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# Multicriteria analysis as a tool for assessing transport projects: ART line in mountain Pellion Greece

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## ABSTRACT

This paper compares MCA and CBA and concludes that the two techniques can offer complementary insights to the evaluation of a transport project. A 20001 preliminary study discussing the construction of an ART line in Mountain Pellion is reviewed. Te project is reevaluated using two different MCA methodologies AHP and MAMCA. For this purpose 3 alternatives are formed. For each one a SWOT analysis is conducted to highlight its key points. Furthermore a stakeholder analysis is undertaken to discover all those who can potentially be affected by the project. AHP compares the alternatives in pairs using 8 criteria, while MAMCA relies upon the views and criteria of each stakeholder. Both methods however arrive at to the same conclusion, that the partial implementation of the project seems the best solution. Finally using the experience gained by studying the project new features and expansions that will enhance its performance is proposed.



Keywords:

Multi criteria Analysis, Aerial Ropeway Transport, stakeholders, AHP, MaMCA, transport evaluation

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ACRONYMS

AHP – Analytic Hierarchy Process

AKV – Astikon KTEL Volou

ART – Aerial Ropeway Transit

CBA – Cost Benefit Analysis

EIB – European Investment Bank

EU – European Union

km – kilometre

MAMCA – Multi Actor Multi Criteria Analysis

MCA – Multi Criteria Analysis

MCDA – Multicriterion Decision Analysis

m – Meters

NIMBY – Not in My Backyard

PEST –

SME – Small and Medium-sized Enterprises

SWOT – Strengths Weaknesses Opportunities Threats

TfL – Transportation for London

THANKS

I would like to thank my professor Pantelis Skayannis for our cooperation. He was the one that proposed this interesting topic. I could easily contact him and discuss my ideas about the project. He was eager to listen and gave valuable advice and feedback. He also provided stimuli and open new pathways every time we met. I would also like to thank my sister which supported me during the last months of this project.

## 1. PREFACE

In the last decades a lot of transports projects have been undertaken in Greece. They were usually roads and highways which were aiming to satisfy the needs of car traffic. Some of those projects were absolutely vital, while others were definitely not the optimal solution to address the given situation. Sometimes difficulties that could definitely been predicted in advance, cause major delays or cancellations of key parts of the projects. Thus bottlenecks were created which eliminated the expected benefits from those investments. Also very few innovative projects were undertaken as decision makers were usually choosing options which were familiar. The severe economic crisis that has struck Greece has left lots of ambitious projects unfinished. It is an absolute necessity to rethink the way transport projects are evaluated. It is time to learn from the past and avoid costly gambles which yield suboptimal results. Decision makers should be open to new ideas and innovative proposals. The most promising proposal should be thoroughly appraised not only by a group of “experts” using some form of monetary technique, but also from stakeholders using a multi criteria analysis framework. The funding opportunities are very few nowadays and should not be wasted in projects that will bring suboptimal results or will create severe stakeholder opposition. A famous known example is the construction of an underwater tunnel to connect the east with the west coast of Thessaloniki. The project was economically feasible and thus had secured funding and was assigned to a conductor. However, the local citizens and organizations decided that the project will be creating problems in the city rather than solving them. The project was cancelled, and as a result a huge compensation had to be paid to the contractor. A multi criteria analysis will give the opportunity to assess various aspects of the project positive or negative. The methodology should be transparent and easy to use. Stakeholders the will be able to participate and commit to the project from the beginning while providing their feedback. This procedure will help decision-makers to chose the best solution and tackle all the problems that will arise early on.

The municipality of Volos is one of the biggest and most crowded urban areas in Greece. The agglomeration has a population that exceeds 120000 inhabitants. It is the capital city of the prefecture of Magnesia which belongs to the region of Thessaly. It is among the five most important cities in the counties and among the two in the region. It is located in the central Greece 300 km north of the capital and 250 south of Thessaloniki. In the north east

lays the mountain Pellion while in the south lays the sea where an important passenger and freight port exists. Recently an increasing number of cruise ships arrive in the port during the summer season mainly. The mountain and the sea have shaped the city and its economic potential.

Volos is mainly a monocentric city. That means that residents living in the outskirts of the agglomeration need to access the city center daily or at least quite often , as administration , education healthcare are located there. The area is also the most profound choice for shopping and recreation.

Pelion is known as the garden of Greece. The combination of traditional villages magnificent landscape and wonderful beaches makes it a unique touristic attraction throughout the year. Two of its biggest Villages Portaria and Makrinitsa are built on the hillside overlooking the city of Volos. The distance between them and the city is less than 12 km but due to the narrow twisty roads the trip would take around 25 minutes at least. Those villages can be considered as suburbs on the agglomeration of Volos. Residents of the city visit those places for recreation especially in the weekends , while residents of the villages visit the city centre for the reasons mentioned above. There is also a ski resort located on the top of the mountain which attracts a lot of domestic tourists every winter. It is relatively close to the city however it is not easily accessible by public transportation and a private car, as it is only served by a limited number of routes daily while the parking spots are limited and the road is passing through Portaria were usually congestion and delays occur.

Tourism is one of the fastest growing sectors of the global economy. It has also multiple effects on other sectors of the economy. The world tourist organization predicts that the average growth rate of international tourist arrivals will be around 4,1% until 2020. Despite the increasing domestic and international competition studies predict that Thessaly and Pelion specifically have great potential for sustainable touristic development provided that they will invest in transport infrastructure among other things. (Πανεπιστήμιο Θεσσαλίας, 2001)

The city is searching for its identity and role in the changing environment. It will become attractive and viable when it will be able to provide a high quality of life, work and transportation as well as more options for recreation culture and better services for its visitors.

There is one very prominent idea that will help as address all the above mentioned challenges the need for reliable and fast transportation for citizens of the area and tourists. It could also help meet the goals of the low carbon economy as it is promotes sustainable multimodal urban transportation. The idea is not new it has been discussed 15 years ago but did not come to life. Constructing an ART line to connect the city of Volos with the mountain Pelion seems a very intrusting proposal, which requires a careful and deep analysis if it is to proceed.

The aim of this paper is to use multi criteria analysis as a tool to evaluate the transport project described above.

After a literature review on the concept of sustainability appraisal as well as the methodologies of multi criteria analysis we used two of them named AHP and MAMCA to evaluate whether or not the project is desirable. The idea was to incorporate various alternatives ranging from neglecting the project to totally or partially undertaking it. Before proceeding to the evolution it was important to review the literature to discover the strong and weak points of ART as well as case studies that are already in operation. Last but not least a 2001feasibility study conducted by the University of Thessaly acted as our guide for the technical and economic details of the project. Of course the findings of the study were updated when necessary. Finally the knowledge that we have acquired allowed us to make proposals for improving the services to users and ideas for future expansions.

# 2. INTRODUCTION

## 2.1. SUSTAINABLE DEVELOPMENT

Discussion of sustainable development in major project appraisal must start from a clear and accepted definition of the term. One which is very widely accepted and which is employed here for this report is that from the Brundtland Report which states:

‘Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.’

This definition implies a very important shift - from an idea of sustainability as a primarily ecological concept to a framework that also emphasizes the economic and social dimensions of development - underlining the need to balance all three dimensions of sustainability: economic, environmental and social.

More recently, a fourth pillar of sustainability has been introduced, namely the institutional dimension Here the premise is that without adequately resourced sustainable institutions to promote, govern and regulate the delivery of sustainable visions, the delivery of sustainability is highly restricted. (Omega centre, 2010)

### *2.1.1. Strong and Weak Sustainability*

The concept of sustainability can be interpreted by two different ways according to the perception of whether or not natural or capital can be substituted. Those who advocate Weak environmental sustainability perceive that welfare can be perceived provided that the total amount of capital doesn’t decrease. Thus they argue we can to a bigger or smaller extent compensated he losses of natural with manufactured capital. Normally dependent on a specific form of capital and can be maintained by substituting manufactured for natural capital, though with exceptions.

On the other hand lays the notion of strong sustainability. The arguments of those in favor of it are solid. They stress that ecological capital is given to us freely by the nature, however it exists in fixed or limited supplies. Destruction of it, unlike man-made capital is sometimes irreversible. Thus the issue of critical natural capital was introduces. It states that: 'Critical natural capital' may then be defined as natural capital which is responsible for important environmental functions and which cannot be substituted in the provision of

these functions by manufactured capital' (Ekins, Simon, Deutsch, Folke, & De Groot, 2003).

## 2.2. EVALUATION TECHNIQUES

Sustainability assessment of transport projects should be conducted at each and every level from conceptualization and design to construction and operation. Thus there is a need of a variety of methods. These methods belong in two different groups. There are methods that they are trying to express all parameters in a single unit which will make direct and objective comparison possible. This unit is usually money so this is also called monetary approach. On the other hand there are methods which acknowledge the difficulty of assessing a complex situation based on a single criterion. There are some aspects that cannot be properly quantified and thus are ignored. So multi criteria methods or otherwise named non-monetary approach were introduced. Bothe methods have their strong and weak points and therefore can offer complementary insights.

### *2.2.1. Cost-Benefit Analysis (CBA)*

Cost benefit analysis is the most common evaluation technique. Direct or indirect benefits and costs that will be created by the project are estimated in monetary terms. To do so market prices are preferred when available. In some cases however shadow prices can be used. Other techniques such as willingness to pay or willingness to accept can be used to discover the value that users are placing in various features of the project. For transport infrastructure CBA usually calculates savings in travel times, increase in safety, environmental impact, prospective revenues and compares them with the cost of infrastructure as well as the cost of the required compensation such as relocating people. CBA is a prerequisite obligation if the projects are to be funded by European Union (EU) structural funds. (EUROPEAN COMMISSION, 2008)

### *2.2.2. Multi Criteria Analysis (MCA)*

Multi criteria Analysis originated in the fields of mathematics and operations research more than three decades ago. Its techniques are now well-developed and well documented. Sometimes the term Multi Criteria Decison Aid (MCDA) is also used. According to : (Department for Communities and Local Government: London, 2009)

> 'Multi-criteria analysis establishes preferences between options by reference to an explicit set of objectives that the decision making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved'

The goal to the multicriteria analysis is to find acceptable compromise solutions. There are different objectives social, environmental and economic which cannot be optimized at the same time. There are two different compromise solutions: a social compromise solution coming from value conflicts and a technical compromise solution coming from conflicting non-equivalent representations of the same policy options (Munda, 2004).

MCA provides a structured framework for decision analysis, which starts from defining the goals and objectives. At this point the best alternatives or options are selected. Then proper criteria are formulated to measure the effects of the different alternatives to the overall goals. After applying the desired weights, procedures and mathematical algorithms are used for ranking options.

### *2.2.3. Comparison of Techniques*

Compared to CBA, MCDA has at least these three advantages (Department for Communities and Local Government: London, 2009):

> '(1) by definition MCDA is multidimensional and can consider different and incommensurable objectives, such as sustainability, equity, and efficiency at the same time
>
> (2) MCDA is much more flexible in structure as well as aggregation procedures. For instance all indicators do not have to be valued in monetary terms. Instead, the original measurement units could be kept or normalized in different ways, which makes room for subjective components of the analysis
>
> (3) MCDA has the capacity to take into account qualitative variables. This is especially useful when uncertainty is an issue.'

On the other hand, 'the MCA methodology is vulnerable to prejudicial ranking of options and irrational tradeoffs' (Omega centre, 2010).

Also the allocation of weights may be problematic; as a particular stakeholder may dominate the analysis. Also aggregation techniques can reduce transparency. But most important it is impossible to reach to an optimum solution.

## 2.3. MULTI CRITERIA TECHNIQUES

### *2.3.1. Dominance*

Dominance occurs when one option performs at least as well as another on all criteria and strictly better than the other on at least one criterion. In principle, one option might dominate all others, but in practice this is unlikely

### *2.3.2. Multi-Attribute Utility Theory*

Provided that the criteria are independent there exists a real valued function U defined on the set A of feasible alternatives, which the decision maker wishes, consciously or not, to examine. This function aggregates the different criteria taken into account, so that the problem can be formulated as: $A \in \max U(gj(a)) : a$ where U(gj(a)) is a utility function aggregating the n criteria This method have been applied successfully in a variety of problems but its complicated so its used only by experts when resources allow it.

### *2.3.3. Linear Additive Models*

It is the most common used technique, because it is simple robust and can provide sufficient results. The linear model shows how an option's values on the many criteria can be combined into one overall value. This is done by multiplying the value score on each criterion by the weight of that criterion, and then adding all those weighted scores together. To do so once again the criteria must be independent.

### *2.3.4. Analytical Hierarchy Process*

This method is based on pairwase comparisons of different alternatives for the same criterion. It will be further discussed in Chapter 7.

### *2.3.5. Outranking Methods*

One option is said to outrank another if it outperforms the other on enough criteria of sufficient importance (as reflected by the sum of the criteria weights) and is not

outperformed by the other option in the sense of recording a significantly inferior performance on any one criterion.

### *2.3.6. Fuzy MCA*

This is an emerging category, but it has not yet prove its advantages to compensate for the complex calculations and difficulties to be used by non-specialist. According to the fuzzy logic varieties can take a true value ranging from 0 to 1 (Department for Communities and Local Government: London, 2009).

## 2.4. TIPS FOR USING MCA

While it is challenging to conduct MCA early on it can be highly rewarding as it can clarify the areas where additional data should be collected and where not. The first plain and reflexive model will initiate an evolutionary process that will shape and be shaped by the key players as more data are collected and the knowledge of the actors becomes deeper. Furthermore sensitivity analysis can be used to discover whether or not a conflict in a specific aspect of the project can influence the total decision. Finally, 'a requisite model is one that is just good enough to resolve the issues at hand. Less work should be done for modest problems that are of less importance, when time is short and resources are limited' (Department for Communities and Local Government: London, 2009).

# 3. AERIAL ROPEWAY TRANSIT AND THE REGION OF MAGNESIA

## 3.1. INTRODUCTION

Aerial ropeway transit (ART) is an aerial public transit technology in which cabins (also called carriers, vehicles, or cars) (Alshalalfah, Shalaby, Dale, & Othman, 2012) are suspended and propelled from above by cables. ART technology is being used for over a century, mostly to carry skiers and tourists in terrain-challenged recreational contexts (eg, gondolas/telepherique in ski resorts). In recent years, however, the concept of aerial transit these is also applied to non-Alpine but geographically constrained urban regions, where conventional transit service was deemed very difficult or unfeasible to implement.

A gondola lift, or as it is technically known a monocable detachable gondola, is a type of aerial lift in which the cabin is suspended from a moving loop of steel cable that is strung between two terminals, often over intermediate supporting towers. The cable is driven by a bull-wheel in the terminal, which is connected to an engine or electric motor. Gondolas are small cabins, set at regularly spaced close intervals. The systems are continuously circulating with cabins passing around the terminal bull-wheels. (Alshalalfah, Shalaby, Dale, & Othman, Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art, 2012)

## 3.2. ADVANTAGES – DISADVANTAGES AND COST OF AERIAL LIFT SYSTEMS

ART is not the solution for every transport problem but it has proved worthy for regions with natural barriers, for which it may be the optimum alternative. However, ART still has several challenges that limit its effectiveness and hinder its path to be a fully recognized transit mode. The following can be thought of as the main advantages of ART technologies compared to conventional transit modes: (Alshalalfah, Shalaby, Dale, & Othman, Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art, 2012)

1. It is a terrain-specialized transit mode that is suitable for overcoming natural barriers such as mountains, valleys, and bodies of water. ART could effectively help connect distant locations at similar or different elevations, which can boost the development of

mountain regions residentially, commercially and last but not least bring new visitors in the area, without the need for changing the mountainous landscape.

2. ART has a limited footprint (with the exception of terminal stations in some cases), as towers usually require minimal space and intermediate stations could be integrated into commercial buildings.

3. It is a relatively inexpensive technology and has fast implementation times.

Table 1: Investment cost per km for various transport modes (Alshalalfah, Shalaby, Dale, & Othman, Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art, 2012).

| **Mode Category** | **Investment cost (million €/km)** | |
|---|---|---|
| Bus | 0.45 | 0.55 |
| Tram | 4.5 | 6.00 |
| Metro | 36.4 | 31.00 |
| mdg (gondola) | 4.5 | 9.00 |

The investment cost required to construct a kilometer of a gondola lift may seem high compared to using common buses as an alternative. However, aerial lift can easily overcome natural barriers reducing the length of the line and thus the total cost. Furthermore the quality of service offered to the passengers is higher, as there are no delays due to traffic or weather. Also the waiting time is very small and the journey more comfortable and pleasurable. The vehicles are smaller all passengers are seated and they can enjoy the view to the region from above. To sum up aerial systems should not be compared with buses but with other more sophisticated modes of transport such as tram and rail and by doing so the first statement is valid.

4. Because of its aerial medium, ART does not need to follow the street topology, allowing for flexible network design that is not restricted to existing street alignments, and therefore reducing the total travel time of passengers by eliminating the need to travel on congested, long roads. For example, the travel time on the ART systems of Portland, Medellin, and

Hong Kong is substantially lower than the comparable travel time by using the street network, which saves the passengers extra travel times.

5. Its operation is automated, which allows for customizing capacity to demand and for relying less on the driver workforce.

6. It is energy efficient because it relies partly on gravity and counterbalancing methods for propulsion.

7. Its emission rates are low, as the ART cabins have no onboard engines/motors. ART technologies usually have one electric engine in one of the terminals to support the operations of the system.

9. It provides a smooth, quite ride, offering riders a very pleasant travel experience.

Despite its many attractive benefits, ART is still a relatively new transit technology in the urban environment. ART manufactures are improving their designs with a fast pace in the last years but there is still a lot that can be done.

1. The design and locations of ART stations need careful consideration. Terminal stations seem to have larger footprints than terminals of other transit modes. This is primarily attributable to the fact that ART terminal stations house maintenance bays and car yards that add to the space requirement. In the absence of new innovative solutions to reduce the terminal station footprint, their locations have to be carefully selected in areas with low space constraints. For intermediate ART stations, it would be desirable to design those stations to allow leapfrogging of cabins. The integration of ART stations with urban land use and with other transit modes is of prime importance. Finally, access to ART stations should be carefully designed to minimize disutility associated with access.

2. One important issue of ART is privacy (flying above private properties) and safety in case of emergencies such as power failure. The latter issue has been addressed by modern gondola and ART installations through the use of a backup diesel engine.

3. Nowadays almost all ART systems are consisting of single lines. But as ART is becoming a promising means of transport bigger and more complex ART networks will be proposed to satisfy the needs of transit. Thus, intersecting lines and transfer stations will be required. This is a challenging engineering problem that will require innovative solutions.

4. Similarly, the integration of ART lines with conventional transit systems poses some design challenges, although recent attempts seem to find some solutions.

## 3.3. CASE STUDIES OF EXISTING LINES

### *3.3.1. The Jounieh-Harissa Line in Lebanon*

It was constructed in 1964 to connect the port city of Jounieh, which today has over 110000 inhabitants with the village of Harissa. A famous religion monument named 'Our lady of Lebanon' is located there, which is one of the oldest and most visited touristic attractions of the country. The cable is 1570 m long and the altitude of the ending station is 530m. It can transfer 480 passengers per hour and per direction. The gondolas are travelling with an average speed of 3,15m/hour. The trip lasts around 9 minutes were one can enjoy the magnificent view of the bay. On the top, except from the monuments one can find restaurants, cafés, etc.

Figure 1: The Jounieh-Harissa line in Lebanon (Ive, 2015)

### *3.3.2. Taormina Cable Cars*

Taormina's public transportation has cable cars which are like bubble-shaped ski lifts and connects the center of Taormina near Porta Messina to Mazzaro'(at the bay, the beach of Isola Bella and the diving school of Taormina) in two minutes. The aerial tramway is called 'funivia' in Italian. The system was created in 1992 and it is the type monocable 'permanent connection' with two clusters of four cabins each with a capacity of about 680 persons / hour. The average number of passages per year is around 850,000 persons (Azienda Servizi Munocipalizzati Taormina). The Taormina cable cars operate Monday from 8.45 to 20.00 and Tuesday to Sunday from 7.45 to 20.00 and leave every 15 minutes. Cost is €3 for one-way ticket but there are also special tickets (e.g. 10 fares, weekly, monthly) for frequent users in order to save money (gotaormina.com & The Go-Group).

Table 2: Technical data of the Taormina cable car (gotaormina.com & The Go-Group).

| Model | Cable car with gondolas |
|---|---|
| Number of gondolas | 8 |
| People per gondola | 12 max. |
| Length horizontal | 701.30 m |
| Length raked | 725.32 m |
| Altitude difference | 170.50 m |
| Slope (maximum) | 68% |
| Distance from the ground (maximum) | 30.05 m |
| Maximum speed | 5 m/s |

### *3.3.3. Emirates Air Line, London*

The Emirates Air Line is a cable car link across the River Thames in London between Greenwich Peninsula and the Royal Docks. The service operates from 28 June 2012 and it can carry 2,500 people an hour. The total cost of the project was about €82million. The Dubai-based airline Emirates is sponsoring the cable car for 10 years at a cost of €49million and it is currently the only sponsor for the project. The deal is structured so that Transportation for London (TfL) will receive €4million ever year for the next nine years. (Transport for London, 2015).

Cabins arrive every 30 seconds and flights are approximately 10 minutes each way. The cars, which accommodate 10 people, arrive every 30 seconds, are accessible to wheelchair users and cyclists and the service is open seven days per week. The passengers can board from either the North Greenwich or Royal Victoria sides of the river (return flights are available) and they can use their Oyster and Visitor Oyster card. Between 28 March and 30 September there are Night Flights with extended flight durations and music and video in cabins to further enhance the in-flight experience (Emirates Air-Line, 2015).

According to the TfL's Head of the Emirates Air Line, Danny Price (Shane, 2013) by November 2013 it has carried over 3.1 million passengers since its opening and it is considered as one of London's success stories. Nevertheless figures from TfL obtained by Snipe under a Freedom of Information Act request, showed that for the week ending 19 October, 23,029 journeys were made on the Air Line, compared to 42,463 in the same period a year ago (Shane, 2013). Thus it seems that the trend over the period is downwards.

People use the Emirates Air Line throughout the day to get to and from work, leisure activities in the area and just for the experience. However critics of the cable car have dismissed it as an impractical transport solution, which appeals to tourists at peak times but it can't generate enough passengers as it does not attract a large number of cross-river locals or commuters due to its location and the cost of tickets (Beard, 2013).

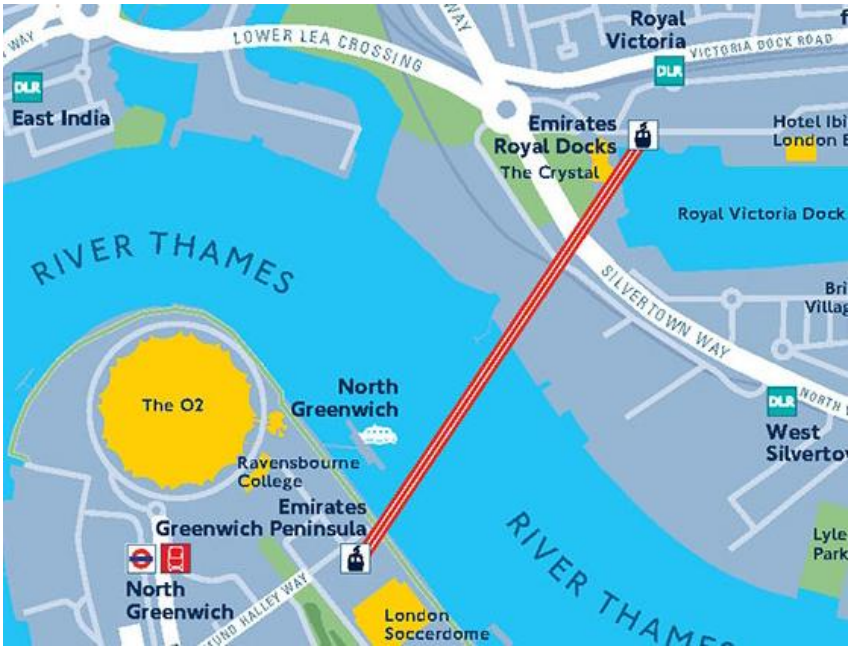


Figure 2: Location of Emirates Air Line (Transport for London, 2015)

### *3.3.4. Maokong Gondola, Taiwan*

The Maokong Gondola is a gondola lift transportation system in Taipei, Taiwan, operates between Taipei Zoo and Maokong. The service began to operate July 2007 and the facilities of the gondola built by the French company Poma. The Maokong Gondola System is shaped like the number '7', is 4.03km long and has 4 passenger stations (Taipei Zoo Station, Taipei Zoo South Station, Zhinan Temple Station, and Maokong Station) and 2 ancillary stations where the gondola changes direction and are not open to the (Taipei Rapid Transit Corporation, 2015). The fares are based on the number of stations traveled and in addition concessional fares are available to disability and seniors aged over 65. Depending on the system speed, from Gondola Taipei Zoo Station to Maokong Station, the journey takes 17–37 minutes (running speed is 2–5m/sec) (Taipei City Government, 2015).

On November 2010 a new version of the Crystal Cabin also known as 'Eyes of Maokong Gondola' was launched. More specifically30 cabins have been retrofitted with thick glass

bottoms and they operate with a service interval of two to four minutes. The capacity is limited to five persons per cabin (Taipei Rapid Transit Corporation, 2015).

Just a few months after the launch of the system (September 2009) Maokong Gondola's total transport capacity reached 1 million passengers, until December 2010 the total transport capacity reached 8 million passengers and in August 2011 10 million visits. The excellent availability rate of the Maokong Gondola has been confirmed in a letter from the President of POMA on April 2012, where they confirmed 'that the service have reached the best availability rate recorded to date on any cable car system, reaching an average of 99.9% over the past two years 2010 and 2011, especially taking into consideration the highly complicated installation consisting of five successive sections which is unique in the world' (Taipei Rapid Transit Corporation, 2015).

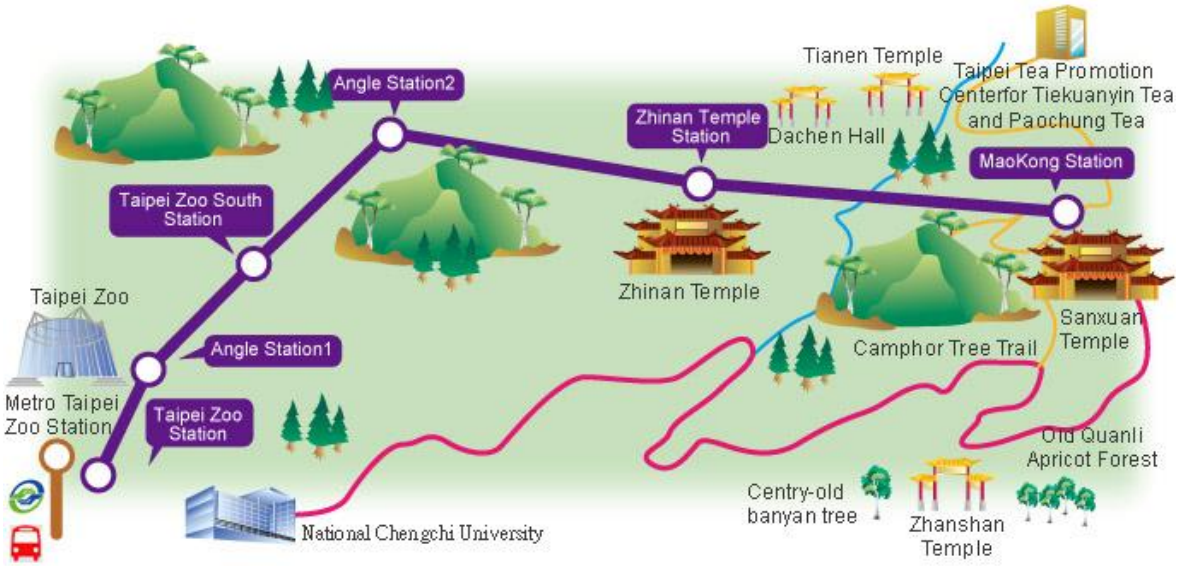



Figure 3: Maokong Gondola Route Map (Taipei Rapid Transit Corporation, 2015).

### *3.3.5. Masada Cableway, Israel*

The Masada Cableway in Israel lifts visitors just 290metres upwards, from the bottom station at 257m below sea level up to the plateau of Masada at 33m above sea level where lies the ancient Jewish fortress town's ruins. Thus it is the holder of the world record for the lowest aerial tramway on the planet. The long cableway is 900m, the duration of the trip is three minutes, each car accommodates 81 people, and the frequency is 30 seconds. The original line was built in 1971 with a support pillar and two cabins but it was replaced

in 1998 by a cableway without any support pillar. The service can carry 1200 people an hour (remontees-mecaniques.net, 2009).

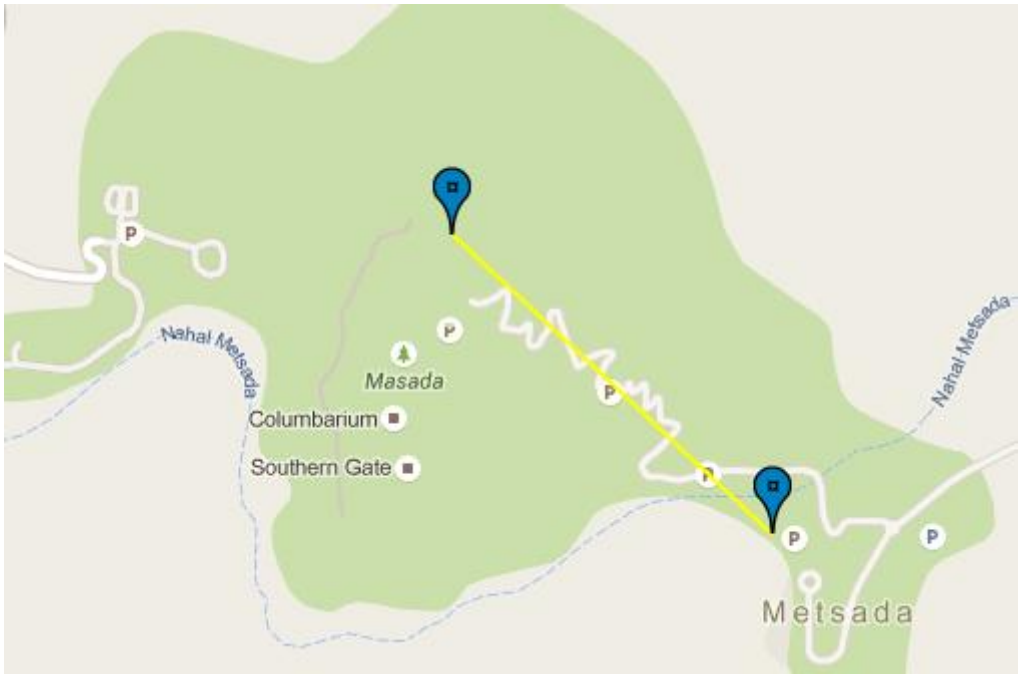



Figure 4: Route of The Masada Cableway in Israel (remontees-mecaniques.net, 2009)

### *3.3.6. Roosevelt Island Tramway, New York*

The Roosevelt Island Tramway was created in 1976 as temporarily solution until the opening of the subway station in order to transfer residents between Roosevelt Island and Manhattan, but it continue to operate even after the completion of the subway in 1989 because it was too popular. Over twenty years later, the Tram has serviced over 20 million passengers. The tramway is now run by Roosevelt Island Operating Corporation (RIOC) but uses the same MetroCard System as Metropolitan Transportation Authority in Manhattan. Fares are the same as the New York City subway (Richman, 2007).

The Tramway travels a distance of over 1000metres at an average speed of 16m/hour in 4 1/2 minutes, linking Long Island City, Queens, and 59th Street in Manhattan and is accessible at 60th Street and Second Avenue. The tramcar can hold about 115 people standing and about 10 sitting whilst offering a unique view of New York City. (Richman, 2007).

The tramway was disrupted by a series of power outages two times in eight months between 2005 and 2006. The first taking place in September 2005 when 80 passengers were trapped for approximately 90 minutes and the second incident in April 2006 leaving

70 passengers trapped for over six hours. As a result the tramway was shut down for a period of six months while its backup electrical system was refurbished (PAUL, 2014).

On March 1, 2010, the tramway was reclosed as part of a €25 million project to upgrade and modernize the system, with the help of the French company Poma. The project took nine months to complete and reopened November 30, 2010. The new modern tramway boasts bigger windows, faster travel times, sturdier cabins and the ability to run both cars independently increasing rush-hour service (PAUL, 2014).

## 3.4. CREATING AN ART NETWORK IN PELION: DISCUSSING AND UPDATING THE 2001 FEASIBILTY STUDY

The municipal developmental company of Magnesia and the University of Thessaly conducted a preliminary study in 2001 to explore the possibility of creating an aerial lift system to connect the municipality Volos with the mountainous region of Pelion and specifically with the main settlement of Portaria, Macrinitsa and Chania, as well as the ski resort.

These areas are very close to the municipality and attract a lot of visitors throughout the year, especially in the winter. The road network passes through historic villages causing congestion, noise and disturbing residents and tourists. Parking is a pressing problem as there are very few spots. The demand is not distributed, but most of visitors come only for the weekend. Consequently, cars are parked and double parked on road-sides making them narrower and traffic even more difficult.

The study has concluded that the preferable ART technology for the region was monocable detachable gondola. The system should meet the following targets (Πανεπιστήμιο Θεσσαλίας, 2001):

- Provide a desirable alternative for residents and visitors of the area compared to street traffic(private cars and local buses)
- Provide a fast connection to the ski resort
- Attract new tourist in the region

Finally, in the long term the gondola lift shall become the backbone of a multimodal transport system.

A total of nine alternatives were proposed and discussed. We have already mentioned the importance of choosing the right position for stations as they have a large footprint. Other important aspects for a proper alternative is respecting privacy (not flying over private property) minimizing damage to the ecosystem, and reducing investment, cost and construction difficulties. Last but not least, it was considered important that the end station could be diverted to intermediate station if the system will be expanded.

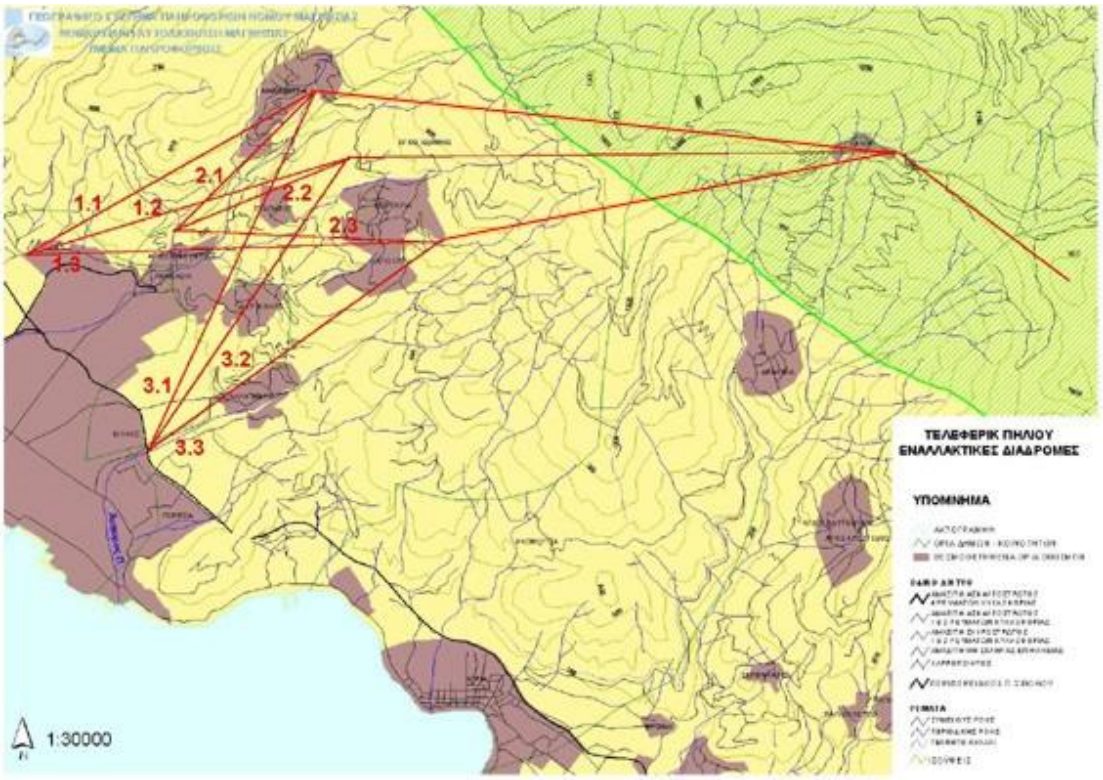



Figure 5: Alternatives for an aerial lift line between the city of Volos (at the left of the map) to Portaria/Makrinitsa (at the center) and Chania, Agroleukes (at the right) (Πανεπιστήμιο Θεσσαλίας, 2001).

The preferred option is 2.2 as shown in the map above. Starting or low level station is Anomalia located around 4 kilometers North West form the city centre in an altitude of 146m. It is easily accessible as it is located next to the provisional road Volos-Makrinitsa. It can be intergraded with urban transport with the expansion of an existing line or with shuttle buses. The site is owned by the public and has sufficient space for a parking lot. However, the space is sufficient for around 300 cars, whereas it is expected that the peak demand may reach to 800-900. In this sense, a parking lot has to be constructed. The route will be as short as possible only around 2100 meters to the next station and won't pass over private properties. The implementation does not pose considerable technical challenges

and the passengers can enjoy a spectacular view of Pagasitikos gulf and mountain Pelion throughout the ride. The first intermediate station a location between the two major poles Makrinitsa and Portaria seems more preferable as it combines lots of advantages with minor disadvantages. First of all the area lies less than 1.5 kilometer from Makrinitsa (Brani) and around 1 kilometer from Portaria (central square). A shuttle bus can easily connect the station with those areas. There is plenty of space for the entire necessary infrastructure. From here the expansion of the line towards the mountain top is easy and straightforward. Also this area has recently been developed with sports facilities and café. Regarding Chania station the choice was easy as the location which was selected had a lot of advantages and no profound disadvantage. However, for the last or upper level station in the ski resort the debate is still open. There are two options. It can be built in the mountain top with excellent view and optimum location to expand the line east, while construction and maintenance will be more difficult and costly there. On the other hand it can be constructed in of the ski resort without the above mentioned advantages and disadvantages.

## 3.5. TOURISM IN THESSALY AND IN THE REGION: DATA AND PROSPECTS

The region of Thessaly has a great potential for sustainable touristic development in the competitive international environment. It has a great natural and cultural dynamic that favors the development of alternative tourism even in areas already developed. (ΙΕΤΕΘ/EKETA, 2013).

To fulfill this potential among others it is necessary to eliminate the bottlenecks in transportation by connecting touristic attractions (cities, ski resorts, historic villages) (ΙΕΤΕΘ/EKETA, 2013).

## 3.6. SCENARIO ANALYSIS

A lot of alternative routes for the construction of Pelion Cableway were proposed. The preliminary study had examined the most prominent of them and found that the most of the proposals would face construction difficulties. In some cases the proposed area for the starting or the end station was not sufficient. While in others the cableway would need to cross Mega Rema and/or above existing houses. Those options would significantly increase the cost of the project and the risks to the environment while decreasing the desirability of the ride. So the authors had concluded that those should be excluded from

the selection process and finally they agreed that one of them was optimum. This will be our base scenario for the multi criteria evaluation and from now on it will be called case C. Case B will be similar to case C but this time the cableway will not continue till the ski resort in the top of mountain Pellion but the last stop will be at Portaria/Makrinitsa. Furthermore, case A will be analyzed to compare the prospects of the region if the cableway will not be constructed. To sum up 3 cases will be examined:

- A: no cableway
- B: cableway only until Portaria/Makrinitsa
- C: cableway till ski resort

Other aspects of context concern the larger political, economic, social and technological (PEST) environments in which the analysis is to be conducted. Scenario analysis of how key PEST features might develop in the future, and so affect the ability of the proposed options to achieve the desired future state, sometimes stimulates key players to develop options and consider objectives that would otherwise have been ignored. Scenario analysis can also help participants to acknowledge uncertainty about the future, and thereby make assumptions about outcomes more explicit, thus directing attention at implications which may otherwise be missed.

This is a project that will shape the area for years, whose influence can last for a period over half a century. Assuming business as usual is not a wise choice as things can change drastically in the future. The change can be gradual but cumulative like the climate change. Or it can be violent and unpredictable like an economic collapse. A researcher should be able to handle the uncertainty and risk that come along with complex infrastructure projects. The future is unpredictable but scenarios can be formed that are trying to sketch it. From those tools one can get precious insights that will help the decision maker to make the right decision regarding the long-term utility of the investment. They can help him avoid pitfalls or encourage him to make a decision that will exploit more opportunities in the future. For our case two scenarios were formed. The first one takes into account the financial risk. This choice is profound because Greece is facing an unprecedented financial crisis. It is possible that Greece will not manage to overcome it and will be forced to abandon the Euro zone. The second choice is also very reasonable. Our planet has already started to face a severe climate change. Global warming is influencing each and every region and has started to cause lots of trouble already. However, it can also create winners. For example mountain Pellion might attract more daily visitors coming from nearby areas

and wishing to escape from high temperatures in the cities or the lowlands. On the other hand the ski resort will be a looser as there won't be sufficient amount of snow to operate through the winter season.

## 4. STAKEHOLDER ANALYSIS

There are situations where no one is wholly in charge, but many are involved, affected, or have some partial responsibility to act. Policy, or the art to address solvable problems is then required to link technical rationality with political rationality in order 'to mobilize support for substance'. A very helpful way to do so is by conducting stakeholder analysis (Bryson, 2003).

At this point it would be useful to define the notion of stakeholder. There are two broad definitions used in public and non-profit management literature. The first one defines stakeholders as those individuals or groups who have the power to affect the future of an organisation, implying that those who do not have such power do not qualify as stakeholders. The other definition has a clear ethical dimension. According to such a definition, stakeholders are a wider range of individuals and groups including the 'nominally powerless' to which certain responsibility is owed. The Word Bank in its recommendation for a project appraisal calls for distinguishing stakeholders: 'Winners and losers: Who enjoys the music? Who pays the piper?'

Although there are some concerns on the procedure and its results which for some are considered rigmarole and not too surprising respectively, it is advisable to be undertaken and can be considered a smart practice.

There are a lot of techniques that have been developed. Each of the techniques has a different purpose and reveals some things, while hiding, or at least not highlighting, others. Like any other technique designed to aid strategic thinking and acting, stakeholder analyses must be undertaken skilfully and thoughtfully, with a willingness to learn and revise along the way (Bardach, 1998).

For our case we are going to use the power versus interest grid. These grids array stakeholders on a two-by-two matrix where the dimensions are the stakeholder's interest, and the stakeholder's power to affect the ART line. This procedure creates four distinct categories of stakeholders: Players who have both an interest and significant power; subjects who have an interest but little power; context setters who have power but little direct interest; and the crowd which consists of stakeholders with little interest or power.

Last but not least a well known syndrome for investments in transport projects is the NIMBY syndrome (Not in My Backyard). Taking into account the goals of the local citizens is crucial ex-ante in order to cope with these goals and to compensate if necessary.

The stakeholders that were identified are:

**Public sector**

- Municipality of Volos
- Regional goverment of Thessaly
- Ministry of Infrastructure, Transport and Networks
- Locan coucil of Makrinitsa and Portaria
- Municiplaity of Zagora Mouresi
- European Union
- University of Thessaly

**Rrivate sector**

- European Investment Bank
- KTEl Magnisiasa (intercity buses )
- Astiko Ktel Volou (municipal buses)
- Kentauron Oros inc (company peratin the ski resort)
- Hotel Owners Association of Magnesia
- Taxi owners
- Touristic buses (touristic agencies)
- Cruise industry
- Shops restaurants and cafe owners
- Constrution companies-suppliers of construction materials

**Champers unions and other groops**

- Technical champer of Greece
- A.PO.DRA.SIS (ecological organizations of citizens of Stagiates)
- Enviromental iniciative of magnesia

**prospective passengers, and road users**

- Local residents
- Foreign visiotors
- Car drivers

The goals and the motives of each stakeholder will be analyzed. Then stakeholders will be categorized to winners and losers based on whether or not their goals and desires can be promoted or blocked by the project. Also the power and the interest of each for the project will be assessed. There are two alternatives for the project which were described above. The interest of stakeholders may vary for each one. So we will use the term interAll for case C interB for Case B. Finally their key goals will be highlighted.

### *4.1.1. Public Sector*

Municipality of Volos: Winner

The proposed line connects the agglomeration of Volos with important settlements and attractions inside the municipality.

On the other hand, the municipality is lacking the necessary funds. It can offer municipal land, though for the construction of the station (for example for the intermediate station in Portaria/Makrinitsa). If the project is funded by the public sector (national and European funds) then the municipality can participate in a company that will be responsible for operating ART line. Thus it can ensure fair prizing for groups with restricted income and residents of mountain villages.

InterAll: High

InterB: High

Power: High

Key goals: Provide sustainable transportation inside the municipality, attract tourism, address and minimize any concern of the citizens for the project.

Regional Government of Thessaly: Winner

The proposed line can be a pilot and innovative project that promotes sustainable and alternative tourism such as active tourism (hiking, skiing, etc) ecological, rural and traditional cucine tourism. Also it can help extent the touristic season, bring new tourist to the region and increase the local added value. Furthermore reliable, comfortable and low carbon transportation can reduce the feeling of isolation for residents of mountainous villages. Not only new jobs will be created in the construction and operating phase but also the region will acquire the necessary know-how. On the other hand the region will invest valuable recourses in a specific area already developed. However, it can be justified as the area has still a lot of potential and unused dynamic.

InterAll: Low

InterB: High

Power: High as decisions for allocating EU funds are made in this level. The structural funds for Thessaly for the period 2014-2020 devoted to build and modernize infrastructure

for economic and societal development are €104,20 million. Also the structural funds allocated for the protection of the environment can be used which amount to €80,30 million.

Key goals: Promote low carbon transport systems and multimodal centers, reduce transportation cost and ensure cohesion and equal developmental opportunities among the region. Connect isolated areas with the core. Attract new tourist and increase synergies between areas and touristic products. Help attract private investment and promote innovation.

Ministry of Infrastructure Traffic and Networks: Winner

The new line can act as a pilot project for lots of mountain and touristic areas of Greece. The experience gained in that project and the actual ridership can become a guide to promote, or reject this technology. It won't require a considerable amount of funding. The operation cost will be most probably covered by the revenue from tickets and advertisement.

InterAll: Low. It is one of the many proposals for new infrastructure in Greece

InterB: High as a new pilot project

Power: Low. Greece is facing a severe financial crisis and the central government lacks the funds to support innovative projects.

Local council of Portaria/Makrinitsa: Winners

These villages will reap the most benefits of the project. The infrastructure will establish a fast comfortable and reliable solution alternative for commuters residents and tourists. An increase especially in day visitors from the surrounding areas is expected as well as cruise tourists from the port. These historic settlements will be relieved from parked cars. Portaria especially will be benefit from a reduction in through traffic.

InterAll: High

InterB: High

Power: Low

Key goals: Take advantage of the opportunity to increase number of tourists that visit the area and increase income from tourism, preserve the natural environment and the beauty of the historic settlements, become an attractive place for new families to settle.

Municipality of Zagora-Mouresi: possibly Winners

The project will not directly affect this area of mountain Pellion, not in its first face at least. They will be interested as the success of the first face can lead to upgrading the network with new branches and lines to serve their area also. In the short term the municipality can take advantage of the fact that gondola will bring publicity and new visitors of Mountain Pelion and persuade some of them to include their municipality in their exhibition. In the worst case the new infrastructure will offer them no benefit, but can do no harm either.

InterAll: Low

InterB: Low

Power: Low

European Union

European Union is promoting low carbon economy, sustainable transport and cohesion. Those things make the project desirable and can be funded by the European structural funds. Each successful and innovative project is strengthening Europe's argument for sustainable transportation and the benefits of multimodal transport systems.

InterAll: Low (the project is very small for the European scale)

InterB: Low

Power: Low. The EU gives the guidelines and the vision for 2020 it's up to regions to decide what suits their needs best.

Key goals: Structural funds must be used in an effective and efficient way to promote sustainable development.

University of Thessaly: Winner

Universities should not only provide knowledge but ensure that the society takes advantage of the spillover effects. In this project the university is a pioneer. It has actively taken place

from the beginning and the preliminary study offering fresh ideas and a lot of alternatives to be discussed. The qualified staff and the active students can assure that design and implementation will be the best possible. Also, the university can evaluate the project after its first phase and the conclusions will be used for improved results in the next phases. To sum up university will be a winner because it will participate actively in an innovative project so the professors and the students will take advantage of the know–how. The challenges of the project will become stimuli and motivation for new research. Local community will acknowledge the role of the university and so its reputation will rise.

InterAll: High

InterB: High

Power: Low

Key goals: Support development plans with the necessary scientific knowledge. Exploit challenges as opportunities to acquire knowledge and know-how.

### *4.1.2. Private Sector*

<u>European Investment Bank (EIB): Winner</u>

European Investment Bank can offer loans for the implementation of infrastructure project provided that they fulfill at least one of their public policy goals:

- Increase in growth and employment potential – including SME and Mid-Cap support
- Economic and social cohesion by addressing economic and social imbalances, promoting the knowledge economy/skills and innovation and linking regional and national transport infrastructure
- Environmental sustainability - including supporting competitive and secure energy supply
- Action for climate-resilient growth

The ART line can help achieve the first the second and the fourth goal so it could be a very interesting project for the bank.

EIB has also set a critical borderline for project financing. When the total cost of the project exceeds 25million it is consider a major project and the developers should contact

EIB directly. On the contrary for smaller investments local public authorities can receive intermediated loans from local partners of EIB (European Investment Bank, 2015).

InterAll: Low

InterB: Low

Power: High

KTEL MAGNISIAS (regional and intercity buses): Looser

Today 'KTEL magnisias' is the only provider of public transport in the area of mountain Pelion. This is going to change with the installation of an ART lift. Ridership is going to decrease in this segments. Fortunately for the bus company these routes constitute only a small percent of the company's transport duty. There are currently over 45 destinations that are served by KTEL only in the prefecture of Magnesia. Among them, they will only face competition on three of them. Also, they would have the opportunity to operate the shuttle lines from the stations of the ART line to the end destinations of the users and complement their loses. They can benefit from the expected increase in tourism in the area of Pelion due to the new infrastructure and increase their ridership in other routes.

Interest: Medium. It is affecting them but it is not so important.

InterAll: Low

InterB: Low

Power: Low

Key goals: Maintain leader position as a transport service provider in the next decade.

Astikon KTEL Volou (AKV) (municipal transportation): Winner

The suggested fixed track system will act as an advertisement for public transportation. In that case AKV can benefit from that trend. One of their lines that end near the lower level station will become a feeder route for the new system, thus increasing ridership. AKV can also participate in the company that will operate the line.

InterAll: Low (profitability isn't sure in operation phase)

InterB: High

Power: Low

Key goals: Persuade citizens of Volos to live the private car and use public buses.

Tourist bus owners and tourist agencies in general: Winner

The new infrastructure will allow the drivers of tourist buses to park their vehicles safety in the ART parking station and allow their riders to use the ART line to reach Portaria and Makrinitsa. They can enjoy a double benefit. Not only will they avoid the narrow streets of Pellion, but also they will attract more who would be interested for a trip to Pellion due to the new attraction.

InterAll: Low

InterB: Low

Power: Low

Key goals: Increase profits

Cruise industry: Winner

In this group belong all those professions that provide services for passengers of cruise ships that arrive on the Port Of Volos. They include tourist agents, bus drivers. According to data from the Port authority the number of cruise tourists that arrive vary ranging from 10000 to over 70000 per year (Οργανισμός Λιμένος Βόλου ΑΕ, 2014) see also table 17. The overall trend is positive though which can be strengthened by ART. If we assume that averagely 60000 thousand cruise tourists will arrive every year and 1/3 of them will chose to visit Pellion. Then a market of 20000 persons will be created for the tourist agents. There will be a need for a variety of services. First of all buses to transfer them to and from ART station. Second tour guides to help them explore the area and learn interesting facts. Finally thematic events can also be organized. To sum up the industry will have a chance to increase and support local economy.

InterAll: High

InterB: High

Power: Low

Key goal: Turn Volos to an established intermediate port for cruise ships. Encourage cruise tourists to explore both Volos and Pellion during their stay, even if that’s for a few hours only.

Taxi owners: Winner

Nowadays very few use a Taxi to reach Portaria/Makrinitas (or the ski resort). So taxi drivers have almost nothing to lose from the new line. However, the location of the lower level station in the outskirt of the agglomeration can become a very lucrative and profitable route for them. For example passengers of cruise ships would find taxi as an appealing mean to reach the lower level station. Their income is usually high and they have very few hours available in ports for sightseeing. Also, taking a cab would be the choice of some passengers to transfer them to their final location especially if they are travelling with equipment.

InterAll: Low

InterB: Low

Power: Low

Key goals: Survive during the financial crisis were people use taxis less while fuel prices are constantly high.

'Kentauron Oros inc' (company operating the ski resort): Winner in case C, Looser in case B

This company is particularly interested in the line providing that its last station will be near or even inside the ski resort. This investment would probably make the ski resort one of the top winter resorts in Greece. First of all it would be easily accessible even with hearse weather conditions from the nearby city of Volos. On top of that Volos is located in the centre of Greece and it is easily accessible from the larger metropolitan areas in the country. The ART will allow the skiers to combine winter sports with the chance to explore mountain Pelion and its historic villages, thus providing a unique experience for them. Last but not least, the easy and pleasant ride to the mountain top can also attract persons that have never tried winter sports before.

The resort can also be relieved from cars that are parked in the nearby area which is very constrained and not sufficient to meet the peak demand. In the midterm however the resort would have to turn to other forms of sustainable tourism to survive and extent its touristic season.

InterAll: High

InterB: Low

Power: Low

Key goals: Development of the ski resort, adjust to changing climate conditions

Hotel Owners Association of Magnesia: Winner

The project is going to offer a significant boost to the tourism of the region. Besides a reliable mean of transport it can also act as a new attraction. It therefore provides an opportunity to increase the number of overnight stays of visitors in the area.

InterAll: Low

InterB: Low

Power: Low

Key goals: Increase the number of overnight stays and the added value of their services.

Construction companies supplier of construction Materials: Winner

They will be the first that reap the benefits. It would be a challenging project allowing them to employ their stuff and acquire know-how. The construction materials that will be used for the infrastructure will be mainly steel and concrete. Those two materials are produced by local firms thus maximizing the local added value of the project.

InterAll: Low

InterB: Low

Power: Low

Shop restaurant and café owners: Winner

The project is going to be a lifetime opportunity for those businesses. It can accommodate day travelers from Volos, the region of Thessaly, or passengers of cruise ships to reach them easily and with low cost. Moreover, those who used to drive can now enjoy their drink and use public transportation to return home with safety. On top of that those businesses won't need to provide a lot of parking spots for their customers anymore, which

will relieve them from a heavy burden. As a result of the above, one can assume that the profits of this group will rise and new firms will open.

InterAll: High

InterB: High

Power: Low

### *4.1.3. Other Groups and Organizations*

A.PO.DRA.SIS (ecological organizations of citizens of Stagiates), Environmental initiative of Magnesia and others: Losers

The project will require the deforestation of around 10 hectares. On top of that, according to the current design which is not the final the line can cross over some houses in the edge of Stagiates village. Also, a lot of people that love nature are displeased with man-made structures. They may argue that the gondolas and the towers will spoil the beauty of the environment. The above nature mentioned arguments would probably cause some environmental groups and citizens to react and oppose the project. However, their discomfort should be eased because during the operation the project is expected to reduce car traffic and thus noise and air pollution. On top of that they can use the new mode to reach the mountain and enjoy walking and other activities there more often. There are also funds allocated for retrofit purposes. Bushes and plants will be planted. According to the financial scheme that will be chosen there may be more funds available to improve the environmental quality and mitigate the effects of construction.

Interest: High

Power: High (they can delay the project with legal action)

Key goals: Preserve the natural beauty of mountain Pellion so that our grandchildren can enjoy it.

Technical chamber of Greece: Winner

The technical Chamber of Greece has the role of state's technical advisor. This is a complex project that requires the expert views of its members. They can help in the design phase and help solving the problems that will arise. They can also propose alternatives that will enable the line to carry also freight efficiently. Finally the discussions for the long

term prospects of the network can be ideally accommodated here. It is also an innovative project which will give the engineers the ability to acquire knowledge.

InterAll: Low

InterB: Low

Power: Low

### *4.1.4. Users*

Local residents: Winners

They will have a more comfortable and faster alternative to move from Portaria/Makrinitsa to Volos or vice versa. It would also be cheaper. For those that do not possess a car the difference would be tremendous. They would have the option to move at any time in the day instead of choosing one of the three scheduled KTEL busses that serve the area today. Finally they would have a chance to enjoy their food and drinks and return home with safety using public transportation. The trip from Portaria/Makrinitsa to the ski resort will take quite a long time. It is a route which serves very few permanent residents and there are only a few taverns in Chania. For the most it would be a trip that they will be willing to do only a few times. So probably they will not be willing to pay an extra fare to have this option.

InterAll: High

InterB: High

Power: Low

Car drivers: Winners

It would be also beneficial for those who would still choose to drive their car to arrive in Portaria/Makrinitsa, because they would enjoy a route with less cars and especially touristic buses. Probably, unless the municipality decides to decrease the available parking spots it would be easier to park at their final destination. However, some may prefer that funds would be given to upgrade the road network of mountain Pellion.

InterAll: Low

InterB: Low

Power: Low

Foreign visitors: Winners

They would have a chance to enjoy a spectacular view and gain an unforgettable experience.

InterAll: High

InterB: High

Power: Low

Table 3: Case C: InterAll-Power

| Interest | Subjects | Players |
|---|---|---|
| High | Local Council of Portaria/Makrinitsa<br>University of Thessaly<br>Cruise Industry<br>Foreign Visitors<br>Shop Restaurant and Café Owners<br>Local Residents<br>Ministry of Infrastructure Traffic and Networks<br>Kentauron Oros(ski resort company) | Municipality of Volos<br>Environmental organisations |
| | Crowd | Contest Setters |
| Low | Municipality of Zagora-Mouresi<br>European Union<br>Ktel Magnisias<br>Astikon Ktel Volou<br>Tourist Bus Owners<br>and Tourist Agencies in general<br>Taxi owners<br>Hotel Owners Association of Magnesia<br>Construction Companies Supplier of Construction Materials<br>Car Drivers | Regional Government of Thessaly<br>EIB |

Low → High

Power

Table 4: Case B: InterB-Power

| | Subjects | Players |
|---|---|---|
| High | Ministry of Infrastructure Traffic and Networks<br>Local Council of Portaria/Makrinitsa<br>University of Thessaly<br>Astikon Ktel Volou<br>Cruise Industry<br>Foreign Visitors<br>Local Residents<br>Shop Restaurant and café owners | Municipality of Volos<br>Regional Government of Thessaly<br>Environmental organisations |
| | Crowd | Contest Setters |
| Low | Municipality of Zagora-Mouries<br>European Union<br>Ktel Magnisias<br>Car Drivers<br>Tourist Bus Owners and Tourist Agencies in general<br>Taxi Owners<br>Hotel Owners Association of Magnesia<br>Construction Companies supplier of Construction Materials<br>Kentauron Oros(ski resort company) | EIB |

Interest

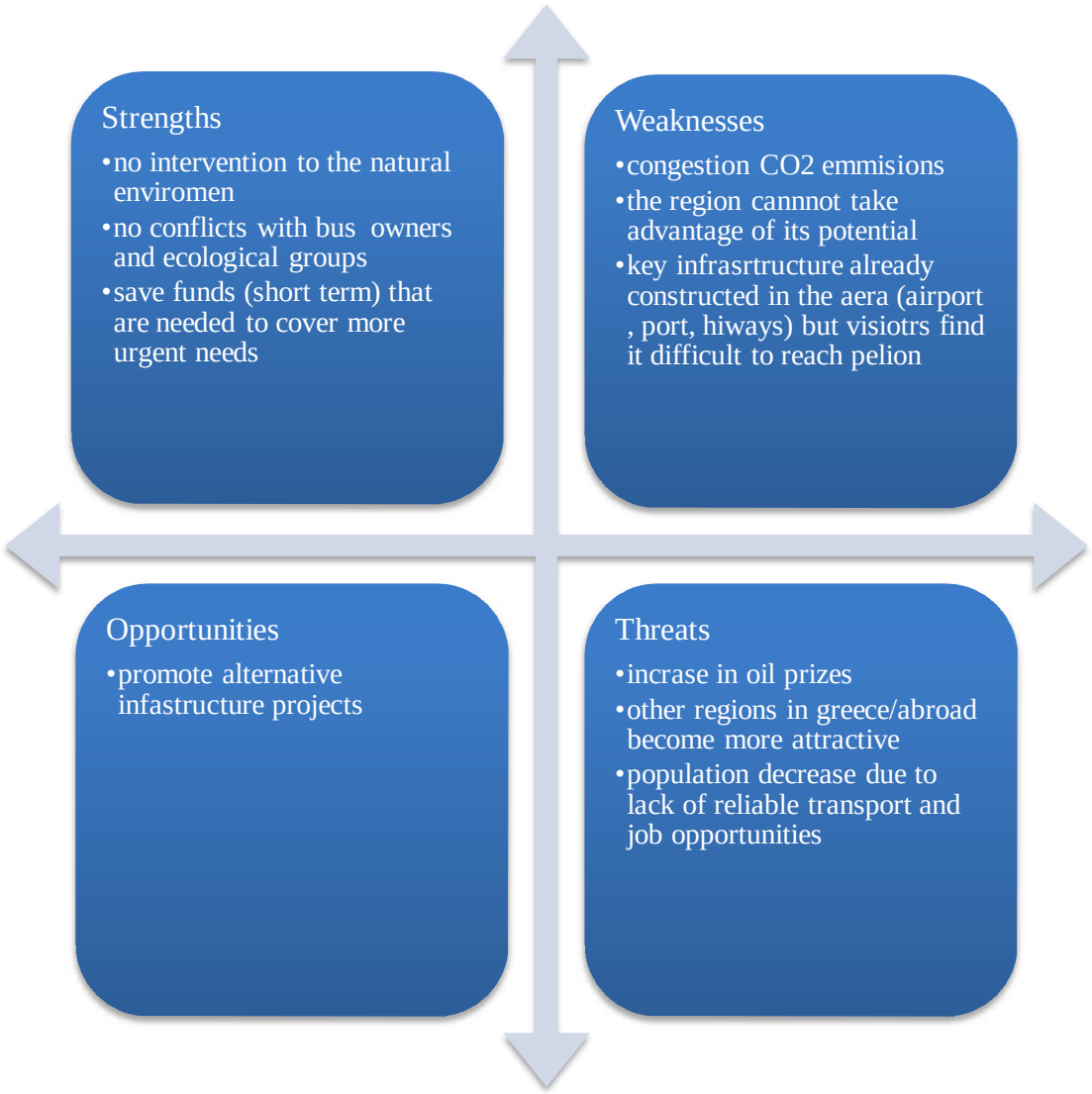
Low → High

Power

## 5. SWOT ANALYSIS

SWOT (Strengths Weaknesses Opportunities Threats) analysis is a useful tool that helps researchers to summarize compare and contrast strength and weaknesses of the proposed solution, as well as the opportunities and threads arising from the outside environment. It will be conducted for all the three cases.

### 5.1. CASE A



## 5.2. CASE B

## 5.3. CASE C

# 6. MULTI ACTOR MULTI CRITERIA ANALYSIS

## 6.1. METHODOLOGY

Multi actor multi criteria analysis (MAMCA) is a suitable method for the evaluation of transport projects. The first step in the MAMCA approach is the definition of the problem and the identification of the alternatives (step 1). The methodology differs from the classical approach of multi criteria decision aid (MCDA) in the explicit introduction of stakeholders in a very early stage (step 2). These stakeholders will be a key to identify the criteria, which are here equal to the objectives of the stakeholders. The weights that have to be given are representing the importance the stakeholders are attaching to these objectives (step 3). The stakeholders will also get the opportunity to discuss the alternatives. New alternatives can be entered as requested by the stakeholders (step 1). In the fourth step, for each criterion, one or more indicators are constructed (step 4). The measurement method for each indicator is also made explicit (for instance, willingness to pay, quantitative scores based on macroscopic computer simulation, and so on.). This allows measuring the performance of each alternative in terms of its contribution to the objectives of specific stakeholder groups. Steps 1 to 4 can be considered as mainly analytical, and they precede the 'overall analysis', which takes into account the objectives of all stakeholder groups simultaneously and is more 'synthetic' in nature. The fifth step is the construction of an evaluation matrix, aggregating each alternative contribution to the objectives of all stakeholders. Next, the MCDA yields a ranking of the various alternatives and reveals the strengths and weaknesses of the proposed alternatives (step 6). The stability of this ranking can be accessed through a sensitivity analysis (Macharis, Witte, & Ampe, 2009).

It is often felt necessary to also give a weight to the stakeholders. However, in order to show that the points of view of all stakeholders are equally important, the weights are usually set equal for every stakeholder (group). Performing a sensitivity analysis on these weights can lead to new insights. When the government is one of the stakeholders, which is usually the case in the evaluation of transport projects, one could say that this stakeholder represents the society's point of view and therefore this should be the one to follow.

## 6.2. IMPLEMENTATION

Steps one and two have been undertaken in previous chapter. For the next step it would be necessary to contact the stakeholders to identify their criteria and the weights they would attribute to them. However, that cannot be completed within the boundaries of this study. This would require a large presentation of the project and the proposed alternatives to various stakeholders and personal meetings with those who will not be able to attend. Then they would have to make comments, give feedback, probably come with a fresh alternative etc. Not only does this study lacks the means to accomplish such procedure but also it would be premature as it would allow stakeholders to from a false impression that the project is about to start in the next years. The purpose of this study is mainly academic. Our goal is to learn how we can use various techniques to evaluate a project. The case study helps to apply theoretical knowledge into a realistic situation. So for the purpose of the study assumptions on stakeholder preferences will be made. Thus a simulation of the technique will be presented. Regarding the two options it is obvious that case B is preferable than case C. AHP has proven it already. So this method will be used to verify this assumption.

First of all stakeholders will be placed in groups. The first group will be composed by the various levels of administration and governance units. In this group also belong public consultants such as the university and the technical camber. They want to compare and contrast cost and benefits for the project so they would allocate the weights equally among those two issues. Also direct impacts count twice as more as indirect ones. Taking all these into account 1/3, of the total weight is allocated in financing the project, while 1/6 in dealing with issues regarding land acquisition and flying over private properties. Regarding the benefits the benefits the weights are allocated equally between promoting sustainable mobility (1/6), providing a boost for tourism in the area (1/6) and users satisfaction, which consist of travel time, cost and comfort(1/6).

The second groups are formed by prospective users of the infrastructure locals, or tourists as well as those who want chose to use it. They have three important criteria travel time, comfort and cost. The first and the third don’t need to be explained.

Regarding the second it consists of how pleasant is trip, the degree of privacy and the necessary transfers to reach towards the end destination. Due to the economic crisis local users regard cost to be the most important so they allocate ½ of the total weight. The rest is divided between travel time 1/3 and comfort 1/6. Tourists will use the ART line just one or a few times at best so for them the experience is the most important. So the weight for the category travel comfort is the highest (2/3), while the cost takes the rest of the weight (1/3). Travel time is not important to them at all.

Moving to the third group one can find all the private companies, agents and freelancers that will be affected by the project. What interests them is how the project will affect their income. In other words what will be the impact for tourism in the area, so a weight of ¾ is allocated. They are also concerned about the fare of the return ticket (1/8). Because, their also taxpayers though their interested in the project finance (1/8).

The last group will formed by environmental groups and concerned citizens. They are wavering between the positive effect of the project on sustainable mobility (1/3) and the sacrifices that have to be made which include the land that has to be offered the issue of flying over private land and the visual impact of the pillars at the mountain (2/3).

To sum up we have the following criteria: financing the project, promoting sustainable mobility, attracting new tourists in the area, user satisfaction, and various concerns on the project. The weight of every group will be equal. Regarding the member of each group players will be attributed a weight of 4, context setters 2, subjects 1 and crowd 1/3.

The stakeholders would then be asked to judge the effects of the alternatives on a Likert Scale ranging from −3 (important negative effect) to +3 (important positive effect) (Macharis, De Witte, & Turcksin, 2012).

This range was chosen in order allow stakeholders to access the criteria easily and accurately. This is based on the findings of Birkett who states that (Birkett, 1986):

> ‘On theoretical grounds, one would expect there to be a positive correlation between reliability and the number of response categories used in a Likert-type scale. Many psychometrists recommend that at least 20 response categories be used. However, when respondents are presented with either too

many or too few response categories, it is possible that respondent fatigue might occur with a corresponding drop-off in response rate and reliability.'

Based on the previous discussion matrices for each group will be formed. Finally the aggregate matrices for case B and C will be produced.

Table 5: Results for Case B

| Case B | impact on buissness (tourism) | project financing | users satisfaction | sustainable mobility | negative issues | |
|---|---|---|---|---|---|---|
| Administration | 0,46 | 0,26 | 0,20 | 0,31 | -0,22 | |
| Users | | | 0,57 | | | |
| Private companies | 1,25 | 0,09 | 0,09 | | | |
| Enviromental groups | | | | 0,33 | -1,34 | |
| Sum | 1,71 | 0,35 | 0,86 | 0,64 | -1,34 | 2,21 |

Table 6 : Results for Case C

| Case B | impact on buissness (tourism) | project financing | users satisfaction | sustainable mobility | negative issues | |
|---|---|---|---|---|---|---|
| Administration | 0,54 | -0,42 | 0,24 | 0,32 | -0,34 | |
| Users | | | 0,48 | | | |
| Private companies | 1,45 | -0,08 | 0,08 | | | |
| Enviromental groups | | | | 0,33 | -2,01 | |
| Sum | 1,99 | -0,50 | 0,80 | 0,65 | -2,01 | 0,919 |

The result confirms that Case B is preferable to case C and that project should be undertaken because the result is positive in both cases.

## 7. ANALYTICAL HIERARCHICAL PROCESS

Analytic Hierarchy Process (AHP) is a multiple criteria decision-making tool (Vaidya & Kumar, 2006). Three steps are required to implement the method. First the criteria for making the decision have to be chosen. Then a hierarchy if formed starting from the overall goal and proceeding to criteria sub-criteria and alternatives. Finally evaluation in the form of comparative-judgment is conducted. Selecting the right factors and organizing a hierarchy requires a lot of subjective judgment. Experience and deep understanding of the project play a significant role. However, it is common that two decision makers will come to different set of priorities. Groups therefore give the ability to eliminate bias and their synthesis can be much more objective. To enhance the contribution of groups Delphi method can be used.

AHP has been applied in various fields such as planning, selecting a best alternative, resource allocations, resolving conflict, optimization, etc. The method is robust, simple and flexible thus it has become popular among researchers and decision makers. The axioms of the theory are as follows (Vargas, 1990):

Axiom 1: (Reciprocal Comparison). The decision maker must be able to make comparisons and state the strength of his preferences. The intensity of these preferences must satisfy the reciprocal condition: If A is x times more preferred than B, then B is 1/x times more preferred than A.

Axiom 2: (Homogeneity). The preference is represented by means of a bounded scale.

Axiom 3: (Independence). When expressing preferences, criteria are assumed independent of the properties of the alternatives.

We will apply the method using relative measure based on fundamental scale that was proposed by Saaty (Saaty, 1990).

Table 7: Fundamental scale proposed by Saaty (Saaty, 1990).

The fundamental scale

| Intensity of importance on a absolute scale | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | Two activities contribute equally to the objective |
| 3 | Moderate importance of one over another | Experience and judgment strongly favor one activity over another |
| 5 | Essential or strong importance | Experience and judgment |

The fundamental scale

| Intensity of importance on a absolute scale | Definition | Explanation |
|---|---|---|
| 7 | Very strong importance | strongly favor one activity over another<br>An activity is strongly favored and its dominance demonstrated in practice |
| 9 | Extreme importance | The evidence favoring one activity over another is of the highest possible order of affirmation |
| 2, 4, 6, 8 | Intermediate values between the two adjustments | When compromise is needed |

The explanation for the scores 3 and 5 is exactly the same. We disagree and propose that the word strongly will be removed when described intensity 3. We keep though the original values as they appear in the reference

It is important to mention here the psychologist George Miller in the 1950's (Miller, 1956). He found that in general, people (such as chess experts) could deal with information involving simultaneously only a few facts, seven plus or minus two, he wrote. With more, they become confused and cannot handle the information properly.

## 7.1. CONCERNS ABOUT AHP

Although AHP is one of the most popular methods for MCA it is not uncriticized. The main doubts raised are:

> "(a) The 1–9 scale has the potential to be internally inconsistent. A may be scored 3 in relation to B and B similarly scored 5 relative to C. But the 1–9 scale means that a consistent ranking of A relative to C (requiring a score of 15) is impossible.
>
> (b) The link between the points on the 1–9 scale and the corresponding verbal descriptions does not have a theoretical foundation.
>
> (c) Weights are elicited for criteria before measurement scales for criteria have been set. Thus the decision maker is induced to make statements about the relative importance of items without knowing what, in fact, is being compared.
>
> (d) Introducing new options can change the relative ranking of some of the original options. This 'rank reversal' phenomenon is alarming and arises from a failure consistently to relate scales of (performance) measurement to their associated weights.

> (e) Although it is a matter of debate among decision analysts, there is a strong view that the underlying axioms on which AHP is based is not sufficiently clear as to be empirically testable." (Department for Communities and Local Government: London, 2009).

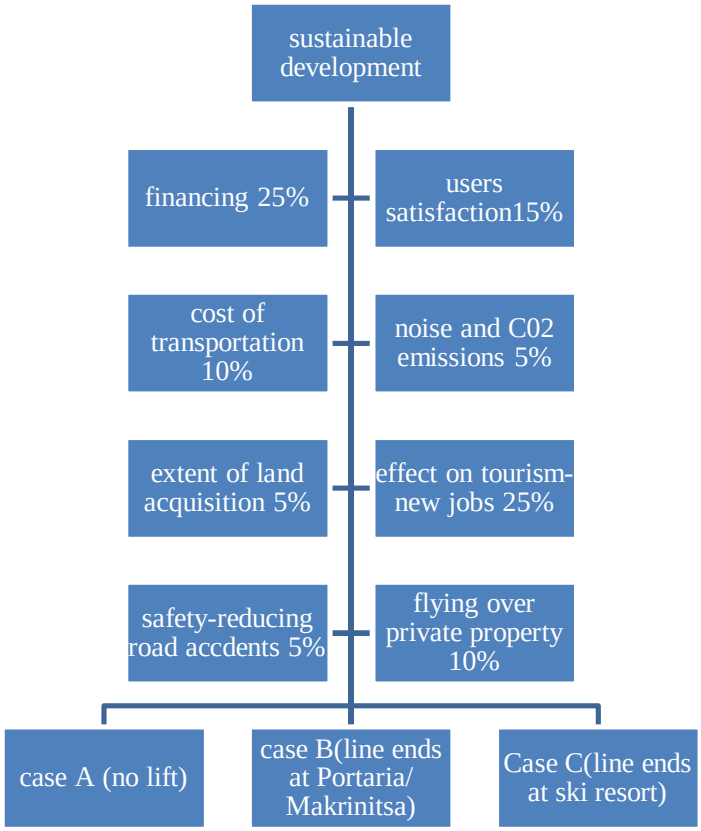
Regarding our case study the overall goal which is placed on the top level of hierarchy is planning a transport infrastructure that will promote sustainable development for mountain Pelion. In the second level are the eight criteria which contribute to the goal and the third (or bottom) level are the three alternatives which are to be evaluated in terms of the criteria in the second level. The definitions and analysis of the criteria follow. Also the hierarchy is shown in table8. In the same table the % weight of its criteria is also depicted.

Financing the project: This criterion consist of the following sub-criteria: total cost of the investment, internal rate of return, ability to secure finance. Case A is continuing business as usual, so no new infrastructure is required and thus no finance. However, in the midterm some improvements such as creating new parking spaces in sloped terrain and improve roads, would be mandatory. Case B is more desirable than case C as it requires only around 1/3 of the investment to serve over 2/3 of the total transport demand. Furthermore it is more probable to secure financing both from the European structural funds, the government and/or private investors due to the economic crisis that has decreased liquidity tremendously.

Utility for users: This is one of the most important aspects of the project to be considered successful. It can be derived from total travel time from starting point to end destination, number of transfers that are required, the travel experience (comfort, view, facilities in the station) and reliability. In case A travelers are using buses or private cars, while in the other two cases they use them to arrive to the lower level station ,then they enter the gondola and finally they use a shuttle bus, a bike or walk to their destination. Case B is better than case A in all of the above mentioned aspects except of the number of transfers. For example, total travel time for a company owning a private car wanting to visit Portaria for recreation. Starting from Volos it is a 26min (Google Maps) drive uphill the mountain. Then it will take them at least 5 minutes to find a decent parking spot. While the others would drive for only 13 minutes (Google Maps) to reach the station. After 2 more minutes

they would already have embarked in the lift. Their trip would last only 6 minutes. Finally they would have to wait for 3 minutes and ride the shuttle bus for 5 before arriving in Portaria. To sum up the two groups will make 34 and 29 minutes respectively. Case C and case B are similar in this matter but case C is considerably better for 1/3 of the passengers that want to reach to Chania or the ski resort. Last but not least case B and C will be beneficial for those who would still chose to use their private cars as traffic will decrease and it would be easier to find a parking spot.

Table 8: Hierarchical organization of goal, criteria and alternatives




Transportation cost: It is the total travel cost that the passengers have to pay. Regarding private cars this cost can be analyzed in direct cost or fuel cost and indirect cost consisting of depreciation, maintenance , license, taxes, financing, insurance (CATO, 2010). Because it is very difficult to calculate the fare of KTEL bus will be used. The Art fare for P/M for case C station will be around 4 € in 2015 prices according to University of Thessaly (Πανεπιστήμιο Θεσσαλίας, 2001): This price includes the ticket of the shuttle bus to collect the passengers from their origin as well as to drop them off to their final destination. The fare would be a bit more expensive compared to a return KTEL ticket to Partari, which is only 3.2€. However, if Case B is chosen the price of the return ticket to

P/M station can be reduced. The last part of the route constitutes 2/3 of the total project cost but will attract less 1/3 of the total passengers. So we can assume that in Case B Art will have a competitive price compared to KTEL.

Noise is a critical issue for the health of humans and wildlife. Its importance is profound in a calm village, where people wish to escape from the noisy atmosphere of cities. A considerable noise reduction is expected in Portaria due to the traffic decrease. This would be much more prominent in case C as it will significantly reduce the number of cars that pass through the historic center.

Air pollution due to car emissions will follow a same pattern as noise but the impact won't be so critical due to the topography of the area.

Extent of land acquisition is referred to the hectares of farm forest or urban land that will be sacrificed for the implementation of the project. It consists of the plots required for the stations and for a corridor of 12m width along the route. In our case 87% of an area of 11 hectares must be deforested. The good thing is at those bushes can be replanted afterwards. This amount corresponds to case C, as in case B this is only 1/3 of that. As far as case A is concerned we estimate that 500 more parking spaces are required. We have derived that number after making the following assumptions: 75% of 24000 average monthly passengers moves of the weekend, 75% of them was using a car, in the a typical car there was on average 2,5 passengers including the driver, each parking spot could be used twice a day,in the peak day demand is 50% higher. It is also known that the required parking space for one private car is $25m^2$. So, we would need 500*25=12500=1,25hectares. That is far less than in the other cases, but taking into account that this area has to be found inside or close to historic mountain villages in slopped terrain so it's much more precious. To wrap things up, most preferable is case B, then A and then C.

Tourism boost and new job creation: The only thing that can be estimated is the number of direct job positions for the operation of the system, which will be around 30. Regarding the effect on sustainable tourism development and thus indirect job creation only predictions can be made. The impact can be tremendous though. For example, Maokong Gondola is voted the second best attraction out of 314 in Taipei (TripAdvisor, 2015). We can expect that at least it would have a moderate to strong influence on tourism.

Safety: It is an old technology that has proved safe if properly maintained. The system has an alternative power source installed for a case of emergency. For gondola systems, the abseil technique (the controlled descent of the cabin down the rope) is used for monocable gondola evacuation on normal terrain with low ground clearance (Alshalalfah, Shalaby, Dale, & Othman, Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art, 2012). For example the Jounieh teleferique in Lebanon which was constructed in 1965 reports no injuries until now (Teleferique, 2009).

On the other hand road traffic is one of the most common causes of severe death and accidents in Greece. According to data from EU there were 92 deaths/ million inhabitants in 2012. It is also estimated that for every death there are 10 severe injuries and 42 light ones. These numbers have been decreased over the last years. But the goal is to avoid half the deaths by 2020 so among other measures investment in infrastructure is required (European Commission, 2013). Also we have to bear in mind that this is a route that is climbing up the mountain which means that weather conditions in the winter can be bad. For example there might be ice in the road or fog.

Flying over private property: Aerial lift doesn't follow the street topography but is connecting two points with a straight line. So sometimes it may be inevitable to cross over a private property or even a house. This is a drawback for the system and requires smooth handling and extra funds, as it may be necessary to compensate the owner.

We will set up 8 3x3 matrices (aij) one for each criterion. In the AHP literature, a wide variety of ways are found to derive the vector of local priorities from the pair wise comparisons matrix (aij). As originally proposed by Saaty, the most frequently used technique to obtain the priority vector is the eigenvector technique. An alternative way to get an approximation to the priorities is to normalize the geometric means of the rows. This result coincides with the eigenvector for n≤3 (Tsampoulas, Yiotis, & Panou, 1999).

Table 9: Pair wise comparison between alternatives for the financing criterion.

| financing 25% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 3 | 7 | 0,649 |
| | B | 1/3 | 1 | 5 | 0,279 |
| | C | 1/7 | 1/5 | 1 | 0,072 |

Table 10: Aggregate matrix basic scenario.

| | finance | users satisfaction | transpor-tation cost | noise and air pollution | land acquisition | effect on tourism and job positions | safety-reducing accidents | flying over private properties | priority vector |
|---|---|---|---|---|---|---|---|---|---|
| % weight | 0,25 | 0,15 | 0,1 | 0,05 | 0,05 | 0,25 | 0,05 | 0,1 | |
| **Case A** | 0,143 | 0,015 | 0,043 | 0,003 | 0,013 | 0,020 | 0,004 | 0,071 | 0,311 |
| **Case B** | 0,076 | 0,050 | 0,043 | 0,017 | 0,033 | 0,083 | 0,017 | 0,022 | 0,341 |
| **Case C** | 0,031 | 0,086 | 0,014 | 0,005 | 0,005 | 0,147 | 0,029 | 0,007 | 0,324 |

The ranking of the 3 alternatives is the following:

Case A: 0,311

Case B: 0,341

Case C: 0,324

So the optimum solution seems to be the alternative B. But the differences are quite small, which means that it is not totally clear. For this reason we would examine two future scenarios and we will re-evaluate the priority vector for the three alternatives.

According to 97% of environmental scientists earth is facing a climate change due to the increasing concentration of greenhouse gases in the atmosphere. The scientists predict that the average temperature will rise between 2-5 Celsius degrees in the next 30 years. For our case we assume that the average temperature will rise 3 degrees and the precipitation will decrease. This will dramatically decrease snowfall in the mountain Pelion. Subsequently the ski resort will lose most of its visitors. On the other hand, Portaria and Makrinitsa will attract more visitors who wish to take a short brake in a nearby and cooler destination. The importance of climate change will press national governments and the EU to take actions to tackle the problem. As a result, it would be easier for a sustainable transportation project to be funded. So the weight assigned to financing is reduced by 5% and the surplus is assigned to the environmental impact of the project.

Table 11: Aggregate matrix for global warming scenario

| | finance | user's satisfaction | transpor -tation cost | noise and air pollution | land acquisition | effect on tourism and job positions | safety-reducing accidents | flying over private properties | priority vector |
|---|---|---|---|---|---|---|---|---|---|
| % weight | 0,2 | 0,15 | 0,1 | 0,1 | 0,05 | 0,25 | 0,05 | 0,1 | |
| **Case A** | 0,086 | 0,039 | 0,011 | 0,007 | 0,013 | 0,018 | 0,004 | 0,074 | 0,252 |
| **Case B** | 0,086 | 0,096 | 0,070 | 0,035 | 0,033 | 0,070 | 0,017 | 0,019 | 0,424 |
| **Case C** | 0,029 | 0,016 | 0,019 | 0,011 | 0,005 | 0,162 | 0,029 | 0,007 | 0,277 |

Case B seems the best option again and the choice is more profound in this scenario.

On the other hand, if Greece leaves euro zone due to the financial crisis this would put a lot of pressure on infrastructure projects. In this case Greece would adopt a national currency which would be heavily depreciated.This scenario will be called economic collapse from now on. We can assume that financing the project will become the most important criterion, because the main priority for the country and its citizens would be to survive economically. The expected ridership would fall dramatically in the first years, but it would rise swiftly following the increased number of foreign tourists who would be attracted by lower prices. Of course interest rates will skyrocket, but construction cost and operational cost will fall. However the cost of the mechanical equipment and the cost of energy won't follow that trend because they are imported. Based on the previous assumptions we derive the following matrices. The figures in the matrices represent cost and revenue for the first section only (case B). In order to make the calculations data from the 2001 preliminary study were used. The values were multiplied by 1/3, transformed in Euros, and converted into 2015 prices.

Table 12: Cost for constructing an ART line under economic collapse scenario.

| | million € | comments |
|---|---|---|
| cost of mechanical equipment | 8,46 | |
| other costs | 3,09 | -30% |
| subtitution from EU structural funds | 5,76 | 50% of total cost |

Table 13: Monthly operation costs for ART line under economic collapse scenario.

| | Quantity | Price per unit | Operation cost per month € | Comments |
|---|---|---|---|---|
| energy cost | 1640/3kw*18h*30*50% days | 0,10039 | 4939 | |
| technical stuff | 10 | 1000 | 10000 | |
| managing stuff | 2 | 2000 | 4000 | |
| various expenditure | | | 1556 | 1/3 energy and stuff cost |

Table 14: Monthly revenues for ART line under economic collapse scenario.

| | number | return ticket price (before VAT) | revenue € | comments |
|---|---|---|---|---|
| passengers | 10080 | 4,7 | 47376 | -30% decrease |
| students | 2520 | 3,525 | 8883 | -30% decrease |
| other revenue | | | 2813 | 5% of fares |

Table 15: Various assumptions that were used to formulate the financial analysis.

| other assumptions | value |
|---|---|
| maximum interest rate for NPV>0 | 6% |
| duration | 20 years |
| ridership and cost increase in the first five years | 10%, 2% |
| ridership and cost increase from 6th to 10th year | 5%, 1% |

So, unless the investor is capable of securing the necessary funds with a relatively low (6%) interest rate, the project cannot be profitable even in the long term. However, the project can offer various social and environmental benefits and can still support sustainable development. So we will conduct AHP once more to discover if this assumption is valid.

Table 16: Aggregate matrix for economic collapse scenario

| | finance | User's satisfaction | transpor-tation cost | noise and air pollution | land acquisition | effect on tourism and job positions | safety-reducing accidents | flying over private properties | priority vector |
|---|---|---|---|---|---|---|---|---|---|
| % weight | 0,45 | 0,05 | 0,1 | 0,025 | 0,025 | 0,3 | 0,025 | 0,025 | |
| **Case A** | 0,295 | 0,005 | 0,064 | 0,002 | 0,006 | 0,018 | 0,002 | 0,019 | 0,410 |
| **Case B** | 0,130 | 0,017 | 0,026 | 0,009 | 0,016 | 0,141 | 0,009 | 0,005 | 0,352 |
| **Case C** | 0,025 | 0,029 | 0,010 | 0,003 | 0,003 | 0,141 | 0,014 | 0,002 | 0,226 |

The results don't seem in favor of the new transport system. Case C can be definitely excluded. Provided that the criteria will be differently weighted in favor and only case A and case B will be compared the outcome can change.

To sum up, it is recommended that the project shall be undertaken until Portaria/Makrinitsa, but a more sophisticated feasibility study is required to examine it under the effect of a strong financial shock.

# 8. VARIOUS IMPROVEMENTS AND IDEAS FOR EXPANSION

## 8.1. LAST MILE CONNECTIVITY

Aerial transportation systems face similar problems with traditional rapid transit systems. Only a few stations can be constructed which means that most of the build area will be out of walking distance from the station. That is known as the 'last mile problem', and is a barrier to better utilization of a rapid transit network (MacKechnie).

There are a lot of ways to overcome this barrier. Shuttle buses are already a part of the basic proposal. We are going to examine some more alternatives:

- Provide a secure route for cyclist and lockers near the station
- Install a system of public bicycles. Bike stations should be put in the station and in points of interest nearby
- Invest in a public rapid transit system that will act as a feeder line.

## 8.2. TRANSPORT OF GOODS

Combining freight and passenger traffic is difficult for a system. It is advisable to separate those two different things. A simple way to do so is by forcing goods to be transferred in the night when passengers don't usually move. However, the area of the station can prove to be inadequate for the handling of materials. A more sophisticated and costly solution is to create a different freight station nearby the passenger one and expand the network to connect them. The question is what goods can be transferred in our case. Possibilities could include:

- Agricultural products (mainly apples) from production to the transport hub of the city of Volos. It is not a desirable solution as it would require loading/reloading the products twice only to cover a small distance.
- Supplies for restaurants and café in the area from the city of Volos
- Sheets and towels to and from hotels to take advantage of scale economies
- The luggage of the passengers that are staying in hotels of the area
- Heavy products that residents of Portaria/Makrinitsa have bought in Volos

## 8.3. IDEAS FROM OTHER ART SYSTEMS THAT CAN BE IMPLEMENTED

A very interesting idea is glass gondolas. They are constructed with reinforced glass and allow passengers an uncontested view around him. They are more expensive can carry less passengers but they can really enhance the experience for tourists.

Another idea is to seek a sponsor that contribute to the project and in return the ART line will be named after his company or a specific product. It can be a local or a multinational company. This can help overcome liquidity and financing problems.

## 8.4. ART EXPANSION

There are two ideas for expanding the system if the first line proves successful. The first one which was stated by University of Thessaly (Πανεπιστήμιο Θεσσαλίας, 2001) is to convert ART to the backbone of a multimodal transport system. In other words build a single line that would be able to connect Volos with both sides of the mountain directly. This may seem a promising idea which will help ease the sense of isolation that residents of east Pellion are rightfully feeling, but it has lots of disadvantages, mainly its extended length. This will raise construction cost tremendously. Moreover the travel time from Volos to the east coast of Mountain Pellion is expecting to exceed 1hour making the journey unpleasant and stressful for a large number of passengers. Imagine to be left in a small box hanging over the earth for so much time.

The most lines in the world have a length around 2 to 5 km. Volos-Portaria/Makrinitsa line has similar characteristics. So another idea would be to follow this model and connect the coast with semi mountainous villages that are close to it. This can have a large impact on tourism. First of all it would create a unique proposal for summer vacation that combines mountain and the sea, historic settlements with natural beauty. It would help the area strengthen its comparative advantage and promote its image worldwide. There are lots of prospective routes that can be examined:

- Zagora-Choreuto
- Muresi-Ntamouxari
- Kissos-Agios Ioannis
- Agioi Taxiarches(Tsagarada)-Mylopotamos
- Afetes-Afyssos
- Argalasti-Chorto

The first route can also be used for transporting agricultural products, mainly apples, produced in Zagora to the coast, provided that a small port that exists in the area will be upgraded to serve small freight ships.

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# 9. CONCLUSIONS

MCA is suitable for the appraisal of transport projects. It can offer complementary insights with the CBA. We used two different methodologies to evaluate the project the Analytical Hierarchy Process and the Multi Actor Multi Criteria Analysis. Both proved to be simple transparent and robust and reach to the same conclusion. The ART line is desirable for connecting Volos with Portaria/Makrinitsa. The result proved sound even under different future scenarios with the exception of economic collapse where it is risky and a deeper analysis is required. Stakeholder and SWOT analysis laid the foundations for understanding all the different dimensions of the project as well as the range of people and organization that it affects. As a result in the last chapter we were able to rethink the project and propose new features to enhance it and discuss various alternatives for expanding the project in other areas of the region. To sum up MCDA model both models and creates a shared understanding of the way forward.

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APENDICIX

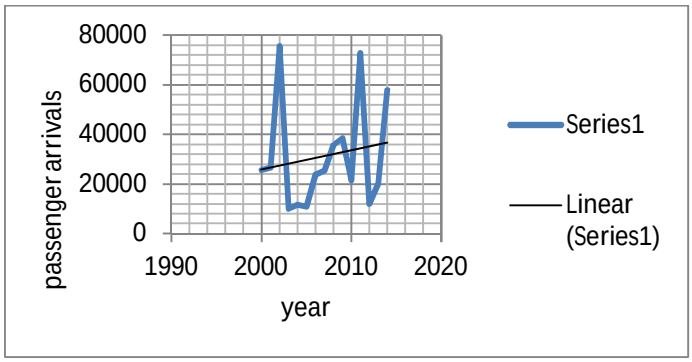


Figure 6: Passengers on cruise ships arriving at the Port of Volos (Οργανισμός Λιμένος Βόλου ΑΕ, 2014).

Table 17: Pairwise comparison matrix for transportation cost: Base scenario.

| Transportation cost 10% | | Case | | | Priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1 | 3 | 0,429 |
| | B | 1 | 1 | 3 | 0,429 |
| | C | 1/3 | 1/3 | 1 | 0,143 |

Table 18: Pairwise comparison matrix for user satisfaction: Base scenario.

| Users satisfaction 15% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/4 | 1/5 | 0,097 |
| | B | 4 | 1 | 1/2 | 0,333 |
| | C | 5 | 2 | 1 | 0,570 |

Table 19: Pairwise comparison matrix for noise and air pollution: Base scenario.

| noise and air pollution 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/6 | 1/7 | 0,069 |
| | B | 6 | 1 | 1/2 | 0,348 |
| | C | 7 | 2 | 1 | 0,582 |

Table 20: Pairwise comparison matrix for land acquisition: Base scenario.

| extent of land acquisition 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/3 | 3 | 0,258 |
| | B | 3 | 1 | 5 | 0,637 |
| | C | 1/3 | 1/5 | 1 | 0,105 |

Table 21: Pairwise comparison matrix for tourism boost: Base scenario.

| tourism boost and new job creation 25% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/5 | 1/6 | 0,079 |
| | B | 5 | 1 | 1/2 | 0,332 |
| | C | 7 | 2 | 1 | 0,589 |

Table 22: Pairwise comparison matrix for safety: Base scenario.

| safety 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/5 | 1/6 | 0,081 |
| | B | 5 | 1 | 1/2 | 0,342 |
| | C | 6 | 2 | 1 | 0,577 |

Table 23: Pairwise comparison matrix for flying over private property: Base scenario.

| flying over private property 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 4 | 8 | 0,707 |
| | B | 1/4 | 1 | 4 | 0,223 |
| | C | 1/8 | 1/4 | 1 | 0,070 |

Table 24: Pairwise comparison matrix for financing: Global warming.

| finanncing 20% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1 | 3 | 0,429 |
| | B | 1 | 1 | 3 | 0,429 |
| | C | 1/3 | 1/3 | 1 | 0,143 |

Table 25: Pairwise comparison matrix for transportation cost: Global warming.

| transportation cost 10% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 1/2 | 2 | 0,286 |
| | B | 2 | 1 | 4 | 0,571 |
| | C | 1/2 | 1/4 | 1 | 0,143 |

Table 26: Pairwise comparison matrix for user satisfaction: Global warming.

| users satisfaction 15% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/4 | 1/5 | 0,097 |
| | B | 4 | 1 | 1/2 | 0,333 |
| | C | 5 | 2 | 1 | 0,570 |

Table 27: Pairwise comparison matrix for noise and air pollution: Global warming.

| noise and air pollution 10% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/6 | 1/7 | 0,069 |
| | B | 6 | 1 | 1/2 | 0,348 |
| | C | 7 | 2 | 1 | 0,582 |

Table 28: Pairwise comparison matrix for extend of land acquisition: Global warming.

| extent of land acquisition 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/3 | 3 | 0,258 |
| | B | 3 | 1 | 5 | 0,637 |
| | C | 1/3 | 1/5 | 1 | 0,105 |

Table 29: Pairwise comparison matrix for tourism boost and new job creation: Global warming.

| tourism boost and new job creation 25% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/5 | 1/6 | 0,081 |
| | B | 5 | 1 | 1/2 | 0,342 |
| | C | 6 | 2 | 1 | 0,577 |

Table 30: Pairwise comparison matrix for safety: Global warming.

| safety 5% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 1/5 | 1/6 | 0,081 |
| | B | 5 | 1 | 1/2 | 0,342 |
| | C | 6 | 2 | 1 | 0,577 |

Table 31: Pairwise comparison matrix for flying over private property: Global warming.

| flying over private property 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| Case | A | 1 | 6 | 7 | 0,743 |
| | B | 1/6 | 1 | 4 | 0,187 |

| flying over private property 5% | | Case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| | C | 1/7 | 1/4 | 1 | 0,070 |

Table 32: Pairwise comparison matrix for financing: Economic Collapse.

| financing 45% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 3 | 9 | 0,655 |
| | B | 1/3 | 1 | 7 | 0,290 |
| | C | 1/9 | 1/7 | 1 | 0,055 |

Table 33: Pairwise comparison matrix for transportation cost: Economic Collapse.

| transportation cost 10% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 3 | 5 | 0,637 |
| | B | 1/3 | 1 | 3 | 0,258 |
| | C | 1/5 | 1/3 | 1 | 0,105 |

Table 34: Pairwise comparison matrix for users satisfaction: Economic Collapse.

| users satisfaction % | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 1/4 | 1/5 | 0,097 |
| | B | 4 | 1 | 1/2 | 0,333 |
| | C | 5 | 2 | 1 | 0,570 |

Table 35: Pairwise comparison matrix for noise and air pollution: Economic Collapse.

| noise and air pollution 2,5% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 1/6 | 1/7 | 0,069 |
| | B | 6 | 1 | 1/2 | 0,348 |
| | C | 7 | 2 | 1 | 0,582 |

Table 36: Pairwise comparison matrix for extend of land acquisition: Economic Collapse.

| extent of land acquisition 2,5% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 1/3 | 3 | 0,258 |
| | B | 3 | 1 | 5 | 0,637 |
| | C | 1/3 | 1/5 | 1 | 0,105 |

Table 37: Pairwise comparison matrix for tourism boost and new job creation: Economic Collapse.

| tourism boost and new job creation 30% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 1/8 | 1/8 | 0,059 |
| | B | 8 | 1 | 1 | 0,471 |
| | C | 8 | 1 | 1 | 0,471 |

Table 38: Pairwise comparison matrix for safety: Economic Collapse.

| safety 2,5% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 1/5 | 1/6 | 0,081 |
| | B | 5 | 1 | 1/2 | 0,342 |
| | C | 6 | 2 | 1 | 0,577 |

Table 39: Pairwise comparison matrix for flying over private property: Economic Collapse.

| flying over private property 2,5% | | case | | | priority vector |
|---|---|---|---|---|---|
| | | A | B | C | |
| case | A | 1 | 6 | 7 | 0,743 |
| | B | 1/6 | 1 | 4 | 0,187 |
| | C | 1/7 | 1/4 | 1 | 0,070 |

Table 40:MAMCA evaluation matrix for private sector: Case B.

| Private sector case B | Weight | Impact on buissness (3/4) | Project financing (1/8) | Travel cost |
|---|---|---|---|---|
| KTEL | 1/3 | -1 | -2 | 0 |
| Taxi owners | 1/3 | 1 | 1 | 2 |
| AKV | 1 | 2 | 1 | -2 |
| Tour Buses | 1/3 | 2 | 1 | -1 |
| Hotels of P/M | 1/3 | 1 | 1 | 3 |
| shops, restaurants and café of P/M | 1 | 3 | 1 | 1 |
| Cruise industry | 1 | 2 | 1 | 3 |
| Ski resort | 1/3 | 1 | 1 | 1 |
| Constuction companies | 1/3 | 1 | 1 | 0 |
| Temporary result | 5 | 6,25 | 0,46 | 0,46 |
| Result | | **1,25** | **0,09** | **0,09** |

Table 41: MAMCA evaluation matrix for private sector: Case C.

| Private sector: Case C | Weight | Impact on buissness (3/4) | Project financing (1/8) | Travel cost |
|---|---|---|---|---|
| KTEL | 1/3 | -1 | -3 | -1 |
| Taxi owners | 1/3 | 1 | -1 | 1 |
| AKV | 1/3 | 2 | -1 | -2 |
| Tour Buses | 1/3 | 2 | -1 | -2 |
| Hotels of P/M | 1/3 | 1 | -1 | 2 |
| Shops, restaurants and café of P/M | 1 | 3 | -1 | 0 |
| Cruise industry | 1 | 2 | -1 | 3 |
| Ski resort | 1 | 3 | 1 | 1 |
| Constuction companies | 1/3 | 3 | 1 | 0 |
| Temporary result | 5 | 7,25 | -0,42 | 0,42 |
| Result | | **1,45** | **-0,08** | **0,08** |

Table 42: MAMCA evaluation matrix for environmental groups: Case B.

| Enviromental groups Case B | weight | promoting sustainable mobility (1/3) | negative issues (2/3) |
|---|---|---|---|
| | 1 | 1 | -2 |
| | | 0,33 | -1,34 |

Table 43: MAMCA evaluation matrix for environmental groups: Case C.

| Enviromental groups Case C | weight | promoting sustainable mobility (1/3) | negative issues (2/3) |
|---|---|---|---|
| | 1 | 1 | -3 |
| | | 0,33 | -2,01 |

Table 44: MAMCA evaluation matrix for users: Case B.

| Users: Case B | weight | cost | time | comfort | Average satifaction |
|---|---|---|---|---|---|
| local users | 1 | 0 | 2 | 1 | |
| car drivers | 1/3 | 0 | 1 | 1 | |
| weights | | 1/2 | 1/3 | 1/6 | |
| tourist | 1 | 3 | 0 | 3 | |
| weights | | 1/3 | 0 | 2/3 | |
| | 2,33 | 1,00 | 0,78 | 2,22 | |
| result | | **0,43** | **0,33** | **0,95** | **0,57** |

Table 45: MAMCA evaluation matrix for users: Case C.

| Users: Case C | weight | cost | time | comfort | Average satifaction |
|---|---|---|---|---|---|
| local users | 1 | -1 | 2 | 2 | |
| car drivers | 1/3 | 0 | 1 | 2 | |
| weights | | 1/2 | 1/3 | 1/6 | |
| tourist | 1 | 2 | 0 | 3 | |
| weights | | 1/3 | 0 | 2/3 | |
| | 2,33 | 0,17 | 0,78 | 2,44 | |
| result | | **0,07** | **0,33** | **1,05** | **0,48** |

Table 46: MAMCA evaluation matrix for administration and consultants: Case B

| Administration and consultants: Case B | weight | impact on buissness (tourism) (1/4) | project financing (1/3) | users satisfaction (1/8) | sustainable mobility (1/8) | negative issues (1/6) |
|---|---|---|---|---|---|---|
| Municipality of Volos | 4 | 2 | 2 | 2 | 2 | -2 |
| Regional Government of Thesaly | 4 | 2 | -1 | 1 | 3 | -1 |
| Ministy of infrastructure traffic and networks | 1 | 1 | -2 | 1 | 2 | -1 |
| European Union | 1 | 1 | 1 | 2 | 3 | -1 |
| University of Thessally | 1 | 2 | 2 | 2 | 3 | -1 |
| Municipality of Zagora_mouresi | 1/3 | 1 | 1 | 1 | 1 | -2 |
| Local council of P/M | 1 | 3 | 3 | 2 | 3 | -2 |
| Technical Chamber of Greece | 1 | 1 | 2 | 2 | 2 | 0 |
| | 13,33 | 6,08 | 3,41 | 2,67 | 4,17 | -2,94 |
| Result | | **0,46** | **0,26** | **0,20** | **0,31** | **-0,22** |

Table 47: MAMCA evaluation matrix for administration and consultants: Case C

| Administration and consultants: Case C | weight | impact on buissness (tourism) (1/4) | project financing (1/3) | users satisfaction (1/8) | sustainable mobility (1/8) | negative issues (1/6) |
|---|---|---|---|---|---|---|
| Municipality of Volos | 4 | 3 | 0 | 3 | 3 | -3 |
| Ministy of infrastructure traffic and | 3 | 3 | -3 | 2 | 3 | -2 |

| Administration and consultants: Case C networks | weight | impact on buissness (tourism) (1/4) | project financing (1/3) | users satisfaction (1/8) | sustainable mobility (1/8) | negative issues (1/6) |
|---|---|---|---|---|---|---|
| Ministy | 3 | 1 | -3 | 1 | 2 | -2 |
| EIB | 3 | 1 | -1 | 2 | 3 | -2 |
| University of Thessally | 1 | 3 | 1 | 2 | 3 | -2 |
| Municipality of Zagora_mouresi | 1/3 | 1/3 | 1 | 1 | 1 | 1 |
| Local council of P/M | 1 | 1 | 3 | 3 | 2 | 3 |
| Technical Chamber of Greece | 1/3 | 2 | 0 | 2 | 2 | -1 |
| | 15,67 | 7,67 | -6,60 | 3,71 | 4,96 | -5,39 |
| Result | | **0,49** | **-0,42** | **0,24** | **0,32** | **-0,34** |