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Preface

This paper is the Master Thesis of Nusimangu Yusuyin and Yingfei Sun, students at Molde University College, Norway. The purpose of this thesis is to explore does distance between home and airport affect travel behavior. Based on a dataset from air transport travel survey offered by AVINOR, we researched relationship between travel demand and distance with software SPSS.

We would like to appreciate all those people who have helped us during the time of preparing for this thesis.

First of all, we would like to express our sincere appreciation to our supervisor Professor Svein Bråthen. He provides very helpful and professional guidance, reviews, comments and gives advises for us. Without his constructive instructions and advices for econometric model, it would be hard for us to finish this thesis.

Secondly, our heartfelt gratitude goes to Øivind Opdal, Laila Dolores Stene and Fei fei Qin. They provided invaluable help and advise in implementation. Thanks for their contribution to improve our thesis.

Fiannly, we would like to thank our family and friends for their full support and encouragement during the moths while writing the thesis.

Nusimangu Yusuyin and Yingfei Sun

Molde, May 2012

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Abstract:

Air travel demand is not only needed by airport planner but also the airlines, the manufactures, the sub-system suppliers and national transport planning. They all need it to forecast air transport activity. There are many determinants of air travel demand. In previous study, various affecting factors have been proved that they have impact to air travel demand. The purpose of this thesis is to test whether the distance from home to an airport can be an affecting factor to air travel demand. It is based on a survey dataset including travelers' flight frequency in Møre og Romsdal county of Norway. Our study is carried out with literature study, economic impact analysis and econometric model testing with SPSS.

Keywords: Air Travel Demand; Affecting factors; Access Distance; Distance Measurement; Economic Impact

1. Introduction

As air transportation develops fast, how to increase the travel demand becomes an important issue for airports. If air transport market aims at increasing the demand they should have a better knowledge of customers' behavior and improve their entire index to satisfy consumers' needs.

Nowadays, more countries face challenges connected to their airport networks. Airports tend to be concentrated because some close down and the remaining ones provide better level of service. That means some parts of the air transportation market may experience decreasing accessibility to the air transport service while other parts of the market get increased accessibility. Will customers get access to the closed airport not travel by air anymore? Obviously, the answer is no. Among the factors affecting travelers' choice of airport, distance can be one of the main factors. In our thesis, we will focus on how travel distances from home to an airport affect the travel market, in terms of demand for air travels. Based on a survey data set offered by AVINOR, this study focuses on the following research issues:

1. Does distance to an airport affect travel demand?
2. Does distance affect travel demand significantly?
3. How does distance affect travel demand together with other factors?

The first question researches whether distance affects travel demand as we expect that the shorter distance is, the more frequent travel demand would be. The second question could be tested by regression with SPSS. Lastly, the third question can be explored by setting up one detailed econometric model.

Our study consists of two parts. The first part is based on previous literature and theoretical knowledge to understand the relationship between air travel demand and affecting factors. According to the previous study we know that there are two different type of air travel model to examine the affecting factors' significance: Generational demand model and Assignment demand model. Also the affecting factors are classified as Geo-economic factors and service-related factors. And most the common geo-economic factors are air traveler's income and population, the most service-related factors are ticket fare and service level of airports and airlines. The second part is based on a survey data of air passengers in Møre og Romsdal county, we will formulate an econometric model using this dataset to examine does the access distance from home to airport have impact to air travel demand. There have been a number of applications presenting air travel demand –affecting factors. Abed and Jasimuddin (2000), Njegovan (2006), Tsekeris(2009), and Carson et al (2011) are some examples. In our model, besides the access distance, there are other affecting factors will be tested, such as air passengers' income and ticket fare.

The purposes of forecasts for air travel demand are not only for multipurpose economic decisions but also for research and development, aircraft design and production planning etc.

Caves and Gosling (1999) give some perspective about air travel demand. Demand prediction often consists of aggregate forecasts at the system level for a complete nation. By digging deeper into the research of travel demand found that sometimes different types of travelers and different regions not always fit within the nation or large areas' forecasting. So the forecasting research about air travel demand trend is to have more segments, like the spread and the need for forecasting are narrowed down and the affecting factors of air travel demand become more diverse and our study will be an example of this.

So when doing research of strategic system planning, knowledge of the travelers' behavior is very important. Traveler's behavior regarding of travelers' needs for communication vary by location, activity and their socio-economic characteristics (Caves and Gosling, 1999). Choosing the determinants of air travel demand should be based on considering if the factor can control the overall demand or not. Air travel demand also has its own feature which can differ from other traffic demand. Since air travel demand somehow bounded to airport demand, there is a common perspective that all those who are living or working visiting the catchment area presumed that will use that airport. Theoretically this view seems to be correct but in practical research, the travelers' behavior is affected by one or more factors which can influence the decision of competing airports. The access trip itself may be sufficient deterrent to travel, since travel will only occur if the overall benefits exceed the overall costs (Caves and Gosling, 1999). Again, it is necessary to examine whether the distance and cost of access trip from home or any other start point to the airport can affect the air travel demand.

2. Research Background

2.1 The Geographic Feature of Norway

Norway is a kingdom consists of the mainland, the archipelago of Svalbard and the island Jan Mayen. The total area of Norway is 385,186 km2, in which the land area is about 0.3 million km2 with a narrow and long shape. Presently the population grows to be 4.98million at the end of 2011. About 12 percent of the inhabitants live in the capital city Oslo (Statistics Norway 2011). With the low population density, decentralized distribution of population on the whole and relative centralized in a few cities, the accessibility to airport becomes a key point. Mountains and fjords are particularly wide spread in Norway, furthermore, snow and ice are common in winter seasons, travelling by air is much easier and takes less time than by bus or train.

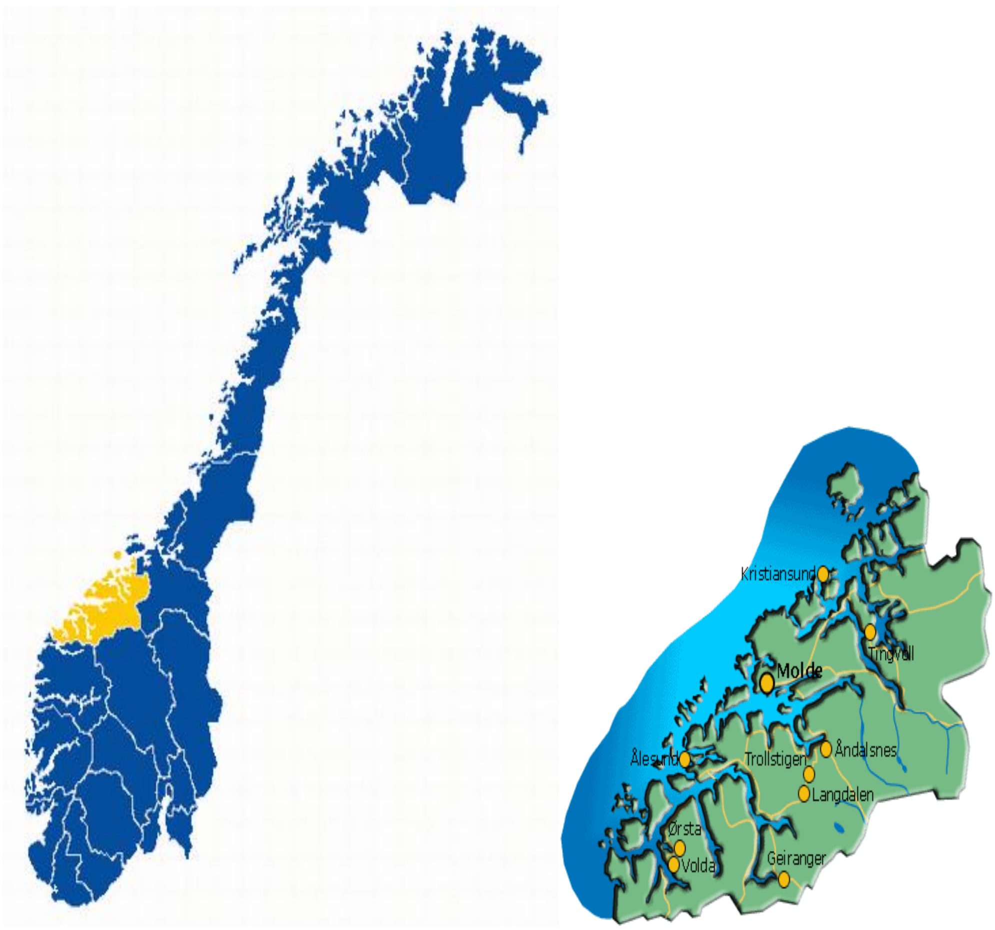

Figure 2.1: Map of county Møre og Romsdal

County Møre og Romsdal is selected as a case in our study. This county lies in the western part of Norway(Figure 2.1), with land area of 14,590 km2 and 258,900 populations (Statistics Norway2011); there are six settlements and 36 municipalities in this county. The brief descriptions of the five cities we focus are shown as follows:

● Ålesund is a historic town as well as the administrative center of the traditional district of Sunnmøre, has more than 40,000 inhabitants. The total area of this town is about 100 km2, 5 percent is seawater. It is the largest city in Møre og Romsdal.

● Molde is an industry and trading center, and also administrative center for county Møre og Romsdal, with a population of above 25,000 and area of 363.12 km2.

●Kristiansund lies on the western coast of Norway. It has 23,813 inhabitants and has a total area of 87.54 km2.

●Volda is located approximately 50 kilometres south of Ålesund. The area of this region is comparatively larger than the three above with an area of 547.53 km2, while 8693 people live there.

●Ørsta is a village in Møre og Romsdal county. This village is located close to the Ørstafjorden, just south of the mountain Saudehornet. There are more than 6500 inhabitants with a total area of 386 km2.

2.2 Four Airports in Møre og Romsdal

According to Lian et al. (2005), getting access to airports in Norway is convenient and fast. Only one third of the population cannot reach their nearest airport within one hours' driving by road. Even better in western and northern parts of Norway, people can get to the nearest airport within half an hour which makes it easy to get to the airports.

Nowadays, a total of 52 airports are located mainly along the western side of the country. In this research, we mainly focus on the four airports in the county of Møre og Romsdal: three medium airports (that is, Ålesund airport, Molde airport and Kristiannsund airport) and one regional airport: Ørsta-Volda airport.

Among the three medium airports, Ålesund airport provide more oversea lines than domestic lines. There are 15 destinations from Ålesund airport, two thirds of the destinations are overseas, such as London Gatwick and Copenhagen. At the same time, it offers a frequent flights to Oslo, more or less ten flights each day except 3 flights on Saturday. It also has connections to other Norwegian cities. (AVINOR)

Compare to Ålesund airport, Molde airport offers fewer lines. Most of them are domestic lines, which connect to Oslo, Bergen, Kristiansund for example. The most frequent line is from Molde to Oslo with six departures per day.

The network of Kristiansund airport is mainly designed for domestic lines; nine of the lines are connected to other Norwegian cities and only one to an international city. Ørsta-Volda airport is the only regional airport in these four airports, providing services to some nearby cities and the capital city Oslo.

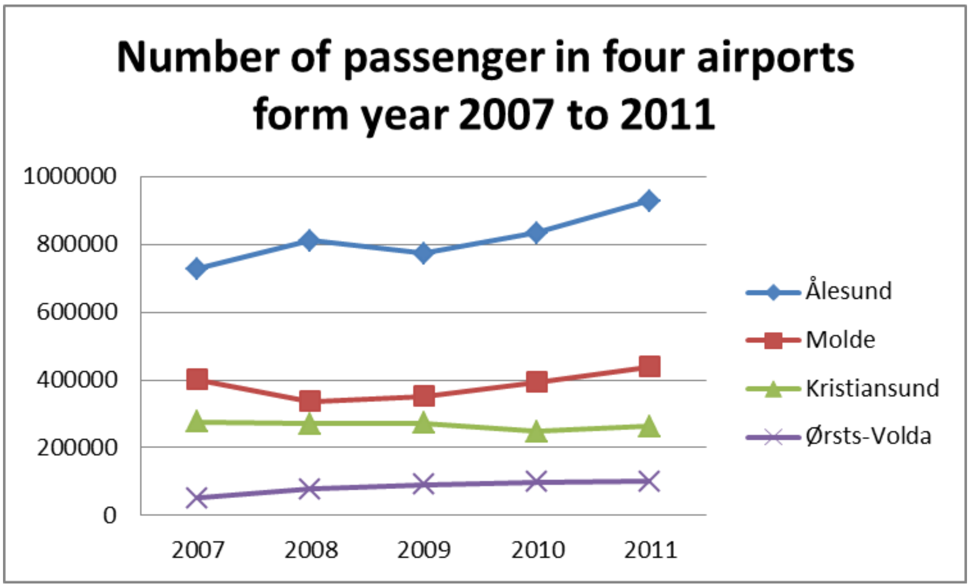

Figure 2.2: Total number of passenger in four airports of Møre og Romsdal

(Sourced from: Traffic Statistics in AVINOR)

From Figure 2.2, we can easily observe that the rank of four airport in terms of total passenger does not change over years, but the develop trend of each airport vary from each other. Obviously, Ålesund airport transported the largest number of passenger among these four airports, which is more or less doubled the number of passengers of the Molde airport in the second place. In addition, the passenger number still grows towards one million in the Ålesund airport. Traveler numbers in Molde airport reduced in the year 2008 but turned to rise from 2009 and kept that increasing trend until last year. During the past five years, passenger number of Kristiansund airport always fluctuated at the point of 0.25 million. It remained in a relative stable situation, not too much changes of the passenger number during these years. Although traveler number in Ørsta-Volda airport is the smallest among the four airports, it keeps growing steady during these past five years. In a word, the Ålesund airport is in an outstanding place and all of these four airports develop toward good way.

2.3 The description of Aviation Products and air travelling

For airlines, if they get as much information as possible about their customers, they may offer better service to meet the specific needs, much easier to make plan and set target of services and products. Having a better knowledge of these variables is helpful to airlines in advertisement, promotion and activity of sale. Furthermore, knowing the market well may even help them do well in demand forecasting. (Doganis,2002)

The main purpose of this paper is to find out whether the variable distance from traveler's home to the airport affects their travel behavior? If the distance between home and airport is shorter, will they travel more frequently? If so, how does it affect travel demand?

Since our study aims to find out the affecting factors to air travel behavior, especially the access distance to airport, so it is important to know the characteristic of air travel behavior. In this subsection, we will introduce the air passenger's behavior. In general, air passenger's choice behavior is a decision process, and this process aims to choose the air products and service. So air passenger's behavior is closely integrated with air products, air travel demand and air passengers characteristic. From the product side, air products have its own characteristics, such as ease of transport, not storable and quasi-public goods. Those characteristics could be the affecting factors of air passengers' choice behavior.

2.3.1 Aviation products features

Aviation products have strong ownership characteristics and air passengers' choices will be strongly affected by those characteristics. Now we will analyze the characteristics of aviation products and how those characteristics impact air passenger's behavior.

Speediness, safety and comfortableness

Compared to other transport modes, like railway, highway or waterway, speed is the most obvious advantage of aviation. Longer the trip distance is, more time will be saved and more obvious the merit of the aviation is. Also the high speed can reduce the monotone and fatigue for the long journey travelers. As technologies and services develop, air travel is also more safety and comfortable than other transport modes.

Strong homogeneous

Usually Railway, highway and Waterway products are categorized in many types. For instance, in some country, Railway is categorized in many types, such as slow train, express train, hard seat, soft seat, hard sleeper or soft sleeper. As compared to other transport modes, aviation products only have three classes: first class cabin, business class cabin and economy class cabin. Regarding the limitation in the choice of product types, passengers' choice is more affected by other factors, such as ticket fare.

2.3.2 Aviation market features

Broadly speaking, aviation market demand is kind of service demand. The aviation market demand may be fluctuate in a short term, but stable in a long term .For the long term, the formation of air passengers is rather stable and passengers travel flow have strong regularity. For the short term, air passengers’ travel flow is fluctuated by many factors such as the timeliness and seasonality. The fluctuation of timeliness and seasonality will directly influence the flight frequency, ticket fare etc.

Generally, air travelling can be divided into business travel and leisure travel. Business travel is formed for firm and paid by the employer, while leisure travel is paid by the traveler himself. The leisure travel can be further divided into holiday travel and travel for visiting friends or relatives. All these types of travel can be for short or long-stay journey. Besides, there are some other passengers that do not fit the criteria of the categories above. They can be students travelling to or from school, and those travelling for medical reasons. The main purpose for travelling varies from market to market. Three categories of purpose are divided in our study as below:

(1)Business Travel

Business travel usually associates with travelers’ occupation and normally the tickets are not paid by traveler themselves. So the ticket fare is less elastic to the business travelers. Compare to ticket fare, service level have more impact to business travelers. But regarding different types of business travel, business travelers have different demand. Short haul business travelers are more elastic to the flight frequency or departure and arrival time, long haul business travelers are more concerned about the on board service. Business travel also has gender difference, in general, male travelers are more than female travelers. Meanwhile, business travels are full of uncertainty, like business travelers may book the ticket just before boarding or cancel the flight in last minute before boarding, and this uncertainty will bring trouble for airlines. Considering economic benefits brought by business travelers, airlines and airports usually provide high density of flight frequency to attract them.

(2)Leisure Travel

Compared to business travel, leisure travel has less necessity and is not restricted in time issue. The tickets are paid by travelers themselves, so this feature causes ticket fare have strong elastic to leisure travelers. The growth or decrease of passenger's income will directly affect the air passenger's choice. When it comes to cost, not only the ticket fare will affect air passenger's choice but also entertainment cost, food and accommodation costs will be the affecting factors. Leisure travel is arranged by traveler themselves, so leisure travelers usually book the ticket month earlier before departure. Leisure travelers usually stay a relative long time in the destination place so the flight frequency is not so important for leisure travelers. Regarding the features of leisure travel, airlines attractive the leisure travelers by offering low cost ticket fare.

(3)Other travels

Besides business and leisure travel, there are still some other types of air travel, such as visit travel (visit relative or friend), medical treatment or migration. Compared to business travel and leisure travel, those other type of travels participation counts less in total air travel demand.

For the analysis of aviation products, air travel market and air travelers characteristics which were mentioned above, we know that air travelers choice behavior is a very complex system. Now we will introduce the specific performance of passenger's choice behavior when they choose aviation products.

2.3.3 Traveler's choice behavior

Which factors can be the affecting factors when air travelers choose aviation products such as airlines or cabins? What will they focus on when they do decisions? Those questions are very important to Airline Companies and airports. The underlying information in these questions will help Airline Company and airport to understand how the air travel market working, improve self-competitiveness and increase revenues. In this section we will introduce the theoretical basis of air travelers' choice behavior when they are choosing air products, such as airlines, flights and cabins. Regarding those theoretical bases it helps analyze the subjective and objective affecting factors of air travelers' behavior.

Consumer behavior and air travelers' behavior

Usually the person who is in the process of demand, purchasing and applying can be called the consumer. In other words, consumer will participate in any one or all of the demand purchases and apply processes. Regarding the demand motivation, consumer needs to make a purchase decision, modify the purchase program and complete the purchase process. So consumer behavior is not only a process which consumer paying for the purchase objectives or service for their money or cash, but also a process which include all the events before purchasing, in the middle of purchasing and consequences of entire purchasing process(eg. see Figure 2.3). The affecting factors of consumer behavior are various and complex. Meanwhile, many aspects can influence the affecting factors, like society, history, economy or regionalism. The research of consumer behavior is aim to analyze the consumer satisfaction of purchase objectives and the marketing campaign in the entire purchasing process But the limited resources and life finiteness will not satisfy all the unlimited desires of the consumer, regarding this point, consumer's choice came up. Although the unlimited desire cannot be satisfied, consumer can choose the relatively most satisfaction of goods or services to meet their demand. So consumer's choice is a process that select one demand objective from different options.

Figure 2.3: A general mode of consumer purchasing

Air travelers' choice behavior which we researched in our thesis also belongs to consumer’s choice. Air travelers will make various decisions when they making an air travel plan. Usually air travelers will select an optimal choice to balance their travel desires and travel expending in entire air trip (From the start point to destination place).

Utility theory and air travelers’ choice behavior

In Economic approaches, the consumers’ satisfaction from purchased goods or service called Utility. There are two notes that we should be aware in understanding Utility. Firstly, Utility is just a subjective expression, and this expression depends on consumers’ psychological satisfaction from individual consumption. So there is no objective criteria’s for utility and same goods or service may have different utility in different consumers, even same goods or service can have different utility for same consumer in different time or place. Second, if assuming utility can be quantifiable, three are no unified units of measurement. The units of measurement can be any units which is helpful to measure the utility (Douma and Schreduer,1991).

Since there are no objective criteria and unified units of measurement for utility, in microeconomics assuming that consumer always desire the maximization of utility, so does air travelers.

Consumers evaluate two or more objects or service, and when they choose one of them this can be called consumer preferences. Consumer preferences show which products consumer prefers or which products consumer dislikes, and this is a kind of consumer attitude tendency. In real life, every consumer has different consumer preferences. Some consumer preferences depend on consumer attitude, and some consumer preferences depend on the product characteristics. No matter what kind of grounds there are for formulating the consumer preferences, all those grounds may directly affect the consumer behavior. Generally speaking, as being rational customers, air travelers will choose airports, airlines or other aviation products by their own consumer preferences, and this consumer preference will meet the balance of travel desire and consumer spending, and maximize the utility at the same time.

2.3.4 Affecting factors when air travelers choose aviation products

Analyze the affecting factors when they chose air products are very important. Regarding the correlation between affecting factors and air travelers, the affecting factors for choosing aviation products can be categorized in three aspects listed below.

(1) Objective factors

The factors which do not have direct impact to air travelers, and cannot decide by air passengers can be a sort of objective factors. Also regarding objective factors itself may be affected by many factors, the objective factors can described in more specific classifications which are listed below.

Regional economic: Usually national economy has close connection with air travelers' behavior. As the differences in regional economy, the affecting factors of air travel can be different in region.

Policy: Since every airport and airline has different policy, the differences in policy can affect air travelers' choice behavior when they chose airports or airlines.

Cultural context: Different region have its own culture, so air travelers may sort the affecting factors depend on the importance regarding the culture differences.

Own attributes: Each aviation products have its own attributes, such as siting of airports and advertisement of airlines .The differences in those attributes will affect the air traveler's behavior as well.

(2) Subjective factors

The factors which have direct impact to air travelers and can be decided by air travelers are categorized as subjective factors. The segmentation of subjective factors is listed below:

Air travelers' characteristics: Air travelers' gender, age, education background, occupation and income can directly influence the air travelers' behavior. For example, high income groups are less elastic to ticket fare, instead, income in relatively low groups are more elastic to ticket fare.

Travel purpose: Air travelers may have different travel behavior depend on different travel purpose. Even same air traveler' can have different travel behavior for different travel purposes.

Psychological factors of air travelers: Since different air travelers have different psychological characteristics, air travelers may have different travel behavior. Economist travelers prefer to low cost aviation products, for the travelers who have showing off personal psychology, they may choose well-known airline or first class cabins to denote status.

(3) Stochastic Factors

Except objective and subjective factors, there are some stochastic factors can affect air travelers' behavior. Usually those stochastic factors are caused by emergencies or extreme weather conditions, so they are uncertain and unpredictable. The stochastic factors will have impact to air travelers' behavior to some extent although its probability may be very small.

3. The impact of an airport to the local region

The relationship between an airport and its local community is crucial to an airports future. In many cases development of the airport will be widely viewed as necessary to support the community's economy or to expand essential transport links, in which case many in the community may consider that the benefits of the air services are more than offset concerns for any inconvenience caused by them. When the airport's main role is to support a wider regional, national or international community, conflicts are likely to arise between the advantage which the airport's growth bring to the wider community and negative impacts which are perceived within the local community. (Caves ad Gosling, 1999)

So as being a very important gateway for a city or region, airport has become one of the critical point in entire air transport and the vital basic condition of local economic growth. Also in nationalization and internationalization commercial market, airport is increasingly seen as the catalyzer of local economic growth. Airport and national economy or other related industry have interdependence and have a closely related relationship .This relationship relies on the local economy growth, meanwhile promote the local economic development. Therefore, regarding the catalytic impact of airport and the traveler's behavior will helpful to establish an appropriate development strategy for the airport. Theoretically, there is a general recognition that an airport has to do and belong to the infrastructure sector. But in practice, local authorities usually judge the value and benefit of airport by the profitability. Since the entire Air transportation is a very complex system and the economic impact of airport or air transport are various, the comprehensive and systematic study of the economic impact of airport will offer theory support to airport authorities or local government for the airport development strategy for long and medium term.

Also this will helpful to local government enable to make use of the airport appropriately to serve the local economy, coordinate the relations between airport and other economy departments, promote the sustainable development of the regional economy.

3.1 Social economic impacts

The social economic influence of airport contains many aspects. Traditionally, the main function of airport is to transport the passengers and cargo handling, so it is categorized in transportation field. Nowadays the modernized airports' function not merely to the transportation functions, gradually penetration in industrial function, commercial function, trade function etc. The more functions the airport brings the wider economic impacts. According to the airport economic activities have different acting forces to the social economics, the impact can be categorized in two types: direct economic impact and indirect economic impact. The core economic activity of airport will directly contribute to the social economic impacts. The other airport related activities which rely on the airport will contribute to the indirect economic impact.

3.1.1 Direct economic impacts

Usually throughput metrics is the most common way to calculate the transport function that measures and brings how much growth for local economy of an airport. The throughput metrics contains passenger throughput and cargo throughput etc. But throughput metrics have a drawback that it will not give exact quantities of value, so it is not possible to get the exact value amount of economic impact directly through the throughput metrics. Besides, the direct economic impact and indirect economic impact should have same measurement standard and throughput metrics cannot meet these requirements. Throughput metrics cannot intuitively reflect the capacity of direct economic impacts, so it is not possible to add the direct economic impacts capacity and indirect economic impacts amount to get the total economic impact by using the throughput metrics. Nowadays using the "added value" seems to the most appropriate way of measure the direct economic impacts volume.

The "added value" is the value differences between outputs and inputs during the operating and manufacturing process. Compared to throughput metrics, added value will reflect the economic impacts capacity in a more profound way.

The activities which contribute to direct economic impact should be the airport's necessary economic activities. Additionally, those necessary economic activities could not exist alone without some government enterprises and institutions' aid. Those government enterprises and institutions comprise the air transportation industry and created the added value. We can get the added value by calculating the value of each unit in government enterprises and institutions, and then the summation of each value will be the added value of airport's economic activities.

Using the added value measurement can intuitively reflect the total amount of airport's economic impact. Nevertheless, measure the economic contribute of airport only by calculating the value quantity is not comprehensive. There are still many aspects which benefited from airport activity such as employment, the added value cannot meet the requirement of measuring the airport's impact to employment. So measure the economic contribute of airport only by calculating the value quantity is not comprehensive, more indicators should be used to describe the economic impact of airport. These supplement indicators are:

Employment figures

The positive influence to local employment is one of important symbols in an airport's economic impact. For any industry the outstanding contributions in local economy growth is bring increased employment. Airport as a base for various kinds of economic activities, this activities not only bring the economic impact but also offer more employment opportunities.

Tax completion level

Tax complication is another important indicator to describe the direct economic impact of an airport. Tax revenue is the main income source of local region or national, meanwhile stable financial revenue give the prerequisites for various authority activities. As one of the important industrial in economic activities, the whole air transportation industrial provide a considerable amount of tax revenue for authorities.

3.1.2 Indirect economic impacts

In the definition of indirect economic impacts which we introduced earlier, the indirect social economic impacts derive from the extension activity of airport transport function. Also the indirect economic impacts are the summation of economic benefit of the entire airport affected economic activities. The indirect economic impact consists of two parts.

Forward impacts

The transport function of airport promotes the connection between raw material and product in each production department, this connection leads to expanded production. Essentially, service in the airport is an important intermediate input for those production departments. Therefore, the development of airport creates the expanded production conditions for the department which seen airport is the intermediate inputs. Additionally, the expanded production will bring more benefits to those departments and provide more economic benefits for local economy. So this is the forward direction impacts in indirect economic impacts of airport.

Backward impacts

There is a strong connection between airport development and infrastructure construction. Building the infrastructure needs a large amount of raw materials and the daily airport operating need respectable amount of resources like electricity. So airport itself will expand the demand of those resources and raw material, this demand brings the expanded production for those relevant departments as well. Finally this demand reflected to local or national economic growth. This is the backward impacts.

Indirect impacts use supplement indicators to describe how airports have indirect impacts to local economy.

Employment figures

One of the important indicators to evaluate the economic impacts is how many job position offered by airport and air transport related departments. The development of air transportation also reflects the increasing employment of airport related and air transport related departments, the increasing employment figures will bring the economic growth naturally. Employment figure is a common indicator to evaluate the economic contribution of airport, so it is applied to both direct economic impacts and indirect impacts.

The ability to attract business collaboration and tourism

The existence of airport in a city or area can offer many economic advantages, because airport creates a great convenience for local transportation. This advantage can attract business project or businessman from outside region or even foreign countries to start business investment there. Also this advantage can enhance the tourism attractions. Usually convenient transportation condition will be an important factor when people choose the tourist destination. So the existence of airport can bring more tourists. Finally, the increasing business activity and tourism will stimulate the local economy.

4. Literature review

With the rapid development of air transportation, airport planning is becoming highly valued nowadays .Since the airport planning process requires plentiful forecasting and the most significant one is given to the prediction of passengers travel demand, a considerable number of research on air travel demand has been published during last three decades. The air travel demand is not only needed by the airport planner but also the airlines, the manufactures, the sub-system suppliers and national transport planning all need forecasts of air transport activity.

4.1 Overview of air travel demand forecasting method

Kazda and Caves（2010）give the introduction of methods for analyze the forecasting of air travel demand, usually three methods are applied. Informed Judgment, Trend Extrapolation and a causal model called econometric models. Section 4.1, 4.2 and 4.3 will devote to the three types of air travel demand methods.

4.1.1 Informed judgment

Informed judgment is the simplest method for forecasting, because it needs very little data and if there is too much data it will confuse the decision maker and slows the process down (Kazda and Caves, 2000).

The recent research of informed judgment illustrated by the UK Office of Science and Technology (Loveridge, Georghiou and Nedeva, 1955) surveyed technical experts in their own fields. Among many quite reasonable predictions, it also concludes that multimedia teleconferencing would be preferred to business by 2007, that the direct operating costs of aircraft would be halved by 2008 and there would be autonomous aircraft that would not need air traffic control by 2007, these dates being the average of responses.

The refined version of expert judgment is called Delphi technique, which also used by IATA in compiling airlines' views for future. The method of Delphi technique is a panel of experts that have their judgments returned to them together with those of the other experts, so that they can adjust their views before the final illustration of the results. (Kazda and Caves, 2000)

As mentioned before, informed judgment is usually applied for a small amount dataset. If more data is available for the research required the more informed the judgment and are able to incorporate them at the expense in time and cost (Kazda and Caves, 2000).

4.1.2 Trend extrapolation

It is usually necessary to generate some predictions which are unique to the situation under study. Further, the predictions have to be justified and therefore be based in some formal analysis of the historic development of the traffic (Kazda and Caves, 2000). So the trend extrapolation is come up. The simple formal analytic technique is called trend extrapolation, and this trend can be in time or scale. Usually historic trend can derive by simple linear regression of the traffic itself or the annual growth rate, and then projected into the future and modified by judgment to considering the changing circumstances. One form of trend analysis which is very popular in USA is the "Step-down" procedure. This derives either regional or local market share from given national forecasts, making use of historic data of how the market shares changed. Since the method is best for predicting future situations in markets where relatively stable traffic patterns is the rule, it has been argued that the uncertainties created by deregulation in the distribution of traffic make it less appropriate now (Kazda and Caves, 2000).

4.1.3 Econometric model

Since the complex feature of the air transportation industry, underlying the continuous economic fluctuation and environmental changing, the previous method for air travel forecasters like trend extrapolation have not been impressive and not well applied for the practice research. So it is necessary to bring causality into the analysis which is called econometric models and which we used for our study. This model not only predicts air travel but also determines the impact of changes within the economic and operating environment on air travel. Also these models relate the traffic to underlying economic parameters like income of passengers or more readily available proxies for them, usually this method is calibrated by multiple regression of historic data to derive elasticity of demand, for instance, the change in demand due to the one percent change in one independent variables affecting the demand. Accordingly, the multiple regression analysis enable to link future growth in air travel demand in a specific area with expected developments of causative factors (Abed and Jasimuddin, 2000).

4.2 Models and affecting factors

Applied the econometric air travel demand model in a specific area or market should be aware of which type of travel demand could be needed and which affecting factors should be chosen.

4.2.1 Travel demand models

Hsiao and Hansen (2011) classified the travel demand model as two types, Demand Generation model and Demand Assignment models.

Demand Generation model

The models refer to air travel quantity categorized as demand generation models (Hsiao and Hansen, 2011).The models which refers to air travel quantity as demand generation models, is a type of research that usually include two different side observation units which are related to the quantity of air travel demand .For the supply-side ,it includes region and airports locations ,airlines which serve in the airports, variety of flight segments, city-pairs ,catalytic connection of airport to city ,city to county ,county to country and country to the world and also the total travel time (total travel time can be the summation of ,travel time from start point to airport ,the travel time between starting airports and destination airports and the travel time spend in the journey) and the flight frequency of airports offered or schedule delays etc..

Demand Assignment models

Another type of demand model is demand assignment explain models. The demand assignment model usually is aim in explaining the distribution of traffic or travelers' choice behavior among alternative modes, for example, the decision of airports choice, the route choice during the travel journey or airline choice. The most evident aspects that distinct the assignment model from the generation model is assignment models are connected with individual human choice or market shares of the air transport traveler. Usually the research of demand assignment model paralleling with the method of random utility generally, for instance Multinomial Logit (MNL), nested logit (NL), mixed multinomial logit (MMNL) models and specialized variants of this type of research have all been applied. Especially in recent years research about demand assignment models increasingly than before .NL models of airport –airline choice and airport –access mode choice haven been developed by Pels et al. (2001, 2003). A MMNL models based on airport passenger surveys with access time, flight frequency and fares developed by Pathomsiri and Haghani (2005), they note that the use of average fare often caused an insignificant or counterintuitive coefficient estimate.

When creating a research it is important to identify which type of demand model will be appropriate for the preparing data. Sometimes it may be either pure Demand generation model or Demand assignment model, or both. Since our study is focused on travel behavior which reflected in how the distance from home to airport affects the travel demand, also included are some other factors such as ticket fares and gender of travelers. So the air travel demand in our thesis is a demand model based on standard microeconomics.

There are a large scale of studies have examined various aspects of analyzing and forecasting air travel demand. Alperovich and Machnes (1994) developed a study to increase the understanding of multiple dimensions of air travel demand. They found that air travel to all foreign destinations is highly deltaic in income and inelastic in price, and there is no difference in demand elasticity between financial and non-financial assets and both of them are inelastic. Ghobrial (1992) conducted a study which presented an econometric model that estimates the aggregate demand for an airline. The demand model explains the airline network structure, operating characteristics and firm-specific variables. Model formulations with various explanatory variables are estimated using a two-stage least-square procedure and the results indicate that airline aggregate demand is elastic in yield, and inelastic in network size and hub dominance.

An econometric model is a causal model where the relationships between traffic and factors not only cause effect relationships but also can be described mathematically. Graham ad Dennis (1991) evaluated a particular model to places the greatest of demands on content and form in both model and data. In Norway, FridstrØm and Thune larsen(1988) developed an econometric model which formulate the traffic trend between two airports can be determined by the trend in: population, average income, average fare, fastest surface alternative fare, travel time between centers of airport and corresponding travel time for fastest surface alternative.

4.2.2 Categorizing of affecting factors for air travel demand

There could be a variety of variables may impact the air travel demand and this causes the research to be complex and untoward. By categorizing the affecting factors before gathering the related data or information, will be helpful in simplifying the research process and make it more doable, it will also be helpful to do the forecasting and to analyze after getting a conclusion of the affecting factors. Jorge (1996) developed the categories of affecting factors for air travel demand. He noted that the previous study of air travel demand defined by two main groups of drivers, geo-economic factors and service –related factors. Service-related factors are determined by quality and fares components of the airline products. Since our study emphasizes on distance factors, we do not give interpretation for the service-related factors.

Geo-economic factors are determined by economic activity at a specific time, geographical and locational characteristics of the area where the air travel demand research takes place which cannot be controlled by airlines (Jorge,1996).

Geo-economic factors separated in two parts, activity factors and locational factors. Activity factors contain the commercial, industrial and culture activities in the area where the air travel demand research taken place (Jorge, 1996). There is a lot of literature based on the activity factors research (e.g. Abrahams, 1983; Bruckner, 1985; Firestorm and Thune-Larsen, 1989; Rendaraju and Arasan, 1922) found that the most common activity-related factors are income of traveler and the population of where the air travel demand research takes place. Russon and Hollingshead (1989) illustrated that the most common variables for locational factors is distance.

After the research they have two conclusions to the distance factors. One is due to the less social and commercial interaction there is a negative effect when the distance increases and the other one is there is a positive effect due to the distance increase and the relative competiveness of air travel improves travel time. When mentioning the travel distance, it basically means the distance from home, work place or any start point to the airport is the most overlooked aspect. Russon and Hollingshead also analyzed this aspect and found that when comparing the closeness position of the airport to the competing airport, can get the results that if the competing airport has a higher quality of service level there will be a diversion for the extra travelling time to the airport, in that case the closeness position will lose the advantage of easy accessibility to the airport. For instance, in our dataset, there are some travelers that prefer the Ålesund airport even though they live near to the Molde airport or Ørsta-Volda airport rather than Ålesund airport. Figure4.1 Show the main framework in previous study regarding the air travel demand and the affecting factors.

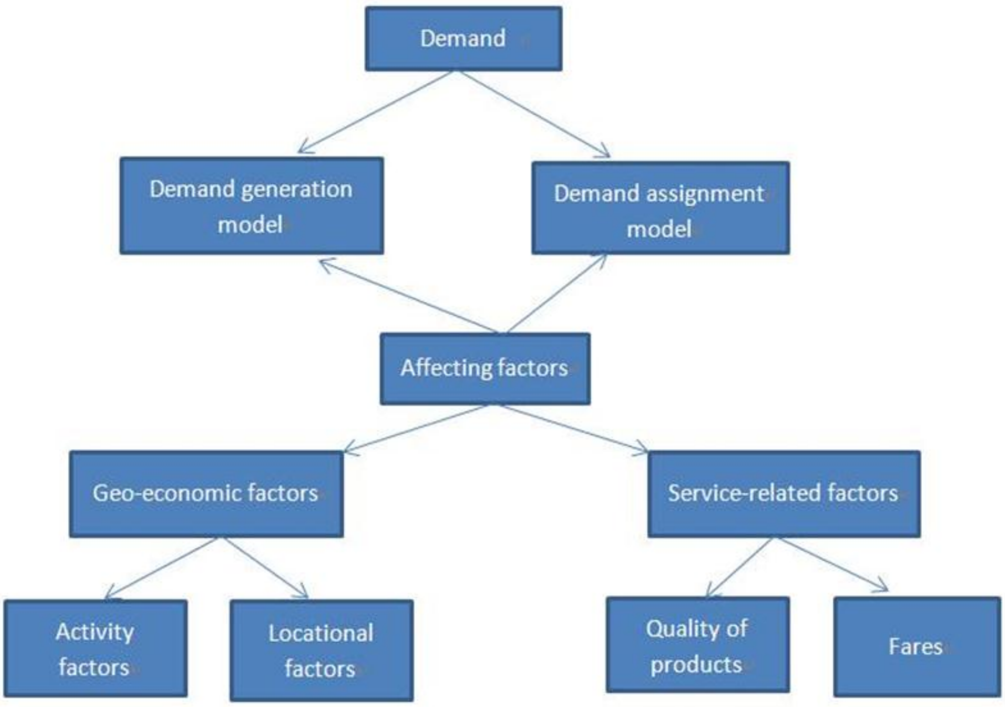

Figure 4.1: The main relationship between air travel demand and affecting factors (Jorge, 1996)

When going through the literature of forecasting for air travel demand in Norway, we found that most of the researches have typical regional characteristics. Strand (1999) developed a model that represents a framework of relation between air travel demand and behavior, accessibility, activity and alternative. He explored that accessibility should be a distance measurement not the pure geographically distance .Because the significance of the distance between two destinations must primarily be linked to both areas' activity and alternative transport modes, so it is not sufficiently convincing to use the absolute distance alone between places to explain the traffic aspects between them (Strand ,1999).

4.3 Importance of accessibility to airport

After the study of previous literature about air travel demand and regarding the geographical nature of Norway, we found that it is important to examine if the access distance has impact to air travel demand or not. Transportation time to the airport is one of the three most important factors affecting the passenger's decision when selecting a particular airport and the other two factors are price of the flight ticket and number of flights (frequencies) the airport offered (Kazda and Caves, 2000).The primary advantage of air transport is speed, so the traveler is also willing to take shorter time to get to the airport to reduce the total travelling times, the trip does not start or finish in the airport, but at home, at the work place or at a hotel etc. Traveler cannot control the flights time so they reduce the average speed by the ground portion of the trip. In our study there is an obvious trend that if the access time by ground transportation is not in a considerable interval then the attractiveness of an airport will markedly decrease.

Construction of a new airport or an existing one needs extensive investment and building work ,the forecasting of how access distance affect air travel demand will be helpful to an airports plan of design of the airport in an appropriate location to make sure that the entire airport project for the longest time period possible.

4.4 Theoretical framework of econometric model

After analyzing our dataset we choose the most appropriate solver for our study –multiple variable regression model .That multiple variable regression enables us to determine the simultaneous effect of several independent variables on a dependent variable using the least squares principle. (Newbold et al, 2009)

$Yi=\beta 0 + \beta 1\ x1\ i + \beta 2x2i + \ldots + \beta kxki + \varepsilon i$

Where Y is the dependent variable, x1 i , x2i , xki are the independent variables and theβ1, β2,βk are the constant linear coefficients of each independent variables. The literature background will provide a relevant knowledge of how to define each variable in the model and how to analyze the results in statistical way.

This type of models usually carried the following assumption (Kazda and Caves, 2000):

- The independent variables in this model can give a satisfactory explanation.
- The explanation is causal rather than co-incidental.
- The ‘independent’ variables are reasonably independent.
- There should be a constant functional relationship between the independent variables and traffic.
- The independent variables are easier to forecast than the traffic itself.
- There are no significant errors in the data base.

5. Theoretical Framework of modeling

In this chapter we will go through the air travel demand model regarding our dataset.

5.1 The description of data set

The objective of our study is aimed to provide an empirical evidence about the relative importance of the various air travel demand drivers with a particular focus on the access distance to the airport for the Møre og Romsdal county in Norway. The data analysis is based on the domestic flight survey data of travels in Møre og Romsdal county in 2009, called the “Air Transport Travel Survey “(ATTS) belong to the AVINOR company, and this dataset will be our primary data for our study. Multiple regression models will be used to do the causal analysis of the data. The dataset include 1955 observations and 73 variables which offer air passengers’ travel related information.

Broadly speaking, the air travel demand for any area usually in a population trend, as well as the four airports in Møre og Romsdal county. Besides population there are still some factors that influence the air travel demand. In general, potential trips for a specific area are derived from various reasons, in our study there are seven travel purposes due to the fact that the air travels research takes place in the four airports that we have mentioned before.

After a rough and precise observation of the data, we found an interesting trend that trip frequency tends to increase as the distance from home decreases. This trend inspired us to look into the relationship between the access distance associated with travel demand. Therefore we do an assumption that the access distance from home to four airports in Møre og Romsdal county have significant impact to the air travel demand. By using the econometric model to test that our estimation is either correct or not.

5.2 Model Structure

In our study we formed the air travel demand in a general form which best suits for travel demand causal analysis, multiple variable regression model. We do the model analysis through some econometric methods, statistic methods and the statistic software IBM SPSS.

The air travel demand model is formed by:

$Yi=\beta0+\quad\beta1\,x1\,i\quad+\quad\beta2x2i\quad+\ldots+\quad\beta kxki\quad+\varepsilon i$

Yi is the dependent variable, x1 i, x2i, xki are the independent variables, i=1, 2... ,n is the number of independent variables and theβ1, β2,βk are the constant linear coefficients of each independent variables. This model will be used to provide estimates of the effect of each variable in combination with the other variable .The marginal change in the dependent variable, Yi, that is related to the changes in the independent variables which estimated by the coefficients β and the coefficient β indicates the change in Yi, given a unit change in order to control the simultaneous effect of the other independent variables. In our study, the dependent variable Yi is the travel frequency as the air travel demand and the independent variables are the affecting factors of travel frequency.

5.2.1 Dependent Variable

According to the study of previous literature, the structured air travel demand can be modeled as a function of Geo-economic and service-related characteristics of the Møre og Romsdal county. Such as the population of each airport within the located city, the travel frequency each airport offered, the size of airport etc. Moreover, the right side of this model includes those two types of variables that respectively influence the quantity of air travel demand for the four airports. Usually typical variables as the causing factors for air travel demand usually are population, income of passengers, employment of cities (metropolitan areas) and the distance between departure airport and destination airport. The air travel demand variation of alternatives in a city is mainly explained by affect factors' characteristics of these alternatives. In other words, because of airport competition, air travel demand for an airport depends on the attractiveness of this airport's Characteristics. Those characteristics can also affect the attractiveness to an airport compared to the competitor airport. Does the ground access distance and accesses time be beneficial and attractive factors for air travel demand? This will be examined in our study. Also there are some factors which affect the air travel demand commonly however not significant to the demand for a single airport city. Meanwhile there are some specific factors which can affect the air travel demand for a single airport city. According to the previous study of air travel behavior travel information in our dataset, we can observe that traveler behavior has a great impact on air travel demand and different regions have its own traveler behavior characteristic. Different Individuals use different decision-making process when choosing the best suited travel mode (Chou, 1992).

In our study, the final demand function for the four airports should define the relationship between the travel frequency and certain factors. We will examine all the variables which are related to the travel demand and find the most significant variables. In other words, we will use the SPSS to examine the affecting factors' significant level and do the adjustment for the model to get the most appropriate model for the air travel demand in Møre og Romsdal county.

5.2.2 Independent Variables

Population

The dependent variable in the model presents the passengers air travel frequency in Ålesund airport, Molde airport, Kristiansund and Ørsta-Volda airport during 2009. The interval for travel frequency is (0,210) times in one year. Table5.1 shows the frequency percent of each frequency interval, we can see that in this county most people fly 0-5 times during one year, but there are some people that travel more than 30times even 210 times in one year. The passengers' choice and the attractiveness factors cause the individual differences in demand.

Travel frequency interval	Frequency	Percent
0-5	858	43.9
6-10	421	21.5
11-15	252	12.9
16-20	148	7.6
21-25	85	4.3
26-30	52	2.7
over 30	139	7.1
Total	1955	100.0

Table 5.1: the statistic description of flight frequency

Table 5.2 below illustrates the flight occupation percent of the four areas in our dataset. Ålesund airport accounts for the largest portion 45.7% in total demand and Kristiansund airport account for the smallest portion 14.3%. Figure 5.1 and Table 5.3 present the population of the four areas. Ålesund have the largest population, with more than 44 thousands inhabitant and Ørsta-volda area have the smallest population of 8693.

Airport	Frequency	Percent
Ålesund	893	45.7%
Molde	476	24.3%
Østa-Volda	307	15.7%
Kristiansund	279	14.3%
Total	1955	100.0%

Table 5.2: Frequency percent of each airport

Population of each area	
ÅLESUND	44416
Molde	25488
Kristiansund	23813
ØRSTA-VOLDA	8693

Table 5.3: Population of four areas

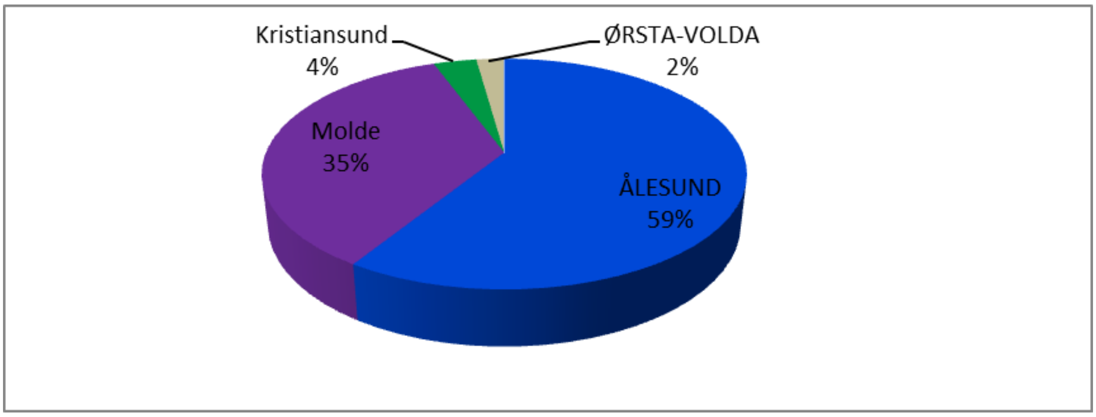

Figure5.1: Population comparison of four areas

In previous literature, air travel demand usually has to do with population trend. Ålesund has the biggest population and Molde has the second largest population in Møre og Romsdal. In addition to having the largest population in Ålesund their airport has the highest air travel demand and Molde has the second busiest airport in the county. But the population trend has broken down by two other small cities in the same county, Kristiansund and Ørsta-volda. From our case study we can see that Kristiansund's population (23813) is much more larger than Ørsta-volda area (8693), but as shown in Table 5.2 the travel frequency in Kristiansund airport (279) is less than Ørsta-volda airport (301).

We run a regression model (see Table5.4) using SPSS to examine if the population has an impact in air travel demand in Møre og Romsdal county. In this regression we do a hypothesis that is; if the significant level of population is less than 0.005 then population has a positive impact to the air travel demand. But the model result showed that the significant level of population is 0.407>0.005. We reject the zero hypothesis. Although population trend was broken down and influenced by Kristiansund and Ørsta-volda, population still has an impact to air travel demand for the ÅLESUND and Molde airport.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.143	.885		13.722	.000
	Population	-2.232E-005	.000	-.019	-.830	.407

Table 5.4 Model results for population

Ticket fares and Income of passengers

Usually the air travel demand will be sensitive to ticket fare and passengers' income. In our SPSS model, the implications of ticket fare and passengers' income are expressed in terms of the elasticity, which indicates the change in demand and it should be demonstrated by change in the independent variable. Usually people desire to travel within their financial budget, so the higher the income, the higher the travel demand. Business travel is usually quite inelastic in ticket fare but has income elasticity. When the air travel is necessary for a business person then the person has to purchase the flight no matter what the ticket costs if it is high or low. Normally the higher income of a passenger, the higher demand of the air travel demand, because the low income travelers are usually willing to choose the lowest fare transportation means. But in general leisure travel typically has much higher elasticity in ticket fares and passengers' income.

From the previous study we realize that sometimes business trips and leisure trips have different affecting factors. Some factors may significant to business trip but not significant to the leisure trip or one factor has different significant level to business and leisure trip. The travel purpose will be an important variable in our model.

Accessibility to the airport

The accessibility to an airport is an attractive factor which may influence the demand of travel at an airport. The significant level of accessibility is important to the air travel demand forecasts. It is widely recognized that the choice of airport of air travelers is determined by the air service offered at the airport and the accessibility to the airport. The air service factors are the market of interest to the traveler and include flight frequency and travel time, and ticket fares (Kazda and Caves, 1994). Accessibility is typically measured by the total travel time from the starting point to the destination airport and the travel time will be different regarding the different access mode choice. In Norway, although a more sophisticated approach would consider the full range of access modes available and derive the access disutility from the ground access mode choice process. We can see from the Table 5.5 that in this county except the transfers, people often go to the airport by bus, airport express or escorted by others except the transfers.

Transport means	Frequency	Percent
Taxi	248	12.7%
Rental Car	60	3.1%
Car that was parked at the airport during the journey	22	1.1%
Driving by others	218	11.2%
Bus	347	17.7%
Airport Express	369	18.9%
Trains	41	2.1%
Others (on foot, bicycle, motorcycle etc.)	59	3.0%

Transferred from another flight	582	29.8%
Total	1946	99.5%
Missing System	9	0.5%
Total	1955	100.0

Table 5.5 Transport means to airport

Norway has good infrastructure and development in accessing to a local airport. Accessibility is particularly good in western and northern parts of Norway where over two thirds of the population will take 30 minutes of travel time to its nearest airport (Lian et al., 2005). The Norwegian population needs about 64-minute drive on average by road from its nearest airport. Almost 40% of the population spent less than 30 minutes and over three quarter take less than 60 minutes of travel time to an airport. Only 3% of the population needs 120 minutes or more drive or travel time from its nearest airport. (Halpern and Bråthen, 2010)

5.3 Study Hypothesis

Before running the model we do several assumptions:

Assuming that all return trips in our dataset is a homebound trip. In other words, the person came from the airport back to his/her home where the data given is the post number.

There are a few occasional incidents that exist. Some travelers choose an alternative airport rather than the nearest airport .When distance distinction of the nearest airport and the alternative airport are over 50 kilometers, we assume that the reason for travelers to neglect the short access distance is low ticket fare, bad weather condition or the flight delay.

5.4 The process of empirical research

1. Select the useful data from dataset. In the data set “Air Transport Travel Survey “(ATTS) for domestic in 2009 we pick the data which we need, the data of destination airport is Ålesund airport, Molde airport, Kristiansund airport and Ørta-volda airport.

2. Calculate the distance from home according to the post number and place of residence and input the distance values as a new variable in dataset.

3. Inspect the data distribution of variables: Confirm the dependent variables and independent variables for model .inspect the distribution of independent variables and reprocessing them.

4. Primarily modeling. Run the liner regression model primarily. Analyze the significant variables and not significant variables, reject the not significant variables except distance, as the case may be, this process will be repeated.

5. Adjustment for model. Add more variables which are related to data measurement and convert distance to time proxy and run the model again.

6. Get the final regression model. Get the most appropriate regression model for air travel demand and analyze the results

6. Data analysis

6.1 Distance calculation

First, we should calculate the distance between the traveler's home and the airport. According to the data set, we know the post number and the destination airport of each traveler. It is a convenient way to use post number as the starting point and the finishing point is each address of those four airports which are fixed. In our cases, we mainly use "Norguide" as the tool to measure the distances. It is a Norwegian local map system like Google Map. This system can offer us a fastest path from where the traveler lives to the airport just by inputting the city (From zip code website (1)) and the name of destination airport. Norguide will output total drive length, drive time as well as tolls directly, furthermore, the detailed route below will show, if anything, ferry number and time.

Here is an example: the post number of one customer is 6480, and then through the zip code website we can get the place he live is in Aukra, he took off from the Molde airport. Then we input "Aukra 6480" and "Molde airport" in to the form respectively, afterwards, a route shade in blue as well as the detailed driving line on the left hand will appear. The picture below display that the total driving distance would be 26.9 km, it takes 42minutes (see Figure 6.1) to go through the whole journey, in addition, there is no fee that should be paid during this line. Detailed route shows that there is a 17 minutes' ferry this people should take (see Figure 6.2).

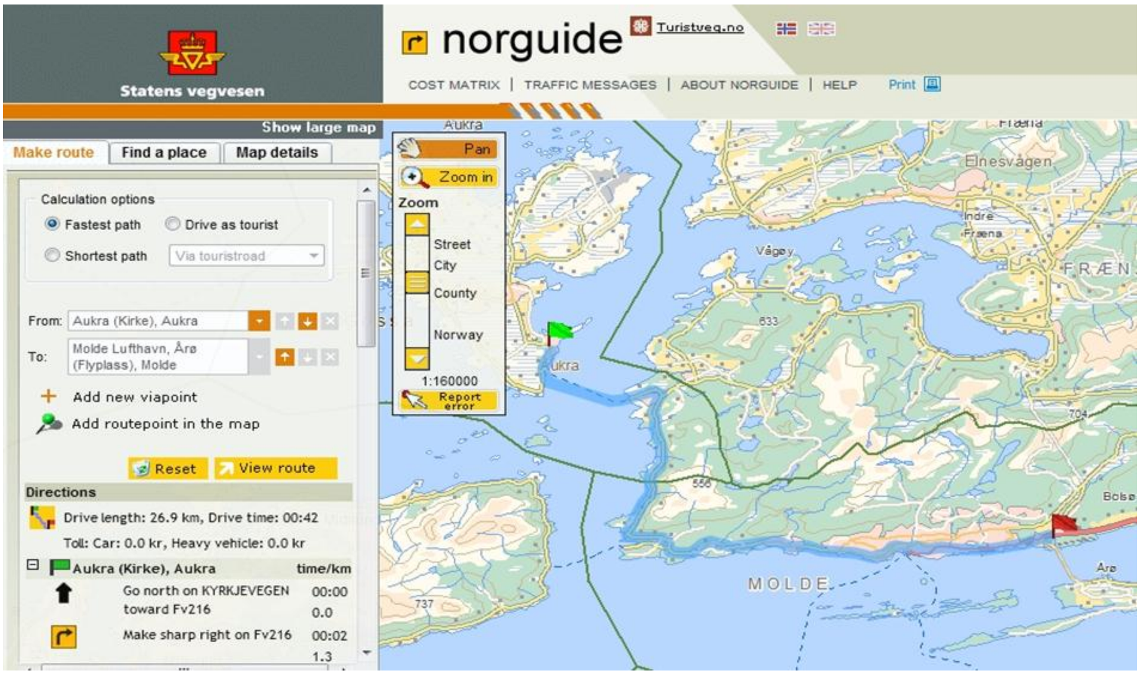

Figure 6.1: Driving route from Aukra to Molde airport

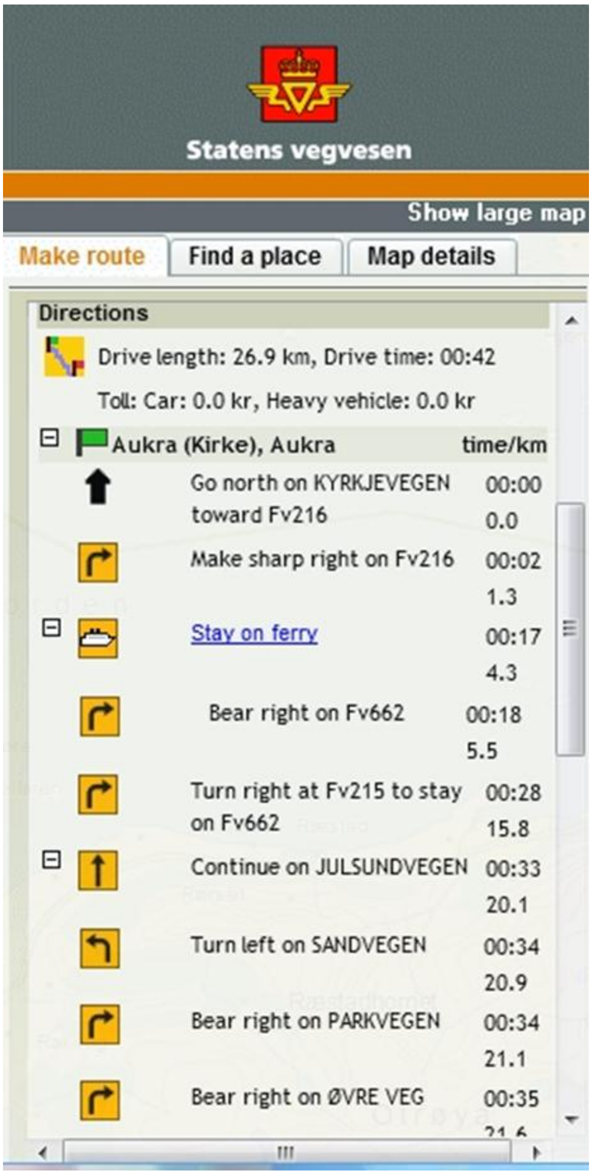

Figure 6.2: Detailed route information from Aukra to Molde airport

With this kind of calculation, we get a new dataset that consist of more than 2000 data. In that updated dataset, we found that some people did not choose a closer airport but the farther one. To improve the accuracy, we delete some data. Such as one traveler who lives in Gurskøy (post number 6080), he went to the Ålesund airport to take a plane rather than to Ørsta-Volda airport. The distance between his home to Ålesund airport is 73.6 km that is more than twice as much as to Ørsta-Volda airport (30.2km). The total time he took on his way to Ålesund airport is 105 minutes, which takes about triple the time to Ørsta-Volda airport and with probable additional costs. These special cases may influence our result, so we delete these cases familiar with the case above.

6.2 Dummy variables

In the beginning, we selected more than ten variables as independent variables. Among these variables, there are some qualitative variables such as gender, means of transportation, purpose of travelling. These variables cannot be readily quantified on well-defined scale, but indicate the presence or an attribute, the method to quantify these attributes is by creating artificial variables which take 1 or 0 as values, 0 expressing the absence of an attribute and 1 indicating the presence of that attribute. (Damodar,1988)

To use dummy variables in regression, we can use model called analysis-of-variance (AOV) model. For instance, consider the model below:

$$Y_i = \alpha + \beta D_i + u_i$$

Where Y = annual frequency of travelling

D_i =1, if male traveler

=0, otherwise (female traveler)

The general rule to avoid the perfect multicollinearity problem is like this: *If a qualitative variable has m categories, introduce only m-1 dummy variables* (Damondar,1988). Just like gender in two categories, we apply only one dummy variable. In our cases, most of the qualitative variables have at least three categories. Then we introduce some tables to describe dummy variables in ANOVA model as following:

Trip purpose (FORMAL)		
Number	Purpose	Dummy variables
1-6	Business	(1,0)
7-9	Leisure	(0,1)
10	Other private trip	(0,0)

Table 6.1: Description of trip purpose in dummy variables

Season (From variable Month)		
Number	Month	Dummy variables
1	1-3	(0,0,0)
2	4-6	(1,0,0)
3	7-9	(0,1,0)
4	10-12	(0,0,1)

Table 6.2: Description of Season in dummy variables

Occupation		
Number	Occupation	Dummy variables
1	On the job	(1,0)
2	Student	(0,1)
3	Others	(0,0)

Table 6.3: Description of occupation in dummy variables

Ways of travelers transfer to airport are grouped into nine categories:

1. Taxi
2. Car
3. Car was parked in the airport
4. Car was bought or rented by others
5. Bus
6. Shuttle bus
7. Trains
8. Others: foot, bicycle, motorcycles
9. Transfer from airport

We divided them into three groups and the dummy variables shown as follows:

Category	Means	Number	Dummy variable
①	Public	1,5,6,7,9	(0,1)
②	Private	2,3,4	(1,0)
③	Others	8	(0,0)

Table 6.4: Description of means of transportation in dummy variables

Afterwards, we did the regression separately in the classified variables, but the results seem not so satisfied.

6.3 Regression model one

6.3.1 Variable explanation

The travel demand in our analysis is represented by travel frequency. As can be seen from the Table 6.5 below, annual travel frequency of the respondents range from 0 to 210 with the mean of 11.47. More details are told in the Figure 6.3, annual frequencies are mainly under 20, to get a better view of how the frequency distribute, we divided them into 7 groups (Table 6.6). More than 40 percent people travel between 0 and 5 times in one year which count 858 among 1955 travelers in total no matter it is a business trip or a leisure trip.

Statistics

Total travel frequency in one year

N	Valid	1955
	Missing	0
Mean		11.47
Std. Deviation		15.142
Variance		229.285
Range		210
Minimum		0
Maximum		210

Table6.5: Statistics of travel frequency of travelers

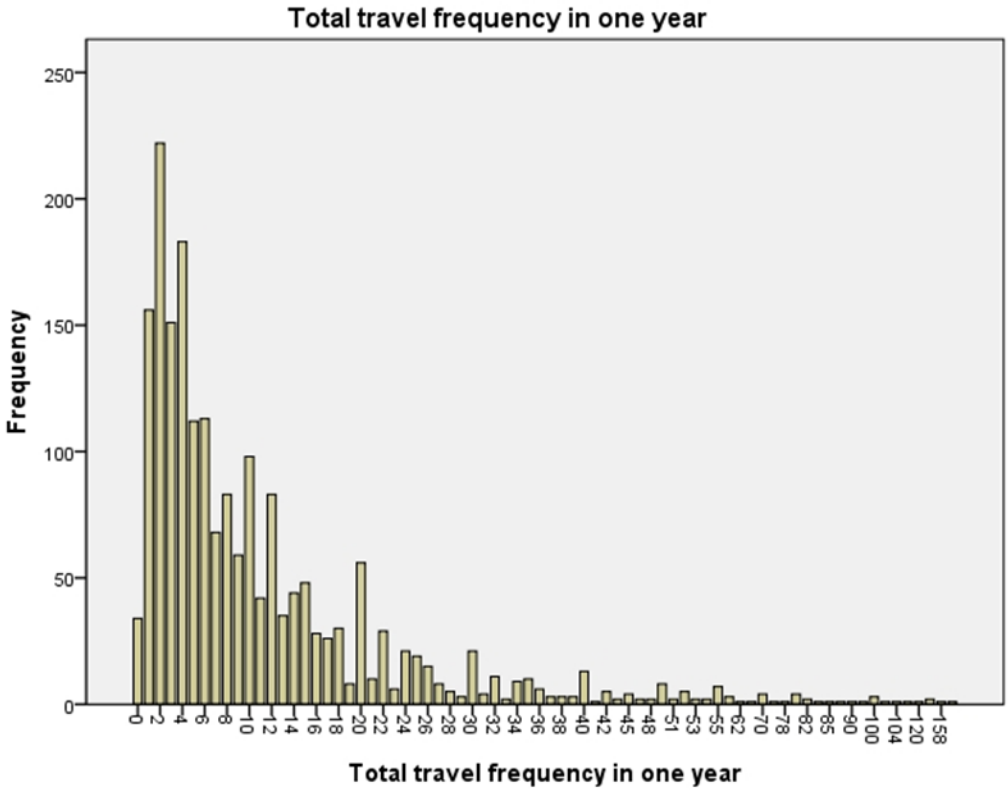

Figure6.3: Bar chart of travel frequency

TravelFrequencyGroup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-5	858	43.9	43.9	43.9
	6-10	421	21.5	21.5	65.4
	11-15	252	12.9	12.9	78.3
	16-20	148	7.6	7.6	85.9
	21-25	85	4.3	4.3	90.2
	26-30	52	2.7	2.7	92.9
	over 30	139	7.1	7.1	100.0
	Total	1955	100.0	100.0	

Table6.6: Travel frequency in Groups

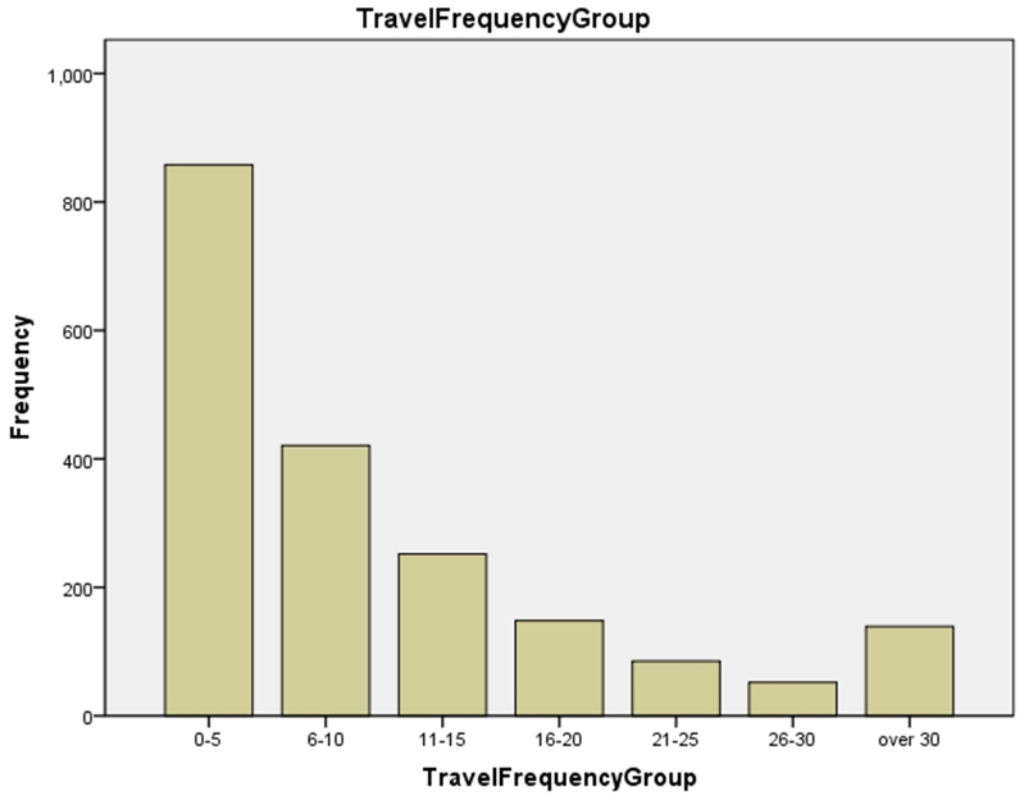

Figure 6.4: Bar chart of travel frequency in groups

The total number of variables in the dataset is 77, that is too much for the analysis, so first of all, we should select the variables that may have correlation with travel demand. About 20 variables are kept including ticket price, gross income, age, gender, purpose and so on (Table 6.7).

Variable	Definition
Post Number	Post number of the inhabitant
Destination Airport	Destination of the airport
Number Of Person	Total number of persons in the trip
Hometown	Home town of the traveler
OPPMOTE	Arrival at airport in minutes
TRANSPOR	Means of transportation to the airport
FLIGHTNR	Flight number
Airline	Airline
Weekday	
Night	Total nights during the trip
Purpose	Purpose of the trip
Ticket Price	Ticket price in Norwegian kroner

Gross Income	Annual gross income
Age	Age
Gender	Gender
Occupation	Occupation
Month	Month

Table 6.7: Description of variables

6.3.2 Hypothesis

We study how the factors affect travel demand from two perspectives: airport and traveler. From the airport's aspect, it contains ticket price and distances between home and airport. From the perspective of traveler, it includes purpose, annual gross income, gender, age, occupation, nights during the trip and month of departure date. Then we begin to set hypothesis:

H1a: Higher ticket price has a negative impact on travel demand.

H1b: Longer distance between home and airport has a negative impact on travel demand.

H2a: Business trip has a positive impact on travel demand

H2b: Higher annual gross income has a positive impact on travel demand

H2c: Gender male has a positive impact on travel demand

H2d: People in middle age has a positive impact on travel demand

H2e: Occupation of business man has a positive impact on travel demand

H2f: More nights during the trip has a negative impact on travel demand

H2g: Month of summer has a positive impact on travel demand

Through our study, we would like to find out whether these hypotheses should be accepted or not. The longer the distance between home and airport, the less frequent will the traveler go out by plane? At the end of our research, we can get the result of this question. Same as other hypotheses, we would find the relationship between these variables and travel demand.

6.3.3 Correlation test

By means of calculating distance mentioned in the previous chapter, we get a new variable called "Distance" indicates distance between traveler's home and the destination airport. As the main variable in our analysis, we believe they are correlated between distance and travel demand. We can check whether there is correlation by the figure6.5 below.

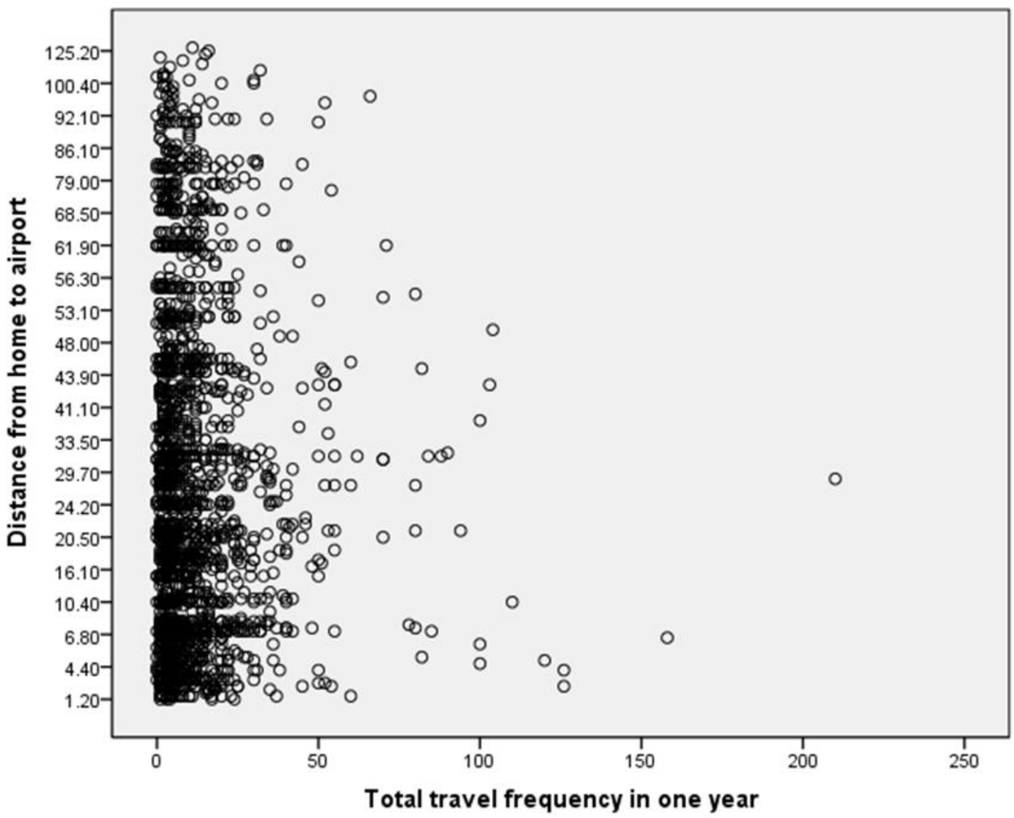

Figure 6.5: Correlation between travel frequency and distance

But the figure shows there is no significant relevance between distance and travel frequency. We decide still treat distance as a relevant variable, it may affect travel demand in some ways, we want to explore further. Meanwhile, we would like to know more whether ticket price, purpose, age, gender and other variables have correlation with travel demand. That is to say we would like to build a regression model to forecast demand for air travelling by variables of distance, ticket price, purpose and so on. It is necessary for us to look at whether there is correlation in travel frequency and ticket price, purpose for traveling, age, etc.

Correlations

Control Variables			Total travel frequency in one year	Total number of person in the trip
Distance from home to airport	Total travel frequency in one year	Correlation	1.000	-.075
		Significance (2-tailed)	.	.001
		df	0	1910
	Total number of person in the trip	Correlation	-.075	1.000
		Significance (2-tailed)	.001	.
		df	1910	0

Table 6.8: Correlation between travel frequency and number of person

Correlations

Control Variables			Total travel frequency in one year	Ticket price in norwegian kroner
Distance from home to airport	Total travel frequency in one year	Correlation	1.000	.186
		Significance (2-tailed)	.	.000
		df	0	1532
	Ticket price in norwegian kroner	Correlation	.186	1.000
		Significance (2-tailed)	.000	.
		df	1532	0

Table 6.9: Correlation between travel frequency and ticket price

Correlations

Control Variables			Total travel frequency in one year	Total nights during the trip
Distance from home to airport	Total travel frequency in one year	Correlation	1.000	-.034
		Significance (2-tailed)	.	.139
		df	0	1915
	Total nights during the trip	Correlation	-.034	1.000
		Significance (2-tailed)	.139	.
		df	1915	0

Table 6.10: Correlation between travel frequency and nights during the trip

Correlations

Control Variables			Total travel frequency in one year	Annual gross income in norwegian kroner
Distance from home to airport	Total travel frequency in one year	Correlation	1.000	.251
		Significance (2-tailed)	.	.000
		df	0	1534
	Annual gross income in norwegian kroner	Correlation	.251	1.000
		Significance (2-tailed)	.000	.
		df	1534	0

Table 6.11: Correlation between travel frequency and annual income

We can see from the four tables above (Table6.8, Table 6.9,Table 6.10 and Table 6.11) that there are partial correlation between travel frequency and total persons in the trip, ticket price, annual gross income. The partial correlation coefficients are -0.075, 0.186, 0.251 respectively. While total nights spent during the trip has no partial correlation since the 2-tailed significance is 0.139 (greater than 0.05). We can build a regression model to forecast travel demand with variables of persons in the trip, ticket price and annual gross income.

The correlations between each variable we think may affect travel demand are shown in the Table 6.12 below. Through the 2-tail significance we can pick out these variables as follow: total number of person in the trip, purpose of travelling, ticket price, annual gross income, age, gender and occupation.

Correlations

		Total travel frequency in one year	Total number of person in the trip	Distance from home to airport	Means of transportation to the airport	Total nights during the trip	Purpose2	Ticket price in norwegian kroner	Annual gross income in norwegian kroner	Age	Gender	Occupation	month
Total travel frequency in one year	Pearson Correlation	1	-.075**	-.023	-.005	-.034	-.325**	.186**	.250**	.094**	.268**	-.189**	-.013
	Sig. (2-tailed)		.001	.302	.838	.131	.000	.000	.000	.000	.000	.000	.552
	N	1955	1913	1955	1946	1918	1923	1535	1537	1937	1895	1892	1955
Total number of person in the trip	Pearson Correlation	-.075**	1	.022	.010	.022	.019	-.021	-.019	-.014	-.018	.017	.013
	Sig. (2-tailed)	.001		.336	.655	.332	.406	.412	.466	.534	.428	.455	.580
	N	1913	1913	1913	1904	1877	1882	1499	1504	1895	1854	1850	1913
Distance from home to airport	Pearson Correlation	-.023	.022	1	-.013	.029	-.011	-.001	.020	.007	.037	-.039	-.006
	Sig. (2-tailed)	.302	.336		.572	.202	.642	.963	.443	.771	.107	.088	.783
	N	1955	1913	1955	1946	1918	1923	1535	1537	1937	1895	1892	1955
Means of transportation to the airport	Pearson Correlation	-.005	.010	-.013	1	.173**	.060**	.254**	.052*	.013	.008	-.022	-.104**
	Sig. (2-tailed)	.838	.655	.572		.000	.009	.000	.044	.575	.714	.332	.000
	N	1946	1904	1946	1946	1909	1915	1530	1531	1928	1887	1883	1946
Total nights during the trip	Pearson Correlation	-.034	.022	.029	.173**	1	.039	.076**	-.003	-.074**	.033	.101**	-.005
	Sig. (2-tailed)	.131	.332	.202	.000		.093	.003	.912	.001	.153	.000	.814
	N	1918	1877	1918	1909	1918	1888	1509	1516	1900	1860	1856	1918
Purpose2	Pearson Correlation	-.325**	.019	-.011	.060**	.039	1	-.218**	-.219**	-.079**	-.371**	.343**	.114**
	Sig. (2-tailed)	.000	.406	.642	.009	.093		.000	.000	.001	.000	.000	.000
	N	1923	1882	1923	1915	1888	1923	1514	1519	1906	1868	1866	1923
Ticket price in norwegian kroner	Pearson Correlation	.186**	-.021	-.001	.254**	.076**	-.218**	1	.107**	.032	.212**	-.122**	-.065*
	Sig. (2-tailed)	.000	.412	.963	.000	.003	.000		.000	.212	.000	.000	.011
	N	1535	1499	1535	1530	1509	1514	1535	1233	1523	1488	1487	1535
Annual gross income in norwegian kroner	Pearson Correlation	.250**	-.019	.020	.052*	-.003	-.219**	.107**	1	.083**	.230**	-.181**	-.017
	Sig. (2-tailed)	.000	.466	.443	.044	.912	.000	.000		.001	.000	.000	.505
	N	1537	1504	1537	1531	1516	1519	1233	1537	1527	1493	1489	1537
Age	Pearson Correlation	.094**	-.014	.007	.013	-.074**	-.079**	.032	.083**	1	.107**	.044	-.027
	Sig. (2-tailed)	.000	.534	.771	.575	.001	.001	.212	.001		.000	.056	.241
	N	1937	1895	1937	1928	1900	1906	1523	1527	1937	1883	1878	1937
Gender	Pearson Correlation	.268**	-.018	.037	.008	.033	-.371**	.212**	.230**	.107**	1	-.157**	-.017
	Sig. (2-tailed)	.000	.428	.107	.714	.153	.000	.000	.000	.000		.000	.448
	N	1895	1854	1895	1887	1860	1868	1488	1493	1883	1895	1835	1895
Occupation	Pearson Correlation	-.189**	.017	-.039	-.022	.101**	.343**	-.122**	-.181**	.044	-.157**	1	.044
	Sig. (2-tailed)	.000	.455	.088	.332	.000	.000	.000	.000	.056	.000		.055
	N	1892	1850	1892	1883	1856	1866	1487	1489	1878	1835	1892	1892
month	Pearson Correlation	-.013	.013	-.006	-.104**	-.005	.114**	-.065*	-.017	-.027	-.017	.044	1
	Sig. (2-tailed)	.552	.580	.783	.000	.814	.000	.011	.505	.241	.448	.055	
	N	1955	1913	1955	1946	1918	1923	1535	1537	1937	1895	1892	1955

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 6.12: Correlation between selected variables

6.3.4 Regression results

Among all the variables, some of them are dummy variables, to simplify our model, we decide to decrease the number of dummy variables. At last, we choose distance, purpose and ticket price, the three variables in our first regression model.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.023[a]	.001	.000	15.142	.010

a. Predictors: (Constant), Distance from home to airport
b. Dependent Variable: Total travel frequency in one year

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	244.845	1	244.845	1.068	.302[a]
	Residual	447777.643	1953	229.277		
	Total	448022.488	1954			

a. Predictors: (Constant), Distance from home to airport
b. Dependent Variable: Total travel frequency in one year

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.884	.530		22.411	.000
	Distance from home to airport	-.014	.014	-.023	-1.033	.302

a. Dependent Variable: Total travel frequency in one year

Table 6.13: Regression results of distance

Next step is running regression. Running linear regression in the SPSS software, we can see that it is not significant by running the regression with the distance alone. R in the model summary of Table 6.13 shows 0.023, the closer R to 1, the better goodness of fit. In our regression, it seems not good enough. In the table of Coefficients (Table 6.13), significance is 0.302, much greater than 0.05, that is also not a good result. It seems that distance is not a significant variable to travel demand.

Then we run linear regression with variable ticket price in SPSS. The results are as follows:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.186[a]	.035	.034	14.399	.094

a. Predictors: (Constant), Ticket price in norwegian kroner

b. Dependent Variable: Total travel frequency in one year

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11419.274	1	11419.274	55.079	.000[a]
	Residual	317832.287	1533	207.327		
	Total	329251.561	1534			

a. Predictors: (Constant), Ticket price in norwegian kroner

b. Dependent Variable: Total travel frequency in one year

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	8.399	.511		16.447	.000
Ticket price in norwegian kroner	.001	.000	.186	7.421	.000

a. Dependent Variable: Total travel frequency in one year

Table 6.14: Regression results of ticket price

Results seem better than variable distance. It is rather significant as Sig. in table Coefficients shows 0.000. R in the Model summary is 0.186 also better than distance, but that is still not good.

6.3.5 Cross table

To study distance deeper, we divided distance into seven groups. The distances in dataset ranges from 1.2 kilometers to 141.8 kilometers, as can be seen from Figure 6.6, data are distributed averagely, so we divided them with a group interval of 15 kilometers. (Table6.15)

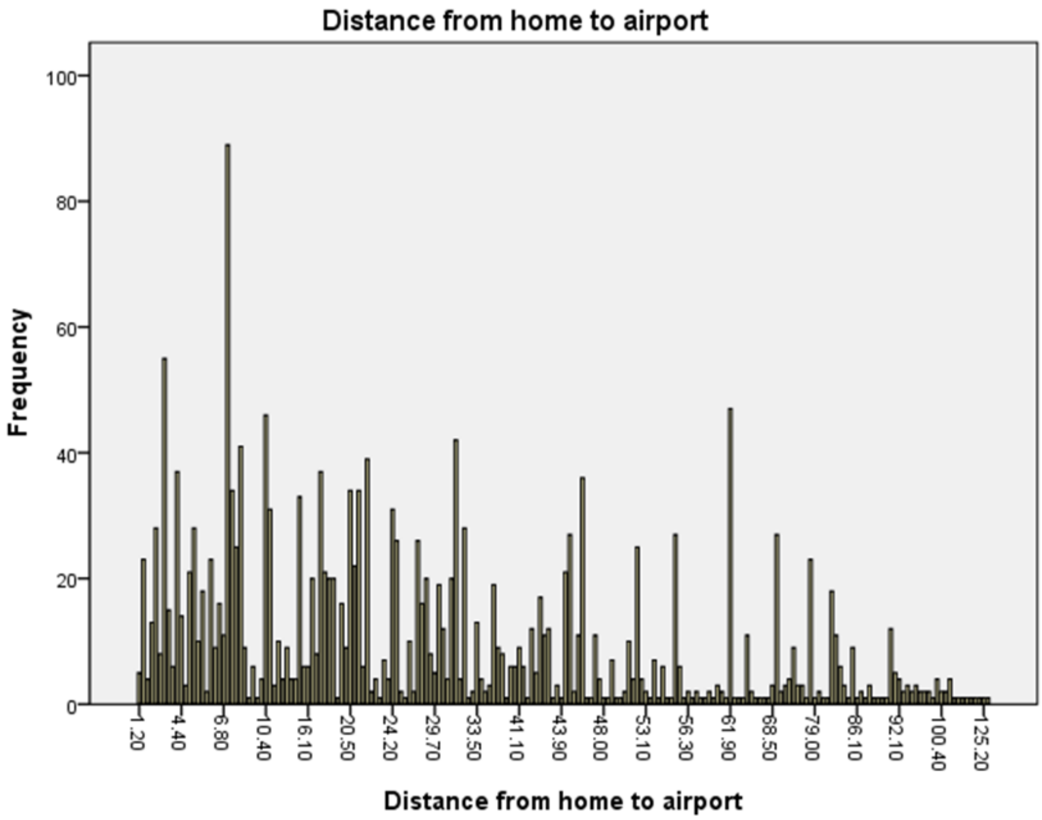

Figure 6.6: Frequency of distance

Group	Distance (kilometers)
1	0-15.99
2	16-30.99
3	31-45.99
4	46-60.99
5	61-75.99
6	76-90.99
7	Over 91

Table 6.15: Group of distance

Consider travel demand as rows, grouped distance as column and purpose as layer, we can get cross tables through SPSS.(Table 6.16)

Purpose		Grouped Distance (kilometers)							
		0-15.99	16-30.99	31-45.99	46-60.99	61-75.99	76-90.99	Over 91	total
Business	Total frequency	372	293	154	80	66	59	23	1047
leisure		328	251	124	45	48	55	25	876
total		700	544	278	125	114	114	48	1923

Table 6.16: Frequency of travel in grouped distances

Due to some missing values, 1923 data are included in the table. More business trips are taken compare to leisure trips. Table6.16 illustrates that no matter if business travel or leisure trip, distance below 15 kilometers account for the most part of all. More or less half of the trips are taken where distances between home and airport are below 30 kilometers in both business and leisure trips. Same results can be obtained from the picture below (Figure 6.7). Down trends emerge as distances increase. Business trips are more frequent than leisure trips, but both of these two kinds of trips experience a decrease trend as distances between travelers' home and airport grow. The shorter distances are, the more trips were taken. At a certain point, we can say that, the closer people live to an airport, the higher travel demands are. That can be one of the reasons that we believe there is relationship between distance and travel demand, shorter distances may bring out more demand for air travel.

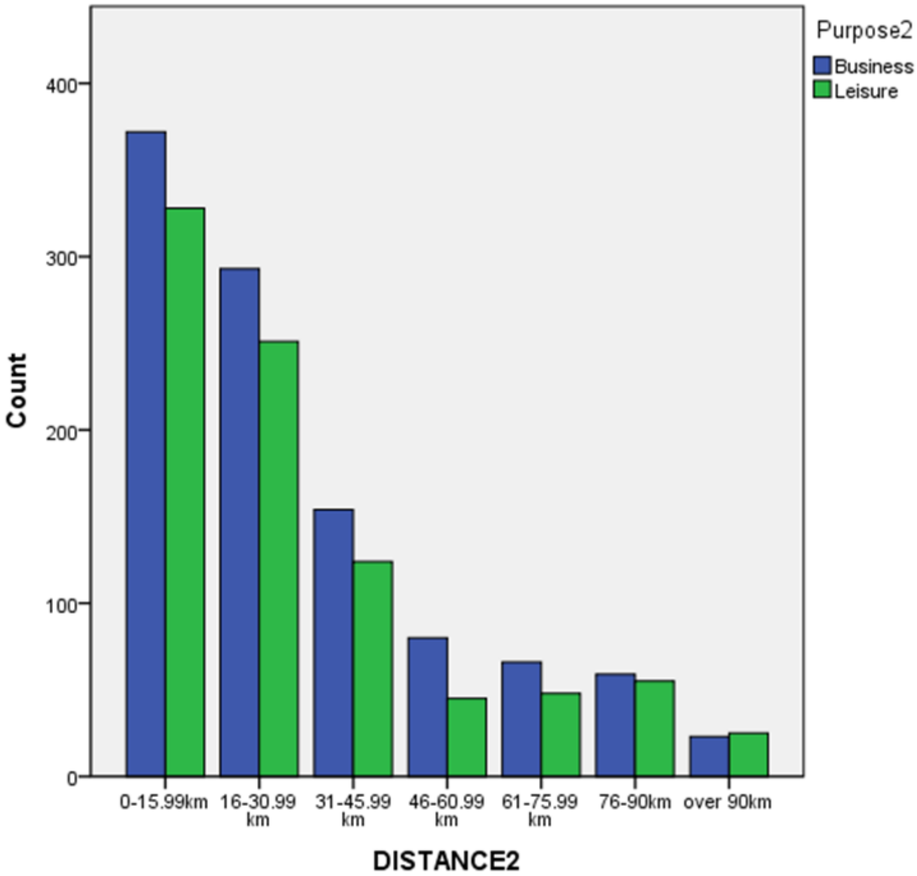

Figure 6.7: Frequency of trips in grouped distance in both business and leisure trips

6.4 Regression model two

6.4.1 New added variables

Norway is a seashore and mountainous country, sometimes this geographical character requires the traveler to take a ferry travelling from one city (municipality) to another city (municipality), especially on the west coast. Møre og Romsdal county is located in the west coast in Norway, this means this county has more ferry route. Strand(1999) mentioned that analysis of the accessibility to an airport should be a distance measurement not just the absolute geographical distance, and regarding the geographical character in this county , we decided to consider the ferry related information to help the distance measurement in our model. We decided to add three new variables in our dataset, ferry fares, ferry time (include ferry waiting time and ferry crossing time) and tolls.

There are 24 ferry routes in this county which operated by two ferry company, FJORD1 and NORLED AS. FJORD1 account for 18 routes and NORLED AS account for 6 routes (see figure 6.8 and 6.9)

One of the ferry routes: 

Figure 6.8: Ferry routes of FJORD1 at Møre og Romsdal(FJORD1 maps of ferries)

Figure 6.9: Ferry routes of NORLED AS at Møre og Romsdal

6.4.2 Variables measurement

The Norguide also give us convenient information in order to calculate the ferry time and tolls. When calculating the distance, Norguide also gives precise details about the route between two points .The route in Norguide also provide the information about whether there is a ferry and tolls in this trip, such as how many ferries in this trip and the route number and name of ferries and exact tolls in Kroner.

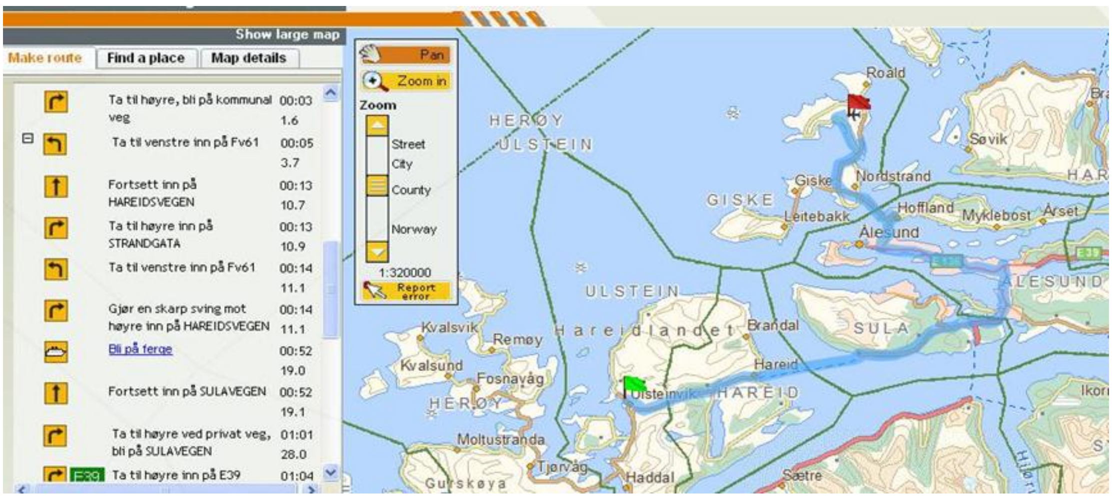

Figure 6.10: Route details from 6065 Ulsteinvik to Ålesund airport

Figure 6.11: Route details form 6065 Ulsteinvik to Ørsta-volda airport

We found that in Norguide the time duration between the ferry starting point and ferry ending point do not equal to the ferry crossing time. For example, from 6065 Ulsteinvik to Ålesund airport (See Figure 6.10 and Figure 6.11) there is a ferry Hareid–Sulesund and crossing time for this ferry is 25 minutes but Norguide show that this ferry needs 38 minutes(00.52 minus 00：14=38 minutes). So we assume that the 38 minutes is the summation of 15 minutes waiting time and 25 minutes crossing time for ferry Hareid–Sulesund. Meanwhile we get that all the ferry times for our observed distance in this way. FJORD1 (see figure 6.12) and NORLED AS provide us the price list for each ferry route in Møre og Romsdal county.

NB! Ferjestrekningane er fort opp under den ferjestaden som kjem først i alfabetet.

Eksempel: Sykkylven-Magerholm, sjå Magerholm-Sykkylven
Example: Sykkylven-Magerholm, look at Magerholm-Sykkylven

Ferry route Rute nr.	Ferry service Ferjestrekning	Farestage Takst-sone
49	Arasvika-Henrset	4
31	Aukra-Hollingsholmen	3
22	Brattvåg-Dryna	7
22	Brattvåg-Fjørtofta	12
22	Brattvåg-Harøya	14
22	Dryna-Fjørtofta	11
22	Dryna-Harøya	13
54	Edøya-Sandvika	7
15	Eidsdal-Linge	3
09	Festøya-Hundeidvika	5
11	Festøya-Solavågen	5
22	Fjørtofta-Harøya	3
	Flakk-Rørvik *)	
18	Geiranger-Hellesylt *)	
17	Geiranger-Valldal*)	
48	Halsa-Kanestraum	6
46	Kvanne-Rykkjem	3

*) Egen taksttabell/
separate faretable

Ferry route Rute nr.	Ferry service Ferjestrekning	Farestage Takst-sone
12	Lekneset-Skår	3
12	Lekneset-Standal	10
12	Lekneset-Sæbø	4
12	Lekneset-Trandal	7
14	Liabygda-Stranda	3
13	Magerholm-Sykkylven (Ørsneset)	4
34	Molde-Sekken	12
33	Molde-Vestnes (Furneset)	12
30	Mordalsvågen-Solholmen	3
50	Seivika-Tømmervåg	7
12	Skår-Standal	12
12	Skår-Sæbø	5
12	Skår-Trandal	9
12	Standal-Sæbø	9
12	Standal-Trandal	5
12	Sæbø-Trandal	7
36	Sølsnes-Åfarnes	4
85	Hasvik - Øksfjord	29
85	Øksfjord - Tverrfjord	5

Grupperabatt: Min. 12 pers. 17%
Group discount: Min. 12 pax 17%

FRA 1. JANUAR 2012 INKL. 8% MVA./FROM JANUARY 1 2012

FERRYRATES incl. 8% tax IN NORWAY 2012

Fare-stage Sone nr.:	Adult Voksne A1:	Senior/ Child Honnør Barn A2:	Car incl driver T.o.m. 6,0 m B2:	6,01 - 7,0 m B3:	7,01 - 8,0 m B4:	8,01 - 10,0 m B5:	10,01 - 12,0 m B6:	12,01 - 14,0 m B7:	14,01 - 17,0 m B8:	17,01 - 19,0 m B9:	19,01 - 22,0 m B10:	MC inkl. fører C:
3	26	13	63	156	184	247	302	363	444	508	597	44
4	28	14	69	169	200	266	323	379	468	532	621	47
5	29	15	75	184	216	286	347	403	492	565	653	49
6	31	15	81	198	232	303	363	428	516	589	678	52
7	32	16	87	211	248	323	387	452	540	613	702	55
8	34	17	92	226	265	339	403	468	565	637	734	57
9	35	18	98	240	281	363	428	492	589	661	758	60
10	37	18	104	253	297	379	444	516	613	686	782	63
11	38	19	110	268	313	395	468	540	637	718	815	64
12	40	20	116	281	331	419	492	557	661	742	839	67
13	41	21	122	295	347	436	508	581	686	766	863	69
14	43	21	128	310	363	460	532	605	710	790	895	72
15	44	22	133	323	379	476	549	629	726	815	920	75
29	66	33	217	516	605	742	839	936	1065	1178	1299	109

Fjord1 MRF AS - 6405 Molde - Tlf. 71 21 95 00 - mrf@fjord1.no - www.fjord1.no

Figure 6.12: Price list for ferry routes at Møre og Romsdal (FJORD1)

After the ferry time calculation for the 1955 observed data from Norguide we found that 80.6% (1575) of the observed distance are non-ferry trip and 19.4 %(480) are ferry trips. The ferry trips contain 15 different ferry routes. The detail information about ferry fares and ferry time showed in Table 6.17 (for the ferry waiting time not given trips in Norguide we assume that the ferry waiting time for the ferry is 10 minutes). We add two variables in our dataset which named FerrytimeW and FerryFare to describe the value of ferrytimeW (including ferry waiting time and crossing time) and ferry fares.

Ferry route name	Ferry crossing time(minute)	Ferry waiting time + crossing time (minute)	Ferry fares (kroner)
Festoya-Solavagen	20	30	75
Hareid–Sulesund	25	38	120
Larsnes–Aram–Voksa–Kvamsoya	15	21	35
Folkestad–Volda	13	15	90
Volda–Lauvstad	25	36	50
Arvika–Koparneset	15	23	44

Magerholm–Sykkylven(ørsneset)	15	25	69
Åfarnes–sølsnes	15	25	69
Molde–Vestnes	35	45	116
Halsa–Kanestraum	20	30	81
Aukra–Hollingsholmen	15	25	63
Eidsdal-Linge	10	15	63
Haramsøya-Lepsøya-Skjeltene	20	25	30

Table 6.17: Ferry time and Ferry fares

Another important variable is the road tolls. There are 4 toll stations in Møre og Romsdal. Tolls will exist if the trip is crossing the following subsea tunnels: to Molde, Kristiansund, Ålesund and the Eiksund tunnel, between Ulstein/Hareid and Ørsta/Volda. In the 1955 observed data 89.5%（1749）are non-tolls trip and 10.5% are tolls trip. According to the tolls shown in the Norguide, we add a new variable named "tolls" to record charging fee of each driving line if there is any tolls exists in this line.

Explanation	Ferry Fare in NOK	ferry crossing time + waiting time	Tolls In NOK
Mean	19.2205	6.6123	7.5090
N	1955	1955	1955
Std. Deviation	41.58670	15.12666	22.72075
Std. Error of Mean	.94055	.34211	.51387
Variance	1729.453	228.816	516.233

Table 6.18: New variables explanation

Table 6.18 gives the statistical explanation for the three new variables FerryFare, FerrytimeW and Tolls. As distance measurement the new variables should convert to time proxy and this information will be introduced in next section.

For the distance measurement, the common way is to convert the geographical distance number in kilometers to time proxy by SPSS and use the time proxy variable value to run the regression model. We assume that a car averagely use one hour for running 60 kilometers. So one kilometer is converted to 1 minute, for instance, the road distance from 6036 MAUSEIDVÅG to Ålesund airport is 36.5 kilometers and this can be convert to 37 minutes. So we get another variable “DriveDistance” to describe distance after convert to time proxy.

6.4.3 Regression

We run the regression model again use the “DriveDistance” as an independent variable to the air travel demand model.

The model formed :

$Y=\beta 0 + \beta 1\, x1 + \beta 2\, x2 + \beta 3\, x3$

Where, dependent variable travel Y = frequency;

X1 = Drive Distance

X2 = Travel Purpose

X3 = Ticket fare

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	24.141	1.311		18.415	.000
	DriveDistance	-.009	.011	-.021	-.860	.390
	Travel Purpose	-9.622	.716	-.329	-13.433	.000
	Ticket fare	.001	.000	.117	4.784	.000

Table 6.19: Model results

We can see from the model results (see table 6.19) that the significant level of Drive distance to travel frequency is 0.390 still higher than 0.05, so drive distance still not significant to air travel demand .The significant level of travel purpose and ticket fare are kept at the same level 0.000 in previous model. To further research of distance measurement it is necessary to covert the new ferry related variables FerrytimeW, FerryFare and tolls to time proxy ,the method of this issue will be introduced in next section.

6.5 Regression model three

6.5.1 Variable explanation

As we collect ferry time, ferry fare and tolls mentioned in previous chapter, we now try to change them into some kinds of time proxy and sum them up to total time. Total time can be converted into total distance, by some means, it may improve accuracy. Set sentences in SPSS as " If (purpose 2 =1 and tolls >0) timeproxy = tolls/380", purpose 2=1 means it is a business trip and 380 is value of business time per hour in Norwegian kroner. In addition with "If (purpose 2=2 and tolls > 0) timeproxy = tolls/150", purpose 2=2 means it is a leisure trip and 150 is value of leisure time per hour in Norwegian kroner. Then in the similar way, two more sentences "If (purpose2=1 and ferryfare >0) timeproxy = ferryfare/380" and "If (purpose 2=2 and ferryfare >0) timeproxy = ferryfare/150" are added. The we sum up driving time, ferry time include waiting time, time proxy tolls and time proxy fares, total time will be got. Now three new variables are added.

6.5.2 Running regression

Running regression with travel frequency as dependent variable and total time as independent variable, we can get the results through SPSS as shown in Table 6.20.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.033[a]	.001	.001	15.138

a. Predictors: (Constant), equal to total driving distance
b. Dependent Variable: Total travel frequency in one year

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	491.792	1	491.792	2.146	.143[a]
	Residual	447530.696	1953	229.150		
	Total	448022.488	1954			

a. Predictors: (Constant), equal to total driving distance
b. Dependent Variable: Total travel frequency in one year

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	11.943	.472		25.277	.000
	equal to total driving distance	-.011	.008	-.033	-1.465	.143

a. Dependent Variable: Total travel frequency in one year

Table 6.20: Regression results of driving distance

The results are improved compare to previous regression, the goodness of fit increased and also significance. As can be seen in the Significant in Coefficients table, Sig. decrease to 0.143 even it is still not significant enough.

6.6 Regression model four

Before converting the three new variables (Ferry fare, FerrytimeW and tolls) to time proxy, we will use the logarithmic regression model to examine if the three variables are affecting the travel frequency or not. In this round, the dependent variable is still travel frequency and the independent variables are the logarithmic transformation value of Ticket fare, Ferry fare, FerrytimeW and tolls. The logarithmic model can help us to get a more direct interpretation of the estimated coefficient of each variables drive distance, Ferry fare and tolls as the average short-term elasticity dependent variable travel frequency with respect to this variable. Also the logarithmic model can reduce the heteroscedasticity since it compresses the scale in which the variables are measured. (Theodore, 2009) .The functional form of the logarithmic demand model can be expressed in the following form:

$$LgY=\beta 0 + \beta 1Lg\ x1 + \beta 2Lg\ x2 + \beta 3Lg\ x3+\beta 4Lg\ x4$$

Where LgY is the logarithmic transformation of travel frequency and Lg x1, Lg x2, Lg x3 and Lg x4 are the logarithmic transformation of Ticket fare, Ferry fare, Ferrytime and tolls respectively.

The model results showed in table 6.21.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.332	.117		-2.837	.005
	Lgticketfare	.340	.035	.246	9.778	.000
	LgFerryfare	.000	.001	.041	.495	.621
	LgFerrytimew	-.002	.003	-.057	-.688	.492
	Lgtolls	.001	.001	.026	1.036	.301

Table 6.21: Model results

The results show that only logarithmic ticket fare has significant impact to travel demand, while the other three variables not significant.

6.7 Regression model five

6.7.1 Variable explanation

Since the results are still not good enough, we decided to group total time into groups then analyze each group separately. To get an overview of how total time distributes, we get a bar chart (Figure 6.13) of frequency of total time. Similar to how distance distributes, we divided them into eight groups:

Number of group	Total time interval	Number of group	Total time interval
1	<30	5	81-100.99
2	31-45.99	6	101-125.99
3	46-60.99	7	126-150.99
4	61-80.88	8	>151

Table6.22: Groups of total time

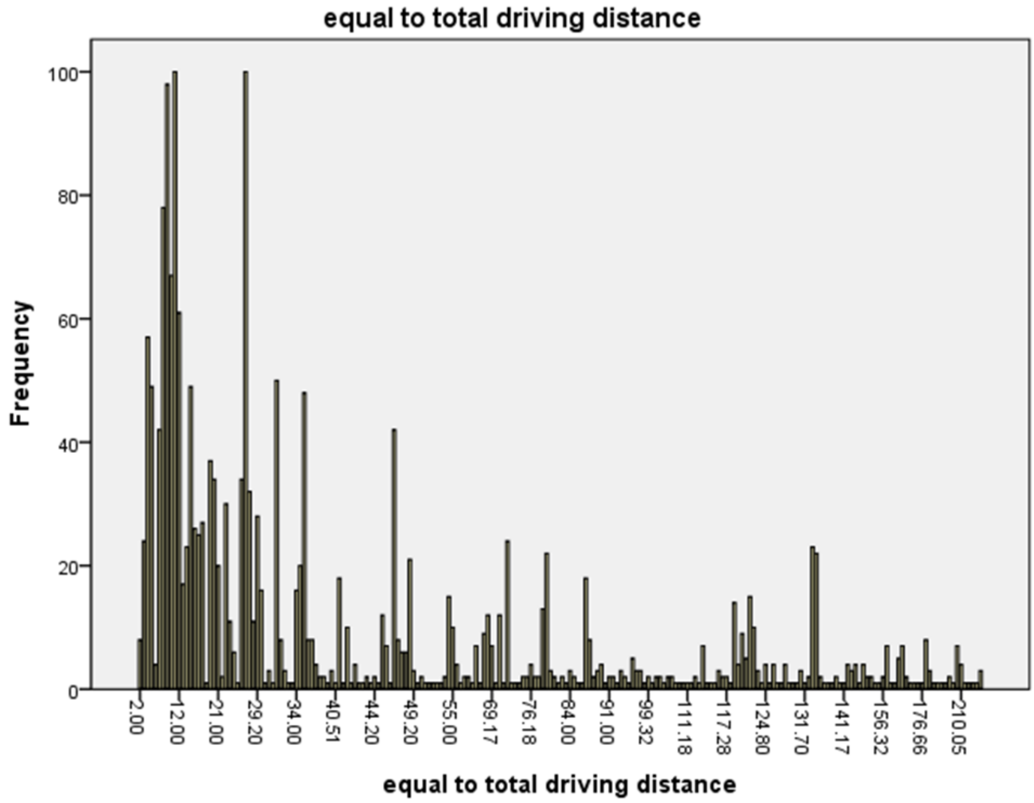

Figure 6.13 : Frequency of total time

6.7.2 Regression

Afterwards, we start to do regression in groups one by one. Results still not good until group 5 appears.

Model Summary[b,c]

Model	R		R Square	Adjusted R Square	Std. Error of the Estimate
	TotalTime Group = 5 (Selected)	TotalTime Group ~= 5 (Unselected)			
1	.293[a]	.	.086	.074	11.754

a. Predictors: (Constant), equal to total driving distance
b. Unless noted otherwise, statistics are based only on cases for which TotalTimeGroup = 5.
c. Dependent Variable: Total travel frequency in one year

ANOVA[b,c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	972.259	1	972.259	7.038	.010[a]
	Residual	10360.909	75	138.145		
	Total	11333.169	76			

a. Predictors: (Constant), equal to total driving distance
b. Dependent Variable: Total travel frequency in one year
c. Selecting only cases for which TotalTimeGroup = 5

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-49.782	23.366		-2.131	.036
	equal to total driving distance	.698	.263	.293	2.653	.010

a. Dependent Variable: Total travel frequency in one year
b. Selecting only cases for which TotalTimeGroup = 5

Table 6.23: Regression result of total driving distance in group 5

In the Table 6.23 we can see that both goodness of fit and significance reach the standard requirements, significance is 0.1 in the table of Coefficients, less than 0.05. We can say that in the total time interval of 81 and 100.99, distances between home and airport is a significant variable to travel demand. Distance has a positive effect on demand, as distance grows, demand will also increase. Finally, we reach the conclusion that we expected.

Group 7 also get a significant result, but not as good as group 5. Distance affects demand significantly when distance is between 126 and 150.99. Now two distance interval were proved to have significant affect to travel demand. Furthermore, we add two more variables which have proved to be significant variables in previous chapter into the regression. Group 7 turns to not significant again except purpose is still a significant variable. In the group 5, distance is significant variable, but the other two variable turn to not significant. Some other variables are tried in the regression, but no more ideal results appear. (See Table 6.24)

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-56.591	38.324		-1.477	.146
	equal to total driving distance	.887	.417	.292	2.129	.039
	Purpose2	-6.830	4.382	-.214	-1.559	.126
	Ticket price in norwegian kroner	.000	.000	-.044	-.326	.746

a. Dependent Variable: Total travel frequency in one year
b. Selecting only cases for which TotalTimeGroup = 5

Table 6.24: Regression Result of three variables in group 5

Service level is consider to be a significant variable to travel demand in previous research, since there is no information about the service level which was provided, we do the assumption to treat frequency of flights to capital city Oslo in these four airports as the measurement of service level. We check the flight table in ANOVA, found that during a work day, there are 9 flights to Oslo from Ålesund airport. In both Molde airport and Ørsta-Volda airport, there are 6 flights to Oslo. Frequency of flights in Kristiansund is the lowest among these four airports, with a total number of 4 flights. We set a new label with number of flights to Oslo according to the destination airport, and then do regression with the variable as service level. The result is service level is not a significant variable in our dataset. (See Table 6.25)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.872	1.340		9.602	.000
	ServiceLevel	-.198	.183	-.025	-1.085	.278

a. Dependent Variable: Total travel frequency in one year

Table 6.25: Regression result of service level

Besides, due to the variance of population of each district, we are wondering whether there is any relationship between population and demand.

Same way as insert service level into the dataset, we create a new label of population in the dataset. Correlate them with travel demand; once again, there is no significant relationship with number of inhabitants and travel demand. (See Table 6.26)

Correlations

		Total travel frequency in one year	NumberOf Population
Total travel frequency in one year	Pearson Correlation	1	-.019
	Sig. (2-tailed)		.406
	N	1955	1955
NumberOfPopulation	Pearson Correlation	-.019	1
	Sig. (2-tailed)	.406	
	N	1955	1955

Table 6.26: Correlations between travel frequency and number of population

6.8 Summary of regression

According to all the analysis above, we can say that in our dataset, it shows distance does not have significant impact on travel demand except that in the distance interval of 81 to 100.99 kilometers, the longer the distance is, the less travel frequency would be. Ticket price can be one affecting variable to travel demand and travel purpose does impact the travel demand.

7. Discussions

In the previous literature the airport choice is one of important factor which can affect air travel demand, especially in dummy airport cities. Russon and Hollingshead (1989) mentioned that if the rival airport has a higher service level then there will be a diversion for the extra travelling time to the airport, in that case the closeness position will lose the advantage of easy accessibility to airport. This viewpoint is fully confirmed in our study. There are some residents that prefer the Ålesund airport instead of the nearest airport. For example, there are 5 travelers from the post number 6064 and in this five trips, destination airport is Ålesund account for 3 and Ørsta-Volda airport account for 2. From post number 6064 to Ørsta-Volda airport is 22.5 kilometers and it take 21 minutes' drive time, to Ålesund airport the distance is 68.5 kilometers and it take 1 hour and 39 minutes, the 1 hour and 39 minutes include a 39 minutes (waiting time and crossing time) and 120 kroner priced ferry .In this case there are still more travelers that choose the Ålesund airport even the access distance is longer than to Ørsta-Volda airport and access time ,access cost are more than to Ørsta-Volda airport. This kind of examples are ubiquitousness in our data and this is the most important reason that caused the broke down of access distance have impacted the air travel demand. Table 7.1 provide the average access distance and average total access time to each airport. Ålesund airport have the longest average access distance 37.61kilometers and average total access time 56.69 minutes meanwhile Ålesund airport have the highest frequency 45.7% of flight in the 1955 trips. Ørsta-Volda airport have the fewest average access time 25.55 minutes but the destination airport frequency is 15.7%, which is lower than Molde airport frequency is 14.3%. This can illustrate that airport competition does exist in this county and airport choice can affect the air travel demand to some extent in a certain airport.

Airport	Average Access Distance(kilometer)	Average Total Access Time(minute)
Ålesund airport	37.61	56.69
Molde airport	17.56	29.15
Ørsta-Volda airport	21.02	25.55
Kristiansund airport	16.71	28.54

Table 7.1: Average access distance and time of four airports

As the largest airport in this county and Ålesund have the highest population it is reasonable that Ålesund airport have the highest flight frequency. In our dataset there are some air travelers who not the resident of Ålesund prefer the Ålesund airport rather than their local airport even though it takes much more time and costs more money to get there .The reason for choosing the Ålesund airport as an alternative choice must be related to the service level of airport. Table7.2 shows some service level indicator of the four airports in 2012.

Airport	Number of flight routes	Flight frequency to Oslo per day
Ålesund airport	16	10
Molde airport	9	7
Ørsta-Volda airport	6	6
Kristiansund airport	8	4

Table 7.2: Service level of four airports

Obviously Ålesund airport have the largest number of flight routes and offer the highest flight frequency to Oslo. This means Ålesund airport has more destinations and if some resident in this county needs to flight to a destination which only the Ålesund airport offers, without considering other transportation means or transfer options, they have chosen the Ålesund airport without considering the access distance and access time to airport. Such as for the residents who live in the area where post number is 6150, the distance from 6150 to Ørsta-Volda airport is 3.5 kilometers and it only takes 4 minutes but there are some people that choose to purchase their flight in the Ålesund airport which the access distance to airport is 76.4 kilometers and takes about 1 hour and 30 minutes to get there. The reason that causes the "unwise" choice may be the person might take a direct flight to Palma Mallorca, Ørsta-Volda airport does not have the flight to Palma Mallorca but Ålesund airport has this direct route, so the person who live in 6150 have to going to Ålesund airport to take this flight. In the table 5.3 we know although Ørsta-Volda (8693) have less population than Kristiansund(23813) but the travel frequency in airport is higher than Kristiansund airport. Since Ørsta-Volda airport offers 6 flights to Oslo and Kristiansund has 4 flights, the frequency of flight to Oslo is higher than in Kristiansund could be a causing factor that Ørsta-Volda airport has higher air travel frequency than the Kristiansund airport.

Molde airport, Ørsta-Volda airport and Kristiansund airport usually choose the Ålesund airport and because the Ålesund airport has the best service level does not mean that Ålesund residents will not have another alternative airport choice . Halpern and Bråthen (2010) analyze the alternatives to Ålesund airport. The proportions for alternative airports to Ålesund in 2009 showed in table 7.3.

Alternatives	Percentage
Oslo gardermoen	45.5%
Ørsta-Volda	25.6%
Molde	16.5%
Trondheim	5.1%
Other	7.3%

Table 7.3: Alternatives to Ålesund airport (Halpern and Bråthen, 2010)

There are 25.6% Ålesund residents choose the Ørsta-Volda airport as alternatives and 16.5% choose the Molde airport. Reasons for choosing the two alternatives provide in table 7.4.

Factor	Ørsta-Volda To a great extent (n)	Molde To a great extent (n)
Proximity to home	63.8%(69)	15.0%(6)
Cheaper	10.8%(7)	15.0%(6)
Public transport	11.9%(8)	7.5%(3)
Routes/package available	2.9%(2)	9.8%(4)
Timing of flights	15.1%(10)	16.7%(7)
Frequency of flights	3.0%(2)	2.4%(1)
Aircraft size/type	1.5%(1)	0.0%(0)

Table 7.4: Reasons for choosing an alternative (Ørsta-Volda and Molde) to Ålesund airport (Halpern and Bråthen, 2010)

The most affecting reasons for choosing Ørsta-Volda as an alternative is proximity to home/work. After calculating the distance from home to airport we found that there are some Ålesund residents who live too far from the Ålesund airport, so they choose the nearest Ørsta-Volda airport. For instance, for the residents who live in the following post number: 6060,6062,6063,6064 and 6065. Distance from those post numbers to Ålesund airport are over 50 kilometers and because of the ferry in this access trip the access time to Ålesund airport are almost one and half hours, so some people who choose the Ørsta-Volda airport is because the short access distance (under 50 kilometers) and short access time (not over 45 minutes).The most import reason for choosing Molde airport is Timing of flights (16.7%).

From the analysis of Ålesund airport we found that airport service level, access distance from home to airport and population have positive impact to the airport travel demand but the impact is not absolute. Also the affecting factors of air travel demand in this Møre og Romsdal and each city or municipality in this county have evidently regional characteristics.

8. Summary

Air forecast is one of the major inputs for fleet planning, route development and preparation of annual operating plan. For an airline, analyzing and forecasting air travel demand is a part of its corporate plan. For an airport, air travel demand offers important information that can improve its competitive ability and do well in operating planning. We know that there are various factors affect travel demand. Therefore, regarding Norwegian geographical features and air travelers' behavior, our study is focus on how travel distances from home to an airport affect the air travel demand, in terms of travel frequency. The survey dataset of air traveling of a Norwegian county Møre og Romsdal is taken as an case. The main objective of this thesis is to explore a model examing the correlation between air travel demand and access distance to airport and other factors (ticket fare, airports' service level etc.). Unfortunately, we do not get an ideal result, for Møre og Romsdal's residents, access distance do not significantly affect air travel demand, but ticket fare and travel purpose still have strong impact to air travel demand. Based on our analysis, we found that reasons for this breaking down can be some air travelers prefer an alternative airport rather than the nearest airport. Since Ålesund airport is the largest airport in this county, and it offers the highest service level meaning more flight route and high flight frequency, Ålesund airport become the most popular alternatives. These results show that most air travelers are still price focused and some air travelers are likely to choose service level over access distance to airport. One more reason can be that we assume the distance is from home to the airport while in reality, the distance may also from work place to the airport. In the dataset, no variable offers information about the working place. So that may cause mistakes in some extent. Although the access distance does not have significant impact to air travel demand in terms of our researched data, this does not means the access distance do not have any impact to air travel demand. After grouping the access distance, we found that the distance between 81-100.99 kilometers do affect air travel demand. Same for residents who lived very close to airport (access distance to airport less than 8 kilometers) there are high demand in air travel. Finally, we get this conclusion: on the whole, access distance from home to airport may not have sufficient impact to air travel demand, but in a certain distance range, the access distance from home to airport will have impact to air travel demand.

In all, we hope that the findings of this research will provide additional information to Ålesund airport, Molde airport, Kristiansund airport, Ørsta-volda airport and other aviation researchers by helping them to get knowledge about Møre og Romsdal residents' air travel behavior. Of course, there are still more to be explored.

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Kun

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Norguide

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