bruke?

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	40 min	45 min	55 min
Kostnad [NOK] Bompenger, billetter,...	245 NOK	105 NOK	85 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

GÅ TIL SPØRSMÅL 24

TOTAL REISE TID: OVER 60 MIN

22. Nedenfor er tre situasjoner presentert. Hvilket av følgende alternativer ville du valgt?

SITUASJON 1. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 10min	1t 35min	1t 25min
Ventid på ferjen [min]	5 min	–	–
Kostnad [NOK] Bompenger, billetter,..	335 NOK	210 NOK	210 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time
Valg?	☐	☐	☐

SITUASJON 2. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 25min	1t 50min	55 min
Ventid på ferjen [min]	10 min	–	–
Kostnad [NOK] Bompenger, billetter,..	245 NOK	240 NOK	245 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

SITUASJON 3. Hvilket transportmiddel vil du bruke?

	BIL OG FERJE [Flakk – Rørvik]	BUSS OG FERJE [Flakk – Rørvik]	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 40min	2t 5min	1t 10min
Ventid på ferjen [min]	15 min	–	–
Kostnad [NOK] Bompenger, billetter,..	290 NOK	180 NOK	210 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

23. Det er foreslått å bygge en bro mellom Flakk og Rørvik i Trondheimfjorden. Hvis denne ble bygget, hvilket av følgende alternativer ville du valgt?

SITUASJON 4. Hvilket transportmiddel vil du bruke?

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	45 min	1t 20min	55 min
Kostnad [NOK] Bompenger, billetter,..	335 NOK	180 NOK	245 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

SITUASJON 5. Hvilket transportmiddel vil du bruke?

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	45 min	1 time	1t 25min
Kostnad [NOK] Bompenger, billetter,..	245 NOK	210 NOK	210 NOK
Antall avganger per dag	–	1 buss per time	2 hurtigbåter per time
Valg?	☐	☐	☐

SITUASJON 6. Hvilket transportmiddel vil du bruke?

	BIL	BUSS	HURTIG BÅT
Total reisetid Dør til dør [min]	1t 5min	1t 10min	1t 10min
Kostnad [NOK] Bompenger, billetter,..	290 NOK	240 NOK	280 NOK
Antall avganger per dag	–	2 busser per time	1 hurtigbåt per time
Valg?	☐	☐	☐

GÅ TIL SPØRSMÅL 24

24. Bosted

Postnummer: .....
Andre land enn Norge (oppgi): .....

25. Alder

☐ 18 – 24 år
☐ 25 – 34 år
☐ 35 – 44 år
☐ 45 – 54 år
☐ 55 – 64 år
☐ 65 – 74 år
☐ Over 75 år

26. Kjønn

☐ Kvinne
☐ Mann

27. Hva er din primære yrkesstatus?

☐ Yrkesaktiv fulltid
☐ Yrkesaktiv deltid/vikariat
☐ Hjemmeværende/foreldrepermisjon
☐ Militærtjeneste/siviltjeneste
☐ Studerer
☐ Sykemeldt/trygdet
☐ Arbeidsledig
☐ Pensjonert
☐ Annet:.....

28. Oppgi antall personer i din husstand

Personer under 18 år: .....
Personer som er 18 år eller eldre: .....

29. Anslå husholdningens samlede brutto årsinntekt

☐ Mindre enn 249 999 kr
☐ 250 000 – 499 999 kr
☐ 500 000 – 749 999 kr
☐ 750 000 – 999 999 kr
☐ 1 000 000 – 1 500 000 kr
☐ over 1 500 000 kr
☐ Vil ikke oppgi inntekt
☐ Vet ikke

30. Har du kommentarer til undersøkelsen?

SLUTT PÅ UNDERSØKELSEN

Tusen takk for at du deltok på undersøkelsen!

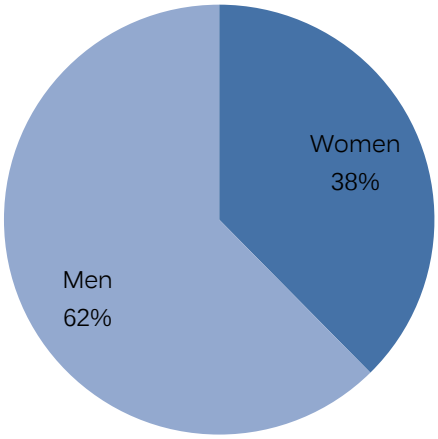
Typeform links

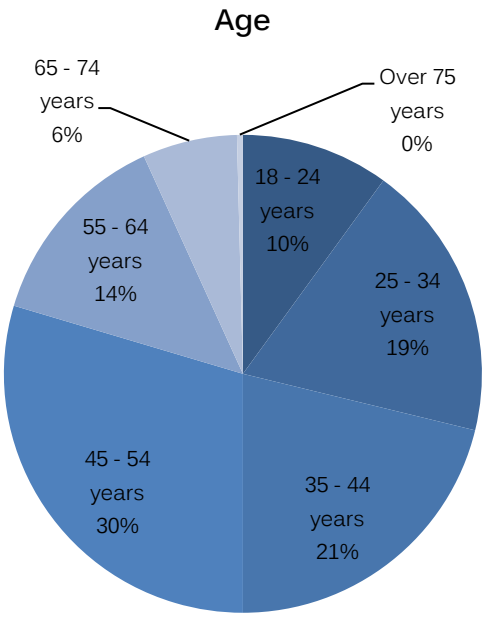
Ferry block 1	*tinyurl.com/ferry171*
Ferry block 2	*tinyurl.com/ferry172*
Speed boat block 1	*tinyurl.com/hurtig171*
Speed boat block 2	*tinyurl.com/hurtig172*

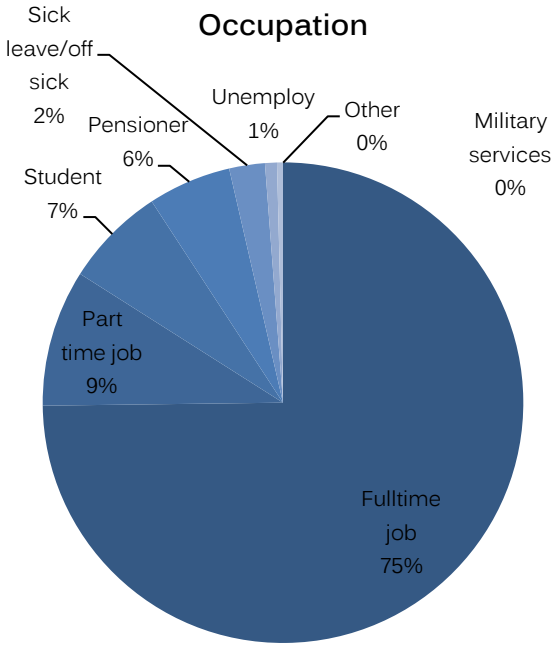
APPENDIX VIII. Respondents' profile

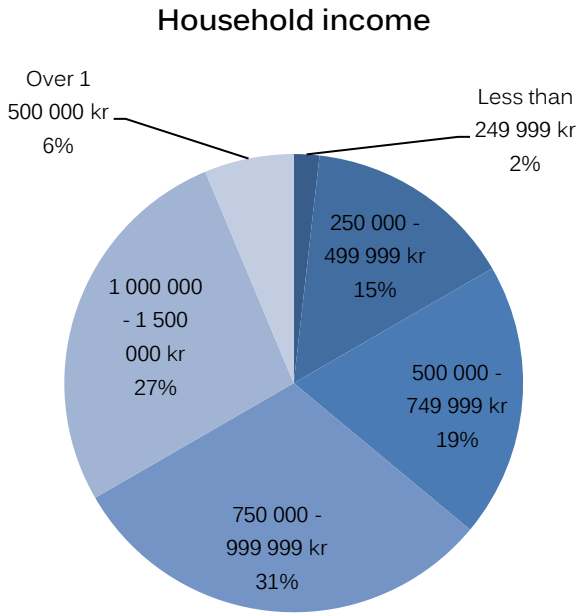
In this appendix, there are all the figures that define the users that answered the survey. Both socio-economic and trip information are included.

Socio-economic figures



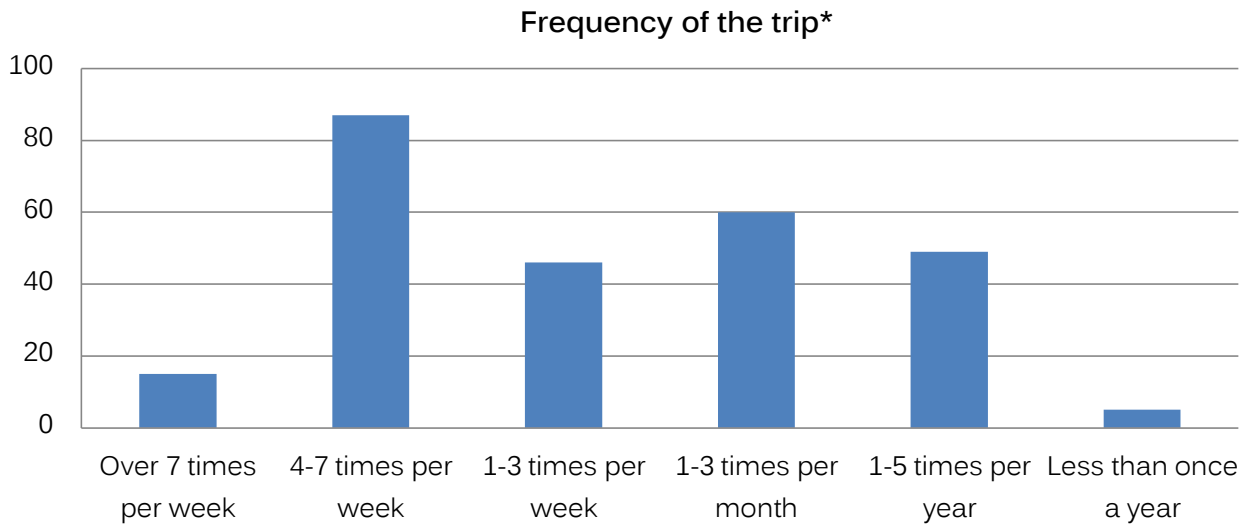




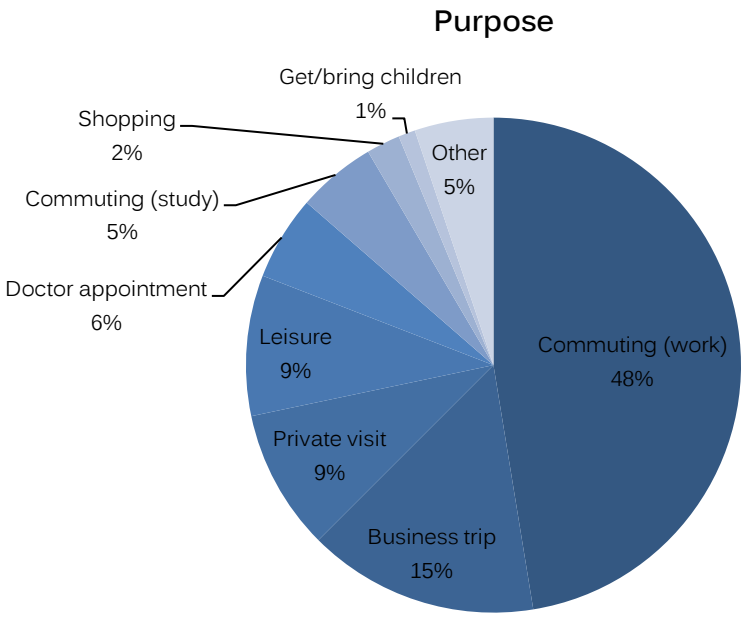


Trip characteristics

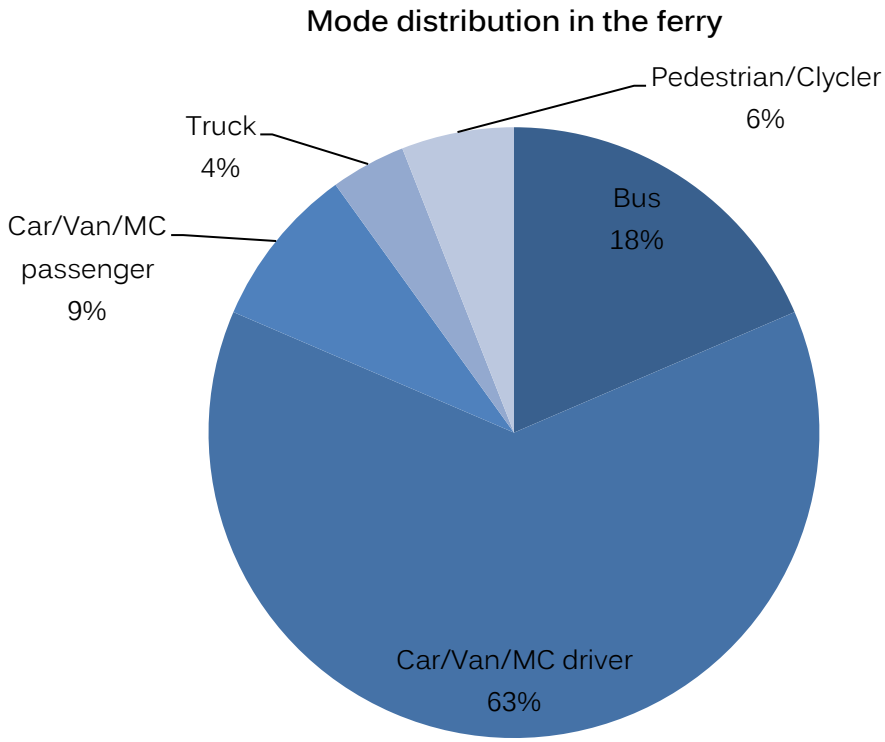
163 answers were gotten in the ferry and 120 in the speed boat.

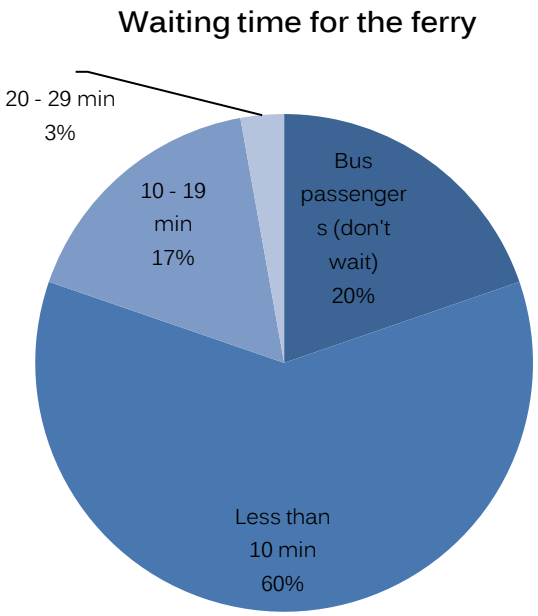


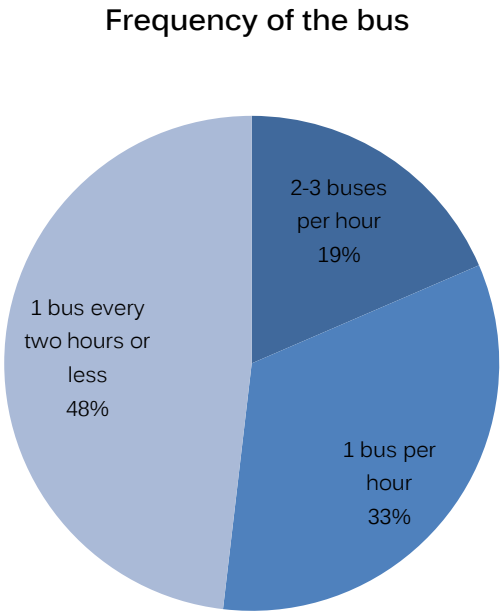
*It was not used because some users count as one time a both ways trip.



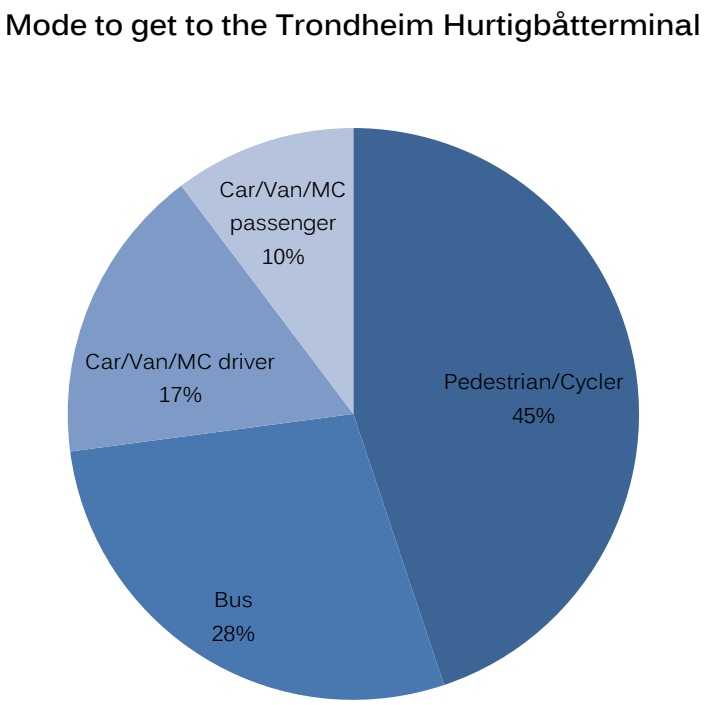
Specific for the ferry trips

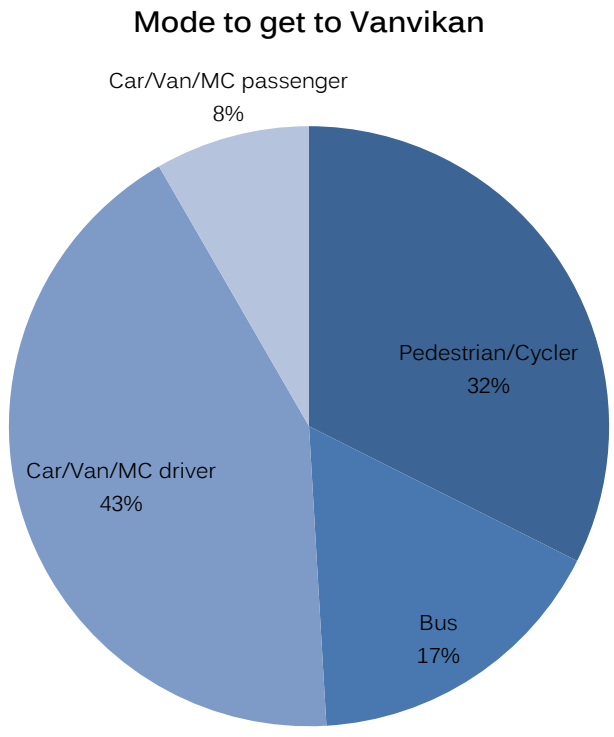






Specific for the speed boat trips





APPENDIX IX. Models

Legend

Alternatives

car rp	car for the RP survey
bus rp	bus for the RP survey
sb rp	speed boat for the RP survey
car sp1	car for the SP current situation survey
bus sp1	bus for the SP current situation survey
sb sp1	speed boat for the SP current situation survey
car sp2	car for the SP fixed link situation survey
bus sp2	bus for the SP fixed link situation survey
sb sp2	speed boat for the SP fixed link situation survey

Availability of alternatives

ALT_1	RPcar passenger or driver (1 available, 0 not available)
ALT_2	RPbus (1 available, 0 not available)
ALT_3	RPspeed boat (1 available, 0 not available)
ALT_4	SPnow car (1 available, 0 not available)
ALT_5	SPnow bus (1 available, 0 not available)
ALT_6	SPnow speed boat (1 available, 0 not available)
ALT_7	SPbridge car (1 available, 0 not available)
ALT_8	SPbridge bus (1 available, 0 not available)
ALT_9	SPbridge speed boat (1 available, 0 not available)
av	availability of the alternative

Data

ID	user
SURVEY	kind of survey
SIT	number of survey: 0 for RP, rest SP
CH	alternative choice
TT_CAR	travel time by car (min)
WT_CAR	waiting time for the car in the ferry dock (min)
C_CAR	car cost (NOK)
C_CAR_S	scaled car cost (C_CAR/10)
ALT1PAX	if the user can go as a passenger in alternative 1 (1yes, 0no)
Park_F	Free parking [1: yes; 0:no]
Park_P	Parking available but paying [1: yes; 0:no]
TT_BUS	trave time by bus (min)
WALK_BUS	walking time by bus (min)
F_BUS	frequency of the bus (bus per hour)
C_BUS	cost bus (NOK)
C_BUS_S	scaled bus cost (C_BUS/10)
TT_SB	travel time speed boat (min)
F_SB	frequency speed boat (boats per hour)
C_SB	cost speed boat (NOK)
C_SB_S	scaled speed boat cost (C_SB/10)
SOF	if the user was in the speed boat or ferje during the survey (1ferje, 0speed boat)

PAY	If the trip is paid by the user [1: yes; 0:no]
SB_W1	Arriving to the speed boat dock walking or cycling [1: yes; 0:no]
SB_W2	Going from the speed boat dock to the destination walking or cycling [1: yes; 0:no]
SB_PT1	Arriving to the speed boat dock by public transport [1: yes; 0:no]
SB_PT2	Going from the speed boat dock to the destination by public transport [1: yes; 0:no]
AGE	
AGE_S	scaled age (AGE/1000)
GENDER	
HOUSING	Place of residence: 0 Trondheim side of the fjord, 1 the other side
INCOME	household income (if it is unknown, the mean: 795 000)
INCOME_S	scaled household income (INCOME/100000)
UNDER18	people under 18 included in the household
OVER18	people over 18 included in the household
TOTAL	total people included in the household
OC_FTJOB	occupation full time job [1: yes; 0:no]
OC_PTJOB	occupation part time job [1: yes; 0:no]
OC_STUD	occupation student [1: yes; 0:no]
OC_RET	occupation retired [1: yes; 0:no]
OC_OTH	occupation others [1: yes; 0:no]
P_COM	purpose commuting (all) [1: yes; 0:no]
P_BT	purpose business trip [1: yes; 0:no]
P_OTH	purpose others [1: yes; 0:no]

Parameters in Python

Vi	utility functions base on ALT_i
ASC_i	indepedient parameter of each alternative
Btc	parameter travel time car
Bwc	parameter waiting time car
Bc	parameter cost (for all modes)
Btb	parameter travel time bus
Bf	parameter frequency (for speed boat and bus)
Bts	parameter speed boat
B_tpt	parameter that assume that part of the value of time is the same for public transport
Bfs	parameter for the bus frequency
Bfb	parameter for the speed boat frequency
Btc_com	parameter for the car travel time for commuting trips
Btc_bt	parameter for the car travel time for business trips
Btc_oth	parameter for the car travel time for other purposes
Btb_com	parameter for the bus travel time for commuting trips
Btb_bt	parameter for the bus travel time for business trips
Btb_oth	parameter for the bus travel time for other purposes
Bts_com	parameter for the speed boat travel time for commuting trips
Bts_bt	parameter for the speed boat travel time for business trips
Bts_com	parameter for the speed boat travel time for other purposes
B_WALK	parameter for waiting time til the bus stop

B_SOF	parameter survey took place in the ferje or speed boat
B_ALT1PAX	parameter for alternative 1 if they can go as car passengers
B_SP	parameter to differ SP VS RP
B_SP_S	second term for monte carlo of B_SP
B_SPR	random B_SP
B_SPBR	parameter to differ SP now and SP bridge
B_SPBR_S	second term for monte carlo of B_SPBR
B_SPBRR	random B_SPBRR
B_SBW1	Arriving to the speed boat dock walking or cycling
B_SBW2	Going from the speed boat dock to the destination walking or cycling
B_SBPT1	Arriving to the speed boat dock by public transport
B_SBPT2	Going from the speed boat dock to the destination by public transport
B_PFree	parameter for free parking
B_PPay	parameter for availability of parking but not free

Btc_s	second term for monte carlo of Btc
Btc_R	parameter of Btc but with random individual differences
Btc_ret	parameter of car travel time for retired people
B_CORR	parameter for correlation between modes
CORR	random correlation between modes
PanelB	parameter to take into account panel data in the SP for the current situation
PanelC	parameter to take into account panel data in the SP for the current situation
Panel1	parameter to take into account panel data in the SP for the fixed link situation
Panel2	parameter to take into account panel data in the SP for the fixed link situation

B_GEN	parameter for gender
B_HOU	parameter for housing
B_AGE	parameter for age
B_P_COM	parameter for purpose: commuting
B_P_BT	parameter for purpose: business trip
B_P_OTH	parameter for purpose: other
B_OC_FT	parameter for occupation: full time job
B_OC_PT	parameter for occupation: part time job
B_OC_STUD	parameter for occupation: student
B_OC_RET	parameter for occupation: retired
B_OC_OTH	parameter for occupation: other

RP models

Model 1RP

bus rp: ASC_2 + Btb * TT_BUS + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_WALK * (WALK_BUS * AGE_S)

car rp: ASC_1 + Btc * TT_CAR + Bwc * WT_CAR + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_ALT1PAX * ALT1PAX

sp rp: Bts * TT_SB + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S)

Estimation report

Number of draws:	100
Number of estimated parameters:	13
Sample size:	250
Excluded observations:	0
Init log likelihood:	-121.289
Final log likelihood:	-25.453
Likelihood ratio test for the init. model:	191.672
Rho-square for the init. model:	0.790
Rho-square-bar for the init. model:	0.683
Final gradient norm:	+1.474e-05
Diagnostic:	Convergence reached...
Iterations:	29
Data processing time:	00:00
Run time:	00:19
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_1	-12.5	260.	-0.05	0.96	*	2.50	-4.99	0.00	
ASC_2	-16.4	260.	-0.06	0.95	*	3.00	-5.46	0.00	
B_ALT1PAX	-1.58	0.791	-2.00	0.05		0.643	-2.45	0.01	
B_GEN	-5.53	2.93e+03	-0.00	1.00	*	1.14	-4.83	0.00	
B_P_BT	-5.76	2.91e+03	-0.00	1.00	*	0.976	-5.90	0.00	
B_P_COM	-6.25	2.96e+03	-0.00	1.00	*	0.753	-8.30	0.00	
B_WALK	-2.43	1.11	-2.19	0.03		1.25	-1.94	0.05	*
Bc	-0.706	0.426	-1.66	0.10	*	0.324	-2.18	0.03	
Bf	-0.0419	0.349	-0.12	0.90	*	0.382	-0.11	0.91	*
Btb	0.0589	0.0391	1.51	0.13	*	0.0439	1.34	0.18	*
Btc	0.0374	0.0301	1.24	0.21	*	0.0306	1.22	0.22	*
Bts	0.00	1.80e+308	0.00	1.00	*	1.80e+308	0.00	1.00	*
Bwc	-0.200	0.0925	-2.16	0.03		0.111	-1.80	0.07	*

Model 2RP

bus rp: ASC_2 + Btb * TT_BUS + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_WALK * (WALK_BUS * AGE_S)

car rp: ASC_1 + (Btc * TT_CAR) * ((1) - OC_RET) + Bwc * (WT_CAR ^ (2)) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_ALT1PAX * ALT1PAX

sp rp: Bts * TT_SB + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S)

Estimation report

Number of draws:	100
Number of estimated parameters:	13
Sample size:	250
Excluded observations:	0
Init log likelihood:	-121.289
Final log likelihood:	-28.548
Likelihood ratio test for the init. model:	185.482
Rho-square for the init. model:	0.765
Rho-square-bar for the init. model:	0.657
Final gradient norm:	+1.628e-05
Diagnostic:	Convergence reached...
Iterations:	29
Data processing time:	00:00
Run time:	00:20
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_1	-12.0	369.	-0.03	0.97	*	1.30	-9.25	0.00	
ASC_2	-15.0	369.	-0.04	0.97	*	1.95	-7.67	0.00	
B_ALT1PAX	-1.68	0.756	-2.22	0.03		0.739	-2.27	0.02	
B_GEN	-3.31	1.76e+03	-0.00	1.00	*	0.826	-4.01	0.00	
B_P_BT	-3.45	1.64e+03	-0.00	1.00	*	0.832	-4.14	0.00	
B_P_COM	-4.27	1.62e+03	-0.00	1.00	*	0.667	-6.40	0.00	
B_WALK	-2.30	1.01	-2.28	0.02		0.954	-2.41	0.02	
Bc	-0.666	0.403	-1.65	0.10	*	0.397	-1.68	0.09	*
Bf	0.0205	0.324	0.06	0.95	*	0.273	0.08	0.94	*
Btb	0.0261	0.0282	0.93	0.35	*	0.0254	1.03	0.30	*
Btc	-0.00359	0.0144	-0.25	0.80	*	0.0132	-0.27	0.78	*
Bts	0.00	0.0373	0.00	1.00	*	0.0263	0.00	1.00	*
Bwc	-0.00422	0.00341	-1.24	0.22	*	0.00281	-1.50	0.13	*

Model 3RP

bus rp: ASC_2 + (Btb * TT_BUS) * ((1) - OC_RET) + ((Bf * F_BUS) * (10)) / TT_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_WALK * ((WALK_BUS * AGE) / TT_BUS) + B_HOU * HOUSING

car rp: ASC_1 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + ((Bwc * WT_CAR) * (10)) / TT_CAR + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_ALT1PAX * ALT1PAX + B_PFree * Park_F + B_PPay * Park_P + B_HOU * HOUSING

sp rp: (Btb * (exp(TT_SB / (100)))) * ((1) - OC_RET) + ((Bf * F_SB) * (10)) / TT_SB + (Bc * PAY) * (C_SB_S / INCOME_S) + B_SBW1 * SB_W1 + B_SBPT1 * SB_PT1 + B_SBW2 * SB_W2 + B_SBPT2 * SB_PT2

Estimation report

Number of draws:	100
Number of estimated parameters:	19
Sample size:	250
Excluded observations:	0
Init log likelihood:	-121.289
Final log likelihood:	-0.000
Likelihood ratio test for the init. model:	242.579
Rho-square for the init. model:	1.000
Rho-square-bar for the init. model:	0.843
Final gradient norm:	+5.648e-07
Diagnostic:	Convergence reached...
Iterations:	23
Data processing time:	00:00
Run time:	00:51
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_1	0.734	1.45e+05	0.00	1.00	*	7.67	0.10	0.92	*
ASC_2	-23.3	1.34e+05	-0.00	1.00	*	7.07	-3.30	0.00	
B_ALT1PAX	-21.8	1.61e+04	-0.00	1.00	*	1.24	-17.51	0.00	
B_GEN	-3.26	8.16e+04	-0.00	1.00	*	1.16	-2.81	0.01	
B_HOU	-8.77	1.20e+05	-0.00	1.00	*	2.20	-3.99	0.00	
B_PFree	60.3	1.99e+04	0.00	1.00	*	1.58	38.24	0.00	
B_PPay	52.0	2.19e+04	0.00	1.00	*	2.18	23.88	0.00	
B_P_BT	-5.09	2.03e+05	-0.00	1.00	*	3.79	-1.35	0.18	*
B_P_COM	-9.33	1.93e+05	-0.00	1.00	*	3.72	-2.51	0.01	
B_SBPT1	3.71	4.63e+05	0.00	1.00	*	2.18	1.70	0.09	*
B_SBPT2	3.05	4.60e+05	0.00	1.00	*	1.18	2.59	0.01	
B_SBW1	3.91	2.08e+05	0.00	1.00	*	1.76	2.22	0.03	
B_SBW2	8.91	2.03e+05	0.00	1.00	*	2.60	3.43	0.00	
B_WALK	-0.596	1.47e+03	-0.00	1.00	*	0.136	-4.39	0.00	
Bc	-0.449	2.14e+04	-0.00	1.00	*	0.440	-1.02	0.31	*
Bf	-11.5	3.16e+04	-0.00	1.00	*	2.66	-4.33	0.00	
Btb	-0.174	1.04e+03	-0.00	1.00	*	0.0765	-2.27	0.02	
Btc	-20.4	3.39e+04	-0.00	1.00	*	2.56	-7.96	0.00	
Bwc	-14.9	1.19e+04	-0.00	1.00	*	0.876	-17.04	0.00	

SP current situation models

29 models were built. Here, the most interesting models are displayed.

Model 1SP1

bus spn: *ASC_5 + Btb * TT_BUS + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_WALK * (WALK_BUS * AGE_S)*

car spn: *ASC_4 + Btc * TT_CAR + Bwc * WT_CAR + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER*

sp spn: *Bts * TT_SB + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	12
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-428.711
Likelihood ratio test for the init. model:	445.041
Rho-square for the init. model:	0.342
Rho-square-bar for the init. model:	0.323
Final gradient norm:	+1.157e-03
Diagnostic:	Convergence reached...
Iterations:	11
Data processing time:	00:00
Run time:	00:26
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	-1.27	0.943	-1.34	0.18	*	0.901	-1.41	0.16	*
ASC_5	0.163	0.997	0.16	0.87	*	0.977	0.17	0.87	*
B_GEN	-0.825	0.301	-2.74	0.01		0.318	-2.59	0.01	
B_P_BT	0.317	0.396	0.80	0.42	*	0.388	0.82	0.41	*
B_P_COM	-1.44	0.334	-4.31	0.00		0.341	-4.21	0.00	
B_WALK	0.00	2.38e+07	0.00	1.00	*	6.76e+05	0.00	1.00	*
Bc	-0.391	0.0792	-4.93	0.00		0.0862	-4.53	0.00	
Bf	0.299	0.192	1.56	0.12	*	0.190	1.58	0.11	*
Btb	-0.0329	0.00655	-5.03	0.00		0.00668	-4.93	0.00	
Btc	-0.00344	0.00711	-0.48	0.63	*	0.00675	-0.51	0.61	*
Bts	-0.0245	0.0135	-1.81	0.07	*	0.0132	-1.85	0.06	*
Bwc	0.0248	0.0255	0.97	0.33	*	0.0248	1.00	0.32	*

bus spn: *ASC_5 + Btb * (exp(TT_BUS / (10))) + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER*

car spn: *ASC_4 + Btc * (exp(TT_CAR / (10))) + Bwc * (WT_CAR ^ (1.5)) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER*

sp spn: *Bts * (exp(TT_SB / (10))) + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	11
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-435.117
Likelihood ratio test for the init. model:	432.229
Rho-square for the init. model:	0.332
Rho-square-bar for the init. model:	0.315
Final gradient norm:	+3.490e-03
Diagnostic:	Convergence reached...
Iterations:	22
Data processing time:	00:00
Run time:	00:47
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	-0.334	0.402	-0.83	0.41	*	0.402	-0.83	0.41	*
ASC_5	-1.29	0.327	-3.95	0.00		0.333	-3.87	0.00	
B_GEN	-0.821	0.302	-2.72	0.01		0.320	-2.57	0.01	
B_P_BT	0.313	0.396	0.79	0.43	*	0.390	0.80	0.42	*
B_P_COM	-1.43	0.335	-4.28	0.00		0.343	-4.18	0.00	
Bc	-0.404	0.0802	-5.04	0.00		0.0900	-4.49	0.00	
Bf	0.123	0.177	0.69	0.49	*	0.176	0.70	0.49	*
Btb	-5.47e-06	1.50e-06	-3.64	0.00		1.64e-06	-3.33	0.00	
Btc	1.98e-05	1.43e-05	1.39	0.17	*	1.26e-05	1.57	0.12	*
Bts	-0.000113	9.61e-05	-1.18	0.24	*	9.51e-05	-1.19	0.23	*
Bwc	0.00218	0.00538	0.40	0.69	*	0.00526	0.41	0.68	*

Model 12SP1

bus spn: *ASC_5 + (Btb * TT_BUS) * P_COM + (Btb_bt * TT_BUS) * P_BT + (Btb_oth * TT_BUS) * P_OTH + Bf * F_BUS + Bc * (C_BUS_S / INCOME_S) + B_GEN * GENDER*

car spn: *ASC_4 + (Btc * (log(1.001 + TT_CAR * (10)))) * ((1) - OC_RET) + (Btc_ret * TT_CAR) * OC_RET + Bwc * WT_CAR + Bc * (C_CAR_S / INCOME_S) + B_GEN * GENDER*

sp spn: *Bts * (log(1.001 + TT_SB * (10))) + Bf * F_SB + Bc * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	12
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-444.729
Likelihood ratio test for the init. model:	413.004
Rho-square for the init. model:	0.317
Rho-square-bar for the init. model:	0.299
Final gradient norm:	+3.019e-04
Diagnostic:	Convergence reached...
Iterations:	11
Data processing time:	00:00
Run time:	00:27
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	-7.90	5.14	-1.54	0.12	*	4.97	-1.59	0.11	*
ASC_5	-8.64	5.20	-1.66	0.10	*	5.16	-1.67	0.09	*
B_GEN	-0.507	0.275	-1.84	0.07	*	0.280	-1.81	0.07	*
Bc	-0.186	0.0776	-2.40	0.02		0.0781	-2.39	0.02	
Bf	0.285	0.185	1.54	0.12	*	0.191	1.49	0.14	*
Btb	-0.0383	0.00609	-6.30	0.00		0.00605	-6.33	0.00	
Btb_bt	-0.0439	0.00672	-6.52	0.00		0.00729	-6.02	0.00	
Btb_oth	-0.0334	0.00600	-5.57	0.00		0.00607	-5.50	0.00	
Btc	-0.453	0.254	-1.78	0.07	*	0.224	-2.02	0.04	
Btc_ret	-0.0189	0.0226	-0.84	0.40	*	0.0192	-0.98	0.33	*
Bts	-1.54	0.814	-1.90	0.06	*	0.806	-1.92	0.06	*
Bwc	0.0180	0.0247	0.73	0.47	*	0.0245	0.74	0.46	*

bus spn: *ASC_5 + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_OC_RET * OC_RET + (B_HOU * HOUSING) * P_COM + B_panelB * (Normal(1)) + B_CORR * (Normal(0))*

car spn: *ASC_4 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_OC_RET * OC_RET + (B_HOU * HOUSING) * P_COM + B_panelC * (Normal(2))*

sp spn: *(Bts * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	17
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-437.386
Likelihood ratio test for the init. model:	427.691
Rho-square for the init. model:	0.328
Rho-square-bar for the init. model:	0.302
Final gradient norm:	+3.620e-04
Diagnostic:	Convergence reached...
Iterations:	16
Data processing time:	00:00
Run time:	01:10
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	1.14	1.21	0.94	0.35	*	1.14	1.00	0.32	*
ASC_5	-0.549	1.12	-0.49	0.62	*	1.09	-0.50	0.61	*
B_CORR	0.354	0.704	0.50	0.61	*	0.432	0.82	0.41	*
B_GEN	-1.00	0.329	-3.05	0.00		0.362	-2.76	0.01	
B_HOU	-0.583	0.454	-1.28	0.20	*	0.460	-1.27	0.21	*
B_OC_JOB	-1.00	0.462	-2.17	0.03		0.461	-2.17	0.03	
B_OC_PJOB	-1.03	0.679	-1.52	0.13	*	0.616	-1.68	0.09	*
B_OC_RET	-0.320	1.20	-0.27	0.79	*	1.19	-0.27	0.79	*
B_P_BT	0.726	0.459	1.58	0.11	*	0.477	1.52	0.13	*
B_P_COM	-0.845	0.450	-1.88	0.06	*	0.482	-1.75	0.08	*
B_panelB	-0.457	1.31	-0.35	0.73	*	1.13	-0.41	0.69	*
B_panelC	0.159	0.751	0.21	0.83	*	0.386	0.41	0.68	*
Bc	-0.504	0.154	-3.28	0.00		0.132	-3.83	0.00	
Bf	0.0787	0.158	0.50	0.62	*	0.158	0.50	0.62	*
Btb	-0.920	0.321	-2.86	0.00		0.270	-3.41	0.00	
Btc	-1.26	0.424	-2.97	0.00		0.345	-3.66	0.00	
Bts	-0.803	0.408	-1.97	0.05		0.383	-2.10	0.04	

Model 21SP1

bus spn: *ASC_5 + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bf * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelB * (Normal(1)) + B_CORR * (Normal(0))*

car spn: *ASC_4 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + (Bwc * (log(1 + WT_CAR * (1000)))) * P_COM + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelC * (Normal(2))*

sp spn: *(Bts * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bf * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	17
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-432.485
Likelihood ratio test for the init. model:	437.492
Rho-square for the init. model:	0.336
Rho-square-bar for the init. model:	0.310
Final gradient norm:	+2.821e-03
Diagnostic:	Convergence reached...
Iterations:	6
Data processing time:	00:00
Run time:	00:48
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	-0.0595	0.630	-0.09	0.92	*	0.664	-0.09	0.93	*
ASC_5	-0.595	0.576	-1.03	0.30	*	0.588	-1.01	0.31	*
B_CORR	0.205	0.523	0.39	0.70	*	0.219	0.93	0.35	*
B_GEN	-1.00	0.325	-3.09	0.00		0.361	-2.78	0.01	
B_HOU	-0.579	0.445	-1.30	0.19	*	0.452	-1.28	0.20	*
B_OC_JOB	-0.906	0.429	-2.11	0.03		0.442	-2.05	0.04	
B_OC_PJOB	-0.971	0.659	-1.47	0.14	*	0.590	-1.65	0.10	*
B_P_BT	0.722	0.452	1.60	0.11	*	0.462	1.56	0.12	*
B_P_COM	-0.656	0.463	-1.42	0.16	*	0.501	-1.31	0.19	*
B_panelB	0.0457	2.45	0.02	0.99	*	1.58	0.03	0.98	*
B_panelC	0.0148	0.870	0.02	0.99	*	0.441	0.03	0.97	*
Bc	-0.472	0.0848	-5.56	0.00		0.0941	-5.02	0.00	
Bf	0.630	0.229	2.75	0.01		0.225	2.80	0.01	
Btb	-0.751	0.265	-2.84	0.00		0.249	-3.01	0.00	
Btc	-1.10	0.336	-3.27	0.00		0.314	-3.51	0.00	
Bts	-0.716	0.304	-2.36	0.02		0.295	-2.43	0.02	
Bwc	-0.0300	0.0231	-1.30	0.19	*	0.0235	-1.28	0.20	*

bus spn: *ASC_5 + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bf * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * (OC_FTJOB + OC_PTJOB) + (B_HOU * HOUSING) * P_COM + B_panelB * (Normal(1)) + B_CORR * (Normal(0))*

car spn: *ASC_4 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + (Bwc * (log(1 + WT_CAR * (1000)))) * P_COM + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * (OC_FTJOB + OC_PTJOB) + (B_HOU * HOUSING) * P_COM + B_panelC * (Normal(2))*

sp spn: *(Bts * (exp(TT_SB / (100)))) * ((1) - OC_RET) + Bf * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	16
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-432.856
Likelihood ratio test for the init. model:	436.750
Rho-square for the init. model:	0.335
Rho-square-bar for the init. model:	0.311
Final gradient norm:	+5.078e-04
Diagnostic:	Convergence reached...
Iterations:	8
Data processing time:	00:00
Run time:	00:55
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	-0.314	0.677	-0.46	0.64	*	0.724	-0.43	0.66	*
ASC_5	-0.647	0.617	-1.05	0.29	*	0.640	-1.01	0.31	*
B_CORR	0.250	0.598	0.42	0.68	*	0.312	0.80	0.42	*
B_GEN	-1.01	0.325	-3.11	0.00		0.360	-2.80	0.01	
B_HOU	-0.574	0.443	-1.30	0.19	*	0.442	-1.30	0.19	*
B_OC_JOB	-0.963	0.429	-2.25	0.02		0.434	-2.22	0.03	
B_P_BT	0.713	0.450	1.59	0.11	*	0.457	1.56	0.12	*
B_P_COM	-0.669	0.463	-1.45	0.15	*	0.506	-1.32	0.19	*
B_panelB	-0.104	2.55	-0.04	0.97	*	1.80	-0.06	0.95	*
B_panelC	0.0588	0.982	0.06	0.95	*	0.570	0.10	0.92	*
Bc	-0.482	0.110	-4.38	0.00		0.105	-4.61	0.00	
Bf	0.769	0.243	3.16	0.00		0.230	3.35	0.00	
Btb	-0.585	0.228	-2.56	0.01		0.217	-2.69	0.01	
Btc	-0.916	0.300	-3.05	0.00		0.280	-3.27	0.00	
Bts	-0.870	0.402	-2.17	0.03		0.399	-2.18	0.03	
Bwc	-0.0288	0.0235	-1.23	0.22	*	0.0236	-1.22	0.22	*

Model 25SP1

bus spn: *ASC_5 + (Btpt * (TT_BUS / (100))) * ((1) - OC_RET) + (Btb * (TT_BUS / (100))) * ((1) - OC_RET) + Bfb * ((F_BUS * (10)) / TT_BUS) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + (B_HOU * HOUSING) * P_COM + B_OC_STUD * OC_STUD + B_panelC * (Normal(1)) + B_OC_RET * OC_RET*

car spn: *ASC_4 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + Bwc * (exp((WT_CAR * TT_CAR) / (1000))) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + (B_HOU * HOUSING) * P_COM + B_OC_STUD * OC_STUD + B_panelB * (Normal(0)) + B_OC_RET * OC_RET*

sp spn: *(Btpt * (TT_SB / (100))) * ((1) - OC_RET) + (Bts * (TT_SB / (100))) * ((1) - OC_RET) + Bfs * ((F_SB * (100)) / TT_SB) + (Bc * PAY) * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	19
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-427.217
Likelihood ratio test for the init. model:	448.027
Rho-square for the init. model:	0.344
Rho-square-bar for the init. model:	0.315
Final gradient norm:	+2.119e-03
Diagnostic:	Convergence reached...
Iterations:	6
Data processing time:	00:00
Run time:	01:03
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	1.89	1.37	1.38	0.17	*	1.33	1.42	0.16	*
ASC_5	-0.333	1.45	-0.23	0.82	*	1.42	-0.23	0.81	*
B_GEN	-0.961	0.319	-3.01	0.00		0.355	-2.70	0.01	
B_HOU	-0.526	0.446	-1.18	0.24	*	0.462	-1.14	0.26	*
B_OC_JOB	-0.325	0.452	-0.72	0.47	*	0.417	-0.78	0.44	*
B_OC_RET	-0.932	1.19	-0.78	0.43	*	1.19	-0.78	0.43	*
B_OC_STUD	0.749	0.645	1.16	0.25	*	0.601	1.25	0.21	*
B_P_BT	0.554	0.444	1.25	0.21	*	0.450	1.23	0.22	*
B_P_COM	-1.04	0.444	-2.34	0.02		0.479	-2.17	0.03	
B_panelB	-0.176	0.486	-0.36	0.72	*	0.149	-1.18	0.24	*
B_panelC	0.0618	1.02	0.06	0.95	*	0.277	0.22	0.82	*
Bc	-0.492	0.0847	-5.81	0.00		0.0946	-5.21	0.00	
Bfb	4.92	1.67	2.95	0.00		1.66	2.96	0.00	
Bfs	0.417	0.264	1.58	0.11	*	0.256	1.63	0.10	*
Btb	-0.816	1.80e+308	0.00	1.00	*	0.531	-1.53	0.12	*
Btc	-1.28	0.326	-3.94	0.00		0.303	-4.24	0.00	
Btpt	-1.02	1.80e+308	0.00	1.00	*	0.453	-2.25	0.02	
Bts	-0.518	1.80e+308	0.00	1.00	*	0.973	-0.53	0.59	*
Bwc	0.359	0.114	3.15	0.00		0.105	3.42	0.00	

s spn: *ASC_5 + (Btf * (TT_BUS / (100))) * ((1) - OC_RET) + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bfb * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + (B_HOU * HOUSING) * P_COM + B_OC_STUD * OC_STUD + B_panelC * (Normal(1)) + B_OC_RET * OC_RET*

car spn: *ASC_4 + (Btf * (TT_CAR / (100))) * ((1) - OC_RET) + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + Bwc * (log((WT_CAR * TT_CAR) / (100))) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + (B_HOU * HOUSING) * P_COM + B_OC_STUD * OC_STUD + B_panelB * (Normal(0)) + B_OC_RET * OC_RET*

sp spn: *(Bts * (exp(TT_SB / (100)))) * ((1) - OC_RET) + Bfs * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	18
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-422.991
Likelihood ratio test for the init. model:	456.480
Rho-square for the init. model:	0.350
Rho-square-bar for the init. model:	0.323
Final gradient norm:	+1.718e-05
Diagnostic:	Convergence reached...
Iterations:	9
Data processing time:	00:00
Run time:	01:21
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	0.0122	1.72	0.01	0.99	*	1.70	0.01	0.99	*
ASC_5	-0.749	1.58	-0.47	0.64	*	1.55	-0.48	0.63	*
B_GEN	-0.933	0.315	-2.97	0.00		0.346	-2.70	0.01	
B_HOU	-0.564	0.442	-1.28	0.20	*	0.447	-1.26	0.21	*
B_OC_RET	-1.61	1.61	-1.00	0.32	*	1.61	-1.00	0.32	*
B_OC_STUD	0.981	0.542	1.81	0.07	*	0.533	1.84	0.07	*
B_P_BT	0.483	0.419	1.15	0.25	*	0.421	1.15	0.25	*
B_P_COM	-1.09	0.434	-2.51	0.01		0.475	-2.30	0.02	
B_panelB	-0.173	0.488	-0.35	0.72	*	0.145	-1.19	0.23	*
B_panelC	0.0531	0.722	0.07	0.94	*	0.132	0.40	0.69	*
Bc	-0.486	0.0861	-5.65	0.00		0.0983	-4.94	0.00	
Bfb	0.588	0.326	1.81	0.07	*	0.306	1.92	0.05	*
Bfs	1.20	0.653	1.84	0.07	*	0.638	1.88	0.06	*
Btb	-5.51	1.67	-3.31	0.00		1.69	-3.27	0.00	
Btc	-6.26	1.74	-3.61	0.00		1.75	-3.58	0.00	
Btf	12.0	3.93	3.06	0.00		3.96	3.04	0.00	
Bts	-0.859	0.621	-1.38	0.17	*	0.603	-1.43	0.15	*
Bwc	0.362	0.243	1.49	0.14	*	0.238	1.52	0.13	*

Model 28SP1

bus spn: *ASC_5 + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + (Bf * (log(F_BUS * TT_BUS))) * ((1) - OC_RET) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * (OC_FTJOB + OC_PTJOB) + (B_HOU * HOUSING) * P_COM + B_OC_STUD * OC_STUD + B_panelC * (Normal(2)) + B_CORR * (Normal(0))*

car spn: *ASC_4 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + (Bwc * (exp((WT_CAR * TT_CAR) / (1000)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * (OC_FTJOB + OC_PTJOB) + (B_HOU * HOUSING) * P_COM + B_OC_STUD * OC_STUD + B_panelB * (Normal(1))*

sp spn: *(Bts * (exp(TT_SB / (100)))) * ((1) - OC_RET) + (Bf * (log(F_SB * (100)))) * ((1) - OC_RET) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	17
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-420.852
Likelihood ratio test for the init. model:	460.758
Rho-square for the init. model:	0.354
Rho-square-bar for the init. model:	0.328
Final gradient norm:	+1.610e-03
Diagnostic:	Convergence reached...
Iterations:	6
Data processing time:	00:00
Run time:	00:51
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	1.29	0.577	2.23	0.03		0.621	2.07	0.04	
ASC_5	-1.29	0.645	-2.00	0.05		0.659	-1.96	0.05	*
B_CORR	0.158	0.480	0.33	0.74	*	0.130	1.21	0.23	*
B_GEN	-1.00	0.325	-3.08	0.00		0.361	-2.78	0.01	
B_HOU	-0.566	0.445	-1.27	0.20	*	0.456	-1.24	0.21	*
B_OC_JOB	-0.504	0.590	-0.85	0.39	*	0.571	-0.88	0.38	*
B_OC_STUD	0.558	0.747	0.75	0.45	*	0.705	0.79	0.43	*
B_P_BT	0.682	0.456	1.49	0.14	*	0.463	1.47	0.14	*
B_P_COM	-0.931	0.461	-2.02	0.04		0.500	-1.86	0.06	*
B_panelB	0.00789	0.526	0.02	0.99	*	0.0696	0.11	0.91	*
B_panelC	-0.119	0.716	-0.17	0.87	*	0.162	-0.73	0.46	*
Bc	-0.486	0.0868	-5.60	0.00		0.0987	-4.92	0.00	
Bf	0.943	0.166	5.69	0.00		0.156	6.04	0.00	
Btb	-1.55	0.289	-5.37	0.00		0.290	-5.35	0.00	
Btc	-0.695	0.329	-2.11	0.03		0.311	-2.23	0.03	
Bts	-2.25	0.502	-4.48	0.00		0.494	-4.56	0.00	
Bwc	0.285	0.123	2.32	0.02		0.113	2.53	0.01	

Model 29SP1 (the chosen one)

bus spn: *ASC_5 + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + (Bf * (log(F_BUS / (10)))) * P_COM + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelB * (Normal(1)) + B_CORR * (Normal(0))*

car spn: *ASC_4 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + (Bwc * (log(1 + WT_CAR * (1000)))) * P_COM + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelC * (Normal(2))*

sp spn: *(Bts * (exp(TT_SB / (100)))) * ((1) - OC_RET) + (Bf * (log(F_SB / (10)))) * P_COM + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	17
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-438.498
Likelihood ratio test for the init. model:	425.466
Rho-square for the init. model:	0.327
Rho-square-bar for the init. model:	0.301
Final gradient norm:	+4.745e-03
Diagnostic:	Convergence reached...
Iterations:	8
Data processing time:	00:00
Run time:	01:02
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	0.837	0.591	1.42	0.16	*	0.634	1.32	0.19	*
ASC_5	-0.682	0.631	-1.08	0.28	*	0.637	-1.07	0.28	*
B_CORR	0.328	0.673	0.49	0.63	*	0.409	0.80	0.42	*
B_GEN	-1.00	0.326	-3.08	0.00		0.364	-2.76	0.01	
B_HOU	-0.589	0.448	-1.32	0.19	*	0.453	-1.30	0.19	*
B_OC_JOB	-0.948	0.439	-2.16	0.03		0.456	-2.08	0.04	
B_OC_PJOB	-0.961	0.661	-1.45	0.15	*	0.624	-1.54	0.12	*
B_P_BT	0.707	0.459	1.54	0.12	*	0.486	1.46	0.15	*
B_P_COM	-0.627	0.465	-1.35	0.18	*	0.509	-1.23	0.22	*
B_panelB	-0.227	1.55	-0.15	0.88	*	0.989	-0.23	0.82	*
B_panelC	0.0947	0.807	0.12	0.91	*	0.345	0.27	0.78	*
Bc	-0.484	0.125	-3.86	0.00		0.109	-4.42	0.00	
Bf	0.159	0.306	0.52	0.60	*	0.299	0.53	0.60	*
Btb	-0.648	0.232	-2.79	0.01		0.214	-3.02	0.00	
Btc	-0.853	0.302	-2.83	0.00		0.277	-3.08	0.00	
Bts	-0.782	0.406	-1.93	0.05	*	0.400	-1.96	0.05	*
Bwc	-0.0689	0.0694	-0.99	0.32	*	0.0657	-1.05	0.29	*

SP fixed link situation models

15 models were built. Here, the most interesting models are displayed.

Model 1SP2

bus spb: *ASC_8 + Btb * TT_BUS + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER + B_WALK * (WALK_BUS * AGE_S)*

car spb: *ASC_7 + Btc * TT_CAR + Bwc * WT_CAR + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER*

sp spb: *Bts * TT_SB + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	12
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-570.194
Likelihood ratio test for the init. model:	162.074
Rho-square for the init. model:	0.124
Rho-square-bar for the init. model:	0.106
Final gradient norm:	+5.468e-05
Diagnostic:	Convergence reached...
Iterations:	10
Data processing time:	00:00
Run time:	00:23
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	0.0209	0.641	0.03	0.97	*	0.644	0.03	0.97	*
ASC_8	0.665	0.643	1.04	0.30	*	0.642	1.04	0.30	*
B_GEN	-0.776	0.247	-3.15	0.00		0.251	-3.09	0.00	
B_P_BT	1.70	0.537	3.17	0.00		0.558	3.05	0.00	
B_P_COM	-0.475	0.278	-1.71	0.09	*	0.280	-1.70	0.09	*
B_WALK	0.00	2.15e+03	0.00	1.00	*	1.80e+308	0.00	1.00	*
Bc	-0.364	0.0710	-5.13	0.00		0.0792	-4.60	0.00	
Bf	0.238	0.135	1.76	0.08	*	0.137	1.74	0.08	*
Btb	-0.0341	0.00727	-4.69	0.00		0.00739	-4.61	0.00	
Btc	-0.00227	0.00763	-0.30	0.77	*	0.00753	-0.30	0.76	*
Bts	-0.0162	0.0100	-1.62	0.11	*	0.00997	-1.63	0.10	*
Bwc	0.00	1.80e+308	0.00	1.00	*	7.25e+05	0.00	1.00	*

bus spb: *ASC_8 + Btb * TT_BUS + Bf * F_BUS + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER*

car spb: *ASC_7 + (Btc * TT_CAR) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_P_COM * P_COM + B_P_BT * P_BT + B_GEN * GENDER*

sp spb: *Bts * TT_SB + Bf * F_SB + (Bc * PAY) * (C_SB_S / INCOME_S)*

Estimation report

Number of draws:	100
Number of estimated parameters:	10
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-565.419
Likelihood ratio test for the init. model:	171.625
Rho-square for the init. model:	0.132
Rho-square-bar for the init. model:	0.116
Final gradient norm:	+3.891e-04
Diagnostic:	Convergence reached...
Iterations:	9
Data processing time:	00:00
Run time:	00:16
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	0.233	0.642	0.36	0.72	*	0.654	0.36	0.72	*
ASC_8	0.647	0.647	1.00	0.32	*	0.648	1.00	0.32	*
B_GEN	-0.806	0.248	-3.24	0.00		0.256	-3.15	0.00	
B_P_BT	1.76	0.536	3.29	0.00		0.552	3.19	0.00	
B_P_COM	-0.430	0.280	-1.54	0.12	*	0.282	-1.52	0.13	*
Bc	-0.410	0.0740	-5.55	0.00		0.0845	-4.86	0.00	
Bf	0.244	0.136	1.80	0.07	*	0.138	1.77	0.08	*
Btb	-0.0423	0.00670	-6.31	0.00		0.00683	-6.19	0.00	
Btc	-0.0174	0.00571	-3.05	0.00		0.00563	-3.09	0.00	
Bts	-0.0239	0.00958	-2.49	0.01		0.00947	-2.52	0.01	

Model 5SP2

bus spb: *ASC_8 + (Btb * (exp(TT_BUS / (1000)))) * ((1) - OC_RET) + Bf * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_CORR * (Normal(0))*

car spb: *ASC_7 + (Btc * (exp(TT_CAR / (1000)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelC * (Normal(2))*

sp spb: *(Bts * (exp(TT_SB / (1000)))) * ((1) - OC_RET) + Bf * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0)) + B_panelB * (Normal(1))*

Estimation report

Number of draws:	100
Number of estimated parameters:	15
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-568.750
Likelihood ratio test for the init. model:	164.962
Rho-square for the init. model:	0.127
Rho-square-bar for the init. model:	0.104
Final gradient norm:	+6.807e-05
Diagnostic:	Convergence reached...
Iterations:	16
Data processing time:	00:00
Run time:	01:14
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	1.09	0.853	1.27	0.20	*	0.828	1.31	0.19	*
ASC_8	-1.05	0.980	-1.08	0.28	*	1.00	-1.05	0.29	*
B_CORR	0.274	0.657	0.42	0.68	*	0.346	0.79	0.43	*
B_GEN	-1.02	0.569	-1.79	0.07	*	0.730	-1.40	0.16	*
B_HOU	-0.149	0.398	-0.38	0.71	*	0.397	-0.38	0.71	*
B_OC_JOB	-1.09	0.686	-1.59	0.11	*	0.804	-1.35	0.18	*
B_OC_PJOB	-1.02	0.869	-1.18	0.24	*	0.971	-1.05	0.29	*
B_P_COM	-0.909	0.601	-1.51	0.13	*	0.756	-1.20	0.23	*
B_panelB	-1.09	1.59	-0.69	0.49	*	2.21	-0.49	0.62	*
B_panelC	0.0383	0.601	0.06	0.95	*	0.138	0.28	0.78	*
Bc	-0.523	0.0852	-6.13	0.00		0.0944	-5.53	0.00	
Bf	0.669	0.235	2.84	0.00		0.298	2.24	0.02	
Btb	-12.5	6.99	-1.79	0.07	*	6.77	-1.85	0.06	*
Btc	-14.7	7.10	-2.07	0.04		6.87	-2.14	0.03	
Bts	-14.7	7.11	-2.07	0.04		6.95	-2.12	0.03	

bus spb: *ASC_8 + B_SOF * SOF + (Btb * (exp(TT_BUS / (1000)))) * ((1) - OC_RET) + Bf * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_CORR * (Normal(0))*

car spb: *ASC_7 + B_SOF * SOF + (Btc * (exp(TT_CAR / (1000)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panel2 * (Normal(2))*

sp spb: *(Bts * (exp(TT_SB / (1000)))) * ((1) - OC_RET) + Bf * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0)) + B_panel1 * (Normal(1))*

Estimation report

Number of draws:	100
Number of estimated parameters:	16
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-568.750
Likelihood ratio test for the init. model:	164.962
Rho-square for the init. model:	0.127
Rho-square-bar for the init. model:	0.102
Final gradient norm:	+2.352e-04
Diagnostic:	Convergence reached...
Iterations:	20
Data processing time:	00:00
Run time:	01:45
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	1.09	0.853	1.27	0.20	*	0.828	1.31	0.19	*
ASC_8	-1.05	0.980	-1.08	0.28	*	1.00	-1.05	0.29	*
B_CORR	0.274	0.657	0.42	0.68	*	0.346	0.79	0.43	*
B_GEN	-1.02	0.570	-1.79	0.07	*	0.730	-1.40	0.16	*
B_HOU	-0.149	0.399	-0.37	0.71	*	0.398	-0.38	0.71	*
B_OC_JOB	-1.09	0.686	-1.59	0.11	*	0.804	-1.35	0.18	*
B_OC_PJOB	-1.02	0.869	-1.18	0.24	*	0.971	-1.05	0.29	*
B_P_COM	-0.909	0.601	-1.51	0.13	*	0.756	-1.20	0.23	*
B_SOF	1.43e-12	69.8	0.00	1.00	*	4.01	0.00	1.00	*
B_panel1	-1.09	1.59	-0.69	0.49	*	2.21	-0.49	0.62	*
B_panel2	0.0383	0.601	0.06	0.95	*	0.138	0.28	0.78	*
Bc	-0.523	0.0852	-6.13	0.00		0.0944	-5.53	0.00	
Bf	0.669	0.235	2.85	0.00		0.297	2.25	0.02	
Btb	-12.5	6.99	-1.79	0.07	*	6.77	-1.85	0.06	*
Btc	-14.7	7.10	-2.07	0.04		6.87	-2.14	0.03	
Bts	-14.7	7.12	-2.07	0.04		6.95	-2.12	0.03	

Model 10SP2

bus spb: *ASC_8 + (Btb * (exp(TT_BUS / (100)))) * ((1) - OC_RET) + Bf * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_OC_STUD * OC_STUD + B_OC_RET * OC_RET + B_CORR * (Normal(0))*

car spb: *ASC_7 + (Btc * (exp(TT_CAR / (1000)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_OC_STUD * OC_STUD + B_OC_RET * OC_RET + B_panel1 * (Normal(1))*

sp spb: *(Bts * (exp(TT_SB / (1000)))) * ((1) - OC_RET) + Bf * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0)) + B_panel2 * (Normal(2))*

Estimation report

Number of draws:	100
Number of estimated parameters:	16
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-560.794
Likelihood ratio test for the init. model:	180.875
Rho-square for the init. model:	0.139
Rho-square-bar for the init. model:	0.114
Final gradient norm:	+9.977e-06
Diagnostic:	Convergence reached...
Iterations:	17
Data processing time:	00:00
Run time:	01:34
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	-4.31	9.34	-0.46	0.64	*	9.19	-0.47	0.64	*
ASC_8	-6.94	9.37	-0.74	0.46	*	9.22	-0.75	0.45	*
B_CORR	0.318	0.576	0.55	0.58	*	0.284	1.12	0.26	*
B_GEN	-0.863	0.277	-3.12	0.00		0.253	-3.41	0.00	
B_OC_JOB	-1.54	0.729	-2.11	0.04		0.691	-2.22	0.03	
B_OC_PJOB	-1.38	0.833	-1.66	0.10	*	0.825	-1.68	0.09	*
B_OC_RET	5.61	9.39	0.60	0.55	*	9.23	0.61	0.54	*
B_OC_STUD	-0.840	0.842	-1.00	0.32	*	0.817	-1.03	0.30	*
B_P_COM	-0.770	0.295	-2.61	0.01		0.278	-2.77	0.01	
B_panel1	0.0490	0.692	0.07	0.94	*	0.143	0.34	0.73	*
B_panel2	0.280	0.977	0.29	0.77	*	0.337	0.83	0.41	*
Bc	-0.488	0.0831	-5.87	0.00		0.0927	-5.26	0.00	
Bf	0.326	0.193	1.69	0.09	*	0.194	1.68	0.09	*
Btb	-1.69	0.415	-4.07	0.00		0.408	-4.14	0.00	
Btc	-5.00	0.919	-5.43	0.00		0.896	-5.58	0.00	
Bts	-10.8	8.98	-1.20	0.23	*	8.87	-1.22	0.22	*

Bus: *ASC_8 + (Btb * (log(TT_BUS / (10)))) * ((1) - OC_RET) + Bf * (log((F_BUS * (10)) / TT_BUS)) + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_OC_JOB * (OC_FTJOB + OC_PTJOB) + B_panel2 * (Normal(2)) + B_P_BT * P_BT + B_CORR * (Normal(0))*

Car: *ASC_7 + (Btc * (exp(TT_CAR / (100)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_OC_JOB * (OC_FTJOB + OC_PTJOB) + B_P_BT * P_BT + B_panel1 * (Normal(1))*

Speed boat: *(Bts * (exp(TT_SB / (100)))) * ((1) - OC_RET) + Bf * (log((F_SB * (10)) / TT_SB)) + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	13
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-565.314
Likelihood ratio test for the init. model:	171.835
Rho-square for the init. model:	0.132
Rho-square-bar for the init. model:	0.112
Final gradient norm:	+2.718e-05
Diagnostic:	Convergence reached...
Iterations:	10
Data processing time:	00:00
Run time:	00:33
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	0.874	0.690	1.27	0.21	*	0.739	1.18	0.24	*
ASC_8	-0.441	0.712	-0.62	0.54	*	0.665	-0.66	0.51	*
B_CORR	0.421	0.697	0.60	0.55	*	0.338	1.25	0.21	*
B_GEN	-1.07	0.311	-3.43	0.00		0.307	-3.48	0.00	
B_OC_JOB	-1.56	0.478	-3.26	0.00		0.444	-3.52	0.00	
B_P_BT	2.47	0.572	4.32	0.00		0.584	4.23	0.00	
B_panel1	0.158	0.705	0.22	0.82	*	0.266	0.60	0.55	*
B_panel2	-1.69	0.780	-2.17	0.03		0.777	-2.17	0.03	
Bc	-0.623	0.171	-3.65	0.00		0.163	-3.82	0.00	
Bf	0.785	0.259	3.03	0.00		0.227	3.47	0.00	
Btb	-0.812	0.506	-1.60	0.11	*	0.482	-1.68	0.09	*
Btc	-1.52	0.571	-2.66	0.01		0.535	-2.84	0.00	
Bts	-1.17	0.537	-2.19	0.03		0.524	-2.24	0.02	

Model 13SP2

Bus: *ASC_8 + (Btb * (exp(TT_BUS / (1000)))) * ((1) - OC_RET) + (Bf * (log(F_BUS / (10)))) * P_COM + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel2 * (Normal(2)) + B_CORR * (Normal(0)) + B_OC_STUD * OC_STUD + B_OC_RET * OC_RET + (B_HOU * HOUSING) * P_COM*

Car: *ASC_7 + (Btc * (exp(TT_CAR / (1000)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel1 * (Normal(1)) + B_OC_STUD * OC_STUD + B_OC_RET * OC_RET + (B_HOU * HOUSING) * P_COM*

Speed boat: *(Bts * (exp(TT_SB / (1000)))) * ((1) - OC_RET) + (Bf * (log(F_SB / (10)))) * P_COM + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	18
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-561.514
Likelihood ratio test for the init. model:	179.433
Rho-square for the init. model:	0.138
Rho-square-bar for the init. model:	0.110
Final gradient norm:	+4.552e-05
Diagnostic:	Convergence reached...
Iterations:	18
Data processing time:	00:00
Run time:	02:13
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	8.53	12.1	0.70	0.48	*	12.2	0.70	0.49	*
ASC_8	4.16	11.9	0.35	0.73	*	12.3	0.34	0.73	*
B_CORR	0.702	0.949	0.74	0.46	*	0.598	1.17	0.24	*
B_GEN	-1.14	0.360	-3.16	0.00		0.318	-3.57	0.00	
B_HOU	-0.126	0.388	-0.32	0.75	*	0.400	-0.31	0.75	*
B_OC_JOB	-2.87	1.03	-2.78	0.01		0.890	-3.23	0.00	
B_OC_PJOB	-2.31	1.09	-2.13	0.03		0.997	-2.31	0.02	
B_OC_RET	-6.35	12.0	-0.53	0.60	*	12.3	-0.52	0.60	*
B_OC_STUD	-1.38	1.02	-1.35	0.18	*	0.972	-1.42	0.16	*
B_P_BT	2.72	0.754	3.61	0.00		0.670	4.07	0.00	
B_P_COM	0.196	0.503	0.39	0.70	*	0.512	0.38	0.70	*
B_panel1	0.229	1.09	0.21	0.83	*	0.622	0.37	0.71	*
B_panel2	-1.88	0.979	-1.92	0.06	*	0.868	-2.16	0.03	
Bc	-0.742	0.251	-2.96	0.00		0.200	-3.71	0.00	
Bf	0.0641	0.140	0.46	0.65	*	0.140	0.46	0.65	*
Btb	-21.1	10.1	-2.10	0.04		9.13	-2.32	0.02	
Btc	-24.3	10.6	-2.29	0.02		9.31	-2.61	0.01	
Bts	-18.5	12.3	-1.51	0.13	*	12.1	-1.53	0.13	*

Bus: *ASC_8 + (Btb * (exp(TT_BUS / (1000)))) * ((1) - OC_RET) + (Bf * (log(F_BUS / (10)))) * P_COM + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel2 * (Normal(2)) + B_CORR * (Normal(0)) + B_OC_STUD * OC_STUD + (B_HOU * HOUSING) * P_COM*

Car: *ASC_7 + (Btc * (exp(TT_CAR / (1000)))) * ((1) - OC_RET) + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel1 * (Normal(1)) + B_OC_STUD * OC_STUD + (B_HOU * HOUSING) * P_COM*

Speedboat: *(Bts * TT_SB) * ((1) - OC_RET) + (Bf * (log(F_SB / (10)))) * P_COM + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	17
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-564.998
Likelihood ratio test for the init. model:	172.467
Rho-square for the init. model:	0.132
Rho-square-bar for the init. model:	0.106
Final gradient norm:	+1.460e-03
Diagnostic:	Convergence reached...
Iterations:	19
Data processing time:	00:00
Run time:	01:48
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	2.38	0.813	2.93	0.00		0.824	2.89	0.00	
ASC_8	-2.45	1.38	-1.78	0.08	*	1.24	-1.97	0.05	
B_CORR	0.594	1.05	0.56	0.57	*	0.748	0.79	0.43	*
B_GEN	-1.10	0.353	-3.13	0.00		0.325	-3.40	0.00	
B_HOU	-0.134	0.398	-0.34	0.74	*	0.410	-0.33	0.74	*
B_OC_JOB	-2.61	0.985	-2.65	0.01		0.814	-3.20	0.00	
B_OC_PJOB	-1.99	1.07	-1.86	0.06	*	0.959	-2.07	0.04	
B_OC_STUD	-1.07	1.01	-1.06	0.29	*	0.933	-1.14	0.25	*
B_P_BT	2.66	0.736	3.61	0.00		0.682	3.90	0.00	
B_P_COM	0.201	0.531	0.38	0.71	*	0.540	0.37	0.71	*
B_panel1	0.248	1.44	0.17	0.86	*	1.12	0.22	0.83	*
B_panel2	-2.37	1.01	-2.36	0.02		0.907	-2.62	0.01	
Bc	-0.795	0.249	-3.19	0.00		0.209	-3.81	0.00	
Bf	0.0567	0.152	0.37	0.71	*	0.152	0.37	0.71	*
Btb	2.93	1.59	1.84	0.07	*	1.36	2.15	0.03	
Btc	-0.141	1.22	-0.12	0.91	*	1.23	-0.12	0.91	*
Bts	-0.00613	0.0117	-0.52	0.60	*	0.0120	-0.51	0.61	*

Model 15SP2 (the chosen one)

Bus: *ASC_8 + (Btb * (exp(TT_BUS / (1000)))) * ((1) - OC_RET) + (Bf * (log(F_BUS / (10)))) * ((1) - OC_RET) + ((Bc * PAY) * (C_BUS_S / INCOME_S)) * ((1) - OC_RET) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel2 * (Normal(2)) + B_CORR * (Normal(0)) + B_OC_STUD * OC_STUD + (B_HOU * HOUSING) * P_COM*

Car: *ASC_7 + (Btc * (exp(TT_CAR / (1000)))) * ((1) - OC_RET) + ((Bc * PAY) * (C_CAR_S / INCOME_S)) * ((1) - OC_RET) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel1 * (Normal(1)) + B_OC_STUD * OC_STUD + (B_HOU * HOUSING) * P_COM*

Speed boat: *(Bts * (exp(TT_SB / (1000)))) * ((1) - OC_RET) + (Bf * (log(F_SB / (10)))) * ((1) - OC_RET) + ((Bc * PAY) * (C_SB_S / INCOME_S)) * ((1) - OC_RET) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	17
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-558.726
Likelihood ratio test for the init. model:	185.010
Rho-square for the init. model:	0.142
Rho-square-bar for the init. model:	0.116
Final gradient norm:	+1.960e-04
Diagnostic:	Convergence reached...
Iterations:	19
Data processing time:	00:00
Run time:	02:06
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	1.01	0.703	1.43	0.15	*	0.663	1.52	0.13	*
ASC_8	-2.29	1.61	-1.42	0.15	*	1.58	-1.45	0.15	*
B_CORR	0.729	1.01	0.72	0.47	*	0.751	0.97	0.33	*
B_GEN	-1.19	0.432	-2.75	0.01		0.376	-3.16	0.00	
B_HOU	-0.117	0.413	-0.28	0.78	*	0.429	-0.27	0.79	*
B_OC_JOB	-2.95	1.22	-2.41	0.02		1.05	-2.81	0.01	
B_OC_PJOB	-2.32	1.20	-1.93	0.05	*	1.11	-2.10	0.04	
B_OC_STUD	-1.32	1.08	-1.22	0.22	*	1.03	-1.28	0.20	*
B_P_BT	2.79	0.909	3.07	0.00		0.791	3.53	0.00	
B_P_COM	0.302	0.513	0.59	0.56	*	0.520	0.58	0.56	*
B_panel1	0.613	1.11	0.55	0.58	*	0.808	0.76	0.45	*
B_panel2	-2.18	1.35	-1.61	0.11	*	1.33	-1.63	0.10	*
Bc	-0.870	0.388	-2.25	0.02		0.353	-2.47	0.01	
Bf	0.296	0.328	0.90	0.37	*	0.316	0.94	0.35	*
Btb	-22.8	11.9	-1.92	0.06	*	10.7	-2.12	0.03	
Btc	-25.2	12.6	-1.99	0.05		11.2	-2.24	0.03	
Bts	-26.1	12.6	-2.07	0.04		11.2	-2.33	0.02	

Travel time divided by purpose. SP current situation model

bus spn:
*ASC_5 + ((Btb_com * (exp(TT_BUS / (100)))) * ((1) - OC_RET)) * P_COM + ((Btb_bt * (exp(TT_BUS / (100)))) * ((1) - OC_RET)) * P_BT + ((Btb_oth * (exp(TT_BUS / (100)))) * ((1) - OC_RET)) * P_OTH + (Bf * (log(F_BUS / (10)))) * P_COM + (Bc * PAY) * (C_BUS_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelB * (Normal(1)) + B_CORR * (Normal(0))*

car spn:
*ASC_4 + ((Btc_com * (exp(TT_CAR / (100)))) * ((1) - OC_RET)) * P_COM + ((Btc_bt * (exp(TT_CAR / (100)))) * ((1) - OC_RET)) * P_BT + ((Btc_oth * (exp(TT_CAR / (100)))) * ((1) - OC_RET)) * P_OTH + (Bwc * (log(1 + WT_CAR * (1000)))) * P_COM + (Bc * PAY) * (C_CAR_S / INCOME_S) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + (B_HOU * HOUSING) * P_COM + B_panelC * (Normal(2))*

sp spn:
*((Bts_com * (exp(TT_SB / (100)))) * ((1) - OC_RET)) * P_COM + ((Bts_bt * (exp(TT_SB / (100)))) * ((1) - OC_RET)) * P_BT + ((Bts_oth * (exp(TT_SB / (100)))) * ((1) - OC_RET)) * P_OTH + (Bf * (log(F_SB / (10)))) * P_COM + (Bc * PAY) * (C_SB_S / INCOME_S) + B_CORR * (Normal(0))*

Estimation report

Number of draws:	100
Number of estimated parameters:	23
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-414.299
Likelihood ratio test for the init. model:	473.863
Rho-square for the init. model:	0.364
Rho-square-bar for the init. model:	0.329
Final gradient norm:	+2.834e-04
Diagnostic:	Convergence reached...
Iterations:	16
Data processing time:	00:00
Run time:	04:06
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_4	0.00331	0.891	0.00	1.00	*	0.950	0.00	1.00	*
ASC_5	-3.48	1.74	-2.00	0.05		1.69	-2.06	0.04	
B_CORR	1.05	0.981	1.07	0.28	*	0.938	1.12	0.26	*
B_GEN	-1.06	0.484	-2.19	0.03		0.551	-1.93	0.05	*
B_HOU	-0.908	0.572	-1.59	0.11	*	0.571	-1.59	0.11	*
B_OC_JOB	-1.15	0.628	-1.84	0.07	*	0.683	-1.69	0.09	*
B_OC_PJOB	-1.11	0.830	-1.34	0.18	*	0.806	-1.38	0.17	*
B_P_BT	4.73	3.70	1.28	0.20	*	3.64	1.30	0.19	*
B_P_COM	8.79	4.14	2.12	0.03		3.63	2.42	0.02	
B_panelB	1.36	1.20	1.13	0.26	*	1.20	1.14	0.26	*
B_panelC	-0.929	0.837	-1.11	0.27	*	0.725	-1.28	0.20	*
Bc	-0.580	0.253	-2.29	0.02		0.251	-2.31	0.02	
Bf	-0.283	0.477	-0.59	0.55	*	0.477	-0.59	0.55	*
Btb_bt	-0.215	0.673	-0.32	0.75	*	0.677	-0.32	0.75	*
Btb_com	-2.46	1.20	-2.05	0.04		1.20	-2.05	0.04	
Btb_oth	-0.255	0.506	-0.51	0.61	*	0.470	-0.54	0.59	*
Btc_bt	-0.646	0.853	-0.76	0.45	*	0.823	-0.78	0.43	*
Btc_com	-0.513	0.720	-0.71	0.48	*	0.793	-0.65	0.52	*
Btc_oth	-1.29	0.730	-1.76	0.08	*	0.637	-2.02	0.04	
Bts_bt	1.02	1.65	0.62	0.54	*	1.62	0.63	0.53	*
Bts_com	0.711	1.13	0.63	0.53	*	1.00	0.71	0.48	*
Bts_oth	-1.69	0.894	-1.90	0.06	*	0.811	-2.09	0.04	
Bwc	-0.720	0.370	-1.95	0.05	*	0.371	-1.94	0.05	*

Travel time divided by purpose. SP fixed link situation model

Bus:
```
ASC_8 + ( ( Btb_com * ( exp(TT_BUS / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_COM + ( ( Btb_bt * ( exp(TT_BUS / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_BT + ( ( Btb_oth * ( exp(TT_BUS / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_OTH + ( Bf * ( log(F_BUS / ( 10 )) ) ) * ( ( 1 ) - OC_RET ) + ( ( Bc * PAY ) * ( C_BUS_S / INCOME_S ) ) * ( ( 1 ) - OC_RET ) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel2 * ( Normal(2) ) + B_CORR * ( Normal(0) ) + B_OC_STUD * OC_STUD + ( B_HOU * HOUSING ) * P_COM
```

Car:
```
ASC_7 + ( ( Btc_com * ( exp(TT_CAR / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_COM + ( ( Btc_bt * ( exp(TT_CAR / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_BT + ( ( Btc_oth * ( exp(TT_CAR / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_OTH + ( ( Bc * PAY ) * ( C_CAR_S / INCOME_S ) ) * ( ( 1 ) - OC_RET ) + B_GEN * GENDER + B_P_COM * P_COM + B_P_BT * P_BT + B_OC_JOB * OC_FTJOB + B_OC_PJOB * OC_PTJOB + B_panel1 * ( Normal(1) ) + B_OC_STUD * OC_STUD + ( B_HOU * HOUSING ) * P_COM
```

Speed boat:
```
( ( Bts_com * ( exp(TT_SB / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_COM + ( ( Bts_bt * ( exp(TT_SB / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_BT + ( ( Bts_oth * ( exp(TT_SB / ( 1000 )) ) ) * ( ( 1 ) - OC_RET ) ) * P_OTH + ( Bf * ( log(F_SB / ( 10 )) ) ) * ( ( 1 ) - OC_RET ) + ( ( Bc * PAY ) * ( C_SB_S / INCOME_S ) ) * ( ( 1 ) - OC_RET ) + B_CORR * ( Normal(0) )
```

Estimation report

Number of draws:	100
Number of estimated parameters:	23
Sample size:	750
Excluded observations:	0
Init log likelihood:	-651.231
Final log likelihood:	-554.808
Likelihood ratio test for the init. model:	192.846
Rho-square for the init. model:	0.148
Rho-square-bar for the init. model:	0.113
Final gradient norm:	+9.895e-03
Diagnostic:	Convergence reached...
Iterations:	43
Data processing time:	00:00
Run time:	11:21
Nbr of threads:	6

Estimated parameters

Click on the headers of the columns to sort the table [Credits]

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value	
ASC_7	6.22	6.41	0.97	0.33	*	8.17	0.76	0.45	*
ASC_8	-24.7	22.6	-1.09	0.27	*	33.4	-0.74	0.46	*
B_CORR	13.5	12.1	1.12	0.26	*	18.4	0.74	0.46	*
B_GEN	-7.87	7.34	-1.07	0.28	*	11.0	-0.72	0.47	*
B_HOU	-1.34	3.10	-0.43	0.67	*	3.87	-0.35	0.73	*
B_OC_JOB	-20.3	17.6	-1.16	0.25	*	25.8	-0.79	0.43	*
B_OC_PJOB	-15.6	14.4	-1.09	0.28	*	20.5	-0.76	0.44	*
B_OC_STUD	-7.69	8.76	-0.88	0.38	*	11.0	-0.70	0.48	*
B_P_BT	146.	223.	0.66	0.51	*	166.	0.88	0.38	*
B_P_COM	-0.415	10.3	-0.04	0.97	*	10.6	-0.04	0.97	*
B_panel1	4.75	4.18	1.14	0.26	*	5.98	0.79	0.43	*
B_panel2	-25.3	22.3	-1.14	0.25	*	33.7	-0.75	0.45	*
Bc	-7.57	6.88	-1.10	0.27	*	10.5	-0.72	0.47	*
Bf	1.29	2.21	0.59	0.56	*	2.20	0.59	0.56	*
Btb_bt	-86.5	12.2	-7.07	0.00		17.4	-4.98	0.00	
Btb_com	-71.1	25.7	-2.77	0.01		36.1	-1.97	0.05	
Btb_oth	-70.6	26.7	-2.65	0.01		39.5	-1.78	0.07	*
Btc_bt	-100.	4.39e-08	-2275945145.90	0.00		1.80e+308	0.00	1.00	*
Btc_com	-87.5	16.7	-5.22	0.00		22.1	-3.96	0.00	
Btc_oth	-91.7	12.7	-7.23	0.00		17.5	-5.23	0.00	
Bts_bt	10.9	205.	0.05	0.96	*	151.	0.07	0.94	*
Bts_com	-100.	1.80e+308	0.00	1.00	*	1.80e+308	0.00	1.00	*
Bts_oth	-100.	2.90e-08	-3449195521.43	0.00		1.80e+308	0.00	1.00	*