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Assessing Welfare Effects of Public Projects through CBA:

A Case Study on Istanbul New Airport.

Valutazione degli Effetti di Benessere dei Progetti Pubblici mediante CBA:

Un Caso di Studio riguardante il Nuovo Aeroporto di Istanbul.

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INA	Istanbul New Airport
CBA	Cost-Benefit Analysis
CV	Contingent Valuation
HPM	Hedonic Price Method
WTP	Willingness to Pay
O&M	Operation and Maintenance
PV	Present Value
NPV	Net Present Value
FNPV	Financial Net Present Value
ENPV	Economic Net Present Value
IRR	Internal Rate of Return
FRR	Financial Rate of Return
ERR	Economic Rate of Return
FDR	Financial Discount Rate
SDR	Social Discount Rate
CF	Conversion Factor
BCR	Benefit-Cost Ratio
DHMI	General Directorate of State Airports Authority
VAT	Value-added tax
CBD	Central Business District

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ABSTRACT

The paper demonstrates a theoretical background to assess the welfare effects of public projects through the use of cost-benefit analysis by focusing on its public economics aspect. Furthermore, it provides a practical approach by the application of the discussed theories to the case study of Istanbul New Airport (INA) in order to measure the success of the project in a 30-year reference life. For this purpose, Contingent Valuation (CV) and Hedonic Price Method (HPM) are also used and their results are embedded in the CBA.

Istanbul New Airport is the biggest investment in the history of the Republic of Turkey. It is currently in use; thus, an *ex-post* CBA is conducted in this paper. Two different scenarios with optimistic and realistic forecasts for the number of passengers are developed. The results prove that in both of the scenarios, the project is not financially profitable, whereas in the economic analysis the optimistic scenario reveals a positive ENPV with a value of 480 Million Euros and the realistic scenario indicates a negative result of ENPV with -750 Million Euros. It is concluded by stating that the success of the project highly depends on the number of passengers and for its economic success, the average growth rate of passengers should be at least 5,2% until 2025 and 4,6% for the next years. Moreover, a cost-benefit analysis should have been conducted before to avoid the extremely expensive investment out of all proportion to its benefits.

Keywords: Cost-benefit analysis, public economics, welfare, airport, contingent valuation method, hedonic price method.

ASTRATTO

Il presente saggio illustra un background teorico per valutare gli effetti sul benessere dei progetti pubblici attraverso l'uso dell'analisi costi-benefici, focalizzandosi sul suo aspetto di economia pubblica. Inoltre, approfondisce un approccio pratico attraverso l'applicazione delle teorie discusse riguardanti il caso studio del nuovo aeroporto di Istanbul (INA) al fine di misurare il successo del progetto considerando una vita di riferimento di 30 anni. A questo scopo, vengono utilizzati anche la Valutazione Contingente (CV) e il Metodo del Prezzo Edonico (HPM), integrando i loro risultati all'interno della CBA.

Il nuovo aeroporto di Istanbul è il più grande investimento nella storia della Repubblica Turca. Attualmente è in uso; pertanto, in questo saggio viene condotto una CBA ex-post. Si è deciso di sviluppare due diversi scenari con previsioni ottimistiche e realistiche riguardanti il numero di passeggeri. I risultati dimostrano che in entrambi gli scenari il progetto non è finanziariamente redditizio, mentre nell'analisi economica lo scenario ottimistico rivela un ENPV positivo con un valore di 480 milioni di Euro e lo scenario realistico indica un risultato negativo dell'ENPV con -750 milioni Euro. Si è concluso affermando che il successo del progetto dipende fortemente dal numero di passeggeri e per il suo successo economico, il tasso di crescita medio dei passeggeri dovrebbe essere almeno del 5,2% fino al 2025 e del 4,6% per i prossimi anni. Inoltre, un'analisi costi-benefici avrebbe dovuto essere condotta prima con il fine di evitare investimenti estremamente costosi, sproporzionati rispetto ai suoi benefici.

Parole chiave: analisi costi-benefici, economia pubblica, benessere, aeroporto, metodo di valutazione contingente, metodo del prezzo edonico.

1. INTRODUCTION

This paper presents a theoretical and practical approach to assess the welfare effects of public projects through cost-benefit analysis. Thus, it focuses on the public economics aspect of the CBA, which evaluates the effects of the projects on society through the change in individuals' welfare.

Cost-benefit analysis mimics an essential function of markets by setting an economic standard for measuring the success of the government's projects and programs (Ackerman & Heinzerling, 2002). In this paper, CBA is chosen for the evaluation of public projects, because it identifies all the costs and benefits related to the projects, monetize them and evaluates the welfare change of the individuals as the result of the project.

The paper is divided into three parts in which the first one, Part A, is an overview about the principles of welfare economics and makes an introduction to the cost-benefit analysis. Part B goes deeper into the explanation of CBA by defining its fundamentals on a microeconomic foundation and continues with the steps to determine the effects of the project and their economic valuation. The chapter is concluded by the calculation of the present value and evaluation methods. Part C is dedicated to the practical approach through the case study of Istanbul New Airport.

Istanbul New Airport is the biggest investment in the history of the Republic of Turkey and is currently in use. Thus, it is an ex-post CBA, which evaluates the project after its construction. It compares the world with-the-project and the world without-the-project and uses a period of 30-years as project life.

In the literature review, no cost-benefit analysis of Istanbul New Airport has been recognized. The most related works are the report of economic impact analysis prepared by Ülgen, Han, Özbek, & Lokmanoğlu (2016) and the financial analysis developed by Gürsel & Toru-Delibaşı (2013). The economic impact analysis is done from a macroeconomic approach, where the growth of GDP and employment are the main sources of benefits. Even though its name is indicated as a cost-benefit analysis, the report of Gürsel & Toru-Delibaşı (2013) deals only with the cash flows of the project owner, thus it should be considered as a financial analysis rather than a CBA.

Therefore, this thesis differs from the other papers in two important points: firstly, it assesses all the costs and benefits of INA on the whole society and ignores the cash flows between the operator and owner by definition of a public-private partnership, and secondly, it deals with the impacts of the project on a microeconomic approach, ignoring the indirect and wider effects (such as growth of GDP, additional tourism etc.). As a consequence, while doing the cost-benefit analysis of INA, European Commission (2014) guideline has been taken as the primary reference along with many other references due to the absence of Turkey's own guideline.

Two analyses have been done in the concept of CBA, financial and economical. Financial analysis is based on the cash flows of the project through the perspective of the project's owner. For this purpose, an FDR of 12,75% is used to discount future cash flows. On the other hand, the economic analysis focuses on all the costs and benefits of the projects on the whole society. An SDR of 5,06% is used to discount future values into the present.

Similarly, two scenarios have been developed with an optimistic and realistic forecast on the number of passengers. It has been observed that the number of passengers plays a vital role in the financial and economic performance of the airport. The optimistic scenario provides a positive ENPV, whereas the realistic scenario provides a negative ENPV. At the same time, both of the scenarios present a negative financial NPV.

The most substantial part of this paper is the use of Contingent Valuation (CV) and Hedonic Price Method (HPM). The results of these two methods are embedded in the CBA for healthier results in the calculation of externalities. Whilst, the weakest part is the absence of a standard and county-specific Conversion Factor (CF) in moving from financial to economic analysis.

All in all, the paper presents a CBA of Istanbul New Airport with CV and HPM results embedded and suggests that cost-benefit analysis should have been used at the beginning of the planning phase in order to avoid the extremely expensive investment out of all proportion to its benefits.

PART A

OVERVIEW

Part A of the paper includes the chapters 2 and 3, which focuses on the principles of welfare economics and makes an introduction to the cost-benefit analysis.

PART A: OVERVIEW

2. PRINCIPLES OF WELFARE ECONOMICS UNDERLYING CBA

In this chapter, firstly, the history of welfare economics is explained through the evolution of the concept of utility. Therefore, the dates of the contributions are not the primary focus, but the definition and understanding the duality of utility are. Afterward, the fundamental theorems of welfare are explained. And the chapter is concluded by discussing the efficiency and equity issues.

According to Baujard (2013), the definition of welfare economics and its principles underlying CBA are explained as:

"Welfare economics is the economic study of the definition and the measure of social welfare. It assesses the consequences of individual actions and public decisions on social states. Welfare economics offers the theoretical framework used in public economics to help collective decision making, to design public policies, and to make social evaluations."

2.1. History of Welfare Economics

The foundation of welfare economics goes back to 1844; to the works of Dupuit, in which he covers a wide array of topics including consumer surplus (termed relative utility). Nevertheless, the concept of welfare economics is born more clearly with A. Marshall and specifically with A. C. Pigou and his book 'Economics of Welfare' that is published in 1920. This part of the history is called "**old welfare economics**", which, broadly speaking dates between 1844 and 1939.

Old welfare economics uses the following assumptions:

i. Utility is cardinal, meaning that it is measurable.
ii. Additional consumption provides smaller increases in the utility (diminishing marginal utility).
iii. Utility is interpersonally comparable and summable.

It is known that utility is a measure for social welfare, hence with these assumptions; by summing all the individual utility functions, it is possible to construct a social welfare function.

Pigou, in his book, deals with two important concepts: the distinction of private and social cost[1], and the role and size of the national income and its distribution to understand the relationship between economic welfare and national dividend. In his own words: *"economic welfare of the country is intimately associated with the size of the national dividend, and changes in economic welfare with changes in the size of the dividend".* Thus, according to his theory, welfare can be measured and maximized by national income and the distribution of the national income.

Nevertheless, as it is one of the first works of the analysis, he has been criticized on many grounds:

Firstly, he fails to give a clear definition of welfare. It could be the 'national dividend' or a mix between the amount of the dividend and the distribution of income, and even something else (Baujard, 2013). Also, the concept of maximization is not clear. He defines the ways for welfare maximization but fails to assign a stable point or level of maximum. He treats the maximum as an 'optimum' point.

According to Pigou, welfare is connected to the national dividend, but national income is not an accurate measurement tool for welfare. Welfare is measured in terms of utility, *"which naturally carries an association with satisfaction".* And he regards social welfare as the sum of individuals' utilities. Modern economists do not agree with this view because quantitative measurement of utility is not possible; they advocate the measurement of utility ordinally.

In conclusion, in the old welfare economics, the utility is treated as a cardinal notion and this approach has been criticized by modern economists. Therefore, the **new welfare economics** is developed based on ordinal utility.

[1] The private marginal cost of a good is the cost of producing an additional unit. The social marginal cost is the expense or damage to society as the consequence of producing that good. By making this distinction between private and social costs/benefits, he opened the way for the analysis of externalities in welfare economics.

Ordinal, instead of the cardinal utility is the major difference between the new and the old welfare economics. Ordinal utility implies that utility is not measurable quantitatively and it could only be ranked by the preferences. This concept results in that new welfare economics relies on individual utilities, thus it is not interpersonally comparable (Baujard, 2013), which means that comparing the utilities of different individuals is not required nor allowed.

The basis of the new welfare economics goes back to A. V. Pareto, who is the first economist used the ordinal utility concept and concentrated on the concept of 'allocative efficiency' under the conditions of an initial allocation and scarce resources. According to Pareto (1971):

"The members of a collectivity enjoy maximum ophelimity in a certain position when it is impossible to find a way of moving from that position very slightly in such a manner that the ophelimity enjoyed by each of the individuals of that collectivity increases or decreases. That is to say, any small displacement in departing from that position necessarily has the effect of increasing the ophelimity which certain individuals enjoy, and decreasing that which others enjoy, of being agreeable to some, and disagreeable to others."

Hence, an allocation is called 'Pareto efficient' or 'Pareto optimal' when as a result of a new allocation of resources, at least one individual is better off without making any other individual worse off.

On the ground of Pareto optimality, Nicholas Kaldor (1939) and John Hicks (1941) developed a new concept of Pareto improvement, in which they propose a 'Kaldor-Hicks compensation criteria, which considers a hypothetical compensation between individuals that transfers benefits from gainers to the losers so that at the end the allocation is Pareto optimum. It is essential to underline that such transfers are just hypothetical; therefore, it does not imply any actual interpersonal comparisons of utility and it is not the responsibility of economists to decide whether or not these transfers should be made eventually, but this decision is left to the politicians. From then on, this general framework led to the improvement of surplus analyses and paved the way for the use of cost-benefit analysis.

Following, Bergson and Samuelson came to the idea of a social welfare function, which is defined as a function of the individual utilities that each individual derive from the social state (Samuleson, 1947). Contrarily, K. Arrow (1951) established the impossibility of deriving a social utility function on the basis of individual preferences without addressing to interpersonal comparisons; meaning that it is not possible for society to logically arrive at a collective choice from individual preferences under five certain conditions (Liberto, 2019):

- Nondictatorship: The wishes of multiple voters should be taken into consideration.
- Pareto Efficiency: Unanimous individual preferences must be respected: If every voter prefers candidate A over candidate B, candidate A should win.
- Independence of Irrelevant Alternatives: If a choice is removed, then the others' order should not change: If candidate A ranks ahead of candidate B, candidate A should still be ahead of candidate B, even if a third candidate, candidate C, is removed from participation.
- Unrestricted Domain: Voting must account for all individual preferences.
- Social Ordering: Each individual should be able to order the choices in any way and indicate ties.

Arrow goes on to prove that there is no social ordering that satisfies all of these criteria. The impossibility theorem of Arrow made it hopeless to say anything about social welfare and public decisions at all until the **promising future of welfare economics** developed with Amartya Sen (1970), who suggests that if some of the restrictive assumptions of Arrow are relaxed, it is possible to arrive at collective decisions. Unlike Arrow's theoretical focus, Sen was more into providing practical solutions to decision-makers. Additionally, he also suggests that the appropriate measure for assessing social situations should be done by considering the quality of life rather than just utility or wealth.

Sen's contribution to welfare economics is not limited to redefining Arrow's theorem, but he also focuses on personal rights and liberty (Sen, Collective Choice and Social Welfare, 1970). In "The Impossibility of a Paretan Liberal" Sen demonstrates that there is a very basic conflict between the rights of people and the

fundamental principle of welfare economics, which is the principle of Pareto Optimality. Therefore, he focuses on integrated rights, which looks at the rights of individuals in a society as socially important and could have some "trade-offs" between them rather than individual rights.

2.1. Fundamental Theorems of Welfare Economics

Welfare Economics has two fundamental theorems:

i. A competitive equilibrium is Pareto optimal.
ii. One can achieve Pareto optimum allocation in a competitive market when the social planner undertakes an appropriate redistribution of endowments.

These two theorems have important policy implications and provide the rationale for the free market and competition among economic actors. A competitive equilibrium means equilibrium based on perfect competition. Assumptions of the perfect competition model include excludability; a good cannot be consumed by more than one individual simultaneously, price system as a vehicle of market signals; prices reflect the quality and scarcity of the goods, price-taking behavior; firms cannot determine their prices and perfect information available to all consumers.

The main idea of the first theorem is that markets lead to the social optimum. Markets work perfectly, so no reallocation of goods or inputs can achieve a Pareto improvement. If you intervene in the market, it will harm someone, thus break down the Pareto optimality. It results in the fact that there is no need for the government intervention.

The second theorem underlies the importance of distributional effects. Imagine a situation where an individual holds every good and the rest of the society holds none. By definition, this is a Pareto optimal situation; because no reallocation can make someone better off without making at least an individual worse off. However, this situation is hardly considered as perfect under any welfare definition. Because of the need for a trade-off between efficiency and equity, a social planner (public sector) is essential.

Efficiency is related to the aggregate level of economic activity and equity is the distribution of the benefits of the economic activity. Whenever the government decides to undertake a policy, it faces with these two conflicting goals: make the best use of available resources (efficiency) and the distribution of these resources (equity). Okun (1975) explained this trade-off by the metaphor of the leaky bucket: *"The money must be carried from the rich to the poor in a leaky bucket. Some of it will simply disappear in transit, so the poor will not receive all the money that is taken from the rich"*. Hence, policies improving equity come at the cost of lowering efficiency.

A market failure exists whenever any of the assumptions underlying the perfect competition is violated, and as a consequence, the economy does not reach an effective allocation. Therefore, public intervention as a reaction to market failure is justified on the basis of the principle of efficiency. However, at some point further in the intervention, a trade-off between efficiency and equity arises.

The economy alone cannot decide on the best way to balance equity and efficiency. This trade-off also involves social and political factors. The different role of the policymakers and economists is pointed out by Andersen & Maibom (2016):

"Economists work out the shape of the trade-off, and policymakers determine where to situate on the trade-off".

3. INTRODUCTION TO CBA

For many countries, CBA is an essential step to decide whether or not a policy should be implemented or to decide the most appropriate project among the alternatives. To be able to benefit from European Union funding, governments must conduct a CBA of the related project and they become eligible for the funding only and only if the result of the CBA has positive economic NPV. This is stated by the European Commission (2014) as:

"Cost-Benefit Analysis (CBA) is explicitly required, among other elements, as a basis for decision making on the co-financing of major projects included in

operational programs (OPs) of the European Regional Development Fund (ERDF) and the Cohesion Fund."

Because of the essential need to have a common base of a CBA, guidelines have been realized for each country to lead a CBA analyst for the procedure and steps to follow to be able to conduct a common frame of CBA. However, for Turkey no guideline has been found. Consequently, the European Union guide 'Guide to Cost-Benefit Analysis of Investment Projects' has been taken as the first reference along with the many other guidelines.

3.1. Definition and Scope of CBA

A Cost-Benefit Analysis seeks the answer to the question: "how does the social welfare change" after the implementation of a project or policy. Therefore, it is used as a decision-making tool by expressing the effects of a project on the whole society in monetary terms and comparing their present value, and finally evaluating the project based on decision rules.

European Commission (2014) defines CBA as *"an analytical tool for judging the economic advantages or disadvantages of an investment decision by assessing its costs and benefits in order to assess the welfare change attributable to it"*. They put attention to the concept of opportunity cost, long-term perspective, calculation of economic performance indicators expressed in monetary terms, and microeconomic approach. All of these terms are explained in Part B of this paper.

Financial Management Group (2006), which presents a **handbook of CBA of Australia** states that CBA *"is a procedure for comparing alternative courses of action by reference to the net social benefits that they produce for the community as a whole"*. In Australia, under national competition policies, government agencies must provide a public benefit justification based on cost-benefit analysis to retain regulations. The important concept in this handbook that is related to the case study of this paper is evaluating the completed projects, in which CBA seeks the focus of resource allocation, meaning that CBA should provide information in response to the question 'would the resources allocated to the program have been better used in other activities?'.

Romijn & Renes (2013) that is a **general guidance of CBA for the Netherlands** defines CBA as *"a tool that provides a systematic overview of the advantages and disadvantages of measures, where possible quantified in euros and presented as the sum of the benefits minus the costs"*. Different than the previously discussed guidelines, they put more attention to the distributional effects, such as income distribution and distribution by region by considering equity issues.

Many other handbooks and guidelines have been analyzed for this paper but the three of them explained in this chapter are the primary references, in which Eurpean Comission (2014) is taking the lead.

3.2. Steps of CBA

According to the Eurpean Commission (2014), CBA has 7 steps:

1- Presentation of the socio-economic, institutional and political context
2- Definition of objectives
3- Project identification
4- Technical feasibility and environmental sustainability
5- Financial analysis
6- Economic analysis
7- Risk assessment

All these steps are applied to the case study of Istanbul New Airport in order in the related chapters. The following figure illustrates the scope of each step:

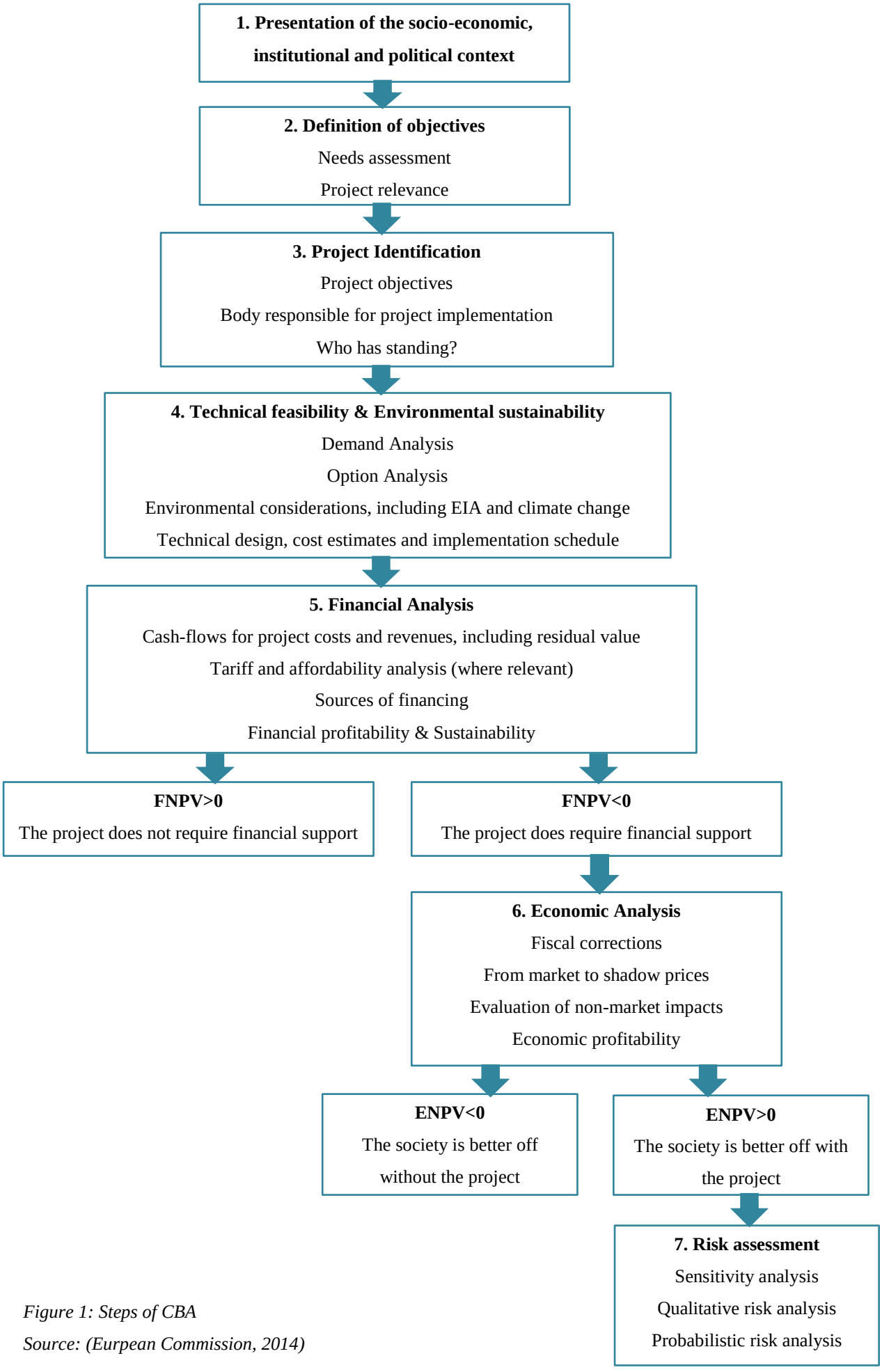

Figure 1: Steps of CBA

Source: (Eurpean Commission, 2014)

PART B

FUNDAMENTALS OF CBA

Part B of the paper includes the chapters between 3 and 7, which provides a theoretical background of Cost-Benefit Analysis by focusing on its welfare aspect.

PART B: FUNDAMENTALS OF CBA

4. MICROECONOMIC FOUNDATION OF CBA

European Commission (2014) defines CBA on the basis of a microeconomic approach enabling the assessment of the project's impact on the whole society by assessing the expected changes in social welfare.

This chapter will show what is understood from social welfare and the ways to measure it. It will explain the relationship between individual preferences and social welfare, thus will give an answer if the utility of an individual represents the utility of the whole society. It will be concluded by discussing whether public projects should be formulated on the basis of welfare analysis.

The theorems explained in this section are based on the assumptions of perfect competition, which means the market is competitive and efficient. As discussed before, it includes the assumptions of excludability, consumers and suppliers are price takers, prices reflect the quality and scarcity of goods and perfect information available to everyone. In conclusion, there is no monopoly, and firms gain zero economic benefits in equilibrium. This assumption left aside in the next chapters.

4.1. On Preferences, Utility & Social Welfare

Individual preferences are the core of welfare economics. It is known that individuals make decisions on the basis of their preferences. Individuals have to decide the way to spend their money based on their preferences and budget constraints. This is called consumer theory, which is a branch of public economics that observes the individuals' decisions based on their income level and price of the goods/services, and tries to predict their purchasing patterns.

An individual's utility is the degree to which his preferences are met. Therefore, utility can be seen as a measure of the individuals' satisfaction or happiness and it can be constrained by the scarcity of resources in the form of time, money and knowledge, and the main assumption is that individuals try to maximize their utility.

In public economics, welfare is represented by individuals' utility. Different actions and goods can have different effects on individuals and their utility. Therefore, a

combination of different goods can give equal satisfaction and utility, which leaves the consumer indifferent with no preference because different combinations provide the same level of utility.

The graph which shows the equal utility derived from the combination of different goods is called indifference curves, as shown in Figure 2, the utility derived on the same curve (i.e., on U_1) is equal. For instance, the individual gets the same utility by choosing the combination of good X_1 and Y_1 (Point A) or the combination of X_2 and Y_2 (Point B). Consumers are always assumed to be more satisfied as they consume more goods, thereby utility increases as the indifference curve goes away from the origin, meaning that $U_3 > U_2 > U_1$.

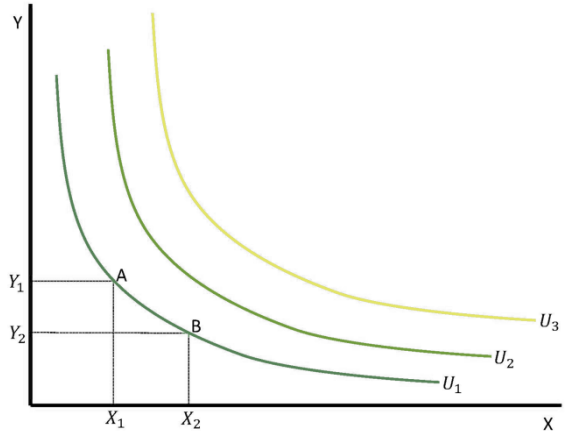

Figure 2: Indifference curves

At the core of welfare theory lays the principle that individual welfare is aggregated to obtain an expression for the welfare of society as a whole (Romijn & Renes, 2013). Accordingly, social welfare can be defined as the sum of the utility of individuals in a society, as 'collective utility'.

Public projects are expected to increase the level of social welfare but all projects create gainers and losers. The rule of CBA is to allow individuals who gain from the project to 'share' the benefits with those who lose from it[2] so that, after the implementation of the project social welfare increases overall. In other words, a project does not have to constitute a Pareto improvement (a situation in which at least an individual is better off and no one is worse) to add economic welfare, but

[2] Kaldor-Hicks compensation criterion

merely a potential Pareto improvement (Campbell & Brown, 2003). Therefore, a project is acceptable if gainers could compensate losers and still leave both parties better off than they would have been in the absence of the project. Hence, a CBA appraises the project from the efficiency point of view, ignoring the distributional consequences. This is the welfare economics basis of CBA, in which it is focused on the society as a whole rather than focusing on individuals separately.

4.2. Demand and Supply Curves

In microeconomics, as prices decrease the quantity demanded increases and quantity supplied decreases (all else is equal). Therefore, the demand curve is sloped downward and the supply curve is sloped upward, which can be seen in Figure 2.

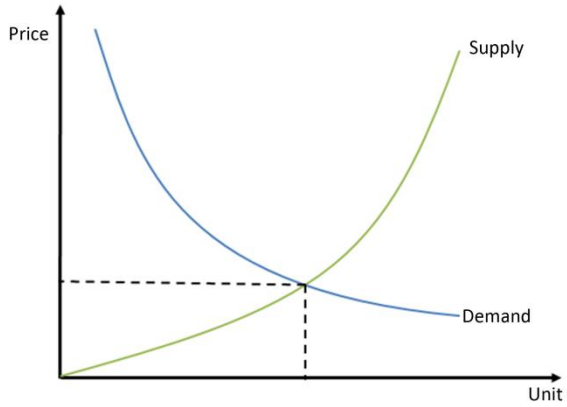

Figure 3: Demand and Supply curves

The intersection point of demand and supply curves is the equilibrium point both for the price and quantity. The equilibrium price is defined as the market price. Accordingly, it is possible to say that the preferences of individuals create a relationship between demand and transaction prices so it provides a vehicle for measuring welfare changes (Romijn & Renes, 2013).

3.3. Willingness to Pay (WTP)

Willingness to pay is defined as the maximum amount someone is prepared to pay for a positive change in their utility. Therefore, it is possible to consider that WTP reveals individuals' preferences, thus their utility; meaning that WTP is a way to measure people's utility, therefore the welfare, which is the main goal of conducting a CBA.

The concept of WTP creates a connection between individual preferences and demand, thus WTP can be illustrated by means of a demand curve for a product or service.

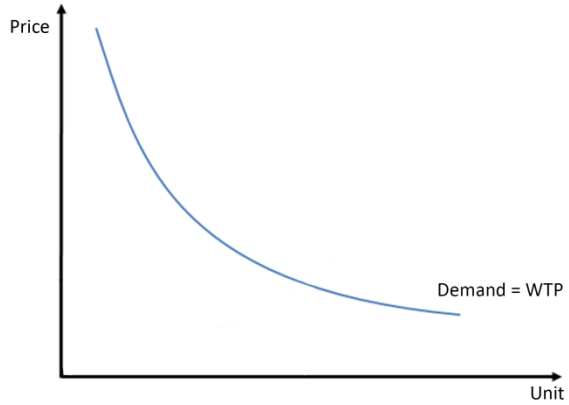

Figure 4: WTP can be illustrated by the demand curve

The demand (thus, WTP) curve tells us, at each level of output of the good, how much money someone is willing to pay for one extra unit of the good, which is the marginal benefit. It is also the additional satisfaction or utility that a consumer gains from the additional good or service. Since the demand curve is sloped downward, the marginal benefit decreases as the output increases (Campbell & Brown, 2003); meaning that consumers are willing to pay less for each additional unit of a good.

On the other side of the equation, the supply curve tells us, at each level of output, what an extra unit of the product will cost, hence the marginal cost. When a company produces more of a good, the marginal cost decreases, and this is called economies of scale.

4.4. Consumer and Producer Surplus

If an individual accepts to purchase a good or service- thus wields a demand, his willingness to pay for it should be, at least, as high as the market price in order to be able to achieve the wished service/good. If he is willing to pay (his WTP is) higher than the market price for that service/ good, the difference is called consumer surplus. Basically, consumer surplus is a measure of individuals' welfare gain from the purchase; since they achieve the desired service/good at a price lower than they were willing to pay for it (they could have paid to achieve it).

Similarly, producer surplus is the difference when a producer can supply a service/good at a price lower than the market price. Since in a CBA framework we look at the costs and benefits from the perspective of all members of an economy, including government, producer surplus is again a welfare gain. The sum of consumer and producer surplus is called social surplus.

As shown in Figure5, the area between the market price and demand curve defines the consumer surplus and the area between the market price and supply curve gives the producer surplus.

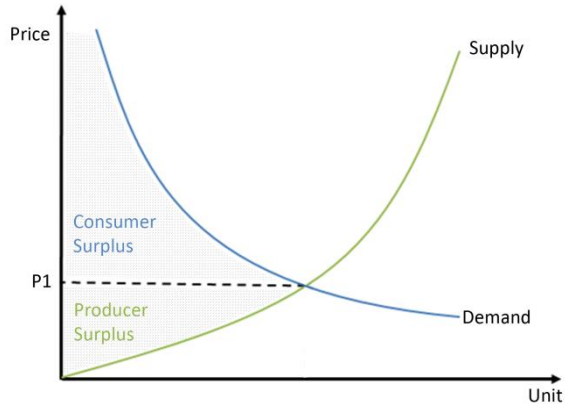

Figure 5: Consumer and producer surplus

As a conclusion to Chapter 4, it can be stated that welfare economics is the economic study of the definition and the measure of social welfare (Baujard, 2013) and the welfare effects of a project can be measured by calculating the changes in social surplus. Thus many of the public projects can be evaluated on the basis of welfare analysis.

5. DETERMINING THE IMPACTS

The determination of the impacts involves 3 steps (Romijn & Renes, 2013):

1. defining the markets in which the relevant welfare effects of policy occur;
2. identifying the impacts and determining the volume changes occurring in these markets;
3. determining the economic valuation of these impacts.

Step 1 and 2 are the subject of this chapter. And step 3 is discussed in detail in the next chapter.

5.1. Defining the Markets

All people affected by a project should be recognized in the analysis as a referent group. This paper is targeted on conducting a CBA from a national perspective rather than just governmental or private, thus it will evaluate the impacts of the project from the perspective of all the sectors of the society. This approach results in the necessity of evaluating all impacts of different groups in the markets. Government, private partners, project financers and the society have different kinds of gains and losses through the life of the project. Therefore, it is crucial to be able to define the relevant markets and to be able to do so, firstly it is necessary to cross out the assumptions of the perfect market and look at the distorted markets as in the real world.

The description of welfare economics foundation of CBA in chapter 3 was based on the assumptions of perfect markets that work efficiently. If we lived in such an ideal world, market prices would measure all the social costs and benefits, and the economy would be working efficiently that no reallocation of resources could make anyone better off without making someone worse off. However in the real-world, markets do not work efficiently; and market prices do not reflect all the costs or benefits related to the good or service. Hence, in such cases it is not possible to use market prices to evaluate public projects.

According to the Eurpean Commission (2014), sources of market distortions are as the following:

- Non-efficient markets where the public sector exercises its power (e.g., monopoly power)
- Administered tariffs for utilities may fail to reflect the opportunity cost of inputs due to affordability and equity reasons;
- Some prices include fiscal requirements (e.g., VAT)
- Some effects have no market and prices (e.g., externalities)

An externality occurs when the action of one party has unrewarded benefits or costs to another party that is external to the market transaction. For instance, the

production of a factory causes air pollution, which is a cost for society (external party) and is not reflected in the price of the produced goods. As a consequence, externalities create the concept of "missing markets". In missing markets, there is demand but no market price. Following the previous example of pollution, there is demand and WTP by society for clean air; however there is no market for clean air (you cannot buy a liter of clean air). In these cases of missing markets, externalities should be included in the analysis by assigning them shadow prices through willingness-to-pay.

Furthermore, it is possible to make another distinction between the markets as primary and secondary. Primary markets are those which are directly influenced by the project, whereas secondary markets are those in which the project shows its effects only indirectly. For instance, the growth of GDP as a consequence of a project is an indirect effect. In what follows, this paper will only deal with the evaluations of costs and benefits in the primary markets. It is crucial to underline that this paper is not an economic impact analysis that work on a macroeconomic approach; but it is a CBA, which, by definition should be done on a microeconomic approach, thus ignoring the indirect effects and secondary markets.

Public policies can have impacts on missing markets; hence a CBA has to value all the direct effects of a project by taking into account the welfare consequences in all the existing or missing markets, without duplication (Romijn & Renes, 2013) and without considering the indirect effects.

5.2. Identifying Costs and Benefits

To identify project benefits and costs, two hypothetical states of the world have to be compared; the world with the project and the world without the project (Campbell & Brown, 2003) by determining what would happen in the absence of the project. While conducting a CBA, only those costs and benefits directly attributable to the project should be taken into account (New Zealand Government, 2015). If they would occur anyway without the project, then they should be ignored.

While identifying project benefits, two distinctions are crucial. The first is whether benefits are derived from project outputs that meet additional demand, which is

called incremental benefits or from project outputs that replace existing supply, which is called non-incremental benefits; and the second is whether project outputs are marketed or non-marketed (Asian Development Bank, 2017). Whether a project will generate incremental or non-incremental outputs usually depends on the project. In many cases, a project may produce both of them.

Costs are defined as the resources required to implement a measure and sustain it (Romijn & Renes, 2013). The distinction between incremental and non-incremental is also relevant while identifying costs. Besides, different types of costs can be distinguished since a generalized scheme to classify all the costs of all investment projects can be developed.

According to the Eurpean Commission (2014), while conducting a CBA of investment projects, the analysis should be divided into two as financial and economic. Financial analysis is carried out from the perspective of the project, and considers incremental cash flows generated by the project (Asian Development Bank, 2017); therefore identification of costs and benefits is simple: benefits are revenues and costs are the payment of inputs valued at market prices (Rus, 2010). For airport investment projects, financial costs are organized under four general headings: Research and Development Cost; Investment Cost; Operations and Maintenance Cost; and Termination Cost (Federal Aviation Administration, 1999). On the other hand, economic analysis is carried out from the perspective of the entire economy and society; thus, it assesses the overall impacts of a project on the welfare of all the citizens. Hence, in economic analysis, benefits are those that are enjoyed by the individuals independent of their conversion into revenues, and costs are net social benefits lost in the best available alternative (Rus, 2010).

While conducting a CBA, only real costs and benefits should be taken into account. In the CBA guidance of many countries, some unchanging rules in the identification of these costs and benefits have been defined. Eurpean Commission (2014), Financial Management Group (2006) and New Zealand Government (2015) presents these rules as the following:

- All expenditures, including capital expenditures, should be recorded in full at the time that cash payment is made.
- Payments to suppliers are proxies for the consumption of real resources, which should be taken into account.
- Accounting depreciation expenses should not be taken into account, since this would double-count the capital investment that has already been taken into account as a cost.
- Interest and departmental capital charges are payments for the time value of money and should be ignored as the time value of money is represented by the discount rate.

5.3. Determining the Volume Changes

So far in this paper, it was assumed that undertaking a project would have no effects on the market prices of goods and services. However, when the project and its consequences are large enough, it will have significant effects on demand and supply, thus result in changes in market prices. Implementation of this kind of large project will lead to changes in the consumption volume.

The determination of volume changes is essential because additional consumption creates additional surplus; thus, it adds up to the total welfare. The welfare change can be calculated via consumer surplus in different markets influenced by the policy.

In transport projects, the determination of volume changes means demand forecasting, which is very crucial and the first step to be able to calculate the benefits and costs of the project.

A policy can cause different effects in markets, such as lowering or increasing prices and expanding or restricting supply. In this section some scenarios will be given in order to determine the volume changes and calculate the consumer surplus.

First the scenario of price reduction and then the increase in supply are explained:

a. Price Reduction

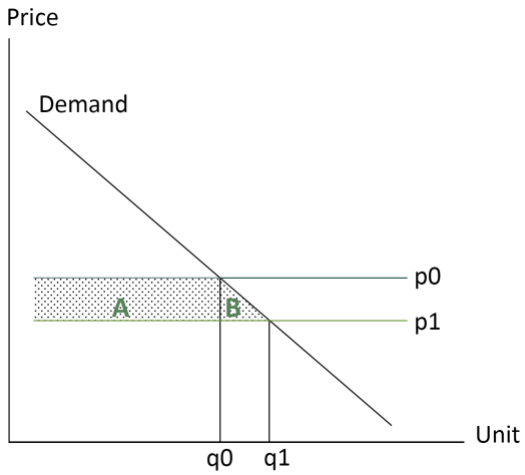

Figure 6: Volume change as a result of price reduction

The reduction in price (from p0 to p1) as a result of a project leads to an increase in quantity demanded (from q0 to q1). As a result of this volume change, there is an increase in consumer surplus equal to the area A+B. Area A is the consumer surplus for the existing (old) users, which is defined as a non-incremental benefit. On the other hand, the reduction in price also leads to incremental benefits through additional volume of consumption (q1-q0), which adds to the total change in welfare. Therefore total welfare gain (A+B) can be calculated by:

$$A + B = (p0 - p1) \times q0 + \frac{1}{2} \times (p0 - p1) \times (q1 - q0)$$

$$= \frac{1}{2} \times (p0 - p1) \times (q1 + q0)$$

The above equation is called the "rule of half" and it is the standard formula for calculating the welfare benefits of policies by the change in consumer surplus. It shows that to calculate the welfare gain, it is only necessary to know the volumes and prices in all the relevant markets and how these change as a result of the policy (Romijn & Renes, 2013).

b. Increase in Supply

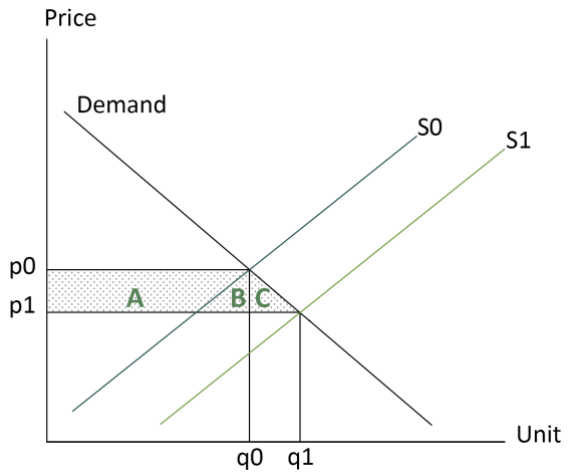

Figure 7: Volume change as a result of an increase in the supply

An increase in supply (from s0 to s1) leads to the change of the equilibrium point. The new equilibrium point becomes e1. Consequently, the price decreases (from p0 to p1) and consumption volume increases (from q0 to q1). This additional volume of consumption leads to an increase in consumer surplus, thus welfare gain shown as the shaded area (A+B+C) in the graph. The welfare gain can be calculated, again, by using the rule of half.

As a conclusion, the general theories explained in this chapter can be adapted to transport projects by the statement of Asian Development Bank (2013):

"...the non-incremental output corresponds to "normal traffic" which would have used a route or other existing mode in the absence of the new project and traffic diverted from another route(s) by the cost savings and convenience of the improved transport facility. The incremental output will be "generated traffic" stimulated by the low costs of the new project. …normal traffic is valued at generalized cost savings and generated traffic at half of cost savings*"*

6. ECONOMIC VALUATION OF THE IMPACTS

Cost-Benefit Analysis is not about inputs or outputs; it is about welfare. CBA sees outputs as a means to increase welfare and since measuring welfare is difficult;

instead, we measure the social value achieved from the outputs and compare it with the value of the goods sacrificed for the sake of the project (Rus, 2010) and express them in a common unit of measure, which is dollars[3]. Therefore, money is just a tool to compare the results of the benefits and costs.

In this chapter, as the last step of impact analysis, the valuation of outcomes and inputs are explained. The project outcomes are measured by the willingness-to-pay for benefits and costs, and inputs are measured the opportunity costs.

6.1. Valuing Outcomes: Willingness to Pay

Project benefits are the maximum amount of money an individual is willing to pay in order to benefit from the project's effects and contrarily, costs are the maximum amount of money an individual is willing to pay in order not to be damaged by the project's effects.

The sum of willingness to pay of all the individuals in a society for the changes in their utility from the implementation of a project is the main measurement tool of outputs in CBA. Gross social benefits of a project are, therefore, equal to the sum of net profits generated by the project (for the government) and of the associated increase in social surplus.

WTP is made up of two components; what is actually paid for a good or service (market price) and consumer surplus. In the case of a small increase in output willingness-to-pay (WTP) is measured by the market price. In most markets, market prices reflect the social price. Accordingly, market price can be taken as a measure of the value assigned by the society to the good or service. However, when project output is significantly large compared to the original quantity of the goods produced and consumed, willingness-to-pay for additional units of the goods will be lower than market price because of the downward slope of the demand curve, as explained in Chapter 3.3. In these circumstances marginal willingness-to-pay (WTP for an additional unit of output) declines as a result of the project and benefits are measured as the area under the demand curve known as consumer surplus (Campbell & Brown, 2003).

[3] Dollars is used just as an expression.

For instance[4], the government decides to expand a harbor's capacity, so that it can accommodate larger and more efficient ships, thus lowering the cost of transporting freight for sea shipping companies. Correspondingly, supply will change from S0 to S1 as in Figure 8 below:

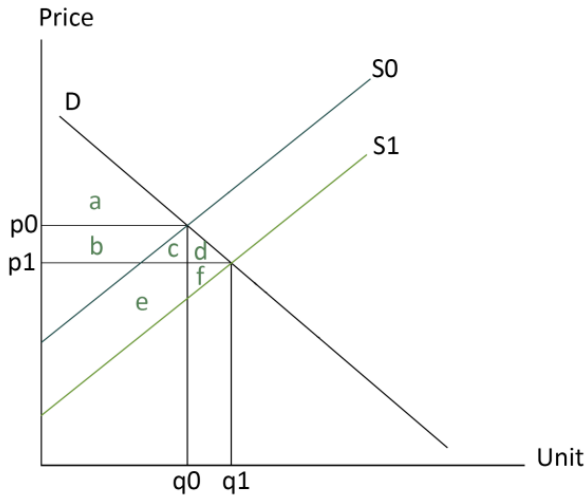

Figure 8: Calculation of social surplus as a result of supply increase

Supply increase results in price reduction and an increase in quantity demanded. As a consequence, the change in consumer surplus equals to the total area of *b+c+d*; similarly, the change in the producer surplus equals the area of *(e+f)-b*. Therefore, the increase in social surplus is *c+d+e+f*.

6.2. Valuing Inputs: Opportunity Cost

The costs of using assets and resources are defined by the value which reflects the best alternative use of a good or service that is called opportunity cost (HM Tresury, 2018). Market prices are the starting point for estimating opportunity costs.

In competitive markets, prices reflect the opportunity cost. The price that a consumer is willing to pay shows what he is willing to forgo through not purchasing something else with that input (resource). In general, the real cost of an input is the highest price someone is willing to pay for it. However, when markets are not competitive, the CBA analysis must estimate the appropriate opportunity cost by using the techniques which are explained in the next section, 6.3.

[4] The example is taken from the lecture notes of Professor Andrea Caragliu.

When there is a high demand, supply needs to adjust itself to meet the project demand (i.e., incremental case). In this case, the value of inputs is their marginal cost (Asian Development Bank, 2017). Therefore, market prices can be used to value the resources (inputs). Whereas, when supply is fixed in the short term and project demand draws the input away from other users, the cost of the input will be determined by what other users are willing to pay for it, as this reflects its opportunity cost in terms of additional consumption that the input can produce elsewhere (Asian Development Bank, 2017). Basically, in this case, the opportunity cost equals to the unit price of the production factor times the extra units demanded.

For instance, demand increases for a specific good, but the number of demanded good is sufficiently low, so it does not affect the market price of that good. Therefore, in the short term supply is fixed. In this scenario, the opportunity cost of the additional unit of the good is equal to the unit price multiplied by the additional units demanded, which is the area between *abq0q1* in Figure 9 below:

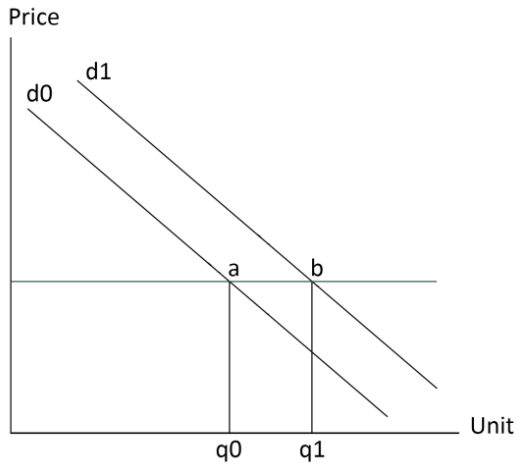

Figure 9: Calculation of opportunity cost as a result of demand change in the short-run

In the long-run where supply expands itself according to the increased demand, the market prices change accordingly. The opportunity cost is equal to the expenditure, minus (plus) any increase (decrease) in social surplus taking place on the market for production factors.

6.3. Pricing the Priceless

It has been explained before that all the direct inputs and outputs of a project have to be considered in a CBA whether they are marketed or not. The ways to value marketed impacts have been discussed in the previous sections, and methods to value externalities (impacts with missing markets) will be explained in this chapter.

In case of market failure, where markets are uncompetitive (i.e., monopoly power), or market prices are not equal to the social value or in case of missing markets, where there is no market price of the impact, the concept of shadow pricing is introduced. Shadow prices are artificial prices created by economists by studying what people would be willing to pay as if there was a market (Ackerman & Heinzerling, 2002). Hence, in the case of missing markets, the valuation of the impact can be done, again, by willingness-to-pay. Nevertheless, here the most challenging part is to estimate the WTP since there is no market price. In order to do so, there are two fundamental methods: stated preferences and revealed preferences. The aim of both of the methods is to produce prices for things that appear to be priceless.

In the stated preferences method, the WTP of people is directly achieved by their answers. Contingent valuation is a widely used example of this method, which is also used in the practical part of the case study of this paper to assign a price for habitat disturbance. In the contingent valuation method, a survey is conducted to a part of the affected population by asking directly, how much they would be willing to pay for something that cannot be bought in the market.

The most significant limitation of the stated preferences method is the biased responses of individuals. The amount of information given to the respondents has a significant role in WTP estimates and moreover, there is the risk that individuals may not act in a way they claimed they would in the real world. Despite of these criticisms CV Method has been widely used by researchers both in developed and least developed countries (Ahmed & Gotoh, 2006) and a valuable tool to value the externalities.

An alternative approach is the revealed preferences method; the WTP of people for missing markets is obtained by the observations of their behavior in other markets. Hedonic Price Method (HPM) is an example of this approach, which aims at evaluating the impact of a characteristic of a good without a direct market on the market price of a good that is instead regularly traded on standard markets. HPM is mostly used on real estate markets and it allows assessing the positive or negative change of the utility by consuming an additional unit of characteristic, which helps to price externalities by revealing people's WTP.

The initial limitation with HPM is that the availability and accessibility of data directly affect its results. The methodology assumes that people can select the combination of preferred features, given their income level. However, the market could also be biased due to external factors (taxes, interest rates) that cannot be modeled with this approach. Despite its limitations, HPM is an excellent practice to value externalities related to the real estate market, since house prices proxy quite well the real value of the houses and of their features.

To make the paper more robust, in the case study of Istanbul New Airport in part C, both the Contingent Valuation and Hedonic Price methods are used to value the externalities; habitat disturbance and land value increase, respectively. The results of these methods are then embedded to the CBA, which makes the final results more precise and healthier.

7. PRESENT VALUE AND EVALUATION METHODS

Costs and benefits should be identified for each year over the life of the project. In order to be able to compare the costs and benefits that occur in different years, it is necessary to know their present value and the evaluation methods, which are discussed in this chapter.

7.1. Discounting to Present Value

Cost and benefits of the projects occur throughout time; not at a single point in time but spread out over the years. Hence, in order to be able to compare the costs and

benefits referring to different times, it is essential to convert all the future values to the current year.

Forecasting is a key element to identify and value the costs and benefits. Generally, costs are likely to appear in the early years of the projects and benefits arise in the future years with the operation and use of the project.

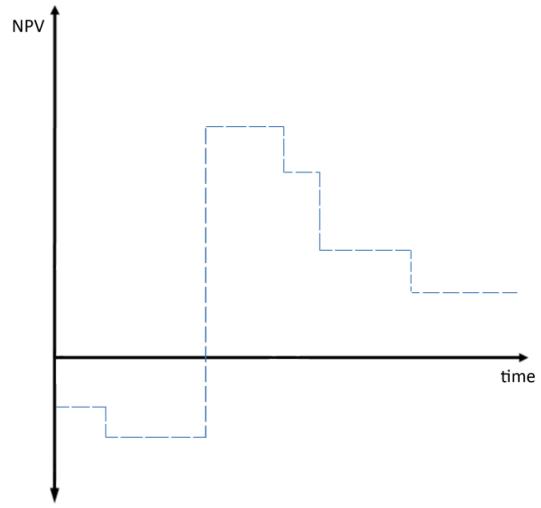

Figure 10: Representation of the NPV during the project life

Concerning the essential rule of the economics that "*a dollar today is worth more than a dollar tomorrow*" due to the inflation and its buying capacity, time value of the money should be taken into account while comparing the costs and benefits, because people are not indifferent with timing – they, usually, prefer receiving the benefits as early as possible and pay the costs as late as possible. Therefore, all the future values have to be discounted to the present value to be able to compare them and the discount rate has to be used for this purpose.

The present value is calculated using the discount rate, which acts as an 'exchange rate' between the value today and the value in the future.

If the benefits received in any year in the future are expressed as Bt, where t stands for the year, and the project life is T years, the present value of the benefits is the sum of all the annual benefits that are discounted by the appropriate discount rate (r):

$$Present\ Value\ of\ Benefits = B0 + \frac{B_1}{1+r} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \frac{B_T}{(1+r)^t}$$

$$Present\ Value = \sum_{t=0}^{T} \frac{B_t}{(1+r)^t}$$

It follows that, it is crucial to choose the correct discount rate and project life to have a correct valuation of the costs and benefits before conducting the CBA. The discount rate reflects the preference of risk and the context where the investment takes place. In private projects, the entrepreneur thinks in short-runs and takes smaller risks (higher discount rate) because private projects are based on profits so benefits should be achieved as soon as possible for the persistence of the company/project. Whereas, public projects have a longer life and are capable of taking more risks (lower rates).

In public projects, the discount rate is called as *Social Discount Rate (SDR),* which reflects a society's valuation of today's well-being to future well-being. Economic efficiency requires that the SDR measure the marginal social opportunity cost of public funds (Asian Development Bank, 2013). In a perfectly competitive world without market distortions, the market interest rate is the appropriate SDR. However, in the real world, where markets are distorted, the market interest rate will no longer reflect the marginal social opportunity cost of public funds. There are several approaches to determine the SDR, but in general, developing countries apply higher SDRs (8%–15%) than developed countries (3%– 7%) (Asian Development Bank, 2013).

7.2. Evaluation Methods

Having discussed the principles of discounting, present values of all the costs and benefits need to be evaluated as a decision rule for accepting or rejecting the projects.

The **Net Present Value (NPV)** is the aggregate value of a project and it is calculated by subtracting the sum of the present values of the costs from the sum of the present values of the benefits.

$$NPV = \sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+r)^t}$$

A project can be accepted if the NPV exceeds zero, and if there are alternative projects, the one with the largest NPV should be chosen.

The **Internal Rate of Return (IRR)** is the discount that delivers a net present value of zero, which is the rate that equalizes the discounted benefits to the discounted costs (Financial Management Group, 2006). If the IRR is more than the discount rate, the project has a positive NPV and is efficient; therefore, it should be accepted. However, when the IRR is less than the discount rate, NPV is negative and the project is inefficient.

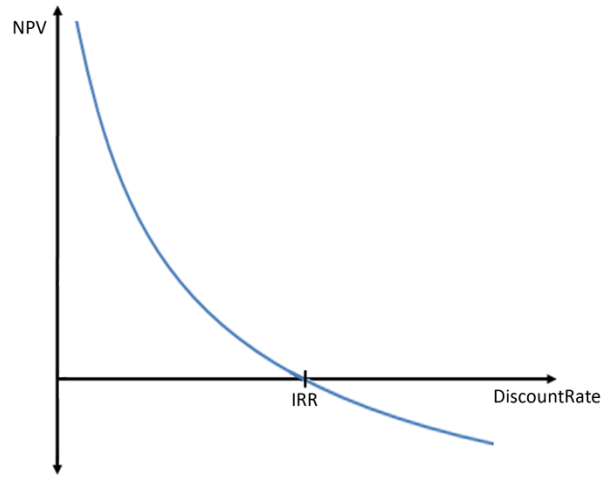

Figure 11: Representation of IRR

The **Benefit-Cost Ratio (BCR)** is the ratio of the discounted net benefits to the discounted net costs. While using this evaluation method, strong attention must be paid to the identification of benefits and costs, because if a negative benefit is treated as a cost, the ratio changes accordingly.

The **payback period** is the minimum time value when NPV turns positive, which shows the payback of the initial investment of the project. The project should be accepted if the payback time is reasonably low, which is usually between 3-5 years.

Generally, in a CBA, when there is only one project option, the project is accepted when NPV is positive and IRR is higher than the social discount rate. However, when there are alternative projects, NPV, IRR and BCR may not yield the same result. In such cases, the use of Net Present Value is recommended (Asian

Development Bank, 2017) (Financial Management Group, 2006) and the project with the highest NPV should be chosen.

8. RISK AND UNCERTAINTY

The distinction between risk and uncertainty is made by Financial Management Group (2006) as "*risk is measurable; it refers to situations with known probabilities. Uncertainty in contrast is vague; it refers to situations with unknown probabilities*".

The benefits of many public projects, including large infrastructure projects such as airports, are not independent of cyclical national income; therefore, a risk assessment in a CBA is obligatory in order to deal with the uncertainty that comes out from the assumptions and predictions. The recommended steps by European Commission for assessing the project risks are as the following:

- sensitivity analysis;
- qualitative risk analysis;
- probabilistic risk analysis.

8.1. Sensitivity Analysis

The values included in a cost-benefit analysis are the average estimates. Sensitivity analysis is a simple procedure for providing the decision-maker with information about the effect of errors in those estimates on the viability of the project (Financial Management Group, 2006).

Sensitivity analysis identifies the 'critical' variables of the project. Critical variables are those which have the largest impact (positive or negative) on the project's financial and economic performance. The analysis is carried out by varying one variable at a time and determining the effect of that change on the NPV. The recommendation by European Commissions is to consider the variables critical for which a variation of ±1 % of the value adopted in the base case gives rise to a variation of more than 1% in the value of NPV.

For transport projects, it is recommended to test at least the following variables (Eurpean Commission, 2014):

- value of time;
- accident costs;
- assumptions on GDP and other economic variables trend;
- rate of increase of traffic over time;
- number of years necessary for the realization of the infrastructure;
- investment and maintenance costs;
- fare/tariff/toll.

8.2. Qualitative Risk Analysis

The qualitative risk analysis should include the following elements (Eurpean Commission, 2014):

- a list of adverse events to which the project is exposed;
- a risk matrix for each adverse event indicating:
    i. the possible causes of occurrence;
    ii. the link with the sensitivity analysis (if applicable);
    iii. the negative effects generated on the project;
    iv. the (ranked) levels of probability of occurrence and of the severity of impact;
    v. the risk level.
- an interpretation of the risk matrix including the assessment of acceptable levels of risk;
- a description of mitigation or prevention measures for the main risks.

The first step is the identification of adverse effects in order to be able to understand the complexities of the project. Then a risk matrix has to be built and link the result with the sensitivity analysis if applicable. For each adverse event, the general effects generated on the project and the relative consequences on the cash flows should be described. A Probability (P) or likelihood of occurrence is attributed to each adverse event. Below, a recommended classification by the European Commission (2014) is given:

A. Very unlikely (0–10 % probability)
B. Unlikely (10–33 % probability)

C. About as likely as not (33–66 % probability)
D. Likely (66–90 % probability)
E. Very likely (90–100 % probability)

To each effect, a severity (S) impact is given from 1 to 5 with no effect to catastrophic effect, respectively. Below the classification by the European Commission (2014) is given:

Rating	Meaning
1	No relevant effect on social welfare.
2	Minor loss of the social welfare generated by the project, minimally affecting the project long-run effects.
3	Moderate: social welfare loss generated by the project, mostly financial damage, even in the medium-long run.
4	Critical: High social welfare loss generated by the project; the occurrence of the risk causes a loss of the primary function(s) of the project.
5	Catastrophic: Project failure that may result in serious or even total loss of the project functions.

Table 1: Rating of the severity impacts, and their meanings

Source: (Eurpean Commission, 2014)

The risk level is the combination of Probability and Severity (P*S). Four risk levels can be defined accordingly:

Severity / Probability	**1**	**2**	**3**	**4**	**5**
A	Low	Low	Low	Low	Moderate
B	Low	Low	Moderate	Moderate	High
C	Low	Moderate	Moderate	High	High
D	Low	Moderate	High	Very high	Very high
E	Moderate	High	Very high	Very high	Very high

Table 2: Identification of the risk level with appropriate colors

Source: (Eurpean Commission, 2014)

Once the risk level is established, it is important to identify the prevention or mitigation measures. The table below shows the kind and the combination of the measures in a qualitative way:

Severity / Probability	**1**	**2**	**3**	**4**	**5**
A	Prevention or mitigation		Mitigation		
B					
C					
D	Prevention		Prevention and mitigation		
E					

Table 3: The combination of measures for the risk levels

Source: (Eurpean Commission, 2014)

8.3. Probabilistic Risk Analysis

Probabilistic risk analysis assigns a probability distribution to each of the critical variables of the sensitivity analysis in order to recalculate the expected values of financial and economic performance indicators (Eurpean Commission, 2014). Probability distributions of the variables are adequately determined on the basis of experience in the past projects.

After establishing the probability distributions for the critical variables, it is possible to proceed with the calculation of the probability distribution of the NPV and IRR of the project. For this purpose, the use of the Monte Carlo method is suggested by the European Commission, which requires a simple computation software. The method consists of the repeated random extraction of a set of values for the critical variables, and then the calculation of the performance indices for the project (NPV and IRR) resulting from each set of extracted values (Eurpean Commission, 2014). By repeating this procedure for a large enough number of extractions, it is possible to obtain the probability distribution of the NPV and IRR.

PART C

AN APPLICATION OF CBA TO THE EVALUATION OF ISTANBUL NEW AIRPORT: EMPIRICAL RESULTS

Part C of the paper includes the chapters between 10 and 18 and it is based on the practical approach by applying Cost-Benefit Analysis to a case study of Istanbul New Airport.

Contingent Valuation and Hedonic Price Methods are used in this chapter in order to value the externalities and their results are embedded in the CBA.

PART C: AN APPLICATION OF CBA TO THE EVALUATION OF ISTANBUL NEW AIRPORT: EMPIRICAL RESULTS

9. A CASE STUDY: ISTANBUL NEW AIRPORT

Part C of the paper is dedicated to the practical approach of CBA through the case study of Istanbul New Airport. The theories explained in the previous chapters are used for this purpose; therefore, it is critical to read the following practical study in the light of the discussed information.

9.1. Presentation of the Context

In the area of Istanbul, there were two active airports; Ataturk and Sabiha Gokcen, one being located in the European and one on the Asian side, respectively. Ataturk is closer and well-connected to the city center with a subway; therefore, it has been the first choice of many travelers. Istanbul, being in a critical and strategic geography as a bridge between Asia and Europe, has been hosting more and more tourists and transit passengers each year. In their current situation, both of the airports were insufficient to host that many passengers, and consequently, a new airport has been constructed causing the closure of Ataturk Airport.

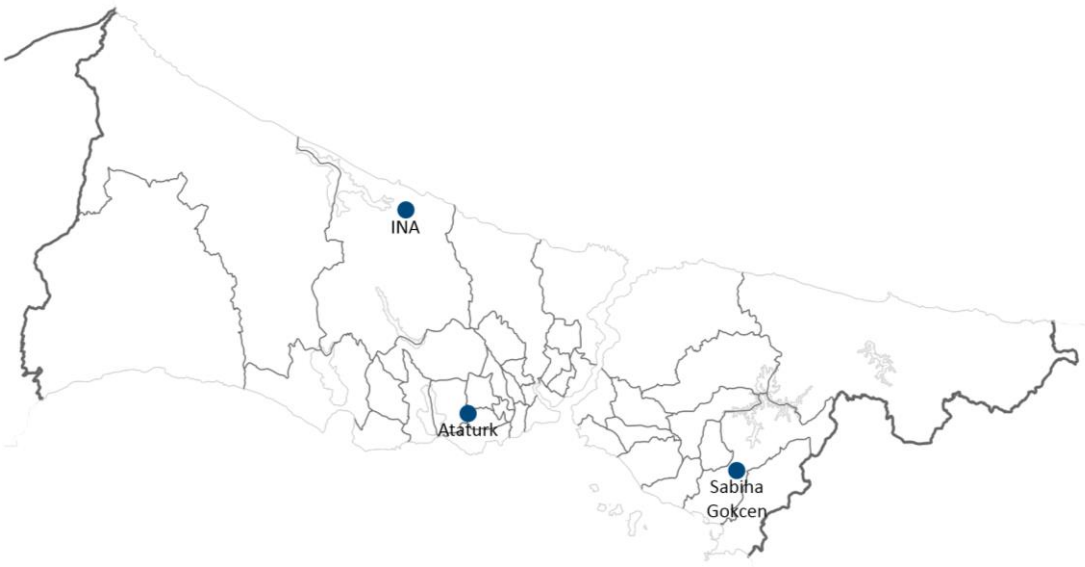

Figure 12: Map of Istanbul, showing the location of airports

After the closure of Ataturk Airport, Sabiha Gokcen, being closer to the city center than the new airport, has been handling more and more passengers beyond its capacity with only one runway. The construction of a 2nd runway for Sabiha Gokcen Airport, which the tender took place in 2014 has been a priority issue but could not be completed in 6 years from now for unknown reasons. Consequently, the minister of transport Mr. Turhan has declared on February 4, 2020 that the frequent use of the existing runaway without proper maintenance due to the limited free time has caused the runway to be "tired". Just after one day from the announcement of Mr. Turhan, there has been a plane crash in Sabiha Gokcen causing many deaths and injuries (Sozcu, 2020). While writing these sentences, still no official explanation for the reason of the crash has been done but the question of the "tired" runaway is on the mind of many citizens, as well as the necessity of constructing a new airport in rush before improving and promoting what is already there.

In order to be able to evaluate the public projects in Turkey, it is essential to understand the political background underlying them. Along the history of politics in Turkey, massive infrastructure projects have helped the ruling party to win the elections (Selcuki, 2020).

Erdogan, who is the current president, has a goal to make Turkey as one of the top-performing economies in the world, which he defined it as his "2023 vision plan". The strategic plan behind is the mega projects, which in Erdogan's own words "crazy projects"; including a 3rd airport in Istanbul together with a 3rd Bosporus bridge and "Kanal Istanbul", which is a canal running parallel to the Bosporus that will turn the European side of Istanbul to an island (if built). With these high-profile public projects, focusing only in Istanbul, Erdogan hopes to boost the economy weakened by terrorism and a failed coup in 2016 (Jamieson, 2018), and gain political power to secure his position for more years. Currently, the airport and the bridge are completed and in-use; and Kanal Istanbul is still under discussion.

The main problem and the reason of criticisms with these megaprojects are the allocation of resources and environmental concerns. In a shaky economy with a 14%

unemployment rate[5], increasing taxes, high inflation rate, crash of Turkish Lira and with many more economic problems, citizens are in doubt that if this is the right allocation of resources. Moreover, the Turkish public is becoming highly sensitive to environmental issues (Selcuki, 2020). In the past decade, many protests have taken place across the different cities of Turkey against the energy and transport projects that would harm the environment.

9.2. Project Description and Objectives

According to the report of the economic impact analysis, Istanbul New Airport (INA) has the characteristic of being the largest infrastructure investment project that will be constructed with an estimated **10.25 billion Euro** investment cost throughout the history of Turkish Republic (Ülgen, Han, Özbek, & Lokmanoğlu, 2016). It is constructed on a **76.5 million square meters site** located in an area in the north of the European side of Istanbul, 35 km to the city center where urban development and expansion is relatively weak. Currently, only one phase is completed and the target is 90 million passengers a year and when the entire airport is completed, it will be able to handle 200 million passengers a year. That will make it the world's biggest airport by passenger traffic compared to Atlanta Airport, which currently is the world's busiest airport by handling 107 million passengers a year.

Istanbul New Airport is constructed with Public-Private Partnership (PPP), more precisely **Built-Operate-Transfer (BOT)** model with "guaranteed usage" by the Turkish Treasury. The tender of INA was held in May, 2013 and IGA consortium won the tender by bidding **22.152 billion Euros,** excluding value-added tax (VAT) for 25 years of operation (Daily Sabah; Reuters, 2019). IGA now consists of Kalyon, Cengiz, Mapa and Limak construction companies; Kolin, which was previously involved, transferred its shares to the other partners in early-2019 (Reuters, 2019). For the financing of the first stage, IGA has signed a loan agreement with Ziraat Bank, Halkbank, VakıfBank, DenizBank, Garanti Bank and Finansbank for the total of **4.5 billion Euros** with a 16-year maturity and a four-year grace period on the principle amount and IGA later borrowed another **1 billion Euros** for additional financing. (Daily Sabah; Reuters, 2019).

[5] February, 2020 data taken from Eurostat: https://ec.europa.eu/eurostat/en/web/products-datasets/-/UNE_RT_M

The main objective of the new airport is to find a solution to the overwhelming air traffic beyond its capacity at Ataturk Airport. According to the report by TINA (2007) in which the transportation infrastructure of Turkey is evaluated, there will be a problem of the bottleneck of air transport in Istanbul area by 2020 and it suggests that if the capacities of Ataturk, Sabiha Gokcen and Corlu Airport were extended accordingly in a co-ordinated way, these airports would be able to manage up to 50 million passengers annually. The report suggests that if and only if:

"Sabiha Gokcen and Corlu airports cannot cover the expected terminal capacity gap of Ataturk Airport, a suitable site for another airport must be found in Istanbul Area, and the planning should begin soon in order to avoid a serious bottleneck in 2020 in Istanbul."

Despite the obvious capacity problem arising in Istanbul, after the announcement of the construction of the new airport, it has been in the center of many discussions of whether it was necessary to invest such a big amount of money to open a new airport instead of expansions, whether the location was a correct choice due to its distance from the city center and environmental concerns, and whether it was mandatory to close Ataturk Airport.

The massive size of the airport is justified by the purpose of creating an "airport city" which will become a vital point for urban development. Istanbul Ekonomi Consultancy and EDAM (2016) explain this purpose in the economic impact analysis report by stating:

"*the project is not simply constructing an airport but also a commercial and cultural center of attraction which would also be influential on the macro form of the city."*

In this framework,

"INA goes beyond the modern insight that airports are located on the periphery of a city and represents an insight by which the city is being shaped around the airport."

Therefore, INA has been planned with a huge commercial space area including food & beverage spaces and the world's biggest Duty-Free shop.

The massive growth of Turkish Airlines (THY)[6] is another major reason for the construction of the new airport. Having a base as a hub airport that would serve as an operation center is a vital aspect for an airline company, and THY being one of the most important global brands of Turkey also needs such a center.

9.3. Methodology

In order to evaluate the Istanbul New Airport, cost-benefit analysis is used in this paper. The purpose is to observe all the costs and benefits related to the new airport affecting the whole population; public, government and the companies, and transform them into monetary terms to be able to compare and evaluate the welfare effect of the airport.

It is an *ex-post* CBA since the construction of the new airport is already completed and in-use. The initial stage of performing a CBA is to define a base and an alternative scenario to be able to make a comparison and identify the benefits and costs. In this paper, CBA compares with-the-project scenario with a without-the-project scenario.

Afterward, an evaluation period of the project has to be set. According to the European Commission (2014), the project reference life is identified as **25-30 years** for ports and airports. Thus, the appraisal will consider all the costs and benefits that will occur in 30 years. Since the tender of the airport is completed in 2013, it is set as the initial year and the CBA is conducted for the years between 2013 and 2043.

While calculating the preset values of the future costs and benefits, all the values are discounted to present year, which is 2019 by using a Financial Discount Rate (FDR) for the future cash flows in financial analysis and Social Discount Rate (SDR) for economic analysis to be able to calculate the NPV and make a comparison between the total costs and benefits.

The **Financial Discount Rate** reflects the opportunity cost of capital. According to Article 19 (Discounting of cash flows) of Commission Delegated Regulation (EU) No 480/2014, the European Commission recommends that a 4% discount rate is considered as the reference parameter for the opportunity cost of capital in the long

[6] 17% growth in terms of profit in 2018 compared to the previous year (Levent, 2019).

term. However, values differing from the 4% benchmark may be justified on the grounds of international macroeconomic trends and conjunctures (Eurpean Commission, 2014), such as in the case of Turkey. According to the Central Bank of Turkey, the financial discount rate is set as **12,75%** based on the average value in 2019[7].

According to European Commission (2014), **Social Discount Rate** reflects the social view of how future benefits and costs are to be valued against present ones and it recommends that a social discount rate of 5% is used for major projects in Cohesion countries and 3% for the other Member States. Since Turkey is not a member of EU, the social discount rate should be close to 5% and according to Halıcıoğlu & Karataş (2011), social discount rate in Turkey should be taken as 5,06%, which is in line with the EU guideline. Therefore, in this paper, present values in the economic analysis are calculated by using an **SDR of 5,06%** during the project life.

10. UNCERTAIN FACTORS & ASSUMPTIONS

In this chapter, to be able to make a demand forecasting for the growth in airline traffic in Istanbul and have an overview of the Turkish economy for the next years, uncertain factors will be identified and assumptions will be made accordingly.

10.1. Growth of the Turkish Economy

An independent report of economic impact analysis for Istanbul New Airport has been prepared by Ülgen, Han, Özbek, & Lokmanoğlu (2016), in which the economic growth of Turkey has been determined as a 3% on dollar basis.

A literature review of the Turkish economy has been done for this paper in order to have an independent opinion for the economic growth prediction of Turkey independent from the presented economic impact analysis report. Statista[8], which is an "*online resource for current statistical data*", has published a report in which the following graph has been extracted that shows the growth of the real gross domestic

[7] https://www.ceicdata.com/en/turkey/saving-discount-rate-and-interbank-rate/central-bank-discount-rate
[8] https://www.statista.com/

product (GDP) from 2014 to 2024 for Turkey. Each year is compared to the previous year:

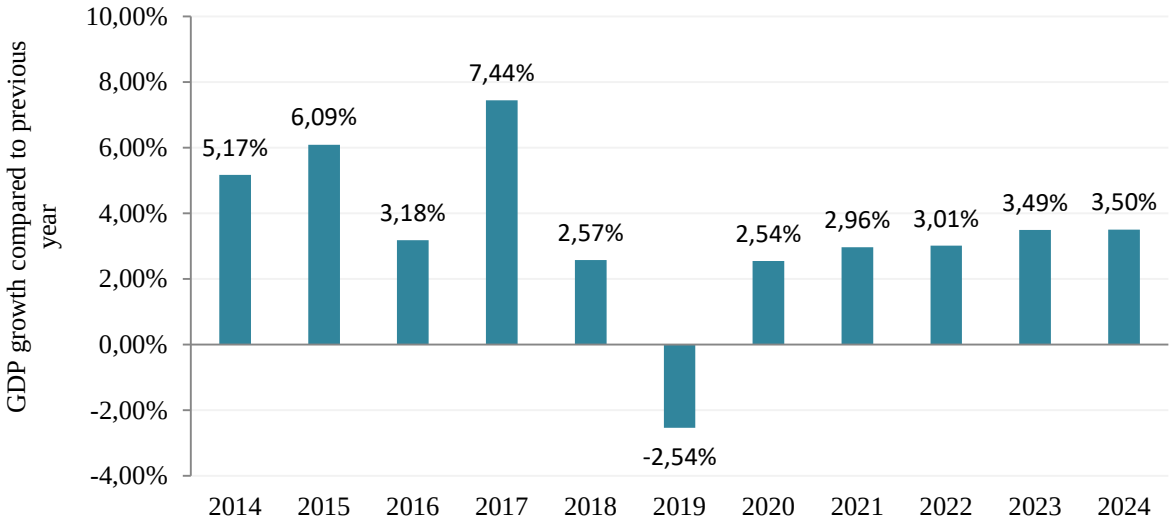

Figure 13: Growth of GDP of Turkey from 2014 to 2024
Source: Statista, 2019

Accordingly, taking the economic growth of Turkey as 3% seems realistic and trustful for the next years, thus for demand forecasting that is discussed in the next section, this result has been taken into consideration.

10.2. Demand Forecasting

In order to forecast the demand and make an assumption of the growth in airline traffic, two reports prepared by EUROCONTROL have been taken as reference for this paper. The first report is done in 2013, focuses on the European aviation growth up to 2035, whereas the second one is prepared in 2018 to forecast the growth up to 2040.

Looking twenty and more years ahead, in both of the reports they do not focus on just one single forecast, but a range of different scenarios for how air transport in Europe, and the factors influencing it, might develop. Three scenarios presented in the reports to anticipate the future of aviation and the risks have been considered in this paper for demand forecasting: Global Growth, Regulation and Growth and Fragmenting World.

Each scenario has different input assumptions: economic growth, fuel prices, load factors, hub-and-spoke versus point-to-point etc., thus leading to different volumes of traffic and different underlying patterns of growth in each scenario (EUROCONTROL, 2018). Global Growth is the optimistic, Fragmenting World is the pessimistic and Regulation and Growth is the most realistic scenario.

EUROCONTROL (2013) presents the results for aviation growth of Turkey as **5,2%, 4,4%** and **3,5%** and in EUROCONTROL (2018) the results are **4,6%, 3,5%** and **1,8%** for Global Growth, Regulation and Growth, and Fragmenting World scenarios, respectively.

Looking at the statistics of Turkey's air traffic for the past years (2013-2018) [9], it is possible to say that Istanbul Ataturk Airport has reached a growth level even bigger than the optimistic scenario of Global Growth for Turkey due to its decline in 2016.

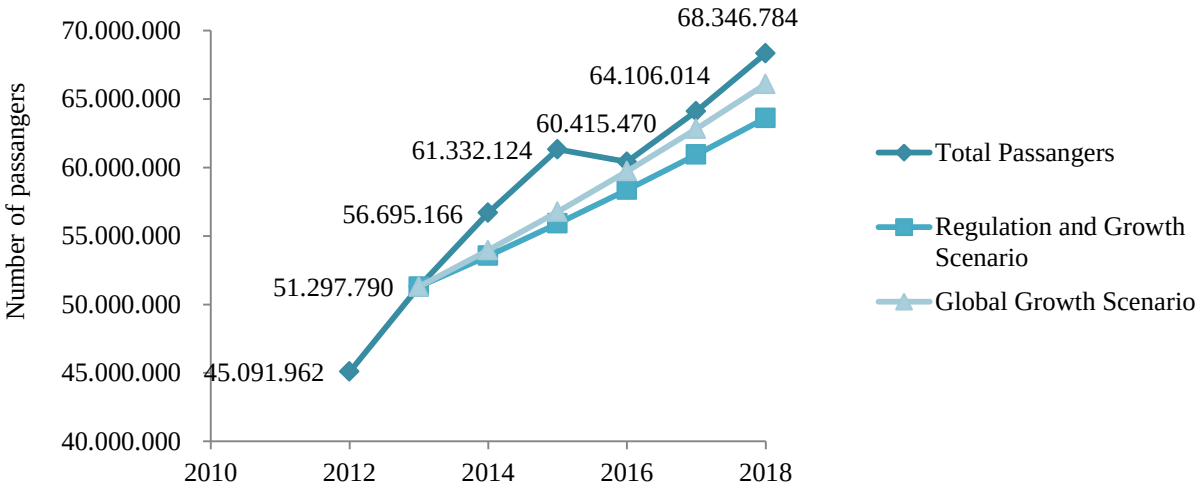

Figure 14: Number of passengers of Ataturk Airport, compared to two scenarios of EUROCONTROL

The apparent fall in 2016 is due to the military coup attempt in July, 15 and the terrorist attack at Ataturk Airport. Turkey has lost a significant portion of the tourist population in this period and it has affected the economy a lot. It should be considered that since Turkey is a developing country without a very stable economy

[9] Data is taken from DHMI Republic of Turkey Ministry of Transport and Infrastructure: https://www.dhmi.gov.tr/sayfalar/istatistik.aspx

and is under the risk of terrorism in the borders, an unexpected fall in air-traffic, like in 2016, should not be ignored and kept in mind.

Consequently, an optimistic and a realistic scenario are created to forecast the demand for Istanbul New Airport. In the rest of the paper, the optimistic scenario is referred to as Scenario A and the realistic one is as Scenario B:

	OPTIMISTIC	REALISTIC
2018-2025	5,2%	4,4%
2026-2043	4,6%	3,5%

Table 4: Two different scenarios for the growth rate of air transportation passengers

Despite the exceptional growth rate of Ataturk Airport, the realistic scenario for INA is considered to have a lower growth rate than Ataturk Airport due to its unconventional location. For instance, passengers on the Istanbul-Ankara route, which has the highest occupancy rate, may prefer using trains that will cause the loss of an important portion of domestic passengers. Similarly, a new highway has been constructed between Istanbul-Izmir, which is considered to be an important drawback for domestic airline growth.

Following the two scenarios, the demand forecast for specific years are as the following (see Appendix B for the optimistic scenario and Appendix C for the realistic scenario):

	OPTIMISTIC	REALISTIC
2019	71.900.817	71.354.042
2025	97.460.416	91.592.819
2043	218.977.042	170.132.672

Table 5: Demand forecast for specific years in the optimistic and realistic scenarios

The airport is projected to serve 200 million passengers annually after the completion of all phases by 2028 (Anadolu Agency, 2019), however even in the optimistic scenario, this number is reached in 2041 and unfortunately, in the realistic scenario the predicted number of 200 million is not reached by 2043.

10.3. Assumptions

In order to proceed with the analysis, some assumptions need to be done for the unknown factors. The following table shows these assumptions:

Variable	Assumption	Explanation
1 USD	5,67 TL	Average currency rate in 2019.
1 EUR	6,35 TL	
Financial Discount Rate (FDR)	12,75 %	Based on the rate of Central Bank of Turkey
Social Discount Rate (SDR)	5,04 %	Based on Halıcıoğlu & Karataş (2011)
Trip purpose mix	36% work trips 64% non-work trips	Based on the CV method findings
Average take-off weight of planes	190 metric tons	Average take-off weight of aircraft of Turkish Airlines
Jet A1 fuel price	629,72 USD/ton	Based on price in 2019, December 24th
Arrival & departure passengers	50% arrival 50% departure	Based on the data of Atlanta Airport
Transit passengers	1/3 of international passengers	
Unit value of time, work trips	13,18 TL per hour	Estimate based on the average wage in the country
Unit value of time, non-work trips	3,95 TL per hour	30% of the value of work time
Maintenance Cost	26 EUR per person	Based on Gürsel & Toru-Delibaşı (2013)
Cost of air pollutant emissions	0,003 per passenger	Based on the European Commission (2014)

Table 6: List of assumptions and their explanations

11. IMPACT ANALYSIS

In order to conduct a CBA from the perspective of the whole economy, it is necessary to be able to make an impact analysis, which is the process of identifying all the effects of the project considering the different groups, such as air passengers, airport operators, airlines, local community and the general public. After the identification, quantifying them in monetary terms is also important. Therefore, in this section, the impacts are divided as cost or benefit and the quantification methods are listed, and later on these impacts will be grouped according to the financial and economic analysis.

COSTS	QUANTIFICATION METHOD
Tender	Market value
Investment	Market value
Operation and Maintenance (O&M)	Market value
Termination from Atatürk Airport	Market value
Employment	Shadow wage
Habitat disturbance	Contingent Valuation
Noise Pollution	-
Air Pollution	-

Table 7: Presentation of the costs of INA and their quantification methods

BENEFITS	QUANTIFICATION METHOD
Residual Value	Market value
Fares	Market value
Travel Time savings	Value of time
Operating Cost Savings	Operating cost per aircraft per hour
Land value increase	HPM
Wider Effects	-
Passenger Satisfaction	-

Table 8: Presentation of the benefits of INA and their quantification methods

COSTS:

- **Tender Cost:** It is the total value that the consortium has to pay to the government to operate the airport for 25 years. However, since a consolidated financial analysis is done for the aim of this paper, the cash flows between the operator (IGA consortium) and the owner (government) are neglected, meaning that tender cost is not included in the analysis.
- **Investment Cost:** It includes the cost of planning, design and construction.
- **Operation and Maintenance (O&M):** The costs that occur during the lifecycle of the airport.
- **Termination from Ataturk Airport:** The cost that is paid by the government to TAV Airports, who had the right to operate Ataturk Airport until 2021, January 3rd for closing Ataturk Airport earlier than the contract time.
- **Employment:** The creation of jobs is frequently presented as a benefit of a project, but labor is an input (cost), not an output (Rus, 2010), because an infrastructure project is not constructed to create jobs, but to move people and goods. It is true that, thanks to the project a portion of unemployed people are able to work and contribute to the improvement of the national economy. But, the effect, in terms of employment used by the project, is captured by applying the Shadow Wage Conversion Factor (*see Chapter 16.1*) to labor cost (Eurpean Commission, 2014). Therefore if employment had been taken as a separate variable of benefit; it would lead to double-counting since the social benefit of employment is already given by using shadow wages.
- **Habitat Disturbance:** The cost of the trees cut for the construction of the airport in its area determined by the WTP of individuals.
- **Noise Pollution:** Airports cause a negative impact in terms of noise pollution for the properties located close to it. However, as the HPM is applied to the area of INA (see Chapter 14), no negative effect of the airport is observed on the property values. The benefit being located close to the airport surpasses the negative effect of the noise pollution.

- **Air Pollution:** The cost of air pollutant emissions are taken into consideration.

BENEFITS:

- **Residual Value:** Since at the end of the 25 years of operation the airport is returned to the government, the residual value is not included in the analysis.
- **Fares:** Aviation and non-aviation revenues are calculated and included in the analysis. However, passenger revenue is not included, since it is based on the exchange between the operator and government.
- **Travel Time Savings:** Consumers benefit from the decreased delays in which the value is calculated in terms of the value of time.
- **Operating Cost Savings:** Airline operators benefit from decreased delays and damage from extra taxiing times in terms of their operating costs.
- **Land Value Increase:** Many CBA appraisals ignore the effect of land value increase in order not to lead to double-counting of the benefit of time-saving. However, economic theory, and ex-post evaluations of transport projects suggest that it is common for major transport projects to have relatively major changes in land use (Parker, 2013). This means the long-run impacts of transport projects are not reduced costs of travel per se, but changed the location and activity patterns of households and firms. Therefore, in this paper, the land value increase is treated as a separate variable of benefit.
- **Wider effects:** Indirect effects occurring in secondary markets (e.g. additional tourism) and wider effects (e.g. regional growth) should be excluded in the CBA, because the indirect and the wider effects are usually transformed, redistributed and capitalized forms of direct effects (Eurpean Commission, 2014). Therefore, counting them as separate variables would be double-counting.
- **Passenger Satisfaction:** It is not possible to monetize passenger satisfaction but it will be taken into consideration by mentioning its qualitative effect at the end of the analysis.

12. CONTINGENT VALUATION: USING SURVEYS FOR INFORMATION ABOUT ENVIRONMENTAL COSTS AND BENEFITS

In this section, the contingent valuation method is applied to the inhabitants of Istanbul in order to obtain information about environmental costs and benefits. Questions about willingness to pay for a tree have been directly asked to the individuals.

The survey is conducted with the help of the computer technology. Google Forms has been used in order to send the questions to the target population, and collect and save the data. Later on, the data gathered has been processed into useful output with the help of the SPSS program to find the correlations between the responses of the individuals (if any), mean, median and mode.

The respondents have been chosen randomly, and there was no control over who could fill up the survey. Therefore, the problem of bias towards the respondents has been minimized. Moreover, the respondents did not have to indicate their name/surname while filling up the survey, which offered them more freedom to be honest with their replies.

The structure of the section involves first the explanation of the method and purpose, and then the explanation of the findings.

12.1. Method & Purpose

Contingent valuation is a stated preferences technique that is used in this paper to figure out the shadow prices of environmental costs and benefits from people's willingness to pay by directly asking questions about the topic.

There are many ways to conduct a survey, such as face-to-face interviews, telephone interviews, mail surveys and computer-assisted interviews. Each method has its own advantages and disadvantages, which is shown in Table 9. Both the users and non-users of the new airport have to be identified and evaluated in this paper. Hence, a computer-assisted survey has been chosen in order to be able to reach the highest number of data in a short period of time.

Method	Advantages	Disadvantages
Face-to-face	High response rate >70% Greatest sample control Complex questions	Relatively expensive Surveys have to be short Possible interviewer bias
Telephone	Response rate between 65-70% Cheaper than face-to-face Easy to monitor	No use of visual aids Respondents may not answer sensitive questions
Mail	Relatively inexpensive Easier to answer sensitive questions	Low response rates 25-50 % Little control of the sample
Computer-assisted	Relatively inexpensive More complex interviews are possible Analysis is quicker Large quantity of data can be collected	Possible rejection of 'computer technology' Little control of the sample

Table 9: Advantages and disadvantages of some methods of CV

Source: (Pearce & Ozdemiroglu, 2002)

Choosing the target population is the first step of a CV method. The new airport is affecting the whole population of Turkey, but mostly Istanbul due to its environmental costs (benefits). The purpose of conducting the CV method in this paper is pricing the environmental impacts, therefore the target population is chosen as the inhabitants of Istanbul.

Since it is not possible to reach the whole target population, in this case the whole population of Istanbul, a sample frame population has to be identified that represents the target population in the best way. This should be the closest approximation of the target population and it is one of the most significant and difficult step of the computer-assisted survey method, since there is little control of the respondents. Consequently, the sample is controlled through the questions. The survey has been sent to the possible greatest number of people who are the residents of Istanbul to have a variance and the answers have been grouped accordingly.

While designing the questionnaire, which you can find in Appendix A, the structure from Pearce & Ozdemiroglu (2002) and Ahmed & Gotoh (2006) has been taken as the primary reference, which is as the following:

i. **Purpose of the questionnaire:** It is essential to state the purpose of conducting the questionnaire to ensure that respondents understand the context, are motivated to cooperate, and are able to participate in an informed manner.

ii. **Who are the interviewers:** The respondents should explain who they are by stating their gender, age, education and occupation. Together with the next step, this is a critical way to group the respondents and their answers.

iii. **Use of the service:** This stage determines the use of the service in question. The aim is to distinguish users of INA from non-users and additionally, understand their familiarity with the service.

iv. **Attitudinal questions:** This section seeks the respondent's attitudes to general issues concerning the service in question by directly asking the most important problem and the benefit of INA.

v. **The valuation scenario and the payment vehicle:** This is the main purpose of the questionnaire. It defines the good in question, makes up a scenario that the respondents have to value and the (hypothetical) expected way to pay for the good. A good scenario defines the problem (13 million trees have been cut) and the institution that is responsible for providing the solution (a voluntary organization). It is essential to underline that the government is not involved in this paper as the responsible organization in order to avoid the strategic behavior, since there is a really strong bias for the use of taxes and political disagreement against the government in Turkey.

In this paper, an open-ended elicitation method is used that directly asks the maximum WTP of people for the good in question. This method is chosen for planting since it is not a very unfamiliar market that people have never crossed their way with. Across the globe, there are so many campaigns that

ask people for money to plant a tree. Therefore, respondents may be able to compare the campaigns in order to come up with their WTP.

vi. **Follow-up questions:** Follow-up questions are a tool to understand the reasons behind the WTP of people. They may protest the organization or the payment vehicle regardless of the good in question. Therefore, it is essential to distinguish the protests from zero valuations. All zero valuations are not necessarily protests; individuals may not be willing to pay anything for the good. Additionally, follow-up questions can be used to test the credibility of the scenario.

In this survey, 291 people have been reached for the first step. After the elimination of the biased answers, 171 replies have been evaluated in order to find out the WTP of individuals for a tree.

The replies are then imposed to the SPSS program in order to obtain useful output from the data. It is checked whether there is any correlation between the demographic information of the respondents and their replies, and the statistics of the replies to the WTP in order to find the relevant WTP to use in the CBA.

12.2. Findings

The data collected with the CV method has to be transformed into useful output. In order to do so, the first step is to analyze the responses. Then, non-valid answers of WTP have to be identified according to the responses to the follow-up questions by recognizing the biases. As the final step, the mean and median of the WTP has to be calculated.

The first step of analyzing the responses is grouping them according to the demographic information, which is shown in Table 10. Accordingly, 38,5% of respondents are male and 61,5% are female. Age distribution is mainly categorized between 36 and 55. The education level of most of the respondents is a bachelor's degree and the primary group of occupation is teachers.

Total observation: 291		Number	Percentage
Gender	Male	112	38,5%
	Female	179	61,5%
Age	18-25	38	13,1%
	26-35	41	14,1%
	36-45	89	30,6%
	46-55	92	31,6%
	56 and more	31	10,7%
Education	High School	33	11,3%
	Bachelor's Degree	190	65,3%
	Master's Degree	60	20,6%
	PhD	8	2,7%
Occupation	Teacher	56	19%
	Sales manager	39	13%
	Engineer	35	12%
	Lawyer	30	10%

Table 10: Demographic information of the respondents

In Table 11, it is possible to see that 74,9% of respondents fly less than 1 in a month, 17,9% fly between 1-3 times in a month, 3,8% between 3-5 times and 3,4% fly more than 5 times in a month. Accordingly, 37,1% of respondents said that their flight frequency has changed after the closure of Ataturk Airport and 62,9% said the closure has not affected their flight frequency.

		Number	Percentage
Flight frequency	Less than 1	218	74,9%
	Between 1-3	52	17,9%
	Between 3-5	11	3,8%
	More than 5	10	3,4%
Change of flight frequency after the closure of Ataturk Airport	Yes	108	37,1
	No	183	62,9

Table 11: Flight habits of the respondents

Table 12 demonstrates the respondents' usage status of the new airport and the purpose of the use. 55% of the respondents have not used the new airport and 45% of them have used the new airport before. Among those, 53,8% have used the new airport for leisure and 30,1% for business purposes.

When asked for the solution to the increasing air traffic in Istanbul, 84,5% of respondents agreed as the expansion of the existing airports instead of a new one.

		Number	Percentage
Usage status of the new airport	Yes	131	45%
	No	160	55%
Purpose of the use	Leisure	84	53,8%
	Business	47	30,1%
Solution to the air traffic	Expansion	246	84,5%
	New airport	33	11,3%
	None	12	4,2%

Table 12: Usage information about INA

When it was asked respondents to rate their opinion about the distance of INA to the city center out of 5 (1 being very close and 5 being very far), 74,2% rated it as 5 and 47,2% of respondents rely on their private car to be able to reach to the airport. Consequently, while traveling domestically the majority of respondents, which is 67,7% prefer Sabiha Gokcen Airport and only 10,7% prefer the new airport.

Since these data reflect the passenger satisfaction of the airport, they are also represented with the histograms to see and understand the extreme difference between the replies.

		Number	Percentage
Distance of INA	1 (very close)	5	1,7%
	2	4	1,4%
	3	29	10%
	4	37	12,7%
	5 (very far)	216	74,2%
Access to INA	Public Transportation	27	11,8%
	Shuttle Bus	89	38,9%
	Car	108	47,2%
	Taxi	37	16,2%
Preferable way for intercity transportation	Plane - INA	31	10,7%
	Plane - SAW	197	67,7%
	Bus	59	20,3%
	Train	29	10%
	Car	112	38,5%

Table 13: Opinions about the location of INA

These outputs are also reflected in the histograms below for better visualization and understanding the extreme difference:

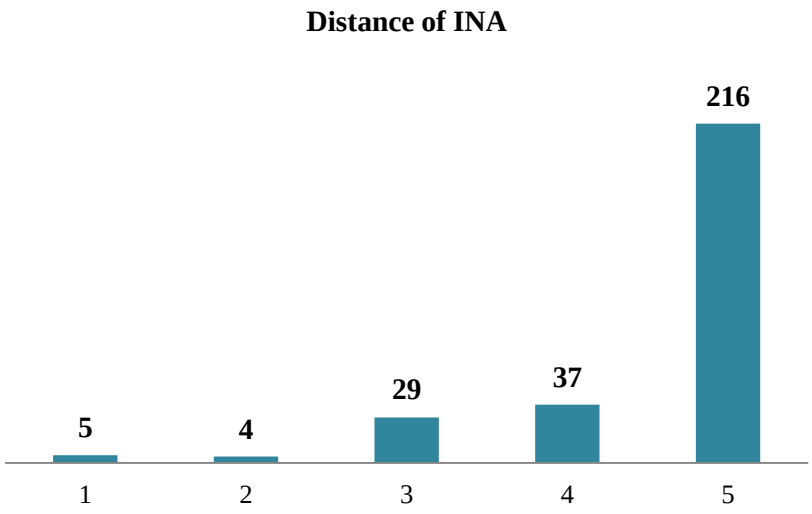

Figure 15: Histogram of distance of INA

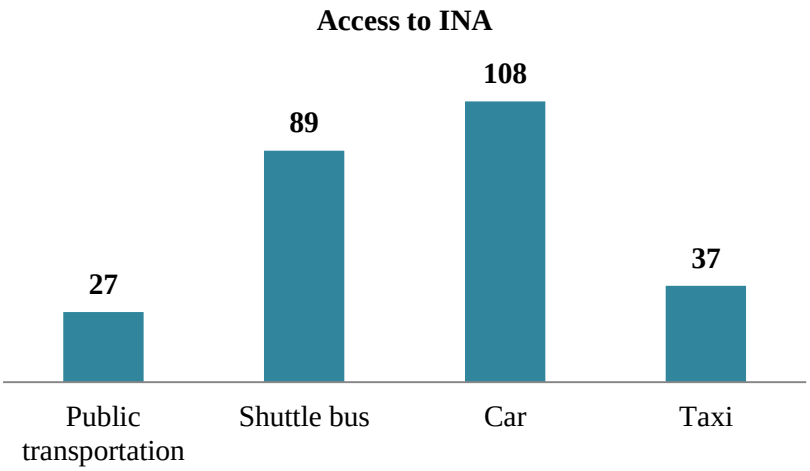

Figure 16: Histogram of access to INA

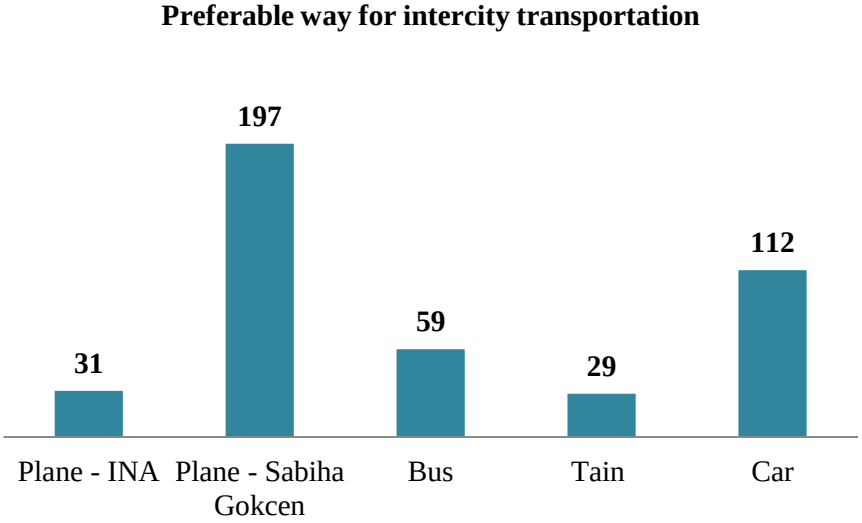

Figure 17: Histogram of preferable way for intercity transportation

These outputs presents that after the closure of Ataturk Airport, people prefer using Sabiha Gokcen Airport, instead of INA, especially for domestic travels. This will cause an overwhelming traffic in the Sabiha Gokcen Airport in the short-term until the public transportation to INA would be provided. Therefore, it is crucial to finish the subway system that connects INA to the city center in the planned time horizon.

In Table 11, the opinions of the respondents about the most significant problem and benefit of INA are shown:

		Number	Percentage
Most significant problem	Distance from the city center	161	55,3%
	Difficulty to reach to the airport	138	47,4%
	Too much time spent inside the airport due to its size	135	46,4%
	Environmental harm it caused for the construction	145	49,8%
	Security concerns due to the wrong location choice	145	49,8%
	No problem	8	2,7%
Most significant benefit	Reduced delays	32	11%
	Easier to reach to the airport	4	1,4%
	Value added to GDP	34	11,7%
	Improvement of the district it is located at	30	10,3%
	No benefit	204	70,1%

Table 14: Opinions about the most significant problem and benefit of INA

As the final step of the questionnaire, WTP for a tree cut during the construction of the new airport has to be discovered. In order to do so, a scenario is presented to the respondents and their maximum WTP is directly asked. Before calculating the mean and the median of the results, first the non-valid responses are identified by the follow-up questions, which are organized to determine the reason why the respondent has or has not agreed to pay.

A non-valid response often reflects the respondents' biases for the scenario. According to Pearce & Ozdemiroglu (2002), the unwillingness to pay is identified as a bias if the respondent's reason is:

- The government should pay for this,
- The awarded party of the tender should pay for this,
- I need more information to answer the question.

Similarly, the willingness to pay is identified as a bias if the respondent's reason is:

- My answer reflects my view on all the works of forestation, not just this one.

After identifying and eliminating the biased answers, the number of total observations has decreased to 171 respondents. The results are as the following:

Total observation:171		
WTP (TL)	**Number**	**Percent**
0	15	8,8%
1	1	0,6%
2	2	1,2%
5	8	4,7%
6	1	0,6%
10	41	24%
11	1	0,6%
15	6	3,5%
20	20	11,7%
25	5	2,9%
30	4	2,3%
40	1	0,6%
50	32	18,7%
100	26	15,2%
150	1	0,6%
200	1	0,6 %
250	2	1,2%
300	1	0,6%
500	2	1,2%
1000	1	0,6%

Table 15: WTP of the respondents

Looking at the top 7 extreme points of 1000, 500, 300, 250 and 200 TL of WTP, no correlation has been observed between the WTP, occupation and the education level. Whereas, 5 out of 7 people have replied to the most significant problem of INA as "environmental harm it caused for the construction" and as their reason for the WTP

they have mentioned that “I believe it is an important problem”. It proves that these answers are not biased but they provide their genuine WTP.

Looking at the lower 16 extreme points of 0 TL of WTP, similarly no correlation has been observed between the WTP, occupation and the education level. The majority stated their reason as “My budget is not enough” and a lower portion as “I do not believe that this problem is a priority” and “The benefit is not worthwhile”. Therefore these zero values have been considered in the analysis since it reflects respondents’ genuine WTP.

The key objective in analyzing CV data is to obtain estimates of two summary statistics: the mean WTP and the median WTP (Pearce & Ozdemiroglu, 2002). The mean WTP is the average value of WTP of the respondents and the median WTP is the value that divides the sample into two; half of the values are lower and half of them are higher than the median. Additionally, mode WTP has been obtained in this analysis, which is the value that the highest number of people has replied. These statistics can be seen in Figure F:

Statistics	
Mean	50,2749
Median	20,0000
Mode	10,00

Table 16: Statistics of WTP.

For policymakers, the measures for summarizing the respondents’ WTP have different interpretations. The statistics of this sample has a higher mean value as a consequence of the extreme values of WTP of a really small group of people. Thus, for the purpose of this paper, in order to be able to reflect the public choice in the best way and receive the approval of the majority, the median value is taken into consideration for the cost-benefit analysis. It is possible to state that, as a consequence, individuals’ **willingness to pay for a tree is 20 TL**.

13. HEDONIC PRICE METHOD: USING REGRESSION ANALYSIS FOR THE INFORMATION ABOUT THE REAL ESTATE MARKET

13.1. Market Information

One of the benefits of the Istanbul New Airport is the increased land values, not only at the district it is located at (Arnavutkoy) but also at the neighborhood districts. In this paper, only the land value increase in Arnavutkoy is taken into account because there is another public project –Kanal Istanbul, which is currently under discussion, and which will and is affecting the land values of the neighborhood districts of the airport. Therefore, in order not to count the benefits of Kanal Istanbul, only Arnavutkoy is evaluated in this paper.

The following figure illustrates the sale prices (TL/sqm) of houses in Arnavutkoy according to the years:

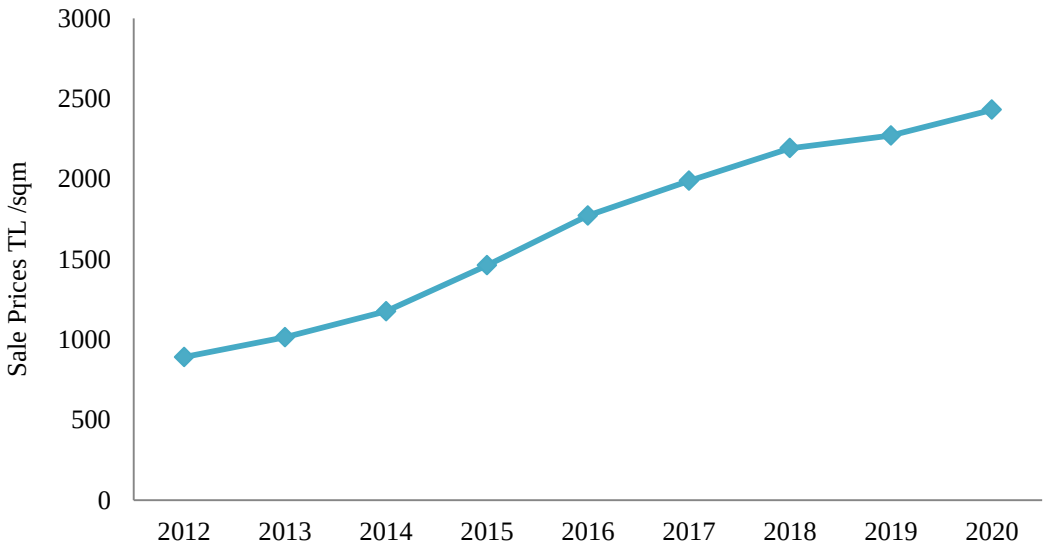

Figure 18: Sale prices per square meter in Arnavutkoy over the years

2012 is the year when the location of the airport is decided and according to the data from Zingat, house prices are seen to be normal, approximately 900 TL/m^2. With the conclusion of the tender bid of the airport in 2013, the subway line to the airport is announced and there is a 14% increase in the prices compared to the previous year. After a year full of discussions with the possibility that the location of the airport could be changed, 2015 is a key year with the construction site delivery and tender bid of the subway. It is possible to see a 25% increase in 2015 compared to the

previous year and a 64% increase compared to 2012. In all the following years up to today, there is an increasing pattern in the sale prices of houses which is the primary proof of the land value increase.

13.2. Method & Findings

In order to be able to estimate the benefits and costs related to the new airport affecting the residential property values, hedonic price regression is applied to the area of Arnavutkoy. Regression is a statistical measurement that attempts to determine the strength of the relationship between one dependent variable and a series of other changing variables (known as independent variables) (Beers, 2019). This is also called a linear regression since there is only one dependent variable.

The first step is to collect data on residential property sales. In this paper, **102 observations** are taken into account from different real estate agents in Turkey; such as *Zingat*[10], *Hurriyet Emlak*[11] and *Remax*[12]. The dependent variable of the analysis is the price of the apartments and independent variables taken into account are the followings:

- Distance to the airport
- Floor surface of the apartment
- Number of rooms in the apartment
- Number of bathrooms in the apartment
- Age of the building, in which the apartment is located at
- Being located in a *site*[13]
- Being in-between floors
- Accessibility to the schools and hospitals

The following table demonstrates the abbreviations used for each variable and their unit of measure:

[10] https://www.zingat.com
[11] https://www.hurriyetemlak.com
[12] https://www.remax.com.tr
[13] *Site* is a term in Turkey which refers to a building complex, in which buildings are grouped together with social spaces (pool, gym etc.) and security.

Abbreviations	Variable	Unit of Measure
DIST_AIR	Distance to the airport (in air distance)	Km
SIZE	Floor surface of the apartment	SqM
N_ROOM	Number of rooms in the apartment	Piece
N_WC	Number of bathrooms in the apartment	Piece
B_AGE	Age of the building, in which the apartment is located at	Year
D_SITE	Being located in a site	Dummy variable
D_FLOOR	Being in-between floors	Dummy variable
D_ACC	Accessibility to the schools and hospitals	Dummy variable

Table 17: Variables used in the HPM, their abbreviations and the unit of measures

Dummy variables are those that take a value between 0 and 1. Meaning that if the apartment is located in a *site*, it takes the value 1 and if not 0. Similarly, if the apartment is in-between floors, the value is 1 and if it is at the ground or roof floor, the value is 0. Accessibility gets the value of 1 if there are both schools and hospitals close to the property. This criterion is ensured only and only in the center of Arnavutkoy; thus, another variable of distance to the CBD is not taken into account since it would give the same result.

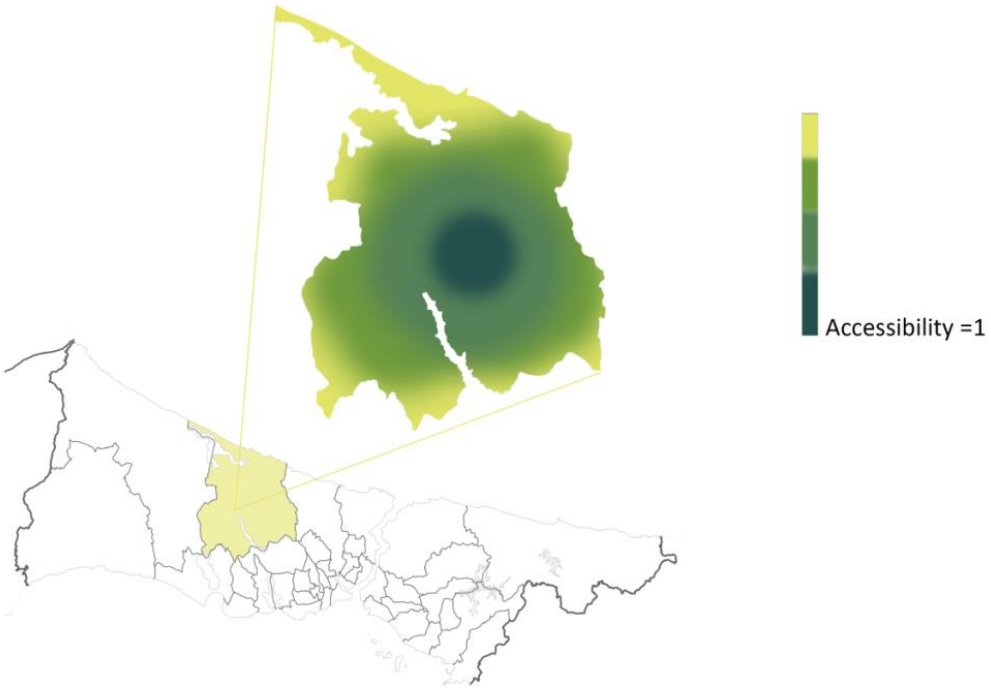

Figure 19: Map of Istanbul, zoomed to Arnavutkoy, showing the accessibility with increasing intensity colors to its center

All observations are new, no second-hand apartments and they all have central heating systems. It is essential to underline again that no variable of distance to the closest central business district is taken into account, because it would lead to double-counting. Istanbul is a multi-centered city and the closest CBD is the center of Arnavutkoy, where, among the samples, the only public hospital is located at. Therefore, distance to the closest CBD is directly proportional to the accessibility. The most significant variables are taken into account in the analysis but no matter how many controls are set; it is not possible to account for all the characteristics.

After the observations made accordingly with these variables, the next step is to build a function that relates property values to property characteristics:

P = *f* (Dist_Air, Size, N_Room, N_WC, B_Age, D_Site, D_Floor, D_Acc)

This is called a hedonic price function. Microsoft Excel can be used for the computation of such functions with the logarithms of the values for the variables. After running the regression analysis in Excel, the following first output is obtained:

	Regression Statistics
Multiple R	0,83
R Squared	0,69
Adjusted R Square	0,66
Standard Error	61163,38
Observations	102

Table 18: Regression statistics results

These are the "Goodness of Fit" measures. They explain how well the calculated linear regression equation fits the data.

- **Multiple R** is the correlation coefficient. Its value indicates the strength of the relationship between the data and the regression. The closer it is to 1, the stronger the relationship is.
- **R Squared** is the coefficient determination. It tells how many points of the data fall on the regression line. For instance, in this analysis 69% of the data fits the model.
- **Adjusted R Square** is used instead of R Squared when there is more than one independent variable of *x*.
- **Standard Error** is the precision that the regression coefficient is measured.
- **Observations** are the number of samples in the data.

These measures are substantial for the accuracy of the regression with the data. Therefore, it is reliable to see the final output of the analysis which is the coefficients. They illustrate the relationship between the sale price and the characteristics of the properties, which is as the following:

	Coefficients
Intersection	37.367,98
DIST_AIR	- 3.125,72
SIZE	1.331,37
N_ROOM	7.733,27
N_WC	42.653,54
B_AGE	- 10.213,42
D_SITE	90.492,23
D_FLOOR	74.178,83
D_ACC	25.382,28

Table 19: Results of coefficients of the regression analysis

These coefficients represent that any 1 km increase of a property's distance to the airport causes a decrease (because of the minus in front) of 3.125,72 TL in the sale price of the property. Similarly, any 1 sqm increase in the size of the property causes an increase of 1.331,37 TL in the sale price. As for the dummy variables, if the property is located in a *site*, in-between floors, or is accessible to the schools and hospitals, it will cause an increase in the sale price equal to 90.492,23 TL, 74.178,83 TL and 25.382,28 TL, respectively.

As a conclusion, it is possible to write the following equation for the sale prices of properties ($\boldsymbol{P_i}$) in Arnavutkoy:

$$\begin{aligned} \boldsymbol{P_i} = \ & \mathbf{37.367,98} + (\mathbf{-3.125,72}) \times \boldsymbol{Dist_{Air_i}} + \mathbf{1.331,37} \times \boldsymbol{Size_i} + \mathbf{7.733,27} \\ & \times \boldsymbol{N_{Room_i}} + \mathbf{42.653,54} \times \boldsymbol{N_{WC_i}} + (\mathbf{-10.213,42}) \times \boldsymbol{B_{Age_i}} \\ & + \mathbf{90.492,83} \times \boldsymbol{D_{Site_i}} + \mathbf{74.178,83} \times \boldsymbol{D_{Floor_i}} + \mathbf{25.382,28} \times \boldsymbol{D_{Acc_i}} \end{aligned}$$

For the purpose of this paper, we are concerned about the coefficient of distance to the airport. The fact that it has a minus in front proves the benefit of being located close to the airport and there is no cost of noise pollution since the distance is taken as air distance.

14. FINANCIAL ANALYSIS

As set out in Article 101 (Information necessary for the approval of a major project) of Regulation (EU) No 1303/2013, a financial analysis must be included in the CBA to compute the project's financial performance indicators.

The methodology used in this paper for financial analysis is **Discounted Cash Flows**, which, as a general rule, is carried out from the perspective of the project owner. The FDR of 12,75% is used to discount the future cash flows into the present. Since INA is constructed with a concession contract, a consolidated financial analysis is applied in this paper, which excludes the cash flows between the owner and the operator and as set out by European Commission (2014), the financial analysis should be carried out net of VAT, both on purchase (cost) and sales (revenues) since it is recoverable.

The following parts are the breakdown of the financial analysis as investment costs, O&M costs and revenues. As a conclusion to this chapter, the financial profitability is calculated. Details for certain years are given in the related chapters, and in order to see the financial analysis for the whole years, see Appendix D and E for the optimistic and realistic scenarios, respectively.

14.1. Investment Costs

The first step in financial analysis is the breakdown of the investment costs over the years. Since the investment cost is independent from the number of passengers, the same result is obtained for both of the scenarios.

INA is constructed with Public-Private Partnership (PPP); thus, financial analysis neglects the cash flows between the government and the private partner (IGA consortium). Therefore, the tender cost of 22.152 billion Euros for operating the airport for 25 years which will be paid by the IGA consortium to the government is excluded in the financial analysis.

The investment cost for the first phase is 7,5 billion Euros and after the completion of all the phases, the total investment cost is expected to be 10,2 billion Euros (Samsunlu, 2019)**.** The shareholders' equity is 1,5 billion Euros and the loan for the

first phase is 6 billion Euros taken from different banks with a 16-year maturity and 4,25% interest rate for the first 10 years (Güler, 2015). For simplicity, the assumption of taking the interest rate as 4,25% for all the years (for 25 years), not just the first 10 years is done in this paper.

The **termination cost** from Ataturk Airport, which is 389 million Euros (Sozcu, 2019) is paid by the government to TAV Airports, who had the right to operate Ataturk Airport until 2021, January 3rd for closing Ataturk Airport earlier than the contract time.

Moreover, the **residual value** of the investment must be included in the financial analysis, which reflects the capacity of the remaining service potential of fixed assets whose economic life is not yet completely exhausted. However, the residual value is excluded in the case of Public-Private Partnership contracts since the infrastructure is returned to the public sector at the end of the period (Eurpean Commission, 2014). Meaning that, at the end of 25 years, INA will be returned to the government and this value is excluded in the analysis for the purpose of the paper.

The present value of the total investment cost with 12,75% FDR is approximately 8,9 billion Euros. Details for certain years are shown in the following table:

SC. A & B	NPV 12,75%	2013	2019	2043
INVESTMENT COST	**€ 8.844.283.831**	**€ 1.500.000.000**	**€ 779.937.500**	**€ 201.202.500**
Equity	€ 3.081.701.447	€ 1.500.000.000	-	-
Debt	€ 5.527.656.963	-	€ 375.000.000	€ 193.000.000
Interest	€ 234.925.420	-	€ 15.937.500	€ 8.202.500
Termination Cost	€ 389.000.000	-	€ 389.000.000	-
Residual Value	-	-	-	-

Table 20: Breakdown of investment costs for certain years

The biggest portion of the total investment cost is the debt that is 60%, followed by the equity with 33%. The following figure illustrates the percentage of each component of the investment cost over the total investment cost.

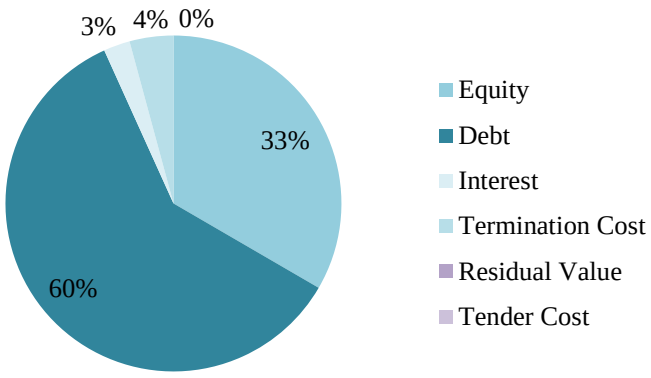

Figure 20: Graphical representation of the percentage of the each component of the investment cost over the total investment cost

14.2. Operation & Maintenance Costs

The second step in the financial analysis is the calculation of the operation and maintenance costs.

According to the Eurpean Commission (2014), O&M costs are distinguished in and should cover the followings:

- Routine maintenance: yearly work required to keep the infrastructure technically safe and ready for day to day operation as well as to prevent deterioration of the infrastructure assets;
- Periodic maintenance: all activities intended to restore the original condition of the infrastructure.

Maintenance costs are estimated based on the research of Gürsel & Toru-Delibaşı (2013), which suggests an average cost of 26 Euro per passenger for the maintenance activities.

Furthermore, operation cost is determined by the historical data of Ataturk Airport obtained from DHMI (General Directorate of State Airports Authority) annual reports, which includes labor cost, sales cost and operating expenses, ordinary expenses and losses from other activities, financing expenses, and unusual expenses and losses.

By analyzing the data between 2011 and 2018, it is possible to adopt the expenses of Ataturk Airport to Istanbul New Airport by making an assumption of a 7% increase in the operation cost each year.

Since the maintenance cost depends on the number of passengers, the O&M costs must be calculated for both of the scenarios, differently. The table below shows the O&M costs for scenarios A and B, respectively:

SC. A	NPV 12,75%	2019	2030	2043
O&M COST	**€ 24.097.775.426**	**€ 1.983.871.273**	**€ 3.413.827.042**	**€ 6.273.935.673**
Operation Cost	€ 1.637.835.320	€ 114.450.037	€ 240.900.385	€ 580.532.589
Maintenance Cost	€ 22.459.940.105	€ 1.869.421.235	€ 3.172.926.656	€ 5.693.403.084

Table 21: Breakdown of O&M costs over the years in Scenario A

SC. B	NPV 12,75%	2019	2030	2043
O&M COST	**€ 22.350.182.453**	**€ 1.969.655.142**	**€ 3.093.866.882**	**€ 5.042.446.831**
Operation Cost	€ 1.637.835.320	€ 114.450.037	€ 240.900.385	€ 580.532.589
Maintenance Cost	€ 20.712.347.132	€ 1.855.205.104	€ 2.852.966.496	€ 4.461.914.242

Table 22: Breakdown of O&M costs over the years in Scenario B

In scenario A, the total O&M costs are found to be around 24 Billion Euros and in scenario B, it is around 22 Billion Euros.

14.3. Revenues

Financial inflows will be represented by the proceeds from the charges applied to users for access to the infrastructure or the sale of transport services. The estimation of revenues should be based on the traffic volume forecast.

Sources of revenues are divided into two; revenues from transport activities and revenues from non-transport activities. According to the Eurpean Commission (2014), typical sources of revenues for airports are listed as the following:

- **Revenues from transport activities:**
  Take-off or landing charge
  Passenger charge

Parking charge

Cargo charge

- **Revenues from non-transport activities:**

  Commercial services

  Real estate rental

  Food services

  Transport services

  Advertising services

  Car parks

Looking at the hub airports around the world, it is possible to see that non-transport activities generate most of the revenues (Federal Aviation Administartion, 2011). For instance, the financial report of Atlanta Airport in 2011[14] shows that only 37% of its revenues are generated from transport activities and the remaining 63% is from non-transport (commercial) activities. Chairman of the board of *Limak* (one of the partners of the consortium), Nihat Özdemir, has mentioned in an interview that revenues from passenger charges are expected to be one-third of the total revenues (Özdemir, 2013). It shows that the consortium (IGA) has aimed an income statement similar to Atlanta Airport.

In this paper, while calculating the revenues from transport activities, passenger charge is not taken into consideration since it is an agreement between the government and the private consortium and this paper ignores the cash flows between the owner and the operator of the infrastructure. Additionally, cargo charge is also not included, since Ataturk Airport is still used for cargo flights.

Take-off, landing and parking charge is calculated from the price list of DHMI separately for international and domestic passengers (DHMI, 2020). Firstly, the number of international and domestic planes are calculated for the years 2019-2043 by the assumption of the growth rate of air traffic in two different scenarios; A and B. Afterwards, the number of planes is multiplied by the average maximum take-off weight (190 metric tons)[15] of planes and lastly, by multiplying it with the unit airport

[14] http://www.atl.com/docs/BusinessInformation/Reports/2011_Annual_Report.pdf

[15] The average maximum take-off weight of the aircraft of Turkish Airlines is used.

charges of DHMI[16], charges for take-off/landing, parking, approach and lighting services are calculated for two different passenger profile and scenarios.

Revenues from non-transport activities are assumed to be the double of the revenues from transport activities. In order to make the calculation of the revenues from non-transport activities, passenger charges need to be calculated, which is a part of the revenues from transport activities but is excluded in the final analysis for the discussed reason. To do so, data from DHMI price list is used, which is 20 Euro for an international, 5 Euro for a transit and 3 Euro for a domestic passenger (DHMI, 2020). Revenues from transport activities are recalculated including the value of passenger charges and doubled to find out the revenues from non-transport activities.

The following table shows the revenues of certain years for the two different scenarios:

SC. A	NPV 12,75%	2019	2030	2043
REVENUES	**€ 29.909.232.466**	**€ 2.489.452.512**	**€ 4.225.291.809**	**€ 7.581.735.105**
International Landing	€ 5.983.872.283	€ 498.059.116	€ 845.344.546	€ 1.516.860.541
Domestic Landing	€ 638.173.107	€ 53.117.432	€ 90.155.025	€ 161.771.434
Non-transport	€ 23.287.187.075	€ 1.938.275.963	€ 3.289.792.238	€ 5.903.103.128

Table 23: Breakdown of revenues over the years in Scenario A

SC. B	NPV 12,75%	2019	2030	2043
REVENUES	**€ 27.260.429.529**	**€ 2.385.034.660**	**€ 3.779.389.266**	**€ 6.401.775.634**
International Landing	€ 5.699.169.246	€ 494.271.594	€ 793.726.970	€ 1.389.241.091
Domestic Landing	€ 607.809.855	€ 52.713.497	€ 84.650.069	€ 148.160.966
Non-transport	€ 20.953.450.427	€ 1.838.049.567	€ 2.901.012.225	€ 4.864.373.576

Table 24: Breakdown of revenues over the years in Scenario B

[16] DHMI airport charges are : for international landing 7,14 Euro/ton, for domestic landing 1,54 Euro/ton, for international parking, approach and lighting services 84 Euro/plane, for domestic parking, approach and lighting services 78,65 Euro/plane.

14.4. Financial Profitability

Determination of investment costs, O&M costs and revenues enable the assessment of financial profitability by the key indicators of Financial Net Present Value (FNPV) and Financial Rate of Return (FRR).

Financial Net Present Value (FNPV) is the sum of all the discounted values. Total inflows are extracted from total outflows. The positive result indicates the project is financially profitable and a negative result means the project is not financially profitable.

Financial Rate of Return (FRR) is the discount rate that produces a zero FNPV. If the result is higher than the financial discount rate used in the analysis, the project is not considered to be financially profitable.

The following table demonstrates the final results and the financial profitability indicators for scenario A:

SC.A	NPV 12,75%	2013	2019	2043
Revenues	-€29.909.232.466	-	-€2.489.452.512	-€7.581.735.105
TOTAL INFLOWS	**-€29.909.232.466**	-	**-€2.489.452.512**	**-€7.581.735.105**
Private Equity	€3.081.701.447	€1.500.000.000	-	-
Loan repayment (inc. interest)	€5.762.582.384	€390.937.500	€390.937.500	€201.202.500
Termination Cost	€389.000.000	-	€389.000.000	-
O&M Costs	€24.097.775.427	-	€1.983.871.274	€6.273.935.673
TOTAL OUTFLOWS	**€33.331.059.259**	**€1.890.937.500**	**€2.763.808.774**	**€6.475.138.173**
NET CASH FLOW	**-€3.421.826.793**	**-€1.890.937.500**	**-€274.356.261**	**€1.106.596.932**
FNPV	**-€ 3.421.826.793**			

Table 25: FNPV and FRR in Scenario A

The FNPV with a 12,75% of discount rate is calculated to be approximately -3,4 Billion Euros. The revenues are taken with a minus in front, since it is an inflow. The

largest portion belongs to the revenues with a 47%, followed by the O%M costs with a 38% of the FNPV.

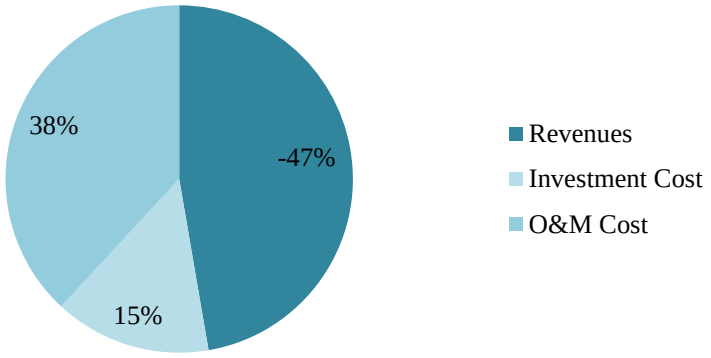

Figure 21: Graphical representation of the percentage of each component over FNPV

The following table illustrates the financial profitability indicators of FNPV and FRR for scenario B. The FNPV calculated with a 12,75% of discount rate is around -4,3 Billion Euros. The minus in front represents that the project is not financially profitable.

SC.B	NPV 12,75%	2013	2019	2043
Revenues	-€27.260.429.529	-	-€2.470.521.315	-€6.607.377.764
TOTAL INFLOWS	**-€27.260.429.529**	**-**	**-€2.470.521.315**	**-€6.607.377.764**
Private Equity	€3.081.701.447	€1.500.000.000	-	-
Loan repayment (inc. interest)	€5.762.582.384	€390.937.500	€390.937.500	€201.202.500
Termination Cost	€389.000.000	-	€389.000.000	-
O&M Costs	€22.350.182.453	-	€1.969.655.143	€5.042.446.832
TOTAL OUTFLOWS	**€31.583.466.285**	**€1.890.937.500**	**€2.749.592.643**	**€5.243.649.332**
NET CASH FLOW	**-€4.355.290.909**	**-€1.890.937.500**	**-€279.071.328**	**€1.363.728.432**
FNPV	**-€ 4.355.290.909**			

Table 26: FNPV and FRR in Scenario B

The following figure demonstrates the graphical representation of the components of financial analysis. Similarly, the biggest portion belongs to the revenues with 46%, followed by O&M costs with 38% of the total investment cost.

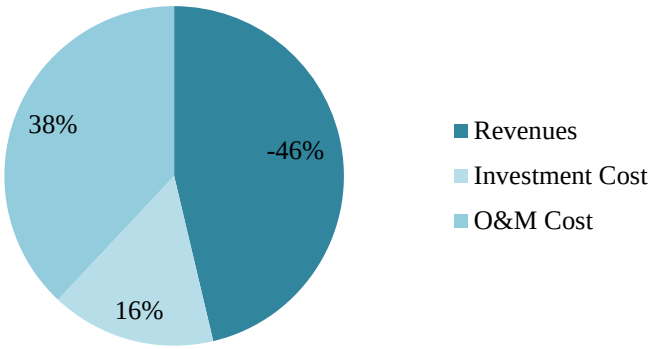

Figure 22: Graphical representation of the percentage of each component over FNPV

As a conclusion, the negative FNPV indicates that the project is not financially profitable in both of the scenarios. The considered discount rate of 12,75% plays an important role in this result, since it is a value much higher than the discount rate of 4% recommended by the European Union. But, because of the shaky economy of Turkey with high inflation rates, the recommended value of the EU cannot be used. In this direction, looking at the cash flows over the years, it is possible to see that in the second year of operation, in 2020, the cash flows are turning to positive sign, which means that the project starts to profit in both of the scenarios. However, the net present value should be taken into consideration in such analysis.

15. ECONOMIC ANALYSIS

As set out in Article 101 (Information necessary for the approval of a major project) of Regulation (EU) No 1303/2013, an economic analysis must be carried out to appraise the project's contribution to the welfare of society. The Social Discount Rate (SDR) of **12,75%** is used to discount the future values into the present.

The standard approach suggested by the European Commission is to move from financial to economic analysis (Eurpean Commission, 2014) in order to calculate the total economic costs. For this purpose, firstly fiscal corrections should be applied to

the market prices by using **Conversion Factors (CF)** in order to find out the shadow prices *(Chapter 16.1).*

Afterward, the main direct benefits need to be calculated. In transport projects, they are measured by the change of the following measurables (Eurpean Commission, 2014):

- Consumer surplus (users) *(Chapter 16.2)*
- Producer surplus (owner and operator) *(Chapter 16.3)*
- Externalities *(Chapter 16.4)*

As a conclusion, to determine the economic performance of the project and its contribution to welfare, economic indicators are calculated *(Chapter 16.5)*. Details for certain years are given in the related chapters, and in order to see the economic analysis for the whole years, see Appendix F and G for the optimistic and realistic scenarios, respectively.

15.1. Fiscal Corrections

When markets do not reflect the real opportunity cost of the inputs and outputs, fiscal corrections are necessary adjustments while moving from financial to economic analysis.

As mentioned earlier, the analysis should be done net of VAT, because:

"Taxes and subsidies are transfer payments that do not represent real economic costs or benefits for society as they involve merely a transfer of control over certain resources from one group in society to another." (Eurpean Commission, 2014)

Therefore, market prices for inputs and outputs must be considered net of VAT. When the value of the taxes are known, they should be directly eliminated from the market prices, but when it is not possible to determine their exact value, appropriate Conversion Factors are applied to the observed market prices. Investment and termination cost are already included in the financial analysis net of VAT, therefore CF for these variables are set to 1.

Moreover, prices used as a proxy for the value of outputs (e.g. tariffs) should be considered net of any subsidy and other transfer granted by the government. Since a consolidated financial analysis is done in this paper, any payments between the government and operator are already excluded in terms of tender cost and passenger revenue. Hence, revenues do not include the tariffs paid by the passengers, but includes only the revenue gained from the airline operators. According to the explanations in the price list of DHMI, revenues include taxes within the mentioned prices, hence for the purpose of socio-economic analysis the CF of 0,78[17] is applied to the revenues free of 22% of taxes in order to find out the shadow price independent from market distortions.

The O&M costs include labor costs, but wages are a distorted social indicator of the opportunity cost of labor because labor markets are imperfect. In order to measure the opportunity cost of labor, **shadow wages** should be used by reducing the unit labor cost by a percentage determined by the share of taxation (Eurpean Commission, 2014). Each country is encouraged to develop its own share of taxation. However, due to the available information limitations, instead of new calculations, the analysis of Del Bo, Fiorio, & Florio (2011) has been taken as a reference in this paper and the results are adapted to the case of Turkey.

Del Bo, Fiorio, & Florio (2011) has defined four labor market conditions by means of cluster analysis and the corresponding SW and CF are calculated. The four labor market conditions are: fairly socially efficient (FSE), quasi-Keynesian unemployment (QKU), urban labor dualism (ULD) and rural labor dualism (RLD), in which he definition of ULD[18] resemble Turkey better and the corresponding CF is 0,8.

In the economic analysis, an SDR of 5,06% is used, thus the present values of investment cost, O&M costs, termination cost and revenues are recalculated by using

[17] In principle, Conversion Factors should be made available by a planning office and not calculated on a project-by-project basis. When national parameters are not available, project-specific calculations can be made (Eurpean Commission, 2014)

[18] ULD: urban labor market, where the presence of an informal labor market attracts workers from the rural areas (Del Bo, Fiorio, & Florio, 2011).

the SDR. Then, the present values are adjusted by multiplying them with the conversion factors.

The sum of the adjusted prices gives the total economic costs. The following tables demonstrate the total economic costs for both of the scenarios:

SC. A	ADJUSTED PRICES	CF	NPV 5,06%
Investment Cost	€ 8.897.216.871	**1**	€ 8.897.216.871
O&M Costs	€ 39.421.044.922	**0,80**	€ 49.276.306.153
Termination Cost	€ 389.000.000	**1**	€ 389.000.000
Revenues	-€ 47.449.406.520	**0,78**	-€ 60.832.572.462
TOTAL ECONOMIC COSTS	**€ 1.257.855.273**		**-€ 2.270.049.438**

Table 27: Fiscal corrections and calculation of total economic costs in Scenario A

SC. B	ADJUSTED PRICES	CF	NPV 5,06%
Investment Cost	€ 8.897.216.871	**1**	€ 8.897.216.871
O&M Costs	€ 35.454.309.481	**0,80**	€ 44.317.886.851
Termination Cost	€ 389.000.000	**1**	€ 389.000.000
Revenues	-€ 42.438.436.140	**0,78**	-€ 54.408.251.461
TOTAL ECONOMIC COSTS	**€ 2.302.090.212**		**-€ 804.147.739**

Table 28: Fiscal corrections and calculation of total economic costs in Scenario B

15.2. Consumer Surplus

It is defined as the excess of individuals' willingness to pay over the cost of the transport. In practical approach, it is usually computed as the sum of monetary costs borne (e.g. tariff, fuel etc.) plus the value of the travel time calculated in monetary units (Eurpean Commission, 2014). Therefore, the main items to consider for this calculation are:

- Fares paid by the users;
- Travel time savings;

For the existing users, the consumer surplus is given by the change in the generalized user cost, namely in the time and fare cost. Since the fares are assumed not to change

as a result of the project and it is between the operator and the owner, the relevant impact is the time-saving.

For the new airport users (from the new demand generated), the consumer surplus is estimated by following the 'rule of half' formula – which assumes half of the savings in the generalized cost of the existing users. Since the fares are not changing, this means half of the travel time savings.

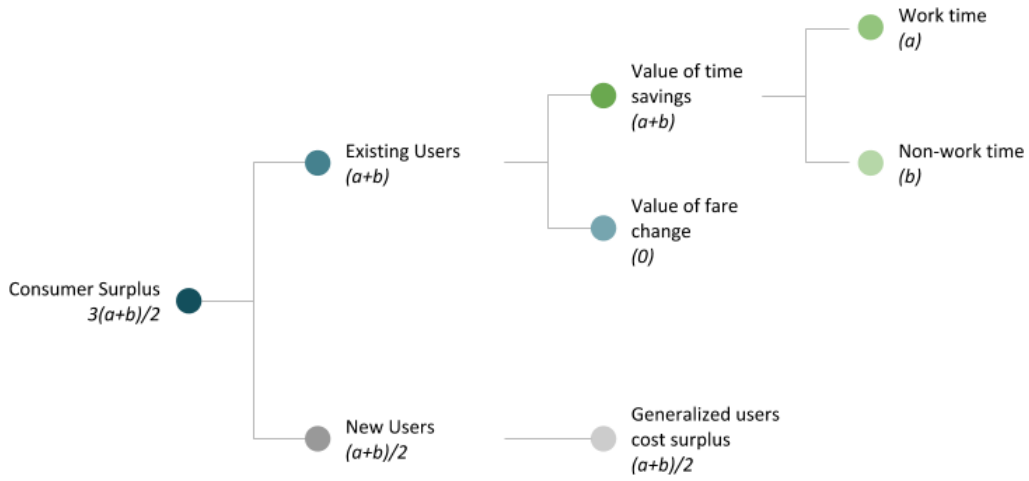

Figure 23: Hierarchical representation of the calculation of the value of consumer surplus

Travel time savings arise as a result of the reduced delays in INA compared to Ataturk Airport. In order to be able to calculate the value of time, a **cost-saving approach** is adopted in this paper. The logic underlying this method is that time spent on a delayed trip is a cost to the individual who could have used that time in an alternative productive way.

A distinction between the purposes of the travels – whether it is a business or leisure trip has to be made for the calculation, since work and leisure times have different monetary values. In order to be able to identify the percentage of different users, the results from the CV method (see Chapter 13.2) are used. Accordingly, it is concluded that 36% of the travelers use the airport for work-related trips and the remaining 64% of travels are for leisure.

The annual reports of Eurocontrol (2015) about the causes of delay and cancellations of air transport in Europe gives the average delay per departure in Ataturk Airport as

13,5 minutes and average delay per arrival as 18,4 minutes, making Ataturk Airport as the 3rd most delay affected airport in departure and the 1st in arrival. The reason is stated as:

"…Istanbul Ataturk Airport saw an average delay per departure of 13,5 minutes with airport capacity delays and weather being observed during the year." (Eurocontrol, 2015)

On the other hand, these statistic corresponds in Istanbul Airport as an average delay of 5 minutes in departure and 8 minutes in arrival in 2020 (Flight Radar, 2020).

Consequently, Istanbul New Airport has decreased the delays in departure as 8,5 minutes and 10,4 minutes in arrival, making it in total **19 minutes** reduced delays.

Work Time

According to Eurpean Commission (2014), the recommended process for valuing work time with the cost savings approach is as below:

1. *Establishing wage rates for a given country or region by the gross hourly labor cost (Euro per hour) must be derived from observed wage rates (or, in absence, from average national). The main data source should be the national statistical office;*
2. *Adjustment to reflect additional employee-related costs: this would include paid holidays; employment taxes; other compulsory contributions and an allowance for overheads required to keep someone employed. Social security payments and overheads paid by the employer shall, therefore, be computed and added to the estimated hourly labor cost.*

According to the statistics from the national statistical office (TUIK), for the year 2014, the gross hourly labor cost is determined as **13,18 TL**, which gives the value of one hour of work time.

Non-work Time

There is no theoretical basis for deriving the economic value of non-work trips from the wage rate. A way to interpret this value is to use revealed preferences methods, but the review of the economic literature about the value of time in specific countries suggests that non-working time usually ranges between 25 % and 40 % of the work time (Eurpean Commission, 2014). The values proposed within the HEATCO study also suggest similar ratios, ranging from 30% to 42 % of the value of working time.

On the grounds of this information, the value of non-work time is set as the 30% of the work-time, which corresponds to **3,95 TL** for one hour non-work time.

Consequently, consumer surplus is calculated as the sum of the travel time savings arising from reduced delays both for the existing and new users. Since the fares are not changing as a consequence of the project, it is not considered in the appraisal.

The following tables show the monetary value of consumer surplus in scenario A and scenario B, respectively:

SC. A	NPV 5,06%	2019	2030	2043
CONSUMER SURPLUS	**€ 955.845.476**	**€ 39.116.082**	**€ 66.390.848**	**€ 119.129.718**
EXISTING USERS	€ 637.230.317	€ 26.077.388	€ 44.260.565	€ 79.419.812
Value of time savings	€ 637.230.317	€ 26.077.388	€ 44.260.565	€ 79.419.812
Work Time	*€ 415.731.274*	*€ 17.012.979*	*€ 28.875.747*	*€ 51.813.761*
Non-work time	*€ 221.499.043*	*€ 9.064.410*	*€ 15.384.819*	*€ 27.606.051*
Value of fare change	-	-	-	-
NEW USERS	€ 318.615.159	€ 13.038.694	€ 22.130.283	€ 39.709.906
Generalized users cost surplus	€ 318.615.159	€ 13.038.694	€ 22.130.283	€ 39.709.906

Table 29: Breakdown of consumer surplus in Scenario A

SC. B	NPV 5,06%	2019	2030	2043
CONSUMER SURPLUS	**€ 852.094.681**	**€ 38.818.622**	**€ 59.695.948**	**€ 93.361.840**
EXISTING USERS	€ 568.063.121	€ 25.879.081	€ 39.797.299	€ 62.241.226
Value of time savings	€ 568.063.121	€ 25.879.081	€ 39.797.299	€ 62.241.226
Work Time	*€ 370.606.355*	*€ 16.883.603*	*€ 25.963.896*	*€ 40.606.392*
Non-work time	*€ 197.456.766*	*€ 8.995.479*	*€ 13.833.403*	*€ 21.634.834*
Value of fare change	-	-	-	-
NEW USERS	€ 284.031.560	€ 12.939.541	€ 19.898.649	€ 31.120.613
Generalized users cost surplus	€ 284.031.560	€ 12.939.541	€ 19.898.649	€ 31.120.613

Table 30: Breakdown of consumer surplus in Scenario B

15.3. Producer Surplus

It is defined as the revenues accrued by the producer (owner and operator together) minus the costs borne. The change in the producer surplus is calculated as the difference between the change in the producer revenue less the change in the producer costs (operating costs) (Eurpean Commission, 2014). The main items to be considered for the calculation of producer surplus are:

- Fares paid by users and received by the producer;
- Producer operating costs.

It must be noted that fares paid by users for the use of the infrastructure appear in the economic analysis as a cost to the user in the estimation of the consumer surplus and as a revenue to the producer in the estimation of the producer surplus. Since the fares are not changing as a result of the project, it is, again, not included in the calculation of the producer surplus.

In airport investments, typically, the first ‘users’ of the infrastructure are the companies (carriers) that, in turn, operate the service for final users (passengers and cargo) (Eurpean Commission, 2014). The cost impact on the infrastructure manager is quantified under the project costs (investment, residual value and O&M), whilst the change in producer operating costs as a result of the project are quantified for the service carriers.

Producer operating costs change as a result of two events:

i. Increased taxi times
ii. Decreased delay times

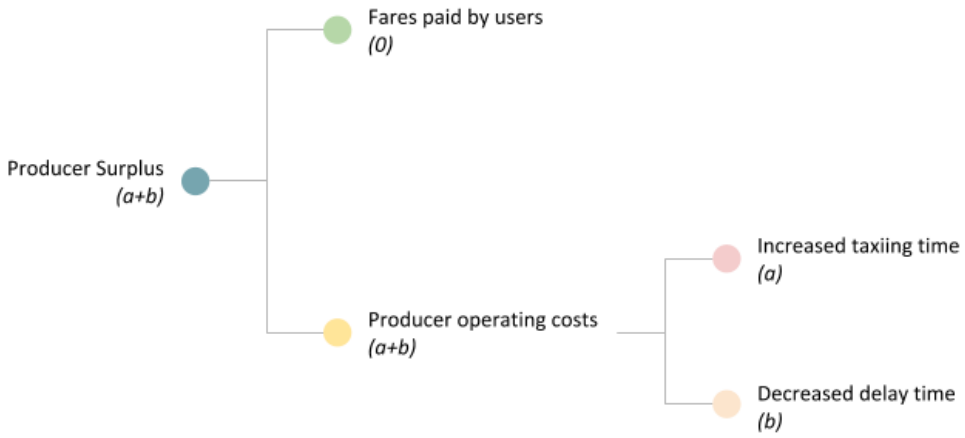

Figure 24: Hierarchical representation of the calculation of the value of producer surplus

According to data from Eurocontrol[19] in 2019, taxi times in Istanbul New Airport are 23,9 and 16,2 minutes for taxi-out and taxi-in, respectively. For Ataturk Airport, Eurocontrol 2018[20] data demonstrates 19,9 minutes for taxi-out and 6,6 minutes for taxi-in times. As a consequence, there is a total of **10,6 minutes additional taxiing time** in Istanbul New Airport.

The cost of increased taxiing time is due to the additional fuel consumption and the additional costs of crew, maintenance, aircraft ownership. The average fuel consumption of a narrow-body aircraft per minute is determined as 20 kg (Ryerson, 2015) and Jet A1 fuel price is 629,72 USD/ton on the day of 2019, December 24th (IATA, 2019). The additional costs are set as 47,2 USD per aircraft per minute (Gorham, 2018).

On the other hand, airline carriers benefit from decreased delay times by reducing their operating costs. The avoided direct aircraft operating cost is 74,2 USD per minute (Gorham, 2018) and the avoided delays are 8,5 minutes per departure and 10,5 minutes per arrival.

[19] https://www.eurocontrol.int/publication/taxi-times-summer-2019
[20] https://www.eurocontrol.int/publication/taxi-times-summer-2018

The following table shows the producer surplus in scenario A and B, respectively:

SC. A	NPV 5,06%	2019	2030	2043
PRODUCER SURPLUS	**€ 808.435.081**	**€ 33.083.604**	**€ 56.152.058**	**€ 100.757.545**
Operating Cost Savings	€ 808.435.081	€ 33.083.604	€ 56.152.058	€ 100.757.545
Increased Taxiing Time Cost	*- € 6.709.648.033*	*- € 274.579.053*	*- € 466.036.857*	*- € 836.242.361*
Reduced Delay Savings	*€ 7.518.083.114*	*€ 307.662.657*	*€ 522.188.915*	*€ 936.999.906*

Table 31: Breakdown of producer surplus in Scenario A

SC. B	NPV 5,06%	2019	2030	2043
PRODUCER SURPLUS	**€ 720.684.724**	**€ 32.832.018**	**€ 50.489.645**	**€ 78.963.586**
Operating Cost Savings	€ 720.684.724	€ 32.832.018	€ 50.489.645	€ 78.963.586
Increased Taxiing Time Cost	*-€ 5.981.359.485*	*-€ 272.491.000*	*-€ 419.041.372*	*-€ 655.362.293*
Reduced Delay Savings	*€ 6.702.044.209*	*€ 305.323.017*	*€ 469.531.017*	*€ 734.325.879*

Table 32: Breakdown of producer surplus in Scenario B

15.4. Externalities

Externalities occur as a result of habitat disturbance, land value increase and air pollutant emissions. Habitat disturbance and emissions appear as a cost to the project, whilst land value increase is a benefit acquired as a result of the project.

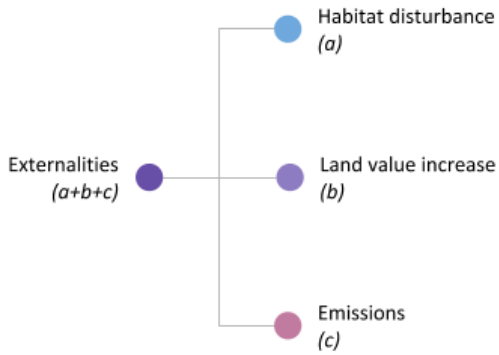

Figure 25: Hierarchical representation of the calculation of the value of externalities

Habitat Disturbance

Habitat disturbance is caused by the trees cut for the construction of the airport. Since there is no market price to determine the value of a tree, the contingent valuation method is used to determine the willingness to pay of individuals.

The Environmental Impact Assessment (ÇED) report of the airport indicates that 2,5 Million trees will be cut for the construction, but many articles on newspapers (Güvemli, 2019) (BIA News Desk, 2019) express that at the end a total number of 13 million trees have been cut (8 million trees solely for the airport, 1.2 million trees for the quarries opened for the construction of the airport and at least 3.7 million trees for the parts of Northern Marmara Highway providing access to the airport), referencing their source to Kuzey Ormanları Savunması (Northern Forests Defense)[21], which is an organization that works independently and voluntarily to protect the Northern forest of Istanbul and resist against any project that harms this habitat. Therefore, the number of trees cut is identified as 13 million for this paper.

The willingness to pay of individuals for a tree was set as 20 TL as a result of the CV method (see Chapter 13.2). Consequently, the monetary value of the cost of habitat disturbance is determined as **260.000.000 TL (40.944.882 Euros)** by multiplying the total number of trees cut (13 million) with the WTP of individuals for a tree (20TL).

[21] https://kuzeyormanlari.org/

Land Value Increase

From the HPM applied to the area of the airport; Arnavutkoy, the following result is obtained:

1 km decrease of a property's distance to the airport causes an increase of 3.125,72 TL in the sale price of the property (Chapter 14.2).

This result means that every single house in the area will have its value increased by this number for every single meter it gets closer to the airport. In order to be able to use this output of HPM in the CBA, the total land value increase has to be calculated by:

1. Dividing both of the sides of the equation by apartment surface in order to obtain the price per square meter.
2. Multiplying the effects per square meter with the total number of square meters available in the area around the airport.

The equation is divided by the square meters on both sides, thus the apartment side is dropped in the right-hand-side of the equation and price per square meter is obtained on the left-hand-side of the equation.

The total square meter available in Arnavutkoy is calculated as 33.211 square meters[22]. By multiplying the effects per square meter with the total square meter available, the monetary term for land value increase is found as **103.808.286,92 TL (16.347.762 Euros) per square meter**.

Emissions

Emissions are also a result of the construction of the new airport. The unit cost of air pollutant emissions per passenger is presented as 0,003 Euro. The calculation is based on the information from the Eurpean Commission (2014) that in road transportation the damage cost of CO2 and air pollutant emissions are 0,015 Euro per passenger. Additionally, IATA claims that road transportation generates 74% of the air pollution, whereas this ratio is 12% for air transport.

[22] The calculation is based on the announcements available on *Zingat* in March,20 2020: https://www.zingat.com/en/arnavutkoy-satilik-daire

The following tables show the overall effect of the externalities, where habitat disturbance and land value increase have the same value in both of the scenarios but the cost of emissions is changing since it is related to the number of passengers. It is also important to underline that habitat disturbance and land value increase are one time effects occurring in the first year of the activity of the airport, which is 2019:

SC. A	NPV 5,06%	2019	2030	2043
EXTERNALITIES	**- € 29.868.052**	**- € 24.812.823**	**- € 366.107**	**- € 656.931**
Habitat Disturbance	-€ 40.944.882	- € 40.944.882	-	-
Land Value Increase	€ 16.347.762	€ 16.347.762	-	-
Emissions	- € 5.270.932	- € 215.702	- € 366.107	- € 656.931

Table 33: Breakdown of externalities in Scenario A

SC. B	NPV 5,06%	2019	2030	2043
EXTERNALITIES	**-€ 29.295.927**	**-€ 24.811.182**	**-€ 329.188**	**-€ 514.836**
Habitat Disturbance	-€ 40.944.882	- € 40.944.882	-	-
Land Value Increase	€ 16.347.762	€ 16.347.762	-	-
Emissions	-€ 4.698.807	- € 214.062	-€ 329.188	-€ 514.836

Table 34: Breakdown of externalities in Scenario B

15.5. Economic Performance

Determination of total economic costs and benefits allows us the calculation of Economic Net Present Value, which reflects the overall welfare effect of the project on society.

Similar to the financial analysis, two indicators are calculated in order to be able to evaluate the economic performance:

- **Economic Net Present Value (ENPV):** the difference between the discounted total social benefits and costs;
- **Economic Rate of Return (ERR):** the rate that produces a zero value for the ENPV.

Scenario A, where an optimistic prediction is done for the number of passengers, generates a positive ENPV, which is calculated as 470 Million Euros. The resulting cash flows and their ENPVs are shown in the following table:

SC.A	NPV 5,06%	2013-2018	2019	2043
TOTAL ECONOMIC COSTS (adjusted prices)	**€ 1.257.855.273**	**€ 3.454.687.500**	**€ 475.050.610**	**-€ 541.767.641**
Consumer Surplus	€ 955.845.476	-	€ 39.116.082	€ 119.129.718
Producer Surplus	€ 808.435.081	-	€ 33.083.604	€ 100.757.545
Externalities	-€ 29.868.052	-	-€ 24.812.823	-€ 656.931
TOTAL ECONOMIC BENEFITS	**€ 1.734.412.504**	-	**€ 47.386.864**	**€ 219.230.331**
NET BENEFITS	**€ 476.557.231**	**-€ 3.454.687.500**	**-€ 427.663.746**	**€ 760.997.973**
ENPV	**€ 476.557.231**			

Table 35: ENPV and ERR in Scenario A

The following chart illustrates the weight of the benefit categories on the overall impact:

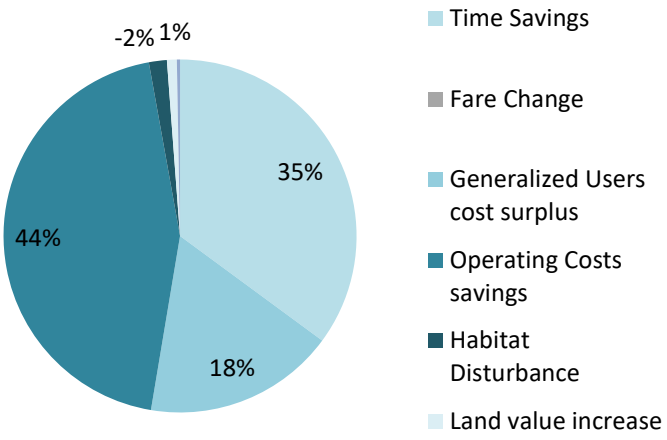

Figure 26: Weight of the benefit categories on the overall impact in Scenario A

In terms of ENPV, the main benefit of the project is travel time savings (53% of total) both for the existing and new users, followed by operating costs savings (44%).

Scenario B, where a realistic prediction is done for the number of passengers, generates a negative ENPV, which is given as -750 Million Euros. The resulting values and their ENPVs are shown in the following table:

SC.B	NPV 5,06%	2013-2018	2019	2043
TOTAL ECONOMIC COSTS (adjusted prices)	**€ 2.302.090.212**	**€ 3.454.687.500**	**€ 5.220.113.957**	**€ 11.851.027.095**
Consumer Surplus	€ 852.094.681	-	€ 38.818.622	€ 93.361.840
Producer Surplus	€ 720.684.724	-	€ 32.832.018	€ 78.963.586
Externalities	-€ 29.295.927	-	-€ 24.811.182	-€ 514.836
TOTAL ECONOMIC BENEFITS	**€ 1.543.483.478**	-	**€ 46.839.457**	**€ 171.810.589**
NET BENEFITS	**-€ 758.606.734**	**-€3.454.687.500**	**-€ 5.173.274.500**	**-€ 11.679.216.506**
ENPV	**-€ 758.606.734**			

Table 36: ENPV and ERR in Scenario B

The following chart illustrates the weight of the benefit categories on the overall impact:

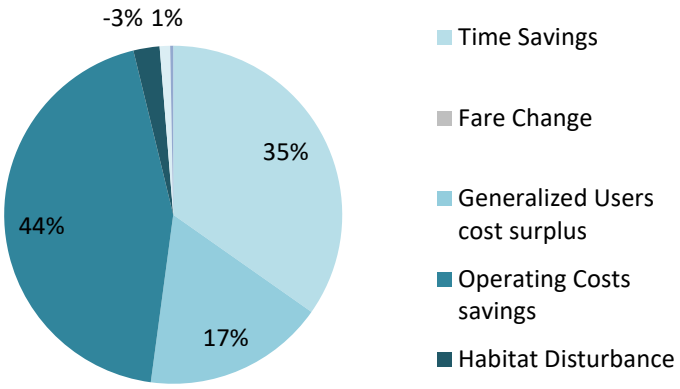

Figure 27: Weight of the benefit categories on the overall impact in Scenario B

Similar to the first scenario, in terms of ENPV, the main benefit of the project are travel time savings (52% of total) both for the existing and new users, followed by operating costs savings (44%).

All in all, the results of economic analysis are heavily depended on the number of passengers. The optimistic scenario yields a positive result with welfare gain to society, whereas the realistic scenario results with welfare loss in the society with a negative NPV. The distribution of the benefits is almost the same with both of the scenarios.

16. RISK ASSESSMENT

A sensitivity and probabilistic risk analysis are developed in this paper to assess the risk related to the implementation and operation of the project. Due to data availability and other constraints, a probabilistic risk analysis is not conducted.

16.1 Sensitivity Analysis

Sensitivity analysis is performed by calculating the percentage change of the FNPV and the ENPV as a consequence of a 1 % change in variables. If the percentage change in FNPV and ENPV is higher than 1%, then the respective variable is considered to be critical (Eurpean Commission, 2014).

The tested variables for the sensitivity analysis are the investment cost, unit cost of maintenance, non-transport revenue, unit value of time, operating costs savings and externalities. The following tables show the sensitivity analysis for both of the scenarios A and B, respectively:

SC.A - Tested Variables	FNPV elasticity	ENPV elasticity
Investment cost +1%	-2,58%	-22,95%
Unit maintenance cost +1%	-6,56%	-328%
Non-transport revenue -1%	-6,80%	-344%
Unit value of time -1%	N/A	-2,04%
Operating costs savings -1%	N/A	-1,72%
Externalities +1%	N/A	-0,06%

Table 37: Sensitivity analysis for Scenario A

Based on the analysis for Scenario A, investment cost, unit cost of maintenance and non-transport revenues are found to be critical for the sensitivity of financial profitability. Besides, non-transport revenue, unit cost of maintenance, investment

cost, the unit value of time and operating cost savings are found to be critical, in decreasing order, for the sensitivity of economic performance.

Attention should be paid to the variables of the unit cost of maintenance and non-transport revenue in the economic analysis, since ENPV elasticity to those variables is much higher than the expected.

SC. B - Tested Variables	FNPV elasticity	ENPV elasticity
Investment cost +1%	-2,60%	-11,72%
Unit maintenance cost +1%	-6,09%	-42,94%
Non-transport revenue -1%	-6,43%	-42,89%
Unit value of time -1%	N/A	-1,12%
Operating costs savings -1%	N/A	-0,95%
Externalities +1%	N/A	-0,03%

Table 38: Sensitivity analysis for Scenario B

Based on the analysis for Scenario B, investment cost, unit cost of maintenance and non-transport revenues are found to be critical for the sensitivity of financial profitability. Besides, non-transport revenue, unit cost of maintenance, investment cost and unit value of time are found to be critical, in decreasing order, for the sensitivity of the economic performance.

It is important to underline that number of passengers is not taken as a separate variable to test in the sensitivity analysis, since two different scenarios are created in the beginning to appraise the financial and economic performance of the project. It is already known from the results that the performance of the New Airport heavily depends on the number of passengers.

16.2. Qualitative Risk Analysis

A qualitative risk analysis has been carried out with the aim to identify the main risks related to project implementation and operation. Besides, the main risk prevention and mitigation strategies are described**.**

Risk Description	Probability (P)	Severity (S)	Risk Level (P*S)	Measures	Residual Risk
Administrative Risks					
Delays in the 2nd stage due to administrative procedures	B	2	Low	The targeted number of passengers is not reached.	Low
Construction Risks					
Investment cost overrun	C	4	High	Cost budget is compared with similar projects in order to avoid possible optimism bias.	Moderate
Delays in the construction of the metro system (results in a lower number of passengers)	C	3	Moderate	The shuttle bus service will continue its operation in the absence of the metro system.	Low
Environmental and Social Risks					
Impacts on air pollution, noise and habitat disturbance exceeding the expectations	B	3	Moderate	Due to the uncertainty, the impacts of these effects are taken into consideration as the maximum.	Low
Public opposition	E	2	High	Public is merely included in the decision-making process of the project.	Moderate
Operational Risks					
Increase of operating costs higher than planned leading to liquidity problems for the operator	B	4	Moderate	The operating cost forecasts have been made based on the historic costs as well as reasonable benchmarks, in order to reduce optimism bias.	Low
A significant shortfall in the expected demand (implies lower benefits and lower revenues)	C	4	High	The demand forecast has been developed in accordance with EUROCONTROL and two different scenarios have been analyzed separately.	Moderate

Table 39: Qualitative risk analysis

The results of the sensitivity and risk analyses indicate that the project's overall risk level is moderate to high. The planned measures to prevent the identified risks and mitigate their adverse impact are expected to bring the project risk to a lower level. The residual project risks can be considered acceptable.

16.3. External Factors

Even though calculating the possible risks that could happen during the life-cycle of the project, it is never possible to completely predict, identify, control and prevent all the risks. The revenues of infrastructure projects heavily depend on the number of passengers and in the case of a significant shortfall in demand, the project will not be able to provide the forecasted benefits.

For instance, as the world is going through the phase of the Covid-19 virus as these sentences are written in this paper, the whole aviation sector is losing revenues due to the reducing number of passengers. This is an external factor, which is an outside influence on the project and cannot be predicted nor controlled.

The CEO of IGA consortium, Kadri Samsunlu, has announced in an interview in March,3rd 2020 that Covid-19 virus has affected the operation of Istanbul New Airport in a negative way by an amount of 15% due to the decreasing number of passengers (DHA, 2020). It means that Istanbul New Airport is not reaching the targeted number of passengers even just 1 year after its start of operation. Since it was constructed with Built-Operate-Transfer (BOT) system with "guaranteed usage" by the Turkish Treasury, the government (therefore, the citizens) has to pay for the lacking passengers from the state treasury. Keeping in mind that it was the biggest investment in the history of Turkey, the public opposition is getting stronger towards the government in using the state treasury.

In developing countries without a stable and strong economy, such as Turkey, external factors may damage the whole economy of the country in the long term. Therefore, it is not healthy to invest in a single "mega" project, but allocate the resources in a healthy way for the benefit of the whole society.

17. CONCLUSION

Cost-benefit analysis is a tool to understand the profitability of the project and help the decision-making process. It sets out to do for government what the market does for business: adds up the benefits of a public project and compares them to the costs (Ackerman & Heinzerling, 2002). In order to do so, it creates artificial prices to monetize the effects with no markets by studying what people would be willing to pay for them.

In this paper, CBA is conducted for Istanbul New Airport and enriched with the results of Contingent Valuation and Hedonic Price Methods. An optimistic and realistic scenario is developed for this purpose. The results demonstrate a negative FNPV, meaning that the project is not financially profitable in both of the scenarios and that it is in need of co-financing. At the same time, it reveals a positive ENPV in the optimistic scenario and a negative ENPV in the realistic scenario.

Europe 2020 strategy and the EU cohesion policy aim to deliver growth and jobs in order to improve Europe's competitiveness and productivity and underpin a sustainable social market economy (European Commission, 2010). In this framework, cost-benefit analysis is especially required as a basis for decision making on the co-financing of major projects. A Project is described to be major and in need of the EU co-financing if it has "*clearly identified goals and if the total eligible cost exceeds EUR 50 million. …to gain a contribution from the Funds, the FNPV should be negative and the FRR should be lower than the discount rate used for the analysis"* (Eurpean Commission, 2014).

Turkey has been receiving pre-accession assistance from the EU since 2001, under the Turkish Financial Instrument (Mueller, 2007). The CBA in this paper is developed in line with the European Commission guideline and ensures the requirements set out for the EU co-financing. Even though mentioning the serious bottleneck problem in Ataturk Airport and the plans for a 3rd airport in Istanbul, no reference to the financing of a new airport has been done in the Technical Assistance to Transportation Infrastructure Needs Assessment (TINA) report as a core network.

All in all, it is possible to say that because of its geographic location, Turkey is a dynamic country where travel is a crucial element for economic growth both for Turkey and the European Union. Therefore, Ataturk Airport has been growing rapidly, leaving the major European airports behind, and hence having many troubles with delays. The need for a new airport was a crystal-clear fact. However, Istanbul New Airport is an unnecessarily big, very risky and extremely expensive investment out of all proportion to its benefits, and its success heavily depends on the number of passengers, which brings out three important points in the results.

The first point is that, even in the optimistic scenario, the targeted number of 200 million passengers in 2028 cannot be reached. The target is reached only in 2041 and in the realistic scenario; the target is not reached even until the end of the project life.

The second point is that, the economic success of the airport, in which the costs and benefits are analyzed for the whole society, is achieved only and only if the growth rate of the number of passengers are at least as much in the optimistic scenario, which is 5,2% until 2025 and 4,6% for the next years. Therefore, for social benefits to be worth of the investment cost, the optimistic scenario has to come true.

The third point is the passenger satisfaction. It has been mentioned in the impact analysis that passenger satisfaction would be evaluated at the end due to the difficulty of its monetization. The results of the CV method and my personal observation as a Turkish citizen proves that the public is not very satisfied with this infrastructure project due to its enormous size non-proportional to the human scale which makes it not user-friendly and due to the enormous investment cost non-proportional to the strength of the Turkish economy.

The government justifies the size of the investment and airport by stating that it is a long-term planning and the aim is the growth of GDP with the non-transport revenues from the airport. However, an important point is forgotten that *"it is an airport project, not a shopping mall"*, according to what the citizens are complaining. A government should be able to understand the needs of its country and citizens, and allocate the resources accordingly while designing infrastructures that should fit properly to the built environment.

In developing countries without a stable economy and scarce resources, as Turkey, the allocation of resources plays an important role. Therefore, the need and importance of performing a CBA or other appraisal methods is crucial. Before investing significant amounts in a project, an *ex-ante* CBA should have been conducted in order to understand the liquidity and profitability of the project to the society.

The most prominent critic against the use of CBA in public projects is the lack of distributional effects. As the general rule of Pareto optimality and Kaldor-Hicks compensation, a project is meant to increase the welfare of the society if, as a result of the project the winners could compensate the losers (thus brings out a positive NPV) and makes at least an individual better-off without making anyone worse-off. This approach generates issues with distributional effects.

Moreover, another criticism is about the general approach of weighing up different things. The view is that health and lives of humans should not be weighed up against the economic interest of the parties (Hansjürgens, 2004). The criticism is not directed against the informational aspects of weighing up, but towards the moral and ethical reason of such comparison.

The limitation of the application of CBA to Istanbul New Airport should also be mentioned in the conclusion of this paper. The initial limitation is the application of conversion factors while moving from financial to economic analysis. European Commission (2014) suggests that conversion factors should be country-specific and made available by a planning office and not calculated on a project-by-project basis. It is recommended that in the absence of national parameters, project-specific calculations could be done, but they should be consistent across all the projects.

Since no national parameter is available and no other project in which the conversion factor is used for its analysis has been found in the literature review, conversion factor is calculated by the extraction of the rate of tax and shadow wage is calculated from the most appropriate category from the study of Del Bo, Fiorio, & Florio, (2011). A new calculation could not be done due to the time limitations.

Secondly, the conversion from Turkish Lira to Euro/US Dollars (or vice versa) is kept fixed to the average value in 2019. However, Turkish Lira has been losing value against Euro/US Dollars very sharply in the last 10 years and it is expected to be the same for the next years. Therefore, using different values for each year or for every 2-3 years would bring healthier results about the future values.

Another limitation is the absence of the calculations for FRR and ERR. Since the most significant economic indicator is set as NPV by many references, no calculation is deemed to be necessary. However, with more time, the calculation could have been done for a better understanding of the result.

Lastly, in the calculation of the debt for the investment cost, even though only the interest rate for the first ten years is known, a generalization for the remaining 15 years is done by taking the same value of the interest rate, which would not be compatible with the reality.

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APPENDICES

APPENDIX A: Survey questions for the Contingent Valuation method

ISTANBUL NEW AIRPORT

This survey is designed for the Master's Degree thesis in Politecnico di Milano in order to find out the problems related to Istanbul New airport (INA). The data gathered will be used only for academic purposes; therefore there is no need to indicate your name/surname while filling up the survey. Please reply the following questions honesty by reflecting your own opinions.

Thank you for your time and help,
Eylul Deniz Basok

- Gender:
  - ☐ Male
  - ☐ Female

- Age:
  - ☐ 18-25
  - ☐ 26-35
  - ☐ 36-45
  - ☐ 46-55
  - ☐ 56 and more

- Education level:
  - ☐ High School
  - ☐ Bachelor’s Degree
  - ☐ Master’s Degree
  - ☐ PhD

- Occupation: …

- What is your flight frequency?
  - More than 5 in a month
  - Between 3-5 in a month
  - Between 1-3 in a month
  - Less than 1 in a month

- Have your flight frequency changed after the closure of Ataturk Airport?
  - Yes
  - No

- As a solution to the increasing air traffic in Istanbul, would you prefer a new airport or the expansion of Ataturk and Sabiha Gokcen Airports?
  - New airport
  - Expansions

- Have you ever used Istanbul New Airport before?
  - Yes
  - No

- For what purpose have you used INA?
  - Business
  - Leisure
  - Other: …

- Could you please rate your opinion about the distance of INA to the city center of Istanbul out of 5?
  - 1 (very close)
  - 2
  - 3
  - 4
  - 5 (very far)

- How do you get access to INA?
  - Public transportation
  - Shuttle bus (Havaist)
  - Car
  - Taxi
  - Other: …

- What is your preferable way for intercity transportation?
  - Plane – INA
  - Plane – Sabiha Gokcen
  - Bus
  - Train
  - Car
  - Other: …

- What do you think is the most significant problem with INA?
  - Distance from the city center
  - Difficulty to reach to the airport
  - Too much time spent inside the airport due to its size
  - Environmental harm it caused for the construction
  - Security concerns due to the wrong location choice
  - No problem
  - Other: …

- What do you think is the most significant benefit of INA?
  - Reduced delays
  - Easier to reach to the airport
  - Value added to GDP
  - Improvement of the district it is located at
  - No benefit
  - Other: …

- During the construction of INA, 13 million trees have been cut. A volunteer environment entity is working to plant the same number of trees to another district in Istanbul. What is the maximum amount you would be willing to pay just for one time for a tree (in Turkish Lira)?

  …

- If your answer was 0 TL, could you specify your reason/s?
  - ☐ My budget is not enough
  - ☐ I don't believe that this problem is a priority
  - ☐ The created benefit is not worthwhile
  - ☐ I am not living close to INA (so the problem doesn't affect me)
  - ☐ I don't trust the volunteer environment entity
  - ☐ Government should pay for this
  - ☐ I need more information to reply
  - ☐ Other: …

- If your answer was different than 0 TL, could you specify your reason/s?
  - ☐ I believe that this is an important problem.
  - ☐ Forestation is important for other livings
  - ☐ Forestation is important for the future generation
  - ☐ I would like to visit the new area of the forestation sometime
  - ☐ I would like to have a contribution to my country
  - ☐ My answer reflects all the works of forestation, not just this area
  - ☐ Other: …

APPENDIX B: Demand Forecasting for scenario A

	DOMESTIC	INTERNATIONAL	TOTAL PASSANGER	NO.PLANE
2017	19.629.425	44.476.589	64.106.014	
2018	19.216.523	49.130.261	68.346.784	464.646
2019	20.215.782	51.685.035	71.900.817	488.808
2020	21.267.003	54.372.656	75.639.659	514.226
2021	22.372.887	57.200.035	79.572.922	540.965
2022	23.536.277	60.174.436	83.710.713	569.096
2023	24.760.164	63.303.507	88.063.671	598.688
2024	26.047.692	66.595.289	92.642.981	629.820
2025	27.402.172	70.058.244	97.460.416	662.571
2026	28.662.672	73.280.924	101.943.596	693.049
2027	29.981.155	76.651.846	106.633.001	724.929
2028	31.360.288	80.177.831	111.538.119	758.276
2029	32.802.861	83.866.011	116.668.873	793.157
2030	34.311.793	87.723.848	122.035.641	829.642
2031	35.890.135	91.759.145	127.649.280	867.806
2032	37.541.082	95.980.065	133.521.147	907.725
2033	39.267.971	100.395.148	139.663.120	949.480
2034	41.074.298	105.013.325	146.087.623	993.156
2035	42.963.716	109.843.938	152.807.654	1.038.841
2036	44.940.047	114.896.759	159.836.806	1.086.628
2037	47.007.289	120.182.010	167.189.299	1.136.613
2038	49.169.624	125.710.383	174.880.007	1.188.897
2039	51.431.427	131.493.060	182.924.487	1.243.586
2040	53.797.272	137.541.741	191.339.014	1.300.791
2041	56.271.947	143.868.661	200.140.608	1.360.628
2042	58.860.456	150.486.620	209.347.076	1.423.217
2043	61.568.037	157.409.004	218.977.042	1.488.685

APPENDIX C: Demand Forecasting for scenario B

	DOMESTIC	INTERNATIONAL	TOTAL PASSANGER	NO .PLANE
2017	19.629.425	44.476.589	64.106.014	
2018	19.216.523	49.130.261	68.346.784	464.646
2019	20.062.050	51.291.992	71.354.042	485.090
2020	20.944.780	53.548.840	74.493.620	506.434
2021	21.866.351	55.904.989	77.771.340	528.718
2022	22.828.470	58.364.809	81.193.279	551.981
2023	23.832.923	60.932.860	84.765.783	576.268
2024	24.881.571	63.613.906	88.495.477	601.624
2025	25.976.360	66.412.918	92.389.278	628.096
2026	26.885.533	68.737.370	95.622.903	650.079
2027	27.826.527	71.143.178	98.969.705	672.832
2028	28.800.455	73.633.189	102.433.644	696.381
2029	29.808.471	76.210.351	106.018.822	720.754
2030	30.851.767	78.877.713	109.729.481	745.980
2031	31.931.579	81.638.433	113.570.012	772.090
2032	33.049.185	84.495.778	117.544.963	799.113
2033	34.205.906	87.453.131	121.659.037	827.082
2034	35.403.113	90.513.990	125.917.103	856.030
2035	36.642.222	93.681.980	130.324.201	885.991
2036	37.924.700	96.960.849	134.885.549	917.000
2037	39.252.064	100.354.479	139.606.543	949.095
2038	40.625.886	103.866.885	144.492.772	982.314
2039	42.047.792	107.502.226	149.550.019	1.016.695
2040	43.519.465	111.264.804	154.784.269	1.052.279
2041	45.042.646	115.159.073	160.201.719	1.089.109
2042	46.619.139	119.189.640	165.808.779	1.127.228
2043	48.250.809	123.361.278	171.612.086	1.166.681

APPENDIX D: Financial Analysis for scenario A

		NPV 12,75%		2013		2014		2015		2016		2017		2018		2019		2020		2021
INVESTMENT COST	€	**8.844.283.832**	€	**1.890.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**
Equity	€	3.081.701.447	€	1.500.000.000																
Debt	€	5.527.656.963	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000
Interest	€	234.925.421	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500
TERMINATION COST	€	**389.000.000**													€	**389.000.000**				
TENDER COST	€	**7.254.019.594,08**													€	**350.000.000**	€	**350.000.000**	€	**1.000.000.000**
O&M COST	€	**24.097.775.427**											€	**106.962.652**	€	**1.983.871.274**	€	**2.089.092.681**	€	**2.199.929.808**
Operation	€	1.637.835.321											€	106.962.652	€	114.450.038	€	122.461.540	€	131.033.848
Maintenance	€	22.459.940.106													€	1.869.421.236	€	1.966.631.140	€	2.068.895.960
TOTAL OUTFLOWS	€	**33.331.059.259**	€	**1.890.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**497.900.152**	€	**2.763.808.774**	€	**2.480.030.181**	€	**2.590.867.308**
REVENUES	€	**29.909.232.466**													€	**2.489.452.512**	€	**2.618.904.043**	€	**2.755.087.053**
Int. Take-off & Landing	€	5.634.958.448													€	469.017.768	€	493.406.692	€	519.063.840
Int. Lightning & Approach	€	348.913.836													€	29.041.348	€	30.551.498	€	32.140.176
Dom. Take-off & Landing	€	502.974.953													€	41.864.406	€	44.041.355	€	46.331.506
Dom. Lightning & Approach	€	135.198.155													€	11.253.026	€	11.838.184	€	12.453.769
Passenger	€	5.021.548.146													€	417.961.433	€	439.695.427	€	462.559.589
International	€	*4.139.758.190*													€	*344.566.897*	€	*362.484.376*	€	*381.333.563*
Transit	€	*517.469.774*													€	*43.070.862*	€	*45.310.547*	€	*47.666.695*
Domestic	€	*364.320.183*													€	*30.323.673*	€	*31.900.504*	€	*33.559.331*
Non-Transport	€	23.287.187.075													€	1.938.275.963	€	2.039.066.313	€	2.145.097.762
TOTAL INFLOWS	€	**29.909.232.466**													€	**2.489.452.512**	€	**2.618.904.043**	€	**2.755.087.053**
NET CASH FLOWS	-€	**3.421.826.793**	-€	**1.890.937.500**	-€	**390.937.500**	-€	**390.937.500**	-€	**390.937.500**	-€	**390.937.500**	-€	**497.900.152**	-€	**274.356.261**	€	**138.873.862**	€	**164.219.745**

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
€	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**
€	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	193.000.000	193.000.000	193.000.000	193.000.000
€	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	8.202.500	8.202.500	8.202.500	8.202.500
€	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**
€	**2.316.684.767**	**2.439.676.087**	**2.569.239.615**	**2.705.729.473**	**2.834.315.236**	**2.969.104.499**	**3.110.402.821**	**3.258.531.232**	**3.413.827.042**	**3.576.644.695**	**3.747.356.673**	**3.926.354.445**
€	140.206.218	150.020.653	160.522.099	171.758.645	183.781.751	196.646.473	210.411.726	225.140.547	240.900.385	257.763.412	275.806.851	295.113.331
€	2.176.478.549	2.289.655.434	2.408.717.517	2.533.970.827	2.650.533.485	2.772.458.026	2.899.991.095	3.033.390.685	3.172.926.657	3.318.881.283	3.471.549.822	3.631.241.114
€	**2.707.622.267**	**2.830.613.587**	**2.960.177.115**	**3.096.666.973**	**3.225.252.736**	**3.360.041.999**	**3.501.340.321**	**3.649.468.732**	**3.615.029.542**	**3.777.847.195**	**3.948.559.173**	**4.127.556.945**
€	**2.898.351.580**	**3.049.065.862**	**3.207.617.287**	**3.374.413.386**	**3.529.636.402**	**3.691.999.676**	**3.861.831.661**	**4.039.475.918**	**4.225.291.810**	**4.419.655.233**	**4.622.959.374**	**4.835.615.505**
€	546.055.160	574.450.028	604.321.430	635.746.144	664.990.467	695.580.028	727.576.710	761.045.238	796.053.319	832.671.772	870.974.673	911.039.508
€	33.811.465	35.569.661	37.419.284	39.365.086	41.175.880	43.069.971	45.051.189	47.123.544	49.291.227	51.558.624	53.930.320	56.411.115
€	48.740.744	51.275.263	53.941.577	56.746.539	59.356.879	62.087.296	64.943.311	67.930.704	71.055.516	74.324.070	77.742.977	81.319.154
€	13.101.365	13.782.636	14.499.334	15.253.299	15.954.951	16.688.878	17.456.567	18.259.569	19.099.509	19.978.086	20.897.078	21.858.344
€	486.612.688	511.916.548	538.536.208	566.540.091	592.600.935	619.860.578	648.374.165	678.199.376	709.396.548	742.028.789	776.162.113	811.865.570
€	*401.162.909*	*422.023.380*	*443.968.596*	*467.054.963*	*488.539.491*	*511.012.307*	*534.518.874*	*559.106.742*	*584.825.652*	*611.727.632*	*639.867.103*	*669.300.990*
€	*50.145.364*	*52.752.922*	*55.496.074*	*58.381.870*	*61.067.436*	*63.876.538*	*66.814.859*	*69.888.343*	*73.103.206*	*76.465.954*	*79.983.388*	*83.662.624*
€	*35.304.416*	*37.140.245*	*39.071.538*	*41.103.258*	*42.994.008*	*44.971.732*	*47.040.432*	*49.204.292*	*51.467.689*	*53.835.203*	*56.311.622*	*58.901.957*
€	2.256.642.845	2.373.988.273	2.497.435.663	2.627.302.318	2.748.158.225	2.874.573.503	3.006.803.884	3.145.116.863	3.289.792.238	3.441.122.681	3.599.414.325	3.764.987.384
€	**2.898.351.580**	**3.049.065.862**	**3.207.617.287**	**3.374.413.386**	**3.529.636.402**	**3.691.999.676**	**3.861.831.661**	**4.039.475.918**	**4.225.291.810**	**4.419.655.233**	**4.622.959.374**	**4.835.615.505**
€	**190.729.313**	**218.452.275**	**247.440.172**	**277.746.413**	**304.383.666**	**331.957.677**	**360.491.340**	**390.007.185**	**610.262.268**	**641.808.038**	**674.400.200**	**708.058.560**

	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
€	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**
€	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000
€	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500
€	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.650.000.000**	**1.650.000.000**
€	**4.114.049.469**	**4.310.874.255**	**4.517.283.477**	**4.733.755.153**	**4.960.791.891**	**5.198.922.199**	**5.448.701.873**	**5.710.715.460**	**5.985.577.803**	**6.273.935.673**
€	315.771.264	337.875.252	361.526.520	386.833.376	413.911.713	442.885.533	473.887.520	507.059.646	542.553.822	580.532.589
€	3.798.278.205	3.972.999.003	4.155.756.957	4.346.921.777	4.546.880.179	4.756.036.667	4.974.814.353	5.203.655.814	5.443.023.981	5.693.403.084
€	**4.315.251.969**	**4.512.076.755**	**4.718.485.977**	**4.934.957.653**	**5.161.994.391**	**5.400.124.699**	**5.649.904.373**	**5.911.917.960**	**6.186.780.303**	**6.475.138.173**
€	**5.058.053.818**	**5.290.724.294**	**5.534.097.611**	**5.788.666.102**	**6.054.944.742**	**6.333.472.200**	**6.624.811.922**	**6.929.553.270**	**7.248.312.720**	**7.581.735.105**
€	952.947.326	996.782.903	1.042.634.916	1.090.596.122	1.140.763.544	1.193.238.667	1.248.127.646	1.305.541.517	1.365.596.427	1.428.413.863
€	59.006.026	61.720.304	64.559.438	67.529.172	70.635.514	73.884.747	77.283.446	80.838.484	84.557.054	88.446.679
€	85.059.835	88.972.587	93.065.326	97.346.331	101.824.263	106.508.179	111.407.555	116.532.303	121.892.788	127.499.857
€	22.863.828	23.915.564	25.015.680	26.166.401	27.370.056	28.629.078	29.946.016	31.323.532	32.764.415	34.271.578
€	849.211.387	888.275.110	929.135.765	971.876.011	1.016.582.307	1.063.345.093	1.112.258.968	1.163.422.880	1.216.940.333	1.272.919.588
€	*700.088.835*	*732.292.922*	*765.978.396*	*801.213.402*	*838.069.219*	*876.620.403*	*916.944.941*	*959.124.409*	*1.003.244.131*	*1.049.393.362*
€	*87.511.104*	*91.536.615*	*95.747.300*	*100.151.675*	*104.758.652*	*109.577.550*	*114.618.118*	*119.890.551*	*125.405.516*	*131.174.170*
€	*61.611.447*	*64.445.574*	*67.410.070*	*70.510.933*	*73.754.436*	*77.147.140*	*80.695.909*	*84.407.920*	*88.290.685*	*92.352.056*
€	3.938.176.803	4.119.332.936	4.308.822.251	4.507.028.075	4.714.351.366	4.931.211.529	5.158.047.259	5.395.317.433	5.643.502.035	5.903.103.129
€	**5.058.053.818**	**5.290.724.294**	**5.534.097.611**	**5.788.666.102**	**6.054.944.742**	**6.333.472.200**	**6.624.811.922**	**6.929.553.270**	**7.248.312.720**	**7.581.735.105**
€	**742.801.849**	**778.647.539**	**815.611.635**	**853.708.448**	**892.950.351**	**933.347.501**	**974.907.548**	**1.017.635.310**	**1.061.532.418**	**1.106.596.932**

APPENDIX E: Financial Analysis for scenario B

		NPV 12,75%		2013		2014		2015		2016		2017		2018		2019		2020		2021
INVESTMENT COST	€	**8.844.283.832**	€	**1.890.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**
Equity	€	3.081.701.447	€	1.500.000.000																
Debt	€	5.527.656.963	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000	€	375.000.000
Interest	€	234.925.421	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500	€	15.937.500
TERMINATION COST	€	**389.000.000**													€	**389.000.000**				
TENDER COST	€	**7.254.019.594,08**													€	**350.000.000**	€	**350.000.000**	€	**1.000.000.000**
O&M COST	€	**22.350.182.453**											€	**106.962.652**	€	**1.969.655.143**	€	**2.059.295.670**	€	**2.153.088.679**
Operation	€	1.637.835.321											€	106.962.652	€	114.450.038	€	122.461.540	€	131.033.848
Maintenance	€	20.712.347.132													€	1.855.205.105	€	1.936.834.130	€	2.022.054.831
TOTAL OUTFLOWS	€	**31.583.466.285**	€	**1.890.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**390.937.500**	€	**497.900.152**	€	**2.749.592.643**	€	**2.450.233.170**	€	**2.544.026.179**
REVENUES	€	**27.260.429.529**													€	**2.470.521.315**	€	**2.579.224.252**	€	**2.692.710.119**
Int. Take-off & Landing	€	5.366.856.171													€	465.451.093	€	485.930.941	€	507.311.903
Int. Lightning & Approach	€	332.313.076													€	28.820.501	€	30.088.603	€	31.412.502
Dom. Take-off & Landing	€	479.044.212													€	41.546.046	€	43.374.072	€	45.282.531
Dom. Lightning & Approach	€	128.765.643													€	11.167.452	€	11.658.820	€	12.171.808
Passenger	€	4.630.824.831													€	414.783.019	€	433.033.471	€	452.086.944
International	€	*3.817.646.364*													€	*341.946.617*	€	*356.992.268*	€	*372.699.927*
Transit	€	*477.205.795*													€	*42.743.327*	€	*44.624.033*	€	*46.587.491*
Domestic	€	*335.972.672*													€	*30.093.075*	€	*31.417.170*	€	*32.799.526*
Non-Transport	€	20.953.450.427													€	1.923.536.222	€	2.008.171.816	€	2.096.531.376
TOTAL INFLOWS	€	**27.260.429.529**													€	**2.470.521.315**	€	**2.579.224.252**	€	**2.692.710.119**
NET CASH FLOWS	-€	**4.323.036.756**	-€	**1.890.937.500**	-€	**390.937.500**	-€	**390.937.500**	-€	**390.937.500**	-€	**390.937.500**	-€	**497.900.152**	-€	**279.071.328**	€	**128.991.082**	€	**148.683.940**

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
€	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**390.937.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**
€	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	375.000.000	193.000.000	193.000.000	193.000.000	193.000.000
€	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	15.937.500	8.202.500	8.202.500	8.202.500	8.202.500
€	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**
€	**2.251.231.461**	**2.353.931.007**	**2.461.404.509**	**2.573.879.882**	**2.669.977.230**	**2.769.858.794**	**2.873.686.479**	**2.981.629.916**	**3.093.866.882**	**3.210.583.736**	**3.331.975.887**	**3.458.248.282**
€	140.206.218	150.020.653	160.522.099	171.758.645	183.781.751	196.646.473	210.411.726	225.140.547	240.900.385	257.763.412	275.806.851	295.113.331
€	2.111.025.244	2.203.910.355	2.300.882.410	2.402.121.236	2.486.195.479	2.573.212.321	2.663.274.752	2.756.489.369	2.852.966.497	2.952.820.324	3.056.169.035	3.163.134.952
€	**2.642.168.961**	**2.744.868.507**	**2.852.342.009**	**2.964.817.382**	**3.060.914.730**	**3.160.796.294**	**3.264.623.979**	**3.372.567.416**	**3.295.069.382**	**3.411.786.236**	**3.533.178.387**	**3.659.450.782**
€	**2.811.189.365**	**2.934.881.697**	**3.064.016.491**	**3.198.833.217**	**3.329.914.773**	**3.466.425.569**	**3.608.592.648**	**3.756.652.632**	**3.910.852.122**	**4.071.448.126**	**4.238.708.503**	**4.412.912.419**
€	529.633.627	552.937.506	577.266.756	602.666.494	629.183.819	656.867.908	685.770.095	715.943.980	747.445.515	780.333.117	814.667.775	850.513.157
€	32.794.652	34.237.616	35.744.072	37.316.811	38.958.750	40.672.935	42.462.545	44.330.897	46.281.456	48.317.840	50.443.825	52.663.353
€	47.274.962	49.355.061	51.526.683	53.793.857	56.160.787	58.631.862	61.211.664	63.904.977	66.716.796	69.652.335	72.717.038	75.916.587
€	12.707.368	13.266.492	13.850.218	14.459.627	15.095.851	15.760.068	16.453.511	17.177.466	17.933.274	18.722.338	19.546.121	20.406.150
€	471.978.770	492.745.836	514.426.652	537.061.425	555.858.575	575.313.625	595.449.602	616.290.338	637.860.500	660.185.617	683.292.114	707.207.338
€	*389.098.724*	*406.219.068*	*424.092.707*	*442.752.786*	*458.249.134*	*474.287.853*	*490.887.928*	*508.069.006*	*525.851.421*	*544.256.221*	*563.305.188*	*583.020.870*
€	*48.637.341*	*50.777.384*	*53.011.588*	*55.344.098*	*57.281.142*	*59.285.982*	*61.360.991*	*63.508.626*	*65.731.428*	*68.032.028*	*70.413.149*	*72.877.609*
€	*34.242.705*	*35.749.384*	*37.322.357*	*38.964.541*	*40.328.299*	*41.739.790*	*43.200.683*	*44.712.707*	*46.277.651*	*47.897.369*	*49.573.777*	*51.308.859*
€	2.188.778.756	2.285.085.022	2.385.628.763	2.490.596.428	2.590.515.565	2.694.492.796	2.802.694.834	2.915.295.313	3.032.475.081	3.154.422.496	3.281.333.744	3.413.413.171
€	**2.811.189.365**	**2.934.881.697**	**3.064.016.491**	**3.198.833.217**	**3.329.914.773**	**3.466.425.569**	**3.608.592.648**	**3.756.652.632**	**3.910.852.122**	**4.071.448.126**	**4.238.708.503**	**4.412.912.419**
€	**169.020.403**	**190.013.189**	**211.674.483**	**234.015.835**	**269.000.043**	**305.629.274**	**343.968.670**	**384.085.216**	**615.782.740**	**659.661.890**	**705.530.116**	**753.461.636**

	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
€	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**	**201.202.500**
€	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000	193.000.000
€	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500	8.202.500
€	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.000.000.000**	**1.650.000.000**	**1.650.000.000**
€	**3.589.615.939**	**3.726.304.491**	**3.868.550.782**	**4.016.603.488**	**4.170.723.778**	**4.331.186.020**	**4.498.278.524**	**4.672.304.336**	**4.853.582.075**	**5.042.446.832**
€	315.771.264	337.875.252	361.526.520	386.833.376	413.911.713	442.885.533	473.887.520	507.059.646	542.553.822	580.532.589
€	3.273.844.675	3.388.429.239	3.507.024.262	3.629.770.111	3.756.812.065	3.888.300.487	4.024.391.004	4.165.244.689	4.311.028.254	4.461.914.242
€	**3.790.818.439**	**3.927.506.991**	**4.069.753.282**	**4.217.805.988**	**4.371.926.278**	**4.532.388.520**	**4.699.481.024**	**4.873.506.836**	**5.054.784.575**	**5.243.649.332**
€	**4.594.350.833**	**4.783.326.997**	**4.980.156.978**	**5.185.170.203**	**5.398.710.032**	**5.621.134.345**	**5.852.816.165**	**6.094.144.302**	**6.345.524.025**	**6.607.377.764**
€	887.935.736	927.004.908	967.793.124	1.010.376.021	1.054.832.566	1.101.245.199	1.149.699.988	1.200.286.787	1.253.099.406	1.308.235.780
€	54.980.541	57.399.685	59.925.271	62.561.983	65.314.710	68.188.557	71.188.854	74.321.163	77.591.294	81.005.311
€	79.256.917	82.744.221	86.384.967	90.185.906	94.154.086	98.296.865	102.621.927	107.137.292	111.851.333	116.772.792
€	21.304.021	22.241.398	23.220.019	24.241.700	25.308.335	26.421.902	27.584.465	28.798.182	30.065.302	31.388.175
€	731.959.595	757.578.181	784.093.417	811.536.687	839.940.471	869.338.387	899.765.231	931.257.014	963.851.009	997.585.794
€	*603.426.601*	*624.546.532*	*646.405.660*	*669.029.858*	*692.445.903*	*716.681.510*	*741.765.363*	*767.727.150*	*794.597.601*	*822.408.517*
€	*75.428.325*	*78.068.316*	*80.800.708*	*83.628.732*	*86.555.738*	*89.585.189*	*92.720.670*	*95.965.894*	*99.324.700*	*102.801.065*
€	*53.104.669*	*54.963.333*	*56.887.049*	*58.878.096*	*60.938.829*	*63.071.688*	*65.279.197*	*67.563.969*	*69.928.708*	*72.376.213*
€	3.550.873.619	3.693.936.785	3.842.833.596	3.997.804.593	4.159.100.335	4.326.981.821	4.501.720.930	4.683.600.877	4.872.916.689	5.069.975.706
€	**4.594.350.833**	**4.783.326.997**	**4.980.156.978**	**5.185.170.203**	**5.398.710.032**	**5.621.134.345**	**5.852.816.165**	**6.094.144.302**	**6.345.524.025**	**6.607.377.764**
€	**803.532.394**	**855.820.006**	**910.403.696**	**967.364.215**	**1.026.783.754**	**1.088.745.825**	**1.153.335.140**	**1.220.637.466**	**1.290.739.450**	**1.363.728.432**

APPENDIX F: Economic Analysis for scenario A

	ADJUSTED PRICES	CF	NPV 5,06%	2013-2018	2019	2020	2021	2022	2023
Investment Cost	€ 8.897.216.871	1	€ 8.897.216.871	€ 3.454.687.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500
O&M Costs	€ 39.421.044.922	0,80	€ 49.276.306.153	-	€ 1.587.097.019	€ 2.089.092.681	€ 2.199.929.808	€ 2.316.684.767	€ 2.439.676.087
Termination Cost	€ 389.000.000	1	€ 389.000.000	-	€ 389.000.000	-	-	-	-
Revenues	-€ 47.449.406.520	0,78	-€ 60.832.572.462	-	-€ 1.891.983.909	-€ 2.618.904.043	-€ 2.755.087.053	-€ 2.898.351.580	-€ 3.049.065.862
TOTAL ECONOMIC COSTS	**€ 1.257.855.273**		**-€ 2.270.049.438**	**€ 3.454.687.500**	**€ 475.050.610**	**-€ 138.873.862**	**-€ 164.219.745**	**-€ 190.729.313**	**-€ 218.452.275**
CONSUMER SURPLUS			**€ 955.845.476**	-	**€ 39.116.082**	**€ 41.150.119**	**€ 43.289.925**	**€ 45.541.001**	**€ 47.909.133**
EXISTING USERS			€ 637.230.317	-	€ 26.077.388	€ 27.433.412	€ 28.859.950	€ 30.360.667	€ 31.939.422
Value of time savings			€ 637.230.317	-	€ 26.077.388	€ 27.433.412	€ 28.859.950	€ 30.360.667	€ 31.939.422
Work Time			*€ 415.731.274*	-	*€ 17.012.979*	*€ 17.897.654*	*€ 18.828.332*	*€ 19.807.405*	*€ 20.837.390*
Non-work time			*€ 221.499.043*	-	*€ 9.064.410*	*€ 9.535.759*	*€ 10.031.618*	*€ 10.553.262*	*€ 11.102.032*
Value of fare change			-	-	-	-	-	-	-
NEW USERS			€ 318.615.159	-	€ 13.038.694	€ 13.716.706	€ 14.429.975	€ 15.180.334	€ 15.969.711
Generalised users cost surplus			€ 318.615.159	-	€ 13.038.694	€ 13.716.706	€ 14.429.975	€ 15.180.334	€ 15.969.711
PRODUCER SURPLUS			**€ 808.435.081**	-	**€ 33.083.604**	**€ 34.803.951**	**€ 36.613.757**	**€ 38.517.672**	**€ 40.520.591**
Operating Cost Savings			€ 808.435.081	-	€ 33.083.604	€ 34.803.951	€ 36.613.757	€ 38.517.672	€ 40.520.591
Increased Taxiing Time Cost			*-€ 6.709.648.033*	-	*-€ 274.579.053*	*-€ 288.857.164*	*-€ 303.877.737*	*-€ 319.679.379*	*-€ 336.302.707*
Reduced Delay Savings			*€ 7.518.083.114*	-	*€ 307.662.657*	*€ 323.661.115*	*€ 340.491.494*	*€ 358.197.051*	*€ 376.823.298*
EXTERNALITIES			**-€ 29.868.052**	-	**-€ 24.812.823**	**-€ 226.919**	**-€ 238.719**	**-€ 251.132**	**-€ 264.191**
Habitat Disturbance			-€ 40.944.882	-	-€ 40.944.882	-	-	-	-
Land Value Increase			€ 16.347.762	-	€ 16.347.762	-	-	-	-
Emissions			-€ 5.270.932	-	-€ 215.702	-€ 226.919	-€ 238.719	-€ 251.132	-€ 264.191
TOTAL ECONOMIC BENEFITS			**€ 1.734.412.504**	-	**€ 47.386.864**	**€ 75.727.151**	**€ 79.664.963**	**€ 83.807.541**	**€ 88.165.533**
NPV (NET BENEFITS)			**€ 476.557.231**	**-€ 3.454.687.500**	**-€ 427.663.746**	**€ 214.601.014**	**€ 243.884.709**	**€ 274.536.854**	**€ 306.617.809**

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
€	390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500
€	2.569.239.615	€ 2.705.729.473	€ 2.834.315.236	€ 2.969.104.499	€ 3.110.402.821	€ 3.258.531.232	€ 3.413.827.042	€ 3.576.644.695	€ 3.747.356.673	€ 3.926.354.445	€ 4.114.049.469
	-	-	-	-	-	-	-	-	-	-	-
-€	3.207.617.287	-€ 3.374.413.386	-€ 3.529.636.402	-€ 3.691.999.676	-€ 3.861.831.661	-€ 4.039.475.918	-€ 4.225.291.810	-€ 4.419.655.233	-€ 4.622.959.374	-€ 4.835.615.505	-€ 5.058.053.818
-€	**247.440.172**	**-€ 277.746.413**	**-€ 304.383.666**	**-€ 331.957.677**	**-€ 360.491.340**	**-€ 390.007.185**	**-€ 610.262.268**	**-€ 641.808.038**	**-€ 674.400.200**	**-€ 708.058.560**	**-€ 742.801.849**
€	**50.400.408**	**€ 53.021.229**	**€ 55.460.206**	**€ 58.011.375**	**€ 60.679.898**	**€ 63.471.174**	**€ 66.390.848**	**€ 69.444.827**	**€ 72.639.289**	**€ 75.980.696**	**€ 79.475.808**
€	33.600.272	€ 35.347.486	€ 36.973.470	€ 38.674.250	€ 40.453.266	€ 42.314.116	€ 44.260.565	€ 46.296.551	€ 48.426.193	€ 50.653.797	€ 52.983.872
€	33.600.272	€ 35.347.486	€ 36.973.470	€ 38.674.250	€ 40.453.266	€ 42.314.116	€ 44.260.565	€ 46.296.551	€ 48.426.193	€ 50.653.797	€ 52.983.872
€	*21.920.934*	*€ 23.060.823*	*€ 24.121.621*	*€ 25.231.215*	*€ 26.391.851*	*€ 27.605.876*	*€ 28.875.747*	*€ 30.204.031*	*€ 31.593.416*	*€ 33.046.713*	*€ 34.566.862*
€	*11.679.338*	*€ 12.286.663*	*€ 12.851.850*	*€ 13.443.035*	*€ 14.061.415*	*€ 14.708.240*	*€ 15.384.819*	*€ 16.092.520*	*€ 16.832.776*	*€ 17.607.084*	*€ 18.417.010*
	-	-	-	-	-	-	-	-	-	-	-
€	16.800.136	€ 17.673.743	€ 18.486.735	€ 19.337.125	€ 20.226.633	€ 21.157.058	€ 22.130.283	€ 23.148.276	€ 24.213.096	€ 25.326.899	€ 26.491.936
€	16.800.136	€ 17.673.743	€ 18.486.735	€ 19.337.125	€ 20.226.633	€ 21.157.058	€ 22.130.283	€ 23.148.276	€ 24.213.096	€ 25.326.899	€ 26.491.936
€	**42.627.662**	**€ 44.844.300**	**€ 46.907.138**	**€ 49.064.867**	**€ 51.321.851**	**€ 53.682.656**	**€ 56.152.058**	**€ 58.735.052**	**€ 61.436.865**	**€ 64.262.961**	**€ 67.219.057**
€	42.627.662	€ 44.844.300	€ 46.907.138	€ 49.064.867	€ 51.321.851	€ 53.682.656	€ 56.152.058	€ 58.735.052	€ 61.436.865	€ 64.262.961	€ 67.219.057
-€	*353.790.447*	*-€ 372.187.551*	*-€ 389.308.178*	*-€ 407.216.354*	*-€ 425.948.306*	*-€ 445.541.928*	*-€ 466.036.857*	*-€ 487.474.553*	*-€ 509.898.382*	*-€ 533.353.708*	*-€ 557.887.978*
€	*396.418.109*	*€ 417.031.851*	*€ 436.215.316*	*€ 456.281.221*	*€ 477.270.157*	*€ 499.224.584*	*€ 522.188.915*	*€ 546.209.605*	*€ 571.335.247*	*€ 597.616.668*	*€ 625.107.035*
-€	**277.929**	**-€ 292.381**	**-€ 305.831**	**-€ 319.899**	**-€ 334.614**	**-€ 350.007**	**-€ 366.107**	**-€ 382.948**	**-€ 400.563**	**-€ 418.989**	**-€ 438.263**
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
-€	277.929	-€ 292.381	-€ 305.831	-€ 319.899	-€ 334.614	-€ 350.007	-€ 366.107	-€ 382.948	-€ 400.563	-€ 418.989	-€ 438.263
€	**92.750.141**	**€ 97.573.148**	**€ 102.061.513**	**€ 106.756.343**	**€ 111.667.135**	**€ 116.803.823**	**€ 122.176.799**	**€ 127.796.931**	**€ 133.675.590**	**€ 139.824.667**	**€ 146.256.602**
€	**340.190.313**	**€ 375.319.561**	**€ 406.445.179**	**€ 438.714.020**	**€ 472.158.475**	**€ 506.811.008**	**€ 732.439.066**	**€ 769.604.969**	**€ 808.075.791**	**€ 847.883.228**	**€ 889.058.451**

	2035	2036	2037	2038	2039	2040	2041	2042	2043
€	201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500
€	4.310.874.255	€ 4.517.283.477	€ 4.733.755.153	€ 4.960.791.891	€ 5.198.922.199	€ 5.448.701.873	€ 5.710.715.460	€ 5.985.577.803	€ 5.019.148.539
	-	-	-	-	-	-	-	-	-
-€	5.290.724.294	-€ 5.534.097.611	-€ 5.788.666.102	-€ 6.054.944.742	-€ 6.333.472.200	-€ 6.624.811.922	-€ 6.929.553.270	-€ 7.248.312.720	-€ 5.762.118.680
-€	**778.647.539**	**-€ 815.611.635**	**-€ 853.708.448**	**-€ 892.950.351**	**-€ 933.347.501**	**-€ 974.907.548**	**-€ 1.017.635.310**	**-€ 1.061.532.418**	**-€ 541.767.641**
€	**83.131.695**	**€ 86.955.753**	**€ 90.955.718**	**€ 95.139.681**	**€ 99.516.106**	**€ 104.093.847**	**€ 108.882.164**	**€ 113.890.744**	**€ 119.129.718**
€	55.421.130	€ 57.970.502	€ 60.637.145	€ 63.426.454	€ 66.344.071	€ 69.395.898	€ 72.588.109	€ 75.927.162	€ 79.419.812
€	55.421.130	€ 57.970.502	€ 60.637.145	€ 63.426.454	€ 66.344.071	€ 69.395.898	€ 72.588.109	€ 75.927.162	€ 79.419.812
€	*36.156.938*	*€ 37.820.157*	*€ 39.559.884*	*€ 41.379.639*	*€ 43.283.102*	*€ 45.274.125*	*€ 47.356.735*	*€ 49.535.145*	*€ 51.813.761*
€	*19.264.192*	*€ 20.150.345*	*€ 21.077.261*	*€ 22.046.815*	*€ 23.060.968*	*€ 24.121.773*	*€ 25.231.375*	*€ 26.392.018*	*€ 27.606.051*
	-	-	-	-	-	-	-	-	-
€	27.710.565	€ 28.985.251	€ 30.318.573	€ 31.713.227	€ 33.172.035	€ 34.697.949	€ 36.294.055	€ 37.963.581	€ 39.709.906
€	27.710.565	€ 28.985.251	€ 30.318.573	€ 31.713.227	€ 33.172.035	€ 34.697.949	€ 36.294.055	€ 37.963.581	€ 39.709.906
€	**70.311.133**	**€ 73.545.446**	**€ 76.928.536**	**€ 80.467.249**	**€ 84.168.742**	**€ 88.040.504**	**€ 92.090.368**	**€ 96.326.524**	**€ 100.757.545**
€	70.311.133	€ 73.545.446	€ 76.928.536	€ 80.467.249	€ 84.168.742	€ 88.040.504	€ 92.090.368	€ 96.326.524	€ 100.757.545
-€	*583.550.825*	*-€ 610.394.163*	*-€ 638.472.295*	*-€ 667.842.020*	*-€ 698.562.753*	*-€ 730.696.640*	*-€ 764.308.685*	*-€ 799.466.885*	*-€ 836.242.361*
€	*653.861.959*	*€ 683.939.609*	*€ 715.400.831*	*€ 748.309.269*	*€ 782.731.495*	*€ 818.737.144*	*€ 856.399.053*	*€ 895.793.409*	*€ 936.999.906*
-€	**458.423**	**-€ 479.510**	**-€ 501.568**	**-€ 524.640**	**-€ 548.773**	**-€ 574.017**	**-€ 600.422**	**-€ 628.041**	**-€ 656.931**
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
-€	458.423	-€ 479.510	-€ 501.568	-€ 524.640	-€ 548.773	-€ 574.017	-€ 600.422	-€ 628.041	-€ 656.931
€	**152.984.406**	**€ 160.021.688**	**€ 167.382.686**	**€ 175.082.290**	**€ 183.136.075**	**€ 191.560.334**	**€ 200.372.110**	**€ 209.589.227**	**€ 219.230.331**
€	**931.631.945**	**€ 975.633.323**	**€ 1.021.091.134**	**€ 1.068.032.641**	**€ 1.116.483.576**	**€ 1.166.467.883**	**€ 1.218.007.420**	**€ 1.271.121.645**	**€ 760.997.973**

APPENDIX G: Economic Analysis for scenario B

	ADJUSTED PRICES	CF	NPV 5,06%	2013-2018	2019	2020	2021	2022	2023
Investment Cost	€ 8.897.216.871	1	€ 8.897.216.871	€ 3.454.687.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500
O&M Costs	€ 35.454.309.481	0,80	€ 44.317.886.851	-	€ 1.969.655.143	€ 2.059.295.670	€ 2.153.088.679	€ 2.251.231.461	€ 2.353.931.007
Termination Cost	€ 389.000.000	1	€ 389.000.000	-	€ 389.000.000	-	-	-	-
Revenues	-€ 42.438.436.140	0,78	-€ 54.408.251.461	-	€ 2.470.521.315	€ 2.579.224.252	€ 2.692.710.119	€ 2.811.189.365	€ 2.934.881.697
TOTAL ECONOMIC COSTS	**€ 2.302.090.212**		**-€ 804.147.739**	**€ 3.454.687.500**	**€ 5.220.113.957**	**€ 5.029.457.422**	**€ 5.236.736.299**	**€ 5.453.358.326**	**€ 5.679.750.204**
CONSUMER SURPLUS			**€ 852.094.681**	-	**€ 38.818.622**	**€ 40.526.641**	**€ 42.309.813**	**€ 44.171.445**	**€ 46.114.989**
EXISTING USERS			€ 568.063.121	-	€ 25.879.081	€ 27.017.761	€ 28.206.542	€ 29.447.630	€ 30.743.326
Value of time savings			€ 568.063.121	-	€ 25.879.081	€ 27.017.761	€ 28.206.542	€ 29.447.630	€ 30.743.326
Work Time			*€ 370.606.355*	-	*€ 16.883.603*	*€ 17.626.481*	*€ 18.402.046*	*€ 19.211.736*	*€ 20.057.053*
Non-work time			*€ 197.456.766*	-	*€ 8.995.479*	*€ 9.391.280*	*€ 9.804.496*	*€ 10.235.894*	*€ 10.686.273*
Value of fare change			-	-	-	-	-	-	-
NEW USERS			€ 284.031.560	-	€ 12.939.541	€ 13.508.880	€ 14.103.271	€ 14.723.815	€ 15.371.663
Generalised users cost surplus			€ 284.031.560	-	€ 12.939.541	€ 13.508.880	€ 14.103.271	€ 14.723.815	€ 15.371.663
PRODUCER SURPLUS			**€ 720.684.724**	-	**€ 32.832.018**	**€ 34.276.627**	**€ 35.784.798**	**€ 37.359.329**	**€ 39.003.140**
Operating Cost Savings			€ 720.684.724	-	€ 32.832.018	€ 34.276.627	€ 35.784.798	€ 37.359.329	€ 39.003.140
Increased Taxiing Time Cost			*-€ 5.981.359.485*	-	*-€ 272.491.000*	*-€ 284.480.604*	*-€ 296.997.750*	*-€ 310.065.651*	*-€ 323.708.540*
Reduced Delay Savings			*€ 6.702.044.209*	-	*€ 305.323.017*	*€ 318.757.230*	*€ 332.782.548*	*€ 347.424.980*	*€ 362.711.679*
EXTERNALITIES			**-€ 29.295.927**	-	**-€ 24.811.182**	**-€ 223.481**	**-€ 233.314**	**-€ 243.580**	**-€ 254.297**
Habitat Disturbance			-€ 40.944.882	-	-€ 40.944.882	-	-	-	-
Land Value Increase			€ 16.347.762	-	€ 16.347.762	-	-	-	-
Emissions			-€ 4.698.807	-	-€ 214.062	-€ 223.481	-€ 233.314	-€ 243.580	-€ 254.297
TOTAL ECONOMIC BENEFITS			**€ 1.543.483.478**	-	**€ 46.839.457**	**€ 74.579.787**	**€ 77.861.297**	**€ 81.287.194**	**€ 84.863.831**
NPV (NET BENEFITS)			**-€ 758.606.734**	**-€ 3.454.687.500**	**-€ 5.173.274.500**	**-€ 4.954.877.635**	**-€ 5.158.875.001**	**-€ 5.372.071.132**	**-€ 5.594.886.373**

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
€	390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 390.937.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500
€	2.461.404.509	€ 2.573.879.882	€ 2.669.977.230	€ 2.769.858.794	€ 2.873.686.479	€ 2.981.629.916	€ 3.093.866.882	€ 3.210.583.736	€ 3.331.975.887	€ 3.458.248.282	€ 3.589.615.939
	-	-	-	-	-	-	-	-	-	-	-
€	3.064.016.491	€ 3.198.833.217	€ 3.329.914.773	€ 3.466.425.569	€ 3.608.592.648	€ 3.756.652.632	€ 3.910.852.122	€ 4.071.448.126	€ 4.238.708.503	€ 4.412.912.419	€ 4.594.350.833
€	**5.916.358.500**	**€ 6.163.650.599**	**€ 6.390.829.503**	**€ 6.627.221.863**	**€ 6.873.216.627**	**€ 7.129.220.048**	**€ 7.205.921.504**	**€ 7.483.234.363**	**€ 7.771.886.889**	**€ 8.072.363.201**	**€ 8.385.169.272**
€	**48.144.048**	**€ 50.262.386**	**€ 52.021.570**	**€ 53.842.325**	**€ 55.726.806**	**€ 57.677.244**	**€ 59.695.948**	**€ 61.785.306**	**€ 63.947.792**	**€ 66.185.965**	**€ 68.502.473**
€	32.096.032	€ 33.508.258	€ 34.681.047	€ 35.894.883	€ 37.151.204	€ 38.451.496	€ 39.797.299	€ 41.190.204	€ 42.631.861	€ 44.123.976	€ 45.668.316
€	32.096.032	€ 33.508.258	€ 34.681.047	€ 35.894.883	€ 37.151.204	€ 38.451.496	€ 39.797.299	€ 41.190.204	€ 42.631.861	€ 44.123.976	€ 45.668.316
€	*20.939.563*	*€ 21.860.904*	*€ 22.626.035*	*€ 23.417.947*	*€ 24.237.575*	*€ 25.085.890*	*€ 25.963.896*	*€ 26.872.632*	*€ 27.813.174*	*€ 28.786.636*	*€ 29.794.168*
€	*11.156.469*	*€ 11.647.354*	*€ 12.055.011*	*€ 12.476.937*	*€ 12.913.629*	*€ 13.365.606*	*€ 13.833.403*	*€ 14.317.572*	*€ 14.818.687*	*€ 15.337.341*	*€ 15.874.148*
	-	-	-	-	-	-	-	-	-	-	-
€	16.048.016	€ 16.754.129	€ 17.340.523	€ 17.947.442	€ 18.575.602	€ 19.225.748	€ 19.898.649	€ 20.595.102	€ 21.315.931	€ 22.061.988	€ 22.834.158
€	16.048.016	€ 16.754.129	€ 17.340.523	€ 17.947.442	€ 18.575.602	€ 19.225.748	€ 19.898.649	€ 20.595.102	€ 21.315.931	€ 22.061.988	€ 22.834.158
€	**40.719.278**	**€ 42.510.926**	**€ 43.998.808**	**€ 45.538.767**	**€ 47.132.624**	**€ 48.782.265**	**€ 50.489.645**	**€ 52.256.782**	**€ 54.085.770**	**€ 55.978.772**	**€ 57.938.029**
€	40.719.278	€ 42.510.926	€ 43.998.808	€ 45.538.767	€ 47.132.624	€ 48.782.265	€ 50.489.645	€ 52.256.782	€ 54.085.770	€ 55.978.772	€ 57.938.029
-€	*337.951.716*	*-€ 352.821.591*	*-€ 365.170.347*	*-€ 377.951.309*	*-€ 391.179.605*	*-€ 404.870.891*	*-€ 419.041.372*	*-€ 433.707.820*	*-€ 448.887.594*	*-€ 464.598.659*	*-€ 480.859.613*
€	*378.670.993*	*€ 395.332.517*	*€ 409.169.155*	*€ 423.490.076*	*€ 438.312.228*	*€ 453.653.156*	*€ 469.531.017*	*€ 485.964.602*	*€ 502.973.363*	*€ 520.577.431*	*€ 538.797.641*
-€	**265.486**	**-€ 277.168**	**-€ 286.869**	**-€ 296.909**	**-€ 307.301**	**-€ 318.056**	**-€ 329.188**	**-€ 340.710**	**-€ 352.635**	**-€ 364.977**	**-€ 377.751**
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
-€	265.486	-€ 277.168	-€ 286.869	-€ 296.909	-€ 307.301	-€ 318.056	-€ 329.188	-€ 340.710	-€ 352.635	-€ 364.977	-€ 377.751
€	**88.597.840**	**€ 92.496.145**	**€ 95.733.510**	**€ 99.084.182**	**€ 102.552.129**	**€ 106.141.453**	**€ 109.856.404**	**€ 113.701.378**	**€ 117.680.927**	**€ 121.799.759**	**€ 126.062.751**
-€	**5.827.760.660**	**-€ 6.071.154.454**	**-€ 6.295.095.993**	**-€ 6.528.137.680**	**-€ 6.770.664.498**	**-€ 7.023.078.595**	**-€ 7.096.065.100**	**-€ 7.369.532.984**	**-€ 7.654.205.963**	**-€ 7.950.563.442**	**-€ 8.259.106.521**

	2035	2036	2037	2038	2039	2040	2041	2042	2043
€	201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500	€ 201.202.500
€	3.726.304.491	€ 3.868.550.782	€ 4.016.603.488	€ 4.170.723.778	€ 4.331.186.020	€ 4.498.278.524	€ 4.672.304.336	€ 4.853.582.075	€ 5.042.446.832
	-	-	-	-	-	-	-	-	-
€	4.783.326.997	€ 4.980.156.978	€ 5.185.170.203	€ 5.398.710.032	€ 5.621.134.345	€ 5.852.816.165	€ 6.094.144.302	€ 6.345.524.025	€ 6.607.377.764
€	**8.710.833.988**	**€ 9.049.910.260**	**€ 9.402.976.191**	**€ 9.770.636.309**	**€ 10.153.522.865**	**€ 10.552.297.189**	**€ 10.967.651.138**	**€ 11.400.308.600**	**€ 11.851.027.095**
€	**70.900.060**	**€ 73.381.562**	**€ 75.949.917**	**€ 78.608.164**	**€ 81.359.449**	**€ 84.207.030**	**€ 87.154.276**	**€ 90.204.676**	**€ 93.361.840**
€	47.266.707	€ 48.921.041	€ 50.633.278	€ 52.405.442	€ 54.239.633	€ 56.138.020	€ 58.102.851	€ 60.136.451	€ 62.241.226
€	47.266.707	€ 48.921.041	€ 50.633.278	€ 52.405.442	€ 54.239.633	€ 56.138.020	€ 58.102.851	€ 60.136.451	€ 62.241.226
€	*30.836.964*	*€ 31.916.257*	*€ 33.033.326*	*€ 34.189.493*	*€ 35.386.125*	*€ 36.624.639*	*€ 37.906.502*	*€ 39.233.229*	*€ 40.606.392*
€	*16.429.743*	*€ 17.004.784*	*€ 17.599.951*	*€ 18.215.950*	*€ 18.853.508*	*€ 19.513.381*	*€ 20.196.349*	*€ 20.903.221*	*€ 21.634.834*
	-	-	-	-	-	-	-	-	-
€	23.633.353	€ 24.460.521	€ 25.316.639	€ 26.202.721	€ 27.119.816	€ 28.069.010	€ 29.051.425	€ 30.068.225	€ 31.120.613
€	23.633.353	€ 24.460.521	€ 25.316.639	€ 26.202.721	€ 27.119.816	€ 28.069.010	€ 29.051.425	€ 30.068.225	€ 31.120.613
€	**59.965.860**	**€ 62.064.665**	**€ 64.236.928**	**€ 66.485.220**	**€ 68.812.203**	**€ 71.220.630**	**€ 73.713.352**	**€ 76.293.320**	**€ 78.963.586**
€	59.965.860	€ 62.064.665	€ 64.236.928	€ 66.485.220	€ 68.812.203	€ 71.220.630	€ 73.713.352	€ 76.293.320	€ 78.963.586
-€	*497.689.699*	*-€ 515.108.838*	*-€ 533.137.648*	*-€ 551.797.466*	*-€ 571.110.377*	*-€ 591.099.240*	*-€ 611.787.713*	*-€ 633.200.283*	*-€ 655.362.293*
€	*557.655.559*	*€ 577.173.503*	*€ 597.374.576*	*€ 618.282.686*	*€ 639.922.580*	*€ 662.319.870*	*€ 685.501.066*	*€ 709.493.603*	*€ 734.325.879*
-€	**390.973**	**-€ 404.657**	**-€ 418.820**	**-€ 433.478**	**-€ 448.650**	**-€ 464.353**	**-€ 480.605**	**-€ 497.426**	**-€ 514.836**
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
-€	390.973	-€ 404.657	-€ 418.820	-€ 433.478	-€ 448.650	-€ 464.353	-€ 480.605	-€ 497.426	-€ 514.836
€	**130.474.947**	**€ 135.041.570**	**#BAŞV!**	**€ 144.659.906**	**€ 149.723.003**	**€ 154.963.308**	**€ 160.387.023**	**€ 166.000.569**	**€ 171.810.589**
-€	**8.580.359.041**	**-€ 8.914.868.690**	**#BAŞV!**	**-€ 9.625.976.404**	**-€ 10.003.799.862**	**-€ 10.397.333.881**	**-€ 10.807.264.114**	**-€ 11.234.308.031**	**-€ 11.679.216.506**